Program Structure

Program: B.Sc. (Hons) Biotechnology

Program Code: SBR0404

Batch: 2019-2022

Department of Life Sciences

School of Basic Science & Research

BACHELOR OF SCIENCE
(B.Sc.)
IN

BIOTECHNOLOGY

COURSE STRUCTURE AND SYLLABI

(As per Guidelines of CBCS of UGC)

(W.E.F. 2019-20)

DEPARTMENT OF LIFE SCIENCES
SCHOOL OF BASIC SCIENCES AND RESEARCH
SHARDA UNIVERSITY

Vision, Mission and Core Values of the University

Vision of the University

To serve the society by being a global University of higher learning in pursuit of academic excellence, innovation and nurturing entrepreneurship.

Mission of the University

1. **Transformative educational experience**
2. **Enrichment by educational initiatives that encourage global outlook**
3. **Develop research, support disruptive innovations and accelerate entrepreneurship**

Core Values

- **Integrity**
- **Leadership**
- **Diversity**
- **Community**

Vision and Mission of the School

Vision of the School

Achieving excellence in the realm of basic and applied sciences to address the global challenges of evolving society

Mission of the School

1. **To equip the students with knowledge and skills in basic and applied sciences**
2. **Capacity building through advanced training and academic flexibility.**
3. **To establish centre of excellence for ecologically and socially innovative research.**
4. **To strengthen interinstitutional and industrial collaboration for skill development and global employability.**

Vision and Mission of Department of Life Sciences

Vision of Life Sciences Department

Strive to achieve excellence in teaching and research in the field of Microbiology and Biotechnology and to build human resource for solving contemporary problems.

Mission of Life Sciences Department

- **Providing distinctive and relevant education in Life Sciences to students.**
- **Motivating young minds through innovative teaching methods, to acquire theoretical knowledge and practical skills in different disciplines of chemistry and empowering them with problem solving skills.**
- **Nurturing innovation by carrying out world class research and scholarly work**
- **Promoting interdisciplinary research in collaboration with national/international laboratories/Institutions.**

Program Educational Objectives (PEO)

PEO1: To create a foundation of various biological concepts and phenomena in the minds of students through theoretical and practical knowledge.

PEO2: To keep students upgraded with new discoveries in biological world and inculcate continuous learning and self-improvement so that students are motivated for higher studies and research.

PEO3: To teach the students various bio-techniques and application of these techniques for betterment of society and environment.

PEO4: To make students industry- or academia-ready by developing independent thinking, good communication and scientific skills and to acquaint them with professional ethics so that they can work well in an industrial or academic environment.

PEO5: To make students understand interdisciplinary nature of research in biotechnology by assigning them different research projects/ case studies/ presentations.

Map PEOs with Mission Statements:

PEO Statements	School Mission 1	School Mission 2	School Mission 3	School Mission 4
PEO1	3	2	-	-
PEO2	3	2	2	-
PEO3	3	3	2	1
PEO4	2	3	2	2
PEO5	3	2	2	2

1. **Slight (Low) 2. Moderate (Medium) 3. Substantial (High)**

Map PEOs with Department Mission Statements:

PEO Statements	Departmental Mission 1	Departmental Mission 2	Departmental Mission 3	Departmental Mission 4
PEO1	3	1	1	1
PEO2	3	3	2	2
PEO3	2	2	2	2
PEO4	3	-	2	3
PEO5	3	2	3	2

Program Outcomes (PO's)

PO1: Knowledge: Students will develop a sound understanding the biological systems and processes.

PO2: Skill Set Development: The student will be skilled in various biological techniques that will enhance the employability of the students.

PO3: Oral Communication and Scientific Writing: The students will be able to demonstrate good oral communication. Students will also be knowledgeable about writing technical (project report and reviews) content.

PO4: Environment and Sustainable Development: Student will be able to realize the effect of human malpractices on environment and the need and importance of sustainable development.

PO5: Ethics, Independent Thinking and Team Work: The students will develop professional ethics and also gain knowledge about various ethical issues associated with biotechnology.

Students will learn to think and analyze a problem independently while at the same time realizing the importance of team work in carrying out successful research/ projects/ presentations.

Mapping of Program Outcome Vs Program Educational Objectives

	PEO1	PEO2	PEO3	PEO4	PEO5
PO1	3	2	2	2	2
PO2	3	2	2	3	2
PO3	1	1	-	3	2
PO4	1	2	3	-	2
PO5	1	2	-	3	2

1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)

1. TITLE: Bachelor of Science in Biotechnology
2. DURATION OF THECOURSE: 3 YEARS

3. YEAR OF IMPLIMENTATION

This syllabus will be implemented from May 2019 onwards.

4. PREAMBLE

Total Credits- 145 (19+20+24+26+29+27)

Total Number of Semesters – 6 (Two semesters per year)

Total Number of Papers (including practical) – 30

Total Number of Practical courses – 10

Dissertation-I & II

Department of Life Science, S.B.S.R., Sharda University

Scheme for CBCS in B.Sc. (H) Biotechnology, effective from 2019

Semester	CORE COURSE (17)	Ability Enhancement Compulsory Course (AECC) (2)	Ability Enhancement Elective Course (AEEC) (Skill Based) (2)	Elective: Discipline Specific DSE (5)	Elective: Generic (GE) (6)
I	Cell Biology	AECC-1	AEEC-1		GE-1
					GE-2
II	Microbiology	AECC-2			GE-3
	Genetics				GE-4
III	Molecular Biology			DSE-1	GE-5
	Biomolecules				GE-6
IV	Genetic Engineering		AEEC-2	DSE-2	
	Enzyme Technology				
	Immunology				
	Metabolic Pathways				
V	Animal Biotechnology			DSE-3	
	Plant Biotechnology				
	Bioinformatics				
	Intellectual Property Rights				
VI	Bioreactors and Downstream Processing			DSE-4	
	Genomics			DSE-5	
	Proteomics				
	Industrial Biotechnology				

Core Papers (C):

1. Cell Biology
2. Microbiology
3. Genetics
4. Molecular Biology
5. Biomolecules
6. Genetic Engineering
7. Enzyme Technology
8. Immunology
9. Metabolic Pathways
10. Animal Biotechnology
11. Plant Biotechnology
12. Bioinformatics
13. Intellectual Property Rights
14. Bioreactors and Downstream Processing
15. Genomics
16. Proteomics
17. Industrial Biotechnology

Discipline Specific Elective Papers (DSE):

TERM-III

1. Instrumentation/ Mycology and Phycology

TERM-IV

- Medical Biotechnology/ Applied Microbiology

TERM-V

1. Medical Microbiology/ Economic Botany
2. Dissertation I

TERM-VI

3. Bioethics and Biosafety/ Environmental Biotechnology
4. Dissertation II

Other Discipline – GE-I to GE-VI

1. Chemistry
2. Principles of Nutrition Science/ Diversity of Plants
3. Physics V9
4. Introduction to Food Biotechnology/ Diversity of Animals
5. Developmental Biology of Plants/ Developmental Biology of Animals
6. Anatomy of Angiosperms/ Animal Physiology and Histology-I

Semester 1

S. No.	Subject Code	Subjects	Teaching Load			Credits
			L	T	P	
THEORY SUBJECTS						
1	BSL101	Essentials of Chemistry for Biosciences	4	0	0	4
2	BSB 102	Cell Biology (C)	4	0	0	4
3	EVS106	Environmental Studies	3	0	0	3
4		University elective	2	0	0	2
5	BFS101/BSZ120	Principle of Nutrition Science/ Diversity of Animals (GE)	4	0	0	4
PRACTICALS						
1	BSL151	Chemistry Lab for Biosciences	0	0	2	1
2	BSP 102	Cell Biology Lab (C)	0	0	2	1
TOTAL						**19**

Semester 2

S. No.	Subject Code	Subjects	Teaching Load			Credits
			L	T	P	
THEORY SUBJECTS						
1	PHY115	Physics V (GE)	4	0	0	4
2	ARP101	Communicative English (AECC)	2	0	0	2
3	BSB 105	Microbiology (C)	4	0	0	4
4	BSB 108	Genetics (C)	4	0	0	4
5	BSB107/ BBT101	Environmental Biotechnology/ Diversity of Plants (GE)	4	0	0	4
PRACTICALS						
1	BSP 105	Microbiology Lab	0	0	2	1
2	PHY151	Physics Lab (GE)	0	0	2	1
TOTAL						**20**

Semester 3

S. No.	Subject Code	Subjects	Teaching Load			Credits
			L	T	P	
THEORY SUBJECTS						
1	BSB201	Molecular Biology (C)	4	0	0	4
2	BSB209	Biomolecules (C)	4	0	0	4
3	BSB210 /BSB211	Developmental Biology of Plants/ Developmental Biology of Animals (GE)	4	0	0	4
4	BBT205 /BSZ202	Anatomy of Angiosperms/ Animal & Physiology and Histology I	4	0	0	4
5	BSB203 /BBT201	Instrumentation / Mycology and Phycology (DSE)	4	0	0	4
PRACTICALS						
1	BSP201	Molecular Biology Lab (CP)	0	0	3	2
2	BSP202	Biomolecules Lab (CP)	0	0	3	2
TOTAL						**24**

Semester 4

S. No.	Subject Code	Subjects	Teaching Load			Credits
			L	T	P	
THEORY SUBJECTS						
1	BSB205	Genetic Engineering (C)	4	0	0	4
2	BSB206	Enzyme Technology	4	0	0	4
3	BSB207	Immunology (C)	4	0	0	4
4	BSB202	Metabolic Pathways (C)	4	0	0	4
5	BSB212	Medical Biotechnology (DSE)	4	0	0	4
6		University Elective	2	0	0	2
PRACTICALS						
1	BSP205	Genetic engineering Lab (CP)	0	0	3	2
2	BSP210	Enzyme Technology and Immunology Lab (CP)	0	0	3	2
TOTAL						**26**

Semester 5

S. No.	Subject Code	Subjects	Teaching Load			Credits
			L	T	P	
THEORY SUBJECTS						
1	BSB 301	Animal Biotechnology (C)	4	0	0	4
2	BSB 302	Plant Biotechnology (C)	4	0	0	4
3	BSB 303	Bioinformatics (C)	4	0	0	4
4	BSB 304	Intellectual Property Rights (C)	4	0	0	4
5	BSB313/ BBT302	Medical Microbiology/ Economic Botany(DSE)	4	0	0	4
PRACTICALS						
1	CCU401	Community Connect	0	0	3	2
2	BSP 302	Bioinformatics Lab (C)	0	0	3	2
3	BSP 301	Plant Biotechnology lab (C)	0	0	3	2
4	PHB361	Project 1/Dissertation 1 (DSE)	0	0	4	3
TOTAL						**29**

Semester 6

S. No.	Subject Code	Subjects	Teaching Load			Credits
			L	T	P	
THEORY SUBJECTS						
1	BSB305	Bioreactors and Downstream Processing(C)	4	0	0	4
2	BSB306	Genomics(C)	4	0	0	4
3	BSB307	Proteomics(C)	4	0	0	4
4	BSB310	Industrial Biotechnology (C)	4	0	0	4
5	BSB308	Bioethics and Biosafety(DSE)	4	0	0	4
PRACTICALS						
1	BSP303	Downstream Processing Lab(C)	0	0	3	2
2	BSP307	Genomics and Proteomics Lab(C)	0	0	3	2
3	PHB362	Project 2/Dissertation 2(DSE)	0	0	4	3
TOTAL						**27**

School: SBSR		**Batch: 2019-22**	
Program: BSc		**Current Academic Year: 2019-20**	
Branch:		**Semester:1**	
1	Course Code	BSL101	
2	Course Title	Essentials of Chemistry for Biosciences	
3	Credits	4	
4	Contact Hours (L-T-P)	3-1-1	
	Course Status	Compulsory	
5	Course Objective	• To provide the basics of ionic equilibrium, thermochemistry and chemical kinetics so as to apply on various biological systems. • To provide thorough knowledge in organic basics and stereochemistry of the organic molecules and to make its use in biomolecules	
6	Course Outcomes	CO1: Use the ion product of water to calculate hydrogen ion and hydroxide ion concentrations in aqueous solution. Identify the components of a buffer and their function; Realize the different types of salts solution and their pH CO2: To recognize the order of reactions, How catalysis increase the rate of reaction and its types. CO3: Important effects, electrophiles and nucleophiles as applied to organic chemistry and reaction intermediates, Different types of organic reactions Important effects, electrophiles and nucleophiles as applied to organic chemistry and reaction intermediates and different types of organic reactions Knowledge of the basic mechanisms of substitution and elimination (Sn^1, Sn^2, E^1, E^2) CO4: To draw the three dimensional structures of typical organic molecules, differentiating between isomers and identical molecules, Naming Structures including stereoisomers and geometric isomers CO5: To understand the synthesis and reactions of carbohydrate molecules CO6: To ensure the basic knowledge of physical and organic chemistry related to life science.	
7	Course Description	This course enrich the students with concepts of physical chemistry and organic chemistry. Acid-base, buffers, salt hydrolysis, solubility product, reactive intermediates in organic chemistry, stereochemistry and simple carbohydrates are the topics covered in this paper.	
8	Outline syllabus		CO Mapping
	Unit 1	Ionic Equillibrium	
	A	Strong and weak acids and bases, Ionization constants of weak acids and base, pH and pOH, Ionic product of water, Factors affecting degree of ionization: Common ion effect	CO1, CO6

	B	Buffers and their types, applications of buffers in analytical chemistry and biochemical processes in the human body, pH of buffers – Henderson equation for acidic and basic buffers	CO1, CO6
	C	Solubility products, applications of solubility product principle, Salt hydrolysis and pH of salt solutions, Related numerical problems	CO1, CO6
	Unit 2	Chemical Kinetics and Catalysis	
		Order and molecularity of a reaction, Rates of reactions and its expressions, Reactions of zero, first and second order, pseudo first order, Half-lives, Determination of order of reactions by half-life method, Experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only)	**CO2, CO6**
		Activation energy, Reaction rate and temperature (Arrhenius equation), Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates	**CO2, CO6**
		Catalysis: Definition, Types of catalysis with example, Characteristics of catalysis, Elementary enzyme catalyzed reactions – Meaning and examples	**CO2, CO6**
	Unit 3	**Principle of Organic Chemistry**	
		Electronic displacements: inductive effect, mesomeric effect, resonance effect (resonance energy and its significance), Hyperconjugation (concepts and consequences), resonance effect (resonance energy and its significance)	**CO3, CO6**
		Reactive intermediates: Generation, Structure, General reactions of carbocations, Reactive intermediates: Generation, Structure, General reactions of free radicals	**CO3, CO6**
		Reactive intermediates: Generation, Structure, General reactions of carbenes (singlet and triplet), Electrophiles and nucleophiles, organic reactions - E_1 and E_2, mechanism of electrophilic reactions	**CO3, CO6**
	Unit 4	Stereochemistry	
		Classification of stereoisomers, Optical isomers: enantiomers and distereomers, D and L configuration	CO4, CO6
		Absolute configuration (R and S), Projection formulae, Stereochemistry of compounds containing one and two asymmetric C-atoms, Stereochemistry of biphenyls and spiro compounds	CO4, CO6
		Conformations: Conformations around a C – C bond in acyclic compounds, Structures of cyclohexanes, Cyclohexane (non-substituted) and its conformations	CO4, CO6
	Unit 5	**Carbohydrates**	
		Classification, and General Properties**,** General Properties - Glucose (open chain and cyclic structure)**,Fructose,** Determination of configuration of monosaccharides	CO5, CO6
		absolute configuration of Glucose and Fructose**,** Mutarotation, ascending and descending in monosaccharides	CO5, CO6
		Structure of disacharrides (sucrose, cellobiose, maltose, lactose) excluding their structure elucidation, Structure of	CO5, CO6

		polysacharrides (starch and cellulose) excluding their structure elucidation			
	Mode of examination	CA/MTE/ETE			
	Weightage Distribution	20	30	50	
		20%	30%	50%	
	Text book/s*	1. Principles of Physical Chemistry by Puri, Sharma and Pathania,42nd Edition. 2. Essentials of Physical Chemistry by B.S. Bahl and G. D. Tuli. 3. A Textbook of Organic Chemistry, Arun Bahl B. S. Ba S.Chand & Co. 4. Concise inorganic chemistry by J. D. Lee. 5. Stereochemistry Conformation and Mechanism by P S Kalsi, 8th Edition. 6. Organic Chemistry by Morrison & Boyd.			
	Other References	1. College chemistry by Linus Pauling. 2. Organic Chemistry by I.L. Finar Volume II.			

