Programme Structure

BACHELOR OF SCIENCE (Hons.) IN MICROBIOLOGY

BACHELOR OF SCIENCE (Hons. with Research) IN MICROBIOLOGY

COURSE CODE: SBR0412

Department of Life Sciences

School of Basic Sciences & Research

Sharda University

(Batch - 2023-2027)

Programme Structure
School of Basic Sciences & Research
B.Sc. (Hons.) in MICROBIOLOGY (SEMESTER: 01)
Session: 2023-2024

S. No.	Course Code	Course Name	Teaching Load			Credits	Type of Course
			L	T	P		
THEORY COURSES							
1.	BSM103	Introduction to Microbiology	4	0	0	4	Major
2.	BMB101 Or BBI102	Elementary Biochemistry Or Applications of Biomolecules	4 Or 4	0 Or 0	0 Or 0	4 Or 4	Multidisciplinary
3.	CHE112	Chemistry III/Minor	3	0	0	3	Open Elective/Minor
4.	ARP101	Communicative English-1	1	0	2	2	Ability Enhancement Course
5.	VAC103	Environmental Management	3	0	0	3	Value Added Course
PRACTICAL COURSES							
6.	BBI103	Basics of Microbiology (Lab)	0	0	2	1	Major
7.	VOL101	Essential Techniques in Life Sciences-1	0	0	6	3	Skill Enhancement Course
					TOTAL CREDITS	**20**	

Programme Structure
School of Basic Sciences & Research
B.Sc. (Hons.) in MICROBIOLOGY (SEMESTER: 02)
Session: 2023-2024

S. No.	Course Code	Course Name	Teaching Load			Credits	Type of Course
			L	T	P		
THEORY COURSES							
1.	BSB120	Cell and Molecular Biology	4	0	0	4	Major
2.	BBI111	Principle of Bioinstrumentation	3	0	0	3	Major
3.	PHR101	Introduction to Renewable energy and management/Minor	3	0	0	3	Minor (Open Elective)
4.	ARP102	Communicative English-2	1	0	2	2	Ability Enhancement Course
5	VAC110	Yoga for Holistic Development	0	1	4	3	Value Added Course
PRACTICAL COURSES							
6.	VOL102	Essential Techniques in Life Sciences-2	0	0	6	3	Skill Enhancement Course
7.	BBI112	Basics of Cell and Molecular Biology (Lab)	0	0	2	1	Major
8.	BBI113	Principle of Bioinstrumentation (Lab)	0	0	2	1	Major
TOTAL CREDITS						**20**	

Programme Structure
School of Basic Sciences & Research
B.Sc. (Hons.) in MICROBIOLOGY (SEMESTER: 03)
Session: 2024-2025

S. No.	Course Code	Course Name	Teaching Load			Credits	Type of Course
			L	T	P		
THEORY COURSES							
1.	BSM201	Bacteriology	4	0	0	4	Major
2.	BMB201	Introduction to Biofertilizers	4	0	0	4	Major
3.	BBT211 Or BMB111	Biophysics Or Physical and chemical aspects of biological sciences	4 Or 4	0 Or 0	0 Or 0	4 Or 4	Multidisciplinary
4.	PHR201	Renewable energy resources/Minor	3	0	0	3	Minor (Open Elective)
5.	ARP207	Logical Skill Building and Soft Skills	1	0	2	2	Ability Enhancement Course
PRACTICAL COURSES							
6.	VOL201	Essential Techniques in Life Sciences-3	0	0	6	3	Skill Enhancement Course
7.	BMB202	Introduction to Bacteriology Lab	0	0	2	1	Major
8.	RBL001	Research Based Learning-1	0	0	4	Audit	Major (Project)
		TOTAL CREDITS				**21**	

Programme Structure
School of Basic Sciences & Research
B.Sc. (Hons.) in MICROBIOLOGY (SEMESTER: 04)
Session: 2024-2025

S. No.	Course Code	Course Name	Teaching Load			Credits	Type of Course
			L	T	P		
THEORY COURSES							
1.	BSB206	Enzyme Technology	4	0	0	4	Major
2.	BBT213	Nanotoxicology	4	0	0	4	Major
3.	BBI213 Or FST419	Introduction to Genetic Engineering Or Introduction to Human Physiology	3 Or 5	0 Or 0	0 Or 0	3 Or 5	Multidisciplinary
4.	CHE113	Chemistry IV/Minor	3	0	0	3	Minor (Open Elective)
5.	ARP305	Personality Development and Decision Making	1	0	2	2	Ability Enhancement Course
PRACTICAL COURSES							
7.	BMB211	Experiments with Enzymes (Lab)	0	0	2	1	Major
8.	RBL002	Research Based Learning -2	0	0	4	AUDIT	Major (Project)
9.	BSP205	*Genetic Engineering (Lab)	0	0	4	2	Multidisciplinary
		TOTAL CREDITS				**19**	

***Genetic Engineering (Lab) BSP205 is a part of BBI213.**

Programme Structure
School of Basic Sciences & Research
B.Sc. (Hons.) in MICROBIOLOGY (SEMESTER: 05)
Session: 2025-2026

S. No.	Course Code	Course Name	Teaching Load			Credits	Type of Course
			L	T	P		
THEORY COURSES							
1.	BMB301	Advanced Microbial Biotechnology	3	0	0	3	Major
2.	BMB302	Basics of Bioinformatics	3	0	0	3	Major
3.	BSB311	Medical Microbiology	4	0	0	4	Major
4.	BMB303 Or FST314	Modern Industrial Microbiology Or Food waste management	3 Or 3	0 Or 0	0 Or 0	3 Or 3	Multidisciplinary
PRACTICAL COURSES							
6.	BMB304	Bioinformatics Lab	0	0	4	2	Major
7.	BMB305	Microbial Biotechnology Lab	0	0	4	2	Major
8.	INC001	Industry Connect	0	0	4	2	Survey (Value Added Course)
9.	RBL003	Research Based Learning - 3	0	0	2	1	Major (Project)
TOTAL CREDITS						**20**	

Programme Structure
School of Basic Sciences & Research
B.Sc. (Hons.) in MICROBIOLOGY (SEMESTER: 06)
Session: 2025-2026

S. No.	Course Code	Course Name	Teaching Load			Credits	Type of Course
			L	T	P		
THEORY COURSES							
1.	BBI313	Fundamentals of Environmental Microbiology	3	0	0	3	Major
2.	BMB311	Modern Food and Dairy Microbiology	3	0	0	3	Major
3.	BMB312	Advanced Immunology	4	0	0	4	Major
4.	CHE111	Chemistry II/MOOC/Minor	3	0	0	3	Minor (Open Elective)
PRACTICAL COURSES							
5.	BSP310	Environmental Microbiology Lab	0	0	4	2	Major
6.	BMB313	Modern Food and Dairy Microbiology Lab	0	0	4	2	Major
7.	CCU108	Community Connect	0	0	4	2	Survey (Value Added Course)
8.	RBL004	Research Based Learning- 4	0	0	2	1	Major (Project)
		TOTAL CREDITS				**20**	

Programme Structure
School of Basic Sciences & Research
B.Sc. (Hons.) in MICROBIOLOGY (SEMESTER: 07)
Session: 2026-2027

S. No.	Course Code	Course Name	Teaching Load			Credits	Type of Course
			L	T	P		
THEORY COURSES							
1.	BMB401	ABC of Mycology and Phycology	4	0	0	4	Major
2.	BBI401	Biostatistics, Bioethics, and IPR	4	0	0	4	Major
3.	BBT406	Cell Signaling and Cancer Biology	4	0	0	4	Multidisciplinary
4.	BMB403 Or FST413	Study of Viruses Or Functional Food and nutraceuticals	4 Or 4	0 Or 0	0 Or 0	4 Or 4	Multidisciplinary
5.	CHE101	Fundamentals of Chemistry/MOOC/Minor	4	0	0	4	Minor/Open Elective
TOTAL CREDITS						**20**	

Programme Structure
School of Basic Sciences & Research
B.Sc. (Hons. with Research.) in MICROBIOLOGY (SEMESTER: 07)
Session: 2026-2027

S. No.	Course Code	Course Name	Teaching Load			Credits	Type of Course
			L	T	P		
THEORY COURSES							
1.	BMB401	ABC of Mycology and Phycology	4	0	0	4	Major
2.	BBI401	Biostatistics, Bioethics and IPR	4	0	0	4	Major
3.	BBT406	Cell Signaling and Cancer Biology	4	0	0	4	Major
4.	BMB403	Study of Viruses	4	0	0	4	Major
5.	CHE101	Fundamentals of Chemistry/MOOC/Minor	4	0	0	4	Minor (Open Elective)
PRACTICAL COURSES							
6.	PJI401	Project	0	0	6	3	Research Project (Value Added Course)
			TOTAL CREDITS			**23**	

Programme Structure
School of Basic Sciences & Research
B.Sc. (Hons) in MICROBIOLOGY (SEMESTER: 08)
Session: 2026-2027

S. No.	Course Code	Course Name	Teaching Load			Credits	Type of Course
			L	T	P		
THEORY COURSES							
1.	BMB411	Fermentation Technology	4	0	0	4	Major
2.	BBI411	Functional Genomics	4	0	0	4	Major
3.	BMB412	Introduction to Recombinant DNA Technology	4	0	0	4	Major
4.	BMB413 Or FST419	Bioreactors and Downstream Processing Or Basic concepts of research design and methodology	4 Or 4	0 Or 0	0 Or 0	4 Or 4	Multidisciplinary
5.		MOOC/Minor	4	0	0	4	Minor (Open Elective)
TOTAL CREDITS						**20**	

Programme Structure
School of Basic Sciences & Research
B.Sc. (Hons. with research.) in MICROBIOLOGY (SEMESTER: 08)
Session: 2026-2027

S. No.	Course Code	Course Name	Teaching Load			Credits	Type of Course
			L	T	P		
THEORY COURSES							
1.	BMB413	Bioreactors and Downstream Processing	4	0	0	4	Major
2.		MOOC/Minor	4	0	0	4	Minor/Open Elective
PRACTICAL COURSES							
3.	PJI402	Project	0	0	18	9	Research Project (Value Added Course)
TOTAL CREDITS						**17**	

Course Module

SEMESTER I

B.Sc. (Hons.) Microbiology

Course code: BSM103 Course Title: Introduction to Microbiology

School: SBSR		Batch: 2023-2027	
Programme: B.Sc.		Current Academic Year: 2023-24	
Branch: Microbiology		Semester: 01	
1.	Course Code	BSM103	
2.	Course Title	Introduction to Microbiology	
3.	Credits	4	
4.	Contact Hours (L-T-P)	4-0-0	
5.	Course Status	CC (Major)	
6.	Course Objective	This course has been designed to make students understand the basic characteristics of microbes. To know about basis principle and to understand the methods of sterilization. Students understand the basic structure of Microorganisms and related pathogens.	
7.	Course Outcomes	The students at the completion of the course will be able to: CO1: To discuss the history of microbiology and its basic concepts. CO2: To understand the various classification of bacteria. CO3: To evaluate how bacteria can be classified based on its morphology and cell structure. CO4: To understand the growth in bacteria and how to isolate bacterial species. CO5: To examine the various ways to control microbial growth and basic understanding of viruses. CO6: To discuss the microbial diversity in extreme environments. To know the cell composition of microbial species.	
8.	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.	
9.	Outline Syllabus		CO Mapping
	Unit 1	**Introduction of Microbiology and Microbial Diversity**	
	A	History and scope of microbiology, concept of cell, prokaryotic and eukaryotic cell (plant cell and animal cell) Spontaneous Generation Versus Biogenesis, Germ theory of disease, Scope of Microbiology.	CO1
	B	Major contribution of scientists–Leeuwenhoek, Edward Jenner, Alexander Flemming, Joshep Lister, Robert Koch, Louis Pasteur, Hargobind Khorana.	

	C	Whittaker's 5 kingdom concept; major groups of Microorganisms introduction–bacteria, archaea, virus, fungi (yeast and moulds), algae, protozoa	
	Unit 2	**Classification of Bacteria**	
	A	Microbial classification, molecular approaches in microbial classification, concept of microbial species.	CO2
	B	Principle and classification of bacteria on the basis of Bergey's manual of Determinative bacteriology.	
	C	Nutritional classification of Bacteria, prochlorons, acidophiles, alkaliphiles, thermophiles, barophiles, non-culturable bacteria. Methanogens, Methanotrophs and Methylotrophs, Psychrophiles,	
	Unit 3	**Morphology of Bacteria and cell composition**	
	A	Morphological study of bacteria-Size, shape, and arrangement of bacterial cells. Components of bacterial cell (nucleoid, flagella, inclusion bodies, plasmids, pili, fimbriae).	CO3
	B	Gram negative and gram-positive bacteria cell wall and membrane, spores and cyst.	
	C	Brief overview on archaea, archaea cell wall, cyanobacteria and PPLO.	
	Unit 4	**Growth and Sporulation in Bacteria**	
	A	Modes of cell division (binary fission, budding and septum formation, fragmentation), Growth curve, conjugation	CO4, CO6
	B	Pure culture, Method of isolating pure culture (Streak method, Pour-plate and spread plate technique); Synchronous and asynchronous	
	C	Growth inhibitory substances (temperature, acidity, alkalinity, water availability, oxygen)	
	Unit 5	**Microbial Growth and control of virus**	
	A	Antibiotics mode of action on bacteria and anti-biotic resistance.	CO5, CO6
	B	Physical and chemical methods of control of Microorganisms; Microbes and Human welfare (medical and food industry).	
	C	Ultra-structure of Virus, Lytic and lysogenic life cycle of virus.	
10.	Mode of examination	Theory	

11.	Weightage Distribution	CA+MSE	ESE	
		25%	75%	
12.	Text book/s*	Suggested Readings: 1.Microbiology- Pelczar, M.J. Reid, R.D. and E.C.S. Chan, Tata McGraw Hill, New Delhi.1977 (4th Edition) 2. Prescott, Harley and Kelvin – Microbiology,2nd ed. TMH Publication.		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO.1	1	1	1	-	1	1	1	-	1	-	1	1	-
CO.2	2	1	1	-	1	1	1	-	1	-	1	1	-
CO.3	2	1	1	-	1	1	1	-	1	-	2	2	-
CO.4	3	1	3	-	1	1	1	-	1	-	1	1	-
CO.5	3	1	3	-	1	2	2	-	1	2	2	1	1
CO.6	1	1	2	-	1	3	3	-	3	2	2	2	1
Avg	2.00	1.00	1.83	-	1.00	1.50	1.50	-	1.33	2.00	1.50	1.33	1.00

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

Course code: BMB101 Course Title: Elementary Biochemistry

School: SBSR		Batch: 2023-2027	
Programme: B.Sc.		Current Academic Year: 2023-24	
Branch: Microbiology		Semester: 01	
1.	Course Code	BMB101	
2.	Course Title	Elementary Biochemistry	
3.	Credits	4	
4.	Contact Hours (L-T-P)	4-0-0	
5.	Course Status	CC (Multidisciplinary)	
6.	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	
7.	Course Outcomes	The students at the completion of the course will be able to: CO1**:** To analyze the basic concepts of thermodynamics and bioenergetics CO2**:** To remember the structure and functions of carbohydrates. CO3**:** To memorize the types of lipids, fatty acids and vitamins CO4**:** To discuss the proteins and various types of it. CO5: To evaluate the nucleic acids and DNA structure types that exist in nature. CO6: To understand the basic concepts of biomolecules and use those concepts to understand the structure and basic functions of cell membrane.	
8.	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.	
7	Outline syllabus		CO Mapping
	Unit 1	**Bioenergetics and thermodynamics**	
	A	Bonds: Covalent, non-covalent bonds, hydrophilic and hydrophobic interactions, hydrogen bonding and their influence on structure of biomolecules.	CO1, CO6
	B	Acids, bases, pH, pK, and ionization of water, Buffers, Polarity, oxidation and reduction	

	C	Water: the solvent of life - Physical properties of water, structure of water, polarity of water, biological functions of water inside the cell and human body	
	Unit 2	**Carbohydrate: Structure and functions**	
	A	Monosaccharide: aldoses and ketoses, configuration and conformation, concept of reducing and non-reducing sugars, stereoisomerism.	CO2, CO6
	B	Oligosaccharides: Conformation of Pyranose and Furanose Rings, Sucrose, Lactose, Maltose, Isomaltose, Trehalose	
	C	Polysaccharides: Storage (starch and glycogen) and structural (cellulose and chitin). Important sugar derivatives and glycosaminoglycans. Importance of carbohydrates.	
	Unit 3	**Fatty acids and lipids**	
	A	Structure and properties of the fatty acids (Saponification, acid values and iodine number, saturated, unsaturated, essential, non-essential fatty acids)	CO3, CO6
	B	Triacylglycerols, phospholoipids and derivatives viz., phosphoglycerides; lacithins, cephalins, plasmogens, phosphatidyl inositol	
	C	Sphingomylin, glycolipids (cerebrosides and gangliosides) and cholesterol; membrane lipids	
	Unit 4	**Protein structure**	
	A	Introduction to proteins, uses.	CO4, CO6
	B	Basic properties, types and structures of Amino acid, DL configuration, Physical properties and ionizability of Amino acids (zwitterion), pK	
	C	Chemical properties of peptide bond. Primary, secondary (alpha helix and beta pleated sheet), tertiary and quaternary structure of proteins.	
	Unit 5	**Nucleic Acids: Structure and functions**	
	A	Nitrogenous bases (purines & pyrimidines)**,** Nucleosides & Nucleotides,	CO5, CO6
	B	Biologically important nucleotides, Double helical model of DNA structure forces responsible for A, B & Z DNA.	
	C	Chemical structures of DNA (Watson-Crick Model) and RNA. Significance of DNA and RNA	

	Mode of examination	Theory		
	Weightage Distribution	CA+MSE	ESE	
		25%	75%	
Books	1. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WHFreeman and Company, New York, USA. 2. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman 3. Buchanan, B., Gruissem, W. and Jones, R. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.			

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO.1	1	-	1	-	1	1	1	-	-	-	1	1	-
CO.2	1	-	1	-	1	1	1	-	-	-	1	1	-
CO.3	1	-	1	-	1	1	1	-	-	-	1	2	-
CO.4	1	-	1	-	1	1	1	-	-	-	1	1	-
CO.5	2	-	1	-	1	1	1	-	-	1	1	1	1
CO.6	1	-	2	-	2	1	2	-	1	1	1	2	1
Avg	1.17	-	1.17	-	1.17	1.00	1.17	-	1.00	1.00	1.00	1.33	1.00

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

Course code: BBI103 Course Title: Basics of microbiology (Lab)

School: SBSR		Batch: 2023-2027	
Programme: B.Sc.		Current Academic Year: 2023-2024	
Branch: Microbiology		Semester: 01	
1.	Course Code	BBI103	
2.	Course Title	Basics microbiology (Lab)	
3.	Credits	1	
4.	Contact Hours (L-T-P)	0-0-2	
5	Course Status	CC (Major)	
6	Course Objective	To explain relationships and terminology relating to the structure, and ecology of prokaryotic microorganisms. To develop the appropriate laboratory skills and techniques related to the isolation, staining, identification of microorganisms.	
7.	Course Outcomes	After finishing the course, the students will be able to: CO1: to learn about the basic tools of Microbiology Lab CO2: To demonstrate the culture media preparation and culturing the bacteria. CO3: How to recognize bacteria using staining methods. CO4: To demonstrate the identification of bacteria. CO5: To demonstrate the bacterial concentration. CO6: To interpret importance of multiple techniques used to study the microbial species.	
8.	Course Description	To explain the principles of physical and chemical methods used in the Microbiology laboratory.	
7	Outline syllabus		CO Mapping
Unit	**Topic**		**CO`s**
Unit 1	**Laboratories equipment's**		
A	Basic tools used for culture		CO1, CO6
B	Laminar Air Flow, Microscope		
C	Autoclave, Rotary Shaker, Incubator, Ovens		
Unit 2	**Maintenance, Preparation and Sub-Culturing**		
A	Media Preparation for culturing the bacteria		CO2, CO6
B	Pure cultures		
C	Maintaining stock cultures		
Unit 3	**Staining And Morphological Study Of Bacteria**		
A	Examination of shape and arrangement of bacterial cells – simple staining		CO3, CO6
B	Separation of bacteria into groups – Gram stain		
C	Separation of bacteria into groups – Acid fast stain		

Unit 4	**Methods in study and identification of bacteria**				
A	To recognize the differences among bacteria based on colonies formed on culture media				CO4, CO6
B	To demonstrate the Colony Characteristics of bacterial colony				
C	To perform the biochemical tests (Starch Hydrolysis)				
Unit 5	**Methods of determining concentration of microorganisms in A sample**				
A	To learn the Heamocytometer.				CO5, CO6
B	To learn how to use a haemocytometer to determine concentration of microorganisms.				
C	To perform serial dilution and determine concentration of bacteria in the dilutions by plating out on agar media.				
	Mode of Examination	Practical			
	Weightage Distribution	CA	CE	ESE	
		25%	25%	50%	
Suggested Readings/Textbooks	Practical manual of Biotechnology by Ritu Mahajan, Jitendar Sharma, RK Mahajan, Vayu Education of India				

CO-PO-PSO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO.1	2	2	3	-	1	1	2	-	2	1	-	1	2
CO.2	2	2	2	-	1	1	2	-	2	1	-	1	2
CO.3	2	1	1	-	1	1	2	-	2	1	-	1	2
CO.4	2	2	3	-	1	1	2	-	3	2	2	2	2
CO.5	1	2	2	-	2	1	2	-	2	2	2	2	-
CO.6	2	2	2	-	2	2	2	-	2	2	1	2	2
Avg	1.83	1.83	2.17	-	1.33	1.17	2.00	-	2.17	1.50	1.67	1.50	2.00

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

Course code: VOL1 Course Title: Essential techniques in life sciences

School: SBSR		Batch: 2023-2027
Programme: B.Sc.		Current Academic Year: 2023-24
Branch: Microbiology		Semester: 01
1	Course Code	VOL101
2	Course Title	Essential techniques in life sciences
3	Credits	3
4	Contact Hours (L-T-P)	0-0-6
5.	Course Status	SEC (Minor)
6.	Course Objective	Develop knowledge of a specific area of specialization. Develop research skills especially in biological experiments, project writing and oral presentation.
7.	Course Outcomes	The students at the completion of the course will be able to: CO 1: To estimate the concentration of protein and carbohydrates. CO 2: To study the effect of temperature and pH on the growth of bacteria. CO 3: To study the growth of bacteria in different carbon sources. CO 4: To prepare the glycerol stock of bacteria. CO 5: DNA isolation and electrophoresis. CO 6: To understand the biomolecules and the growth of bacteria.
8.	Course Description	Vocational education is concerned with the training on vocation. It is related to productivity. Vocational education prepares individuals for jobs. It has adequate employment potentialities. It helps in broadening of horizon. It leads to dignity of labor. It is helpful in the maximum utilization of the material resources of the country.

Unit	Topic	CO
Unit 1	A. To estimate the protein concentration using Lowry method.	CO1
	B. To calculate the carbohydrate concentration using Molisch Test	
	C. Iodine test for lipids.	
Unit 2	A. Culture bacterial cells using nutrient broth.	CO2
	B. To study the bacterial growth at different pH.	
	C. To study the bacterial growth at different temperature	
Unit3	A. To study the bacterial growth at different carbon sources- glucose, lactose.	CO3, CO4
	B. Study the effect of antibiotics on the growth of bacteria.	
	C. To prepare glycerol stock of bacterial cells.	
Unit4	A. To isolate DNA from bacterial cells.	CO5, CO6

	B. To run the DNA on an agarose gel electrophoresis.			
	C. To estimate the DNA concentration using spectrophotometry method.			
Mode of examination	Rubric assessment. Monthly Presentation to be audited by supervisor. Mid Term Presentation and End Term Presentation.			
	Weightage Distribution	CA	CE	ESE
		25%	25%	50%
Text book/s*	Recent International Journal Articles of repute.			

CO-PO-PSO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	2	-	1	1	2	-	2	1	1	1	1
CO2	1	1	1	-	1	1	2	-	2	1	1	3	3
CO3	1	1	2	-	1	1	2	-	2	1	1	2	1
CO4	1	1	1	-	1	1	2	-	3	2	1	3	1
CO5	1	1	3	-	1	1	2	-	2	2	1	3	1
CO6	1	1	3	-	1	2	2	-	2	2	1	3	1
Avg	1.00	1.00	2.00	-	1.00	1.17	2.00	-	2.17	1.50	1.00	2.50	1.33

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

Course code: ARP101 **Course Title: Communicative English-1**

School: SBSR		Batch: 2023-2027
Programme: B.Sc.		Academic Year: 2023-2024
Branch: Microbiology		Semester: 01
1.	Course Code	ARP101
2.	Course Title	Communicative English-1
3.	Credits	2
4.	Contact Hours (L-T-P)	1-0-2
5.	Course Status	AEC (Minor)
6.	Course Objective	To minimize the linguistic barriers that emerges in varied socio-linguistic environments through the use of English. Help students to understand different accents and standardize their existing English. Guide the students to hone the basic communication skills - listening, speaking, reading and writing while also uplifting their perception of themselves, giving them self-confidence and building positive attitude.
7.	Course Outcomes	After completion of this course, students will be able to: CO1. Develop a better understanding of advanced grammar rules and write grammatically correct sentences. CO2. Acquire wide vocabulary and punctuation rules and learn strategies for error-free communication. CO3. Interpret texts, pictures and improve both reading and writing skills which would help them in their academic as well as professional career. CO4. Comprehend language and improve speaking skills in academic and social contexts. CO5. Develop, share and maximize new ideas with the concept of brainstorming and the documentation of key critical thoughts articulated towards preparing for a career based on their potentials and availability of opportunities. CO6. Function effectively in multi-disciplinary teams through the knowledge of team work, Inter-personal relationships, conflict management and leadership quality.
8.	Course Description	The course is designed to equip students, who are at a very basic level of language comprehension, to communicate and work with ease in varied workplace environment. The course begins with basic grammar structure and pronunciation patterns, leading up to apprehension of oneself through written and verbal expression as a first step towards greater employability.
Outline syllabus			CO Mapping
	Unit A	Sentence Structure	

	A	Subject Verb Agreement		CO1
	B	Parts of speech		
	C	Writing well-formed sentences		
	Unit B	Vocabulary Building & Punctuation		
	A	Homonyms/ homophones, Synonyms/Antonyms		CO1, CO2
	B	Punctuation/ Spellings (Prefixes-suffixes/Unjumbled Words)		
	C	Conjunctions/Compound Sentences		
	Unit C	Writing Skills		
	A	Picture Description – Student Group Activity		CO2, CO3
	B	Positive Thinking - Dead Poets Society-Full-length feature film - Paragraph Writing inculcating the positive attitude of a learner through the movie | SWOT Analysis – Know yourself		
	C	Story Completion Exercise –Building positive attitude - The Man from earth (Watching a Full length Feature Film)		
	Topic 4	Digital Literacy | Effective Use of Social Media		
	Unit D	Speaking Skill		
	A	Self-introduction/Greeting/Meeting people – Self branding		CO4
	B	Describing people and situations - To Sir with Love (Watching a Full length Feature Film)		
	C	Dialogues/conversations (Situation based Role Plays)		
	Unit E	Professional Skills | Career Skills		
	A	Exploring Career Opportunities		CO4, CO5
	B	Brainstorming Techniques & Models		
	C	Social and Cultural Etiquettes		
	D	Internal Communication		
	Unit F	Leadership and Management Skills		
	A	Managerial Skills		CO6
	B	Entrepreneurial Skills		
	Weightage Distribution	CA+MSE	ESE	
		60%	40%	
10	Texts & References | Library Links	• Blum, M. Rosen. *How to Build Better Vocabulary*. London: Bloomsbury Publication • Comfort, Jeremy (et.al). *Speaking Effectively*. Cambridge University Press		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	-	1	3	-	-	-
CO2	-	-	-	-	-	-	-	-	1	3	-	-	-
CO3	-	-	-	-	-	-	-	-	1	3	-	-	-
CO4	-	-	-	-	-	-	-	-	1	2	-	-	-
CO5	-	-	-	-	-	-	-	-	1	2	-	-	-
CO6	-	-	-	-	-	-	-	-	1	2	-	-	-
Avg	-	-	-	-	-	-	-	-	1	2.5	-	-	-

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

Course code: VAC109 Course Title: Environmental Management

School: SBSR		Batch: 2023-2027	
Programme: B.Sc.		Current Academic Year: 2023-24	
Branch: Microbiology		Semester: 01	
1	Course Code	VAC109	
2	Course Title	Environmental Management	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	VAC (Major)	
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 sustainable practices and environmental management.	
6	Course Outcomes	The students at the completion of the course will be able to: CO1.Develop a better understanding of the principles and scope of environmental science. CO2. Acquire to learn various pollution causes, effects and control and solid waste management. CO3. Interpret the effect of global warming and ozone layer depletion CO4. Comprehend about various types of natural resources and its conservation. CO5.Develop a better understanding about sustainable practices and environmental management. CO6.Function effectively an 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. Sustainable and Environmental environment.	
8	Outline syllabus		CO Mapping
	Unit 1	Natural resource management	
	A	Introduction to Natural Resources	CO1/CO6

