Program Structure

Program: B.Sc. (Hons) Microbiology

Program Code: SBR0412

Batch: 2020-2023

Department of Life Sciences

School of Basic Science & Research

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 (H) in Microbiology

2. DURATION OF THE COURSE: 3 YEARS

3. YEAR OF IMPLIMENTATION

This syllabus will be implemented from June 2020 onwards.

4. PREAMBLE

Total Credits- 147 (19+20+24+26+28+30)

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

Total Number of Papers (including practical) – 31

Total Number of Practical courses – 13

Community Connect

Dissertation

B.Sc Microbiology (H) Course Structure

Semester 1

S. No.	Subject Code	Subjects	Teaching Load			Credits
			L	T	P	
THEORY SUBJECTS						
1	BSL101	Essential of Chemistry for Biosciences (GE)	4	0	0	4
2	BSB102	Cell Biology (C)	4	0	0	4
3	EVS106	Environmental Studies	3	0	0	3
4	OPE	University Elective	2	0	0	2
5	BSB103	Biomolecules (GE)	4	0	0	4
PRACTICALS						
1	BSL151	Chemistry Lab for Biosciences (GE)	0	0	2	1
2	BSP102	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	BSM101	Introduction to Microbiology and Microbial Diversity(C)	4	0	0	4
4	BSB 108	Genetics (C)	4	0	0	4
5	BBT112/BBT101	Bioanalytical techniques/ Diversity of Plants (GE)	4	0	0	4
PRACTICALS						
1	BMP101	Microbial Diversity 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	BSM201	Bacteriology (C)	**4**	**0**	**0**	**4**
2	BSB203	Instrumentation (C)	**4**	**0**	**0**	**4**
3	BSB201/ BSZ201	Molecular Biology / Non Chordates	**4**	**0**	**0**	**4**
4	BBT201/BFS202	Mycology and Phycology/ Food Biotechnology	**4**	**0**	**0**	**4**
5	BBT208	Advanced Biochemistry	**4**	**0**	**0**	**4**
PRACTICALS						
1	BMP201	Bacteriology Lab (CP)	0	0	3	2
2	BSP208	Instrumentation 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	BSM202	Microbial Physiology and Metabolism (C)	4	0	0	4
5	BSB202	Metabolic pathways (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	BSB310	Industrial Biotechnology (C)	4	0	0	4
2	BSB311	Medical Microbiology (C)	4	0	0	4
3	BSM301	Virology (C)	4	0	0	4
4	BSB303	Bioinformatics (C)	4	0	0	4
5	BSM302	IPR and Industrial Ethics	**4**	**0**	**0**	**4**
PRACTICALS						
1	BMP311	Medical Microbiology Lab (C)	0	0	3	2
2	BSP 302	Bioinformatics Lab(C)	0	0	3	2
3	BSP306	Industrial Biotechnology Lab (C)	**0**	**0**	**3**	**2**
4	CCU401	Community Connect	2	0	0	2
TOTAL						28

Semester 6

S. No.	Subject Code	Subjects	Teaching Load			Credits
			L	T	P	
THEORY SUBJECTS						
1	BSM305	Microbial Biotechnology	4	0	0	4
2	BSM303	Food and Dairy Microbiology	4	0	0	4
3	BSM304	Environment Microbiology	4	0	0	4
4	BSB308	Bioethics and Biosafety	4	0	0	4
5	BTP001	Term Paper	4	0	0	4
PRACTICALS						
1	BMP305	Microbial Biotechnology Lab	0	0	3	2
2	BMP303	Food and Dairy Microbiology Lab	0	0	3	2
3	BSP355	Project (DSE)	0	0	6	6
TOTAL						30

Total credits of the B.Sc. (H) program: 147

Department of Life Science, S.B.S.R., Sharda University
Scheme for CBCS in B.Sc. (H) Microbiology, effective from 2020-21

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	Introduction to Microbiology and Microbial Diversity	AECC-2			GE-3
	Genetics				GE-4
III	Bacteriology			DSE-1	GE-5
	Instrumentation				GE-6
IV	Genetic Engineering		AEEC-2	DSE-2	
	Enzyme Technology				
	Immunology				
	Microbial Physiology and Metabolism				
V	Industrial Biotechnology			DSE-3	
	Medical Microbiology				
	Virology				
	Bioinformatics				
VI	Microbial Biotechnology			DSE-4	
	Food and Dairy Microbiology				
	Environment Microbiology			DSE-5	
	Term Paper				

Core Papers (C):

1. Cell Biology
2. Introduction to Microbiology and Microbial Diversity
3. Genetics
4. Bacteriology
5. Instrumentation
6. Genetic Engineering
7. Enzyme Technology
8. Immunology
9. Microbial Physiology and Metabolism
10. Industrial Biotechnology
11. Medical Microbiology
12. Virology
13. Bioinformatics
14. Microbial Biotechnology
15. Food and Dairy Microbiology
16. Environment Microbiology
17. Term Paper

Discipline Specific Elective Papers (DSE):

TERM-III

1. Advanced biochemistry / Biofertilizers

TERM-IV

1. Applied Microbiology/ Metabolic pathways

TERM-V

1. Intellectual Property Rights / Bioreactors and Downstream Processing

TERM-VI

1. Bioethics and Biosafety / Genomics
2. Project / Dissertation

Other Discipline – GE-I to GE-VI

1. Essentials of Chemistry and Biosciences
2. Biomolecules/Principles of Nutrition Science
3. Physics V
4. Diversity of Plants/ Bioanalytical Techniques
5. Molecular biology/ Non-Chordates
6. Mycology and Phycology/ Food Biotechnology

SEM	COURSE OPTED	COURSE NAME	Credits
I	Ability Enhancement Compulsory Course-I	Environmental Sciences	3
	Core course-I	Cell Biology	4
	Core course-I Practical	Cell Biology Lab	1
	Ability Enhancement Elective Course-I	University Elective	2
	Generic Elective-I	Essentials of Chemistry for Biosciences	4
	Generic Elective-I Practical	Chemistry Lab for Biosciences	1
	Generic Elective-II	Biomolecules/Principle of Nutrition Sciences	4
II	Ability Enhancement Compulsory Course-II	Communicative English	2
	Core course-II	Introduction to microbiology and microbial diversity	4
	Core course-II Practical	Microbiology Diversity Lab	1
	Core course-III	Genetics	4
	Generic Elective-III	Physics V	4
	Generic Elective-I Practical	Physics Lab	1
	Generic Elective-IV	Diversity of Plants / Bioanalytical Techniques	4
III	Core course-IV	Bacteriology	4
	Core course-V	Instrumentation	4
	Core course Practical	Bacteriology Lab	2
	Core course Practical	Instrumentation Lab	2
	Discipline Specific Elective-I	Biofertilizers/Advanced Biochemistry	4
	Generic Elective-V	Mycology and Phycology/ Food Biotechnology	4
	Generic Elective-VI	Molecular Biology/ Non Chordates	4
IV	Core course-VI	Enzyme Technology	4
	Core course-VII	Genetic Engineering	4
	Core course-VIII	Immunology	4
	Core course-IX	Microbial Physiology and Metabolism	4
	Discipline Specific Elective-II	Applied Microbiology /Metabolic Pathways	4
	Ability Enhancement Elective Course-II	University Elective	2
	Core course Practical	Genetic Engineering lab	2
	Core course Practical	Enzyme Technology and Immunology Lab	2
V	Core course-X	Industrial Biotechnology	4
	Core course-XI	Medical Microbiology	4
	Core course-XII	Virology	4
	Core course-XIII	Bioinformatics	4
	Core course Practical	Medical Microbiology Lab	2
	Core course Practical	Industrial Biotechnology Lab	2
	Discipline Specific Elective-III	IPR and industrial ethics/ Bioreactor and Downstream Processing	4
	Core course Practical	Bioinformatics Lab	2
	Community Connect		2
VI	Core course-XV	Microbial Biotechnology	4
	Core course-XVI	Food and Dairy Microbiology	4
	Core course-XVII	Environmental Microbiology	4
	Core course-XVIII	Term Paper	4
	Core course Practical	Microbial Biotechnology Lab	2
	Core course Practical	Food and Dairy Microbiology Lab	2
	Discipline Specific Elective-IV	Genomics/ Bioethics and Biosafety	4
	Discipline Specific Elective-V	Project /Dissertation	6