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**1**	**1**	**1**	**1**
CO2	**1**	**3**	**1**	**1**	**1**
CO3	**1**	**1**	**3**	**1**	**1**
CO4	**1**	**1**	**1**	**3**	**1**
CO5	**1**	**1**	**1**	**1**	**3**
CO6	**3**	**3**	**3**	**3**	**3**

BSB102: Cell Biology

L T P: 4-0-0 **Credit: 4**

School: SBSR		**Batch: 2019-2022**
Program: B.Sc. (H)		**Current Academic Year: 2019-20**
Branch: Biotechnology		**Semester: 01**
1	Course Code	**BSB102**
2	Course Title	**Cell Biology**
3	Credits	4
4	Contact Hrs. (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. Understanding the concept of structure and function of biological cells and its living and non-living components 2. Learn and discuss the techniques of protein synthesis, protein sorting and transportation from organ to organ 3. Discuss the metabolic activities of a cell and the production of metabolic energies in form of ATP 4. Recognize the cell nucleus and its function 5. Analyze and discuss the cell movement and structural framework of the cell
6	Course Outcomes	CO1: Identify different types of cell organs and review the complexity of cell organelles CO2: Analyze the importance of protein synthesis in biological cell and its transportation from cell to cell CO3: Demonstrate the metabolic activities of a cell and the production of metabolic energies in form of ATP CO4: Identify and analyze the cell nucleus, cell ribosome and cell movement and its function CO5: Analyze and discuss the cell movement and structural framework of the cell CO6: Complete understanding to function of cell.
7	Course Description	This course will to help us to understand how biological cells do have different minute organelles which coordinate with each other and perform all the functions and metabolic activities of the cell. Study this course will help them to explore the structure and function of cells. Student will learn about cell diversity that arises during its growth and how cells co-operate and communicate with each other in normal tissues. This course will help them to prepare for a wide range of careers both inside and outside the lab
8	Outline syllabus	CO Mapping

	Unit 1	**Cell and Cell Theory**			
	A	Cell as a basic unit of life, Cell theory, Cell size and shape			CO1
	B	Prokaryotic and Eukaryotic cells			CO1
	C	Different types of cells			CO1
	Unit 2	**Ultra-structure of Cell**			
	A	Plasma membrane, Ribosomes			CO1
	B	Protein sorting and transportation; Endoplasmic Reticulum, Golgi Apparatus, Lysosomes;			CO2
	C	Bioenergetics and metabolism, Mitochondria, Chloroplast, peroxisomes			CO3
	Unit 3	**Nucleus and Chromosomes**			
	A	Ultra-structure of nucleus, nuclear membrane			CO1, CO4
	B	Chromosome structure, Centromeres, Telomeres			CO4
	C	Euchromatin and heterochromatin, Polytene and lampbrush chromosomes			CO4
	Unit 4	**Cell Cycle**			
	A	Growth cycle and cell division			CO1
	B	Mitosis, Meiosis			CO4
	C	Significance of cell division			CO3
	Unit 5	**Cytoskeleton and Cell-to-cell interaction**			
	A	Concept about cytoskeleton, microtubules, microfilaments, intermediary filaments			CO1
	B	Structure of cilia and flagella and their movement;			CO3
	C	Cell to cell interaction			CO4
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	Cooper G.M., and Hausman R.E., *The Cell: A Molecular Approach, 5th Edition.* Sinauer Associates (2009)			
	Other References	Karp G., *Cell and Molecular Biology: Concepts and Experiments, 6th Edition*. Wiley (2009).			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	1
CO2	1	3	1	1	1
CO3	1	1	3	1	1
CO4	1	1	1	3	1
CO5	1	1	1	1	3
CO6	3	3	3	3	3

EVS106: Environmental Studies

L T P: 3-0-0 Credit: 3

School: SBSR		**Batch : 2019-22**
Program: B.Sc.		**Current Academic Year: 2019-2020**
Branch: Biotechnology		**Semester: I**
1	Course Code	**EVS106**
2	Course Title	Environmental Studies
3	Credits	03
4	Contact Hours (L-T-P)	3-0-0
	Course Status	Compulsory
5	Course Objective	1. Enable students to learn the concepts, principles and importance of environmental science 2. Provide students an insight of various causes of natural resource depletion and its conservation 3. Provide detailed knowledge of causes, effects and control of different types of environmental pollution and its effect on climate change, global warming and ozone layer depletion. 4. Provide knowledge of different methods of water conservation 5. Provide and enrich the students about social issues such as R&R, population and sustainability.
6	Course Outcomes	CO1.Understand the principles and scope of environmental science CO2. Study about various pollution causes, effects and control and solid waste management. CO3. Effect of global warming and ozone layer depletion CO4. Knowledge about various types of natural resources and its conservation CO5. Understand about sustainable development, resettlement and rehabilitation, impact of population explosion on environment the methods of water conservation CO6. Overall understanding of various environmental components, its protection and management.
7	Course Description	Environmental Science emphasises on various factors as 1. Importance and scope of environmental science 2. Natural resource conservation 3. Pollution causes, effects and control methods 4. Social issues associated with environment
8	Outline syllabus		CO Mapping
	Unit 1	**General Introduction**	
	A	Definition, principles and scope of environmental science	CO1/CO6
	B	Land resources, Forest Resources	CO1/CO6
	C	Water Resources ,Energy Resources	CO1/CO6

	Unit 2	**Environmental Pollution (Cause, effects and control measures) and solid waste management**			
	A	Air pollution ,Water Pollution			CO2/CO6
	B	Soil and Noise pollution			CO2/CO6
	C	Solid wastes and its management			CO2/CO6
	Unit 3	**Climate Change and its impact**			
	A	Concept of Global Warming and greenhouse effect			CO3/CO6
	B	Ozone layer Depletion and its consequences			CO3/CO6
	C	Climate change and its effect on ecosystem, Kyoto protocol and IPCC concerns on changing climate			CO3/CO6
	Unit 4	**Natural resource conservation**			
	A	Hot spots, threats to biodiversity, endemic species			CO4/CO6
	B	Conservation of biodiversity, ex-situ, in-situ conservation, biodiversity services.			CO4/CO6
	C	Need of Water Conservation, Rain Water Harvesting Watershed management			CO4/CO6
	Unit 5	**Social Issues and the Environment**			
	A	Concept of sustainable development			CO4/CO6
	B	Resettlement and rehabilitation of people; its problems and concerns, Case studies			CO4/CO6
	C	Population explosion and its consequences			CO4/CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	**1.** Joseph, Benny, "Environmental Studies", Tata Mcgraw-Hill.			
	Other References				

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**2**	**2**	**2**	**2**
CO2	**2**	**3**	**2**	**2**	**2**
CO3	**2**	**2**	**3**	**2**	**2**
CO4	**2**	**2**	**2**	**3**	**2**
CO5	**2**	**2**	**2**	**2**	**3**
CO6	**3**	**3**	**3**	**3**	**3**

BSF101: Principles of Nutrition Sciences

L T P: 4-0-0 **Credit: 4**

School: SBSR		**Batch : 2019-2022**	
Program: B.Sc.		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester:01**	
1	Course Code	BSF101	
2	Course Title	Principles of Nutrition Sciences	
3	Credits	4	
4	Contact H (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	To develop basic knowledge of food as nutritional component, its related disorders, food hygiene and regulatory laws.	
6	Course Outcomes	After successfully completion of this course students will be able to: 1. Define food and its nutritional value. 2. Provide an overview of the major macro and micronutrients relevant to human health 3. Comprehend the importance of nutrition in health and disease. 4. Discuss the scientific rationale for defining nutritional requirements in healthy individuals and populations, with reference to specific conditions such as pregnancy, lactation, and older age. 5. Describe the role of microbes in food industry. 6. Identify and understand the role personal hygiene and food sanitation in food processing.	
7	Course Description	This course has been designed to make student understand the value nutritional requirements and the role of food sanitation, safety in food manufacturing.	
8	Outline syllabus		CO Mapping
	Unit 1	**Components of food**	CO1,CO2,CO4
	A	Introduction of Food	
	B	Major nutrition in food: Carbohydrates, Lipids, proteins	
	C	Micro components of Food including minerals and trace elements	
	Unit 2	**Food Disorders**	CO3,CO4
	A	Food proteins disorders;	
	B	Food Carbohydrate and lipids disorders;	
	C	Food trace elements disorders	
	Unit 3	**Growth of Microorganisms in Food**	CO5
	A	Food as a substrate for microorganisms;	
	B	Factors affecting growth of microbes;	
	C	Use of Microbes in Food industry	
	Unit 4	**Food Safety Aspects**	CO6

	A	Personal Hygiene procedures			
	B	Food Safety guidelines			
	C	Food regulatory agencies and laws			
	Mode of examination	Theory			
	Weight age Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Food Science - Fifth Edition | Norman N. Potter | Springer			
	Other References	1. Essentials of Food & Nutrition by Swaminathan, Vol. 1 & 2 (2012). 2. Frazier, W. C. and Westhoff, D. C. (2007) Food Microbiology. Tata McGraw Hill Publishing Company Ltd. New Delhi			

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**1**	**1**	**1**	**1**
CO2	**1**	**3**	**1**	**1**	**1**
CO3	**1**	**1**	**3**	**1**	**1**
CO4	**1**	**1**	**1**	**3**	**1**
CO5	**1**	**1**	**1**	**1**	**3**
CO6	**1**	**1**	**1**	**1**	**3**

BSZ120: Diversity of Animals
L T P: 4-0-0 **Credit: 4**

School: SBSR		**Batch : 2019-2022**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 01**	
1	Course Code	BSZ120	
2	Course Title	Diversity of Animals	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Core	
5	Course Objectives	To get a brief idea about the whole animal world in terms of their general characteristics	
6	Course Outcomes	After successfully completion of this course students will be able to: CO1: To learn about the general characteristics of protists, poriferans and cnidarians CO2: To understand the general features of Platyhelminthes, aschelminthes and annelids CO3: To understand the diversity of arthropods, molluscs, and echinoderms CO4: To learn about the salient features of protochordates, pisces and amphibians CO5: To get a brief idea about reptiles, aves and mammals CO6:To understand the salient features of whole animal world	
7	Course Description	The 'Diversity of Animals' course outlines the general characteristics of different animal phylum and also provides the basic knowledge of different animal species affecting human beings. The course covers whole non-chordates and chordates with brief discussion about important species.	
8	Outline syllabus		CO Mapping
	Unit 1	**Diversity of Protista, Porifera and Radiata**	
	A	Basic introduction to non-chordates and chordates	CO1, CO6
	B	General Characteristics of Protista, Porifera and Cnidarians	CO1
	C	Life cycle of *Plasmodium* and *Leishmania* in brief	CO1
	Unit 2	**Diversity of Platyhelminths, Aschelminthes and Annelids**	
	A	General features of Platyhelminthes and Life cycle of *Taeniasolium*	CO2
	B	General Characteristics of Aschelminthes, Life cycle of *Ascaris*	CO2

	C	General characteristics of Annelids, General features of Earthworm and Vermicomposting			CO2, CO6
	Unit 3	**Diversity of Arthropods, Mollusca and Echinodermata**			
	A	General characteristics of Arthropods			CO3 , CO6
	B	Metamorphosis in insects; General features of Mollusca			CO3, CO6
	C	General characteristics of Echinodermata			CO3, CO6
	Unit 4	**Diversity of Protochordates, Pisces and Amphibia**			
	A	Salient features of protochordates; General features of *Branchiostoma*			CO4, CO6
	B	General characteristics of Pisces; Overview of Migration in Fishes			CO4, CO6
	C	General features of Amphibia, Adaptations for living on land in Amphibia			CO4, CO6
	Unit 5	**Diversity of Reptiles, Aves and Mammals**			
	A	General features of reptiles, terrestrial adaptations in reptiles			CO5, CO6
	B	General characteristics of Aves, flight adaptations in birds			CO5, CO6
	C	Mammalia-general features and dentition in mammals			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	Cleveland P. Hickman, Jr., Larry S. Roberts, Allan Larson (2003). Animal Diversity. 3rd Edition. McGraw−Hill			
	Other References	1. Ruppert, F & Barnes. (2006). Invertebrate Zoology. A Functional Evolutionary Approach. 7th Edition. Thomas Books/ Cole. 2. Campbell & Reece. (2005). Biology. Singapore Pvt. Ltd.			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	1
CO2	1	3	1	1	1
CO3	1	1	3	1	1
CO4	1	1	1	3	1
CO5	1	1	1	1	3
CO6	1	1	1	1	3

BSP102: Cell Biology Lab

L T P: 0-0-2 Credit: 1

School: SBSR		**Batch: 2019-2022**			
Program: B.Sc.		**Current Academic Year: 2019-20**			
Branch: Biotechnology		**Semester: 1**			
1	Course Code	BSP102			
2	Course Title	Cell Biology Lab			
3	Credits	1			
4	Contact Hours (L-T-P)	0-0-2			
	Course Status	Compulsory			
5	Course Objective	● To understand how cell is to maintain life			
6	Course Outcomes	After finishing the course the students will be able to CO1: To Understand the basic components of prokaryotic and eukaryotic cell. CO2: To understand the structure and purpose of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membrane and organelles. CO3: To learn the transpiration by stomata. CO4: To understand movement across the cell membrane. CO5: To learn different phases of growth cycle and cell division. CO6: To Understand the basic concept of Biology			
7	Course Description	Introduces the basics of cell biology. The structure and function of the cell.			
8	Outline syllabus				CO Mapping
	Unit 1	**Practical based on Cell observation**			
		Sub unit – a ,b.c			CO1, CO6
	Unit 2	**Practical related to cell and cell organelle**			
		Sub unit –c			CO2, CO6
	Unit 3	**Practical based to Transportation**			
		Sub unit – a			CO3, CO6
	Unit 4	**Practical based upon Nucleus and Chromosomes**			
		Sub unit – c			CO4, CO6
	Unit 5	**Practical related to Cytoskeleton and Cell to cell interaction**			
		Sub unit - a			CO5, CO6
	Mode of examination	Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	Text book/s*	-			

	Other References		

List of Practical's:

Week 1	**Unit 1**	**Practical based on Cell and Cell Theory**	
Week 1-2	a	Lab expt.1	To Prepare a Stained Temporary Mount of Onion Peel.
Week 3		Lab expt.2	To Prepare a stained Temporary Mount of Human Cheek Cells
	Unit 2	**Practical related to study different types of cell**	
Week 4	b	Lab expt.4	To observe Bacterial cell
		Lab expt.5	To prepare a thin blood smear and visualize and identify the different blood cell types in human blood.
	Unit 3	**Practical based upon Bacterial cell and cell division**	
Week 5	a	Lab expt.5	To study mitosis in onion root tip.
Week 6	b	Lab expt.6	To study miosis
Week 7	Mid term		
	Unit 4	**Practical based upon study movement**	
Week 8	a	Lab exp 7	Preparation of temporary of leaf epidermis to visualize stomata and study the structure of stomatal apparatus.
Week 9-10	b	Lab exp 8	Demonstration of Osmosis
	Unit 5	**Practical related**	
Week 11-14	a, b and c	Lab expt 9	To isolate and observe filamentous soil fungi using dilution and plating techniques.

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**1**	**1**	**1**	**1**
CO2	**1**	**3**	**1**	**1**	**1**
CO3	**1**	**1**	**3**	**1**	**1**
CO4	**1**	**1**	**1**	**3**	**1**
CO5	**1**	**1**	**1**	**1**	**1**
CO6	**3**	**3**	**3**	**3**	**3**

BSL-151: Chemistry Lab for Biosciences

L-T-P 0-0-2 Credits 1

1	Course number	**BSL-151**		
2	Course Title	**Chemistry Lab for Biosciences**		
3	Credits	1		
4	Contact Hours (L-T-P)	0-0-2		
5	Course Objective	1. To learn methods for preparation of solution of different concentration, their standardization 2. To learn quantitative estimation of different chemical species by various volumetric methods. 3. To prepare the buffer solutions of desired pH and study of change in pH. 4. To understand the practical concepts of reaction kinetics 5. To understand the procedure for testing of functional groups in organic compounds.		
6	Course Outcomes	1. Able to prepare solutions of different strength, standardize them and buffer solutions of different strength. 2. Able to understand neutralization titration by indicator method/pH metrically. 3. Perform complex metric/Redox/Precipitation titration. 4. Understand the order of reaction- First order/second order. 5. Able to detect functional groups present in organic compound. 6. Able to gain the basic knowledge of qualitative and quantitative analysis of chemicals		
7	Outline syllabus:			
7.01	BSL 151.01(a)	Task 1	To prepare N/10 normality solution of sodium carbonate and use it to standardize the given hydrochloric acid solution.	Outcome no.
7.02	BSL 151.01(b)	Task 2	To prepare the N/5 oxalic acid and use it to standardize given NaOH solution.	1,6

7.03	BSL 151.01(c)	Task 3	To prepare N/30 normality solution of potassium dichromate and use it to standardize the given hypo solution.	1,6
7.04	BSL 151.02(a)	Task 4	To prepare an acidic buffer with CH_3COOH and CH_3COONa and observe the change in pH on addition of acid and base.	1,6
7.05	BSL151.02(b)	Task 5	To prepare a basic buffer with NH_4OH and NH_4Cl and observe the change in pH on addition of acid and base.	1,6
7.06	BSL 151.03	Task 6	To determine the strength of NaOH and Na_2CO_3 in a given alkali mixture.	2,6
7.07	BSL 151.04 (a,b)	Task 7	To determine the strength of given HCl solution by titrating with standard NaOH solution: a. Indicator method; b. pH metrically.	2,6
7.08	BSL 151.05	Task 8	To determine the hardness of water by EDTA method.	3,6
7.09	BSL 151.06	Task 9	To determine the chloride content in water by Mohr's Method.	3,6
7.10	BSL 151.07	Task 10	To determine the Fe^{2+}content in the given sample by titrating with standard $K_2Cr_2O_7$ solution using potassium ferricyanide as external indicator.	3,6
7.11	BSL 151.08	Task 11	To determine the rate constant and order of the reaction of hydrolysis of an ester catalyzed by an acid.	4,6
7.12	BSL 151.09	Task 12	To determine the rate constant of hydrolysis of ethyl acetate with NaOH and show that the reaction is of second order.	4,6
7.13	BSL 151.10	Task 13	Detection of functional groups in organic compound(C, H,O containing).	5,6
8	Course Evaluation			
8.1	Course work: 100% marks			
8.11	Attendance	None		
8.12	Homework	None		

8.13	Quizzes	None
8.14	Labs	Evaluation of work done on each lab turn in the lab notebook and feedback from oral quiz about the work done that day. Zero, if the student is absent. 0.75N best marks out of N such evaluations: 100 marks
8.15	Presentations	None
8.16	Any other	None
8.2	MTE	None
8.3	End-term examination: None	
9	References	
9.1	Text book	O.P. Pandey, D.N. bajpai, S.Giri, " Practical Chemistry", S. Chand & Co.
9.2	Other References	Vogel's "Textbook of quantitative Analysis", Pearson.

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**1**	**3**	**2**	**1**	**3**
CO2	**2**	**1**	**3**	**2**	**2**
CO3	**2**	**1**	**2**	**1**	**2**
CO4	**3**	**2**	**1**	**3**	**1**
CO5	**1**	**1**	**2**	**2**	**3**
CO6	**3**	**3**	**3**	**3**	**3**

PHY115: Physics 5

L T P: 4-0-0 Credit: 4

School: SBSR		**Batch : 2019-22**	
Program: B.Sc.		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 2**	
1	Course Code	PHY115	
2	Course Title	Physics 5	
3	Credits	4	
4	Contact Hours (L-T-P)	3-1-0	
	Course Status	Compulsory	
5	Course Objective	1. To make students aware of basic laws governing the fluids and associated physical parameters. 2. To teach students fundamental laws of thermodynamics and how heat flows. 3. To encourage students to apply the knowledge of fluids and thermodynamics in the study of biological systems	
6	Course Outcomes	CO1: Students will learn about the basic parameters related with fluids and fluid properties. CO2: Students will learn basic laws governing the fluid statics and floating of bodies. CO3: Students will learn basic concepts of heat and temperature. CO4: Students will gain knowledge about the basics of thermodynamics, thermodynamic cycle and zeroth law of thermodynamics and first law of thermodynamics. CO5: Students will learn the concept of heat transfer, its different modes of transfer, Black body radiation Planck's law, Stefan Boltzmann law. CO6: Students will learn about the thermodynamics and will be able to use the knowledge to understand various biological and chemical processes better under the light of heat exchange.	
7	Course Description	This is a basic course on fluids and thermodynamics designed for the biotechnology students so that they can appreciate the fluid behavior and thermal mechanism of various processes which they study.	
8	Outline syllabus		CO Mapping
	Unit 1		
	A	Physical properties of fluids, Concept of fluid and flow. Types of fluids- Ideal and real fluids	CO1, CO6
	B	Continuum concept, Density, Specific weight, Specific volume, Specific gravity, Compressibility	CO1, CO6
	C	Elasticity, Surface tension and its applications, Capillarity, Vapour pressure, Viscosity	CO1, CO6

	Unit 2				
	A	Pascal's law, hydrostatic equation, hydrostatic forces on plane surface			CO2, CO6
	B	Pressure-density-height relationship, Manometers			CO2, CO6
	C	Buoyancy, Stability of immersed and floating bodies			CO2, CO6
	Unit 3				
	A	Macroscopic and Microscopic Approaches, Thermodynamics system and surroundings, Thermodynamic Property– Intensive and Extensive			CO3, CO6
	B	Thermodynamic Equilibrium, State, Path, Process and Cycle, Quasi-static.			CO3, CO6
	C	Zeroth law of thermodynamic and its utility, Concept of thermal equilibrium. Temperature and its measurement and scales.			CO3, CO6
	Unit 4				
	A	Thermodynamic processes, calculation of work in various processes			CO4, CO6
	B	first law for a closed system undergoing a cycle and undergoing a change of state			CO4, CO6
	C	Internal energy as a system property, specific heat, Limitations of First Law.			CO4, CO6
	Unit 5				
	A	Definition of Heat Transfer, Reversible and irreversible processes, Modes of heat flow, Combined heat transfer system and law of energy conservation.			CO5, CO6
	B	Heat Conduction (Steady State): Introduction, 1-D heat conduction through a plane wall, long hollow cylinder, hollow sphere, Critical Insulation.			CO5, CO6
	C	Heat Transfer by Radiation: Thermal radiation, The Stephen-Boltzmann law, The black body radiation, Laws of black body radiation, Plank's law (qualitative). Combined heat transfer by conduction, convection and radiation.			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*				
	Other References	1. Engineering Fluid Mechanics By K. L. Kumar, S. Chand & Co. **2.** Fluid Mechanics By V. L. Streeter, Wylie, MGH 3. Engg. Thermodynamics- Hawkins, G.A. John Wiley & Sons. 4. Engg. Thermodynamics- Nag, P.K. Tata McGraw Hill.			