	B	Management of Land and Forest Resources	
	C	Water and Energy resource Management	
	Unit 2	Environmental Pollution Management	
	A	Air pollution Control and Water Pollution treatment Methods	CO2/CO6
	B	Soil and Noise Pollution Management	
	C	Solid waste management	
	Unit 3	Climate Change Mitigation	
	A	Concept of Global Warming and greenhouse effect	CO3/CO6
	B	Ozone layer Depletion and its consequences	
	C	Climate change, its effect on ecosystem and its mitigation. Kyoto protocol and IPCC concerns on changing climate.	
	Unit 4	Natural resource conservation and management	
	A	Hot spots, Endangered and endemic species of India	CO4/CO6
	B	Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions	
	C	Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	
	Unit 5	Sustainable practices and environmental management	
	A	Sustainable development and sustainable consumption	CO5/CO6
	B	Environmental Issues and Management in India	
	C	Environmental Management System (EMS)	
	Mode of examination	Theory	
	Weightage Distribution	CA+MSE: 25% / ESE: 75%	
	Text book/s*	Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha, Pub: Orient Blackswan Pvt Ltd	
	Other References	Environmental Science by G. Tyler Miller, JR. and Scott E. Spoolman; Broks/Cole	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	-	-	-	1	1	1	-	-	1	1	-	-
CO2	1	-	-	-	2	2	1	-	-	-	1	-	-
CO3	1	-	-	-	2	2	1	-	-	-	1	-	-
CO4	1	-	-	-	1	2	1	-	-	1	-	-	-
CO5	1	-	-	-	2	3	1	-	-	1	1	-	-
CO6	1	-	-	-	2	2	1	-	-	1	-	1	1
Avg	1.00	-	-	-	1.67	2.00	1.00	-	-	1.00	1.00	1.00	1.00

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

Course code: CHE112 Course Title: Chemistry III

School: SBSR		Batch: 2023-2027
Programme: B.Sc.		Current Academic Year: 2023-24
Branch: Microbiology		Semester: 01
1	Course Code	CHE112
2	Course Title	Chemistry III
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
5	Course Status	OE (Minor Elective)
6	Course Objective	1. To discuss importance of clean water and water treatment. 2. To explain the method to determine hardness and alkalinity in water sample and discussion on boiler trouble at industrial scale using different suitable technology 3. To describe the basic concepts of spectroscopy to apply in various engineering applications. 4. To provide an introduction to the basic concepts in Electrochemistry and apply them to understand corrosion. 5. To equip the students with the knowledge of chemistry and its various applications.
7	Course Outcomes	The students at the completion of the course will be able to: 1. Realize the importance of clean and healthy water by giving knowledge about water quality parameters and cleaning measures. 2. Explain various kind of boiler troubles, water desalination, softening and treatment method. 3. Discuss the chemistry of various type of Cement, Ceramics and Refractories and its industrial importance. 4. Illustrate the chemical properties of material by having the knowledge of spectroscopic techniques. 5. Describe the basics of electrochemistry and apply it to understand the corrosion of a metals. 6. Have a thorough grounding in water technology, cement chemistry, basic spectroscopic techniques and electrochemistry to solve the contemporary issues.
8	Course Description	The course includes the water technology, Electrochemistry and corrosion, chemistry of cement, ceramic and refractories, basic spectroscopic techniques.
9	Outline syllabus	CO Mapping

	Unit 1	Water Technology I	
	A	Drinking water standards, Water quality parameters, hardness: definition and expression, estimation of hardness by EDTA method. Turbidity,	CO1, CO6
	B	Alkalinity and acidity – determination by titrimetry, Dissolved Oxygen (DO). Ill effects of fluoride, nutrients (N, P, etc.) and dissolved metals.	CO1, CO6
	C	Biological oxygen demand (BOD), Chemical oxygen demand (COD)Determination of chloride present in water (by Mohr's method),	CO1, CO6
	Unit 2	Water Technology II	
	A	Boiler Troubles: Carry Over, Priming, Foaming, Scale, Sludge, Corrosion, Caustic Embrittlement.	CO2, CO6
	B	Desalination of water; Softening of water: Ion exchange process, Zeolite process.	CO2, CO6
	C	Municipal Water treatment process - screening, sedimentation, flocculation; Coagulation, Filtration (slow sand and rapid sand), disinfection-chlorination (break-point chlorination).	CO2, CO6
	Unit 3	Cement, Ceramics and Refractories	
	A	Cement: Raw material, composition, manufacturing process and application of Portland cement, Chemistry of setting of cement	CO3, CO6
	B	Ceramics and Refractories: Introduction, classification	CO3, CO6
	C	Properties, raw materials, manufacturing and applications	CO3, CO6
	Unit 4	Spectroscopy	
	A	Introduction of UV-Vis spectroscopy, Lamberts Beer's law. Different type of electronic transitions Chromophore, auxochrome, effect of conjugation on chromophore and applications.	CO4, CO6
	B	Introduction of Atomic Absorption Spectroscopy (AAS), Principle of AAS, Instrumentation.	CO4, CO6
	C	Detection Limit and Sensitivity, Application of AAS	CO4, CO6
	Unit 5	Electrochemistry and corrosion	
	A	Electrochemistry: Redox reactions, Nernst Equation, Electrochemical cells-Galvanic cells and Concentration cell.	CO5, CO6

	B	Electrode potentials and its relevance to oxidation and reduction, measurement of EMF under standard conditions, determination of pH using Hydrogen electrode.		CO5, CO6
	C	Types of corrosion, mechanism of Electrochemical corrosion, galvanic corrosion and protection against electrochemical corrosion		CO5, CO6
	Mode of examination	Theory		
	Weightage Distribution	CA+MSE	ESE	
		25%	75%	
Text book/s*		Puri, B.R., Sharma, L.R., and Pathania, M.S., "Principles of Physical Chemistry", Vishal publishing company. Engineering Chemistry by Jain & Jain.		
Other References		Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan.		

CO-PO-PSO Mapping need to add from Nupoor madam

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	1	-	2	1	1	1	1	1	2	1	2
CO2	1	1	1	-	2	1	2	1	1	1	1	2	2
CO3	1	1	3	-	2	1	2	1	1	1	1	2	2
CO4	1	1	2	-	2	2	3	1	2	1	-	2	3
CO5	1	1	2	-	2	2	3	1	1	1	1	2	2
CO6	1	1	2	-	2	2	3	1	2	1	-	2	3
Avg	1.00	1.00	1.83	-	2.00	1.50	2.33	1.00	1.33	1.00	1.25	1.83	2.33

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

Course code: BBI102 **Course Title: Application of Biomolecules**

School: SSBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2023-24	
Branch: Biotechnology		Semester: 01	
1	Course Code	BBI102	
2	Course Title	Application of Biomolecules	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Multidisciplinary (Major)	
5	Course Objective	1. To study the structure and function of macromolecules present in biological systems 2. Understanding the general properties of biomolecules 3. To learn the structure and function of tertiary and quaternary proteins	
6	Course Outcomes	The students at the completion of the course will be able to: CO1**:** to Understand the concept of solutions in biological solutions CO2**:** Identify the different biomolecules in a given mixture. CO3**:** Demonstrate the concept and structures of amino acids and protein CO4**:** Differentiate between tertiary and quaternary structure of protein. CO5: Explain the concept of the basic techniques used in Biotechnology. CO6: Investigate the basic concepts of biomolecules and use those concepts to understand the structure and basic functions of cell membrane.	
7	Course Description	Student must be able to understand when and how to use which technique of a given biological problems. Also, to understand and interpret the result obtained from various techniques	
8	Outline syllabus		CO Mapping
	Unit 1	Introduction to Chemistry	CO1, CO6
	A	Understand the concept of pH and acid base	
	B	Molarity, Molality, Normality (concept and numerical problems)	
	C	Understanding the concept of buffers, serial dilutions (numerical problems)	
	Unit 2	To learn the various test for identification of	CO2, CO6
	A	Carbohydrates	
	B	Proteins	
	C	Lipids	
	Unit 3	Amino acids	CO3, CO6
	A	Structure and properties of amino acids	
	B	Introduction to Ramachandran plot	
	C	Tertiary and Quaternary structure of protein- Hemoglobin;	

		difference between myoglobin and hemoglobin	
	Unit 4	Spectrophotometer	CO4, CO6
	A	Principle of spectrophotometer, the Lamber Beer's law: working, advantages, uses, limitations	
	B	UV/VIS absorption spectroscopy: Principle, working, advantages, uses, limitations	
	C	Theoretically plot absorption spectrum of DNA and protein using BSA/Egg Albumin and find λmax	
	Unit 5	Electrophoresis	CO5, CO6
	A	Polarimetry: Determination of the percentage composition of optically active solution	
	B	Introduction to Electrophoresis: Principle, working, advantages, uses, limitations	
	C	Types of Electrophoresis: PAGE and Native gel Electrophoresis: Principle, working, advantages, uses, limitations	
Mode of examination		Theory	
Weightage Distribution		CA+MSE	ESE
		25%	75%
	Text book/s*	1. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, W.H. Freeman and Company, New York, USA.	
	Other References	1. S 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. 3. Swayam - Government of India, https://swayam.gov.in/	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	3	1	1	1	-	1	-	1	3	2	3
CO2	3	2	3	1	1	1	1	1	-	1	3	2	3
CO3	3	2	3	1	1	2	2	-	-	1	3	2	3
CO4	3	2	3	1	1	2	2	3	2	2	3	2	3
CO5	3	2	3	1	1	3	2	3	1	2	3	2	3
CO6	3	2	3	1	1	3	2	2	3	3	3	2	3

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

SEMESTER II

B.Sc. (Hons) Microbiology

Course code: BSB120 **Course Title: Cell and Molecular Biology**

School: SSBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2023-24	
Branch: Microbiology		Semester: 02	
1	Course Code	BSB120	
2	Course Title	Cell and Molecular Biology	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course Status	CC (Major)	
6	Course Objective	1. Understanding the concept of structure and function of biological cells and cellmembrane 2. To understand the concept and functioning of the cell organelles 3. Discuss the replication of DNA 4. To understand the concept of transcription and post transcriptionalmodifications 5. Analyze the translation and gene regulation	
7	Course Outcomes	The students at the completion of the course will be able to: CO1: Define cell and plasma membrane. CO2: Illustrate the detailed structure of a cell. CO3: Organize how genetic information is stored in cells and how genetic information flows through replication. CO4: Sketch the concept of transcription and post modification. CO5: Categorize the concept of translation and gene regulation. CO6: Elaborate how cell and how protein is formed from the DNA.	
8	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 thestructure 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	
9	Outline syllabus		CO Mapping
	Unit 1	Overview of Cells and membrane system	CO1,

	A	Cell theory, different types of cells: Prokaryotic and Eukaryotic cells, plant cell and animal cell	CO6
	B	Cell cycle: mitosis and meiosis	
	C	Structure and function of nucleus, nucleolus, nucleoid.	
	Unit 2	Function and structure of cell organelles	CO2, CO6
	A	Basic understanding of DNA and RNA; Watson and Crick model of DNA	
	B	DNA Replication in prokaryotes and eukaryotes (telomerereplication).	
	C	Semi-conservative, bidirectional and semi-discontinuous replication	
	Unit 3	DNA replication	CO3, CO6
	A	Basic understanding of DNA and RNA; Watson and Crick model of DNA	
	B	DNA Replication in prokaryotes and eukaryotes (telomere replication).	
	C	Semi-conservative, bidirectional and semi-discontinuous replication	
	Unit 4	Transcription and Post Transcriptional Modifications	CO4, CO6
	A	RNA polymerase and mechanism of transcription in prokaryotes andeukaryotes	
	B	Concept of introns and exons, splicing mechanism	
	C	Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements	
	Unit 5	Translation and Gene regulation	CO5, CO6
	A	Genetic code, Degeneracy of the genetic code and Wobble Hypothesis;	
	B	Process of protein synthesis in prokaryotes.	
	C	Gene regulation: lac operon and trp operon	
Mode of examination		Theory	
Weightage Distribution		CA+MSE: 25%	ESE: 75%
Text book/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).	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	1	-	1	1	-	-	1	-	2	2	1
CO2	2	1	1	-	1	1	-	-	1	-	2	3	1
CO3	1	1	1	-	1	1	1	-	1	1	3	3	1
CO4	1	1	1	-	2	1	-	-	2	1	2	3	1
CO5	1	1	1	-	2	1	-	-	1	2	2	3	1
CO6	1	1	1	-	2	1	1	-	2	2	2	3	1
Avg	1.17	1.00	1.00	-	1.50	1.00	1.00	-	1.33	1.50	2.17	2.83	1.00

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

Course code: BBI111 Course Title: Principles of Bioinstrumentation

School: SSBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2023-24	
Branch: Microbiology		Semester: 02	
1	Course Code	BBI111	
2	Course Title	Principles of Bioinstrumentation	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
5	Course Status	CC (Major)	
6	Course Objective	To get a brief idea about different instruments commonly use in the biotechlaboratories	
7	Course Outcomes	The student at the completion of the course will be able to: CO1: Define the concept of biosafety and principle of microscopyCO2: Illustrate brief idea about common biotech lab instruments CO3: Construct the principle of centrifugation and different types of centrifugesCO4: Analyze basic principle of chromatography and discuss different types of chromatographic techniques CO5: Evaluate different types of electrophoresis and understand the principleof PCR and DNA sequencing. CO6: Develop the understanding of biological instruments and techniques.	
8	Course Description	Bioinstrumentation is the development of technologies for the measurement and manipulation of parameters within biological systems, focusing on the application ofengineering tools for scientific discovery.	
9	Outline syllabus		CO Mapping
	Unit 1	Laboratory Techniques	CO1, CO6
	A	Biosafety in microbiological laboratories: General safety measures, Personal protection, chemical and Biological hazards,Spillage and Waste disposal, First aid.	
	B	Principle and uses of microscope – compound microscopy, phase contrast microscopy	
	C	Theory, principle, uses of centrifuge.	
	Unit 2	Chromatographic Techniques	CO2, CO6
	A	Theory, Principle, Apparatus, Methods and Applications of Paper Chromatography, TLC, HPTLC	
	B	Gel Filtration Chromatography, Ion Exchange	

		Chromatography	
	C	Affinity Chromatography, Gas Chromatography, HPLC and types of Columns used in HPLC.	
	Unit 3	Centrifugation	CO3, CO6
	A	Principle of centrifugation, different types of centrifuge and rotors.	
	B	Types of rotor: fixed angle and swinging bucket rotors, Bench top and high-speed centrifuges	
	C	Preparative, differential and density gradient centrifugation, Analytical centrifugation	
	Unit 4	Spectroscopy	CO4, CO6
	A	Concept of electromagnetic radiation, principle and uses of spectrophotometer	
	B	Types of spectroscopies- absorption spectroscopy, emission spectroscopy, scattering spectroscopy	
	C	UV/VIS absorption spectroscopy, IR spectroscopy, Circular dichroism, Raman spectroscopy	
	Unit 5	Electrophoresis and PCR	CO5, CO6
	A	Electrophoresis – principle and working of Gel Electrophoresis; Immunoelectrophoresis, isoelectric focusing	
	B	Capillary electrophoresis, 2D electrophoresis, Pulse field electrophoresis	
	C	Polymerase Chain Reaction (PCR), DNA sequencing (Sanger's Dideoxy method)	
Mode of examination		Theory	
Weightage Distribution		CA+MSE	ESE
		25%	75%
Text book/s*		Alka Gupta. Instrumentation &Bioanalytical Techniques. Pragati Edition	
Other References		Subramanian M A. Biophysics: Principles and Techniques. MJP Publishers Ltd. Cottenil, R M S. Biophysics: An Introduction. John Wiley& Sons Ltd, England, 2002	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	1	**1**	**2**	1	1	-	**1**	**1**	**1**	1	1
CO2	1	2	2	**1**	2	**1**	1	-	1	1	1	1	1
CO3	1	2	2	1	2	1	1	-	**1**	**1**	1	2	1
CO4	1	2	2	**2**	2	1	**2**	**2**	**1**	**1**	**2**	3	2
CO5	1	2	2	3	1	1	3	3	2	1	2	3	3
CO6	1	2	3	**3**	2	1	3	3	2	2	3	3	3
Avg	1.00	2.00	2.00	1.83	1.83	1.00	1.83	2.67	1.33	1.17	1.67	2.17	1.83

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

Course code: BBI112 Course Title: Basics of Cell and Molecular Biology Lab

School: SSBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2023-24	
Branch: Microbiology		Semester: 02	
1	Course Code	BBI112	
2	Course Title	Basics of Cell and Molecular Biology Lab	
3	Credits	1	
4	ContactHours (L-T-P)	0-0-2	
5	CourseStatus	CC (Major)	
6	Course Objective	To understand how cell is to maintain life.	
7.	Course Outcomes	After finishing the course, the students will be able to CO1: Demonstrate safe laboratory practices and handle the equipment safely. CO2: Study the structure of the cells. CO3: Study mitosis and meiosis CO4: Gene amplification CO5: Construct a phylogenetic tree, CO6: To understand the concept of cell and molecular biology basic techniques	
8.	Course Description	In this laboratory, Students will investigate the principles of molecular and cellular biology and practice using the scientific method to explore biological processes. They will make observations, formulate own hypotheses, collect data, and analyze data to drawconclusions.	
9	Outline syllabus		CO Mapping
	Unit 1	Biomolecules test	
	A	Good lab practices in molecular biology laboratory	CO1, CO6
	B	Concept of Molarity in solutions	CO1,CO6
	C	Preparation of standard solutions for molecular biology experiments	CO1,CO6
	Unit 2	Cell study	
	A	To study cell structure from onion leaf peels	CO2, CO6
	B	To study cell structure from cheek cells	CO2, CO6
	C	To study cell structure from stem	CO2, CO6
	Unit 3	Mitosis and Meiosis	
	A	Concept of Staining	CO3, CO6
	B	To study the different stages of Mitosis in root tip of onion.	CO3, CO6
	C	To study the different stages of Meiosis in grasshopper testis	
	Unit 4	Bacterial DNA	
	A	To isolate DNA from bacterial cells	CO4, CO6
	B	16S rRNA gene amplification – PCR	CO4, CO6
	C	Gel Elctrophoresis to confirm the amplification	CO4, CO6
	Unit 5	Bioinformatics Tools	

	A	Introduction to BLAST Tool			CO5, CO6
	B	Sequence similarity search with freely available tools			CO5, CO6
	C	Construction of phylogenetic tree			CO5, CO6
Weightage Distribution		CA	CE	ESE	
		25%	25%	50%	
Text books		Michael, R. G., Sambrook. J., "Molecular Cloning-A Laboratory Manual",4th edition, Cold Spring Harbor Laboratory Press, 2012.Laboratory Press,2012.			
Referencebooks		Chard, T., Work, T. S., & Work, E. (1987). Laboratory techniques in biochemistry and molecular biology. Elsevier, Amsterdam.			

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	3	-	2	-	2	-	1	1	1	1	1
CO2	1	3	3	-	2	-	2	-	1	1	1	2	2
CO3	1	3	3	-	2	-	2	-	2	1	1	2	2
CO4	1	3	3	2	2	-	2	-	2	1	3	2	1
CO5	1	3	3	3	3	-	3	-	3	2	3	2	3
CO6	2	3	3	3	3	-	2	-	3	3	2	2	3
Avg	1.17	2.83	3.00	2.67	2.33	-	2.17	-	2.00	1.50	1.83	1.83	2.00

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

Course code: BBI113 Course Title: Principles of Bioinstrumentation (Lab)

School: SSBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2023-24	
Branch: Microbiology		Semester: 02	
1	Course Code	BBI113	
2	CourseTitle	Principles of Bioinstrumentation (Lab)	
3	Credits	1	
4	ContactHours (L-T-P)	0-0-2	
5	CourseStatus	CC (Major)	
6	Course Objective	This course is designed to make students learn about various instruments and techniques of biotechnology laboratory and will also enable them to use and applythese techniques and equipment to solve experimental problems	
7	Course Outcomes	After finishing the course, the students will be able to CO1: The conceptual understanding of autoclave and how to operate it. CO2: Able to operate basic instruments in the lab. CO3: Separate and visualize nucleic acids using gel electrophoresis. CO4: Operate spectrophotometer and perform absorbance assays. CO5: Able to understand the concept of chromatography technique. CO6: To learn the operation and working of different instruments and bioanalytical techniques	
8.	Course Description	To make students learn the working and operation of various biotechnologicalinstruments.	
9	Outline syllabus		CO Mapping
	Unit 1	Practical based on Sterilization	
	A	To learn the working of an autoclave.	CO1, CO6
	B	To learn the working of a laminar air flow.	CO1, CO6
	C	To sterilize glassware using hot air oven.	CO1, CO6
	Unit 2	Practical related to centrifuge	
	A	Using pH meter	CO2, CO6
	B	Working and principle of incubator shaker	CO2, CO6
	C	Working of refrigerated centrifuges	CO2, CO6
	Unit 3	Practical related to gel-electrophoresis	
	A	Concept and working of electrophoresis	CO3, CO6
	B	Separation of DNA using PAGE	CO3, CO6
	C	Separation of proteins using PAGE	

	Unit 4	Practical related to spectrophotometer			
	A	Demonstration of spectrophotometer			CO4, CO6
	B	Principle and working of a spectrophotometer			CO4, CO6
	C	Measuring concentration of protein using spectrophotometer			CO4, CO6
	Unit 5	Practical related to chromatography			
	A	Chromatography: Principle and working			CO5, CO6
	B	Use of paper chromatography for separation of plant pigments			CO5, CO6
	C	HPLC			CO5, CO6
	Weightage Distributionon	CA	CE	ESE	
		25%	25%	50%	
	Text books	Wilson K.and Walker., "Principles and Techniques of Biochemistry andMolecular Biology", Cambridge Press, 2010.			
	Referencebooks	Cottenil R.M.S., "Biophysics: An Introduction", John Wiley and Sons, 2002.Gupta A., "Instrumentation and Bioanalytical Techniques", Pragati Prakashan, 2009.			

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	3	1	-	-	-	1	-	-	1	1	1
CO2	3	3	3	3	1	1	-	1	-	-	3	2	2
CO3	3	3	3	2	-	-	1	1	-	-	3	2	2
CO4	3	3	3	2	-	1	-	-	-	-	3	2	1
CO5	3	3	3	3	2	1	2	1	1	1	3	2	3
CO6	3	3	3	1	1	2	1	1	2	3	3	2	3
Avg	2.7	2.8	3.0	2.0	1.3	1.3	1.3	1.0	1.5	2.0	2.7	1.8	2.0

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

Course code: VOL102 Course Title: Essential Techniques in Life Sciences-2

School: SSBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2023-24	
Branch: Microbiology		Semester: 02	
1	Course Code	VOL102	
2	CourseTitle	Essential Techniques in Life Sciences-2	
3	Credits	3	
4	ContactHours (L-T-P)	0-0-6	
5	CourseStatus	SEC (Minor)	
6	Course Objective	Develop knowledge of a specific area of specialization. Develop research skills especially in biological experiments, project writing and oral presentation.	
7	Course Outcomes	The student at the completion of the course will be able to: CO 1: Define the protein concentration using Lowry method. CO 2: Demonstrate the Electrophoresis technique CO 3: Identify and amplify the DNA using a thermocycler. CO 4: Examine the organic and inorganic solutes in the water CO 5: Assess and able to isolate the bacteria from the milk products CO 6**:** Estimate the digested DNA using DNA ligase.	
8.	Course Description	Vocational education is concerned with the training on vocation. It is related to productivity. Vocational education prepares individuals for jobs. It has adequate employment potentialities. It helps in broadening of horizon. It leads to dignity of labour.It is helpful in the maximum utilisation of the material resources of the country	
9	Outline syllabus		CO Mapping
	Unit 1	Biomolecules	
	A	To estimate the protein concentration using Lowry method.	CO1, CO6
	B	To estimate the DNA concentration using spectrophotometry method	CO1,CO6
	C	To calculate the carbohydrate concentration using Molisch Test	CO1,CO6
	Unit 2	Electrophoresis	
	A	To understand the working principle of gel electrophoresis	CO2, CO6
	B	Isolate DNA using kit	CO2, CO6
	C	Run on gel electrophoresis	CO2, CO6
	Unit 3	PCR	
	A	Understand the working of Thermocycler	CO3, CO6
	B	To amplify the gene using a thermocycler.	CO3, CO6

	C	To purify DNA from an agarose gel			
	Unit 4	Water Microbiology			
	A	Determination of total dissolved oxygen of water			CO4, CO6
	B	Determination of chemical oxygen demand (COD) of water			CO4, CO6
	C	Determination of biochemical oxygen demand (BOD) of water			CO4, CO6
	Unit 5	Isolation of Bacteria			
	A	Isolation of Bacteria from milk and gram staining			CO5, CO6
	B	Determination of quality of milk sample by methylene blue reduction test			CO5, CO6
	C	Detection of Arsenic by microbiological methods			CO5, CO6
	Mode of examination	Continuous Assessment (CA): 25 Marks Viva-Voce (on the basis of weekly Viva performance): 25 Marks ETE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks)			
	Weightage Distribution	CA	CE	ETE	
		25%	25%	50%	
	Text books	Experiments in Microbiology, plant pathology and Biotechnology, K R Aneja			
	Reference books				

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	-	1	-	-	-	-	-	-	1	1
CO2	1	2	2	-	1	-	-	-	-	-	1	1	1
CO3	1	2	2	-	1	-	-	-	-	-	-	1	1
CO4	1	3	2	-	1	-	-	-	-	-	-	1	1
CO5	1	3	2	-	2	-	-	-	1	-	2	2	1
CO6	1	3	2	-	2	-	2	-	2	-	2	1	1
Avg	1.00	2.50	2.00	-	1.33	-	2.00	-	1.50	-	1.67	1.17	1.00

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

Course code: ARP102 Course Title: Communicative English-2

School: SBSR		Batch: 2023-2027	
Programme: B.Sc.		Current Academic Year: 2023-2024	
Branch: Microbiology		Semester: 02	
1	Course Code	ARP102	
2	Course Title	Communicative English -2	
3	Credits	2	
4	Course Status	AEC (Minor)	
5	Contact Hours (L-T-P)	1-0-2	
6	Course Objective	To Develop LSRW skills through audio-visual language acquirement, creative writing, advanced speech et al and MTI Reduction with the aidof certain tools like texts, movies, long and short essays.	
7	Course Outcomes	After completion of this course, students will be able to: CO1: Acquire Vision, Goals and Strategies through Audio-visual Language Texts CO2: Synthesize complex concepts and present them in creativewriting CO3: Develop MTI Reduction/Neutral Accent through ClassroomSessions & Practice CO4: Determine their role in achieving team success through defining strategies for effective communication with different people CO5: Realize their potentials as human beings and conduct themselves properly in the ways of world. CO6: Acquire satisfactory competency in use of Quantitative aptitudeand Logical Reasoning.	
8	Course Description	The course takes the learnings from the previous semester to an advanced level of language learning and self-comprehension through the introduction of audio-visual aids as language enablers. It also leadslearners to an advanced level of writing, reading, listening and speakingabilities, while also reducing the usage of L1 to minimal in order to increase the employability chances.	
9	Outline syllabus		

	Unit A	Acquiring Vision, Goals and Strategies through Audio-visual Language Texts	CO Mapping
	Topic 1	Pursuit of Happiness / Goal Setting & Value Proposition in life	CO1
	Topic 2	12 Angry Men / Ethics & Principles	
	Topic 3	The King's Speech / Mission statement in life | strategies & Action Plans in Life	
	Unit B	Creative Writing	
	Topic 1	Story Reconstruction - Positive Thinking	CO2
	Topic 2	Theme based Story Writing - Positive attitude	
	Topic 3	Learning Diary Learning Log – Self-introspection	
	Unit C	Writing Skills 1	
	Topic 1	Precis	CO2
	Topic 2	Paraphrasing	
	Topic 3	Essays (Simple essays)	
	Unit D	MTI Reduction/Neutral Accent through Classroom Sessions & Practice	
	Topic 1	Vowel, Consonant, sound correction, speech sounds, Monothongs, Dipthongs and Tripthongs	CO3
	Topic 2	Vowel Sound drills , Consonant Sound drills, Affricates and Fricative Sounds	
	Topic 3	Speech Sounds | Speech Music| Tone | Volume| Diction |Syntax |Intonation | Syllable Stress |	
	Unit E	Gauging MTI Reduction Effectiveness through Free Speech	
	Topic 1	Jam sessions	CO3
	Topic 2	Extempore	
	Topic 3	Situation-based Role Play	
	Unit F	Leadership and Management Skills	
	Topic 1	Innovative Leadership and Design Thinking	CO4
	Topic 2	Ethics and Integrity	CO4
	Unit F	Universal Human Values	
	Topic 1	Love & Compassion, Non-Violence & Truth	CO5
	Topic 2	Righteousness, Peace	CO5
	Topic 3	Service, Renunciation (Sacrifice)	CO5
	Unit G	Introduction to Quantitative aptitude & Logical Reasoning	
	Topic 1	Analytical Reasoning & Puzzle Solving	CO6
	Topic 2	Number Systems and its Application in Solving Problems	CO6
9	Evaluations	CA | ESE	
		60% | 40%	
Texts & References | Library Links		• Wren, P.C.&Martin H. *High English Grammar and Composition*, S.Chand& Company Ltd, New Delhi. • Blum, M. Rosen. *How to Build Better Vocabulary*. London: Bloomsbury Publication	