BSL101: Essentials of Chemistry for Biosciences
L-T-P 3-1-1 Credits 4

School: SBSR		**Batch: 2020-23**	
Program: B.Sc.		**Current Academic Year: 2020-21**	
Branch: Microbiology		**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 polysacharrides (starch and cellulose) excluding their structure elucidation			CO5, CO6
	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 Bahl 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: 2020-2023**	
Program: B.Sc. (H)		**Current Academic Year: 2020-21**	
Branch: Microbiology		**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	2	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 : 2020-23**	
Program: B.Sc.		**Current Academic Year: 2020-2021**	
Branch: Microbiology		**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 : 2020-2023**	
Program: B.Sc.		**Current Academic Year: 2020-21**	
Branch: Microbiology		**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**

BSB103: Biomolecules
L T P: 4-0-0 **Credit: 4**

School: SBSR		**Batch: 2020-2023**	
Program: B.Sc. (H)		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 01**	
1	Course Code	**BSB103**	
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	3	3	3	3	3

BSP102: Cell Biology Lab

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

School: SBSR		**Batch: 2020-2023**	
Program: B.Sc.		**Current Academic Year: 2020-21**	
Branch: Microbiology		**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
	MMB202, Unit 1	**Practical based on Cell observation**	
		Sub unit – a ,b.c	CO1, CO6
	MMB202, Unit 2	**Practical related to cell and cell organelle**	
		Sub unit –c	CO2, CO6
	MMB202, Unit 3	**Practical based to Transportation**	
		Sub unit – a	CO3, CO6
	MMB201, Unit 4	**Practical based upon Nucleus and Chromosomes**	
		Sub unit – c	CO4, CO6
	MMB201, 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	2	3	1	1	1
CO3	2	2	3	1	1
CO4	2	1	1	3	1
CO5	1	1	1	1	3
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 : 2020-23**	
Program: B.Sc.		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 2**	
1	Course Code	PHY115	
2	Course Title	Physics 5	
3	Credits	4	
4	Contact H (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

BSM101: Introduction to Microbiology and Microbial Diversity

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

School: SBSR		**Batch : 2020-23**	
Program: B. Sc. (H)		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 02**	
1	Course Code	**BSM101**	
2	Course Title	**Introduction to Microbiology and Microbial Diversity**	
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: Structure and life cycle of bacteriophage and virus, algae and fungi CO5: Application of microorganisms in different industries that can benefit human. CO6: Learn the general characteristics of different microorganisms and also the basic knowledge of significance of different microbes affecting human beings.	
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	CO1
	B	Contribution of various Microbiologists	CO1
	C	Systems of classification. Whittaker's five kingdom and Carl Woese's three kingdom classification systems	CO1
	Unit 2		
	A	Occurrence, diversity, characteristic features, Morphology and fine structure of Bacteria, Nutritional	CO2

		requirements and nutritional categories of microorganisms			
	B	potential applications of various bacteria, Pure culture method of isolating pure culture (Streak method, Pour-plate and spread plate technique			CO2
	C	Growth of bacteria (Batch and Continuous growth), growth curve, measurement of growth			CO2
	Unit 3				
	A	Preservation of microorganisms			CO3
	B	Sterilization and disinfection, Various physical methods of control of microorganisms			CO3
	C	Chemical methods of control of microorganisms			CO3
	Unit 4				
	A	Ultra-structure of Virus, Life cycle of bacteriophage, Viroids, Prions			CO4
	B	General characteristics of algae including occurrence, algae cell ultra-structure			CO4
	C	General characteristics of fungi including habitat, nutritional requirements, fungal cell ultra-structure			CO4
	Unit 5				
	A	Microbes and Human welfare; Beneficial microbes-probiotics and their applications			CO5
	B	Applications of microbes in medical field, Applications of microbes in industry			CO5
	C	Applications of microbes in production of pharmaceuticals			CO5
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/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	3	2	1	1	1
CO2	2	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

BSB108: Genetics

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

School: SBSR		**Batch : 2020-2023**	
Program: B.Sc. (H)		**Current Academic Year: 2020-21**	
Branch: Microbiology		**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	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

BBT112: Bioanalytical techniques

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

School: SBSR		**Batch: 2020 - 2023**	
Program: B.Sc. (H)		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 02**	
1	Course Code	**BBT112**	
2	Course Title	**Bioanalytical techniques**	
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 bioanalytical techniques commonly use in the biotech laboratories	
7	Course Outcomes	After successfully completion of this course, students will be able to: CO1: To understand how to prepare the solutions and buffers CO2: To know the procedure of cell lysis and different extraction methods CO3: To comprehend the principle and technical overview on mass spectrometry CO4: To know the basic principle of spectroscopy and discuss different types of spectroscopies CO5: To discuss different types of chromatography techniques, different DNA-protein, protein-protein interactions methods, and x-ray crystallography CO6: To understand various bioanalytical techniques and know the basic principles.	
8	Course Description	This course will help us to understand the preparation of different solutions and buffers, types of cell lysis and extraction methods. Also, students will learn the working principles and applications of various bioanalytical techniques which will help them to enhance their basic and advanced knowledge on biotech research.	
9	Outline syllabus		CO Mapping
	Unit 1	**Preparations of Solutions and Buffers**	
	A	Preparation of solutions, polar, nonpolar, molar and normal solutions, ppm solutions	CO1
	B	Mass Fraction, Solution by Serial Dilutions, Percentage Solutions	CO1
	C	Preparation of Standard Solution of Acids and Bases, Buffer System, various types of buffers	CO1
	Unit 2	**Cell lysis and Extraction methods**	
	A	Principle and working: Cell lysis (Mechanical, Chemical, enzymatic)	CO2
	B	Methods of extraction: Solid-liquid, liquid-liquid macerations	CO2
	C	Conventional and non-conventional type of extraction methods	CO2
	Unit 3	**Mass spectrometry**	
	A	Mass spectrometric techniques: Ionisation	CO3
	B	Mass analysers, Detectors	CO3
	C	Structural information by tandem mass spectrometry, Analysing protein complexes	CO3

	Unit 4	**Spectroscopy**			
	A	Principles and working: Spectroscopy, UV-VIS spectrophotometer			CO4
	B	Fundamentals of Infrared and Raman spectroscopy			CO4
	C	Atomic spectroscopy, Circular dichroism spectroscopy, NMR Spectroscopy			CO4
	Unit 5	**Advance techniques in biochemistry and molecular biology**			
	A	Chromatography: HPLC, FPLC, GC			CO5
	B	DNA-Protein, Protein-protein interactions – Northern, western, southern blotting			CO5
	C	ELISA, X-ray crystallography			CO5
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30 %	20 %	50 %	
	Textbook/s*	Principles of Biochemistry, Latest Edition, A.L. Lehninger, D.L. Nelson, M.M. Cox., Worth Publishing			
	Other References	1. Biochemistry by Mathews, Van Holde. 2. Textbook of Biochemistry by Metzler 3. Biological Instrumentation and Methodology by Dr. PK Bajpai 4. The Tools of Biochemistry by Cooper 5. Practical biochemistry by Wilson and Walker			

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

BBT101: Diversity of Plants

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

School : SBSR		**Batch : 2020-23**	
Program: B.Sc.		**Current Academic Year: 2020-21**	
Branch: Microbiology		**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

BMP101: Microbial Diversity Lab

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

School: SBSR		**Batch: 2020-23**	
Program: B.Sc. (H)		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 02**	
1	Course Code	**BMP101**	
2	Course Title	**Microbial Diversity Lab**	
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

	Unit 2	**Practical based on Morphology and Nutrition of Microbes**			CO2, CO6
	Unit 3	**Practical related to Bacteria Growth and Sporulation in Bacteria**			CO1, CO3, CO6
	Unit 4	**Control of Microbial Growth**			CO4, CO5, CO6
	Unit 5	**Virus and Its Control**			CO1, CO6
	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	1	2	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

PHY151: Physics Lab 2

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

School: SBSR		**Batch: 2020-23**	
Program: B.Sc.		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 2**	
1	Course Code	PHY151	
2	Course Title	Physics Lab 2	
3	Credits	1	
4	Contact H (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	PO1	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