		5. Heat Transfer-Principles & Applications -Binay K. Dutta, PHI, New Delhi 6. Thermal Radiation Heat Transfer -Siegel, R. and J.R. Howell, Mc. Graw Hill

COs	PO1	PO2	PO3	PO4	PO5
CO1	3	1	2	2	2
CO2	3	1	2	2	2
CO3	3	1	2	2	2
CO4	3	1	2	2	2
CO5	3	1	2	2	2
CO6	3	1	2	2	2

BSB105: Microbiology

L T P: 4-0-0 Credit: 4

School: SBSR		**Batch : 2019-2022**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 02 (Even)**	
1	Course Code	BSB105	
2	Course Title	Microbiology	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Core	
5	Course Objectives	1. This course has been designed to make students understand the basic characteristics of microbes 2. To know about basis principle and to understand the methods of sterilization 3. Students understand the basic structure of Bacteria	
6	Course Outcomes	After successfully completion of this course students will be able to: CO1: To study the history of microbiology and its basic concepts. Structure and nutrition of bacteria CO2: Growth, multiplication, factors affecting growth of bacteria and techniques related to its isolation CO3: Principles of physical and chemical methods used in the control of microorganisms CO4: Prevention and control of microbial diseases CO5: Structure and life cycle of bacteriophage and virus CO6: Application of microorganisms in different industries that can benefit human	
7	Course Description	Microbiology course outlines the general characteristics of different microorganisms and also provides the basic knowledge of significance of different microbes affecting the human beings.	
8	Outline syllabus		**CO Mapping**
	Unit 1	**Introduction to Microbiology**	
	A	History of Microbiology & contribution of microbiologists	CO1, CO6
	B	Spontaneous generation; Koch Postulates	CO1
	C	Whittaker's 5 kingdom concept; Pasteurization.	CO1
	Unit 2	Morphology and Nutrition of Bacteria	
	A	Morphology and fine structure of Bacteria; outer surface of bacteria; Cell wall of Gram +ve and Gram – ve bacteria	CO2
	B	Nutritional classification of Bacteria	CO2,
	C	Brief overview on Archaea; Cyanobacteria, PPLO	CO2, CO6
	Unit 3	**Growth and Sporulation in Bacteria**	

	A	Modes of cell division (Binary fission; budding and Septum formation); Normal growth of bacteria; Growth curve			CO3, CO6
	B	Pure culture, Method of isolating pure culture (Streak method, Pour-plate and spread plate technique); Synchronous and asynchronous			CO3, CO6
	C	Growth inhibitory substances (temperature, acidity, alkalinity, water availability, oxygen)			CO3, CO6
	Unit 4	**Control of Microbial Growth**			
	A	Microbes and Human welfare (medical and chemical industry)			CO4, CO6
	B	Microbes in food industry			CO4, CO6
	C	Physical and chemical methods of control of microorganisms			CO4, CO6
	Unit 5	**Virus and Its Control**			
	A	Ultra-structure of Virus			CO5, CO6
	B	Life Cycle and its control			CO5, CO6
	C	Life cycle of Bacteriophage			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	***Microbiology - Pelezar,*** M.J. Reid, R.D. and E.C.S. Chan, Tata McGraw Hill, New Delhi.1977 (4th Edition)			
	Other References	1. ***Prescott***, ***Harley*** and ***Kelvin*** – ***Microbiology***, 2nd ed. TMH Publication 2. General Microbiology: Roger & Strainer et.al. PHL Publication			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	1	3	2	1	3
CO2	2	1	3	2	2
CO3	2	1	2	1	2
CO4	3	2	1	3	1
CO5	1	1	2	2	3
CO6	3	3	3	3	3

BSB108: Genetics

L T P: 4-0-0 Credit: 4

School: SBSR		**Batch : 2019-2022**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 02**	
1	Course Code	BSB108	
2	Course Title	Genetics	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. This course has been designed to make students understand the basic principles of classical Mendelian Genetics 2. To know about modern basis of heredity and to understand the transmission of characters via non-nuclear genes and effect of mutations on transmission of characters 3. Students understand the fine structure of gene and classical experiments that lead to the development of gene fine structure and its function	
6	Course Outcomes	After the successful completion of this course students will be able to: CO1:describe various Mendelian laws as well as exception to these laws CO2:explain the structure of DNA, chromosomes and aberrations in chromosomes CO3: analyze extranuclear inheritance and examples to understand cytoplasmic inheritance CO4: describe mutation, its consequences and types CO5:demonstrate the fine structure of gene and experiments that lead to the understanding of gene structure and function CO6: describe basic principles of genetics and gene mutations and mechanisms of inheritance and heredity	
7	Course Description	The 'Genetics' course outlines the basic principles of Classical Genetics. This course also sheds light upon modern genetics and is designed to make student learn the structure of chromosomes; nucleosomal organization of genetic material etc to understand the basis of heredity. The course also further encompasses the concept of mutation; extra nuclear inheritance of characters and effect of these phenomena on transmission of characters.	
8	Outline syllabus		CO Mapping
	Unit 1	**Mendelism**	

	A	Brief overview of Mendel's work; Mendel's experimental design, monohybrid and di-hybrid crosses; Mendel's Law of segregation & Law of independent assortment	CO1, CO6
	B	Verification of segregates by back and test crosses; Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, multiple allele, pseudo-allele, essential and lethal genes.	
	C	Non allelic interactions: epistasis (dominant & recessive), duplicate genes.	
	Unit 2	**Physical Basis of Inheritance**	
	A	Chromosome theory of inheritance; Eukaryotic Chromosome: Macromolecular Organization; packaging of DNA molecule into chromosomes	CO2, CO6
	B	Chromosome banding pattern, Heterochromatin and Euchromatin and its significance, karyotype; Chromosome types, primary and secondary constrictions; Centromere and Telomeres; Satellite -bodies	
	C	Variation in chromosome number Aneuploidy and Euploidy; Variations in chromosomes structure - deletion, duplication, inversion and translocation.	
	Unit 3	**Linkage and Crossing Over**	
	A	Concept of linkage and crossing over; Coupling and repulsion hypothesis; Linkage in maize and Drosophila; Linkage groups; Theories of linkage; Cis-Trans arrangement	CO3, CO6
	B	Crossing over and Genetic recombination	
	C	Extrachromosomal Inheritance: Maternal Inheritance: shell coiling in Limnaea; Inheritance of Mitochondrial DNA and Mitochondrial diseases in Human; Inheritance of Chloroplast DNA and Cytoplasmic Male Sterility (CMS) in crop plants	
	Unit 4	**Mutation**	
	A	Discovery of DNA as the genetic material	CO4, CO6
	B	Definition and types of mutations, Molecular basis of mutations	
	C	Ames test for mutagenic agents, screening procedures for isolation of mutants	
	Unit 5	**Fine Structure of Gene**	
	A	Benzer and T4 rII locus, Complementation test;	

	B	Cistron, recon and muton			CO5, CO6
	C	Beadle and Tatum's one gene one enzyme concept; One gene one polypeptide concept			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	1. Hartl D.L. and Jones E.W, **"Genetics: analysis of genes and genomes".** Edition 5. Jones and Bartlett Publishers, 2000. 2. Gardner E.J., Simmons M.J., Snustad M.J., **"Principles of genetics".** Edition 8. John Wiley & Sons (Asia) Pte. Ltd., 2007.			
	Other References	1. Griffiths J.F., Wessler, S.R., Levonotin, R.C., Gelbart, W.M., Suzuki, D.T., Miller J.H., **"An Introduction to Genetic Analysis".** Edition 8.			

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**1**	**3**	**2**	**1**	**3**
CO2	**2**	**1**	**3**	**2**	**2**
CO3	**2**	**1**	**2**	**1**	**2**
CO4	**3**	**2**	**1**	**3**	**1**
CO5	**1**	**1**	**2**	**2**	**3**
CO6	**3**	**3**	**3**	**3**	**3**

BBT101: Diversity of Plants

L-T-P: 4-0-0 **Credits 4**

School : SBSR		**Batch : 2018-21**	
Program: B.Sc.		**Current Academic Year: 2018-19**	
Branch: Biotechnology		**Semester: 2**	
1	Course Code	**BBT101**	
2	Course Title	**Diversity of Plants**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course Status	Compulsory	
6	Course Objective	1) The primary objective of this course design is to achieve a general understanding about diverse forms of plants and Fungi. 2) To gain knowledge about Fungi, Algae, Archegoniates, and Angiosperms.	
7	Course Outcomes	After studying this course, students will be abe to CO1: Comprehend on Algae CO2: Discuss about Fungi CO3: Elaborate on Archegoniate CO4: Discuss various members of Bryophytes and Pteridophytes CO5: Understand the characteristics of Angiosperms (Dicots and Monocots) CO6: Study diverse forms of plants	
8	Course Description	The aim of this course is to acquaint the students about the various of Fungi and Plants (Thallophytes, Archegoniates, and Angiosperms)	
9	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Algae**	
	A	General characteristics and distribution	**CO1, CO6**
	B	Broad Classification of algae	
	C	Economic importance of algae	
	Unit 2	**Fungi**	**CO2, CO6**
	A	General characteristics; cell wall composition; nutrition of Fungi	
	B	Reproduction and broad classification	
	C	Economic importance of Fungi	
	Unit 3	**Introduction to Archegoniate**	**CO3, CO6**
	A	Introduction to Archegoniate; Unifying features of archegoniates	
	B	Transition to land habit	
	C	Alternation of generations	
	Unit 4	**Bryophytes and Pteridophytes**	
	A	Bryophytes: General characteristics; adaptations to land habit and reproduction	**CO4, CO6**

	B	Pteridophytes: General characteristics; classification and reproduction			
	C	Economic importance of Bryophytes and Pteridophytes			
	Unit 5	**Angiosperms**			**CO5, CO6**
	A	General characteristics			
	B	Monocots and dicots; morphology			
	C	Anatomy with one example each for monocot and dicot			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.			
	Other References	Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition. Sethi, I.K. and Walia, S.K. (2011). Textbook of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.			

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	1	1	1
CO2	1	3	1	1	1
CO3	1	1	3	2	1
CO4	2	1	1	3	1
CO5	2	1	1	2	3
CO6	3	3	3	3	3

BSB107: Environmental Biotechnology

L-T-P: 4-0-0 Credits 4

School: SBSR		**Batch: 2019-2022**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 02**	
1	Course Code	BSB107	
2	Course Title	**Environmental Biotechnology**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course Status	Compulsory	
6	Course Objective	1. Concept of biological control of air pollution 2. Physical, chemical and biological treatment of waste water. 3. Microbial degradation of xenobiotics 4. Biofertilizers, Microbes in oil recovery and bioleaching	
7	Course Outcomes	After studying this course, students will be able to CO1: Determine scope and market Biological control of air pollution CO2: Summarize the Aerobic processes: activated sludge, oxidation ponds and trickling filter towers CO3: Describe the pulp mill effluent, tannary effluent CO4: Determine the Bioremediation of fuel oils and lubricants in soil and water. CO5: Analyze the Use of R-DNA technology to enhance the efficacy microbial insecticides CO6: Compare the Biodeterioration of stored plant food materials.	
8	Course Description	The course comprises of general concept of environmental biotechnology to combat air pollution, waste water treatment, treatment of industrial effluents and bioremediation.	
9	Outline syllabus		CO Mapping
	Unit 1	**Environmental Biotechnology:**	**CO1**
	A	An overview, concept, scope and market Biological control of air pollution	
	B	Testing of water for physiochemical parameters including BOD & COD,	
	C	Solid waste: Sources and management (composting and verrmicomposting)	
	Unit 2	**Waste water:**	**CO2**
	A	origin, composition and treatment.	
	B	Physical, chemical and biological treatment of waste water.	

	C	Aerobic processes: activated sludge, oxidation ponds and trickling filter towers. Anaerobic processes: anaerobic digesters.			
	Unit 3	**Treatment of industrial effluents:**			**CO3**
	A	distillery effluent, paper mill effluents			
	B	pulp mill effluent, tannary effluent,			
	C	textile dye effluent.			
	Unit 4	**Bioremediation:**			**CO4**
	A	Bioremediation of fuel oils and lubricants in soil and water.			
	B	Degradation of sulphur compounds present in coal and petroleum.			
	C	Microbial degradation of xenobiotics, genetic engineering of biodegradation pathways.			
	Unit 5	**Microbial Insecticides:**			**CO5**
	A	Use of R-DNA technology to enhance the efficacy microbial insecticides,			
	B	Biofertilizers, Microbes in oil recovery and bioleaching,			
	C	Biodeterioration of stored plant food materials, leather, wool, metals, textiles, stone & related building.			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1.Environmental Chemistry. A.K. De, Wiley Eastern Ltd., New Delhi. 2.Introduction to Biodeterioration. D. Allsopp and K.J. Seal, ELBS/Edward Arnold.			
	Other References	1. Advanced Environmental Biotechnology by S.K. Agarwal. APH Publishing, New Delhi,(2005). 2. Bioremediation Protocols. David S. (1997), Humana Press, New Jersey. 3. Environmental Science and Technology. Stankey E.M. (1997), Lewis Publishers, NewYork. 4. Microbial Biotechnology: Fundamentals of Applied Microbiology (2 nd edition). Glazer and Nikaido Cambridge University Press, (2007). 5. Biodegradation and Bioremediation: Soil Biology. Singh A. and Ward O.P. (2004), Springer			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	1	1
CO2	1	3	1	1	1
CO3	1	1	3	2	1
CO4	2	1	1	3	1
CO5	2	1	1	2	3
CO6	3	3	3	3	3

BSP105: Microbiology Lab

L T P: 0-0-2 **Credit: 1**

School: SBSR		**Batch: 2019-2022**
Program: B.Sc. (H)		**Current Academic Year: 2019-20**
Branch: Biotechnology		**Semester: 02**
1	Course Code	**BSP105**
2	Course Title	**Microbiology Laboratory**
3	Credits	1
4	Contact Hours (L-T-P)	0-0-2
	Course Status	Compulsory
5	Course Objective	To explain relationships and apply appropriate terminology relating to the structure, metabolism, and ecology of prokaryotic microorganisms, eukaryotic microorganisms, and viruses. To explain the principles of physical and chemical methods used in the control of microorganisms and apply this understanding to the prevention and control of infectious diseases. To develop the appropriate laboratory skills and techniques related to the isolation, staining, identification, assessment of metabolism, and control of microorganisms. To develop an information base for making personal health decisions in regard to infectious diseases
6	Course Outcomes	CO1: Analyze the identifying characters and classify the bacteria in terms of nutritional development, oxygen requirement and other characters. CO2: Isolate and culture bacteria in laboratory under both aerobic and anaerobic conditions. CO3: Comprehend the kinetics of bacterial growth in terms of growth phases, generation time, yields and determine factors affecting growth and methods of growth determination. CO4: Determine the impact of microbes on human health and examine physical and chemical methods used in the control of microorganisms and apply this understanding to the prevention and control of infectious diseases. CO5: Identify the host and determine the life cycle of pathogenic bacteria, bacteriophage and virus. CO6: Develop the ability to work both independently and with others in the laboratory and draw appropriate conclusions from laboratory results.

7	Course Description	To explain the principles of physical and chemical methods used in the control of microorganisms and apply this understanding to the prevention and control of infectious disease.			
8	Outline syllabus				CO Mapping
	Unit 1	**Practical based on Introduction to Microbiology**			CO1, CO6
		Sub-topic A			
	Unit 2	**Practical based on Morphology and Nutrition of Microbes**			CO2, CO6
		Sub-topic A			
	Unit 3	**Practical related to Bacteria Growth and Sporulation in Bacteria**			CO1, CO3, CO6
		Sub-topic A,B			
	Unit 4	**Control of Microbial Growth**			CO4, CO5, CO6
		Sub-topic A			
	Unit 5	**Virus and Its Control**			CO1, CO6
		Sub-topic A, B, C			
	Mode of examination	Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	Textbook/s*	Practical manual of Biotechnology by Ritu Mahajan, Jitendar Sharma, RK Mahajan, Vayu Publishers			

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**3**	**1**	**2**	**1**
CO2	**3**	**3**	**1**	**2**	**2**
CO3	**1**	**1**	**3**	**2**	**1**
CO4	**2**	**2**	**1**	**3**	**2**
CO5	**2**	**2**	**1**	**1**	**3**
CO6	**3**	**3**	**3**	**3**	**3**

PHY151: Physics Lab 2

L-T-P 0-0-2 Credits 1

School: SBSR		**Batch: 2019-22**	
Program: B.Sc.		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 2**	
1	Course Code	PHY151	
2	Course Title	Physics Lab 2	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	Compulsory	
5	Course Objective	To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.	
6	Course Outcomes	On successful completion of the course the students will have: CO1: Knowledge and study of basic physics experiments based on Semiconductors, energy band gap, planck constant etc. CO2: Use the concept of electricity and magnetism to find out variation of magnetic field through a current carrying coil and hall effect CO3: Understand and learn how to determine specific resistance CO4: Understand and perform laser-based experiments. CO5: Knowledge and study of various optical experiments. CO6: Apply the mathematical concepts/equations to obtain quantitative results and ability to conduct, analyze and interpret experiments	
7	Outline Syllabus		CO Mapping
	Unit 1		
	A B C	1. To determine Energy band gap of a semiconductor using Four Probe method. 2. To determine the variation of magnetic field along the axis of a current carrying coil and estimate the radius of the coil. 3. To study Hall effect and determine the Hall coefficient, carrier density and the mobility of a semiconductor material	CO1 CO2,CO6
	Unit 2		
	A B C	4. To draw hysteresis curve (B-H curve) of a specimen in the form of a transformer on a C.R.O. And to determine its hysteresis loss 5. To determine the Planck's constant by measuring radiation in a fixed spectral range. 6. To determine the specific resistance of the material of a given wire using Carey Foster's bridge.	CO2,CO6
	Unit3		

	A B C	7. To determine the diameter of thin wire by diffraction using laser. 8. To determine the wavelength of laser light by diffraction at a single slit. 9. To determine slit width of single and double slit by using Laser.	CO3,CO6 CO4,CO6
	Unit 4		
	A B C	10. To determine the wavelength of prominent lines of mercury by plane diffraction grating. 11. To determine the wavelength of monochromatic light by Newton's Ring method.	CO4,CO6
	Unit 5		
	A B C	12. To determine the focal length of the combination of two lenses separated by a distance with the help of a nodal slide and to verify the formula. 13. To verify Stefan's Law.	CO5,CO6 CO5,CO6
	Mode of Examination	Practical/Viva	
	Weightage Distribution	CA: 60% / MTE: 0% / ETE: 40%	
	Text books	1. B.Sc. Practical Physics- Harnam Singh, S. Chand Publishing. 2. B.Sc. Practical Physics- C L Arora, S. Chand Publishing.	
	Other References	1. Geeta Sanon, BSc Practical Physics, 1st Edn. (2007), R. Chand & Co. 2. B. L. Worsnop and H. T. Flint, Advanced Practical Physics, Asia Publishing House, New	