	• Comfort, Jeremy(et.al). *Speaking Effectively*. Cambridge University Press. The Luncheon by W.Somerset Maugham - http://mistera.co.nf/files/sm_luncheon.pdf	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	-	1	3	-	-	-
CO2	-	-	-	-	-	-	-	-	1	3	-	-	-
CO3	-	-	-	-	-	-	-	-	1	3	-	-	-
CO4	-	-	-	-	-	-	-	-	1	2	-	-	-
CO5	-	-	-	-	-	-	-	-	1	2	-	-	-
CO6	1	-	-	-	-	-	-	-	1	2	-	-	-
Avg	1.00	-	-	-	-	-	-	-	1.00	2.00	-	-	-

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

School: SSHSS		Semester – 1	ACADEMIC SESSION:	FOR VAC – 1 Practical
1	Course code	VAC110		
2	Course Title	Yoga for Holistic health		
3	Credits	3		
4	Learning Hours	0-1-4		
5	Course Objective	To make the students familiar with the different practices of yoga, chanting and meditation techniques and learn the correct teaching skills.		
6	Course Outcomes	1. To make the students understand the concept of health and wellness through Yoga 2. To define the concept and principles of Yoga. 3. To interpret and understand the breathing practice. 4. To describe the knowledge about Yoga, its foundations and applications to the aspirants. 5. To make students aware of Yogic impact on the positive health and personality development. 6. The students will learn primary level of Yoga practices, which will groom their personality.		
7.1		**Unit A**	**Importance of Health, Wellness through Yoga**	**CO mapping**
7.11		Unit A Topic 1	Meaning, Definition, Aim of Yoga; Concept of health according to WHO and Ayurveda	CO1, CO2, CO4, CO5, CO6
7.12		Unit A Topic 2	Misconception about Yoga, Difference between asana and physical exercise	CO1, CO2, CO4, CO5, CO6
7.13		Unit A Topic 3	Need, Importance of Yoga in health and wellness	CO1, CO2, CO4, CO5, CO6
7.2		**Unit B**	**Schools of Yoga, Modern and Ancient schools of Yoga existing in India, Yogic diet, Yogic attitudes, Sadhak tatva & Badhak tatva**	
7.21		Unit B Topic 1	Schools/ Streams of Yoga – Ashtanga Yoga, Bhakti Yoga, Karma Yoga, Jnana Yoga	CO3, CO4, CO5, CO6

7.22		Unit B Topic 2	Modern and ancient schools of Yoga existing in India – Natha Sampradaya, Kaivalyadhama, Bihar School of Yoga, Munger, Pragya Yoga (Shantikunj), Iyengar Yoga, Patanjali Yoga Peeth, Ashtanga Vinyasa Yoga	CO3, CO4, CO5, CO6
7.23		Unit B Topic 3	Yoga Ahaara (Yogic diet), Yogic Attitudes – Maitri Karuna, Mudita, Upeksha, Sadhak Tatva Badhak Tatva (facilitating/helping factors and obstacles in Yoga sadhana)	CO3, CO4, CO5, CO6
7.3		**Unit C**	**Beginner level practices – Sukshma Vyayama and Surya Namaskara**	
7.31		Unit C Topic 1	Sukshma Vyayama and their benefits for health Part-1 (Bihar School of Yoga) Part-1	CO4, CO5, CO6
7.32		Unit C Topic 2	Sukshma Vyayama & their benefits for health (Swami Dhirendra Brahmachari) Part-1	CO4, CO5, CO6
7.33		Unit C Topic 3	Surya Namaskara (Sun Salutation) with mantra chanting (12 steps) & their benefits for health	CO4, CO5, CO6
7.4		**Unit D**	**Asana - all categories**	
7.41		Unit D Topic 1	Standing & Sitting - Tadasana, Vrikshasana, Katichakrasana, Padmasana, Vajrasana, Ushtrasana, Paschimottanasana, Vakrasana	CO4, CO5, CO6
7.42		Unit D Topic 2	Supine and Prone: Uttanapadasana, Pawanamuktasana, Shalabhasana, Bhujangasana	CO4, CO5, CO6
7.43		Unit D Topic 3	Balancing and Inverted: Trivikramasana, Sarvangasana, Viparitakarani mudra	CO4, CO5, CO6
7.5		Unit E	**Pre-practices of Pranayama, Pranayama and Dhyana**	

7.51		Unit E Topic 1	Kapalabhati, Mukha dhauti, Vibhagiya pranayama (Sectional breathing)	CO1, CO4, CO5, CO6
7.52		Unit E Topic 2	Anuloma – Viloma, Bhastrika, Shitali	CO1, CO4, CO5, CO6
7.53		Unit E Topic 3	Om Dhyana, Aanapaanasati Dhyana (breath meditation)	CO1, CO4, CO5, CO6
8	**Course Evaluation**			
8.1	Course work:			
8.11	Attendance			
8.12	Homework	Three best out of five assignments: 10 marks		
8.13	Quizzes	Three best out of five tests: 10 marks		
8.14	Projects	None		
8.15	Presentations	One best out of two: 10 marks		
8.2	CA: 60 % Practical			
8.3	End-term examination: 40% Viva			
9	**References**			
9.1	Text book	1. Sri Ananda: The Complete book of Yoga, Orient Course Backs, Delhi, 2003. 2. Basavaraddi, I.V. & other: SHATKARMA: A Comprehensivedescription about Cleansing Process, MDNIY New Delhi, 2009 3. Joshi, K.S.: Yogic Pranayama, Oriental Paperback, New Delhi, 2009 4. Dr. Nagendra H R: Pranayama, The Art & Science, Swami Vivekananda Yoga Prakashan, Bangalore, 2005. 5. Swami Niranjanananda Saraswati: Asana Pranayama Mudra Bandha, Yoga Publication Trust, Munger Bihar. 6. Joshi, K.S.: Yogic Pranayama, Oriental Paperback, New Delhi, 2009 7. Swami Kuvalyananda: Pranayama, Kaivalyadhama, Lonavla, 2010 8. Swami Rama: Science of Breath, A Practical Guide, The Himalayan International Institute, Pennselvenia, 1998. 9. Swami Niranjanananda Saraswati: Prana, Pranayama & Pranavidya, Yoga Publications Trust, Munger, Bihar, 2005	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO 2	PSO 3
CO1	-	-	-	-	-	-	-	-	3	-	-	-	-
CO2	-	-	-	-	-	-	-	-	3	-	-	-	-
CO3	-	-	-	-	-	-	-	-	3	-	-	-	-
CO4	-	-	-	-	-	-	-	-	3	-	-	-	-
CO5	-	-	-	-	-	-	-	-	3	-	-	-	-
CO6	-	-	-	-	-	-	-	-	3	-	-	-	-
Avg	-	-	-	-	-	-	-	-	3	-	-	-	-

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

Course code: PHR101 Course Title: Introduction to renewable energy and management

School: SSBSR		Batch: 2023-2027	
Programme: B.Sc.		Current Academic Year: 2023-2024	
Branch: Microbiology		Semester: 02	
1	Course Code	PHR101	
2	Course Title	Introduction to Renewable energy and management	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
5	Course Status	OE (Minor elective)	
6	Max. Marks	15+10+75 = 100	
7	Min. Marks		
8	Course Objective	1. To familiarize the concept of energy and its classification. 2. To know the importance of renewable energy. 3. To provide the awareness about climate change. 4. To familiarize with various renewable energy resources and its management.	
9	Course Outcomes	After the completion of this course, the student will be able to: CO1: comprehend the different types of energy. CO2: examine the importance of fossil fuels and renewable energy resources. CO3: apply the concept of greenhouse effect for climate change. CO4: inculcate the knowledge of renewable energy resources to obtain clean energy and its environmental impact. CO5: familiarize with energy management and sustainable development. CO6: obtain asses the importance of various renewable energy resources and their impacts.	
10	Course Description	This course deals with different types of energy and their impact on the climate change. In this course, the students will learn about the energy management and sustainable energy development.	
11	Outline syllabus		CO Mapping
	Unit 1	Energy and its classification	
	A	Introduction to energy: Definition and units of energy and power.	CO1, CO2
	B and C	Forms of energy and conservation of energy. Fossil fuels, renewable and non-renewable energy & their types. Conventional and non-conventional energy.	CO1, CO2
	Unit 2	Fossil fuels and Alternate Sources of Energy	
	A	Fossil Fuels - Types, Uses, Advantages & Disadvantages, need of renewable energy.	CO1, CO3
	B and C	An overview of renewable energy resources: solar energy, wind energy, hydroelectric energy, wave energy, ocean thermal energy, tidal energy, geothermal energy and biomass energy.	CO1, CO3
	Unit 3	Climate Change	
	A	Greenhouse gases (GHG) types and sources. The greenhouse effect.	CO1, CO3

	B and C	The link between energy and climate change. Climate change – causes and consequences. global warming.		CO3, CO6
	Unit 4	Renewable energy resources		
	A	Various renewable energy resources- Introduction, availability, classification, relative merits and demerits.		CO4, CO6
	B and C	Social, economic and environmental impacts of renewable energy resources.		CO4, CO6
	Unit 5	Energy Management		
	A	Principles of Energy Management, energy needs of growing economy, energy conservation and its importance.		CO5, CO6
	B and C	Concept of sustainability; Renewable energy for sustainable development.		CO5 ,CO6
Mode of examination		Theory		
Weightage Distribution		CA+MSE	ESE	
		25%	75%	
Text book/s		1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi 2. Solar energy - M P Agarwal - S Chand and Co. Ltd. 3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd. 4. Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, 5. Oxford University Press, in association with The Open University. 6. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009 7. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA). 8. http://en.wikipedia.org/wiki/Renewable_energy		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	-	2	1	1	1	2	2	1	2	2
CO2	1	2	2	-	2	1	2	2	2	2	1	2	2
CO3	1	2	2	-	3	1	2	2	2	2	1	2	2
CO4	1	2	2	-	3	1	1	2	2	2	1	2	2
CO5	1	2	2	-	2	1	2	2	2	2	1	2	2
CO6	1	2	2	-	3	1	2	2	2	2	1	2	2
Avf	1.00	2.00	2.00	-	2.50	1.00	1.67	1.83	2.00	2.00	1.00	2.00	2.00

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

SEMESTER III

B.Sc. (Hons) Microbiology

Course code: BSM201 Course Title: Bacteriology

School: SBSR		Batch: 2023-2027	
Programme: B.Sc.		Current Academic Year: 2024-25	
Branch: Microbiology		Semester: 03	
1.	Course Code	BSM201	
2.	Course Title	Bacteriology	
3.	Credits	4	
4.	Contact Hours (L-T-P)	4-0-0	
5.	Course Status	CC (Major)	
6.	Course Objective	To get a brief idea about different instruments commonly use in the biotech laboratories.	
7.	Course Outcomes	The students at the completion of the course will be able to: CO1: Understand the basic concepts of Cell organization. CO2: Know about the Bacteriological techniques. CO3: Explain about Growth and nutrition. CO4: Understand the cell reproduction method in bacteria. CO5: Important archaeal groups. CO6: Important eubacterial groups.	
8.	Course Description	This course is a general microbiology course covering microorganisms emphasizing bacteria as examples of all microorganisms and as models for all living organisms/cells in regard to structure, physiology, and reproduction.	
9.	Outline syllabus		CO Mapping
	Unit 1	Bacteriological techniques	
	A	Pure culture isolation: Streaking, serial dilution and plating methods; cultivation,	CO1, CO6
	B	Maintenance and preservation/stocking of pure cultures.	
	C	Cultivation of anaerobic bacteria, and accessing nonculturable bacteria	
	Unit 2	Growth and nutrition	
	A	Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media.	CO2, CO6
	B	Complex media, selective, differential, indicator, enriched and enrichment media	

	C	Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation Chemical methods of microbial control: disinfectants, types and mode of action	
	Unit 3	Reproduction in Bacteria and Hypersensitivity	
	A	Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth,	CO3, CO6
	B	Calculation of generation time and specific growth rate.	
	C	Physical and chemical methods of control of Bacteria; Mode of action of Anti-microbial agents, factors responsible for controlling microbes, Physical and chemical agents.	
	Unit 4	Reproduction in Bacteria and Hypersensitivity and Autoimmunity	
	A	Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth,	CO4, CO6
	B	Calculation of generation time and specific growth rate.	
	C	Physical and chemical methods of control of Bacteria; Mode of action of Anti-microbial agents, factors responsible for controlling microbes, Physical and chemical agents.	
	Unit 5	Important archaeal and eubacterial groups	CO5, CO6
	A	Archaebacteria: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota	
	B	Nanoarchaeum), Crenarchaeota (Sulfolobus, Thermoproteus) and Euryarchaeota	
	C	Methanogens (Methanobacterium, ethanocaldococcus), Thermophiles, (Thermococcus, Pyrococcus, Thermoplasma), Halophiles (Halobacterium, Halococcus). Eubacteria: Morphology, metabolism, ecological significance and economic importance of following groups.	
	Mode of examination	Theory	
	Weightage Distribution	CA+MSE: 25%	ESE: 75%
	Text book/s*	Pelezar, M.J. Reid, R.D. and E.C.S. Chan, (1986) Microbiology - Tata Mc Graw Hill, New Delhi.	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO.1	1	-	1	-	1	2	1	1	1	1	2	2	1
CO.2	1	-	1	-	1	2	1	1	1	1	2	2	1
CO.3	2	-	1	-	1	2	1	1	2	1	2	2	2
CO.4	1	1	2	-	1	2	1	1	2	1	2	3	1
CO.5	1	1	2	-	1	2	1	2	2	1	3	3	1
CO.6	2	1	1	-	1	2	1	2	2	1	3	3	1
Avg	1.33	1.00	1.33	-	1.00	2.00	1.00	1.33	1.67	1.00	2.33	2.50	1.17

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

Course Code: BMB201 Course Title: Introduction to Biofertilizers

School: SBSR		Batch: 2023-2027
Programme: B.Sc.		Current Academic Year: 2024-25
Branch: Microbiology		Semester: 03
1	Course Code	BMB201
2	Course Title	Introduction to Biofertilizers
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
5	Course Status	CC (Major)
6	Course Objective	To know about general account of microbes used as biofertilizer. Symbiotic association bacterial biofertilizer for nitrogen fixation. To know about non-symbiotic bacterium for nitrogen fixation and their response to field crop for yield. To know about cyanobacterial biofertilizer and their response to field crop for yield. Know about mechanism of mycorrhizal symbiosis and effect of mycorrhizas on growth and yield of crop plants. Know about organic farming and vermicomposting.
7.	Course Outcomes	After successfully completion of this course students will be able to: CO.1 Know about general account of microbes as biofertilizer. Symbiotic bacterium, Rhizobium and Azospirillum, used as biofertilizer. Methods for identification, isolation and field application of symbiotic nitrogen fixing bacteria. CO.2 Know about non-symbiotic bacterium, *Azatobacter*, used as biofertilizer. Methods for identification, isolation and field application of non-symbiotic nitrogen fixing bacteria. CO.3 Know about isolation, mass culture and application of cyanobacterial biofertilizer to field and crop response for yield. CO.4 Know about mechanism of mycorrhizal symbiosis, methods for inoculums production and effect of mycorrhizas on growth and yield of crop plants. CO.5 Know about organic farming and vermicomposting. CO.6 To provide learning related to environmentally safe and effective fertilizers
8	Course Description	The objective of the cource is to use natural fertilizers that are microbial inoculants of bacteria, algae and fungi (separately or in combination) which may help biological nitrogen fixation for the benefit of plants. They help build up the soil micro-flora and there by the soil health. Biofertilizer also include

		organic fertilizers (manure, etc.). Use of bio-fertilizer is recommended for improving the soil fertility in organic farming.	
8.	Outline syllabus		CO Mapping
	Unit 1	Symbiotic bacterial biofertilizer	
	A	General account about the microbes used as biofertilizer.	CO1, CO6
	B	*Rhizobium*: Isolation, identification, mass culture and preparation of carrier-based inoculants. Methods for seed inoculation with *Azospirillum* culture and effect of crop yield.	
	C	*Azospirillum*: Isolation, identification, mass cultivation and preparation of carrier-based inoculants. Methods for seed inoculation with *Azospirillum* culture and effect of crop yield.	
	Unit 2	Growth and nutrition	
	A	Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media.	CO2, CO6
	B	*Azospirillum*: Isolation, identification, mass cultivation and preparation of carrier-based inoculants.	
	C	Methods for seed inoculation with *Azospirillum* culture and effect of crop yield.	
	Unit 2	Non-symbiotic bacterial biofertilizer	
	A	Azotobacter: Characteristics of Azatobacter	CO3, CO6
	B	Islolation, identification and mass multiplication of *Azatobacter* inoculants.	
	C	Methods for seed inoculation with *Azatobacter* and their effect on crop yield.	
	Unit 3	Cyanobacterial Biofertilizer	
	A	*Cyanobacteria* (blue green algae): Isolation, preparation of starter culture and mass culture.	
	B	*Azolla* and *Anabaena azollae* association and nitrogen fixation. Factors affecting their growth.	CO4, CO6
	C	Crop response of blue green algae and *Azolla* in rice cultivation.	
	Unit 4	Mycorrhizal Biofertilizer	
	A	Mechanism of mycorrhizal symbiosis, types of mycorrhizae.	CO5, CO6
	B	Methods for inoculums production and inoculation.	
	C	Effect of mycorrhizas on growth and yield of crop plants.	
	Unit 5	Organic Farming	
	A	Green manuring and organic fertilizers.	
	B	Recycling of biodegradable municipal, agricultural and	

		Industrial wastes.		
	C	Biocompost making methods, Vermincomposting and method of vermincomposting and their application to field.		
	Mode of examination	Theory		
	Weightage Distribution	CA+MSE	ESE	
		25%	75%	
	Text book/s*	1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand& Co, New Delhi.		
	Other References	1. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi. 2. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi. 3. Sathe, T.V. 2004. Vermiculture and Organic Farming. Daya publishers. 4. SubhaRao, N.S. 2000. Soil Microbiology, Oxford & IBH Publishers, New Delhi. 5. Vayas, S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming. Akta Prakashan, Nadiad.		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO.1	2	1	1	-	-	1	2	2	-	-	1	-	2
CO.2	1	1	1	-	-	1	2	2	-	-	1	-	2
CO.3	1	1	1	-	-	1	2	2	-	-	1	-	2
CO.4	1	1	1	-	-	1	2	2	1	-	1	1	2
CO.5	1	2	1	-	1	1	2	2	-	-	1	-	2
CO.6	2	2	1	-	-	1	2	2	1	2	1	1	2
Avg	1.33	1.33	1.00	-	1.00	1.00	2.00	2.00	1.00	2.00	1.00	1.00	2.00

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

Course code: BBT211 **Course Title: Biophysics**

School: SSBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2024-25	
Branch: Microbiology		Semester: 03	
1	Course Code	BBT211	
2	Course Title	Biophysics	
3	Credits	4	
4	Contact Hours(L-T-P)	4-0-0	
5	Course Status	Multidisciplinary (Minor)	
6	Course Objective	1. To understand the basic concepts involved in the field of research and industrial endeavors. 2. Biophysics plays a pivotal role in biomedicine, diagnostics and academics fields	
	Course Outcomes	The students at the completion of the course will be able to: CO1: Identify the basic concepts involved in Biophysics at the molecular & cellular level. CO2: Summarize about the crucial concepts and role of pH and buffers CO3: Discover the basics of water in biological system CO4: Illustrate the concepts of optics CO5: Appraise the concepts of radiation in association with biophysics CO6: Examine the concepts of biophysics that can be used to study biology associated with research, industry, medicine and diagnostics	
7	Course Description	Biophysics broadly concerns trying to understand biology in a quantitative way, using experimental techniques, theories, and concepts developed from different areas of physics such as statistical physics, nonlinear dynamics, polymer physics, mechanics, fluid mechanics, optics, quantum mechanics, and nanoscience.	
8	Outline syllabus		CO Mapping
	Unit 1	Physical and chemical aspect of Biology-1	CO1,CO6
	A	Structure of atom, Bohrs theory, Rutherford experiment, Gold foil experiment	
	B	Secondary bonding: weak interactions, hydrogen bonding; dipole-dipole & dipole-induced dipole interactions; London dispersion forces	

	C	Bonds within molecules- Ionic, covalent, Electrostatic, Disulphide & peptide bonds, Vander Waals forces, Bond lengths & Bond energies, Bond angles.	
	Unit 2	Physical and chemical aspect of Biology-2	CO2, CO6
	A	Acid & Bases, mole concept, weak acids base, Ampholyte, pH, Calculations of pH from H & OH concentrations	
	B	Henderson –Hasselbalch equation, pK values, Buffer, numerical problems	
	C	Redox potential: Oxidation –Reduction, Equivalence of electrical & chemical energy,	
	Unit 3	Water properties and Importance	CO3, CO6
	A	Molecular structure of water, Association of water through H-bonding, Nature of hydrophobic interactions, physicochemical properties of water	
	B	The Influence of Ions: Structure-Making and Structure-Breaking, Long-Range Hydrophobic Interactions and the Role of Bubbles, Hydrophilic Surfaces.	
	C	Specific Roles of Water in :- Secondary Structure of protein, Protein-Protein Interactions, Mediation of Ligand Binding	
	Unit 4	Role of light and its application in biology	CO4, CO6
	A	Light: Reflection, Refraction, Diffraction, Interference phenomena	
	B	Microscope general principle, uses. Polarization, compound, phase contrast, fluorescence microscopy	
	C	Electron Microscopy and its types	
	Unit 5	Radiation Biophysics	CO5, CO6
	A	Introduction to Radioactivity, General properties of alpha, beta and gamma radiations, Units of measurement- Curie,Becquerel	
	B	Radiolysis of water, Direct and indirect effects of radiation. Effect of radiation on Nucleic acids, Proteins, Enzymes	
	C	Radiation sources, Tele-gamma Unit (Cobalt unit), Gamma chamber, Particle Accelerators, Nuclear reactors. Principles of radiation detection and measurement	
Mode of examination		Theory	
Weightage Distribution		CA+MSE	ESE
		25%	75%
Text book/s*		1. Subramanian M A. Biophysics: Principles and Techniques. MJP Publishers Ltd.	
Other References		1. R M S. Biophysics: An Introduction. John Wiley& Sons Ltd, England, 2002. 2. Molecular Driving Forces: Statistical Thermodynamics in Biology, Chemistry,Physics, and Nanoscience: Ken Dill, 3. Alka Gupta. Instrumentation & Bioanalytical Techniques. Pragati Edition	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	-	2	1	1	1	1	1	1	2	1
CO2	1	2	2	-	2	1	1	1	1	1	1	2	1
CO3	1	2	2	-	2	1	2	1	1	1	1	2	1
CO4	2	2	2	-	3	1	1	1	1	1	1	2	2
CO5	1	2	2	-	2	1	2	1	1	1	1	2	2
CO6	2	2	2	-	2	2	2	2	2	1	1	2	2
Avf	-	2.00	2.00	-	2.17	1.17	1.50	1.17	1.17	1.00	1.00	2.00	1.50

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

Course Code: BMB202 Course Title: Introduction to Bacteriology (Lab)

School: SBSR		Batch: 2023-2027
Programme: B.Sc.		Current Academic Year: 2024-2025
Branch: Microbiology		Semester: 03
1	Course Code	BMB202
2	Course Title	Introduction to Bacteriology (Lab)
3	Credits	1
4	Contact Hours (L-T-P)	0-0-2
5	Course Status	CC (Major)
5	Course Objective	Apply the knowledge to understand the microbial physiology and to identify the microorganisms. To complement the students with the basic knowledge about microbial growth.
6	Course Outcomes	After finishing the course, the students will be able to CO1: To formulate of different media. CO2: To execute Simple staining. CO3: To execute Negative staining. CO4: To execute Gram's staining. CO5: To execute Capsule staining; Assess bacterial growth curve; Isolation of pure cultures of bacteria by streaking, spreading method. CO6: Estimation of CFU count by spread plate method/pour plate method.; Motility by hanging drop method.
7	Course Description	

List of Practical's:

S. No.	Experiment	CO Mapping
Unit 1	A. Preparation of different media: synthetic media B. CzapekDox media C. BG-11	CO1, CO6
Unit 2	A. Complex Media-Nutrient agar B. McConkey agar, EMB agar.Simple staining C. Gram's staining	CO2, CO6
Unit 3	A. B. Isolation of lactobacillus from dairy samples C. Biochemical test	CO3, CO6
Unit 4	A. Sample collection from different water sites. B. Preparation of media for culturing. C. Isolation of gram-negative bacteria from water sample	CO4, CO6
Unit 5	A. Acid fast staining-permanent slide only. Capsule staining. B. Isolation of pure cultures of bacteria by streaking, spreading method.	CO5, CO6

	C. Estimation of CFU count by spread plate method/pour plate method.; Motility by hanging drop method.			
Mode of examination	Practical/Viva			
Weightage Distribution	CA	CE	ESE	
	25%	25%	75%	
Text book/s*	Practical Microbiology - A Laboratory Manual, DOI:10.13140/2.1.2667.6163. https://faculty.washington.edu/korshin/Class-486/MicrobiolTechniques.pdf			

CO-PO_PSO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO.1	1	2	2	-	2	2	2	2	1	1	1	1	1
CO.2	1	2	2	-	2	2	2	2	2	1	1	1	1
CO.3	1	2	2	-	2	2	2	2	2	1	1	1	1
CO.4	1	2	2	-	2	2	2	2	1	1	1	1	1
CO.5	1	2	2	-	2	2	2	3	2	1	1	2	1
CO.6	1	3	3	-	2	2	3	3	2	1	1	2	1
Avg	1.00	2.17	2.17	-	2.00	2.00	2.17	2.33	1.67	1.00	1.00	1.33	1.00

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

Course Code: VOL201 Course Title: Essential techniques in Life Sciences

School: SBSR		Batch:2023-2027	
Programme: B.Sc.		Current Academic Year: 2024-25	
Branch: Microbiology		Semester: 03	
1	Course Code	VOL201	
2	Course Title	Essential techniques in life sciences	
3	Credits	3	
4	Contact Hours(L-T-P)	(0-0-6)	
	Course Status	SEC (Minor)	
5	Course Objective	• Develop knowledge of a specific area of specialization. • Develop research skills especially in biological experiments, project writing andoral presentation.	
6	Course Outcomes	The student at the completion of the course will be able to: CO 1: To learn the basic principles of Blood grouping analysis CO 2: Studying the hemagglutination and precipitation CO 3: Vertical sectioning of plant stem and root. CO 4: Hematological analysis using light microscope. CO 5: Preparation of a permanent slide of plant tissue CO 6: Preparation of a permanent slide of plant tissue	
7	Course Description	Vocational education is concerned with the training on vocation. It is related to productivity. Vocational education prepares individuals for jobs. It has adequate employment potentialities. It helps in broadening of horizon. It leads to dignity of labour. It is helpful in the maximum utilisation of the material resources of the country..	