BSM201: Bacteriology

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

School : SBSR		**Batch : 2020-2023**	
Program: B.Sc.		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 3**	
1	Course Code	**BSM201**	
2	Course Title	**Bacteriology**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
6	Course Objective	1. Morphology and Fine structure of Bacteria 2. Growth and Nutrition of Bacteria 3. Bacterial reproduction-asexual and sexual 4. Hypersensitivity and Autoimmunity	
7	Course Outcomes	After studying this course, students will be able to CO1: Determine Size, shape and arrangement of bacterial cells CO2: Evaluate Continuous culture, Chemostat. Quantitative measurement of bacterial growth CO3: Interpret the Method of isolating pure culture, pour plate and spread plate technique CO4: Analyse Modes of cell division; Binary fission; Budding CO5: Determine Physical and chemical methods of control of Bacteria. CO6 : Analyze and study Mode of action of Anti-microbial agents	
8	Course Description	This course contains various bacteriology concepts ranging from morphology, fine structure, growth nutrition of bacteria. After studying course, students will be able to learn modes of bacterial reproduction and genetics.	
9	Outline syllabus		CO Mapping
	Unit 1	**Morphology and Fine structure of Bacteria**	**CO1**
	A	Size, shape and arrangement of bacterial cells, Structures external to the bacterial cell wall	
	B	cell wall composition of Gram Positive and Gram-Negative Bacteria	
	C	Other organelles internal to cell wall; spore and cysts.	
	Unit 2	**Growth and Nutrition of Bacteria**	**CO2**
	A	Normal growth cycle (growth curve) of Bacteria; Factors responsible for bacterial growth, synchronous growth;	
	B	Continuous culture, Chemostat. Quantitative measurement of bacterial growth (direct microscopic, plate count method);	
	C	Method of isolating pure culture, pour plate and spread plate technique, Nutritional requirements and types of bacteria	
	Unit 3	**Reproduction**	**CO3**
	A	Bacterial reproduction-asexual and sexual	
	B	Modes of cell division; Binary fission; Budding, fragmentation	

	C	Formation of conidiophores; septum formation.			
	Unit 4	**Bacterial Genetics**			**CO4**
	A	Phenotypic changes due to environmental Alterations; Genotypic changes; Mutation Types; Bacterial Recombination			
	B	Conjugation, Molecular mechanism of gene transfer by conjugation; Hfr strains, mapping bacterial genomes using Hfr strains; Transduction			
	C	Bacterial Transformation, Natural transformation and competence, Ti plasmid transfer system and its application in creating transgenics			
	Unit 5	**Hypersensitivity and Autoimmunity**			**CO5**
	A	Microbes and Human welfare (medical, chemical and food industry),			
	B	Physical and chemical methods of control of Bacteria,			
	C	Mode of action of Anti-microbial agents, factors responsible for controlling microbes, Physical and chemical agents			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	*Pelezar*, M.J. Reid, R.D. and E.C.S. Chan, (1986*) Microbiology* - Tata McGraw Hill, New Delhi.			
	Other References	Mackie and McCartney (1996) Medical Microbiology, Churchill Livingstone			

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

BSB203: Instrumentation

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

School: SBSR		**Batch : 2020-2023**	
Program: B.Sc. (H)		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 3**	
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	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

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

School : SBSR		**Batch : 2020-2023**	
Program: B.Sc.		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 3**	
1	Course Code	**BSB201**	
2	Course Title	**Molecular Biology**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
6	Course Objective	5. DNA replication and its machinery 6. Transcription and post- transcription processes 7. Prokaryotic and Eukaryotic translation and its mechanism 8. 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	3	2	3	3
CO2	3	3	2	3	2
CO3	3	2	3	3	2
CO4	3	3	2	3	3
CO5	3	2	3	2	3
CO6	3	3	2	3	3

BSZ201: Non-chordates

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

School: SBSR		**Batch : 2020-2023**	
Program: B. Sc.(H)		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 3**	
1	Course Code	BSZ201	
2	Course Title	Non-chordates	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. To be familiar with the different non-chordate phyla and distinguish between lower and higher organism. 2. To predict and construct relationship between the complex evolution process for rearranging study contrasts in the life processes of different phyla.	
6	Course Outcomes	After successfully completion of this course students will be able to: CO1: Recognize common and distinctive features of lower invertebrate phyla, including poriferans, protists and protozoans CO2: Sketch distinctive features of taxonomic classes within Cnidierians and cteophorans. CO3: Assess distinctive measurable features of different group of helminthes and pathogenicity caused by them. CO4: Summarize characteristics of Annelids and Arthropodans with their economic importance. CO5: Grade the evolution of mollusks and echinoderms as higher invertebrates and predict their role in zoolgy. CO6: Combine the characteristic of different phyla to formulate and prepare phylogenetic relationship amongst invertebrates.	
7	Course Description	At the end of the course, the students will be familiar with the non-chordate world that surrounds us. They will be able to appreciate the process of evolution and see how it progressed from simple, unicellular cells to complex, multicellular organisms.	
8	Outline syllabus		CO Mapping
	Unit 1	**Protista, Metazoa and Porifera**	**CO1, CO6**
	A	General characteristics and Classification of protista; General account of locomotion in protista	CO1
	B	Study of Euglena; Life cycle of Paramecium, Segmentation of Metazoa	CO1
	C	General characteristics and classification of sponges; Canal system in porifera	CO1, CO6
	Unit 2	**Unit 2: Cnidaria and Ctenophora**	**CO2, CO6**

	A	General characteristics and Classification uptp classes in Cnideria			CO2
	B	Structure and life cycle of *Obelia*; polymorphism in Obelia			CO2
	C	Evolutionary significance of Ctenophora			CO2, CO6
	Unit 3	**Unit 3: Platyhelminthes and Nemathelminthes**			**CO3, CO6**
	A	General characteristics and Classification of platyhelminthes			CO3
	B	General characteristics and Classification of Nemathelminthes			CO3
	C	Life cycle of *Taenia solium*, *Ascaris Lumbricoides* and *Wuchereria bancrofti*			CO3, CO6
	Unit 4	**Annelida and Arthropoda**			**CO4**
	A	General characteristics and Classification up to classes in Annelida;			CO4
	B	General characteristics and Classification up to classes in Arthropoda			CO4
	C	Excretion in Annelida; Vision and Respiration in Arthropoda			CO4, CO6
	Unit 5	**Mollusca and Echinodermata**			**CO5, CO6**
	A	General characteristics and Classification up to classes of mollusks; Respiration in Mollusca			CO5
	B	General characteristics and Classification up to classes of echinoderms			CO5
	C	General characteristics and Classification up to classes of echinoderms; Water vascular systems in Asteroidea			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	Kotpal, R. L. *Modern Text Book of Zoology: Invertebrates*. Rastogi Publications, 2012.			
	Other References	1. Purves, William K., Gordon H. Orians, David Sadava, and H. Craig Heller. *Life: The Science of Biology: Volume III: Plants and Animals*. Vol. 3. Macmillan, 2003. 2. Campbell, N., and J. Reece. "Biology 7th edition, AP." (2005).			