COs	PO 1	PO2	PO3	PO4	PO5
CO1	2	2	2	1	1
CO2	2	2	2	1	1
CO3	2	2	2	1	1
CO4	2	2	2	1	1
CO5	2	2	2	1	1
CO6	2	2	2	1	1

BSB201: Molecular Biology
L T P: 4-0-0 Credit: 4

School : SBSR		**Batch : 2019-2022**	
Program: B.Sc.		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 3rd**	
1	Course Code	**BSB 201**	
2	Course Title	**Molecular Biology**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
6	Course Objective	1. DNA replication and its machinery 2. Transcription and post- transcription processes 3. Prokaryotic and Eukaryotic translation and its mechanism 4. DNA repair and its mechanism	
7	Course Outcomes	After studying this course, students will be able to CO1: Determine Prokaryotic and Eukaryotic DNA replication CO2: Evaluate Prokaryotic and eukaryotic transcription CO3: Interpret the regulation of translation, post translational modifications of proteins CO4: Analyse the Homologous recombinations CO5: Determine Operon Concept. CO6 : Analyze and study DNA repair mechanisms	
8	Course Description	This course contains various molecular biology concepts ranging from replication, transcription and translation in both prokaryotes and eukaryotes. After studying course, students will be able to learn molecular machinery inside the organisms.	
9	Outline syllabus		CO Mapping
	Unit 1	**DNA replication**	**CO1**
	A	Prokaryotic and Eukaryotic DNA replication	
	B	Mechanism of DNA replication	
	C	Enzymes, factors and other accessory proteins involved in DNA replication.	
	Unit 2	**Transcription**	**CO2**
	A	Prokaryotic and eukaryotic transcription- basis of initiation, elongation and termination	
	B	post transcriptional modifications- polyadenylation	
	C	capping and RNA splicing	
	Unit 3	**Translation**	**CO3**
	A	Prokaryotic and eukaryotic translation	
	B	mechanisms of initiation, elongation and termination	
	C	regulation of translation, post translational modifications of proteins	
	Unit 4	**Operon Concept**	**CO4**
	A	Operon Concept	
	B	the lac operon	

	C	tryptophan operon			
	Unit 5	**DNA Repair and Recombination**			**CO5**
	A	Homologous recombinations			
	B	Holiday junction			
	C	DNA repair mechanisms			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	Molecular Cloning: a Laboratory Manual, J. Sambrook, E. F. Fritsch and I. Maniatis, Cold Spring Harbour Laboratory Press, New York,2000.			
	Other References	Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley & sons Ltd., Yourk,1988. Molecular Biology Lab Fax. T.A. Brown (Ed.), bios Scientific Publishers Ltds., Oxford, 1991. Molecular biology of the Gene (4th Edition),J .D. Watson, N. H. Hopkins, J. W. Roberts,J.A. Steitz and A.M.			

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**1**	**1**	**1**	**1**
CO2	**3**	**3**	**1**	**1**	**1**
CO3	**3**	**2**	**3**	**2**	**1**
CO4	**3**	**2**	**1**	**3**	**2**
CO5	**2**	**2**	**1**	**1**	**3**
CO6	**3**	**3**	**3**	**3**	**3**

BSB209: Biomolecules
L T P: 4-0-0 **Credit: 4**

School: SBSR		**Batch: 2019-2022**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 02**	
1	Course Code	**BSB209**	
2	Course Title	**Biomolecules**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. To study the structure and function of macromolecules present in biological systems 2. Understanding the general properties of lipids, amino acids and carbohydrates 3. To learn the hierarchical level of proteins 4. To study the structure as well as properties of DNA and RNA	
6	Course Outcomes	After studying this course, students will be able to CO1: Summarize structural chemistry and general properties of lipids CO2: Distinguish the structure, classification and significance of carbohydrates CO3: Analyze the structure and properties of amino acids and proteins CO4: Evaluate the structure of nucleosides and nucleotides and stability of DNA backbone CO5: Illustrate the structure as well as properties of DNA and RNA CO6 : Summarize the structure, properties and significance of biological macromolecules	
7	Course Description	This course comprises of the structure, function, properties and significance of various macromolecules found in biological systems. Several different macromolecules viz. lipids, carbohydrates, amino acids, proteins, and nucleic acids will be studied in details.	
8	Outline syllabus		CO Mapping
	Unit 1	**Lipids**	
	A	Structure and chemistry of fatty acids	CO1, CO6
	B	Saturated and unsaturated fatty acids	CO1, CO6

	C	General properties and structures of phospholipids, sphingolipids and cholesterol			CO1, CO6
	Unit 2	**Carbohydrates**			
	A	Carbohydrate classification, Monosaccharides; D- and L-designation, Open chain and cyclic structures			CO2, CO6
	B	Structure and biological importance of disaccharides			CO2, CO6
	C	Structural polysaccharides and storage polysaccharides			CO2, CO6
	Unit 3	**Proteins**			
	A	Amino Acids			CO3, CO6
	B	Classification, Structure and Properties; Proteins: Primary, Secondary,			CO3, CO6
	C	Tertiary and Quaternary Structure; Biological functions of proteins			CO3, CO6
	Unit 4	**Nucleic Acids**			
	A	Nature of nucleic acids, Structure of purines and pyrimidines			CO4, CO6
	B	Nucleosides and Nucleotides			CO4, CO6
	C	Stability and formation of phosphodiester linkages			CO4, CO6
	Unit 5	**Structure of DNA**			
	A	Watson-Crick model, Types of DNA - A, B and Z DNA,			CO5, CO6
	B	Complementary pairing between A/T/G and C, Structure of DNA and RNA			CO5, CO6
	C	5’ and 3’ end of DNA, DNA denaturation, monocistronic and polycistronic mRNA.			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	Nelson D.L., and Cox M.M., *Lehninger Principles of Biochemistry, 6th Edition.* W. H. Freeman (2012).			
	Other References	Berg J.M., Tymoczko J.L., and Stryer L., *Biochemistry, 7th Edition.* W. H. Freeman (2010). Voet D., and Voet J.G., *Biochemistry, 4th Edition.* Wiley (2010)			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	1
CO2	1	3	1	1	1
CO3	1	1	3	1	1
CO4	1	1	1	3	1
CO5	1	1	1	1	3
CO6	1	1	1	1	3

BSB203: Instrumentation

L T P: 4-0-0 Credit: 4

School: SBSR		**Batch: 2019-2022**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 03**	
1	Course Code	**BSB203**	
2	Course Title	**Instrumentation**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course Status	Compulsory	
6	Course Objective	To get a brief idea about different instruments commonly use in the biotech laboratories	
7	Course Outcomes	After successfully completion of this course, students will be able to: CO1: To understand the concept and principle of microscopy CO2: To get a brief idea about common biotech lab instruments CO3: To discuss the principle of centrifugation and different types of centrifuges CO4: To understand the basic principle of chromatography and discuss different types of chromatographic techniques CO5: To discuss different types of electrophoresis and understand the principle of PCR and DNA sequencing CO6: To get a brief idea about different instruments commonly use in the biotech laboratories	
8	Course Description	This course outlines the working principles of various techniques and provides a complete overview, description and applications of these different bioanalytical techniques in brief.	
9	Outline syllabus		CO Mapping
	Unit 1	**Microscopy**	
	A	Simple, phase contrast, bright and dark field microscopy	CO1
	B	Confocal and super resolution microscopy	CO1
	C	Fluorescence and Electron microscopy (TEM and SEM)	CO1
	Unit 2	**Common instruments principle and usage**	
	A	pH meter, Weighing balances	CO2
	B	Usage and applications of horizontal and vertical autoclave	CO2
	C	Laminar air flow, incubator, oven and rotary shaker	CO2
	Unit 3	**Centrifugation**	
	A	Principle of centrifugation, different types of centrifuge and rotors,	CO3
	B	Types of rotor: fixed angle and swinging bucket rotors, Bench top and high-speed centrifuges	CO3
	C	Preparative, differential and density gradient centrifugation, Analytical centrifugation	CO3
	Unit 4	**Chromatographic Techniques**	
	A	Liquid, column, and affinity chromatography	CO4
	B	Thin layer and gel-filtration chromatography	CO4
	C	Ion exchange and hydrophobic chromatography	CO4

	Unit 5	**Electrophoresis**			
	A	Electrophoresis – principles and working, Gel electrophoresis			CO5
	B	Immunoelectrophoresis, isoelectric focusing, capillary electrophoresis			CO5
	C	2D electrophoresis, Pulse field electrophoresis, Polymerase Chain Reaction (PCR), DNA sequencing (Sanger's Dideoxy method)			CO5
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30 %	20 %	50 %	
	Textbook/s*	Keith Wilson & John Walker. Principles and Techniques of Biochemistry and Molecular Biology. Cambridge Press			
	Other References	1. Alka Gupta. Instrumentation &Bioanalytical Techniques. Pragati Edition 2. Subramanian M A. Biophysics: Principles and Techniques. MJP Publishers Ltd. **3.** Cottenil, R M S. Biophysics: An Introduction. John Wiley & Sons Ltd, England, 2002			

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**1**	**2**	**1**	**1**
CO2	**1**	**3**	**1**	**2**	**1**
CO3	**2**	**1**	**3**	**1**	**1**
CO4	**1**	**2**	**1**	**3**	**1**
CO5	**1**	**2**	**1**	**1**	**3**
CO6	**3**	**3**	**3**	**3**	**3**

BSB210: Developmental Biology of Plants

L T P: 4-0-0 **Credit: 4**

School : SBSR		**Batch : 2019-22**	
Program: B.Sc.		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 3**	
1	Course Code	BSB210	
2	Course Title	Developmental Biology of Plants	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course Status		
6	Course Objective	This course concentrates upon fundamental knowledge of overall plant development and reproduction of plants.	
7	Course Outcomes	After the successful completion of this course students will be able to: CO1: Critically analyze the similarities and differences between plant and animal development. CO2: Decipher the molecular mechanism and regulation of embryo development in lower and higher plants. CO3: Cellular and molecular mechanism of development of male and female gametophytes, fertilization, self-incompatibility of fertilization and apomixes. CO4: Understand mechanistic details of root, stem and leaf development. CO5: Analyze the molecular mechanism of flower development. CO6: This course concentrates upon fundamental knowledge of overall plant development and reproduction of plants.	
8	Course Description	The 'Plant Developmental Biology' course outlines the basic Overview of plant development, differences between plant and animal development, similarities between plant and animal development and distinguished embryologists of the World. It further goes into the study of role of light, Ca^{2+} and cell wall in *Fucus* development, Embryo development in angiosperms, Role of auxin in basal pole formation of embryo, radial cell pattrn, scarerow and short root transcription factors, The course shall focus in detail Development of male and female reproductive structure i.e., pollen grain, cytoplasmic male sterility, megasporogenesis, gene expression during megasporogenesis, Development of root i.e., cellular organization in a developing root, Developmet of Shoot i.e., leaf primodium, auxillary meristem and leaf development. It will also focus on development of Flowers; transition from vegetative to reproductive development and ABC Model of flower development.	
9	Outline syllabus		CO Mapping
	Unit 1		**CO1**
	A	Overview of plant development	

	B	Differences between plant and animal development, Similarities between plant and animal development			
	C	Distinguished embryologists of the World and their work in brief			
	Unit 2	**Embryo and seed development**			**CO2**
	A	**Embryo development in the brown alga *Fucus*,** Role of light, Ca2+ and cell wall in *Fucus* development			
	B	**Embryo development in angiosperms;** Different stages of embryo development, Role of auxin in basal pole formation**,** Radial cell pattrn, role of scarerow and short root transcription factors**,**			
	C	Formation of root meristem**,** Formation of shoot meristem**,** Endosperm development**,** Dormancy			
	Unit 3	**Development of male and female reproductive structure**			**CO3**
	A	**Development of male gametophyte;** Pollen grain, Tapetum**,** Microsporophyte**,** Cytoplasmic male sterility			
	B	**Development female gametophyte;** Megasporogenesis**,** Gene expression during megasporogenesis**,**			
	C	Fertllization**,** The Molecular basis of self incompartibility**,** endosperm development, apomixis			
	Unit 4				**CO4**
	A	Germination, Vivipary, Differential regulation of root and shoot meristem			
	B	**Development of root;** Cellular organization in a developing root**;** Primary root development**;** Development of root hair**;** Secondary/adventious root development			
	C	**Development of Shoot;** Leaf primodium, Auxillary meristem**,** Tunica corpus**,** Rib meristem**,** The fate of new meristems**,** Lateral meristem**,** Leaf development			
	Unit 5				**CO5**
	A	**Development of Flowers,** From vegetative to reproductive development**,** Reproductive structures in angiosperms			
	B	Floral meristem, Regulation of gene expression for floral development			
	C	Role of Leafy-like genes in the development of inflorescence, ABC Model of flower development.			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30	20	50	
	Text book/s*	A. Plant Biology, Alison M. Smith et al., Garland Science, Taylor & Francis Group, 2010, ISBN 978-0-8153-4025-6			

	Other References	B. Developmental Biology, Tenth Edition. Scott F. Gilbert, editor.Sunderland, MA: Sinauer Associates, ISBN-13: 978-0878939787	

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	1
CO2	1	3	1	1	1
CO3	1	1	3	1	1
CO4	1	1	1	3	1
CO5	1	1	1	1	3
CO6	3	1	1	1	1

BSB211: Developmental Biology of Animals

L T P: 4-0-0 Credit: 4

School : SBSR		**Batch : 2019-20**	
Program: B.Sc.		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 3**	
1	Course Code	**BSB211**	
2	Course Title	**Developmental Biology of Animals**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course Status	Compulsory	
6	Course Objective	1. Introduction to Ultrastructure of sperm and ovum 2. Types of menstrual cycles in mammals 3. Molecular events of fertilization 4. Steps in development of eye	
7	Course Outcomes	After studying this course, students will be able to CO1: Determine Process of Spermatogenesis in humans and its hormonal control CO2: Summarize the Egg types and egg membranes in animals CO3: Describe the Cleavage types and role of yolk in cleavage CO4: Determine the Production of Antibiotics CO5: Analyze the Extra-embryonic membranes in humans CO6: Compare the Placenta: types; structure and function of placenta in humans	
8	Course Description	The course comprises of features of developmental biology processes like gametogenesis, fertilization, embryonic development and their events. It includes concept of potency; introduction to types of stem cells and embryonic stem cells.	
9	Outline syllabus		CO Mapping
	Unit 1	**Gametogenesis**	
	A	Process of Spermatogenesis in humans and its hormonal control; Process of oogenesis in humans and its hormonal control	**CO1**
	B	Ultrastructure of sperm and ovum- changes in sperm body during maturation	
	C	changes in ovum structure during maturation; layers of ovum and their function	
	Unit 2	**Female Reproductive Biology**	
	A	Types of menstrual cycles in mammals- Estrous cycle	**CO2**
	B	menstrual cycle in human females- role of hormones in menstruation	
	C	Egg types and egg membranes in animals	
	Unit 3	**Fertilization**	**CO3**
	A	Physical events of fertilization- changes in sperm before ejaculation, female genital tract environment, features of female reproductive tract that help in sperm motility	
	B	Molecular events of fertilization- changes in sperm before fertilization (capacitation),	

	C	site of fertilization, mechanisms to prevent polyspermy, sperm-egg fusion; Cleavage types and role of yolk in cleavage			**CO4**
	Unit 4	**Embryonic Development**			
	A	Formation of blastula (humans); Morphogenetic movements and process of gastrulation (humans)- formation of epiblast and hypoblast, formation of primitive streak			
	B	Extra-embryonic membranes in humans			
	C	Organogenesis: brain and eye (humans)- organizer and its role; notochord formation; formation of brain vesicles; steps in development of eye			
	Unit 5	**Embryonic Development- associated events**			**CO5**
	A	Placenta: types; structure and function of placenta in humans			
	B	Introduction to *in vitro* fertilization			
	C	Concept of Potency; introduction to types of stem cells and embryonic stem cells			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	Developmental Biology. 6th Edition. Gilbert SF			
	Other References	Comparative Reproductive Biology. Ed: Schatten H, Constantinescu GM. Blaackwell Publishing. 2007			

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**1**	**1**	**1**	**1**
CO2	**1**	**3**	**1**	**1**	**1**
CO3	**1**	**1**	**3**	**1**	**1**
CO4	**1**	**1**	**1**	**3**	**1**
CO5	**1**	**1**	**1**	**1**	**3**
CO6	**3**	**1**	**1**	**1**	**1**

BSZ202: Animal Physiology & Histology I

L T P: 4-0-0 **Credit: 4**

School: SBSR		**Batch : 2019-2022**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 3**	
1	Course Code	**BSZ202**	
2	Course Title	**Animal Physiology and Histology I**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. To make the students know about the basics of animal body organization. 2. In-depth knowledge of different types of body systems and their organisation. 3. To acquire knowledge about how body actually works via coordination of different body systems.	
6	Course Outcomes	CO1: To learn about basic structural organisation; and the various types of body tissues and their structures. CO2: To understand the types and growth mechanism of bones and cartilages. CO3: To learn the fundamentals behind the body response involving nervous system. CO4: To learn about the types and working mechanism of muscular system. CO5: To learn about the histology and functions of human endocrine systems. CO6: To understand the importance of various body systems and their interactions to perform various tasks.	
7	Course Description	The subject provides a deeper basics of physiology and histology with main emphasis over nervous system, muscular system, and endocrine systems. In histology part an in depth knowledge about all the different types of body tissues present at various body locations has been included in the course contents.	
8	Outline syllabus		CO Mapping
	Unit 1	**Study of Tissues**	
	A	Basic structural organisation, Types and classification of epithelial tissue	CO1, CO6
	B	Types and classification connective tissue	CO1, CO6
	C	Types and classification of muscular and nervous tissue	CO1, CO6
	Unit 2	**Study of Bone and Cartilage**	

	A	Structure and types of bone			CO2, CO6
	B	Ossification, bone growth and resorption			CO2, CO6
	C	Structure and types of cartilages			CO2, CO6
	Unit 3	**Nervous System**			
	A	General organization of nervous system			CO3, CO6
	B	Basic structure of nervous system and its working			CO3, CO6
	C	Propagation of nerve impulse			CO3, CO6
	Unit 4	**Muscle**			
	A	Histology of muscle			CO4, CO6
	B	Mechanism of muscle contraction			CO4, CO6
	C	Muscular dystrophy			CO4, CO6
	Unit 5	**Endocrinology**			
	A	Histology and hormone functions of pineal and pituitary glands			CO5, CO6
	B	Histology and hormone functions of thyroid and parathyroid glands			CO5, CO6
	C	Histology and hormone functions of pancreas and adrenal glands			CO5, CO6
	Mode of examination	**Theory**/Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company. 2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology, XI Edition. John Wiley & Sons			
	Other References	1. Victor, P. Eroschenko. (2008). diFore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	1
CO2	1	3	1	1	1
CO3	1	1	3	1	1
CO4	1	1	1	3	1
CO5	1	1	1	1	3
CO6	3	1	1	1	1