List of Practical's:

S. No.	Experiment	CO Mapping
1	A) Blood grouping analysis; Rh factor antigen analysis. B) Studying the hemagglutination and precipitation. C) Quantitative estimation of antigen by double and radial immunodiffusion assay.	CO1, CO6
2	A) Vertical sectioning of plant stem and root. B) Transverse sectioning of plant stem and root.	CO2, CO6
3	A) Studying different plant tissue under compound light microscope	CO3, CO6
4	A) Preparation of a permanent slide of plant tissue	CO4, CO6

Mode of examination	Practical/Viva			
Weightage Distribution	CA	MSE	ESE	
	25%	25%	50%	
Text book/s*	Practical Manual of Biotechnology 1 Edition (by Dr. R.K. Mahajan Dr. Ritu Mahajan, Dr. J. Sharma			
Other References	NA			

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	-	1	2	-	2	1	-	-	1	1	1	2	2
CO2	-	1	2	-	2	1	-	-	1	1	1	2	2
CO3	1	2	2	-	2	1	-	-	1	1	1	2	2
CO4	1	1	2	-	2	1	-	-	1	1	1	2	2
CO5	1	2	2	-	2	1	-	-	1	1	1	2	2
CO6	1	1	2	-	2	1	-	-	1	-	1	2	2
Avg	1.80	1.80	1.80	-	1.80	1.80	-	-	1.80	1.80	1.80	1.80	2.00

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

Course Code: ARP207 Course Title: Logical Skills Building and Soft Skills

School: SBSR		Batch:2023-2027	
Programme: B.Sc.		Current Academic Year: 2024-25	
Branch: Microbiology		Semester 03	
1	Course Code	ARP207	
2	Course Title	Logical Skills Building and Soft Skills	
3	Credits	2	
4	Contact Hours(L-T-P)	(1-0-2)	
5	Course Status	AEC (Minor)	
6	Course Objective	To enhance holistic development of students and improve their employability skills. To provide a 360-degree exposure to learning elements of Business English readiness Programme, behavioral traits, achieve softer communication levels and a positive self-branding along with augmenting numerical and altitudinal abilities. To step up skill and upgrade students across varied industry needs to enhance employability skills. By the end of this semester, a student will have entered the threshold of his/her 1st phase of employability enhancement and skill building activity exercise	
7	Course Outcomes	After completion of this course, students will be able to: CO1: Ascertain a competency level through Building Essential Language and Life Skills. CO2: Build positive emotional competence in self and learn GOAL Setting and SMART Goals techniques. CO3: Apply positive thinking, goal setting and success-focused attitudes, time Management, which would help them in their academic as well as professional career. CO4: Acquire satisfactory competency in use of aptitude, logical and analytical reasoning CO5: Develop strategic thinking and diverse mathematical concepts through building number puzzles CO6: Demonstrate an ability to apply various quantitative aptitude tools for making business decisions	

List of Practical's

S. No.	Experiment	CO Mapping
1	Know Yourself: Core Competence. A very unique and interactive approach through an engaging questionnaire to ascertain a student's current skill level to	CO1

	design, architect and expose a student to the right syllabus as also to identify the correct TNI/TNA levels of the student	
2	Techniques of Self Awareness | Self Esteem & Effectiveness| Building Positive Attitude | Building Emotional Competence .	CO1, CO2
3	Positive Thinking & Attitude Building | Goal Setting and SMART Goals – Milestone Mapping | Enhancing L S R W G and P (Listening Speaking Reading Writing Grammar and Pronunciation) |	CO1, CO2, CO3
4	Syllogism | Letter Series | Coding, Decoding, Ranking & Their Comparison Level-1	CO4
5	Number Puzzles	CO5
6	Selection Based on Given Conditions	CO5
7	Number Systems Level 1 | Vedic Maths Level-1	CO6
8	Percentage, Ratio & Proportion | Mensuration - Area & Volume |Algebra	CO6
9	Reading Comprehension	CO1
10	Spotting the Errors	CO2
11	Steven Covey Time Management Matrix	CO3
12	Creating Self Time Management Tracker	CO3

Mode of examination	Practical/Viva		
Weightage Distribution	CA+MSE	ESE	
	25%	75%	
Text book/s*	Wiley's Quantitative Aptitude-P Anand | Quantum CAT–Arihant Publications | Quicker Maths- M. Tyra | Power of Positive Action (English, Paperback, Napoleon Hill) | Streets of Attitude (English, Paperback, Cary Fagan, Elizabeth Wilson) The 6 Pillars of self-esteem and awareness – Nathaniel Brandon | Goal Setting (English, Paperback, Wilson Dobson.		

Lesson Plan 3rd Semester ARP 207	
LOGICAL SKILLS BUILDING AND SOFT SKILLS	
S. No.	Lecture Topics
1	ENGLISH LANGUAGE MASTERY | Speed Reading| Art of Comprehension | Concision and Precision
2	Subject Verb Agreement | Pronouns & Tenses
3	Misplaced Modifiers | Parallelism & Comparisons
4	Practice Worksheets
5	SPEAK ON A TOPIC | Idea Formation | Power Words
6	Spotting the Errors | Vocabulary Building
7	Paragraph Summary | Paragraph Jumbles
8	WORKSHOP | From GOAL SETTING To GOAL GETTING
9	JOHARI WINDOW | EISENHOWER MATRIX

10	Formal Business Letter Writing
11	LSRWG Skills
12	Positive Thinking & Attitude Building
13	Positive Thinking Quiz (Self-Assessment Questionnaire)
14	Positive Attitude Building (Self-Assessment Questionnaire)
15	Goal and Milestone Mapping
16	Know Yourself: Core Competence (Self-Assessment Questionnaire)
17	Understand Techniques of Self Awareness
18	Self Esteem & Effectiveness
19	Building Emotional Competence
20	Close test
21	Verbal Analogies
22	Change of Voice
23	Idioms and Phrases
24	One Word substitites
25	Comprehension
26	Ordering of Words
27	Sentence Corrections
28	Writing a Letter of Recommendation for Higher Studies
29	The Art of Presentation Skills
30	Time Management (Scheduling the Priority) Steven Covey Matrix Technique
31	Team Building & Team Synergy Skills
32	The art of Delegation and conflict Resolution
33	Introduction of ARP and Vedic Math's
34	Vedic Maths
35	Number series
36	Letter series,Word series
37	Coding Decoding
38	Number classification and their defination
39	Decimal to binary conversion
40	Factorials,Factor and factorisation
41	Divisibility rule
42	Practice Test
43	Selection based on given condition
44	Syllogism-1
45	Ranking and order
46	Percentage level-1
47	Ratio & Proportion level-1
48	Class Test

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
ARP203.1	-	-	-	-	1	-	-	-	1	3	-	-	-
ARP203.2	-	-	-	-	1	-	-	-	1	3	-	-	-
ARP203.3	-	-	-	-	1	-	-	-	1	3	-	-	-
ARP203.4	-	-	-	-	-	-	-	-	1	2	-	-	-
ARP203.5	1	-	-	-	-	-	-	-	1	2	-	-	-
ARP203.6	1	-	-	-	-	-	-	-	1	2	-	-	-
Avg	1	-	-	-	1.0	-	-	-	-	-	1.0	2.0	-

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

Course code: RBL001 Course Title: Research Based Learning-1

School: SSBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2024-25	
Branch: Microbiology		Semester 03	
1	Course Code	RBL001	
2	Course Title	Research Based Learning-1	
3	Credits	Audit based	
4	Contact Hours (L-T-P)	0-0-4-0	
5	Course Status	Project (Major)	
6	Course Objective	Develop knowledge of a specific area of specialization. Develop research skills especially in biological experiments, project writing and oral presentation.	
7	Course Outcomes	The student at the completion of the course will be able to: CO 1: Articulate research-based investigation done on a topic. CO 2: Demonstrate capacity to identify theoretical/ experimental method followed in the research articles. CO 3: Demonstrate an understanding of the ethical issues associated with practitioner research. CO 4: Compare research data and extract the outstanding results. CO 5: Report research findings in written and verbal forms. CO 6: Use research findings to advance education theory and practices.	
8	Course Description	Research-based learning (RBL) aims to promote and develop student competencies related to research practice and to benefit students through activities linked to research. This technique implies the application of learning and teaching strategies that link research with teaching	
	Outline syllabus		CO Mapping
	Unit 1	Introduction to various research problems	CO1,CO6
	Unit 5	Identify a research question	CO2,CO6
	Unit 3	Literature survey	CO3,CO6
	Unit 4	Report writing	CO4,CO6
	Unit 5	Presentation	CO5 ,CO6

Mode of examination	Continuous Assessment (CA): 25 Marks Viva-Voce (on the basis of weekly Viva performance): 25 Marks ETE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10Marks and Lab record for 10 marks)			
Weightage Distribution	CA	CE	ESE	
	25%	25%	50%	
Text books	10 Recent International Journal Articles of repute.			

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	-	1	-	-	1	-	1	-	1	1	-	-	1
CO2	-	1	-	-	1	-	1	-	1	1	-	-	1
CO3	-	1	-	-	1	-	1	-	1	1	-	-	1
CO4	-	1	-	-	1	-	1	-	-	1	-	-	1
CO5	-	1	-	-	1	-	-	-	-	1	-	-	1
CO6	-	1	-	-	1	-	-	-	-	-	-	-	1
Avg	-	1	-	-	1	-	1	-	1	1	-	-	1

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

Course Code: PHR201 Course Title: Renewable Energy Resources

School: SSBSR		Batch: 2023-2027	
Programme: B.Sc.		Current Academic Year: 2023-2024	
Branch: Microbiology		Semester: 03	
1	Course Code	PHR201	
2	Course Title	Renewable Energy Resources	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
5	Course Status	OE	
6	Max. Marks	15+10+75=100	
7	Min. Marks		
8	Course Objective	This course provides an opportunity to develop knowledge and understanding of the key principles and applications of biomass energy and resources	
9	Course Outcomes	The student at the completion of the course will be able to: CO1: Understand and develop knowledge about the different kinds of renewable energy resources. CO2: Analyse the energy consumption (both in rural and urban areas) and energy demand and current Indian energy scene. CO3: Understand the Impact on environmental degradation due to production and utilization of energy. CO4: Understand and Analyse the solar cells CO5: Understand and develop knowledge about the Geothermal, wind, ocean and bioenergy resources. CO6: Students will have deep knowledge about the various renewable resources including solar energy, geothermal energy, wind and ocean energy and adverse effect of energy consumption on environment.	
10	Course Description	This course provides deep knowledge about the different forms of energy, various renewable resources including solar energy, geothermal energy, wind and ocean energy, solar cells (1st, 2nd, and 3rd generation), and adverse effect of energy consumption on environment.	
11	Outline syllabus		CO Mapping
	Unit 1	Renewable energy and its Resources	

	A	Definition, units, and power of energy, Forms of energy, Second law of thermodynamics and conversion of energy, Origin and time scale of fossil fuels.		CO1
	B	Conventional and nonconventional energy sources, Renewable-non-renewable energy resources, Green energy, clean energy (definition and example only),		CO1
	C	Energy resources, coal, oil, natural gas, nuclear and hydroelectric power, Concepts of ecological footprint, green footprint, and carbon footprint.		CO1
	Unit 2	Energy demand, Energy Consumption, and Indian Energy Scene:		
	A	Role of energy in economic development, Energy consumption in various sectors, Exponential increase in energy consumption and its impact on global economy, Energy demand and Energy trilemma index.		CO2
	B	Indian Energy Scene: Energy resources available in India, Urban and rural energy consumption, Nuclear energy (scope and future) variation of energy consumption as a function of energy,		CO2
	C	Need of new renewable resources, National Green Tribunal (NGT) act and activities.		CO2
	Unit 3	Environmental effects on energy consumption		
	A	Environmental degradation due to production and utilization of energy, Impact of environmental degradation activities on biological damage.		CO3
	B	Environmental effects of thermal power stations and nuclear power generation, Air and water pollution, Effect on Ozone layer, Global warming.		CO3
	C	Hydroelectric power, Geothermal power, Energy harvesting (Ocean, wind, solar and bioenergy).		CO3, CO6
	Unit 4	Solar Energy and Solar Cells		
	A	Need of Solar energy, Solar Energy, Solar constant, Solar radiation spectrum		CO4
	B	Classification of solar cells: 1st generation (single vs polycrystalline), 2nd generation, 3rd generation.		CO4, CO6
	C	Key elements of silicon solar cells, PV solar cell, Module, Panel and array, solar thermal system types. Applications of solar thermal systems.		CO4, CO6
	Unit 5	Geothermal, Wind, Ocean and Bioenergy		
	A	Geothermal Energy: Introduction, Geothermal power, Geothermal resources, Advantage and disadvantage of geothermal energy over other form of energy.		CO5
	B	Wind energy: Introduction, Principle of wind energy conversion, Advantage and Disadvantage of wind mills, Application of wind energy.		CO5, , CO6
	C	Ocean Energy: Introduction, Principle of ocean thermal energy conversion, Tidal power generation, tidal energy technologies, Wave energy conversion, Advantages and Disadvantages. Bio Energy: Introduction, Sources of biomass, Advantage and disadvantage of bio energy over other form of energy.		CO5, CO6
	Mode of examination	20 marks for Test / Quiz / Assignment / Seminar. 05 marks for Class Interaction		
		CA+MSE	ESE	

	Weightage Distribution	25%	75%	
	Text book/s* Reference book/s*	PART A 1. Renewable Energy: Power for a Sustainable Future, Godfrey Boyle. 2. Solar Photovoltaics: Fundamentals, Technologies and Applications, Chetan Singh Solanki PART B 1. Physics of Energy Sources, G. C. King 2. Physics and Technology of Sustainable Energy; E L Wolf 3. Advanced renewable Energy Systems, S C Bhatia 3. D.P.Kothari, K.C Singal and Rakesh Ranjan "Renewable Energy Sources And Emerging Technologies", 2011, PHI Learning Private Ltd, New Delhi.		
	Suggestive Digital Platforms / Web Links	1. https://www.edx.org/learn/renewable-energy 2. https://www.coursera.org/courses?query=renewable%20energy 3. National Programmeme on Technology Enhanced Learning (NPTEL), https://onlinecourses.nptel.ac.in/noc21_ch11/preview		
	Suggested Equivalent Online Courses	1. The Renewable Energy Institute, renewable energy course, 2. National Programmeme on Technology Enhanced Learning (NPTEL), https://onlinecourses.nptel.ac.in/noc21_ch11/preview 3. https://onlinecourses.nptel.ac.in/noc22_ph44/preview (swayam course)		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	-	2	2	2	2	2	2	1	1	2
CO2	1	2	2	-	2	2	2	1	2	2	1	2	2
CO3	1	2	2	-	2	2	2	1	2	2	1	2	2
CO4	1	2	2	-	2	2	2	1	2	2	2	1	2
CO5	1	2	2	-	2	2	2	2	2	2	2	2	2
CO6	1	2	2	-	2	2	2	2	2	2	2	1	2
Avg	1.00	2.00	2.00	-	2.00	2.00	2.00	1.50	2.00	2.00	1.50	1.50	2.00

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

School: SSBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2024-25	
Branch: Microbiology		Semester: 03	
1	Course Code	BBI203	
2	Course Title	Physical and Chemical aspects of Biological Sciences	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Minor	
5	Course Objective	Understanding the general properties of vitamins and minerals in the body To understand the physical aspect of biology To understand the chemistry aspect of biology	
6	Course Outcomes	The students at the completion of the course will be able to: CO1: Understand the role of vitamins and minerals in human body CO2: Summarize about the crucial concepts of PCR and Sequencing CO3: Discover the role of thermodynamics in human body CO4: Illustrate the concepts of the redox potential and role of ATP CO5: Appraise the concepts of plasma membrane in a cell CO6: Examine the concepts of physics and chemistry in biology.	
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	Vitamins and micronutrients	CO1,CO6
	A	Role of micronutrients – vitamins and minerals	
	B	Dietary sources, biochemical functions, requirements	
	C	Deficiency diseases associated with vitamin B complex, C and A, D, E & K vitamins	
	Unit 2	PCR and sequencing	CO2, CO6
	A	Tm of DNA, factors of responsible of denaturation and renaturation of DNA.	
	B	Introduction to PCR – Principle and applications	
	C	Introduction to sequencing and utility. Maxman Gilbert Sequencing, and Sangers sequencing	
	Unit 3	Bioenergetics	CO3, CO6
	A	Concepts of bioenergetics: Laws of thermodynamics, Gibbs free	

		energy	
	B	Enthalpy, Entropy, change in free energy, Standard free energy change pH 7.0 (derivations and numerical)	
	C	Biological systems as open, non-equilibrium systems	
	Unit 4	Redox potential	CO4, CO6
	A	Biological oxidation-reduction reactions, redox potential and its significance	
	B	high energy compounds (ATP, GTP)	
	C	Reasons for high group transfer potential of ATP including structural basis, ATP hydrolysis and equilibria of coupled reactions.	
	Unit 5	Plasma Membrane	CO5, CO6
	A	Plasma Membrane structure; Membrane lipids; Architecture and composition of bio-membrane, Membrane fluidity – Cholesterol, floppase and flippase	
	B	Transport across membranes: Diffusion, Active and Passive transport, Facilitated transport	
	C	Cell junctions: Tight junctions, Desmosomes, Gap junctions	
	Mode of examination	Theory/Jury/Practical/Viva	
	Weightage Distribution	CA+MSE	ESE
		25%	75%
	Text book/s*	Subramanian M A. Biophysics: Principles and Techniques. MJP Publishers Ltd.	
	Other References	R M S. Biophysics: An Introduction. John Wiley& Sons Ltd, England, 2002. Molecular Driving Forces: Statistical Thermodynamics in Biology, Chemistry, Physics, and Nanoscience: Ken Dill, Alka Gupta. Instrumentation & Bioanalytical Techniques. Pragati Edition	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	2	-	1	-	1	1	1	1	1	2	1
CO2	1	2	1	-	1	-	3	1	1	1	1	-	1
CO3	1	1	1	-	1	-	1	1	2	2	2	1	1
CO4	1	1	1	-	1	-	2	1	1	1	2	2	1
CO5	1	1	1	-	1	-	2	1	2	1	1	-	1
CO6	1	1	2	-	1	-	2	1	2	1	2	2	1
Avg.	1.00	1.17	1.33	-	1.00	-	1.83	1.00	1.50	1.17	1.50	1.75	1.00

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

SEMESTER IV

B.Sc. (Hons) Microbiology

Course Code: BSB206 Course Title: Enzyme Technology

School: SSBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2024-25	
Branch: Microbiology		Semester: 04	
1	Course Code	BSB206	
2	CourseTitle	Enzyme Technology	
3	Credits	4	
4	ContactHours (L-T-P)	4-0-0	
5	CourseStatus	CC (Major)	
6	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	
7	Course Outcomes	The student at the completion of the course will be able to: CO1: Show an overview on enzymes, their nomenclature and factors affecting enzyme activity CO2: Classify the factors affecting rate of biochemical reactions, lock and key as well as induced fit hypothesis CO3: Build the kinetics of enzyme catalysis as well as inhibition reactions CO4: Analyze the isolation, purification and immobilization of enzymes CO5: Conclude the Industrial and clinical application of enzymes CO6: Adapt the use of enzymes in leather, dairy, pharmaceutical, food processing and various other industries for human welfare	
8	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	
9	Outline syllabus		CO Mapping
	Unit 1	Enzymes as Catalysts: Overview	CO1,CO6
	A	Proteins as catalysts (Historical background); Enzyme nomenclature & classification; EC number of enzymes	
	B	Enzyme characteristics and properties; Factors affecting Enzyme Activity	

	C	Co-enzyme; Co-factors and their role in enzyme activity; Structure and function of coenzymes - TPP, pyrodoxal phosphate, Nicotinamide, flavin nucleotide, coenzyme A and biotin	
	Unit 2	Factors affecting the rate of chemical reactions	CO2, CO6
	A	Collision theory, activation energy and transition state theory	
	B	Catalysis, reaction rates and thermodynamics of reaction.Catalytic power and specificity of enzymes (concept of active site)	
	C	Fischer's lock and key hypothesis, Koshland's induced fithypothesis	
	Unit 3	Enzyme Kinetics	CO3, CO6
	A	Kinetics of single substrate reactions,	
	B	Enzyme inhibition Irreversible and reversible inhibition	
	C	Competitive non-competitive and un-competitive inhibition	
	Unit 4	Isolation, purification and immobilization of enzymes	CO4, CO6
	A	Isolation and purification of enzymes	
	B	Localization of proteins in various organelles/Enzyme Immobilization: Adsorption, Matrix entrapment, Encapsulation, Cross linking, covalent binding and their examples. Enzymestabilization & protein engineering; Catalytic antibodies	
	C	Advantages and disadvantages of different immobilization techniques	
	Unit 5	Industrial and Clinical Applications of Enzymes	CO5, CO6
	A	Applications in leather industry, food processing industry	
	B	Applications in dairy industry, pharmaceutical industry	
	C	Enzyme engineering: In vitro approaches to improve functional efficiency; Recombinant enzymes and their uses	
	Mode of examination	Theory	
	Weightage Distribution	CA+MSE: 25%	ESE: 75%
	Text book/s*	Text Book: Palmer T., Bonner P. L., Enzymes: Biochemistry, Biotechnology, Clinical Chemistry, Woodhead Publishing (2007)	
	Other References		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	-	1	2	2	2	2	1	1	1	2
CO2	1	2	2	-	1	2	2	2	2	1	1	1	2
CO3	1	2	2	-	1	2	2	2	2	2	1	2	3
CO4	1	2	2	-	1	2	2	2	3	2	2	2	3
CO5	1	2	2	-	1	2	2	3	3	2	2	2	3
CO6	1	2	2	-	1	2	2	3	3	2	3	2	3
Avg	1.00	2.00	2.00	-	1.00	2.00	2.00	2.33	2.50	1.67	1.67	1.67	2.67

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

Course Code: BBT213 **Course Title: Nanotoxicology**

School: SBSR		Batch: 2023-2027	
Programme: B.Sc.		Current Academic Year: 2024-25	
Branch: Microbiology		Semester:04	
1	Course Code	BBT213	
2	Course Title	Nanotoxicology	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course Status	CC (Major)	
6	Course Objective	To understand the nature and properties of nanomaterials. To provide scientific understanding of application of nanomaterials and nanotechnology in agriculture, health and environmental conservation.	
7	Course Outcomes	The student at the completion of the course will be able to: CO1: To introduce about nanomaterials and toxicity of nanomaterials. CO2: Studying various effects of nanomaterials on human health. CO3: To analyze the toxicity on nanomaterials on various platforms. CO4: Determining various factors and their effects on the level of nanotoxicity. CO5: To learn the risk and reach analysis emphasizing the role of regulatory guidelines. CO6: Studying the toxicity level of nanomaterials prior to clinical use.	
8	Course Description	Nanotoxicology is a new area of study that deals with the toxicological profiles of nanomaterials (NMs). Compared with the larger counterparts, the quantum size effects and large surface area to volume ratio brings NMs their unique properties that may or may not be toxic to living things	
9	Outline syllabus		CO Mapping
	Unit 1	Introduction to Nanomaterials and Nanotoxicology	
	A	Natural and synthetic nanomaterials.	CO1, CO6
	B	Biological and Environmental applications of nanomaterials.	
	C	Study of nano-bio interface.	
	Unit 2	Nanotoxicity and human health	
	A	Fate of nanomaterials in human body: short term and long-term effects.	CO2, CO6
	B	Acute and chronic toxicity.	
	C	Study of different levels toxicity based on organs.	

	Unit 3	Determination of nanotoxicity		
	A.	In vitro, in vivo, and ex vivo models to study the effects of nanomaterials on mammalian cells and tissues,		
	B.	Histological analysis, hematological analysis		
	C.	Serum biochemical analysis		
	Unit 4	Factors for determining nanotoxicity		CO3, CO6
	A	Size, shape, charge, aggregation, and interaction behavior of nanomaterials for determining the toxicity level.		
	B	Nanomaterials interactions with serum proteins.		
	C	protein-corona formation.		CO3, CO6
	Unit 5	Regulatory guidelines for nanomaterials		
	A	Risk assessment analysis.		
	B	Regulatory guidelines like ISO guidelines.		
	C	ASTM guidelines, CDSO and reach analysis.		
	Mode of examination	Theory		
	Weightage Distribution	CA+MSE	ESE	
	Mode of Examination	25%	75%	
	Text book/s*	Nelson, D. L., and Cox, M.M. Lehninger Principles of Biochemistry, 6th Edition, W.H.Freeman and Company, N.Y., USA. Palmer, T, and Bonner, P. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry Publisher: Horwood Publishing Limited.		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO.1	1	2	2	-	3	2	1	1	2	2	2	2	2
CO.2	1	2	2	-	3	2	2	1	2	2	2	2	2
CO.3	2	2	3	-	3	2	2	1	2	2	2	3	2
CO.4	1	3	3	-	3	2	2	1	2	2	2	3	3
CO.5	2	3	3	-	3	2	3	2	3	2	3	3	3
CO.6	2	3	3	-	3	2	3	2	3	2	3	3	3
Avg	1.50	2.50	2.67	-	3.00	2.00	2.17	1.33	2.33	2.00	2.33	2.67	2.50

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

Course Code: BBI213 Course Title: Introduction to Genetic Engineering

School: SBSR		Batch: 2023-2027	
Programme: B.Sc.		Current Academic Year: 2024-25	
Branch: Microbiology		Semester: 04	
1	Course Code	BBI213	
2	Course Title	Introduction to Genetic Engineering	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
5	Course Status	Multidisciplinary (Major)	
6	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	
7	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: To understand the complex molecular techniques.	
8	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	
9	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+MSE: 25% / ESE: 75%	
	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.	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO.1	1	2	2	-	2	2	3	1	2	1	1	3	2
CO.2	1	2	2	-	2	2	3	1	2	1	1	3	2
CO.3	1	2	2	-	2	2	3	1	3	2	1	3	3
CO.4	1	2	2	-	2	2	3	1	3	2	2	3	3
CO.5	1	2	2	-	3	2	3	1	3	3	2	3	3
CO.6	1	2	2	-	3	2	3	1	3	3	3	3	3
Avg	1.00	2.00	2.00	-	2.33	2.00	3.00	1.00	2.67	2.00	1.67	3.00	2.67

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

Course Code: BMB211 Course Title: Experiments with Enzymes (Lab)

School: SBSR		Batch: 2023-27
Programme: B.Sc.		Current Academic Year: 2024-25
Branch: Microbiology		Semester: 04
1.	Course Code	BMB211
2.	Course Title	Experiments with Enzymes (Lab)
3.	Credits	1
4.	Contact Hours (L-T-P)	0-0-2
5.	Course Status	CC (Major)
6.	Course Objective	To carry Practical Experiments related to Microbiology 1. Carry out the experiment related to identification of theenzymes present in different biological samples. 2. Carry out the experiment of Enzymes production fromdifferent 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.
7.	Course Outcomes	After successfully completion of this practical course students will beable to: CO1: Learn the identification of the enzyme activity present indifferent biological samples. CO2: Evaluate and perform isolation of various enzymes from microorganisms. CO3: Evaluate and perform analysis of various enzyme activityagainst 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.
8.	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.

List of Practical's:

S. No.	Experiment	CO Mapping
1	Identification of the enzymes present in different biological samples.	CO1, CO6
2	Isolation of enzymes from different biologicalsources	CO1, CO6
3	Microbial production of enzymes (Amylase)	CO1, CO6
4	Estimation of enzyme activity (Amylase)	CO1, CO6
5	Demonstration of Enzyme Activity (Starch Hydrolysis by amylase)	CO2, CO3, CO6
6	Demonstration of Enzyme Activity (Lipid Hydrolysis by Lipase)	CO2, CO3, CO6
7	Demonstration of Enzyme Activity (protein Hydrolysis by Protease)	CO4, CO6
8	Enzyme Immobilization by Gel Entrapment Method	CO6
9	To identify blood group in a given sample.	CO5, CO6
10	To isolate serum from given blood sample.	CO5, CO6

Mode of examination	Practical/Viva			
Weightage Distribution	CA	CE	ESE	
	25%	25%	50%	
Text book/s*	Practical Enzymology by Hans Bisswanger Wiley VCH; 4th edition. ISBN-10: 3527320768			
Other References	A Practical Book for Enzyme Technology by LinYing. Chemical Industry Press, ISBN-10:7122037010			

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO.1	1	2	2	-	2	1	2	1	2	1	1	2	1
CO.2	1	2	2	-	2	1	2	1	2	1	1	2	1
CO.3	1	2	2	-	2	1	2	1	2	1	1	2	2
CO.4	1	2	2	-	2	1	2	1	2	1	1	2	2
CO.5	1	2	2	-	2	1	2	1	1	1	1	2	1
CO.6	1	2	3	-	2	1	2	1	1	1	1	2	1
Avg	1.00	2.00	2.17	-	2.00	1.00	2.00	1.00	1.67	1.00	1.00	2.00	1.33

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

Course code: BSP205 Course Title: Genetic Engineering Lab

School: SSBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2024-25	
Branch: Microbiology		Semester: 04	
1	Course Code	BSP205	
2	Course Title	Genetic Engineering Lab	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-4	
5	Course Status	Multidisciplinary (Major)	
6	Course Objective	To learn the different techniques used for genetic engineering	
7	Course Outcomes	After completion of this course, students will be able to: CO1: List the experiments on DNA isolation from biological resources. CO2: Illustrate the particular gene of interest by PCR method. CO3: Build the amplified gene by electrophoresis method. CO4: Categorize the gene of interest in the expression vector. CO5: Choose the gene of interest. CO6: Construct the use different tools of genetic engineering	
8.	Course description	Genetic engineering will help to develop novel genes of economic importance that can be used to improve the genetics of microorganisms.	
9	Outline syllabus		CO Mapping
	Unit 1	DNA	
	A	Principle of DNA isolation	CO1, CO6
	B	Buffer preparation of DNA Isolation	CO1, CO6
	C	DNA isolation from bacteria	CO1, CO6
	Unit 2	PCR	
	A	Concept and working of PCR	CO2, CO6
	B	Demonstration of PCR machine	CO2, CO6
	C	Amplification of specific gene of interest by PCR method	CO2, CO6
	Unit 3	Validation of amplified gene	
	A	Preparation of buffers	CO3, CO6

	B	Concept and working of Electrophoresis			CO3, CO6
	C	Validation of amplified gene by electrophoresis method			
	Unit 4	Cloning of gene			
	A	Concept of gene cloning and expression vector			CO4, CO6
	B	Preparation of buffers			CO4, CO6
	C	Cloning of gene of interest in expression vector			CO4, CO6
	Unit 5	Protein expression			
	A	Concept of protein expression			CO5, CO6
	B	Growth of Cloned bacteria in media plate and broth			CO5, CO6
	C	To check the protein expression of the vector			CO5, CO6
	Mode of examination	Continuous Assessment (CA): 25 Marks Viva-Voce (on the basis of weekly Viva performance): 25 Marks ETE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10 Marks and Lab record for 10 marks)			
	Weightage Distribution	CA	CE	ESE	
		25%	25%	50%	
	Text books	Brown T.A, "Gene Cloning and DNA Analysis: An Introduction", John Wiley & Sons, 2010.			
	Reference books	Old R.W and Primrose S.B., "Principles of Gene Manipulation", Blackwell Scientific Publication, 2002.			