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

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

School: SBSR		**Batch : 2020-2023**	
Program: B.Sc		**Current Academic Year: 2020-21**	
Branch: Microbiology		**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	3	3	3	3	3

BFS202: Food Biotechnology

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

School: SBSR		**Batch : 2020-2023**	
Program: B.Sc.		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 3**	
1	Course Code	BFS202	
2	Course Title	Food Biotechnology	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objectives	1. To develop fundamental knowledge of food biotechnology. 2. To acquire knowledge for applications of biotechnology in food industry.	
6	Course Outcomes	After successfully completion of this course students will be able to: **CO1.**Understand the basic principles, application, safety, regulations and food authentication methods of food biotechnology. **CO2.**Understand fundamentals of downstream processing and biosensors in food industry. **CO3.**Understand natural control of micro-organism and production with control of Aflatoxin. **CO4.**Understand all about GMOs and Protein Engineering applications in food industry. **CO5.**Understand the biotechnology and industrial production of different food product **CO6.** Develop an overall idea of food-borne microbes involved in beneficial and harmful activities and methods of influencing their growth and survival.	
7	Course Description	Biotechnology is tool for various quality measurements in food products like PCR, Immunological methods and DNA based methods. Biotechnology offers various purification operations for food products. Fermented food products manufacturing are based on biotechnology.	
8	Outline syllabus		CO Mapping
	Unit 1	**Food Biotechnology**	**CO1**
	A	Introduction to Food Biotechnology, basic principles of Gene technology and its application in food industry	CO1
	B	Food safety and biotechnology- Impact of Biotechnology on foods, New challenges	CO1
	C	Immunological methods, DNA based methods in food authentication, Real time PCR based methods	CO1
	Unit 2	**Downstream processing**	**CO2**

	A	Principle and types of downstream processing of food products, General types and stages in downstream processing			CO2
	B	Bacterial starter culture, Methods of inoculation, media preparation, Slurry processing and product isolation			CO2
	C	Biosensors types and applications in food processing			CO2
	Unit 3	**Toxins and Bacteriocins**			**CO3**
	A	Natural control of micro-organisms – Bacteriocins of Lactic acid bacteria			CO3
	B	Applications of bacteriocins in food systems			CO3
	C	Aflatoxins – production, control and reduction using molecular strategies			CO3
	Unit 4	**GMO**			**CO4**
	A	Transgenic plants and animals : Current status of transgenic Plants and animals, methods, concept, risks regulation and application, Ethical issues			CO4
	B	Protein engineering in Food technology –objectives, methods,Limitations			CO4
	C	Protein engineering: applications(e.g. Lactobacillus, β-galactosidase, nisin and Glucose isomerase).			CO4
	Unit 5	Industrial Application			**CO5**
	A	Biotechnology and industrial production of enzymes, beer, wine			CO5
	B	Amino acids, organic acids, vitamins			CO5
	C	baker's yeast, brewer's yeast and single cell protein.			CO5
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1.Gupta.P.K, "Botechnology and genomics", Rastogi publications, 2010.			
	Other References	1. Lovric J., "Introducing Proteomics: From concepts to sample separation, mass spectrometry and data analysis", Wiley-Blackwell, 2011. 2. Nelson D.L. and Cox M.M., "Lehninger Principles of Biochemistry", W. H. Freeman, 2004.			

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

BBT208: Advanced Biochemistry

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

School: SBSR		**Batch : 2020-2023**	
Program: B.Sc. (H)		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 03**	
1	Course Code	**BBT208**	
2	Course Title	**Advanced Biochemistry**	
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 of biochemistry 2. The course is designed to give students an up-to-date understanding of various biomolecules and their roles 3. This course focuses on proteins and nucleic acids along with their various conformations 4. The course also highlights the biological membranes and how the cell response to the signals	
6	Course Outcomes	After the successful completion of this course students shall be able to: CO1: Understand the basic concepts of bioenergetics and its role in the functioning of a cell. CO2: Know about the proteins and various types of it. CO3: Explain about various nucleic acid molecules and DNA structure types that exists in nature. CO4: Understand the cell membranes and mode of transportation across them. CO5: Understand how cell functions when it receives a signal and how the cell cycle is regulated. CO6: Apply his knowledge in understanding the cellular structure and cellular function.	
7	Course Description	The 'Advanced Biochemistry' course covers different aspects of biochemistry starting from bioenergetics to cell signaling. This course provides detailed information about different biomolecules and their role in the cell. Lastly, with the help of some important cellular receptors, it helps in understanding how a cell function.	
8	Outline syllabus		CO Mapping
	Unit 1	**Molecular Tools of Genetic Engineering**	
	A	Principles of Bioenergetics**,** Bioenergetics and Thermodynamics	

	B	Biological Oxidation-Reduction Reactions, Free Energy Calculations, The Cell's Energy Currency- Phosphoryl Group Transfers and ATP			CO1, CO6
	C	Free-Energy-Driven Transport across Membranes			
	Unit 2	**Protein structure**			
	A	Primary Secondary and Tertiary structure, Quaternary structures			CO2, CO6
	B	Fibrous and globular proteins, Protein-assisted folding and chaperones in protein folding, protein targeting			
	C	the physiological chemistry of oxygen binding by myoglobin and hemoglobin, The regulatory compound, 2,3 — bisphosphoglycerate (BPG)			
	Unit 3	**Nucleic acids**			
	A	Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines			CO3, CO6
	B	Biologically important nucleotides, Double helical model of DNA structure			
	C	forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA			
	Unit 4	**Biological Membranes and Transport**			
	A	The Composition and Architecture of Membranes			CO4, CO6
	B	Solute Transport across Membranes; transport of small molecules, active and passive transport			
	C	transport of macromolecules- Endocytosis, Phagocytosis, Pinocytosis			
	Unit 5	**Biosignaling**			
	A	Molecular Mechanisms of Signal Transduction, Gated Ion Channels, Receptor Enzymes, G Protein-Coupled Receptors and Second Messengers			CO5, CO6
	B	Signaling in Microorganisms and Plants			
	C	Regulation of Transcription by Steroid Hormones, Regulation of the Cell Cycle by Protein Kinases			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.			
	Other References	1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman 2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.			

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

BMP201: Bacteriology Lab

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

School : SBSR		**Batch : 2020-2023**	
Program: B.Sc.		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 3**	
1	Course Code	**BMP201**	
2	Course Title	Bacteriology 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 2. To motivate students towards use of different media for different organisms growth. 3. To acquaint with Microbiological Transfer Instruments. 4. Design and manage Isolation of bacteria from different sources	
7	Course Outcomes	After successfully completion of this course students will be able to: CO1: Demonstrate Physical methods of sterilization. CO2: Estimate Different classes of culture media. CO3: Amalgamation of Isolation of bacteria from different sources. CO4: Perform The streak –plate method. CO5: learn Fluorescence Microscopy. CO6: To acquaint the students about the versatile tools and techniques employed in bacteriology laboratory.	
8	Course Description	The aim of this course is to acquaint the students about the versatile tools and techniques employed in bacteriology laboratory. The course will also provide students with a hands-on understanding of how to control the microbial growth in laboratory conditions, their media preparation. Students will also learn to isolate the bacterial organisms from different sources.	
9	Outline syllabus		CO Mapping
	Unit 1		
	A	The control of microbial growth	**CO1**
	B	Physical methods of sterilization	
	C	Chemical methods of sterilization	
	Unit 2		**CO2**
	A	Microbiological culture media preparation	
	B	Different classes of culture media	
	C	Procedure for Pouring autoclaved culture media	
	Unit 3		**CO3**
	A	Isolation of bacteria from different sources	
	B	Culture transfer techniques	
	C	Maintenance of pure cultures	
	Unit 4		**CO4**
	A	Microbiological Transfer Instruments	
	B	The streak –plate method:	
	C	Pour plate method	

	Unit 5				**CO5**
	A	Use of Bright –field Microscope			
	B	Use of Fluorescence Microscopy			
	C				
	Mode of examination	Practical/or Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	Text book/s*	1.Freshney RI. 2010. Culture of animal cells: a manual of basic technique and specialized applications: Wiley-Blackwell. 2.Madigan MT, Martinko JM, Dunlap PV, Clark DP. 2012. Brock biology of microorganisms: Pearson/Benjamin Cummings.			
	Other References	1.Brown AE. 2009. Benson's Microbiological Applications: Laboratory Manual in General Microbiology, Short Version: McGraw Hill.. 2.Tiwari R. 2009. Laboratory Techniques in Microbiology & Biotechnology: Abhishek Publications.			