BBT205: Anatomy of Angiosperms
L-T-P 4-0-0 **Credit: 4**

School: SBSR		**Batch: 2019-22**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 3**	
1	Course Code	**BBT205**	
2	Course Title	**Anatomy of Angiosperms**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. This course provides a comprehensive introduction to Anatomy of Angiosperms. 2. The course is designed to give students an up-to-date understanding of a wide array of applications of tissues such as Simple and complex tissues (tracheary elements and sieve elements; Pits and plasmodesmata). 3. This course also focuses on concepts of apical meristems how meristems can be used for various industrial/ research applications. 4. The course also highlights the applications of anatomy in systematics, forensics and pharmacognosy.	
6	Course Outcomes	After the successful completion of this course students will be able to: CO1: Explain the introduction and scope of plant anatomy. CO2: Analyze the role of Simple and complex tissues (tracheary elements and sieve elements; Pits and plasmodesmata) in angiosperm plants. CO3: Classify different types of vascular bundles; Structure of dicot and monocot stem. CO4: Explain the development and composition of periderm and lenticels. CO5: Identify different methods of various industries and environmental benefits of use of the angiosperms. CO6: Highlights of the applications of anatomy in systematics, forensics and pharmacognosy.	
7	Course Description	The 'Anatomy of Angiosperms is a course designed to give students knowledge about basic concepts of structure or morphology and the role angiosperm plants maintaining the ecosystem balance. This course throws light on various industries and environmental benefits of use of the angiosperms.	
8	Outline syllabus		CO Mapping
®tr	**Unit 1**	**Structure and Development of Plant Body**	
	A	Introduction and scope of Plant Anatomy	CO1
	B	Internal organization of plant body: root and shoot anatomy; Development of plant body	
	C	Cytodifferentiation and organogenesis during embryogenic development	

	Unit 2	**Tissue system**			
	A	Classification of tissues			CO2
	B	Simple and complex tissues (tracheary elements and sieve elements; Pits and plasmodesmata)			
	C	Ergastic substances. Hydathodes, cavities, lithocysts and laticifers			
	Unit 3	**Apical meristems**			
	A	Organization of shoot apex			CO3
	B	Types of vascular bundles; Structure of dicot and monocot stem			
	C	Structure of dicot and monocot leaf; Organization of root apex; Structure of dicot and monocot root			
	Unit 4	**Vascular Cambium and Wood**			
	A	Secondary growth in root and stem; Structure, function and seasonal activity of cambium			CO4
	B	Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses			
	C	Development and composition of periderm and lenticels			
	Unit 5	**Adaptive and Protective Systems**			
	A	Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and nonglandular, two examples of each)			CO5
	B	stomata (structure and function); Anatomical adaptations of xerophytes and hydrophytes			
	C	Applications of anatomy in systematics, forensics and pharmacognosy			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	Structure, Function and Development. John Wiley and Sons, Inc			
	Other References	1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA. 2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA. 3. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA. 4. Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	1
CO2	1	3	1	1	1
CO3	1	1	3	1	1
CO4	1	1	1	3	1
CO5	1	1	1	1	3
CO6	3	3	3	3	3

BBT201: Mycology and Phycology
L-T-P: 4-0-0 **Credit: 4**

School: SBSR		**Batch : 2019-22**	
Program: B.Sc		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: Term 3**	
1	Course Code	**BBT201**	
2	Course Title	**Mycology and Phycology**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. To prepare students with a basic understanding of fungal and algal characteristics 2. To help the students understand the vegetative, asexual and sexual stages of life cycles of these organisms. 3. To impart knowledge to students about economically important organisms 4. To explain the role of the organisms in the ecosystem	
6	Course Outcomes	CO1: Identify structure and properties of fungi CO2: Distinguish between life cycles of selected fungi. CO3: Describe general characteristics of algae CO4: Compare life cycles of different algal species CO5: Discuss the role of fungi and algae in economy CO6: Develop an overall idea of fungal and algal species, their life stages and their economic importance	
7	Course Description	The course gives an insight into the morphology and physiology of selected algae and fungi, their role in the environment, agriculture, biotechnology, industry and disease. It provides a foundation for careers in microbiology, food industry, environment and biotechnology.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Mycology**	CO1, CO6
	A	Occurrence and distribution, somatic structure, Cell wall composition, hyphal growth	
	B	Nutrition, Thallus organization; heterothallism; Role of fungi in ecosystem	
	C	Saprophytic parasitic, mutualistic and symbiotic relationship with plants and animals; Classification of fungi	
	Unit 2	**Characteristics of Fungi**	CO2, CO6
	A	Characteristics, ecology, thallus organization, life cycle , reproduction with reference to *Olpidium, Rhizopus, Neurospora,*	

	B	*Peziza, Puccinia* (Physiological Specialization),			
	C	*Agaricus, Phytophthora*; Status of Slime molds			
	Unit 3	**Introduction to Phycology**			CO3, CO6
	A	Occurrence and distribution, thallus organization			
	B	Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella			
	C	Methods of reproduction; Significant contributions of important phycologists.			
	Unit 4	**Life cycle of algae**			CO4, CO6
	A	Morphology and life-cycle of *Nostoc and Chlamydomonas*			
	B	*Chara, Vaucheria, Ectocarpus*			
	C	*Fucus* and *Polysiphonia*			
	Unit 5	**Economic Importance of Algae and Fungi**			CO5, CO6
	A	Algae as food supplement; Role of cyanobacteria and selected microalgae in agriculture- biofertilizer; Production of algal pigments, biofuels and hydrogen.			
	B	Role of algae in the environment, agriculture, biotechnology and industry; Role of fungi in biotechnology			
	C	Application of fungi in food industry; Secondary metabolites; Agriculture (Biofertilizers); Mycotoxins			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition. 2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.			
	Other References	Websites as mentioned in slides			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	1
CO2	1	3	1	1	1
CO3	1	1	3	1	1
CO4	1	1	1	3	1
CO5	1	1	1	1	3
CO6	1	1	1	1	1

BSP201: Molecular Biology Lab

L T P: 0-0-3 Credit: 2

School : SBSR		**Batch : Batch : 2020– 23**	
Program: B.Sc**.**		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 3rd**	
1	Course Code	**BSP201**	
2	Course Title	Molecular Biology Lab	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-3	
5	Course Status	Compulsory	
6	Course Objective	1. To familiarize students with sterilization techniques and solution/media preparations etc. 2. To motivate students towards molecular techniques for better genome understanding. 3. To acquaint with principles, technical requirement, scientific and commercial applications in molecular biology. 4. Design and manage techniques for understanding interplay amongst macromolecules.	
7	Course Outcomes	After successfully completion of this course students will be able to: CO1: Demonstrate safe laboratory practices and handle the equipment safely. CO2: Estimate the quality and quantity of nucleic acids. CO3: Amalgamation of tools for plasmid vectors and DNA uptake. CO4: Perform *in silico* analysis for studying genome. CO5: To design primers and carry out amplification of DNA by PCR. CO6: Familiarize students with sterilization techniques and solution/media preparations etc	
8	Course Description	The aim of this course is to acquaint the students about the versatile tools and techniques employed in molecular biotechnology. The course will also provide students with a hands-on understanding of how modern DNA-sequencing technology, along with bioinformatics tools, can be used to discover genetic differences and understand molecular function.	
9	Outline syllabus		CO Mapping
	Unit 1		
	A	**Practical based on introduction to molecular biology lab**	**CO1**
	B	Good lab practices in molecular biology laboratory.	
	C	Preparation of standard solutions for molecular biology experiments	
	Unit 2	**Isolation of Nucleic acids and quantification**	**CO2**
	A	Isolation of DNA from bacteria	
	B	Isolation of RNA from bacteria	
	C	Gel electrophoresis	
	Unit 3	**Practical related to preparation of plasmids and transformations**	**CO3**
	A	Plasmid isolation	
	B	Preparation of competent cells	

	C	Transformation of plasmid into competent cells			
	Unit 4	**Practical related to in silico analysis of genome**			**CO4**
	A	Sequence similiarity search with freely available tools			
	B	Construction of phylogenetic tree			
	C	Identification of motifs and domain in sequences			
	Unit 5	**Practical related to gene amplification**			**CO5**
	A	Designing of primers for CDs and partial sequences			
	B	Performing PCR reactions			
	C				
	Mode of examination	Practical/or Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	Text book/s*	Michael, R. G., Sambrook. J., "Molecular Cloning-A Laboratory Manual", 4th edition, Cold Spring Harbor Laboratory Press, 2012.			
	Other References	1. Davis, L. (2012). Basic methods in molecular biology. Elsevier. 2. Chard, T., Work, T. S., & Work, E. (1987). Laboratory techniques in biochemistry and molecular biology. Elsevier, Amsterdam.			

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**2**	**2**	**1**	**2**
CO2	**2**	**3**	**1**	**2**	**2**
CO3	**2**	**2**	**3**	**1**	**2**
CO4	**2**	**2**	**1**	**3**	**1**
CO5	**2**	**3**	**1**	**1**	**3**
CO6	**3**	**3**	**3**	**3**	**3**

BSP202: Biomolecules Lab

L-T-P: 0-0-3 Credits 2

School: SBSR		**Batch : 2019-2022**	
Program: B.Sc.		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 03**	
1	Course Code	**BSP202**	
2	Course Title	**Biochemistry Lab**	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-3	
	Course Status	Compulsory	
5	Course Objective	1. To understand difference between types of biomolecules 2. To learn qualitative estimation of biomolecules 3. To learn the separation techniques for various biomolecules 4. To understand the enzymatic parameters that indicate proper functioning of living systems	
6	Course Outcomes	After finishing the course, the students will be able to CO1: identify and distinguish between mono-, di-, and oligosaccharides present in different samples CO2: analyse individual compounds present in a particular mixture/ extract and explain different chromatographic techniques CO3: illustrate presence of starch and other plant secondary metabolites in leaf CO4: isolation and quantitation of DNA CO5: illustrate metabolite/ enzymatic markers for particular organs CO6: use biotechniques for identification, separation and or analysis of biomolecules and enzymatic markers in different samples	
7	Course Description	Biochemistry lab course is designed to make students learn the estimation of carbohydrates, lipids, proteins and nucleic acids. The students also learn various techniques such as various types of chromatography used for separation of amino acids and plant secondary metabolites, estimation of various plant secondary metabolites, estimation of biomarkers for hepatic and renal function etc.	
8	Outline syllabus		CO Mapping
	Unit 1	**Practical based on estimation of carbohydrates**	
		Subunit – a and b	CO1, CO6
	Unit 2	**Practical related to estimation and separation of amino acids**	
		Subunit – a and b	CO2, CO6
	Unit 3	**Practical related to estimation of starch**	
		Subunit - b and c	CO3, CO6
	Unit 4	**Practical related to isolation and estimation of nucleic acids**	

		Subunit - c			CO4, CO6
	Unit 5	**Practical related to Practical related to study of enzymes**			
		Subunit - b			CO5, CO6
	Mode of examination	Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	Textbook/s*	Sawhney S.K. and Singh R. **Introductory Practical Biochemistry.**			
	Other References	NA			

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	1	1	1	1
CO2	1	3	1	1	1
CO3	1	1	3	1	1
CO4	1	1	1	3	1
CO5	1	1	1	1	3
CO6	3	3	3	3	3

BSB202: Metabolic Pathways

L T P: 4-0-0 **Credit: 4**

School: SBSR		**Batch : 2019-2022**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 04**	
1	Course Code	**BSB202**	
2	Course Title	**Metabolic Pathways**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1.Carbohydrate Metabolism 2. Lipid metabolism 3. Amino Acid Metabolism 4. Electron Transport Chain 5. Nucleotide Metabolism	
6	Course Outcomes	After studying this course, students will be able to CO1: Evaluate metabolism of carbohydrates by different pathways CO2: Interpret the metabolism of different types of lipids CO3: Determine and differentiate between gluconeogenic and ketogenic amino acids CO4: Analyze and learn the electron transport chain CO5: Differentiate between de novo and salvage pathways for biosynthesis of purines and pyrimidines CO6: Understand metabolic pathways inside living cells such as metabolism of carbohydrates, lipids, nucleic acids and also carbon dioxide fixation.	
7	Course Description	This course contains various metabolic pathways inside living cells such as metabolism of carbohydrates, lipids, nucleic acids and also carbon dioxide fixation. After studying course, students will be able to learn various metabolic processes going inside the body of living cells.	
8	Outline syllabus		CO Mapping
	Unit 1		
	A	Glycolysis	CO1
	B	Glycogenolysis, Kreb's cycle and net energy yield	CO1
	C	Pentose Phosphate pathway and its clinical significance	CO1
	Unit 2		
	A	Beta oxidation of fatty acids and energy yield	CO2
	B	Cholesterol synthesis	CO2
	C	Synthesis of fatty acids	CO2
	Unit 3		
	A	Introduction to gluconeogenic and ketogenic amino acids	CO3

	B	Degradation of amino acids			CO3
	C	Synthesis of amino acids, Urea Cycle			CO3
	Unit 4				
	A	ATP synthase and proton transfer during electron transfer			CO4
	B	Coupling of electron transport to oxidative phosphorylation			CO4
	C	Inhibitors of electron transport			CO4
	Unit 5				
	A	Biosynthesis of purines			CO5
	B	Biosynthesis of pyrimidines			CO5
	C	Structure of DNA and RNA			CO5
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	Nelson D.L., Cox M. M., "Principles of Biochemistry" W. H. Freeman, 2012.			
	Other References	Stryer L., "Biochemistry", W. H. Freeman, 2010. Jain JL., "Principles of Biochemistry", S. Chand Publications.			

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**2**	**1**	**2**	**1**
CO2	**3**	**3**	**2**	**1**	**1**
CO3	**3**	**3**	**1**	**1**	**2**
CO4	**3**	**3**	**2**	**1**	**1**
CO5	**3**	**3**	**2**	**1**	**1**
CO6	**3**	**3**	**3**	**3**	**3**

BSB205: Genetic Engineering

L T P: 4-0-0 **Credit: 4**

School: SBSR		**Batch : 2019-2022**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 4**	
1	Course Code	**BSB205**	
2	Course Title	**Genetic Engineering**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. This course provides a comprehensive introduction to fundamentals and applications of genetic engineering 2. The course is designed to give students an up-to-date understanding of a wide array of techniques that are used in genetic manipulation 3. This course also focuses on various DNA sequencing and DNA amplification techniques 4. The course also highlights the modern methods of gene and protein probing	
6	Course Outcomes	After the successful completion of this course students will be able to: CO1: Identify various molecular tools for genetic engineering; host cells and right kind of enzymes to perform DNA digestion, ligation etc. CO2: Classify different kinds of cloning vectors and their uses. CO3: Analyze the use of Polymerase chain reaction in molecular cloning along and describe various DNA sequencing techniques. CO4: Explain different ways of cloning blunt ended DNA fragments and transfection as well as transformation methods. CO5: Recognize different types of gene libraries and apply different techniques of probing gene libraries. CO6: This course provides a comprehensive introduction to fundamentals and applications of genetic engineering	
7	Course Description	The 'Genetic Engineering' course outlines the definition, procedure and study of molecular tools in genetic engineering for undergraduate students. This course encompasses the detailed procedure of genetic engineering so that students can become familiar with the Recombinant DNA Technology and its applications.	
8	Outline syllabus		CO Mapping
	Unit 1	**Molecular Tools of Genetic Engineering**	
	A	Restriction enzymes Type I, II and III	

	B	DNA polymerase and RNA polymerase' reverse transcriptase			CO1
	C	Modifying enzymes terminal deoxynucleotidyl transferase, polynucleotide kinase, Phosphatases and DNA ligase			
	Unit 2	**Cloning Vectors**			
	A	Introduction to cloning vectors;			CO2
	B	Phage vectors; cosmid vectors; phagemid vectors;			
	C	Plasmid vectors BAC vectors and YAC vectors			
	Unit 3	**Nucleic Acid Isolation and Amplification**			
	A	Isolation of nucleic acid; PCR and its application			CO3
	B	cDNA synthesis; RT-PCR			
	C	Nucleic acid sequencing			
	Unit 4	**Cloning Techniques**			
	A	Steps to cloning; Cloning after restriction digestion			CO4
	B	blunt and cohesive end ligation; creation of restriction sites by PCR			
	C	cloning using linkers and adapters; cloning after homopolymer tailing; Strategies for cloning PCR products – TA cloning			
	Unit 5	**Techniques of Genetic engineering**			
	A	Library construction			CO5
	B	DNA hybridization, colony hybridization and in-situ hybridization			
	C	Screening methods; Blotting techniques (Southern, Northern and Western blotting)			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	**Genomes 3.** Brown TA. Garland Science Publishing @ 2007. ISBN 08153-41385.			
	Other References	1. **Molecular Biotechnology. Principles and Applications.** 3rd Edition. Glick BR and Pasternak JJ. ASM Press @2003. ISBN 1-55581-224-4. 2. **Gene cloning and DNA Analysis- An Introduction.** 6th Edition. Wiley-Blackwell. Brown TA @2010.			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	1
CO2	1	3	1	1	1
CO3	1	1	3	1	1
CO4	1	1	1	3	1
CO5	1	1	1	1	3
CO6	3	3	3	3	3

BSB206: Enzyme Technology

L T P: 4-0-0 Credit: 4

School: SBSR		**Batch : 2019-2022**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 04**	
1	Course Code	**BSB206**	
2	Course Title	**Enzyme Technology**	
3	Credits	4	
4	Contact Hrs. (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1.Introduction to Enzymes, their classification and nomenclature 2.Factors affecting enzymatic catalysis 3. Enzyme substrate kinetics 4.Isolation, purification and Immobilization of Enzymes 5. Applications of enzymes in various industries	
6	Course Outcomes	After studying this course, students will be able to CO1: Get an overview on enzymes, their nomenclature and factors affecting enzyme activity CO2: Understand the factors affecting rate of biochemical reactions, lock and key as well as induced fit hypothesis CO3: Learn kinetics of enzyme catalysis as well as inhibition reactions CO4: Paraphrase the isolation, purification and immobilization of enzymes CO5 : Implement use of enzymes in leather, dairy, pharmaceutical, food processing and various other industries for human welfare CO6: To understand and learn the basics of enzyme technology and apply them in various fields for commercial usage and research purposes for the benefit of human beings.	
7	Course Description	The course comprises of the study of enzymes, their nomenclature, classification etc. It comprises of the Fischer's Lock and key as well as Koshland's Induced fit theory of enzyme substrate reaction, enzyme kinetics and applications of enzymes in various industrial sectors.	
8	Outline syllabus		CO Mapping
	Unit 1		
	A	Enzymes as Catalysts: Overview--Proteins as catalysts (Historical background); Enzyme characteristics and properties	CO1
	B	Enzyme nomenclature & classification; EC number of enzymes	CO1
	C	Factors affecting Enzyme Activity; Co-enzyme; Co-factors	CO1
	Unit 2		