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	-	2	1	2	1	2	1	1	1	1
CO2	1	2	2	-	2	1	2	1	2	1	1	1	1
CO3	1	2	2	-	2	1	2	1	2	2	1	2	1
CO4	2	2	3	-	3	1	2	1	2	2	2	2	2
CO5	2	3	3	-	3	2	2	1	2	2	1	2	3
CO6	2	3	3	2	3	2	2	2	2	2	2	2	2
Avg	1.50	2.33	2.50	2.00	2.50	1.33	2.00	1.17	2.00	1.67	1.33	1.67	1.67

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

Course code: RBL002 **Course Title: Research Based Learning-2**

School: SSBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2024-25	
Branch: Microbiology		Semester: 04	
1	Course Code	RBL002	
2	Course Title	Research Based Learning II	
3	Credits	Audit Based	
4	ContactHours (L-T-P)	0-0-4-0	
5	CourseStatus	Project (Major)	
6	Course Objective	Develop knowledge of a specific area of specialization. Develop research skills especially in biological experiments, project writing and oral presentation.	
7.	Course Outcomes	After completion of this course, students will be able to: CO 1: Articulate research-based investigation done on a topic. CO 2:Demonstrate capacity to identify theoretical/ experimental method followed in the research articles. CO 3: Demonstrate an understanding of the ethical issues associated with practitioner research. CO4: Compare research data and extract the outstanding results. CO5: Report research findings in written and verbal forms. CO6: Use research findings to advance education theory and practice.	
8.	Course Description	Research-based learning (RBL) aims to promote and develop student competencies related to research practice and to benefit students through activities linked to research [.This technique implies the application of learning and teaching strategies that link research with teaching.	
	Outline syllabus		CO Mapping
	Unit 1	Introduction to various research problems	CO1,CO6
	Unit 2	Identify a research question	CO2,CO6
	Unit 3	Literature survey	CO3,CO6
	Unit 4	Report writing	CO4,CO6
	Unit 5	Presentation	CO5 ,CO6

	Mode of examination	Continuous Assessment (CA): 25 Marks Viva-Voce (on the basis of weekly Viva performance): 25 Marks			
		ETE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10Marks and Lab record for 10 marks)			
	Weightage Distribution	CA	CE	ESE	
		25%	25%	50%	
	Text books	10 Recent International Journal Articles of repute.			
	Reference books				

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	-	1	-	-	1	-	1	-	1	1	-	-	1
CO2	-	1	-	-	1	-	1	-	1	1	-	-	1
CO3	-	1	-	-	1	-	1	-	1	1	-	-	1
CO4	-	1	-	-	1	-	1	-	-	1	-	-	1
CO5	-	1	-	-	1	-	-	-	-	1	-	-	1
CO6	-	1	-	-	1	-	-	-	-	-	-	-	1
Avg	-	1	-	-	1	-	1	-	1	1	-	-	1

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

Course Code: ARP305 Course title: Personality Development and Decision-Making Skills

School: SBSR		Batch: 2023-27
Programme: B.Sc.		Current Academic Year: 2024-2025
Branch: Microbiology		Semester: 04
1	Course Code	ARP 305
2	Course Title	Personality Development and Decision-making Skills
3	Credits	2
4	Contact Hours (L-T-P)	1-0-2
5	Course Status	AEC (Minor)
6	Course Objective	To enhance holistic development of students and improve their employability skills. Provide a 360 degree exposure to learning elements of Business English readiness Programme, behavioural traits, achieve softer communication levels and a positive self-branding along with augmenting numerical and altitudinal abilities. To up skill and upgrade students across varied industry needs to enhance employability skills. By the end of this semester, a will have entered the threshold of his/her 3rd phase of employability enhancement and skill building activity exercise.
7	Course Outcomes	After completion of this course, students will be able to: CO1: Apply skills of personality development which will help a student groom to meet the needed social strata for establishing themselves in the society. CO2: Build a positive behavioural attitude and attributes developing interpersonal skills for building positive and meaningful social and professional relationships. CO3: Review and revise development plans to adapt to changing aspirations, circumstances and working environments. CO4: Acquire higher level competency in use of numbers and digits, logical and analytical reasoning. After completion of this course, students will be able to: CO1: Apply skills of personality development which will help a student groom to meet the needed social strata for establishing themselves in the society. CO2: Build a positive behavioural attitude and attributes developing interpersonal skills for building positive and meaningful social and professional relationships. CO3: Review and revise development plans to adapt to changing aspirations, circumstances and working environments. CO4: Acquire higher level competency in use of numbers and digits, logical and analytical reasoning. CO5: Develop higher level strategic thinking and diverse mathematical concepts through building cubes and cuboids.

		CO6: Demonstrate higher level quantitative aptitude such as analytical and statistical tools for making business decisions.
8	Course Description	This bundles Training approach attempts to explore the personality, character, and the natural style of the student. This helps to develop character, personality, confidence and interpersonal abilities within the student along with level 3 readiness in quant, aptitude and reasoning skills.

List of Practical's:

S. No.	Experiment	CO Mapping
1	What is Personality?| Creating a positive impression – The 3 V's of Impression | Individual Differences and Personalities	CO1
2	Personality Development and Transformation | Building Self Confidence | Behavioural and Interpersonal Skills	CO2
3	Avoiding Arguments | The Art of Assertiveness | Constructive Criticism | The Personal Effectiveness Grid | Assessing our Strengths & Limitations and Creating an Action Plan for Learning with the 4M Model	CO3
4	Introduction to APTITUDE TRAINING- Reasoning- Logical/ Analytical	CO4
5	Numbers & Digits, Mathematical Operations | Analytical Reasoning	CO4
6	Cubes & Cuboids | Statement & Assumptions	CO5
7	Strong & Weak Argument	CO5
8	Quantitative Aptitude	CO6
9	Work & Time, Pipes & Cistern	CO6
10	Time, Speed & Distance, Quadratic & Linear Equations, Logs & Inequalities	CO6
11	Sequence & Series, Logarithms, Data Interpretation | Data sufficiency - Level 1	CO6
12	Verbal Abilities-3	CO3
13	Cloze Test	CO3
15	Sentence Rearrangement	CO3
16	Charisma Building	CO2
17	How to Build Charisma	CO2
18	Steps Towards Building a Charisma	CO2

Mode of examination	Practical/Viva		
Weightage Distribution	CA+MSE	ESE	
	25%	75%	

Text book/s*	Wiley's Quantitative Aptitude-P Anand | Quantum CAT – Arihant Publications | Quicker Maths- M. Tyra | Power of Positive Action (English, Paperback, Napoleon Hill) | Streets of Attitude (English, Paperback, Cary Fagan, Elizabeth Wilson) The 6 Pillars of self-esteem and awareness – Nathaniel Brandon | Goal Setting (English, Paperback, Wilson Dobson	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	1	-	-	1	2	-	-	-
CO2	-	-	-	-	-	1	-	-	1	2	-	-	-
CO3	-	-	-	-	-	-	-	-	1	2	-	-	-
CO4	1	-	-	-	-	-	-	-	1	2	-	-	-
CO5	1	-	-	-	-	-	-	-	1	2	-	-	-
CO6	1	-	-	-	-	-	-	-	1	2	-	-	-
Avg	1	-	-	-	-	-	-	-	1	2	-	-	-

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

Course Code: CHE113 Course Title: Chemistry IV

School: SBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2024-25	
Branch: Microbiology		Semester: 04	
1	Course No.	CHE 113	
2	Course Title	Chemistry IV	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
5	Course status	OE (Minor Elective)	
6	Course Objective	• To provide the basics of Chemical equilibrium, ionic equilibrium, thermochemistry and chemical kinetics so as to apply on various biological systems. • To make students confident in making solutions of concentrations and standardize them.	
7	Course Outcomes	Students will be able to: 1. Understand basics of Chemical equilibrium. 2. Identify the components of a buffer and their function and realize the different types of salts solution and their pH 3. explain the concept of enthalpy change in different reactions and Heat capacities. 4. recognize the order of reactions and role and working of catalyst 5. prepare solutions with desired molar or percent concentrations and carry out dilutions of these solutions and different types of titrations and understand the choice of indicators 6. apply the basic knowledge to solve various analytical problems.	
8	Outline Syllabus		
	Unit 1	Chemical Equilibrium	
	A	Law of mass action; Thermodynamic treatment of Law of mass action, Relation between Kp, Kc and Kx	CO1
	B	Variation of equilibrium constant with temperature - The Van't Hoff Equation;	CO1
	C	Le-chatelier's principle and its application.	CO1, CO6
	Unit 2	Ionic Equilibrium	
	A	Strong and Weak acids and bases, ionization constants of weak acids and bases, pH and pOH, Ionic product of water	CO2

	B	Common Ion Effect, Buffers and their types, pH of buffers- Henderson equation for acidic and basic buffers.	CO2, CO6
	C	Solubility products, Salt Hydrolysis and pH of salt solutions	CO2
	Unit 3	Thermochemistry	
	A	Principles of heat flow, enthalpy, calorimetry, Heat capacity (C_v and C_p) and specific heats	CO3, CO6
	B	Hess's Law, heats of formation, Different types of Heat of a reaction	CO3, CO6
	C	Effect of temperature on heat of reaction, at constant pressure (Kirchoff's Equation).	CO3, CO6
	Unit 4	Chemical Kinetics	
	A	Rates of reactions and its expressions, Reactions of Zero, First and second order, half lives	CO4, CO6
	B	Determination of order of reactions by half life method, Activation energy, Effect of temperature on rate of reaction	CO4, CO6
	C	Types and characteristics of catalysis, Elementary enzyme catalyzed reactions	CO4, CO6
	Unit 5	Titrations	
	A	General principle. Requirements for titrimetric analysis and Concentration systems	CO5, CO6
	B	Primary and secondary standards, criteria for primary standards, Types of titrations, Limitation of volumetric analysis	CO5, CO6
	C	endpoint and equivalence point, Theoretical aspects of acid-base titration curves and end point evaluation, Choice of indicators	CO5, CO6
Mode of examination	Theory		
Weightage Distribution	CA+MSE	ESE	
	25%	75%	
8	References		
Text Book	1. Essentials of Physical Chemistry by B.S. Bahl and G.D. Tuli. 2. Concise Inorganic Chemistry by J. D. Lee 5th Edition. 3. Stereochemistry Conformation and Mechanism By P S Kalsi 4. College Chemistry by Linus Pauling		
Other references	1. Text Book of Physical Chemistry by Samuel Glasstone 2. Physical Chemistry by Walter J Moore 3. Physical Chemistry by Atkin 4. Arthur I. Vogel's Quantitative Inorganic Analysis including Elementary Instrumental Analysis, ELBS, Longmann Group, 5th Edition, 1989.		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	-	2	2	-	1	1	1	-	1	2	1	2	2
CO2	-	2	2	-	1	1	2	1	1	2	1	2	2
CO3	-	2	2	-	1	1	2	1	1	2	1	2	2
CO4	1	2	2	-	1	1	2	2	1	2	1	2	2
CO5	1	2	2	-	1	1	1	2	1	2	2	2	2
CO6	1	2	2	-	1	1	2	2	1	2	1	2	2
Avg	1.00	2.00	2.00	-	1.00	1.00	1.67	2.00	1.00	2.00	1.33	2.00	2.00

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

School: SSBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2024-25	
Branch: Microbiology		Semester: 04	
1	Course Code	BBI214	
2	Course Title	Introduction to Human Physiology	
3	Credits	5	
4	Contact Hours (L-T-P)	5-0-0	
5	Course Status	Multidisciplinary (Major)	
6	Course Objective	To understand the functioning of major human system including digestive, respiration, kidney, reproductive system etc	
	Course Outcomes	The student at the completion of the course will be able to: CO1: Understand the digestion and absorption of the body. CO2: Describe the structure and functions of nerve and muscles CO3: Illustrate the concept of physiology of respiration CO4: Compare different ways of the Renal Physiology and Cardiovascular Physiology. CO5: Assess the functioning of Endocrine and Reproductive system CO6: Elaborate the concept of the basic functioning of human physiology.	
7	Course Description	This course comprises of the structure, function of major systems to understand the holistic view of human functioning. Several different systems viz. respiratory, digestive, kidney, cardiovascular, reproductive, endocrine system will be studied for basic understanding.	
8	Outline syllabus		CO Mapping
	Unit 1	Digestion and Absorption of Food	CO1, CO6
	A	Structure and function of digestive glands	
	B	Digestion and absorption of carbohydrates, fats and proteins	
	C	Nervous and hormonal control of digestion (in brief)	
	Unit 2	Functioning of Excitable Tissue (Nerve and Muscle)	CO2, CO6
	A	Structure of neuron, Propagation of nerve impulse (myelinated and non-myelinated nerve fibre);	
	B	Structure of skeletal muscle	
	C	Mechanism of muscle contraction (Sliding filament theory), Neuromuscular junction	
	Unit 3	Respiratory Physiology	CO3, CO6

	A	Ventilation, External and internal Respiration	
	B	Transport of oxygen and carbon dioxide in blood	
	C	Factors affecting transport of gases	
	Unit 4	Renal Physiology and Cardiovascular Physiology	CO4, CO6
	A	Functional and anatomy of kidney,	
	B	Mechanism and regulation of urine formation	
	C	Structure of heart, Coordination of heartbeat, Cardiac cycle, ECG	
	Unit 5	Endocrine and Reproductive Physiology	CO5, CO6
	A	Structure and function of endocrine glands	
	B	Pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries, and testes,	
	C	Brief account of spermatogenesis and oogenesis, Menstrual cycle	
	Mode of examination	Theory	
	Weightage Distribution	CA+MSE	ESE
		25%	75%
Text book/s*		Molecular Biotechnology. Principles and Applications. 3rd Edition. Glick BR and Pasternak JJ. ASM Press @2003. ISBN 1-55581-224-4.	
Other References		Gene cloning and DNA Analysis- An Introduction. 6th Edition. Wiley-Blackwell. Brown TA, 2010	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	1	-	-
CO3	-	-	-	-	-	-	-	-	-	-	1	-	-
CO4	-	-	-	-	-	-	-	-	-	-	1	-	-
CO5	-	-	-	-	-	-	-	-	-	-	1	-	-
CO6	-	-	-	-	-	-	-	-	-	-	1	-	-
Avg	-	-	-	-	-	-	-	-	-	-	1	-	-

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

SEMESTER V

B.Sc. (Hons.) Microbiology

Course Code: BMB301 Course Title: Advanced Microbial Biotechnology

School: SBSR		Batch: 2023-2027	
Programme: B.Sc.		Academic Year: 2025-2026	
Branch: Microbiology		Semester: 05	
1	Course Code	BMB301	
2	Course Title	Advanced Microbial Biotechnology	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
5	Course Status	CC (Major)	
6	Course Objective	1. Some Potential Sources of Components of Industrial Media 2. Product recovery, Solids (Insolubles) Removal 3. Industrial production of organic acids 4. Role of microorganisms in hydrocarbon degradation	
7	Course Outcomes	After studying this course, students will be able to CO1: Define and understand the Primary and Secondary screening, Production strains, andProduction media. CO2: Describe Filtration; Centrifugation; Coagulation and flocculation. CO3: Illustrate the interpret the production of microbial insecticides, production of Biopolymers, Biofuels. CO4: Analyze the role of microorganisms in hydrocarbon degradation. CO5: Determine Role of microorganism in Bioleaching and Textile Industry. CO6: Determine types of microorganisms found on textile fibers.	
8	Course Description	This course contains introductory part of industrial biotechnology which includes various useful microorganisms, their production, different types offer mentors, product recovery processes. After this course study student willable to learn the role of microorganisms in textile industry and marine environment.	
9	Outline syllabus		CO Mapping
	Unit 1		CO1
	A	Introduction and history, Isolation and screening, Primary and Secondary screening, Production strains, Production media,	
	B	Raw Materials Used in Compounding Industrial Media, Growth Factors, Water,	
	C	Some Potential Sources of Components of Industrial Media, Inoculum preparation, Introduction to Fermenter, Industrial sterilization	

	Unit 2	Product recovery, Solids (Insolubles) Removal		CO2
	A	Filtration; Centrifugation; Coagulation and flocculation;		
	B	Foam fractionation; Whole-broth treatment; Primary Product isolation: Cell disruption;		
	C	Liquid extraction; Dissociation extraction ;Ion-exchangeadsorption; precipitation		
	Unit 3	Antibiotics		CO3
	A	Introduction, Industrial production of penicillin, production of streptomycin		
	B	Industrial production of organic acids- production of citricacid, lactic acid, amino acids such as L- glutamic acid,		
		Production of single cell proteins, production of fermented foods.		
	C	Production of microbial insecticides, production of Biopolymers, Biofuels, Production of Alcohol Yeasts , food yeast and Baker's Yeast.		
	Unit 4	Petroleum Microbiology		CO4
	A	Types of compounds in petroleum, products of compounds in petroleum, Microorganisms in hydrocarbon system		
	B	Role of microorganisms in hydrocarbon degradation.		
	C	Marine Microbiology: Characters of marine environment, characters of marine microorganisms, role of marinemicroorganisms		
	Unit 5	Vaccines		CO5
	A	Production of Vaccines -Production of virus vaccines; Production of bacterial toxoids; Production of killed bacterial vaccines;		
	B	Role of microorganism in Bioleaching and Textile Industry : A. Bioleaching of elements – Microorganisms involved,chemistry of microbial leaching and beneficiationB		
	C	Textile Industry – Types of microorganisms found on textile fibres,Prevention of growth of microorganisms.		
	Mode of examination	Theory		
	Weightage Distribution	CA+MSE	ESE	
		25%	75%	
Text book/s*		Crueger & Crueger Biotechnology: A Text Book ofIndustrial microbiology 2nd edition. Demain, A.L Biology of Industrial Microorganisms		
Other References		1. Hobbs, B.C. and Rioberts,D 1993 Food Poisoning andFood Hygiene Edward Anold, London.		

	2. Hui Y H 2006 Food Biochemistry and Food Processing Blackwell 5. Joshi, V.K. Ashok Pondey 1999 Biotechnologyand Food fermentation Vol. I & II. Patel, A.H. Industrial microbiology

CO-PO-PSO Mapping

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	1	-	1	1	1	1	1	1	1	1	1
CO2	1	1	2	-	1	1	1	1	1	1	1	2	1
CO3	1	2	2	-	1	1	1	1	2	1	1	1	2
CO4	1	2	1	-	2	1	2	1	2	2	2	1	2
CO5	1	1	2	-	1	1	2	1	2	2	1	2	2
CO6	1	1	2	-	2	1	1	1	2	1	2	2	2
Avg	1.00	1.33	1.67	-	1.33	1.00	1.33	1.00	1.67	1.33	1.33	1.50	1.67

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

Course Code: BMB302 Course Title: Basics of Bioinformatics

School: SBSR		Batch: 2023-2027	
Programme: B.Sc.		Current Academic Year: 2025-26	
Branch: Microbiology		Semester: 05	
1	Course Code	BMB302	
2	Course Title	Basic of Bioinformatics	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
5	Course Status	CC (Major)	
6	Course Objective	An application of bioinformatics is to determine the function of genes and proteins, to establish evolutionary relationships, and to calculate the three-dimensional shape of proteins by using computer Programmes.	
7.	Course Outcomes	**Course outcomes:** The students at the completion of the course will be able to: CO1: Understand the Introduction of bioinformatics. CO2: Describe the biological database. CO3: Illustrate data storage and retrieval. CO4: To assess the sequence allignment. CO5: to assess the gene expression. CO6: Design pathways analysis	
8	Course description	Bioinformatics is concerned with applying technology, engineering, and statistics to biological data processing.	
9	Outline syllabus		CO Mapping
	Unit 1	Introduction	
	A	What is Bioinformatics and its relation with molecular biology Examples of related tools (FASTA, BLAST, BLAT, RASMOL)	CO1, CO6
	B	Databases (GENBANK, Pubmed, PDB) and software (RASMOL, Ligand Explorer), Data generation.	
	C	Generation of large scale molecular biology data.	

	Unit 2		
	A	Data storage and retrieval and Interoperability, Flat files, relational object oriented databases and controlled vocabularies. File Format (Genbank, DDBJ, FASTA, PDB, SwissProt).	CO2, CO6
	B	Introduction to Metadata and search; Indices, Boolean, Fuzzy, Neighboring search.	
	C	The challenges of data exchange and integration.	
	Unit 3		
	A	Sequence Alignments and Visualization, Introduction to Sequences, alignments and Dynamic Programmeming,Local alignment and Global alignment (algorithm and example), Pairwise alignment (BLAST and FASTA Algorithm)	CO3, CO6
	B	and multiple sequence alignment (Clustal W algorithm).Methods for presenting large quantities of biological data: sequence viewers (Artemis,	
	C	SeqVISTA), 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol), Anatomical visualization	
	Unit 4		
	A	Gene Expression and Representation of patterns and relationship,General introduction to Gene expression in prokaryotes and eukaryotes, transcription factors binding sites.	CO4, CO6
	B	SNP, EST, STS. Introduction to Regular Expression, Hierarchies, and Graphical models (including Marcov chain and Bayes notes).	
	C	Genetic variability and connections to clinical data. phosphorylation and adenylation (glycogen phosphorylase and glutamine synthetase)	
	Unit 5		CO5, CO6
	A	Small molecules data bases data bank	
	B	Protein information resources	
	C	Biological data analysis and application	
	Mode of examination	Theory	

	Weightage Distribution	CA+MSE	ESE	
		25%	75%	
	Text book/s*	Essential Bioinformatics by Jin Xiong		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	3	2	1	1	1	1	1	1	2	2
CO2	1	2	2	3	2	1	1	1	1	1	1	2	2
CO3	1	1	2	3	1	1	2	1	1	1	1	1	3
CO4	1	2	2	3	1	1	2	1	1	1	1	2	3
CO5	1	2	2	3	2	1	2	1	1	1	1	2	3
CO6	1	2	2	3	2	1	1	2	1	1	1	2	3
Avg	3	2.17	3	2	3	2	1.5	1.17	3	3	1	1	1.83

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

Course Code: BSB311 Course Title: Medical Microbiology

School: SBSR		Batch: 2023-2027	
Programme: B.Sc.		Current Academic Year: 2025-26	
Branch: Microbiology		Semester: 05	
1	Course Code	BSB311	
2	Course Title	Medical Microbiology	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course Status	CC (Major)	
6	Course Objective	• To get the knowledge of medical microbiology and the importance of microorganisms in infectious diseases • Gain the knowledge of eukaryotic microogranisms and their role in infectious diseases • To gain knowledge of normal flora, key concepts in medical microbiology, infection control and epidemiology	
7.	Course Outcomes	The students at the completion of the course will be able to: CO1: Understand the Beneficial microbial interactions with human. CO2: Know about the Harmful microbial interactions with human. CO3: Explain about General account of Epidemiology. CO4: Understand the person-to-person Microbial disease. CO5: Important Animal transmitted, arthropod transmitted, Soil borne and water borne microbial diseases. CO6: Important Chemical control of pathogens.	
7	Course description	This course provides learning opportunities in the basic principles of medical microbiology and infectious disease.	
8	Outline syllabus		CO Mapping
	Unit 1	Beneficial Microbial Interactions with Human	
	A	Normal microbial population of healthy human body	CO1, CO6
	B	Skin, mouth, upper respiratory tract, intestinal tract,	
	C	urino-genital tract, eye.	

	Unit 2	Harmful Microbial Interactions with Human	
	A	Entry of pathogens into the host, types of bacterial pathogens, Mechanism of bacterial pathogenicity, colonization and growth, Virulence	CO2, CO6
	B	Virulence factors – exotoxins, enterotoxins, endotoxins, neurotoxins. – avoidance of host defense mechanisms, damage to	
	C	Host cell, Host factors for infection and innate resistance to infection.	
	Unit 3	General Account of Epidemiology	
	A	Principles of epidemiology, Current epidemics (AIDS,Nosocomical, Acute respiratory Syndrome)	CO3, CO6
	B	Measures for prevention of epidemics –Global health consideration, Emerging and reemerging infectious diseases	
	C	Biological warfare and biological weapons.	
	Unit 4	Person to person Microbial disease	
	A	Airborne transmission of diseases by airborne pathogens. Names of pathogen, disease symptoms, and preventive measures *Streptococcal* diseases, *Corynebacterium* and Diptheria, *Bordetella* and Whooping cough, Mycobacterium-Leprosy and Tuberculosis,	CO4, CO6
	B	*Nisseria meningitides* meningitis and meningococcemia, Viruses and respiratory tract infection.	
	C	Direct contact transmission of diseases *Staphylococcus*, *Helicobactor pylori* and Gastric ulcers, Hepatitis viruses. Sexually transmitted diseases, Gonorrhea and syphilis, AIDS and HIV	
	Unit 5	Diseases	
	A	Water borne microbial diseases, Animal transmitted disease: Rabies, Hantavirus pulmonary syndrome.	CO5, CO6
	B	Arthropod transmitted disease: Rickettsia, Malaria, Plague, Soil borne diseases : Tetanus, Water borne microbial diseases: Cholera, Typhoid, Amoebiasis, Giardiasis.	
	C	Chemical control of Pathogens Definition and Classification of antibiotics on the basis of structure and mode of action. Assay of antibiotics, antibiotic spectrum Naturally produced	

		drugs. Antibiotics produced by bacteria, actinomycetes and fungi used in chemotherapy. Semisynthetic antibiotic. Sulfa drugs their use and mechanism of action. Naldixic acid, nitrofurans, isonicotinic hydrazide, metronidazole; Prophylactic agents. Drug toxicity, Drug resistance – chromosomal mutation and plasmid-borne multiple drug resistance. cyclic polypeptide antibiotics of bacteria.		
	Mode of examination	Theory		
	Weightage Distribution	CA+MSE	ESE	
		25%	75%	
	Text book/s*	Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	2	-	1	2	1	1	1	1	1	1	1
CO2	2	1	2	-	1	1	1	1	1	1	1	2	1
CO3	1	1	2	-	2	1	2	2	1	1	2	2	1
CO4	2	1	2	-	2	1	2	1	1	1	2	2	2
CO5	2	1	2	-	2	2	2	1	1	1	2	2	2
CO6	2	1	2	-	2	2	2	1	1	1	2	2	2
Avg	3	3	1.5	-	2.67	2.5	1.33	1.17	3	2.67	3	2.5	1.67

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

Course Code: BMB303 Course Title: Modern Industrial Microbiology

School: SBSR		Batch: 2023-2027	
Programme: B.Sc.		Current Academic Year: 2025-26	
Branch: Microbiology		Semester: 05	
1	Course Code	BMB303	
2	Course Title	Modern Industrial Microbiology	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
5	Course Status	Multidisciplinary (Major)	
6	Course Objective	To acquaint students with basic concepts of industrial microbiology.	
7	Course Outcomes	After finishing the course, the students will be able to: The students at the completion of the course will be able to: CO1: Understand the Bioreactor / Fermenter CO2: Describe about the Technology of Microbial cell maintenance. CO3: Explain about Downstream processing. CO4: Illustrate the Enzyme technology. CO5: Analyze about the Biological fuel generation CO6: Design the biotechnological methods in specific medical and industrial application.	
8	Course Description	A study of the microbial cultures and bioprocess technologies for bioproduct synthesis and transformation by various industrial microorganisms, traditional and biotechnological strain improvements, fermentation systems, immobilized cell reactors, downstream processing, product recovery, development and safety.	
9	Outline syllabus		CO Mapping
	Unit 1	Bioreactor/ Fermenter	
	A	Types & operation of Bioreactors, physicochemical standards used in bioreactors, limitations of bioreactors, stages of fermentation processes, Media design for fermentation processes, Solid substrate	CO1, CO6
	B	Fermentation, Fermenters (Stirred tank, bubble columns, airlift. Bioreactors, Static,	

	C	Submerged and agitated fermentation), advantages & disadvantages of solid substrate & liquid fermentations.	
	Unit 2	Technology of Microbial cell maintenance	
	A	Steps to maintain microbial culture in an aseptic & sterile environment (how to inoculate, preserve & maintain).	CO2, CO6
	B	Strain Preservation, maintenance and	
	C	Strain improvement by mutation of gene transfer.	
	Unit 3	Downstream processing	
	A	Extraction, separation, concentration, recovery & purification, operations (Insulin, Vitamins, Metabolites),	
	B	Industrial production of Ethyl alcohol, Acetic Acid (Vinegar), Citric acid, lactic acid, α-amylase, protease penicillin, tetracycline and vitamin B12, with reference to easily available raw materials.	CO3, CO6
	C	Production of herbal drugs.	
	Unit 4	Enzyme technology	
	A	Nature of enzymes, application of enzymes, limitations of microbial cells used as catalysts in fermentation,	
	B	Multi-enzyme reactors, genetic engineering & protein engineering of enzymes, cloning strategy for enzymes, technology of enzyme production,	CO4, CO6
	C	Use of immobilized cells and enzymes (Ca-alginate beads, polyacrylamide), industrial applications of immobilized enzymes.	
	Unit 5	Biological fuel generation	
	A	Photosynthesis, sources of biomass, ethanol from biomass, methane from biomass, hydrogen, microbial recovery of petroleum.	CO5, CO6
	B	Biotechnology in specific medical & industrial applications- Retting of jute, microbial process for immunization (Production of monoclonal antibodies), Deterioration of paper, textiles, painted surfaces and their prevention, Biofilms, microbial biopolymers, biosurfactants,	
	C	Microbial culture selection with high yield potential.	