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	2	3	1
CO5	1	1	2	1	3
CO6	3	3	3	3	3

BSP208: Instrumentation Lab

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

School: SBSR		**Batch: 2020-2023**			
Program: B.Sc. (H)		**Current Academic Year: 2020-21**			
Branch: Biotechnology		**Semester: 03**			
1	Course Code	**BSP208**			
2	Course Title	**Instrumentation 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 tools and techniques in Biotechnology Laboratories To make students learn the working and operation of various biotechnological instruments			
6	Course Outcomes	CO1: Operate autoclave, laminar air flow and hot air oven CO2: Operate refrigerated and non-refrigerated centrifuges CO3: Operate and visualize nucleic acids using gel electrophoresis CO4: Operate Chromatography and thermal cyclers CO5: Operate microscopy CO6: Operation and working of different instruments and bioanalytical techniques			
7	Course Description	This course is designed to make students learn about various instruments and techniques of biotechnology laboratory and will also enable them to use and apply these techniques and equipments to solve experimental problems.			
8	Outline syllabus				CO Mapping
	Unit 1	**Practical based on Sterilization**			CO1
		Subunit - a, b and c detailed in Instructional Plan			CO1
	Unit 2	**Practical related to centrifuge**			CO2
		Subunit - a, b and c detailed in Instructional Plan			CO2
	Unit 3	**Practical related to gel electrophoresis**			CO3
		Subunit - a, b and c detailed in Instructional Plan			CO3
	Unit 4	**Practical related to chromatography and PCR**			CO4
		Subunit - a, b and c detailed in Instructional Plan			CO4
	Unit 5	**Practical related to microscopy**			CO5
		Subunit - a, b and c detailed in Instructional Plan			CO5
	Mode of exam	Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	Textbook/s*	Wilson K. and Walker J., "Principles and Techniques of Biochemistry and Molecular Biology", Cambridge Press, 2010.			

	Other References	1. Cottenil R.M.S., "Biophysics: An Introduction", John Wiley and Sons, 2002. 2. Gupta A., "Instrumentation and Bioanalytical Techniques", Pragati Prakashan, 2009.

	Unit 1	**Practical related to – Sterilization**	
Week 1	a	Lab expt. 1	To learn the working of an autoclave.
Week 2	b	Lab expt. 2	To learn the working of a laminar air flow.
Week 3	c	Lab expt. 3	To sterilize glasswares using hot air oven.
	Unit 2	**Practical related to – Centrifuge**	
Week 4, 5	a, b, c	Lab expt. 4	Working and principle of refrigerated and non-refrigerated centrifuge
	Unit 3	**Practical related to -- Gel electrophoresis**	
Week 6, 7	a, b, c	Lab expt. 5	Separation of DNA using agarose gel electrophoresis
	Unit 4	**Practical related to – Chromatography and PCR**	
Week 8	a, b	Lab expt. 6	Working and principle of chromatography
Week 9	c	Lab expt. 7	PCR using thermal cycler
	Unit 5	**Practical related to – Microscopy**	
Week 10	a, b, c	Lab expt. 8	Use of microscopy to visualize microorganisms.

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

BSB205: Genetic Engineering

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

School: SBSR		**Batch : 2020-2023**	
Program: B.Sc. (H)		**Current Academic Year: 2020-21**	
Branch: Microbiology		**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	2	2	2	3
CO2	3	2	2	3	3
CO3	3	2	2	3	3
CO4	2	2	2	3	3
CO5	2	2	3	3	3
CO6	3	3	3	3	3

BSB206: Enzyme Technology

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

School: SBSR		**Batch : 2020-2023**	
Program: B.Sc. (H)		**Current Academic Year: 2020-21**	
Branch: Microbiology		**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	2	1	1
CO3	1	2	3	2	1
CO4	1	1	2	3	1
CO5	1	1	2	2	3
CO6	3	3	3	3	3

BSB207: Immunology

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

School: SBSR		**Batch : 2020-2023**	
Program: B.Sc. (H)		**Current Academic Year: 2020-21**	
Branch: Microbiology		**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

BSM202: Microbial Physiology and Metabolism

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

School : SBSR		**Batch :**	
Program: B.Sc.		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 6th**	
1	Course Code	**BSM202**	
2	Course Title	**Microbial Physiology and Metabolism**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course Status	Compulsory	
6	Course Objective	1. Microbial growth and nutrient requirement 2. Microbial transport of nutrient 3. Microbial anabolism process 4. Microbial catabolism process	
7	Course Outcomes	After studying this course, students will be able to CO1: Summarize the Microbial Nutritional classification CO2: Describe the Transport of nutrients CO3: Describe the cell component biosynthesis processes CO4: Summarize the Microbial photosynthesis processes CO5: Describe the major catabolism processes including glycolysis and ETC CO6: Describe the Microbial Physiology and Metabolism	
8	Course Description	The course comprises of general features of microbial organisms, their microbial physiology and wide ranges of metabolism. It includes various nutritional requirement, growth characteristics, nutrient transport, cell component biosynthesis and major catabolism and anabolism processes.	
9	Outline syllabus		CO Mapping
	Unit 1	**Nutritional classification**	
	A	Nutritional classification – importance of various macro, micro elements and growth factors in bacterial growth	**CO1**
	B	bacterial growth curve, measurement of microbial growth- gravimetry, turbidometry and nephlometery.	
	C	Continuous culture, synchronous culture ,sporulation	
	Unit 2	**Transport of nutrients**	
	A	uptake of nutrient – passive diffusion – facilitated diffusion – active transport (periplasmic binding protein and ABC transport)	**CO2**
	B	simple transport (uniport, symport and antiport) – group translocation and protein export system.	
	C	Role of osmoregulatory proteins – permiomics.	
	Unit 3	**Biosynthesis of cell structures**	**CO3**

	A	Biosynthesis of cell structures from glucose (cell wall, capsule, flagella structure and synthesis, cell inclusions)			
	B	biochemistry of nitrogen fixation, nitrogenase enzyme			
	C	nitrogen assimilation, sulfate assimilation, anaplerotic reactions in the catabolic pathways.			
	Unit 4	**Photosynthesis**			**CO4**
	A	Characteristics and metabolism of autotrophs, anoxygenic photosynthetic bacteria and cyanobacteria			
	B	CO_2 fixation and mechanism of photosynthesis chemolithotrophs – hydrogen bacteria			
	C	Nitrifying bacteria, sulphur bacteria and iron bacteria – methanogens – methylotrophs			
	Unit 5	**Central catabolic pathways**			**CO5**
	A	Glycolysis, hexose monophosphate pathway, Entner Doudoroff pathway			
	B	Ttricarboxylic acid cycle ,electron transport system and its components			
	C	adenosine tri phosphate structure and their generation types, fermentations, types, anaerobic respirations.			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Microbiology. Author, Pelczar. Publisher, McGraw-Hill Education, 1998. ISBN, 0074623206, 9780074623206. 2. Textbook of Microbiology. Edited by. CK J Paniker.			
	Other References	1. Industrial Microbiology by Cruger 2. Oxford Industrial Microbiology by Casida			

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

BSB202: Metabolic Pathways

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

School: SBSR		**Batch : 2020-2023**	
Program: B.Sc. (H)		**Current Academic Year: 2020-21**	
Branch: Microbiology		**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	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

BSP205: Genetic Engineering Lab

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

School : SBSR		**Batch: 2020-2023**			
Program: B.Sc.		**Current Academic Year: 2020-21**			
Branch: Microbiology		**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: 2020-2023**	
Program: B.Sc. (H)		**Current Academic Year: 2020-21**	
Branch: Microbiology		**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	2	2	1	2
CO2	2	3	2	3	1
CO3	2	3	1	3	2
CO4	1	1	2	2	2
CO5	2	3	1	1	2
CO6	3	3	3	3	3

BSB310: Industrial Biotechnology

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

School: SBSR		**Batch : 2020-2023**
Program: BSc		**Current Academic Year: 2020-21**
Branch: Microbiology		**Semester: 5**
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**
	A	Units and dimensions			CO1
	B	Unit operations involved in Industrial Biotechnology			CO1
	C	Products and market economics relating to industrial biotechnology			CO1
	Unit 2	**Production of commercially important enzymes**			**CO2**
	A	Cellulases, Amylase, Lipase, Proteases, Lysozyme			CO2
	B	Enzymes for the food, pharmaceutical and detergent industries			CO2
	C	Biotechnological advances in enzyme production			CO2
	Unit 3	**Biotransformation**			**CO3**
	A	Transformation – steroids, alkaloids, and polysaccharides			CO3
	B	Recent advances in biotransformation (Indigo, Xanthan, Malanins)			CO3
	C	Natural biopreservatives (nisin)			CO3
	Unit 4	**Biosensors**			**CO4**
	A	Types of Biosensors			CO4
	B	Biomedical Sensors			CO4
	C	Commercial examples of Biosensors			CO4
	Unit 5	**Industrial Bio-waste management**			**CO5**
	A	Types of industrial waste			CO5
	B	Techniques of waste treatment			CO5
	C	Value addition to industrial waste			CO5
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	3. Michael L. Shuler and Fikret Kargi (2009, Second edition) Bioprocess Engineering-Basic concepts. Pearson Prentice Hall 4. 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	1	3
CO6	3	3	3	3	3