	A	Factors affecting the rate of chemical reactions, collision theory, activation energy and transition state theory			CO2
	B	Catalysis, reaction rates and thermodynamics of reaction. Catalytic power and specificity of enzymes (concept of active site)			CO2
	C	Fischer's lock and key hypothesis, Koshland's induced fit hypothesis			CO2
	Unit 3				
	A	Kinetics of single substrate reactions			CO3
	B	Enzyme inhibition; Irreversible and reversible inhibition, Competitive			CO3
	C	non-competitive and un-competitive inhibition			CO3
	Unit 4				
	A	Isolation and purification of enzymes; Localization of proteins in various organelles			CO4
	B	Enzyme Immobilization: Adsorption, Matrix entrapment, Encapsulation			CO4
	C	Cross linking, covalent binding and their examples; Advantages and disadvantages of different immobilization techniques			CO4
	Unit 5				
	A	Industrial and Clinical Applications of Enzymes: Comprehensive Account Applications in beverage industry			CO5
	B	Applications in leather industry, Applications in food processing industry			CO5
	C	Applications in dairy industry, Applications in pharmaceutical industry			CO5
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	Palmer T., Bonner P. L., *Enzymes: Biochemistry, Biotechnology, Clinical Chemistry*, Woodhead Publishing (2007)			
	Other References	Lubert Stryer: Biochemistry, WH Freeman, USA (2002)			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	1
CO2	1	3	1	2	1
CO3	1	1	2	1	2
CO4	1	2	2	3	1
CO5	1	1	1	2	3
CO6	3	3	3	3	3

BSB207: Immunology

L T P: 4-0-0 **Credit: 4**

School: SBSR		**Batch : 2019-2022**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 04**	
1	Course Code	**BSB207**	
2	Course Title	**Immunology**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. Understand the concepts of immune system, immunity, immune responses, cells and organs of immune system 2. Describe about antigens, antibodies and their types & properties, qualitative and quantitative analysis of antigens or antibodies for diagnostic purposes, role of molecules like MHC and cytokines in generation of immune response 3. Explore immunology as a basic toll for medical applications	
6	Course Outcomes	CO1: Understand immune system, immunity and immune response. CO2: Describe cells and organs of immune system. CO3: Illustrate about antigens, antibodies and their types & properties. CO4: Demonstrate the qualitative and quantitative analysis of antigens or antibodies for diagnostic purposes. CO5: Identify the role of molecules like MHC and cytokines in generation of immune response. CO6: Explore immunology as a basic tool for medical applications.	
7	Course Description	This course will cover the major topics in Immunology, including immune system, lines of defense, immunity, immune response, cells and organs of immune system, "antigens, antibodies and their types & properties", qualitative and quantitative analysis of antigens or antibodies for diagnostic purposes, "role of molecules like MHC and cytokines in generation of immune response".	
8	Outline syllabus		CO Mapping
	Unit 1	**Immune responses**	CO1, CO6
	A	Innate and acquired immunity, humoral and cell mediated immune response	
	B	Lines of defense and various barriers	

	C	Clonal nature of immune response, Primary and secondary immune response			
	Unit 2	**Cells and organs of Immune system**			CO2, CO6
	A	Primary and secondary lymphoid organs, their structure and function			
	B	Cells of immune system; hematopoiesis and differentiation			
	C	Structure and role of B and T lymphocytes, NK cells, macrophages, Dendritic cells, mast cells, eosinophil's, basophils and neutrophils			
	Unit 3	**Antigen and Antibody**			CO3, CO6
	A	Antigen and Immunogen, antigenicity vs immunogenicity, properties of antigens			
	B	Antibody molecule, types and structure			
	C	Role in immune response, monoclonal antibody and hybridoma technology			
	Unit 4	**Antigen Antibody Interaction**			CO4, CO6
	A	Antigen antibody interaction: Immunodiffusion (double and radial)			
	B	RIA & ELISA			
	C	Immunoelectrophoresis			
	Unit 5	**MHC and Cytokines**			CO5, CO6
	A	MHC molecule and its types, structure and their function			
	B	Cytokines and their role in immune response			
	C	Overview of hypersensitivity and autoimmunity			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	Kuby Immunology,7th Edition-R.A. Goldsby, Thomas			
	Other References	1. Immunology-A short course,4th Edition-Eli Benjamini, Richard Coico, Geoffrey Sunshine, (Wiley-Liss). 2. Fundamentals of Immunology, William paul 3. Immunology, By Roitt and others.			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	1
CO2	1	3	1	1	1
CO3	1	1	3	1	1
CO4	1	1	1	3	1
CO5	1	1	1	1	3
CO6	3	3	3	3	3

BSB212: Medical Biotechnology

L T P: 4-0-0 **Credit: 4**

School: SBSR		**Batch: 2019-2022**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 04**	
1	Course Code	**BSB212**	
2	Course Title	**Medical Biotechnology**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. To acquire a fundamental knowledge of Medicinal Biotechnology 2. To have knowledge of Host Pathogen interactions 3. To have knowledge of Microbial and parasitic diseases and its treatment 4. To have knowledge of Immunotherapy, Gene and Stem Cell therapy and medical applications	
6	Course Outcomes	After successfully completion of this course students will be able to: CO1. Understand basics of Host Pathogen interactions. CO2. Clinical Diagnosis and treatment of Bacterial, Viral and Parasitic diseases. CO3. Determine tests for Infectious Diseases transmission. CO4. Evaluation of Water and Food borne diseases and its prevention and treatment. CO5. Concepts of Immune response to infection, Immunotherapy in various diseases including cancer. CO6. Review the future perspectives, medical importance and ethical issues related with stem cell technology in treating diseases.	
7	Course Description	To acquire a fundamental and advanced knowledge of Medicinal Biotechnology, Host Pathogen interactions, Microbial and parasitic diseases and its treatment, Immunotherapy, Gene and Stem Cell therapy and medical applications.	
8	Outline syllabus		CO Mapping
	Unit 1	**Host pathogen interactions**	CO1, CO2
	A	Host pathogen interactions in disease process	CO1
	B	Protective immune response in Bacterial, Viral and Parasitic diseases	CO2
	C	Clinical diagnosis of diseases; Molecular Genetics of the host and the pathogen	CO2
	Unit 2	**Microbial Diseases**	CO2, CO3, CO4

	A	Disease reservoirs; Epidemiological terminologies; infectious disease transmission			CO2, CO3
	B	Disease transmitted by animals, insects and ticks, Food and water borne diseases			CO3, CO4
	C	Public health and water quality; Pathogenic fungi; Emerging and resurgent infectious diseases.			CO4
	Unit 3	**Immunotherapy**			
	A	Immunotherapy; Monoclonal antibodies and their role in cancer			CO5
	B	Role of recombinant interferons; Immunostimulants			CO5
	C	Immunosuppressors in organ transplants; Role of cytokine therapy in cancers			CO5
	Unit 4	**Gene Therapy**			CO6
	A	Gene therapy and its types; Intracellular barriers to gene delivery			CO6
	B	Overview of inherited and acquired diseases for gene therapy			CO6
	C	Retro and adeno virus mediated gene transfer; Liposome and nanoparticles mediated gene delivery.			CO6
	Unit 5	**Cellular therapy**			CO7, CO8
	A	Stem cells: definition, properties and potency of stem cells; Sources: embryonic and adult stem cells			CO7
	B	Role of adult and embryonic stem cells; Clinical applications.			CO7, CO8
	C	Concept of tissue engineering; Role of scaffolds; Role of growth factors			CO8
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	Pongracz J., Keen M., “Medical Biotechnology”, Elsevier Health Sciences, 2009.			
	Other References	1. Willey J., Sherwood L., Woolverton C., “Prescott’s Microbiology”, McGraw-Hill, 2010. 2. Collier L., Balows A., Sussman M., “Topley and Wilson's Textbook on principles of Bacteriology, Virology and Immunology”, Holder Education Publication, 1998. 3. Black J.G., “Microbiology: Principles and Explorations”, Wiley, 2012.			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	1
CO2	1	3	1	1	1
CO3	1	1	3	1	1
CO4	1	1	1	3	2
CO5	1	1	1	1	3
CO6	1	1	1	1	3

BSP205: Genetic Engineering Lab

L T P: 0-0-3 **Credit: 2**

School : SBSR		**Batch : 2019-22**			
Program: B.Sc.		**Current Academic Year: 2019-20**			
Branch: Biotechnology		**Semester: 04**			
1	Course Code	**BSP205**			
2	Course Title	**Genetic Engineering Lab**			
3	Credits	2			
4	Contact Hours (L-T-P)	0-0-3			
	Course Status	**Compulsory**/Elective			
5	Course Objective	To give students a introduction and hands on basic experiments of genetic engineering technique			
6	Course Outcomes	CO1: Perform experiments on DNA isolation from biological resource and understanding different methods for DNA isolation CO2: Perform experiments on RNA isolation. CO3: Validation of isolated DNA and RNA content. CO4: Amplification of particular gene of interest by PCR method. CO5: Validation of amplified gene by electrophoresis method. CO6: Performing basic experiments of Genetic engineering technique.			
7	Course Description	This course is designed to make students a thorough understanding of Database usage, tools and software for each bioinformatics applications			
8	Outline syllabus				CO Mapping
	Unit 1	**DNA isolation**			CO1, CO6
	Unit 2	**RNA isolation**			CO2, CO6
	Unit 3	**Validation of isolated DNA and RNA**			CO3, CO6
	Unit 4	**Amplification of specific gene of interest by PCR method**			CO4, CO6
	Unit 5	**Validation of amplified gene by electrophoresis method**			CO5, CO6
	Mode of exam	Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	Text book/s*	Brown T.A, "Gene Cloning and DNA Analysis:An Introduction", John Wiley & Sons, 2010.			
	Other References	1. Old R.W and Primrose S.B., "Principles of Gene Manipulation", Blackwell Scientific Publication, 2002. 2. Dale W., von Schantz M. and Plant N., "From Genes to Genomes: Concepts and Applications of DNA Technology", John Wiley, 2011.			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	1
CO2	1	3	1	1	1
CO3	1	1	3	1	1
CO4	1	1	1	3	1
CO5	1	1	1	1	3
CO6	3	3	3	3	3

BSP210: Enzyme Technology & Immunology Lab

L T P: 0-0-3 **Credit: 2**

School: SBSR		**Batch: 2019-22**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 04**	
1	Course Code	**BSP 206**	
2	Course Title	**ENZYME TECHNOLOGY & IMMUNOLOGY LAB**	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-3	
	Course Status	**Compulsory**	
5	Course Objective	To carry Practical Experiments related to Microbiology 1. Carry out the experiment related to identification of the enzymes present in different biological samples. 2. Carry out the experiment of Enzymes production from different biological sources 3. Determine Microbial enzyme metabolic activity of lipase. 4. Determine Microbial enzyme metabolic activity of protease. 5. Determine Microbial enzyme metabolic activity of amylase. 6. To identify blood group in a given sample. 7. To isolate serum from given blood sample.	
6	Course Outcomes	After successfully completion of this practical course students will be able to: CO1: Learn the identification of the enzyme activity present in different biological samples CO2: Evaluate and perform isolation of various enzymes from microorganisms. CO3: Evaluate and perform analysis of various enzyme activity against their target molecules. CO4: Learn to identify blood group in a given sample. CO5: Learn to isolate serum from given blood sample. CO6: Overall learning about enzyme's isolation, activity determination and immobilization along with blood group determination and serum isolation.	
7	Course Description	To Plan and carry out the experiment of enzyme isolation and determine enzyme's activity for carbohydrates, lipids, and protein. To plan and carry out experiments related to blood group determination.	
8	Outline syllabus		CO Mapping
	Unit 1	Identification of the enzymes present in different biological samples	CO1, CO6
		Isolation of enzymes from different biological sources	
	Unit 2	Microbial production of enzymes (Amylase)	CO1, CO6
		Estimation of enzyme activity (Amylase)	

	Unit 3	Demonstration of Enzyme Activity (Starch Hydrolysis by amylase			CO2, CO3, CO6
		Demonstration of Enzyme Activity (Lipid Hydrolysis by Lipase			CO2, CO3, CO6
	Unit 4	Demonstration of Enzyme Activity (protein Hydrolysis by Protease			CO4, CO6
		Enzyme Immobilization by Gel Entrapment Method			CO6
	Unit 5	To identify blood group in a given sample.			CO5, CO6
		To isolate serum from given blood sample.			CO5, CO6
	Mode of examination	Practical and Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	Textbook/s*	1. Practical Enzymology by Hans Bisswanger Wiley VCH; 4th edition. **ISBN-10:** 3527320768			
	Other References	A Practical Book for Enzyme Technology by Lin Ying. Chemical Industry Press, **ISBN-10:** 7122037010			

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**1**	**1**	**1**	**1**
CO2	**1**	**3**	**1**	**1**	**1**
CO3	**1**	**1**	**3**	**1**	**1**
CO4	**1**	**1**	**1**	**3**	**1**
CO5	**1**	**1**	**1**	**1**	**3**
CO6	**3**	**3**	**3**	**3**	**3**

BSB302: Plant Biotechnology

L-T-P: 4-0-0 **Credit: 4**

School: SBSR		**Batch: 2019-2022**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 05**	
1	Course Code	BSB302	
2	Course Title	Plant Biotechnology	
3	Credits	4	
4	Contact Hrs (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. To introduce students with the basic concepts and techniques involved in Plant Biotechnology 2. Learn how applications of Plant Biotechnology are applied for human, social and environmental welfare	
6	Course Outcomes	1. The student will be able to understand the concept of totipotency, concept of culture media for plants and its formulations. 2. The student will learn about the culturing methods in Plant Tissue Culture. 3. The student will be able to explain the process of zygotic and somatic embryogenesis. 4. The student will be able to demonstrate the process of micropropagation and its utility. 5. The student will learn about production and optimization of secondary metabolites by using different cultural techniques. 6. The students will learn about the basic concepts of plant tissue culture and its application for human, social and environmental welfare.	
7	Course Description	Help student to understand the concept of totipotency, culture media for plants, its formulations and the culturing methods in Plant Tissue Culture. The student will be able to explain the process of embryogenesis, demonstrate the process of micropropagation and its utility. Student will learn about optimized production of secondary metabolites by using culture techniques.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction of plant Biotechnology**	**CO1, CO6**
	A	History of plant tissue culture	CO1, 6
	B	Concept of totipotency	CO1, 6
	C	Media composition & Growth Hormones	CO1, 6
	Unit 2	**Culture Initiation**	**CO2, CO6**
	A	Explant; Callus Initiation	CO2, 6
	B	maintenance of callus, Subculture	CO2, 6
	C	Cytodifferentiation- advantage and disadvantage	CO2, 6
	Unit 3	**Somatic Embryogenesis**	**CO3, CO6**

	A	Somatic and zygotic embryo			CO3, 6
	B	Process of embryogenesis; isolation of protoplast & its fusion			CO3, 6
	C	Somatic and zygotic embryo			CO3, 6
	Unit 4	**Micropropagation**			**CO4, CO6**
	A	Micropropagation technique			CO4, 6
	B	Purpose of micropropagation			CO4, 6
	C	Factors responsible for micropropagation			CO4, 6
	Unit 5	**Production of Secondary Metabolism**			**CO5, CO6**
	A	Concept of Primary & Secondary metabolites			CO5, 6
	B	Production and optimization of secondary metabolites, Elicitor			CO5, 6
	C	Hairy root culture: Advantage , Disadvantage			CO5, 6
	Mode of examination	Theory/Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	• Bhojwani S.S., Dantu P.K., "Plant Tissue Culture: An Introductory Text", Springer, 2013. • Stewart C.N., "Plant Biotechnology and Genetics: Techniques and Applications", Wiley-Interscience' 2008.			
	Other References	Oksman-Caldentey K-M., "Plant Biotechnology and Transgenic Plants; CRC Press, 2002.			

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**2**	**1**	**1**	**1**
CO2	**2**	**3**	**1**	**1**	**2**
CO3	**1**	**2**	**3**	**1**	**2**
CO4	**1**	**1**	**1**	**3**	**2**
CO5	**1**	**2**	**1**	**1**	**3**
CO6	**3**	**3**	**3**	**3**	**3**

BSB303: Bioinformatics

L T P: 4-0-0 **Credit: 4**

School: SBSR		**Batch : 2019-2022**
Program: B.Sc. (H)		**Current Academic Year: 2019-20**
Branch: Biotechnology		**Semester: 05**
1	Course Code	**BSB303**
2	Course Title	**Bioinformatics**
3	Credits	4
4	Contact Hrs. (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	**1.** To acquire a fundamental knowledge of bioinformatics by studying an overview of bioinformatics, fields and their scope in India as well as abroad. **2.** To have introduction about database design and Biological database. **3.** To attain knowledge about data storage model, retrieval of information and integration. **4.** To learn the procedure of sequence alignment and phylogenetic analysis by using different online and offline tool along with their algorithms. **5.** To understand about gene organization, genome sequencing, gene prediction methods and motif search methods. **6.** To have a clear-cut idea about bioinformatics scope, concepts and major databases/tools/softwares with their algorithms used for various applications.
6	Course Outcomes	**CO1:** Understand about overview of bioinformatics scope and their disciplines. Generation of large-scale data in the field of molecular biology. **CO2:** Review of database source, database management system, Biological databases and their classification. Sequences databases and specialized databases. **CO3:** To attain knowledge about data storage model/format, retrieval of information and integration. **CO4:** Understanding about different sequence formats. Perform sequence alignment and phylogenetic prediction with different tools/softwares with algorithm. **CO5:** To apply different techniques for gene prediction, motif search and genome sequencing analysis. **CO6:** Basic knowledge of various bioinformatics concepts, scope, database usage, tools and software used for each application along with their algorithms.

7	Course Description	To acquire a fundamental knowledge of basic computational biology by studying, designing and analyzing *in-silico* experiments. To learn the procedure of sequence alignment and its application in molecular phylogenetics. To understand different techniques used for gene prediction and creation of biological databases.			
8	Outline syllabus				**CO Mapping**
	Unit 1	**Introduction to Bioinformatics**			**CO1**
	A	Introduction to bioinformatics; Scope and importance			CO1
	B	Large scale generation of molecular biology data; Different fields in bioinformatics			CO1
	C	Omics; Bioinformatics scenario in India & the rest of the world			CO1
	Unit 2	**Databases**			**CO2**
	A	Introduction to data types and Sources; Classification and Presentation of Data; Quality of data; Private and Public data sources			CO2
	B	General Introduction of Biological Databases: Nucleic acid databases, Protein databases			CO2
	C	Specialized Genome databases, Structure databases			CO2
	Unit 3	**Data Storage and Integration**			**CO3**
	A	Flat files, relational, object-oriented databases and controlled vocabularies			CO3
	B	File Format (GenBank, DDBJ, FASTA, PDB, SwissProt); Introduction to Metadata			CO3
	C	File Storage; Boolean Search and Fuzzy Search, Data integration			CO3
	Unit 4	**Sequence Alignments and Analysis**			**CO4**
	A	Biological sequences and Alignment Methods			CO4
	B	Global and Local alignment, Pairwise alignment and Multiple sequence alignment			CO4
	C	Phylogenetic tree analysis			CO4
	Unit 5	**Gene, Genome and Analysis**			**CO5**
	A	Structure of Prokaryotic and Eukaryotic gene			CO5
	B	DNA and genome sequencing Motif and consensus; Gene Expression			CO5
	C	Gene finding composition-based finding, sequence motif-based finding			CO5
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	Xiong Jin “Essential Bioinformatics”, Cambridge University Press.2006.			