	Mode of examination	Theory		
	Weightage Distribution	CA+MSE	ESE	
		25%	75%	
	Text book/s*	Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO.1	1	2	2	-	2	2	2	2	1	1	1	1	1
CO.2	1	2	2	-	2	2	2	2	2	1	1	1	1
CO.3	1	2	2	-	2	2	2	2	2	1	1	1	1
CO.4	1	2	2	-	2	2	2	2	1	1	1	1	1
CO.5	1	2	2	-	2	2	2	3	2	1	1	2	1
CO.6	1	3	3	-	2	2	3	3	2	1	1	2	1
Avg	1.00	2.17	2.17	-	2.00	2.00	2.17	2.33	1.67	1.00	1.00	1.33	1.00

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

Course Code: BMB304 Course Title: Bioinformatics lab

School: SBSR		Batch: 2023-27
Programme: B.Sc.		Current Academic Year: 2025-26
Branch: Microbiology		Semester: 05
1	Course Code	BMB304
2	Course Title	Bioinformatics lab
3	Credits	2
4	Contact Hours (L-T-P)	0-0-4
	Course Status	CC (Major)
5	Course Objective	Bioinformatics is the science of storing, extracting, organizing, analyzing, interpreting and using information. The approaches to the discipline of bioinformatics incorporate expertise from the biological sciences, computer science and mathematics. The major in bioinformatics is designed for students interested in molecular biology and genetics, information technologies and computer science. Bioinformaticists are involved in the analysis of the human genome, identification of targets for drug discovery, development of new algorithms and analysis methods, the study of structural and functional relationships, and molecular evolution
6	Course Outcomes	After finishing the course, the students will be able to: CO1 Define and understand the use of Pubmed tool CO2: Describe protein sequence CO3: Illustrate the structural classification of proteins CO4: Analyze the various bibliographic databases. CO5: To assess the KEGG pathway CO6: Design pathways analysis
7	Course Description	An application of bioinformatics is to determine the function of genes and proteins, to establish evolutionary relationships, and to calculate the three-dimensional shape of proteins by using computer Programmes.

List of Practical's:

Unit	Experiment	CO Mapping
1	A. Basics of Bioinformatics B. Understanding PubMed database. C. Introduction of National Center for Biotechnology Information (NCBI).	CO1, CO6
2	A. BLAST and FASTA B. Analysis of protein sequence from protein database. C. Analysis of gene sequence from nucleotide database.	CO2, CO6
3	A. Getting and analysis of primary protein structure.	CO3, CO6

	B. Secondary structure analysis of protein. C. Tertiary protein structure analysis using Rasmol		
4	A. Introduction of various bibliographic databases. B. Getting the gene sequences by exploring C. Querying the nucleic acid databases.		CO4, CO6
5	A. Understanding of Kyto Encyclopedia of Genes and Genome (KEGG) database for biological pathways B. metabolism, cellular process C. genetic information processing.		CO5,CO6
Mode of examination	Practical/Viva		
Weightage Distribution	CA	CE	ESE
	25%	25%	50%
Text book/s*	Manual of Industrial Microbiology and Biotechnology by Richard H. Baltz, Arnold L. Demain, Julian E. Davies.		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	3	2	1	1	1	1	1	1	2	1
CO2	1	2	2	3	2	1	1	1	1	1	1	2	1
CO3	1	1	2	3	1	1	2	1	1	1	1	1	2
CO4	1	2	2	3	1	1	2	1	1	1	1	2	2
CO5	1	2	2	3	2	1	2	1	1	1	1	2	2
CO6	1	2	2	3	2	1	1	2	1	1	1	2	2
Avg	3	2.17	3	2	3	2	1.5	1.17	3	3	1	1	1.67

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

Course Code: BMB305 Course Title: Microbial Biotechnology Lab

School: SBSR		Batch: 2023-2027
Programme: B.Sc.		Current Academic Year: 2025-26
Branch: Microbiology		Semester: 05
1	Course Code	BMB305
2	Course Title	Microbial Biotechnology Lab
3	Credits	2
4	Contact Hours (L-T-P)	0-0-4
	Course Status	CC (Major)
5	Course Objective	•To develop practical knowledge of microorganism •To teach students about fermenter; other instruments and their components •To teach about microbial production of various biomolecules
6	Course Outcomes	The students at the completion of the course will be able to: CO1: To understand the screening methods of amylose and proteolytic enzyme producing microbes. CO2: To execute the screening of microorganisms CO3: To determine the impact of various factors on microbial growth. CO4: To understand the concept of fermentation. CO5: To understand the isolation of proteins from microbes, CO6: To learn and understand the microbial processes.
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.

List of Practical's:

S. No.	Experiment	CO Mapping
Unit 1	Isolation and Screening of microbes	
A	Sample collection	CO1,CO6
B	Isolation and screening of microorganism producing proteases.	
C	Isolation and screening of microorganism producing amylases	
Unit 2	Isolation and Screening of Phosphate and Nitrogen based microbes	
A	Sample collection	CO2,CO6
B	Isolation of Nitrogen fixers from soil	
C	Isolation of phosphate solubilizers from soil	
Unit 3	Factors affecting microbial Growth	
A	Sample collection and culturing	CO3,CO6
B	Estimation of effect of temperature on microbial growth	
C	Estimation of effect of pH on microbial growth	
Unit 4	Fermentation Process	

A	Fermentative production of Wine	CO4, CO6
B	Fermentative production of Beer	
C	Fermentative production of Amylase	
Unit 5	Protein Isolation	
A	Sample collection and culturing	CO5, CO6
B	Cell lysis and isolation of Protein	
C	PAGE, Quantitative estimation of protein using Bradford`s/Lowery`s method.	

Mode of examination	Practical/Viva		
Weightage Distribution	CA	CE	ESE
	25%	25%	50%
Text book/s*	Manual of Industrial Microbiology and Biotechnology by Richard H. Baltz, Arnold L. Demain, Julian E. Davies.		

CO-PO-PSO Mapping

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	-	1	1	1	1	1	1	1	2	1
CO2	1	2	2	-	1	1	1	1	1	1	1	2	2
CO3	1	2	2	-	1	1	1	1	2	1	1	2	1
CO4	1	2	2	-	2	1	2	1	2	2	2	2	1
CO5	1	2	2	-	1	1	2	1	2	2	1	2	2
CO6	1	2	2	-	2	1	1	1	2	1	2	2	2
Avg	1.00	2.00	2.00	-	1.33	1.00	1.33	1.00	1.67	1.33	1.33	2.00	1.50

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

Course Code: INC001 Course Title: Industry Connect

School: SSBSR		Batch: 2023-27	
Programme: B.Sc.		Year 2025-26	
Branch: Microbiology		Semester 05	
1	Course Code	INC001	
2	Course Title	Industry Connect	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-4	
5	Course Status	Major (Training/Survey)	
6	Course Objective	This course will expose students to apply theories learned in the classroom and provides currenttechnological developments relevant to the subject area of training. Students will be able to identify the career preferences and professional goals.	
7	Course Outcomes	The students at the completion of the course will be able to: CO1: Get familiarize with industry principles and practices. CO2: Identify and analyze an appropriate problem. CO3: Develop teamwork and apply prior acquired knowledge in problem solving. CO4: Demonstrate effective verbal and written communication skills. CO5: Practice scientists' responsibilities, self-understanding, self-discipline and ethical standards. CO6: Identify the career preferences and professional goals.	
8	Course Description	The Internship aims to offer students the opportunity to apply their prior acquired knowledge in problem solving. Students will acquire skills important for time management, discipline, self-learning, and effective communication and so on.	
9	Outline syllabus		CO Mapping
	Unit 1		
	A, B, C	Define objectives and conditions for the internship, ensuring students that it isrelated to the study path carried out at the University	CO1, CO6
	Unit 2		
	A, B, C	Problem Definition and identification, Team/Group formation and ProjectAssignment. Finalizing the problem statement, resource requirement, if any.	CO2, CO6,
	Unit 3		
	A, B, C	The internship work plan is drawn up by developing team work and appliesprior acquired knowledge in problem solving.	CO3, CO6,
	Unit 4		
	A, B, C	Demonstrate and execute Project with the team. Submission of evaluation formand final report completed by the intern.	CO4, CO6
	Unit 5		

	A, B, C	Final evaluation form completed by the supervisor at the Host Organization andfinal presentation before departmental committee.		CO5, CO6
Mode of examination		Theory+Practical+Viva		
Weightage Distribution		CA	CE	ESE
		25%	25 %	50%
Text book/s*		NA		
Other References		NA		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	1	-	1	1	1	1	2	1	1	1	2
CO2	1	1	1	-	1	2	1	1	2	1	1	1	2
CO3	-	-	1	-	1	1	1	2	2	2	2	2	2
CO4	-	-	3	-	-	1	1	2	2	2	2	2	2
CO5	-	-	3	-	1	1	1	2	2	2	1	2	2
CO6	1	1	3	-	1	1	1	2	2	2	2	2	2
Avg	1.00	1.00	2.00	-	1.00	1.17	1.00	1.67	2.00	1.67	1.50	1.67	2.00

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

Course code: RBL003 Course Title: Research Based Learning-3

School: SSBSR		Batch: 2023-27			
Programme: B.Sc.		Current Academic Year: 2025-26			
Branch: Microbiology		Semester: 05			
1	Course Code	RBL003			
2	Course Title	Research Based Learning-3			
3	Credits	1			
4	Contact Hours (L-T-P)	0-0-2			
5	Course Status	Compulsory			
6	Course Objective	Develop knowledge of a specific area of specialization. Develop research skills especially in biological experiments, project writing and oral presentation			
8	Course Outcomes	The students at the completion of the course will be able to: **CO1:** Relate the understanding of various research articles to identify researchgap on a given topic. **CO2:** Illustrate line of approach to overcome the research gap. **CO3:** Identify appropriate method/s uitable for a given problem. **CO4:** Analyze characterization techniques/ theoretical analysis for obtainingresult. **CO5:** Explain graphs, diagrams, flowchart etc. **CO6:** Compile research findings in written and verbal forms			
9	Outline syllabus				CO Mapping
	Unit 1	Introduction to various research problems			CO1,CO6
	Unit 2	Identify a research question			CO2,CO6
	Unit 3	Literature survey			CO3,CO6
	Unit 4	Report writing			CO4,CO6
	Unit 5	Presentation			CO5 ,CO6
	Mode of examination	Continuous Assessment (CA): 25 Marks Viva-Voce (on the basis of weekly Viva performance): 25 Marks ETE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10Marks and Lab record for 10 marks)			
	Weightage Distribution	CA	CE	ESE	
		25%	25%	50%	
	Text books	10 Recent International Journal Articles of repute.			
	Reference books				

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	-	1	-	-	1	-	1	-	1	1	-	-	1
CO2	-	1	-	-	1	-	1	-	1	1	-	-	1
CO3	-	1	-	-	1	-	1	-	1	1	-	-	1
CO4	-	1	-	-	1	-	1	-	-	1	-	-	1
CO5	-	1	-	-	1	-	-	-	-	1	-	-	1
CO6	-	1	-	-	1	-	-	-	-	-	-	-	1
Avg	-	1	-	-	1	-	1	-	1	1	-	-	1

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

School: SSBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2025-26	
Branch: Microbiology		Semester: 05	
1	Course Code	FST314	
2	Course Title	Food Waste Management	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
5	Course Status	Multidisciplinary (Major)	
6	Course Objective	• Understanding the food industry waste. • Importance and need of management the industrial waste. • Various treatment methods available for food waste. • Types, availability and utilization of by-products from waste. • Bio methanation and bio composting technology for organic waste utilization • Industrial waste treatments and ways for waste disposal method. • Food Additives; Food Adulteration	
7	Course Outcomes	After successful completion of this course students will be able to: CO1: Define the basic concept of waste and types. CO2: Illustrate the waste disposal method. Recognize the importance and utility of waste from food Industry CO3: Develop the treatment of plant waste by physical, chemical, and biological methods, Effluent treatment plants, Use of waste and waste water. Various hazards and their control measures. CO4: Compare the types, availability, and utilization of by-products of cereals, legumes & oilseeds, Utilization of by-products from food processing Industries. CO5: Explain status and utilization of dairy by-products. Industrial waste management CO6: Case study.	
8	Outline syllabus		CO Mapping
	Unit 1	Introduction	CO1, CO6
	A	Classification and characterization of food industrial wastes from fruit and vegetable processing industry, beverage industry, fish, meat and poultry industry, sugar industry and dairy industry;	
	B	Waste disposal methods – physical, chemical and biological; Economical aspects of waste treatment and disposal.	
	C	Identification of waste	
	Unit 2	Treatment methods for liquid wastes	CO2, CO6
	A	Treatment methods for liquid wastes, Treatment methods from food process industries;	
	B	Design of activated sludge process,	
	C	Rotating biological contactors, Trickling filters, UASB, Biogas plant.	
	Unit 3	Treatment methods of solid wastes	CO3, CO6
	A	Treatment methods of solid wastes, Biological composting, drying and incineration;	

		Design of solid waste, management system: Landfill digester, Vermicomposting pit.	
	B	Treatment methods of solid wastes, Biological composting, drying and incineration; Design of solid waste, management system: Landfill digester, Vermicomposting pit.	
	C	Treatment methods of solid wastes, Biological composting, drying and incineration; Design of solid waste, management system: Landfill digester, Vermicomposting pit.	
	Unit 4	Bio filters and bio clarifiers	CO4, CO6
	A	Bio filters and bio clarifiers,	
	B	Ion exchange treatment of waste water,	
	C	Drinking-water treatment, Recovery of useful materials from effluents by different methods	
	Unit 5	Case Studies	CO5, CO6
	A	Cane Sugar waste, molasses for alcohol,	
	B	Baggasse for paper pulp, chemicals, bioethanol, cogeneration	
	C	Milk Industry Case studies	
	Mode of examination	Theory/Jury/Practical/Viva	
Weightage Distribution		CA+MSE	ESE
		25%	75%
Text book/s*		Handbook of Waste management and co-product recovery in Food Processing – Vol.1-Keith Waldron	
Other References		Food Industry Wastes: Disposal and Recovery; Herzka A & Booth RG; 1981, Applied Science Pub Ltd.	

CO-PO PSO Mapping

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	1	1	-	1	1	2	1	2	1	-	-	2
CO2	3	1	-	-	1	2	2	1	2	1	-	-	2
CO3	3	2	1	-	1	3	3	2	2	2	-	-	2
CO4	3	2	2	-	1	3	3	2	2	1	-	-	2
CO5	3	2	1	-	1	3	3	2	2	2	-	-	2
CO6	3	3	3	-	1	3	3	2	2	1	-	-	2
Avg.	3	1.8	1.3	-	1	2.5	2.6	1.6	2	1.3	-	-	2

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

SEMESTER VI

B.Sc. (Hons.) Microbiology

Course Code: BBI313 Course Title: Fundamentals of Environmental Microbiology

School: SBSR		Batch: 2023-2027	
Programme: B.Sc.		Current Academic Year: 2025-26	
Branch: Microbiology		Semester: 06	
1	Course Code	BBI313	
2	Course Title	Fundamentals of Environmental Microbiology	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
5	Course Status	CC (Major)	
6	Course Objective	Course is designed to introduce students to understand environmental concepts, principals and the world of microorganisms from the point-view of interaction and reaction of microbial impacts and role of microorganisms in the environment.	
7	Course Outcomes	The students at the completion of the course will be able to: CO1: Understand the Microorganisms and their Habitats. CO2: Know about the Microbial Interactions. CO3: Explain about Biogeochemical Cycling. CO4: Understand the Waste Management. CO5: Know about the Microbial Bioremediation. CO6: Important Waste potability.	
8	Course Description	Environmental Microbiology is devoted to the advancement of our understanding of microbial interactions and microbial processes in the environment, and publishes original research reporting significant advances in or relating to this subject.	
9	Outline syllabus		CO Mapping
	Unit 1	Microorganisms and their Habitats	
	A	Structure and function of ecosystems. Terrestrial Environment: Soil profile and soil microflora. Aquatic Environment: Microflora of fresh water and marine habitats.	CO1, CO6
	B	Atmosphere: Aeromicroflora and dispersal of microbes Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures,	
	C	Salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter	
	Unit 2	Microbial Interactions	

	A	Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, Predation Microbe-Plant interaction: Symbiotic and non-symbiotic interactions.	CO2, CO6
	B	Microbe-animal interaction: Microbes in ruminants	
	C	Nematophagus fungi and symbiotic luminescent bacteria	
	Unit 3	Biogeochemical Cycling	CO3, CO6
	A	Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin	
	B	Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction Phosphorus cycle: Phosphate immobilization and solubilization	
	C	Sulphur cycle: Microbes involved in sulphur cycle Other elemental cycles: Iron and manganese	
	Unit 4	Waste Management	
	A	Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill)	CO4, CO6
	B	Liquid waste management: Composition and strength of sewage (BOD and COD),	
	C	Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment.	
	Unit 5	Microbial Bioremediation	CO5, CO6
	A	(Principles and degradation of common pesticides, organic hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants.	
	B	Water Potability Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure:	
	C	Presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.	
	Mode of examination	Theory	
	Weightage Distribution	CA+MSE: 25% / ESE: 75%	
	Text book/s*	Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA	

		Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO.1	1	2	1	-	1	2	2	1	1	1	1	1	1
CO.2	1	2	2	-	1	1	2	1	1	1	1	1	2
CO.3	1	2	2	-	2	1	1	1	2	1	1	2	2
CO.4	2	2	2	-	2	2	1	1	1	1	1	2	1
CO.5	2	2	2	-	2	2	2	1	2	1	1	2	2
CO.6	1	2	2	-	2	2	3	1	2	1	1	2	1
Avg	1.33	2.00	1.83	-	1.67	1.67	1.83	1.00	1.50	1.00	1.00	1.67	1.50

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

Course Code: BMB311 Course Title: Modern Food and Diary Microbiology

School: SBSR		Batch: 2023-2027	
Programme: B.Sc.		Current Academic Year: 2025-26	
Branch: Microbiology		Semester: 06	
1	Course Code	BMB311	
2	Course Title	Modern Food and Diary Microbiology	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
5	Course Status	CC (Major)	
6	Course Objective	To study the basics of industrial and food microbiology processes.	
7	Course Outcomes	The students at the completion of the course will be able to: CO1: Understand the foods as a substrate for microorganisms. CO2: Analyze the microbial spoilage of various foods. CO3: To describe principles and methods of food preservation. CO4: Understand the fermented food. CO5: Analyze the food borne diseases (causative agents, foods involved, symptoms and preventive measures) CO6: Important Food sanitation and control.	
8	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	Intrinsic and extrinsic factors that affect growth and survival of microbes in natural flora	
	C	source of contamination of foods in general	
	Unit 2	**Microbial spoilage of various foods**	
	A	Spoilage of vegetables	CO2, CO6
	B	Spoilage of Fruits, meat, eggs, milk	
	C	Spoilage of butter, bread, canned Foods.	
	Unit 3	**Principles and methods of food preservation**	
	A	Principles, physical methods of food preservation: temperature (low, high, canning, drying)	CO3, CO6
	B	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 4	**Fermented foods**	

	A	Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese.	CO4, CO6
	B	Other fermented foods: dosa, sauerkraut, soy sauce and tampeh.	
	C	Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.	
	Unit 5	**Food borne diseases (causative agents, foods involved symptoms and preventive measures)**	CO5, CO6
	A	Food intoxications: *Staphylococcus aureus, Clostridium botulinum* and mycotoxins;	
	B	Food infections*: Bacillus cereus, Vibrio parahaemolyticus, Escherichia coli, Salmonellosis, Shigellosis, Yersinia enterocolitica, Listeria monocytogenes* and *Campylobacter jejuni*	
	C	**Food sanitation and control** HACCP, Indices of food sanitary quality and sanitizers	
	Mode of examination	**Theory**	
	Weightage Distribution	CA+MSE: 25% / ESE: 75%	
	Text book/s*	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.	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	3	-	1	2	2	2	2	2	1	2	2
CO2	1	2	3	-	2	2	2	2	2	2	1	2	2
CO3	1	2	3	-	1	2	2	2	2	2	1	2	2
CO4	2	2	3	-	2	2	2	2	3	2	1	2	2
CO5	1	2	3	-	2	2	2	2	3	2	1	2	2
CO6	1	3	3	-	2	2	2	3	2	2	1	2	2
Avg	1.17	2.17	3.00	-	1.67	2.00	2.00	2.17	2.33	2.00	1.00	2.00	2.00

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

Course Code: BMB312 **Course Title: Advanced Immunology**

School: SBSR		Batch: 2023-2027	
Programme: B.Sc.		Current Academic Year: 2025-26	
Branch: Microbiology		Semester: 06	
1	Course Code	BBI201	
2	Course Title	Advanced Immunology	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	CC	
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	The students at the completion of the course will be able to: 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".	
7	Outline syllabus		CO Mapping
	Unit 1	**Cells and organs of immune system**	
	A	Primary and secondary lymphoid organs, their structure and function.	CO1, CO6
	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 2	**Immune Responses and Effector Mechanism**	

	A	Innate and adaptive immunity, humoral and cell mediated immune response; Lines of defense and various barriers; Clonal nature of immune response,	CO2, CO6
	B	Signaling through immune system receptors- antigen receptor, structure and signaling pathways.	
	C	Regulation of immune response.	
	Unit 3	**Antigen and Antibody**	
	A	Antigen and Immunogen, antigenicity vs immunogenicity, properties of antigen.	CO3, CO6
	B	Antibody molecule, types and structure; Role in immune response.	
	C	Types of hypersensitivity.	
	Unit 4	**Antigen Antibody Interaction and MHC molecule**	
	A	Antigen antibody interaction: Immunodiffusion (Double and radial) RIA & ELISA; Immuno-electrophoresis.	CO4, CO6
	B	MHC molecule and its types, structure and their function.	
	C	Cytokines and their role in immune response**.**	
	Unit 5	**Immunity in health and disease**	
	A	Introduction to infectious diseases and immunonological responses; Autoimmunity	CO5, CO6
	B	Responses to self-antigens, transplant rejection-responses to alloantigens.	
	C	Vaccines and diseases; Monoclonal antibody and hybridoma technology	
	Mode of Examination	Theory	
	Weightage Distribution	CA+MSE: 25% / ESE: 75%	
	Text book/s*	•Kuby Immunology,7th Edition-R.A. Goldsby, Thomas • Immunology-A short course,4th Edition-EliBenjamini, • Richard Coico, Geoffrey Sunshine, (Wiley- Liss).	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO.1	1	2	2	-	2	2	2	2	1	1	1	1	1
CO.2	1	2	2	-	2	2	2	2	2	1	1	1	1
CO.3	1	2	2	-	2	2	2	2	2	1	1	1	1
CO.4	1	2	2	-	2	2	2	2	1	1	1	1	1
CO.5	1	2	2	-	2	2	2	3	2	1	1	2	1
CO.6	1	3	3	-	2	2	3	3	2	1	1	2	1
Avg	1.00	2.17	2.17	-	2.00	2.00	2.17	2.33	1.67	1.00	1.00	1.33	1.00

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

Course Code: BSP310 Course Title: Environmental microbiology lab

School: SBSR		Batch: 2023-27		
Programme: B.Sc.		Current Academic Year: 2025-26		
Branch: Microbiology		Semester: 06		
1	Course Code	BSP310		
2	Course Title	Environmental microbiology lab		
3	Credits	2		
4	Contact Hours (L-T-P)	0-0-4		
5	Course Status	Compulsory		
6	Course Objective	Understand the role of microorganisms as agents of environmental change. Recognize microorganisms as indicators of alteration of an ecosystem. To understand the microbial processes aimed to solve environmental problems.		
7	Course Outcomes	After finishing the course, the students will be able to CO1: Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action CO2: Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC) CO3: Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane. CO4: Assessment of microbiological quality of water. CO5: Determination of BOD of waste water sample. CO6: Learning the microbial contaminants of water sample		
8	Course Description	Environmental microbiology is designed to introduce students to understand environmental concepts, principals and the world of microorganisms from the point-view of interaction and reaction of microbial impacts and role of microorganisms in the environment.		
Mode of examination		Practical/Viva		
Weightage Distribution		CA	CE	ESE
		25%	25%	50%
Text book/s*		Atlas RM, Bartha R (2002). Ecología microbiana y microbiologia ambiental. 4ª ed., Pearson Educación SA. Alexander, M. 1999. Biodegradation and Bioremediation. 2d ed. Academic Press Bitton, G. 2003. Encyclopedia of environmental microbiology. Wiley , John & sons.		
Other References				

S. No.	Experiment	CO Mapping
Unit 1	**Soil analysis**	
A	Analysis of soil – pH, percolation, capillary action.	CO1, CO6
B	moisture content	CO1, CO6
C	water holding capacity	CO1, CO6

Unit 2	**Isolation of microbes from Soil**	
A	Preparation of media and autoclave	CO2, CO6
B	Bacteria from soil	CO2, CO6
C	Fungi from soil	CO2, CO6
Unit 3	**Isolation of microbes from rhizosphere**	
A	Preparation of media	CO3, CO6
B	Bacteria from rhizosphere	CO3, CO6
C	Fungi from rhizosphere	CO3, CO6
Unit 4	**Assessment of microbiological quality of water.**	
A	Sample collection	CO4, CO6
B	Determination of BOD of waste water sample.	CO4, CO6
C	Determination of microbial contamination	CO4, CO6
Unit 5	**Design and conduct sampling for microbes in air**	
A	Media preparation	CO5, CO6
B	Sample collection from air	CO5, CO6
C	Gram staining isolated colonies	CO5, CO6

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	3	-	2	-	2	-	1	1	1	1	1
CO2	1	3	3	-	2	-	2	-	1	1	1	2	2
CO3	1	3	3	-	2	-	2	-	2	1	1	2	2
CO4	1	3	3	-	2	-	2	-	2	1	3	2	1
CO5	1	3	3	-	3	-	3	-	3	2	3	2	3
CO6	2	3	3	-	3	-	2	-	3	3	2	2	3
Avg	1.17	2.83	3.00	-	2.33	-	2.17	-	2.00	1.50	1.83	1.83	2.00

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

School: SBSR		Batch: 2023-27
Programme: B.Sc.		Current Academic Year: 2025-26
Branch: Microbiology		Semester: 06
1	Course Code	BMB313
2	Course Title	Modern Food and Dairy Microbiology (Lab)
3	Credits	2
4	Contact Hours (L-T-P)	0-0-4
5	Course Status	CC
6	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.
7	Course Outcomes	The students at the completion of the course will be able to: 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.
8	Course Description	**Food and Dairy Microbiology**, is a specialization of Microbiology. It deals with the interaction of different microorganisms in food and milk products.