BSB311: Medical Microbiology

LTP: 4-0-0 Credit – 04

School : SBSR		**Batch : 2020-2023**	
Program: B.Sc. H		**Current Academic Year: 2020-21**	
Branch: Microbiology		**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	1	1	1	1
CO2	1	3	2	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

BSM301: VIROLOGY

LTP: 4-0-0 Credit – 04

School : SBSR		**Batch : 2020-2023**	
Program: B.Sc		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 5**	
1	Course Code	**BSM301**	
2	Course Title	**Virology**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course Status		
6	Course Objective	This course provide the deep insight of viruses and their basic biology. In addition, the classification, the replication strategies and importance of viruses will be discussed	
7	Course Outcomes	After successfully completion of this course students will be able to: CO1 Identify the general characteristics of viruses CO2 Understand the taxonomy of the viruses CO3 Understand the multiplication and replication strategies of viruses CO4 Understand the mode of transmission of viruses CO5 To comprehend the virus's importance including their medical importance CO6 Provide the deep insight of viruses and their basic biology.	
8	Course Description		
9	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Virology**	**CO1**
	A	Discovery of viruses	CO1
	B	General properties of viruses; Morphology and ultra-structure of viruses; Viroids and prions	CO1
	C	Isolation, purification and cultivation of viruses	CO1
	Unit 2	**Viral Taxonomy**	**CO1 CO2**
	A	**Di**versity of viruses; Salient features of viral genomes	**CO1 CO2**
	B	Classification of viruses infecting microbes, plants and animals	**CO1 CO2**
	C	nomenclature of viruses infecting microbes, plants and animals	**CO1 CO2**
	Unit 3	**Multiplication and Replication Strategies**	**CO1 CO3**
	A	Replication strategies of viruses as per Baltimore classification	**CO1 CO3**
	B	Assembly, maturation and release of virions;	**CO1 CO3**
	C	Concept of early and late proteins, one step multiplication curve, lytic and lysogenic phages (lambda and P1 phage)	**CO1 CO3**
	Unit 4	**Transmission**	**CO1 CO4**
	A	**M**ode of transmission in plant and animals	**CO1 CO4**

	B	Cell to cell transmission			**CO1 CO4**
	C	Viremia; Persistent and non-persistent mode of transmission;			**CO1 CO4**
	Unit 5	**Importance of Viruses**			**CO1 CO5**
	A	Concepts of oncogenes; DNA and RNA oncogenic viruses			**CO1 CO5**
	B	Prevention and control of viral diseases; Antiviral compounds, interferons and viral vaccines;			**CO1 CO5**
	C	Application of viral vectors in cloning and expression.			**CO1 CO5**
	Mode of examination	Theory / practical			Theory
	Weightage Distribution	CA	MTE	ETE	
		30 %	20 %	50 %	
	Text book/s*	Dimmock N.J., Easton A.L., and Leppard K.N., *Introduction to Modern Virology, 6th Edition.* Wiley-Blackwell (2007).			
	Other References	Carter J. and Saunders V., *Virology: Principles and Applications*. Wiley (2007). Acheson N.H., *Fundamentals of Molecular Virology, 2nd Edition.* 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	2	2	1	3
CO6	3	3	3	3	3

BSB303: Bioinformatics

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

School: SBSR		**Batch : 2020-2023**
Program: B.Sc. (H)		**Current Academic Year: 2020-21**
Branch: Microbiology		**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

BSM302: IPR and Industrial Ethics

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

School: SBSR		**Batch : 2020-2023**	
Program: B.Sc. (H)		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 5**	
1	Course Code	**BSM302**	
2	Course Title	**IPR and Industrial Ethics**	
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 quality management issues related to biotechnology	
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: Understand the character merchandising and franchising. CO4: Understand the utility of IPRs in biotechnology. CO5: Understand about quality standards. CO6: Learn the quality assurance.	
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	Importance of IPR in biotechnology, Indian laws and treaties for IPR	
	Unit 2	**Patents & Copyrights**	
	A	Patents-basic concepts	**CO2, CO3, CO6**
	B	Infringement, compulsory licenses, Exploitation of the Patented Invention, Compulsory Licenses	
	C	Copyright and related rights; piracy and infringement and their remedies	
	Unit 3	**Trademarks**	**CO2, CO3, CO4, CO6**
	A	Definitions, Signs which serve as trademarks	

	B	Protection of Trademark Rights, Trademark piracy, and counterfeiting			
	C	Imitation of Labels and Packaging trademark Licensing Trade Names Franchising Character Merchandising			
	Unit 4	**Work ethics**			**CO2, CO3, CO4, CO5, CO6**
	A	Work ethic – Self learning, self-egoism			
	B	Accountability			
	C	Management of staff and inventory			
	Unit 5	**Ethics in industries**			**CO3, CO4, CO6**
	A	Risk-Benefit Analysis			
	B	Team work, Working with colleagues and sharing of work, work flow related difficulties			
	C	Minimum input and maximum output; proactiveness			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	1. Managing intellectual capital: organizational, strategic and policy dimensions Oxford Univ. press 2005 Teece, David J.			
	Other References	2. Techniques used in Bio product analysis, Butterworth Heinemann Ltd, 2017. 3. 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	3	2	2	3
CO2	3	2	3	1	2
CO3	3	2	3	1	3
CO4	2	3	2	3	3
CO5	3	2	3	3	2
CO6	3	2	2	2	3

BSP306: Industrial Biotechnology Lab

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

School: SBSR		**Batch:**	
Program: B. Sc.		**Current Academic Year: 2020-21**	
Branch: BT		**Semester: 5th**	
1	Course Code	**BSP306**	
2	Course Title	**Industrial Biotechnology Lab**	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	Compulsory/Elective	
5	Course Objective	● To develop practical knowledge of microorganism ● To teach students about fermentor; other instruments and their components ● To teach about microbial production of various biomolecules	
6	Course Outcomes	CO1:Practical knowledge of fermentor other instruments and their components CO2: Isolation and screening of microorganisms CO3: Practical knowledge of solid state fermentation. CO4: Able to produce different biomolecules CO5: Cradle to grave knowledge of microbial process engineering. CO6: To develop practical knowledge on various application of industrial biotechnology	
7	Course Description	**Industrial Biotechnology**, is a specialization of biotechnology, It deals with the design and development of reactor and processes for the manufacturing of products such as like enzymes, acids, biopolymers etc. This lab covers the design of bioreactor and its operations.	
8	Outline syllabus		CO Mapping
	Unit 1	**Bioreactor and other instruments**	**CO1, CO5**
		Demonstration of working principles of various components of a batch bioreactor	
		Demonstration of working principles of biosafety cabinet; and autoclave; centrifuge	
		Demonstration of working principles of centrifuge and incubator.	
	Unit 2	**Isolation and screening of microorganism**	**CO2, CO5**
		Isolation and screening of microorganism producing enzyme (proteases)	
		Isolation and screening of microorganism producing acid (citric acid)	
	Unit 3	**Practical related to microbial fermentation**	**CO2, CO5**
		Fermentative production of Amylase	

		Fermentative production of Beer			
	Unit 4	**Practical related to Enzyme assay**			**CO2, CO3, CO5**
		Estimation of Protease activity.			
	Unit 5	**Practical related to solid state fermentation**			**CO3, CO4, CO5**
		Citric acid production be solid state fermentation			
	Mode of examination	Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	Text book/s*	-			
	Other References				

Course Outcome No	PO1	PO2	PO3	PO4	PO5
CO1	Strong-H	Moderate-M	Weak-L	Moderate-M	Moderate-M
CO2	Weak-L	Strong-H	Weak-L	Weak-L	Weak-L
CO3	Weak-L	Weak-L	Strong-H	Weak-L	Weak-L
CO4	Weak-L	Weak-L	Weak-L	Strong-H	Moderate-M
CO5	Weak-L	Weak-L	Weak-L	Weak-L	Strong-H
CO6	Strong-H	Strong-H	Strong-H	Strong-H	Strong-H