	Other References	1. Attwood TK., "Introduction to Bioinformatics", Pearson Education, 2006. 2. J. S, Ignacimuthu.S, "Basic Bioinformatics", Narosa, 2013. 3. Roy Darbeshwar., "Bioinformatics", Narosa,2009.	

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**1**	**1**	**1**	**1**
CO2	**1**	**3**	**1**	**1**	**1**
CO3	**1**	**1**	**3**	**1**	**1**
CO4	**1**	**1**	**1**	**3**	**1**
CO5	**1**	**1**	**1**	**1**	**3**
CO6	**3**	**3**	**3**	**3**	**3**

BSB304: Intellectual Property Rights

L T P: 4-0-0 **Credit: 4**

School: SBSR		**Batch : 2019-2022**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 05**	
1	Course Code	**BSB304**	
2	Course Title	**Intellectual Property Rights**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	To elucidate the ways of protection of intellectual property and research with the help of WIPO and its different treaties. To correlate different instruments of IP protection and their enforcement in different countries. To understand different ethical issues related to genetic engineering, drug development and release of GMO in environment	
6	Course Outcomes	By the end of this course students will be able to: CO1: Administer and follow the guidelines of WIPO. CO2: Understand the patents, copyrights and trademarks. CO3: Apply and follow regulatory steps related with use of GMOs. CO4: Enforce instructions issued under TRIPS, GATT and biodiversity bill. CO5: Understand the utility of IPRs in franchising. CO6: Understand the utility of IPRs in biotechnology.	
7	Course Description	*Intellectual property* (IP) includes intangible creations of the human intellect, and primarily encompasses copyrights, patents, and trademarks. It also includes other types of rights, such as trade secrets, publicity rights, moral rights, and rights against unfair competition. Present paper deals with knowledge of types and protection of different IPRs.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Intellectual Property Rights**	**CO1, CO6**
	A	The concept of intellectual property	
	B	WIPO- history, mission and activities, structure, administration	
	C	Indian laws and treaties for IPR	
	Unit 2	**Patents**	**CO2, CO3, CO6**
	A	Patents, Patents -Conditions of Patentability	
	B	Infringement, Compulsory Licenses	
	C	Exploitation of the Patented Invention	
	Unit 3	**Copyrights**	**CO2, CO3, CO4, CO6**

	A	Copyright and related rights			
	B	subject matter of copyright protection, ownership of copyright			
	C	piracy and infringement and their remedies			
	Unit 4	**Trademarks and Service Marks**			**CO2, CO3, CO4, CO5, CO6**
	A	Definitions Signs Which May Serve as Trademarks			
	B	Criteria of Protectability, Trademark Piracy, and Counterfeiting			
	C	Franchising, Character Merchandising			
	Unit 5	**IPR in Biotechnology**			**CO3, CO4, CO6**
	A	Introduction, Adoption and Dissemination			
	B	Need for Protection of Traditional Knowledge, Patenting of biological material and transgenic organisms			
	C	GATT and TRIPS, biodiversity bill-2002			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	Managing intellectual capital : organizational, strategic and policy dimensions Oxford Univ. press 2005 Teece, David J.			
	Other References	● Agriculture and intellectual property rights: economic, institutional and implementation issues in Biotechnology CABI Publishing 2000 by Santaniello, V. (ed.) et.al. ● Law relating to patents, trademarks, copyright designs geographical indications. Universal Law Publishing house by Wadehra, B. L.			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	1
CO2	3	3	1	1	1
CO3	3	3	2	1	1
CO4	2	2	2	1	1
CO5	2	2	2	2	3
CO6	3	3	3	3	3

BSB311: Medical Microbiology

LTP: 4-0-0 Credit – 04

School : SBSR		**Batch : 2019-2022**	
Program: B.Sc. H		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 5**	
1	Course Code	BSB311	
2	Course Title	**Medical Microbiology**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course Status		
6	Course Objective	The objective of this course is to provide basic knowledge of microbes along with their medical importance. This course will help students to understand the nature of various microorganisms such as bacteria and viruses.	
7	Course Outcomes	After successfully completion of this course students will be able to: CO1 Identify general microorganisms in human body CO2 Comprehend the characteristics and pathogenesis of Gram positive bacteria CO3 Comprehend the characteristics and pathogenesis of Gram negative bacteria CO4 Compare diseases caused by different viruses CO5 Identify fungal and protozoal pathogens CO6 To understand basic knowledge of microbes along with their medical importance.	
8	Course Description	Course is composed of medical importance of various bacteria. This includes the general features, disease caused, their importance in the area of medical microbiology.	
9	Outline syllabus		CO Mapping
	Unit 1	**HUMAN MICROFLORA AND PATHOGENS**	**CO1**
	A	Normal microflora of human body	CO1
	B	carriers, septic shock, septicemia, pathogenicity	CO1
	C	virulence factors, toxins, biosafety levels	CO1
	Unit 2	**GRAM POSITVE BACTERIA**	**CO1 CO2**
	A	Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: Staphylococcus	**CO1 CO2**
	B	Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: Clostridium	**CO1 CO2**

	C	Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: Mycobacterium			**CO1 CO2**
	Unit 3	**GRAM NEGATIVE BACTERIA**			**CO1 CO3**
	A	Morphology, pathogeneis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria Neisseria			**CO1 CO3**
	B	Morphology, pathogeneis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria Haemophilus			**CO1 CO3**
	C	Morphology, pathogeneis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria Vibrio			**CO1 CO3**
	Unit 4	**DISEASES CAUSED BY VIRUSES**			**CO1 CO4**
	A	Rhabdoviruses, Reoviruses			**CO1 CO4**
	B	Pox virus, Herpes virus, Papova virus,			**CO1 CO4**
	C	Retro viruses (including HIV/AIDS) and Hepatitis viruses.			**CO1 CO4**
	Unit 5	**FUNGAL AND PROTOZOAN INFECTIONS**			**CO1 CO5**
	A	Dermatophytoses (Trichophyton) Subcutaneous infection (Sporothrix)			**CO1 CO5**
	B	systemic infection (Histoplasma) and opportunistic fungal infections (Candidiasis/Aspergillosis)			**CO1 CO5**
	C	Gastrointestinal infections (Amoebiasis), Blood-borne infections (Leishmaniasis, Malaria)			**CO1 CO5**
	Mode of examination	Theory / practical			Theory
	Weightage Distribution	CA	MTE	ETE	
		30 %	20 %	50 %	
	Text book/s*	1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.			
	Other References	2. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier. . 3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	1	1
CO2	1	3	1	1	1
CO3	1	1	3	1	1
CO4	2	2	1	3	2
CO5	3	2	1	2	3
CO6	3	3	3	3	3

BBT302: Economic Botany

L-T-P 4-0-0 **Credit: 4**

School: SBSR		**Batch : 2019-2022**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Botany		**Semester: 5**	
1	Course Code	**BBT302**	
2	Course Title	**Economic Botany**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory/Elective/Open Elective	
5	Course Objectives	To understand basis of Economical plants From this course students will be able to learn about different types of Origin of Cultivated Plants, properties and their Economic importance.	
6	Course Outcomes	After successfully completion of this course students will be able to: 1. Identify different types Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions. 2. Study of origin, morphology, processing & uses: Wheat, Rice, Chick pea, Pigeon pea and fodder legumes, fibers. 3. Study of Economic importance with special reference to fennel, saffron, clove and black pepper, Tea and Coffee. 4. Study of general description, classification, extraction, their uses and health implications groundnut and essential and nonessential oil. 5. Therapeutic and habit-forming drugs with special reference to Cinchona, Digitalis, Papaver, and Cannabis; Tobacco (Morphology, processing, uses and health hazards). 6. To be able to understand and apply the economics in botany	
7	Course Description	This subject is designed to make students familiar about Economical importance of biological plants and their medical value for human beings as well as research.	
8	Outline syllabus		CO Mapping
	Unit 1	**Origin of Cultivated Plants**	CO1, CO2
	A	Brief introduction of Cultivated Plants	
	B	Crop domestication and loss of genetic diversity	
	C	importance of germplasm diversity,	
	Unit 2	Spices and Beverages	
	A	Listing of important spices, their family and part used	CO2, CO3
	B	Economic importance with saffron, clove and black pepper	
	C	Tea, Coffee (morphology, processing & uses)	
	Unit 3	**Sources of oils and fats**	CO1, CO3
	A	General description, classification, extraction and their uses	

	B	Health implications of groundnut, coconut, linseed, soybean and mustar.			
	C	Essential Oils: Extraction methods, comparison with fatty oils & their uses.			
	Unit 4	**Drug-yielding plants**			CO2, CO4
	A	Study of therapeutic and habit-forming drugs			
	B	Morphology, processing of Cinchona, Digitalis, Papaver and Tobacco			
	C	Application and health hazards of Cinchona, Digitalis, Papaver and Tobacco			
	Unit 5	**Fibers**			C01, C05
	A	Classification based on the origin of fibers			
	B	Study of morphology, extraction and uses of Cotton and Coir.			
	C	Morphology, extraction and uses of jute			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.			
	Other References	2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.			

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**1**	**1**	**1**	**1**
CO2	**1**	**3**	**1**	**1**	**1**
CO3	**1**	**1**	**3**	**1**	**1**
CO4	**1**	**1**	**1**	**3**	**1**
CO5	**1**	**1**	**1**	**1**	**3**
CO6	**3**	**3**	**3**	**3**	**3**

BSP305: Plant Biotechnology Lab.

L-T-P 0-0-3 Credits 2

School: SBSR		**Batch: 2019-2022**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 05**	
1	Course Code	**BSP305**	
2	Course Title	**Plant Biotechnology Laboratory**	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-3	
	Course Status	Compulsory	
5	Course Objective	To learn methods of cell isolation from tissues and differentiate between animal and plant cell culture techniques.	
6	Course Outcomes	CO1: Identify standard operating procedures for laboratory equipments. CO2: Estimate free drug and drug-conjugates by spectrophotometry. CO3: Isolate and separate DNA (by electrophoresis) from animals pre-treated with drugs. CO4: Prepare drug-conjugates and purify by column chromatography. CO5: Separate total proteins by PAGE and visualize protein bands by Coomassie blue staining method. CO6: Design and conduct an experiment and analyze experimental results and communicate data through writing.	
7	Course Description	To Plan and carry out the experiment and to learn methods of cell isolation from tissues and determine enzyme activity and inhibition of different proteins. Design and conduct the experiment.	
8	Outline syllabus		CO Mapping
	Unit 1	Basics about Plant Cell Culture	CO1,CO7
	Unit 2	To Prepare the material required for various cell culture practices in sterile conditions	CO1,CO2
		To Prepare serum from the given blood sample	CO1,CO5,CO7
	Unit 3	Purify DNA and separate DNA by agarose gel electrophoresis.	C03,CO6,CO7
		To prepare desired medium for the plant culture	CO7

	Unit 4	Conduct an experiment to detect glucose from given sample.			CO4,CO5,CO 6
	Unit 5	To prepare permanent slide using the given section like stem, root and leaf			CO6,CO7
		To grow organic Lemon/rose artificially			CO7
	Mode of examination	Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	Textbook/s*	Freshney R.I., "Culture of Animal Cells: A Manual of Basic Technique", Wiley-Liss, 2005.			
	Other References	Boyer R.F., "Biochemistry Laboratory: Modern Theory and Techniques", Prentice Hall, 2011.			

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**3**	**1**	**1**	**1**
CO2	**3**	**3**	**1**	**1**	**2**
CO3	**1**	**2**	**3**	**1**	**2**
CO4	**2**	**1**	**1**	**3**	**2**
CO5	**2**	**1**	**1**	**1**	**3**
CO6	**3**	**3**	**3**	**3**	**3**

BSP302: Bioinformatics Lab

L-T-P 0-0-3 Credits 2

School: SBSR		**Batch: 2019-2022**			
Program: B.Sc. (H)		**Current Academic Year: 2019-20**			
Branch: Biotechnology		**Semester: 05**			
1	Course Code	**BSP302**			
2	Course Title	**Bioinformatics lab**			
3	Credits	2			
4	Contact Hours (L-T-P)	0-0-3			
	Course Status	Compulsory			
5	Course Objective	To give students a thorough understanding of Database usage, tools and software for each bioinformatics applications.			
6	Course Outcomes	CO1: Usage of NCBI database/specialized database and information retrieval. CO2: Using of pairwise alignment tools. CO3: Using of multiple sequence alignment tools. CO4: Performing Phylogenetic experiments. CO5: Gene prediction and motif search. CO6: Usage and retrieving information from primary, secondary and specialized databases. Performing *in-silico* experiments of sequence alignment, gene prediction, phylogenetic analysis and motif search using different tools and softwares.			
7	Course Description	This course is designed to make students a thorough understanding of Database usage, tools and software for each bioinformatics applications.			
8	Outline syllabus				CO Mapping
	Unit 1	**Usage of NCBI database/specialized database**			CO1
	Unit 2	**Using of pairwise alignment tools**			CO2
	Unit 3	**Using of multiple sequence alignment tools**			CO3
	Unit 4	**Phylogenetic analysis**			CO4
	Unit 5	**Gene prediction and motif search methods**			CO5
	Mode of exam	Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	Textbook/s*	1. Xiong Jin"Essential Bioinformatics",Cambridge University Press.2006.			
	Other References	2. Attwood TK., "Introduction to Bioinformatics", Pearson Eduction, 2006. 3. J.S,Ignacimuthu.S, "Basic Bioinformatics", Narosa, 2013. 4. Roy Darbeshwar., "Bioinformatics", .Narosa,2009.			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	1
CO2	1	3	1	1	1
CO3	1	1	3	1	1
CO4	1	1	1	3	1
CO5	1	1	1	1	3
CO6	3	3	3	3	3

BSB301: Animal Biotechnology

L T P: 4-0-0 **Credit: 4**

School: SBSR		**Batch: 2019-2022**	
Program: B.Sc (H)		**Current Academic Year: 2019-20**	
Branch: Zoology		**Semester: Odd**	
1	Course Code	BSB301	
2	Course Title	Animal Biotechnology	
3	Credits	3	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. This course provides a comprehensive introduction to fundamentals and applications of animal biotechnology. 2. The course is designed to give students an up-to-date understanding of a wide array of techniques that are used in animal cell culture, tissue culture and organ culture. 3. This course also focuses on stem cell culture and their applications. 4. The course also highlights the potential of transgenic animals to improve human welfare.	
6	Course Outcomes	After the successful completion of this course students will be able to: CO1: Understand the methods of obtaining cells from the tissue for cell culture. CO2: Classify the different types of media used in animal cell culture based on cell types and the cell line types. CO3: Know about the animal cell cloning and the methods of transfecting cells in the culture. CO4: Explain the stem cell technology and its applications. CO5: Understand the basics of tissue and organ culture as well as the applications of transgenic animal in different sectors. CO6: To get a complete knowledge about various techniques and methodology used in animal biotechnology.	
7	Course Description	The aim of this course is to provide better understanding about the animal cell culture and its types. The student get acquainted with the various types of media used in animal cell culture and about the types of cell lines. It briefs about the applications of cell culture and transgenic animals.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Animal Cell Culture**	
	A	Structure and organization of animal cell; sources of cell	CO1, CO6
	B	Techniques of obtaining cells by disaggregation of tissues, Enzymatic disaggregation	

	C	EDTA treatment; Types of cell culture, Equipments required for animal cell culture			
	Unit 2	**Development of Cell Lines**			
	A	Medium preparations and its various types Natural, artificial serum protein free media Advantages and disadvantages			CO2, CO6
	B	sub culturing techniques, viable cell counts with haemocytometer, development of cell lines, types of cell lines, their characteristics			
	C	Suspension culture advantages & disadvantages, totipotency in animal cell culture.			
	Unit 3	**Animal Cell Cloning**			
	A	Cloning, types of cell cloning methods of cloning			CO3, CO6
	B	Transfection; methods, retro-virus mediated gene transfer			
	C	Embryonic stem cell-mediated gene transfer, artificial twining, risk of cloning cloned animals.			
	Unit 4	**Stem Cell Culture and Technology**			
	A	Stem cell technology; haematopoiesis			CO4, CO6
	B	Methods to study repopulation assay, in vitro cloning assay, long term culture			
	C	Embryonic stem cell culture, Application of stem cell culture.			
	Unit 5	**Application of Animal Cell Culture Technology**			
	A	Transgenic cells and animals & their application;			CO5, CO6
	B	Organ culture, Histotypic & organotypic culture, rearing animal models and advantages			
	C	Potential of transgenic animals to improve human welfare in Agriculture, medicine and industry, ethical and value issues in animal biotechnology			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Freshney I.R., “Culture of Animal Cells: A Manual of Basic Technique”, Wiley, 2005.			
	Other References	1. Jenkins N., “Animal Cell Biotechnology: Methods and Protocols”, Humana Press, 2006. 2. Shenoy M., “Animal Biotechnology”, Laxmi Pub, 2007.			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	2	2
CO2	3	2	2	2	2
CO3	2	3	2	3	2
CO4	3	2	3	2	2
CO5	3	2	3	3	2
CO6	3	2	2	2	3

BSB305: Bioreactors and Down-stream processing

L-T-P:4-0-0 **Credit: 4**

School: SBSR		**Batch: 2019-22**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 06**	
1	Course Code	**BSB305**	
2	Course Title	**Bioreactors and downstream processing**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. To enable students bridge the gap between theoretical concepts and practical aspects in industrial settings. 2. To have In-depth knowledge and hands-on laboratory/industrial skills required for employment or for creation of employment in desired product processing.	
6	Course Outcomes	After successfully completion of this course students will be able to: CO1: Improve the yield of products by improving fermentation efficiency by choosing correct mode of operation and nutritional requirement of microbes involved. CO2: Design bioreactors to achieve desired results (i.e. specified cell concentration, production rates, etc.). CO3: To separate different bio-products from any mixture keeping in mind the cost involved for the production. CO4: To extract product from extracellular/intracellular compartment of cells and carry out different membrane-based strategies for differentiating between the products of varying sizes. CO5: Choose various chromatographic techniques for separating pigments, drugs, amino acids and hormones etc. and carry out finishing of product for marketability. CO6: Create experiments for integrating separation, extraction and bioanalytical techniques for problem solving.	
7	Course Description	The challenge for biochemical engineers is to design compact and clean processes to make and efficiently separate instable products, such as recombinant proteins, from dilute complex fermentation broths to the required pharmaceutical degree of purity. Therefore, the quantitative systematic design of integrated bioreactors and downstream processes is the general theme of this course and helps the students in quantitatively and systematically design an integrated industrial process.	
8	Outline syllabus		CO Mapping
	Unit 1	**Fermentation process**	**CO1, CO6**
	A	Introduction to fermentation process, Microbial growth kinetics, Industrial media/nutrients	CO1