Mode of examination	Practical/Viva		
Weightage Distribution	CA	CE	ESE
	25%	25%	50%
Text book/s*	Food and Dairy Microbiology; Lakshi Publishers; ISBN: 8126163364		
Other References	Methods in Food and Dairy Microbiology; Leo R. DiLiello; A V I Publishing Company, Inc.; ISBN: 0870554115		

List of Practical's:

S. No.	Experiment	CO Mapping
1	Demonstration of working principles of various components of a batch bioreactor; incubator; biosafety cabinet; and autoclave; centrifuge.	CO1, CO5
2	Effect of environmental condition (temperature and moisture) on the quality of food sample	CO2, CO5
3	Isolation and characterization of microorganisms from idli batter	CO2, CO5
4	Isolation of microorganism from curd sample Characterization of curd producing microorganism	CO2, CO3, CO5
5	Isolation of microorganism from spoiled food Handling of spoiled food	CO3, CO4, CO5

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	2	-	2	2	2	2	2	1	1	2	2
CO2	1	1	2	-	2	2	2	2	2	1	1	2	2
CO3	2	2	2	-	3	2	2	2	2	1	1	2	2
CO4	2	2	2	-	3	2	2	2	2	1	3	2	2
CO5	2	2	2	-	3	2	3	2	2	2	3	2	2
CO6	2	2	2	-	3	2	2	2	2	3	2	2	2
Avg	1.67	1.67	2.00	-	2.67	2.00	2.17	2.00	2.00	1.50	1.83	2.00	2.00

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

Course code: RBL004 Course Title: Research Based Learning-4

School: SSBSR		Batch: 2023-27
Programme: B.Sc.		Current Academic Year: 2025-26
Branch: Microbiology		Semester: 06
1	Course Code	RBL004
2	CourseTitle	Research Based Learning-4
3	Credits	**1**
4	Contact Hours (L-T-P)	**0-0-2**
	Course Status	Project/DSE
5	Course Objective	Develop knowledge of a specific area of specialization. Develop research skills especially in biological experiments, project writing and oral presentation
6	Course Outcomes	The students at the completion of the course will be able to: **CO 1:** Recognize research-based investigation carried out on problems in physicsand interdisciplinary science **CO 2:** Comprehend and compare a research article with are view article or asurvey-based article **CO 3:** Demonstrate capacity to follow research articles **CO 4:** Identify concepts of physics referred in research articles **CO 5:** Extract important results of research findings **CO 6:** Report research findings in written and verbal forms
7	Course Description	Research-based learning (RBL) aims to promote and develop student competencies related to research practice and to benefit students through activities linked to research. This technique implies the application of learning and teaching strategies that link research with teaching

8.	Outline syllabus				CO Mapping
	Unit 1	Introduction to various research problems			CO1,CO6
	Unit 2	Identify a research question			CO2,CO6
	Unit 3	Literature survey			CO3,CO6
	Unit 4	Report writing			CO4,CO6
	Unit 5	Presentation			CO5 ,CO6
	Mode of examination	Continuous Assessment (CA): 25 Marks Viva-Voce (on the basis of weekly Viva performance): 25 Marks ETE: 50 marks (Quiz for 15 marks; Lab Work for 15 Marks; Viva for 10Marks and Lab record for 10 marks)			
	Weightage	CA	CE	ESE	

	Distribution	25%	25%	50%	
	Text books	10 Recent International Journal Articles of repute.			

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	-	1	-	-	1	-	1	-	1	1	-	-	1
CO2	-	1	-	-	1	-	1	-	1	1	-	-	1
CO3	-	1	-	-	1	-	1	-	1	1	-	-	1
CO4	-	1	-	-	1	-	1	-	-	1	-	-	1
CO5	-	1	-	-	1	-	-	-	-	1	-	-	1
CO6	-	1	-	-	1	-	-	-	-	-	-	-	1
Avg	-	1	-	-	1	-	1	-	1	1	-	-	1

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

Course code: CCU108 Course Title: Community Connect

School: SBSR		Batch: 2023-2027
Programme: B.Sc.		Current Academic Year: 2025-26
Branch: Microbiology		**Semester 06**
1	Course Code	CCU108
2	Course Title	Community Connect
3	Credits	2
4	Contact Hours (L-T-P)	0-0-4 Contact Hours: 15 Project/Field Work: 10 Assessment: 00 Guided Study: 05 Total hours: 30
5	Course Status	Multidisciplinary
6	Course Objective	1. **Contribute to the holistic development of students** by making them more aware of socially and economically disadvantaged communities and their specific issues 2. **Provide more richer context to classrooms**, so as to make them more effectivelaboratories oflearning by aligning them to social realities beyond textbooks 3. **Provide scope to faculty members to align their teaching and researchgoals** by giving them ample opportunity to carry out community -oriented projects 4. **Ensure that the community connect Programmes provides benefits to communities** in tangible ways so that they may feel perceptibly better off post the interaction and involvement of the Sharda academic community **5. Provide ample opportunity for Sharda University academic community to contribute** effectively to society and nation building
7	Course Outcomes	The student upon the completion of the course will be able to: **CO1:** Students learn to be sensitive to the living challenges of disadvantaged communities. **CO2:** Students learn to appreciate societal realities beyond textbooks and classrooms **CO3:** Students learn to apply their knowledge via research, and training for community benefit **CO4:** Students learn to work on socio-economic projects with teamwork and timely delivery **CO5:** Students learn to engage with communities for meaningful contribution to society
8	Course Description	To connect with the community and able to understand the prevailing issues in the society.
9	**Theme**	**Major themes for research:** 1. ***Survey and self-learning***: In this mode, students will make survey, analyze data and will extract results out of it to correlate with their theoretical knowledge. E.g. Crops and animals, land holding, labour problems, medical problems of animals and humans, savage and sanitation situation, waste management etc.

		2. ***Survey and solution providing***: In this mode, students will identify the common problems and will provide solution/ educate rural population. E.g. air and water pollution, need of after treatment, use of renewable (mainly solar) energy, electricity saving devices, inefficiencies in cropping system, animal husbandry,poultry, pest control, irrigation, machining in agriculture etc. 3. ***Survey and reporting***: In this mode students will educate villagers and survey the ground level status of various government Schemes meant for rural development.The analyzed results will be reported to concerned agencies which will help themfor taking necessary/corrective measures. E.g. Pradhan Mantri Jan Dhan Yojana,Pradhan Mantri MUDRA Yojana, Pradhan Mantri Jeevan Jyoti Bima Yojana, Atal pension Yojana, Pradhan Mantri Awas Yojana, Pradhan Mantri FasalBima Yojana, Swachh Bharat Abhiyan, Soil Health Card Scheme, Digital India, Skill India Programme,BetiBachao, BetiPadhao Yojana, DeenDayal Upadhyaya Gram Jyoti Yojana, Shyama Prasad Mukherjee Rurban Mission, UJWAL DiscomAssurance Yojana, PAHAL,Pradhan Mantri Awas Yojana-Gramin, Pradhan Mantri Yuva Yojana, Pradhan Mantri Jan Aushadhi Yojana, Pradhan Mantri KhanijKshetra Kalyan Yojana, Pradhan Mantri Suraksha Bima Yojana, UDAN Scheme, DeenDayal Upadhyaya Grameen Kaushalya Yojana, Pradhan Mantri Sukanya Samriddhi Yojana, Sansad Adarsh Gram Yojana, Pradhan Mantri SurakshitMatritva Abhiyan, Pradhan Mantri RojgarProtsahan Yojana, Midday Meal Scheme, Pradhan Mantri Vaya Vandana Yojana, Pradhan Mantri Matritva ndana Yojana, and Ayushman Bharat Yojana.	
9.1	**Guidelines for Faculty Members**	It will be a group assignment. There should be not more than 10 students in each group. The faculty guide will guide the students and approve the project title and help thestudent in preparing the questionnaire and final report. The questionnaire should be well design and it should carry at least 20 questions(Including demographic questions). The faculty will guide the student to prepare the PPT. The topic of the research should be related to social, economical or environmental issues concerning the common man. The report should contain 2,500 to 3,000 words and relevant charts, tables and photographs. **Plagiarism check of the report must**. ETE will conduct out of 100, divided in three parts (i) 30 Marks for report (ii) 30 Marksfor presentation (iii) 40 Marks for knowledge. The student should **submit the report** to CCC-Coordinator signed by the faculty guide by …… The students have to send the hard copy of the **report and PPT**, and then only theywillbe allowed for ETE.	
9.2	**Role of CCC-Coordinator**	The CCC Coordinator will supervise the whole process and assign students to faculty members.	
9.3	**Layout of theReport**	Abstract (250 words) a. Introduction b. Literature review(optional) c. Objective of the research d. Research Methodology e. Finding and discussion f. Conclusion and recommendation g. References Note: Research report should base on primary data.	

9.4	**Layout of theReport**	Abstract (250 words) h. Introduction i. Literature review(optional) j. Objective of the research k. Research Methodology l. Finding and discussion m. Conclusion and recommendation n. References Note: Research report should base on primary data.	
9.5	**Guideline for Report Writing**	**Title Page: The following elements must be included:** • Title of the article; • Name(s) and initial(s) of author(s), preferably with first names spelled out; • Affiliation(s) of author(s); • Name of the faculty guide and Co-guide **Abstract:** Each article is to be preceded by a succinct abstract, of up to 250 words, thathighlights the objectives, methods, results, and conclusions of the paper. **Text: Manuscripts should be submitted in Word.** • Use a normal, plain font (e.g., 12-point Times Roman) for text. • Use italics for emphasis. • *Use the automatic page numbering function to number the pages.* • *Save your file in docx format* (Word 2007 or higher) or doc format (olderWordversions) **Reference list:** The list of references should only include works that are cited in the text and that havebeen published or accepted for publication. The entries in the list should be in alphabetical order.Journal article	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	-	2	1	2	2	2	1	1	1	2
CO2	1	2	2	-	2	1	2	2	2	1	1	1	2
CO3	1	2	2	-	3	1	2	2	2	2	1	2	2
CO4	1	2	3	-	3	1	2	2	2	1	1	2	2
CO5	1	2	3	-	3	1	2	2	2	1	1	2	2
Avg	1.00	2.00	2.40	-	2.60	1.00	2.00	2.00	2.00	1.20	1.00	1.60	2.00

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

School: SBSR		Batch: 2023-2027
Programme: B.Sc.		Current Academic Year: 2025-26
Branch: Microbiology		Semester 06
1	Course Code	CHE111
2	Course Title	Chemistry II
3	Credits	3
4	Contact hours (L-T-P)	3-0-0
5	Course Status	OE
6	Course Objective	The objectives of the course are to 1.To provide basic knowledge of quantum mechanics. 2. To learn MO theory in the perspective of quantum chemistry. 3.To understand Hartree-Fock theory of quantum chemical calculations. 4.To teach the concept of ab initio theory in quantum chemistry calculations. 5.To introduce the implementation of DFT to solve quantum mechanical problems. 6.To provide knowledge of various electronic structure theory to solve problems theoretically.
7	Course Outcomes	The students at the completion of the course will be able to: CO1: Develop the knowledge of quantum mechanics in the context of chemical systems. CO2: Master fundamental concept of MO theory of quantum chemistry. CO3: Understand the essential features of Hartree Fock theory. CO4: Apply the concepts of ab initio theory in computational chemistry. CO5: Able to understand the role of DFT to solve quantum mechanical problems. CO6: Develop deep knowledge and application of electronic structure theory to solve quantum mechanical problems.
8	Course Description:	The goal of this course is to provide basic concepts of Quantum Chemistry and its applications in the field of Chemical Sciences. This course will review the various theories/approximations necessary to understand most popular framework of Theoretical and Computational Chemistry and its applications.
9	**Outline of syllabus**	

	Units	**Topics**	**COs**
	I	**Quantum Mechanics** Introduction of Quantum mechanics, Schrodinger equation, Position and momentum, MO formation, Operators, Hamiltonian operator, Quantum oscillator, Oscillator Eigen value problems, Quantum numbers, Labelling of atomic electrons.	**CO1, CO6**
	II	**Huckels MO theory** Huckel's MO theory, approximate and exact solution of Schrodinger equation, exception values of energy.	**CO2, CO6**

		Computational techniques: Introduction to molecular descriptors, Curve fitting			
	III	**SCF theory and Hartree-Fock equation** Self consistent field theory, Elements of secular matrix, Vibrational calculations, Semi empirical methods, Slater determinants, Hartree equation, Fock equation.			**CO3, CO6**
	IV	**Ab initio theory** Ab-initio calculations, Gaussian implementations, Koopman's theorem,			**CO4, CO6**
	V	**Density Functional Theory** Concept of Density Functional Theory and its applications, DFT for larger molecules. Computer aided assignments/mini projects with softwares.			**CO5, CO6**
		Mode of examination	Theory		
		Weightage Distribution	CA+MSE	ESE	
			25%	75%	
		Text Book/s *	Suggested Readings: 1. Quantum Chemistry, I.N. Levine, Tata McGraw Hill Pub. Co. Ltd., New Delhi. 2. Alberty,R A, Physical Chemistry,4 th edition, Wiley Eastern Ltd ,2001. 3. Atkins,P W,the elements of physical chemistry,Oxford ,1991 4. Barrow,G .M,International student Edition .McGraw Hill, McGraw-Hill,1973.		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	-	-	1	-	-	-	1	-	-	1	-	-	-
CO2	-	-	1	-	-	-	1	-	-	1	-	-	-
CO3	-	-	1	-	-	-	1	-	-	1	-	-	-
CO4	-	-	1	1	-	-	1	-	-	1	-	-	-
CO5	-	-	1	1	-	-	1	-	-	1	-	-	-
CO6	-	-	1	-	-	-	1	-	-	1	-	-	-
Avg	-	-	1	1	-	-	1	-	-	1	-	-	-

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

SEMESTER VII

B.Sc. (Hons.) Microbiology

Course Code: BMB401 Course Title: ABC of Mycology and Phycology

School: SBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2026-27	
Branch: Microbiology		Semester: 07	
1	Course Code	BMB401	
2	Course Title	ABC of Mycology and Phycology	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	CC	
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	The students at the completion of the course will be able to: CO1: Identify the structure and properties of fungi CO2: Compare between life cycles of selected fungi. CO3: Articulate the general characteristics of algae CO4: Illustrate the life cycles of different algal species CO5: Evaluate the role of fungi and algae in economy CO6: Design and invent an overall idea of fungal and algal species, their lifestages and their economic importance	
7	Course Description	The course gives an insight into the morphology and physiology ofselected 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+MSE	ESE	
		25%	75%	
	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	Introduction To Mycology, Author: Chelin Rani Gnanam		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	-	-	-	1	1	1	-	2	1	1	2	2
CO2	2	-	-	-	1	1	1	-	2	1	2	2	2
CO3	2	-	-	-	1	1	1	-	2	1	2	3	2
CO4	2	-	-	-	1	1	1	-	2	1	2	2	2
CO5	2	-	1	-	1	1	2	-	2	1	3	3	2
CO6	2	-	1	-	1	1	2	1	2	1	3	3	2
Avg	1.83	-	1.00	-	1.00	1.00	1.33	1.00	2.00	1.00	2.17	2.50	2.00

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

School: SBSR		Batch: 2023-2027	
Programme: B.Sc.		Current Academic Year: 2026-27	
Branch: Microbiology		Semester: 07	
1	Course Code	BBI401	
2	Course Title	Biostatistics, Bioethics and IPR	
3	Credits	4-0-0	
4	Contact Hours (L-T-P)	4	
5	Course Status	CC	
6	Course Objective	To understand the concepts of statistics and able to utilize it on the experimental biological data.	
7.	Course Outcomes	The students at the completion of the course will be able to: CO1**:** Understand the basic concepts of Statistics. CO2**:** Understand the concept of probability and its application. CO3**:** Correlation and regression. CO4**:** Understanding of IPR. CO5: To understand the bioethics in biology. CO6: Create and evaluate the biostatistics data for biological application	
8	Course Description	Indepth understanding of statistics as well as to know the basics of bioethics and IPR.	
9	Outline Syllabus		CO Mapping
	Unit 1	**Introduction**	
	A	Introduction to Biostatistics	CO1, CO6
	B	Frequency distribution: Measures of central tendency: Mean, Median, Mode, standard deviation.	
	C	Measures of dispersion: Skewness & Kurtosis	
	Unit 2	**Basic Stats**	
	A	Probability: definition of probability and binomial distribution (numerical)	CO2, CO6
	B	Sample, Population, large sample, small sample. Null hypothesis, alternative hypothesis, sampling, essence of sampling, types of sampling, difference.	
	C	Correlation: Definition, Karl Pearson's coefficient of correlation, Simple Regression,	
	Unit 3	**Hypothesis and Error**	
	A	Concept of Test of Hypothesis.	CO3, CO6
	B	Applications of t-test statistics to biological problems/data: Chi square, statistic applications in Biology	
	C	Error-I type, Error-II type, Standard error of	

		mean.	
	Unit 4	**IPR**	
	A	The concept of intellectual property, Importance of IPR in biotechnology, Indian laws and treaties for IPR	CO4, CO6
	B	Patents-basic concepts, Infringement, compulsory licenses, Exploitation of the Patented Invention, Compulsory Licenses	
	C	Copyright and related rights; piracy and infringement and their remedies Definitions, Signs which serve as trademarks	
	Unit 5	**Bioethics**	CO5, CO6
	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 Biosafety Regulations.	
	C	Laws and Policies, Biosafety and Agriculture, Genetic Engineering and Health; Genetic Engineering and Food Safety, International Centre for Genetic Engineering and Biotechnology (ICGEB).	
	Mode of examination	Theory	
	Weightage Distribution	CA+MSE: 25% / ESE: 75%	
	Text book/s*	• Pharmaceutical Statistics- Practical and Clinical Applications by Sanford Bolton, Marcel Dekker Inc. New York. • Design and Analysis of Experiments by R. Pannerselvam, PHI Learning Private Limited. • Design and Analysis of Experiments by Douglas and C. Montgomery, Wiley Students Edition.	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	1	2	2	1	1	1	1	2
CO2	1	2	2	2	1	1	2	1	1	1	1	1	1
CO3	1	1	1	1	1	1	2	2	1	1	1	1	1
CO4	2	1	2	1	2	1	1	1	1	2	2	1	2
CO5	2	1	1	2	2	1	2	1	1	2	2	1	1
CO6	1	3	2	2	-	-	3	2	3	2	1	1	2
Avg	1.3	1.5	1.5	1.5	1.4	1	2	1.5	1.3	1.5	1.3	1	1.5

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

Course Code: BBT406 Course Title: Cell signaling and Cancer Biology

School: SBSR		Batch: 2023-2027	
Programme: B.Sc.		Current Academic Year: 2026-27	
Branch: Microbiology		Semester: 07	
1	Course Code	BBT406	
2	Course Title	Cell signaling and cancer biology	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course Status	DSE	
6	Course Objective	The objective of this course is to learn general principles of signal transduction and to learn the principles of cancer biology and identify the main cellular and molecular mechanisms underlying the initiation and progression of neoplastic growth.	
7	Course Outcomes	Course Outcomes The student will be able to understand following purposes CO1. Understand the basic principles of signal transduction mechanisms, in particular the concepts of response specificity, signal amplitude and duration, signal integration and intracellular location CO2. Students will be able to interpret cancer biology as a discipline, the technologies used in cancer research and translational research approaches. CO3. Students will articulate hypotheses, design experiments; collect scientific data related to their research area and analyze, interpret and critique the data. CO4. Students will effectively connect the scientific findings and the significance and impact of these findings, through oral presentations. CO5. Students will effectively reframe scientific findings and the significance and impact of these findings, through written works including published articles in peer-reviewed journals. CO6. Students will design and modify the ethical and professional responsibility and integrity in research as required by the National Institutes of Health.	
8	Course description	It focuses on the mechanisms that underlie fundamental processes such as cell growth, the transformation of normal cells to cancer cells, and the spread (metastasis) of cancer cells. How the disturbance in cell signaling results in initiation and progression of cancer in the body.	
9	Outline syllabus		CO Mapping
	Unit 1	**Cell signaling**	
	A	Signal Transduction and G Protein– Coupled Receptors- Signaling Molecules Can Act Locally or at a Distance. Receptors Bind Only a Single Type of Hormone or a Group of Closely Related Hormones.	CO1, CO6

	B	Protein Kinases and Phosphatases Are Employed in Many Signaling Pathways. GTP-Binding Proteins Are Frequently Used in Signal Transduction Pathways as on/Off Switches.	
	C	Intracellular "Second Messengers" Transmit Signals from Many Receptors Signal Transduction Pathways Can Amplify the Effects of Extracellular Signals	
	Unit 2	**Studying Cell-Surface Receptors and Signal Transduction Proteins**	
	A	G Protein–Coupled Receptors: Structure and Mechanism. Protein–Coupled Receptors That Regulate Ion Channels.	CO2, CO6
	B	G Protein–Coupled Receptors That Activate or Inhibit Adenylyl Cyclase	
	C	G Protein–Coupled Receptors That Trigger Elevations in Cytosolic and Mitochondrial Calcium	
	Unit 3	**Signaling Pathways That Control Gene Expression**	
	A	Receptor Serine Kinases That Activate Smads , Cytokine Receptors and the JAK/STAT Signaling Pathway.	CO3, CO6
	B	Receptor Tyrosine Kinases, The Ras/MAP Kinase Pathway, Phosphoinositide Signaling Pathways.	
	C	Signaling Pathways Controlled by Ubiquitinoylation and Protein Degradation: Wnt, Hedgehog, and NF-κB	
	Unit 4	**Cancer- Fundamentals of cancer biology**	
	A	Introduction to Cancer Biology, Modulation of cell cycle in cancer	CO4, CO6
	B	Different forms of cancers, Cancer screening and early detection, De, action using biochemical assays tumour markers molecular tools for early diagnosis of cancer	
	C	**Principles of carcinogenesis** Theory of Carcinogenesis, Chemical carcinogenesis, Principles of physical carcinogenesis, Mechanisms of radiation carcinogenesis, Nutrition and Cancer.	
	Unit 5	**Principles of molecular cell biology of cancer**	
	A	Signal targets and cancer Activation of kinases Proto oncogenes and oncogenes activity	CO5, CO6
	B	Identification of oncogenes, Retroviruses and oncogenes	
	C	Detection of oncogenes, Growth factors related to transformation, Telomerases Tumour suppressor genes. Single Nucleotide Polymorphism (SNP) in cancer. Molecular tools for identifying cancer	

		genes.		
	Mode of examination	Theory		
	Weightage Distribution	CA+MSE	ESE	
		25%	75%	
	Text book/s*	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.		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	1	-	1	1	-	-	1	-	1	2	2
CO2	2	1	1	-	1	1	-	-	1	-	1	2	2
CO3	1	1	1	-	1	1	1	-	1	1	2	2	2
CO4	1	1	1	-	2	2	-	-	2	1	1	2	2
CO5	1	1	1	-	2	2	-	-	1	2	2	2	2
CO6	1	1	1	-	2	2	1	-	2	2	2	3	2
Avg	1.17	1.00	1.00	-	1.50	1.50	1.00	-	1.33	1.50	1.50	2.17	2.00

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

Course Code: BMB403 Course Title: Study of Viruses

School: SBSR		Batch: 2023-27
Programme: B.Sc.		Current Academic Year: 2026-27
Branch: Microbiology		Semester: 07
1	Course Code	BMB403
2	Course Title	Study of Viruses
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
5	Course Status	DSE
6	Course objective	The course will give an overview on viruses families, their replication strategies and mechanisms for development of viral infectious diseases.
7	Course outcomes	The students at the completion of the course will be able to: CO1: Understand the basic concepts of Nature and Properties of Viruses CO2: Paraphrase about the Bacteriophages. CO3: Discover about Viral Transmission, Salient features of viral nucleic acids and Replication CO4: Give illustration on the Viruses and Cancer CO5: Rewrite about prevention & control of viral diseases and applications of Virology CO6: To understand the concept of virology.
8	Course Description	This course will offer deep knowledge about Viruses, its nature, properties, multiplication and its applications.

Unit	Topic	CO mapping
Unit I	**Nature and Properties of Viruses**	
A	Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroid's, virusoids, satellite viruses and Prions.	**CO1,CO6**
B	Theories of viral origin Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses	
C	Isolation, purification and cultivation of viruses. Viral taxonomy: Classification and nomenclature of different groups of viruses	
Unit II	**Bacteriophages**	
A	Diversity, classification, one step multiplication curve,	**CO2**
B	lytic and lysogenic phages (lambda phage) concept of early and late proteins	**CO2**
C	regulation of transcription in lambda phage	**CO2**
Unit III	**Viral Transmission, Salient features of viral nucleic acids and Replication**	

A	Modes of viral transmission: Persistent, non-persistent	**CO3**	
B	vertical and horizontal Salient features of viral Nucleic acid: Unusual bases (TMV, T4 phage), overlapping genes (ϕX174, Hepatitis B virus)	**CO3**	
C	Alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV) Viral multiplication and replication strategies	**CO3**	
Unit IV	**Viruses and Cancer**		
A	Introduction to oncogenic viruses	CO4, CO6	
B	Types of oncogenic DNA and RNA viruses:		
C	Concepts of oncogenes and proto-oncogenes		
Unit V	**Prevention & control of viral diseases and Applications of Virology**		
A	Antiviral compounds and their mode of action	CO5, CO6	
B	Interferon and their mode of action. General principles of viral vaccination		
C	Use of viral vectors in cloning and expression, Gene therapy and Phage display		
Mode of action	Theory		
Weightage distribution	CA+MSE: 25%	ESE: 75%	
Textbook/s*	Virology: Principles and Applications by John Carter		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	1	-	2	1	2	1	2	2	2	1	2
CO2	2	1	1	-	2	1	2	1	2	2	2	2	2
CO3	2	1	1	-	2	1	2	1	2	2	2	2	2
CO4	2	1	1	-	2	1	2	1	2	2	2	2	2
CO5	2	1	1	-	2	1	2	1	2	2	2	2	2
CO6	2	1	1	-	2	1	2	-	2	2	2	2	2
Avg	1.83	1.00	1.00	-	2.00	1.00	2.00	1.00	2.00	2.00	2.00	1.83	2.00

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

Course Code: CHE101 **Course Title: Fundamentals of Chemistry**

School: SBSR		Batch:2023-27	
Programmeme: B.Sc.		Current Academic Year:2026-27	
Branch: Microbiology			
1	Course Code	CHE101	
2	Course Title	Fundamentals of Chemistry	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course status	OE	
6	**Course Objective**	Students will gain an understanding of 1. Molecular polarity and weak chemical forces. 2. Current bonding models for simple inorganic and organic molecules in order to predict structures and important bonding parameters. 3. Periodic properties of elements. 4. The basics of organic chemistry give the most primary and utmost important knowledge and concepts of organic Chemistry, theoretical picture in multiple stages in an overall chemical reaction. 5. Reactive intermediates, transition states and states of all the bonds broken and formed, reaction mechanism. 6. Stereochemistry of simple organic molecules.	
7	**Course Outcomes**	The student will be able to CO1: explain molecular polarity and weak chemical forces CO2: describe simple bonding theories of molecules. CO3: discuss periodic properties of elements and recapitulate basics of Organic Chemistry CO4: explain mechanism of organic reactions. CO5: illustrate stereochemistry of simple organic molecules. CO6: apply the knowledge to solve simple scientific problems.	
8	**Course Description**	This course includes introduction to Indian ancient Chemistry and the contribution of Indian Chemists, describes molecular polarity, weak chemical forces, chemical bonding, periodic properties of elements, organic reaction intermediate, reaction mechanism, stereochemistry.	
9	**Outline Syllabus**		CO Mapping
	Unit 1		
	A	Introduction to Indian Ancient Chemistry and contribution of Indian Chemists. **Molecular Polarity and Weak Chemical Forces** Formal charge, Van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction, dipole moment and molecular Structure (Diatomic and polyatomic molecules), Percentage ionic character from dipole moment.	CO1
	B	Polarizing power and polarizability. Fajan's rules and consequences of polarization. Hydrogen bonding.	CO1, CO6

	C	Effects of weak chemical forces, melting and boiling points, solubility, energetics of dissolution process. Lattice energy and Born-Haber cycle, solvation energy, and solubility of ionic solids.	CO1, CO6
	Unit 2	**Simple Bonding theories of Molecules**	
	A	Atomic orbitals, Aufbau principle, multiple bonding (σ and π bond approach), valence bond theory (VBT), Concept of hybridization, hybrid orbitals and molecular geometry.	CO2, CO6
	B	Bent's rule, Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O, NH_3, PCl_5, SF_6, SF_4, ClF_3, I_3^-, ClF_2^{--}.	CO2, CO6
	C	Molecular orbital theory (MOT). Molecular orbital diagrams, bond orders of homonuclear and heteronuclear diatomic molecules and ions (N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions).	CO2, CO6
	Unit 3		
	A	**Periodic Properties of Elements** Brief discussion, factors affecting and variation trends of following properties in groups and periods. Effective nuclear charge, shielding or screening effect, Slater rules, Atomic and ionic radii, Electronegativity, Pauling's/ Allred Rochow's scales, Ionization enthalpy, Electron gain enthalpy.	CO3, CO6
	B	**Recapitulation of Basics of Organic Chemistry** Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bonding, Van der Waals interactions, inclusion compounds, Clathrates, Charge transfer complexes, hyperconjugation, Dipole moment	CO3, CO6
	C	Electronic Displacements: Inductive, electromeric, resonance, mesomeric effects and their applications	CO3 , CO6
	Unit 4		
	A	**Mechanism of Organic Reactions** Curved arrow notation, drawing electron movements with allows, half-headed and double-headed arrows, homolytic and heterolytic bond fission, Types of reagents – electrophiles and nucleophiles.	CO4
	B	Reactive intermediates – Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples).	CO4, CO6
	C	Types of organic reactions, Energy considerations.	CO4, CO6
	Unit 5		
	A	Concept of isomerism, Types of isomerism; Optical isomerism – elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro diastereomers, Newman projection and Sawhorse formulae, Fischer and flying wedge formulae, Difference between configuration and conformation.	CO5, CO6