BMP311: Medical Microbiology Lab

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

School: SBSR		**Batch: 2020-2023**	
Program: B.Sc. (H)		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 5**	
1	Course Code	**BMP311**	
2	Course Title	**Medical Microbiology Lab**	
3	Credits	2	
4	Contact H (L-T-P)	0-0-3	
	Course Status	Compulsory	
5	Course Objectives	To understand basis of Medical Microbiology From this course students will be able to learn on the importance of microbiology and their medical importance in research.	
6	Course Outcomes	After successfully completion of this course students will be able to: CO1 Understand the medical importance of microbes CO2 Comprehend the importance of staining of tissues CO3 Comprehend the understanding of tools such as microscope used in medical microbiology CO4 Compare the differences between medical importance of various microbial species CO5 Understand the clinical aspects of microbes CO6 To understand the overall importance of microbes and their applications in medical sciences	
7	Course Description	Course is composed of preparation, culture and staining of medically important micro-organisms.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction**	CO1, CO2
	A	Rules & regulations in the lab	
	B	Brief of Equipment used	
	C	General medical microbiology lab set up	
	Unit 2	**Staining techniques**	
	A	Understanding staining techniques	CO2, CO3
	B	Gram staining	
	C	Gram positive and Gram Negative bacteria	
	Unit 3	**Microbial Slide and bacteria culture**	CO1, CO3
	A	Preparation of Slides	
	B	Preservation of slides	
	C	Bacterial culture	
	Unit 4	**Microscopy**	CO2, CO4

	A	Bright Field Microscopy			
	B	Dark Field Microscopy			
	C	Florescence Microscopy			
	Unit 5	**Importance of Microbes**			C01, C05
	A	Type of microbes			
	B	Type of staining needed			
	C	Method of identification			
	Mode of examination	Viva			
	Weightage Distribution	CA		ETE	
		60%		40%	
	Textbook/s*	1. Textbook on Basic Principles of Histology- CF Bowen			
	Other References	MEDICAL MICROBIOLOGY LABORATORY MANUAL Second Edition 2009 by M. Daw			

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

BSP302: Bioinformatics Lab

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

School: SBSR		**Batch: 2020-2023**			
Program: B.Sc. (H)		**Current Academic Year: 2020-21**			
Branch: Microbiology		**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*	Xiong Jin “Essential Bioinformatics”, Cambridge University Press. 2006.			
	Other References	Attwood TK., “Introduction to Bioinformatics”, Pearson Eduction, 2006. J. S, Ignacimuthu. S, “Basic Bioinformatics”, Narosa, 2013. 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

BSM305: Microbial Biotechnology

L-T-P: 4-0-0 CREDITS: 4

School : SBSR		**Batch : 2020-2023**	
Program: B.Sc.		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 6**	
1	Course Code	**BSM305**	
2	Course Title	**Microbial Biotechnology**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course Status	Compulsory	
6	Course Objective	• Introduction and Historical developments in industrial microbiology • Microbial substrates and Media formulation • Production of Microbial Biomass • BOD and COD treatment disposal of effluents	
7	Course Outcomes	After studying this course, students will be able to CO1: Determine industrially important microbes and metabolic pathways CO2: Summarize the Microbial substrates and Media formulation CO3: Describe the Working and application of fluidized, airlift, plug flow and photo bioreactors CO4: Determine the Production of Antibiotics CO5: Analyze the introduction, removal of microbial cells and solid matter, foam separation CO6: Compare the effluent treatment: BOD and COD treatment disposal of effluents.	
8	Course Description	The course comprises of general features of diverse industrial microbial organisms, their microbial substrates and media formulation. It includes various fermentation processes, and production of variant antibiotics.	
9	Outline syllabus		CO Mapping
	Unit 1		
	A	Introduction and Historical developments in industrial microbiology	**CO1**
	B	industrially important microbes and metabolic pathways; Various Microbial metabolites ,Isolation and selection of industrially important microorganisms;	
	C	Preservation and maintenance of microbial cultures	
	Unit 2		
	A	Microbial substrates and Media formulation; Components of microbial fermentation process;	**CO2**
	B	Types of fermentation process: Working and application of fluidized, airlift, plug flow and photo bioreactors; Types of Bioreactor: Stirred tank reactor, bubble column etc.;	
	C	Measurements of parameters: Temperature, gas supply, pH, DO, antifoam, airflow, weight process.	
	Unit 3		**CO3**

	A	Production of Microbial Biomass - Baker's Yeast, Mushroom; Production of fermented foods; Alcoholic beverages- wine, beer, etc			
	B	Production of Ethanol, Citric acid; Biopesticides and biofertilizers,			
	C	Whole cell immobilization and their industrial applications.			**CO4**
	Unit 4	**Production of Antibiotics**			
	A	penicillin and other antibiotics; Bioweapons and Bioshields			
	B	Pigments, Microbial transformation, Production of Insulin			
	C	Interluekin, growth hormones, etc using rDNA technology			
	Unit 5	**Downstream processing**			**CO5**
	A	Introduction, removal of microbial cells and solid matter, foam sreparation, precipitation, filtration			
	B	centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process, drying and crystallization			
	C	Effluent treatment: BOD and COD treatment disposal of effluents.			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	3. Principles of fermentation technology, Stanbury P.F. et al, Butterworth-Heinemann Ltd, 4. Oxford Industrial Microbiology by Casida			
	Other References	3. Industrial Microbiology by Cruger 4. Food Microbiology by Frazier			

Course Outcome No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	1	2
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

BSM303: Food and Dairy Microbiology

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

School : SBSR		**Batch : 2020-23**	
Program: B.Sc.		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 06**	
1	Course Code	**BSM303**	
2	Course Title	**Food and Dairy Microbiology**	
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 principles and methods of food preservation. 2) To gain knowledge about food borne diseases (causative agents, foods involved, symptoms and preventive measures).	
7	Course Outcomes	CO1: Developed a clear understanding of the multifarious roles of microorganisms in soil, in association with plants and thus in the field of agriculture CO2: Describe the role of microorganisms in the production of food, its spoilage, including their role in homemade fermented foods CO3: Develop an understanding of dairy products or fermented dairy products. CO4: Develop an understanding of how microbiology is relevant to technological developments for industries related to food and fermentations. CO5: Identify the role of microorganisms in the causation of the diseases and how to protect against food-borne pathogens. CO6: Identify all concepts of dairy and food microbiology	
8	Course Description	The aim of this course is to acquaint the students about the various food borne diseases and to achieve a general understanding about principles and methods of food preservation.	
9	Outline syllabus		CO Mapping
	Unit 1	**Foods as a substrate for microorganisms**	
	A	Intrinsic and extrinsic factors that affect growth and survival of microbes in foods	**CO1, CO6**
	B	Natural flora and source of contamination of foods in general	

	C	Microbial spoilage of various foods: Principles, spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned foods			
	Unit 2	**Principles and methods of food preservation**			**CO2, CO6**
	A	Principles, physical methods of food preservation			
	B	Temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging			
	C	Chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins			
	Unit 3	**Fermented foods**			**CO3, CO6**
	A	Dairy starter cultures, fermented dairy products			
	B	yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods			
	C	dosa, sauerkraut, soy sauce and tampeh and probiotics			
	Unit 4	**Food borne diseases (causative agents, foods involved, symptoms and preventive measures)**			
	A	Food borne diseases (causative agents, foods involved, symptoms and preventive measures)			**CO4, CO6**
	B	Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins; Food infections: *Bacillus cereus, Vibrio parahaemolyticus*			
	C	*Escherichia coli, Salmonellosis, Shigellosis, Yersinia enterocolitica, Listeria monocytogenes* and *Campylobacter jejuni*			
	Unit 5	**Food sanitation and control- HACCP, Indices of food sanitary quality and sanitizers**			**CO5, CO6**
	A	Water Potability- Treatment and safety of drinking (potable) water, methods to detect potability of water samples:			
	B	(a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms			
	C	(b) Membrane filter technique and (c) Presence/absence tests			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	

	Text book/s*	Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.	
	Other References	Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.	