	B	Modes of operation of fermenters- batch, continuous and fed batch mode			CO1
	C	Inoculum development and transfer into fermenter			CO1, CO6
	Unit 2	**Bioreactor design and operations**			**CO2, CO6**
	A	Definition of bioreactor, Types of bioreactor- Continuous stirred tank bioreactor (CSTR)			CO2
	B	Tower reactor, Loop reactor, Anaerobic digester			CO2
	C	Activated sludge bioreactor, Uses of bioreactor for biotechnological applications			CO2, CO6
	Unit 3	**Bio-separation process in Biotechnology**			**CO3, CO6**
	A	Range and characteristics of Bioproducts, Need for downstream processing			CO3
	B	Nature of bio-separation, Differences between chemical separation and bio-separation			CO3
	C	Economic importance of bio-separation, RIPP scheme, cost cutting strategies in downstream processing			CO3, CO6
	Unit 4	**Membrane based separations and cell disruption**			**CO4**
	A	Membrane based purification, Microfiltration, Dialysis			CO4
	B	Ultrafiltration, Filtration processes, Types of filtration equipments, Floatation			CO4
	C	Mechanical and enzymatic based methods for cell disruption			CO4, CO6
	Unit 5	**Resolution of products and case studies**			**CO5, CO6**
	A	Centrifugation- Differential and Density gradient, Molecular sieve chromatography			CO5
	B	Affinity Chromatography, Ion-exchange chromatography, High performance liquid chromatography			CO5
	C	Production and polishing of Glutamic acid, Citric acid, Penicillin			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	Bioseperations: Principles and Techniques- B. Sivasankar, Published by PHI Learning Pvt. Ltd., 2006.			
	Other References	1. Principles and Techniques of Practical Biochemistry- Keith Wilson And John Walker, Cambridge Press. 2. Bioseparation Technology- Mishra Neeraj, Publisher: CRC Press, 2008.			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	1
CO2	1	3	1	1	1
CO3	1	1	3	1	1
CO4	1	1	1	3	1
CO5	1	1	1	1	3
CO6	3	3	3	3	3

BSB306: Genomics

L T P: 4-0-0 **Credit: 4**

School: SBSR		**Batch: 2019-22**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 06**	
1	Course Code	**BSB306**	
2	Course Title	**GENOMICS**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. To comprehend the basic principles of genomics, so that they realise its importance and use its knowledge for human benefit. 2. To acquire knowledge of techniques and strategies involved in understanding a genome.	
6	Course Outcomes	After successfully completion of this course students will be able to: CO1: Comprehend the basic concept of Genome and its importance. Choose the right of sequencing method. CO2: Differentiate between different sequencing methods and the degree of enhancement in techniques with application of bioinformatics. CO3: Relate the differences between different Genome structure. CO4: Apply the techniques of locating unidentified genes in a sequence and their organization. CO5: Discuss different application of Genomics in different field of study CO6: Be familiar with the different techniques used in genome analysis.	
7	Course Description	Genomics is an interdisciplinary field of science focusing on the structure, function, evolution, mapping, and editing of genomes. Genomics also involves the sequencing and analysis of genomes through uses of high throughput DNA sequencing and bioinformatics to assemble and analyze the function and structure of entire genomes. Advances in genomics have triggered a revolution in discovery-based research and systems biology to facilitate understanding of even the most complex biological systems such as the brain.	
8	Outline syllabus		CO Mapping
	Unit 1	**DNA Sequencing**	**CO1, CO6**
	A	Introduction to concept of Genome; DNA and RNA as genome	
	B	Information flow in Biology; DNA Sequencing technologies, Maxam-Gilbert	
	C	Sanger method of Sequencing, manual and automated	

	Unit 2	**Whole Genome Sequencing**			**CO2, CO6**
	A	Concept and application of Whole genome sequencing, Shot Gun Sequencing methods			
	B	Clone contig Sequencing methods; Pyrosequencing			
	C	Genome sequence data and genome databases; Application of Bioinformatics in genomics			
	Unit 3	**Genome Anatomy**			**CO3, CO6**
	A	Difference between gene and genome; Prokaryotic and eukaryotic genome structure			
	B	Intergenic spaces, gene families, monopartite genome, multipartite genome, split genes, overlapping genes; C value Paradox			
	C	Viral genome, Yeast and *Drosophila* genome structure			
	Unit 4	**Functional genomics**			**CO4, CO6**
	A	Gene prediction methods, function prediction, Annotation			
	B	Functional genomics, its tools and methodologies, organellar genomes, endosymbiosis			
	C	Comparative genomics its tools and methodologies, phylogeny			
	Unit 5	**Application of Genomics**			**CO5, CO6**
	A	Application of comparative genomics, Pharmaco-genomics			
	B	Application of genomics in crop improvement			
	C	Application of genomics in industry; personalized medicine			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	1. Brown TA. Genomes 3. 3rd edition. Oxford: Wiley-Lis; (2002) 2. Pevsner J., "Bioinformatics and Functional Genomics", John Wiley and Sons, 2008.			
	Other References	1. Lewin B., Jocelyn E.K., Elliot S., "Lewin Genes XI", Jones and Bartlette; (2014) 2. Bioinformatics: Tools and Applications, David Edwards, Jason Stajich, David Hansen, Springer Science & Business Media, (2009)			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	1
CO2	3	3	2	1	2
CO3	3	2	3	1	1
CO4	2	3	3	1	2
CO5	3	3	1	2	3
CO6	3	3	3	1	2

BSB307: Proteomics

L-T-P: 4-0-0 **Credit: 4**

School: SBSR		**Batch: 2019-20**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 06**	
1	Course Code	**BSB307**	
2	Course Title	**Proteomics**	
3	Credits	4	
4	Contact Hrs. (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. Understand about proteins, protein folding and proteomics. 2. Discuss about post-translational modifications of protein, their localization and transport. 3. Understand the various methods of protein characterization and protein-protein interaction. 4. Discuss about the various applications of proteomics.	
6	Course Outcomes	CO1: understand the introduction and basics of proteomics, protein structure and protein folding. CO2:.Discuss about post-translational modifications, localization and transport of proteins. CO3: Discuss about various techniques and methods for protein characterization. CO4: Discuss about various methods to understand the protein -protein interactions. CO5: Describe the various applications of proteomics CO6: To be able to apply the gained knowledge in research methodology	
7	Course Description	With this course the students will acquire fundamental knowledge of proteomics and can address structural proteomics, interaction proteomics, protein modification analysis and functional proteomics.	
8	Outline syllabus		**CO Mapping**
	Unit 1	**Introduction to proteomics**	
	A	History of proteomics, scope and challenges of proteomics	CO1
	B	Protein structures (-primary, secondary, tertiary and quaternary)	CO1
	C	Protein folding, Role of protein folding for biological functions	CO1
	Unit 2	**Complexity and localization of proteins**	
	A	Post translational modification	CO2

	B	Phosphorylation, Ubiquitation, Methylation, Acetylation, Glycosylation of proteins			CO2
	C	Cellular localization of protein, Protein transport			CO2
	Unit 3	**Analytical methods for proteins**			
	A	Edman degradation, N-terminal sequencing			CO3
	B	Isoelectric focusing, Gradient gel electrophoresis			CO3
	C	2D gel-electrophoresis of proteins, Mass spectrometry			CO3
	Unit 4	**Study of protein-protein interactions**			
	A	Pull-down assay, ELISA (enzyme-linked immunosorbent assay)			CO4
	B	Phage display, Co-immunoprecipitation			CO4
	C	Yeast two hybrid system			CO4
	Unit 5	**Application of proteomics**			
	A	Understanding mechanism of pathogenesis			CO5
	B	Disease diagnosis, Identification and characterization of novel proteins			CO5
	C	Utility of proteomics for studying gene structure			CO5
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	Principles of Proteomics, by R.M. Twyman, garland Science/BIOS. Scientific publishers, 2004, ISBN-10: 1-85996-273-4			
	Other References	1. Proteomics: From protein sequence to function by S.R. Pennington and M.J. Dunn. Viva Books Private Limited. (2001) 2. Lehninger Principles of Biochemistry-David L. Nelson, Michael M. Cox, Macmillan Worth Publishers. 3. Introducing Proteomics, from concepts to sample preparation, mass spectrometry and data analysis by J. Lovric (2011), Wiley-Blackwell Publishers			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	1
CO2	1	3	1	1	1
CO3	1	1	3	1	1
CO4	1	1	1	3	1
CO5	1	1	1	1	3
CO6	3	3	3	3	3

BSB308: Bioethics and Biosafety

L-T-P: 4-0-0 **Credit: 4**

School: SBSR		**Batch: 2019-2022**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 06**	
1	Course Code	BSB308	
2	Course Title	Bioethics and Biosafety	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1.To understand what is biosafety and why it is needed. 2. To learn national and international regulatory bodies that draw guidelines for biosafety. 3. To become familiar with genetically modified organisms and the factors to be considered before and after release of GMOs. 4.To understand the ethics and safety issues associated with use of stem cells, xenotransplantation, nanoparticles etc.	
6	Course Outcomes	After the successful completion of this course students will be able to: CO1: Describe biosafety measures and levels. CO2: Explain the several international bodies that control biosafety regulations and also various biosafety databases. CO3: recall various national committees that form the biosafety framework of our country and procedure for r-DNA release. CO4: describe various biosafety guidelines put up at national and international level. CO5: analyze safety and bioethical issues associated with stem cells, pharmaceuticals, xenotransplantation, nanoparticles etc. CO6: Know the basics as well as applicability of the subject.	
7	Course Description	The 'Bioethics and Biosafety' course is designed to make students understand the need for biosafety and ethical issues related to biological research. This course sheds light upon the detailed national and international framework for biosafety regulations and guidelines. The course also further highlights bioethical issues related to important aspects of research in biotechnology.	
8	Outline syllabus		CO Mapping
	Unit 1	**Need and design of Biosafety measures**	
	A	Introduction to Biosafety, Need for Biosafety in present scenario	
	B	Classification and Description of Biosafety Levels, Design of Clean rooms, Design of Biosafety Labs	CO1

	C	Biosafety regulations for protection of nature, Growers and Consumers, Justification of Biosafety measures arrangement of stamens and petals; Basic structure of androecium and gynoecium			
	Unit 2	**Biosafety**			
	A	Biosafety Regulations, Laws and Policies, Biosafety and Agriculture, Genetic Engineering and Health**;** Genetic Engineering and Food Safety**,** International Centre for Genetic Engineering and *Biotechnology*			CO2
	B	Third World Network Information Service on Biosafety; National & International guidelines for biosafety			
	C	Guidelines for laboratories, guidelines for containments of green house, guidelines for small scale field trials, r-DNA guidelines; levels of containments			
	Unit 3	**Environmental Aspects of Biotechnology and its applications**			
	A	Use of genetically modified organisms and their release in Environment			CO3
	B	Special procedures for r-DNA based product production			
	C	Biosafety Committees that form the Regulatory authorities: National Biosafety Committees (NBC); Their roles, responsibilities and activities; Institutional Biosafety Committee (IBC), Their roles, responsibilities and activities			
	Unit 4	**Biosafety Guidelines**			
	A	Risk assessment; Determination of the level of safety concern (LSC)			CO4
	B	NIH guidelines, Code of conduct, Permit application system (PAS)			
	C	Environmental assessment & Finding of no significant Impact; Biodiversity & farmer's right			
	Unit 5	**Bioethical Issues**			
	A	Ethical, social, legal, philosophical and other issues arising in biological and medical research, health care and other areas of biotechnology			CO5
	B	Safety of GMOs, cloning, stem cell research, drug trials, availability, distribution and use of pharmaceuticals, xenotransplantation			
	C	Safety of nanoparticles			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	

	Textbook/s*	Goel D., **"IPR, Bio safety and Bioethics",** Pearson Education, 2013.	
	Other References	1. Santaniello V., "Agriculture and intellectual property rights: Economic, institutional and implementation issues in Biotechnology", CABI Publishing, 2000. 2. Wasehra B.L., "Law relating to patents, trademarks, copyright designs geographical indications", Universal Law Publishing House.	

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	2
CO2	3	3	3	3	2
CO3	3	2	3	2	3
CO4	3	3	2	3	2
CO5	2	3	3	2	2
CO6	3	3	3	2	3

BSP303: Downstream Processing Lab

L-T-P: 0-0-3 **Credit: 2**

School: SBSR		**Batch: 2019-2022**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 06**	
1	Course Code	**BSP303**	
2	Course Title	**Downstream Processing Lab**	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-3	
	Course Status	Compulsory	
5	Course Objective	To learn about the various unit operation involved in the separation and purification of biomolecules. To use natural sources for recovery of biomolecules. To develop a working knowledge of the purification techniques Interpret data from experiments that utilize methodologies described and draw appropriate conclusions from the data	
6	Course Outcomes	After successfully completion of this course students will be able to: CO1: Understand the importance of downstream processing of biomolecules along with the importance of instrumentation. CO2: Prepare and use the crude extracts of natural source. CO3: Analyze the total protein present in different samples. CO4: Apply different techniques for downstream processing. CO5: Apply different liquid-liquid extraction techniques for separation and purification of biomolecules. CO6: Use different DSP techniques for the purification of biomolecule from crude extract.	
7	Course Description	In this laboratory, students are given the chance to gain hands on experience in downstream processing. This laboratory course will assist students to consolidate their fundamental understanding in unit operations involved in downstream processes of biological products. Among the experiments performed are related to removal, isolation and purification of biomolecules.	
8	Outline syllabus		CO Mapping
	Unit 1	**General introduction about DSP lab and instruments**	CO1, CO6
		Subunit - a, b and c detailed in Instructional Plan	
	Unit 2	**Practical related removal and isolation of biomolecules**	CO2, CO6
		Subunit - a, b and c detailed in Instructional Plan	
	Unit 3	**Practical related to analysis of biomolecules**	CO3, CO6
		Subunit - a, b and c detailed in Instructional Plan	

	Unit 4	**Practical related to separation and purification of biomolecules**			CO4, CO6
		Subunit - a, b and c detailed in Instructional Plan			
	Unit 5	**Practical related to separation and purification of biomolecules**			CO5, CO6
		Subunit - a, b and c detailed in Instructional Plan			
	Mode of examination	Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**1**	**1**	**1**	**1**
CO2	**1**	**3**	**1**	**1**	**1**
CO3	**1**	**1**	**3**	**1**	**1**
CO4	**1**	**1**	**1**	**3**	**1**
CO5	**1**	**1**	**1**	**1**	**3**
CO6	**3**	**3**	**3**	**3**	**3**

BSP307: Genomics and Proteomics Lab

L- T- P: 0-0-3 **Credit: 2**

School: SBSR		**Batch: 2019-2022**	
Program: B.Sc. (H)		**Current Academic Year: 2019-20**	
Branch: Biotechnology		**Semester: 6**	
1	Course Code	BSP307	
2	Course Title	Genomics and Proteomics Lab	
3	Credits	3	
4	Contact Hours (L-T-P)	0-0-3	
	Course Status	Compulsory	
5	Course Objective	To introduce the concept of genomic databases To develop understanding of information presented in specific targeted genomic repositories To annotate proteomic databases To analyse protein interactions To comprehend metabolic network maps	
6	Course Outcomes	CO1. To introduce the concept of genomic databases CO2. To develop understanding of information presented in specific targeted genomic repositories CO3. To annotate proteomic databases CO4. To analyse protein interactions CO5. To comprehend metabolic network maps CO6. To understand genome and proteome structure and function with respect to data repositories	
7	Course Description	The course starts with basic knowledge of genomes and proteomes from different databases. It gradually involves into annotation of repository data involving sequence, structure, functionality, ontology, homology, interactions and networks.	
8	Outline syllabus		CO Mapping
	Unit 1	**Experiment related to genomics**	
		Subunit – A and B	CO1
	Unit 2	**Experiment related to protein expression**	
		Subunit – A	CO2
	Unit 3	**Experiment explaining protein interaction**	
		Subunit – B	CO3
	Unit 4	**Experiment demonstrating transcription**	
		Subunit – C	CO4
	Unit 5	**Experiment related to metabolic pathway**	
		Subunit - A	CO5
	Mode of examination	Practical/Viva	

	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	Textbook/s*	NA			
	Other References	Databases and online tools			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	1
CO2	1	3	1	1	1
CO3	1	1	3	1	1
CO4	1	1	1	3	1
CO5	1	1	1	1	3
CO6	3	3	3	3	3

BSB310: Industrial Biotechnology

L T P: 4-0-0 **Credit: 4**

School: SBSR		**Batch : 2019-2022**
Program: B.Sc. (H)		**Current Academic Year: 2019-20**
Branch: Biotechnology		**Semester: 06**
1	Course Code	**BSB310**
2	Course Title	**Industrial Biotechnology**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	5. To introduce the students with industrial biotechnology and its application. 6. To develop the knowledge and techniques of production of compounds at industrial level. 7. To enable students about process economics and developing cost effective processes. 8. To create awareness about fermentation and industrial application microbes.
6	Course Outcomes	After successfully completion of this course students will be able to: CO1: Learn the basics of industrial biotechnology and unit operations used in biotech industries. CO2: Apply microbes for the production of industrially important enzymes. CO3: Learn the basics of sustainable processing for biobased products to further understand their impact on global sustainability. CO4: Gain knowledge about basics of biosensors and commercial biosensors. CO5: Develop new approaches to pollution prevention, resource conservation, and cost reduction during bioprocessing. CO6: Comprehend the basic concept of industrial biotechnology and the requirements for its application.
7	Course Description	Industrial biotechnology includes modern application of biotechnology for sustainable processing and production of chemical products, materials and fuels. Biotechnological processing uses enzymes and microorganisms to produce products that are useful to a broad range of industrial sectors, including chemical and pharmaceutical, human and animal nutrition, pulp and paper, textiles, energy, materials and polymers, using renewable raw materials.

8	Outline syllabus				CO Mapping
	Unit 1	**Introduction to Industrial Biotechnology**			**CO1, CO6**
	A	Units and dimensions			CO1, 6
	B	Unit operations involved in Industrial Biotechnology			CO1, 6
	C	Products and market economics relating to industrial biotechnology			CO1, 6
	Unit 2	**Production of commercially important enzymes**			**CO2, CO6**
	A	Cellulases, Amylase, Lipase, Proteases, Lysozyme			CO2, 6
	B	Enzymes for the food, pharmaceutical and detergent industries			CO2, 6
	C	Biotechnological advances in enzyme production			CO2, 6
	Unit 3	**Biotransformation**			**CO3, CO6**
	A	Transformation – steroids, alkaloids, and polysaccharides			CO3, 6
	B	Recent advances in biotransformation (Indigo, Xanthan, Malanins)			CO3, 6
	C	Natural bio-preservatives (nisin)			CO3, 6
	Unit 4	**Biosensors**			**CO4, CO6**
	A	Types of Biosensors			CO4, 6
	B	Biomedical Sensors			CO4, 6
	C	Commercial examples of Biosensors			CO4, 6
	Unit 5	**Industrial Bio-waste management**			**CO5, CO6**
	A	Types of industrial waste			CO5, 6
	B	Techniques of waste treatment			CO5, 6
	C	Value addition to industrial waste			CO5, 6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	1. Michael L. Shuler and Fikret Kargi (2009, Second edition) Bioprocess Engineering-Basic concepts. Pearson Prentice Hall 2. Pauline M. Doran (2010) Bioprocess Engg. Principles. Elsevier, California.			
	Other References	1. P. F. Stanbury, S. J. Hall and A. Whitaker, Principles of Fermentation Technology, 2nd Edn., Elsevier, Science & Technology Books, 2005. 2. B. D. Singh (2009, Revised edition) Biotechnology- Expanding Horizons. Kalyani publishers, Ludhiana-141008			

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	1	1
CO2	1	3	1	1	1
CO3	1	1	3	1	1
CO4	1	1	1	3	1
CO5	1	1	1	3	1
CO6	3	3	3	3	3