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

BSM304: Environment Microbiology

L-T-P: 4-0-0 CREDITS: 4

School : SBSR		**Batch : 2020-2023**	
Program: B.Sc		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 6th**	
1	Course Code	**BSM304**	
2	Course Title	**Environment Microbiology**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course Status	Compulsory	
6	Course Objective	1 Diversity of Microbial habitat 2 Microbial interactions 3 Microbiology of air, soil and water 4 Microbiology of waste water and effluent treatments	
7	Course Outcomes	After studying this course, students will be able to CO1: Determine Basic concepts, types and microbial habitats, factors affecting microbial population. CO2: Summarize the Microbial interactions: competition, commensalism CO3: Describe the diversity, characteristic features and significance of eubacteria CO4: Determine the characteristics of population, population growth curves(r and k selection) population regulation CO5: Analyze the microbial degradation of xenobiotics, petroleum and oil spills in environmental decay behaviours and degradative plasmid. CO6: Compare the physiology, morphology, biochemistry of microbial biofilms.	
8	Course Description	The course comprises of general and basic features of microbial ecology, microbiology of air, water and soil. This also focussed on microbiology and its use in effluent treatment.	
9	Outline syllabus		CO Mapping
	Unit 1	**Microbial ecology**	**CO1**
	A	Basic concepts, types and microbial habitats, factors affecting microbial population.	
	B	Microbial interactions: competition, commensalism, parasitism, mutualism, commensalisms, synergism.	
	C	Population ecology: characteristics of population, population growth curves(r and k selection) population regulation. Conservation and management of microbial diversity: biodeterioration and biodegradation.	
	Unit 2	**Microbiology of air:**	**CO2**
	A	Microbiology of air: microorganism of air, enumeration of air micro flora. Significance of air micro flora.	
	B	Brief account of air borne transmission of bacteria, fungi, pollens and viruses.	

	C	Airborne diseases and their prevention.			
	Unit 3	**Soil microbiology**			**CO3**
	A	microflora of soil: soil microorganisms associated with plants: rhizosphere, mycorrhizae. Role of microorganisms in organic matter decomposition (cellulose, hemi cellulose, lignin).			
	B	Bioleaching; introduction, application of bacterial leaching techniques, properties of bioleaching.			
	C	Microbial degradation of xenobiotics, petroleum and oil spills in environmental decay behaviours and degradative plasmid.			
	Unit 4	**Water microbiology:**			**CO4**
	A	aquatic microorganisms; fresh water and sea water microflora. Microorganisms and water quality, water pollution.			
	B	Water purity test and indicator organisms, method used in environmental studies –BOD, COD, DO.			
	C	Common water born disease and their control measure. Water purification: flocculation, chlorination and purification.			
	Unit 5	**Microbiology of waste water and effluent treatments**			**CO5**
	A	aerobic process: primary, secondary and tertiary treatment: trickle filter, oxidation ponds and stabilization ponds, principle of aerobic digestion.			
	B	Bioremediation of contaminations. Extremophiles – acidophilic, alkalophilic, thermophilic microbes with adaptation and application in ecosystem.			
	C	Microbial biofilms: physiology, morphology, biochemistry of microbial biofilms, mechanism of microbial adherence, beneficial and harmful role of biofilms.			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Microbial Ecology: Fundamentals and applications, Ronals M, Atlas, fourth edition, Animprint of Addison Wesley Longman. Inc, California 2. Environmental chemistry, A.K. De, Wiley Eastern Ltd., New Delhi			
	Other References	1. Environmental Science, Physical Principles and applications; Egbert Boeker et. al. 2. Comprehensive Biotechnology, vol.4, M.moo-young (Ed-in-chief), Pergmon Press, Oxford. 3. Wastewater Treatment for Pollution Control By Soli J Arceivala, Second Edition, Tata McGraw- Hill Publishing Company Limited. 4. Environmental Biotechnology Theory and Application by Gareth M. Evans and Judith C. Furlong, John Wiley and Sons, LTD, U.S.A.			

		5. Ecology and Environment by P.D. Sharma, Rastogi Publications, New Delhi, India 6. Environmental Sciences earth as a living planet by Daniel K. Botkin and Edward A. Keller, Third edition, John Wiley and Sons, LTD, U.S.A.	

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

BSB308: Bioethics and Biosafety

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

School: SBSR		**Batch: 2020-2023**	
Program: B.Sc. (H)		**Current Academic Year: 2020-21**	
Branch: Microbiology		**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	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: 2020-2023**	
Program: B.Sc. (H)		**Current Academic Year: 2020-21**	
Branch: Microbiology		**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 realize 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	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

BMP305: Microbial Biotechnology Lab

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

School: SBSR		**Batch: 2020-23**	
Program: B.Sc.		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 6**	
1	Course Code	**BMP305**	
2	Course Title	**Microbial Biotechnology Lab**	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-3	
	Course Status	Compulsory/Elective	
5	Course Objective	• To develop practical knowledge of microorganism • To teach students about fermentor; other instruments and their components • To teach about microbial production of various biomolecules	
6	Course Outcomes	CO1:Practical knowledge of fermentor other instruments and their components CO2: Isolation and screening of microorganisms CO3: Practical knowledge of solid state fermentation. CO4: Able to produce different biomolecules CO5: Cradle to grave knowledge of microbial process engineering.	
7	Course Description	**Microbial Biotechnology**, is a specialization of biotechnology, It deals with the design and development of reactor and processes for the manufacturing of products such as like enzymes, acids, biopolymers etc. This lab covers the design of bioreactor and its operations.	
8	Outline syllabus		CO Mapping
	Unit 1	**Isolation and screening of microorganism**	**CO1, CO5**
		Isolation and screening of microorganism producing proteases	
		Isolation and screening of microorganism producing amylases	
	Unit 2	**Isolation and screening of microorganism**	**CO2, CO5**
		Isolation of Nitrogen fixers from soil	
		Isolation of phosphate solubilizers from soil	
	Unit 3	**Microbial Growth Kinetics**	**CO2, CO5**
		Estimation of effect of temperature on microbial growth	
		Estimation of effect of pH on microbial growth	
	Unit 4	**Microbial fermentation**	**CO4, CO5**
		Fermentative production of Wine	
		Fermentative production of Beer	
	Unit 5	**Microbial fermentation**	**CO4, CO5**

		Fermentative production of Amylase			
	Mode of examination	Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	Text book/s*	-			
	Other References				

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

BMP303: Food and Dairy Microbiology Lab

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

School: SBSR		**Batch: 2020-23**	
Program: B.Sc.		**Current Academic Year: 2020-21**	
Branch: Microbiology		**Semester: 6**	
1	Course Code	**BMP303**	
2	Course Title	**Food and Dairy Microbiology Lab**	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-3	
	Course Status	Compulsory/Elective	
5	Course Objective	• To develop practical knowledge of food and dairy microorganism • To teach students about various food and dairy related instruments and their components • To teach about microbial food spoilage • To teach students about	
6	Course Outcomes	CO1: Understand the basics of food and dairy microbiology instruments CO2: Understand the effects of different environmental conditions on food spoilage. CO3: Understand the isolation of microorganisms from food samples. CO4: Understand the characterization of milk bacteria. CO5: Understand about quality standards. CO6: Learn the food and dairy microorganisms, their handling, and safety protocols.	
7	Course Description	**Food and Dairy Microbiology**, is a specialization of Microbiology. It deals with the interaction of different microorganisms in food and milk products.	
8	Outline syllabus		CO Mapping
	Unit 1	**Basics of Bioreactor and basic instruments**	**CO1, CO5**
		Demonstration of working principles of various components of a batch bioreactor;	
		incubator; biosafety cabinet; and autoclave; centrifuge	
	Unit 2	Effect of environmental condition (temperature) on the quality of food sample	**CO2, CO5**
		Effect of environmental condition (moisture) on the quality of food sample	
	Unit 3	**Screening of microorganism**	**CO2, CO5**
		Isolation of microorganism from idli batter	
		Characterization of idli batter microorganism	
	Unit 4	**Milk Microorganisms**	**CO2, CO3, CO5**

		Isolation of microorganism from curd sample Characterization of curd producing microorganism			
	Unit 5	**Isolation of microorganism from spoiled food** Handling of spoiled food			**CO3, CO4, CO5**
	Mode of examination	Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	Text book/s*	-			
	Other References				

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