	B	Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometric isomerism – determination of configuration of geometric isomers, E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds.	CO5, CO6
	C	Conformational isomerism – conformational analysis of ethane and n-butane; conformations of cyclohexane, axial and equatorial bonds	CO5, CO6
	Mode of examination	Theory	
	Weightage Distribution	CA+MSE: 25%	ESE: 75%
	Text Book/s *	1. Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010. 2. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 3. Graham Solomons, T.W., Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc.	
	Other References	1. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970. 2. Carey, F. A., Guiliano, R. M.Organic Chemistry, Eighth edition, McGraw Hill Education, 2012. 3. Clayden, J., Greeves, N. &Warren, S. Organic Chemistry, 2nd edition, Oxford University Press, 2012. 4. Shriver, D.D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press, 1994.	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	-	1	1	-	1	1	1	-	1	2	1	1	1
CO2	-	1	1	-	1	1	1	-	1	2	1	1	1
CO3	-	1	1	-	1	1	1	-	1	2	1	1	1
CO4	1	1	1	-	1	-	-	-	1	2	1	2	2
CO5	1	1	2	-	1	-	1	-	1	2	2	2	2
CO6	1	1	2	-	1	-	1	-	1	2	1	2	2
Avg	1.00	1.00	1.67	-	1.00	1.00	1.00	-	1.00	2.00	1.33	2.00	2.00

School: SSBSR		Batch: 2023-27	
Programme B.Sc.		Current Academic Year: 2026-27	
Branch: Microbiology		Semester: 07	
1	Course Code	FST413	
2	Course Title	Functional Food and Nutraceuticals	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	DSE	
5	Course Objective	• To understand the interrelationship between nutraceuticals and health maintenance. • Understanding the traditional system of medicine as well as the need for changing trends in the nutraceutical Functional Food Industry. • To learn the efficacy and safety of nutraceutical and functional food products. • 4. To learn the packaging and labelling strategies of remedial food.	
6	Course Outcomes	**Course outcomes:** After successful completion of this course students will be able to: CO1: Recall the basic principles and concepts of functional food and nutraceuticals. CO2: Describe and understand the properties, structure, and functions of nutraceuticals. CO3: Apply the principles of formulation and development of functional food and nutraceutical products for specific health conditions or populations CO4**:** Analyze about the different sources of functional food and nutraceuticals, there application and packaging and labelling requirements. CO5: Assess the potential risks and benefits associated with the consumption of specific functional food and nutraceutical products and Safety regulations in USA, EU and India. CO6: Understand the basic concepts of nutraceuticals and functional food and use those concepts to development of food products and Evaluate the impact of functional food and nutraceutical interventions on the overall health and well-being of individuals	
7	Course Description	This course comprises of the structure, function, properties and significance of functional and nutraceutical food. Sources and health benefits will be studied in details.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Introduction to Nutraceuticals and Functional Food**	CO1, CO6
	A	Definition, national and international status, scope & prospects of nutraceuticals and functional food.	
	B	Applied aspects of the Nutraceutical and Functional Food Science. Sources of Nutraceuticals. Relation of functional foods & Nutraceutical to foods.	
	C	Formulation considerations and challenges, new product development	
	Unit 2	**Properties and Functions of Nutraceuticals and Functional Foods**	CO2, CO6
	A	Nutraceuticals: Glucosamine, Octacosanol, Lycopene, Carnitine, Melatonin and Ornithine alpha-ketoglutarate, pro-anthocyanidins, grape products, flaxseed oil and others	
	B	Functional Foods: Sources and role of Isoprenoids, Isoflavones, Flavonoids, carotenoids, Tocotrienols, Polyunsaturated fatty acids, sphingolipids, lecithin, choline, Terpenoids	
	C	Vegetables, Cereals, milk and dairy products as Functional foods and others.	
	Unit 3	**Role of Functional Foods as Remedial Foods and Disease Prevention**	CO3, CO6

	A	Nutraceuticals bridge the gap between food and drug.	
	B	Nutraceuticals – garlic, grape, wine, tea, soy proteins and soy isoflavones, dietary fibre, omega-3 fatty acids, antioxidants and phytochemicals, single-cell proteins, and marine-derived nutraceuticals.	
	C	Nutraceutical remedies for common disorders like circulatory problems, hypo-glycemia, nephrological disorders, liver disorders, osteoporosis, gastrointestinal disorders, and cardiovascular diseases.	
	Unit 4	**Nutraceutical Sources and Packaging & Labelling Requirements for Functional Food Products**	CO4, CO6
	A	Plant secondary metabolites: Role of Plant Sterols and Phytoestrogens in Functional Foods, Phenolics in Herbal and Nutraceutical Products.	
	B	Animal metabolites: Fat-rich functional food and their applications - Functional Fats and Spreads, modified fats and oils. Functional Meat as Functional Foods, Functional Confectionery and other functional Products	
	C	Packaging and labelling requirements: Packaging and packaging materials, an overview of dietary supplements labelling, nutrition labelling requirements.	
	Unit 5	**Claims, Marketing and Regulations for Functional Food Products**	CO5, CO6
	A	Nutritional content claims, health claims and exemption from FDA requirements, Dietary supplements labelling issues, regulatory agencies views on label claims.	
	B	The market for Functional Food Products: Market scenario, Functional foods and consumers.	
	C	The role of health in food choice; Functional foods market; Regulations and laws for functional food. Regulations in USA, EU and India	
	Mode of examination	Theory/Jury/Practical/Viva	
	Weightage Distribution	CA+MSE: 25%	ESE: 75%
	Text book/s*	1. A. E. Bender, "Nutrition and Dietetic Foods", Chem. Pub. Co. New York, 2ndEdition, 2004. 2. P. S. Howe, "Basic Nutrition in Health and Disease",2ndEdition,W. B. Saunders Company, London, 2003. 3. Kramer, "Nutraceuticals in Health and Disease Prevention", Hoppe and Packer, Marcel Dekker, Inc., NY 2001.	
	Other References	1. Bao and Fenwick, "Phytochemicals in Health and Disease", Marcel Decker, Inc. NY 2004. 2. Rotimi E.Aluko. Functional Foods and Nutraceuticals. Springer.	

CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	3	1	1	-	2	-	-	-	1	1	1
CO2	3	2	3	1	1	2	3	1	-	-	2	1	1
CO3	1	2	3	1	1	-	3	2	2	2	2	1	1
CO4	2	2	3	1	1	1	3	2	1	2	1	3	2
CO5	1	2	3	1	1	2	3	2	1	2	3	2	2
CO6	3	2	3	1	1	2	3	2	1	2	2	2	2
Avg	2.17	2.00	3.00	1.00	1.00	1.75	2.83	1.80	1.25	2.00	1.83	1.67	1.50

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

SEMESTER VIII

B.Sc. (Hons.) Microbiology

Course Code: BMB411 Course Title: Fermentation Technology

School: SBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2026-27	
Branch: Microbiology		Semester: 08	
1	Course Code	BMB411	
2	Course Title	Fermentation Technology	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course Status	CC	
6	Course Objective	1. To enable students bridge the gap between theoretical concepts and practical aspects in fermentation technology. 2. To provide knowledge about the different processes being used to prepare various industrially important substances 3. To enable students to understand the bioreactor designs. 4. To provide insight of various industrial fermentation process.	
7.	Course Outcomes	After successfully completion of this course students will be able to: CO1: Understand the history of fermentation technology and growth kinetics of microorganisms. CO2: Design bioreactors to achieve desired results (i.e. specified cell concentration, production rates). CO3: Examine the mass transfer operation of various biochemical processes. CO4: Apply scale-up methods for increasing yield. CO5: Justify the use of different biochemical strategies for the production of biologicals. CO6: Provide insight of various industrial fermentation process.	
8	Course Description	This course will provide the in-depth knowledge of fermentation and its application along with discussion of bioreactors and their role at industrial level.	
9	**Outline syllabus**		**CO Mapping**
	Unit 1	**Introduction to Fermentation Process**	
	A	Microbial growth kinetics; Media for Industrial fermentation.	**CO1**
	B	Sterilization: Batch and continuous.	
	C	Heat sterilization of liquid media; Filter sterilization of liquid media and air.	
	Unit 2	**Bioreactors**	
	A	Packed bed bioreactors; Fluidized-bed bioreactors.	**CO2**
	B	Air lift bioreactors; Bubble column bioreactors.	
	C	Immobilized enzymes bioreactors.	
	Unit 3	**Bioreactor Instrumentation**	
	A	Measurement of physical and chemical parameters in bioreactors.	**CO2, CO3**
	B	Measurement of biological parameters in bioreactors.	
	C	Transport phenomenon in bioreactor.	

	Unit 4	**Bioreactor Control**		
	A	Agitation and mixing; Effect of stirring and sparging.		**CO4, CO5**
	B	Monitoring and control of dissolved oxygen, pH.		
	C	Impeller speed and temperature in stirred tank fermenter.		
	Unit 5	**Downstream Processing**		
	A	Isolation-physical and chemical techniques for cell separation and cell disruption.		**CO5, CO6**
	B	Chromatographic and electrophoretic separation.		
	C	evaporation, drying and crystallization techniques.		
	Mode of examination	Theory		
	Weightage Distribution	CA+MSE	ESE	
		25%	75%	
	Text book/s*	Doran P.M., "Bioprocess Engineering Principles", Academic Press, 2012.		
	Other References	Katoh S. and Yoshida F., "Biochemical Engineering", Wiley-VCH, 2009. McNeil B. and Harvey L., "Practical Fermentation Technology", Wiley, 2008.		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	-	1	3	2	2	1	1	3	2	2
CO2	1	2	2	-	1	2	2	2	1	2	2	2	2
CO3	2	2	2	-	2	2	2	2	2	1	2	2	2
CO4	2	2	2	-	2	1	1	2	1	1	3	3	2
CO5	2	3	2	-	2	3	2	2	1	1	3	3	2
CO6	3	3	2	-	2	3	2	2	1	1	3	3	2
Avg	1.83	2.33	2.00	-	1.67	2.33	1.83	2.00	1.17	1.17	2.67	2.50	2.00

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

Course Code: BBI411 **Course Title: Functional Genomics**

School: SBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2026-27	
Branch: Microbiology		Semester: 08	
1	Course Code	BBI411	
2	Course Title	Functional Genomics	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course Status	CC	
6	Course Objective	• To comprehend the basic principles of genomics, so that they realize its importance and use its knowledge for human benefit. • To acquire knowledge of techniques and strategies involved in understanding a genome.	
7	Course Outcomes	Course Outcomes The student will be able to understand following purposes CO1: Comprehend the basic concept of Genome and its importance. CO2: Choose the right of sequencing method. CO3: Differentiate between different sequencing methods and the degree of enhancement in techniques with application of bioinformatics. CO4: Relate the differences between different Genome structure. CO5: Apply the techniques of locating unidentified genes in a sequence and their organization. CO6: Discuss different application of Genomics in different field of study	
8	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.	
9	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	Monopartite genome, multipartite genome, split genes, overlapping genes.		
	C	C value Paradox, viral genome, Yeast and Drosophila		
	Unit 4	**Functional genomics**		CO4, CO6
	A	Gene prediction methods, function prediction, Annotation, Functional, genomics, its tools and methodologies.		
	B	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+MSE	ESE	
		25%	75%	
	Text book/s*	Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition. 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		

CO-PO/PSO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	1	2	2	2	2	2	1	1	3	1	2
CO2	2	2	1	3	2	2	2	2	2	2	3	3	2
CO3	2	2	1	2	2	2	2	2	2	2	3	2	2
CO4	2	2	3	3	2	2	2	2	1	1	2	3	2
CO5	3	2	3	3	3	2	2	2	1	1	1	3	2
CO6	3	2	1	1	3	2	2	2	1	1	3	3	2
Avg	2.17	2.00	1.67	2.33	2.33	2.00	2.00	2.00	1.33	1.33	2.50	2.50	2.00

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

School: SBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2026-27	
Branch: Microbiology		Semester: 08	
1	Course Code	BMB412	
2	Course Title	Introduction to Recombinant DNA Technology	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course Status	CC	
6	Course Objective	1. To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences. 2. To train students in strategizing research methodologies employing genetic engineering techniques.	
7	Course Outcomes	After successfully completion of this course students will be able to: CO1: Recognize the ability of restriction endonucleases and other modification enzymes for genetic engineering. CO2: Apply different types of cloning and expression vectors for genetic transformation. CO3: Categorize libraries for gene isolation and use different strategies for transformation of DNA. CO4: Reframe and screen constructed libraries for differentiating between transformants and non-transformants for estimating molecular changes. CO5: Perform gene amplification using polymerase chain reaction, demonstrate DNA sequencing methods and analyse the expression of gene using RAPD, RFLP, microarray and blotting techniques. CO6: Create and formulate experiments for integrating RDT techniques for analyzing manipulations and expression.	
8	Course Description	Recombinant DNA Technology is the construction of new DNA molecules by combining at least two different DNA molecules.	
9	Outline syllabus		CO Mapping
	Unit 1	**Enzymes in r-DNA Technology**	
	A	Introduction to gene cloning, Restriction endonucleases,ligases, alkaline phosophatase	CO1, CO6
	B	Polynucleotide kinase, terminal deoxynucleotidyl transferase, S1 nuclease, DNA polymerase I Holoenzyme, DNA polymerase III, Klenow fragment	
	C	Taq DNA polymerase, RNases, ribonuclease, reverse transcriptase, poly (A) polymerase, deoxyribonuclease	
	Unit 2	**Vectors for Gene Cloning and Expression**	
	A	Essential requirements of cloning vector, Plasmids, Isolation of plasmid DNA; criteria for plasmid cloning	CO2, CO6
	B	Cloning vectors based on bacterial plasmids, bacteriophage vector for *E. Coli*, lambda replacement andinsertion vectors, M13 bacteriophage	
	C	Phagemids and cosmid vectors and their use vector for	

		plant cells-Ti Plasmid; shuttle vectors; expression vectors	
	Unit 3	**DNA Libraries**	
	A	Generation of sticky and blunt ends for cloning, Linkersand adaptors, construction of genomic library	CO3, CO6
	B	construction of cDNA libraries; probe construction and labelling	
	C	Methods for gene transfer-electroporation, gene gun, microinjection, liposome mediated, heat shock	
	Unit 4	**Screening and Selection**	
	A	Methods of selection and screening of recombinant DNA	CO4, CO6
	B	Introduction to antisense technology, Molecularmechanism of anti-sense technology	
	C	Application of anti-sensing technology; Ribozymes and their significance in cloning	
	Unit 5	**Techniques in Genetic Engineering**	
	A	Different types of blotting techniques-Southern, northern and western	CO5, CO6
	B	RAPD, RFLP, micro array	
	C	Nucleic acid sequencing (Maxam-Gilbert method and Sanger's method), Polymerase Chain Reaction and its applications	
	Mode of examination	Theory	
	Weightage Distribution	CA+MSE: 25% / ESE: 75%	
	Textbook/s*	S. B. Primrose (1994). Molecular Biotechnology (2nd Edn.), Blackwell Scientific Publishers, Oxford.	
	Other References	1. J. A. Davies and W. S. Roznikolf (1992) Milestones in Biotechnology. Classic papers on genetic Engineering, Butterworth-Helnemann,Boston. 2. S. M. Kingsman and A. J. Kingsman (1998) Genetic Engineering. An Introduction to gene analysis and exploitation in eukaryotes, BlackwellScientific Publications.Oxford. 3. Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten (2010) Molecular Biotechnology Principlesand Applications of Recombinant DNA, American Society for Microbiology.	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	2	3	3	2	2	1	1	3	3	1
CO2	2	2	2	2	3	3	2	2	1	1	3	3	1
CO3	3	2	2	2	3	3	2	2	1	1	3	3	1
CO4	3	2	2	2	3	3	2	2	1	1	3	3	1
CO5	3	3	2	2	3	3	2	2	1	1	3	3	1
CO6	3	3	2	2	3	3	2	2	1	1	3	3	1
Avg	2.67	2.33	2.00	2.00	3.00	3.00	2.00	2.00	1.00	1.00	3.00	3.00	1.00

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

School: SBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2026-27	
Branch: Microbiology		Semester: 08	
1	Course Code	BMB413	
2	Course Title	Bioreactors and downstream processing	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course Status	DSE	
6	Course Objective	1. To enable students bridge the gap between theoretical concepts and practical aspects in industrial settings. 2. To have In-depth knowledge and hands-on laboratory/industrial skills required for employment or for creation of employment in desired product processing.	
7	Course Outcomes	After successfully completion of this course students will be able to: CO1: Improve the yield of products by improving fermentation efficiency by choosing correct mode of operation and nutritional requirement of microbes involved. CO2: Design bioreactors to achieve desired results (i.e. specified cell concentration, production rates, etc.). CO3: To separate different bio-products from any mixture keeping in mind the cost involved for the production. CO4: To extract product from extracellular/intracellular compartment of cells and carry out different membrane-based strategies for differentiating between the products of varying sizes. CO5: Choose various chromatographic techniques for separating pigments, drugs, amino acids and hormones etc. and carry out finishing of product for marketability. CO6: Create experiments for integrating separation, extraction and bioanalytical techniques for problem solving.	
8	Course Description	The challenge for biochemical engineers is to design compact and clear processes to make and efficiently separate instable products, such as recombinant proteins, from dilute complex fermentation broths to the required pharmaceutical degree of purity. Therefore, the quantitative systematic design of integrated bioreactors and downstream processes i the general theme of this course and helps the students in quantitatively and systematically design an integrated industrial process.	
9	Outline syllabus		CO Mapping
	Unit 1	**Fermentation process**	
	A	Introduction to fermentation process, Microbial growth kinetics, Industrial media/nutrients	CO1, CO6
	B	Modes of operation of fermenters- batch, continuous and fed batch mode	
	C	Inoculum development and transfer into fermenter	
	Unit 2	**Bioreactor design and operations**	
	A	Definition of bioreactor, Types of bioreactor- Continuous stirred tank bioreactor (CSTR)	CO2, CO6
	B	Tower reactor, Loop reactor, Anaerobic digester	

	C	Activated sludge bioreactor, Uses of bioreactor for biotechnological applications	
	Unit 3	**Bio-separation process in Biotechnology**	
	A	Range and characteristics of Bioproducts, Need for downstream processing	CO3, CO6
	B	Nature of bio-separation, Differences between chemical separation and bio-separation	
	C	Economic importance of bio-separation, RIPP Scheme, cost cutting strategies in downstream processing	
	Unit 4	**Membrane based separations and cell disruption**	
	A	Membrane based purification, Microfiltration, Dialysis	CO4, CO6
	B	Ultrafiltration, Filtration processes, Types of filtration equipments, Floatation	
	C	Mechanical and enzymatic based methods for cell disruption	
	Unit 5	**Resolution of products and case studies**	
	A	Centrifugation- Differential and Density gradient, Molecular sieve chromatography	CO5, CO6
	B	Affinity Chromatography, Ion-exchange chromatography, High performance liquid chromatography	
	C	Production and polishing of Glutamic acid, Citric acid, Penicillin	
	Mode of examination	Theory	
	Weightage Distribution	CA+MSE: 25% / ESE: 75%	
	Textbook/s*	Bioseperations: Principles and Techniques- B. Sivasankar, Published by PHI Learning Pvt. Ltd., 2006.	
	Other References	1. Principles and Techniques of Practical Biochemistry- Keith Wilson And John Walker, Cambridge Press. 2. Bioseparation Technology- Mishra Neeraj, Publisher: CRC Press, 2008.	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	-	2	2	2	2	2	2	2	2	3
CO2	2	2	2	-	2	2	2	3	2	2	2	3	3
CO3	2	2	2	-	2	2	2	3	3	2	2	3	3
CO4	2	2	2	-	2	2	3	3	3	2	2	3	3
CO5	2	2	2	-	2	2	3	3	3	2	2	3	3
CO6	2	2	3	-	2	2	3	3	3	2	2	3	3
Avg	1.83	2.00	2.17	-	2.00	2.00	2.50	2.83	2.67	2.00	2.00	2.83	3.00

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

School: SSBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2026-27	
Branch: Microbiology		Semester: 08	
1	Course Code	FST 419	
2	Course Title	Basic Concepts of Research Design and Methodology	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	DSE	
5	Course Objective	1. To understand the various research concepts. 2. To understand the research design, hypothesis and selecting the research problem. 3. To learn the sampling procedure and data collection. 4. To learn the data interpretation, data analysis, writing research project.	
6	Course Outcomes	After successful completion of this course students will be able to: CO1: Define various research concepts. CO2: Explain research design, hypothesis and selecting the research problem CO3: Identify and discuss the concepts and procedure of sampling, data collection. CO4: Identify, explain compare and prepare the key element of a research proposal and report CO5: Evaluate the data interpretation and data analysis. CO6: Demonstrate the knowledge of research process, research design and complete research hypothesis in research methodology.	
7	**Outline syllabus**		**CO Mapping**
	Unit 1	**Basics of Research in Food Science**	CO1, CO6
	A	Exploration, Description, Explanation, Scientific method and research.	
	B	Research Designs –Experimental and Observational, Quantitative and Qualitative approaches	
	C	Conceptualization and Measurement, Variables, concepts and measurement.	
	Unit 2	**Sampling & Tools**	CO2, CO6
	A	Role of sampling in research, Types of sampling	
	B	Research Tools and Techniques, Validity and reliability	
	C	Interviewing and observational methods	
	Unit 3	**Research Process**	CO3, CO6
	A	Defining the problem, research questions, objectives, hypotheses, Review of related literature and originality in writing	
	B	Planning the research, Subjects context and ethics, Methodology, and tools	
	C	Citation formats: in biological sciences.	
	Unit 4	**Sampling Process**	CO4, CO6
	A	Exercise in sampling, Random Number Table, Exercise in designing tools and their analysis	
	B	Interview and Questionnaire method	

	C	Data collection Process: Conducting interviews, FGDs (focus on group discussion)	
	Unit 5	**Data Collection**	CO5, CO6
	A	Levels of measurement	
	B	Units of analysis, Case studies	
	C	Result Interpretation	
	Mode of examination	Theory/Jury/Practical/Viva	
	Weightage Distribution	CA+MSE	ESE
		25%	**75%**
	Text book/s*	1. Kumar, R. (2005) Research Methodology: A Step-by-Step Guide for Beginners. Sage 2. Kothari C.R. (2008) Research Methodology: Methods and Techniques 2nd Ed New Age-International Pvt Tld, New Delhi.	
	Other References	1.Kerlinger F.N. and Lee, H.B. (2000) Foundations of Behavioural Research 4th Ed. Harcour College Publishers 2. Black J.A. & Champion, D.J. (1976) Methods and Issue in Social Research. New York Wiley and Sons.	

CO-PO-PSO Mapping

CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3
CO1	3	2	2	-	1	3	1	2	3	2	1	1	1
CO2	2	2	3	-	3	3	1	2	1	2	1	2	1
CO3	2	2	3	-	2	3	-	1	1	3	1	2	1
CO4	1	1	2	-	2	3	-	2	1	2	1	1	1
CO5	1	1	2	-	2	3	-	2	1	2	1	1	1
CO6	1	1	2	-	2	3	-	3	1	3	1	1	1
Avg	1.67	1.50	2.33	0	2.00	3.00	1.00	2.00	1.33	2.33	1.00	1.33	1.00

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

SEMESTER VII

B.Sc. (Hons. with research) in Microbiology

Course Code: BMB401 Course Title: ABC of Mycology and Phycology

School: SBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2026-27	
Branch: Microbiology		Semester: 07	
1	Course Code	BMB401	
2	Course Title	ABC of Mycology and Phycology	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course Status	CC	
6	Course Objective	To prepare students with a basic understanding of fungal and algal characteristics. To help the students understand the vegetative, asexual and sexual stages of life cycles of these organisms. To impart knowledge to students about economically important organisms To explain the role of the organisms in the ecosystem.	
7	Course Outcomes	The students at the completion of the course will be able to: CO1: Identify the structure and properties of fungi CO2: Compare between life cycles of selected fungi. CO3: Articulate the general characteristics of algae CO4: Illustrate the life cycles of different algal species CO5: Evaluate the role of fungi and algae in economy CO6: Design and invent an overall idea of fungal and algal species, their lifestages and their economic importance	
8	Course Description	The course gives an insight into the morphology and physiology ofselected 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.	
9	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+MSE	ESE	
		25%	75%	
	Text book/s*	3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition. 4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.		
	Other References	Introduction To Mycology, Author: Chelin Rani Gnanam		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	-	-	-	1	1	1	-	2	1	1	2	2
CO2	2	-	-	-	1	1	1	-	2	1	2	2	2
CO3	2	-	-	-	1	1	1	-	2	1	2	3	2
CO4	2	-	-	-	1	1	1	-	2	1	2	2	2
CO5	2	-	1	-	1	1	2	-	2	1	3	3	2
CO6	2	-	1	-	1	1	2	1	2	1	3	3	2
Avg	1.83	-	1.00	-	1.00	1.00	1.33	1.00	2.00	1.00	2.17	2.50	2.00

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

School: SBSR		Batch: 2023-2027	
Programme: B.Sc.		Current Academic Year: 2026-27	
Branch: Microbiology		Semester: 07	
1	Course Code	BBI401	
2	Course Title	Biostatistics, Bioethics and IPR	
3	Credits	4-0-0	
4	Contact Hours (L-T-P)	4	
	Course Status	CC	
5	Course Objective	To understand the concepts of statistics and able to utilize it on the experimental biological data.	
6	Course Outcomes	The students at the completion of the course will be able to: CO1**:** Understand the basic concepts of Statistics. CO2**:** Understand the concept of probability and its application. CO3**:** Correlation and regression. CO4**:** Understanding of IPR. CO5: To understand the bioethics in biology. CO6: Create and evaluate the biostatistics data for biological application	
7.	Course Description	Indepth understanding of statistics as well as to know the basics of bioethics and IPR.	
7	Outline Syllabus		CO Mapping
	Unit 1	**Introduction**	
	A	Introduction to Biostatistics	CO1, CO6
	B	Frequency distribution: Measures of central tendency: Mean, Median, Mode, standard deviation.	
	C	Measures of dispersion: Skewness & Kurtosis	
	Unit 2	**Basic Stats**	
	A	Probability: definition of probability and binomial distribution (numerical)	CO2, CO6
	B	Sample, Population, large sample, small sample. Null hypothesis, alternative hypothesis, sampling, essence of sampling, types of sampling, difference.	
	C	Correlation: Definition, Karl Pearson's coefficient of correlation, Simple Regression,	
	Unit 3	**Hypothesis and Error**	
	A	Concept of Test of Hypothesis.	CO3, CO6
	B	Applications of t-test statistics to biological problems/data: Chi square, statistic applications in Biology	
	C	Error-I type, Error-II type, Standard error of	

		mean.	
	Unit 4	**IPR**	
	A	The concept of intellectual property, Importance of IPR in biotechnology, Indian laws and treaties for IPR	CO4, CO6
	B	Patents-basic concepts, Infringement, compulsory licenses, Exploitation of the Patented Invention, Compulsory Licenses	
	C	Copyright and related rights; piracy and infringement and their remedies Definitions, Signs which serve as trademarks	
	Unit 5	**Bioethics**	CO5, CO6
	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 Biosafety Regulations.	
	C	Laws and Policies, Biosafety and Agriculture, Genetic Engineering and Health; Genetic Engineering and Food Safety, International Centre for Genetic Engineering and Biotechnology (ICGEB).	
	Mode of examination	Theory	
	Weightage Distribution	CA+MSE: 25% / ESE: 75%	
	Text book/s*	• Pharmaceutical Statistics- Practical and Clinical Applications by Sanford Bolton, Marcel Dekker Inc. New York. • Design and Analysis of Experiments by R. Pannerselvam, PHI Learning Private Limited. • Design and Analysis of Experiments by Douglas and C. Montgomery, Wiley Students Edition.	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	1	2	2	1	1	1	1	2
CO2	1	2	2	2	1	1	2	1	1	1	1	1	1
CO3	1	1	1	1	1	1	2	2	1	1	1	1	1
CO4	2	1	2	1	2	1	1	1	1	2	2	1	2
CO5	2	1	1	2	2	1	2	1	1	2	2	1	1
CO6	1	3	2	2	-	-	3	2	3	2	1	1	2
Avg	1.3	1.5	1.5	1.5	1.4	1	2	1.5	1.3	1.5	1.3	1	1.5

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

School: SBSR		Batch: 2023-2027	
Programme: B.Sc.		Current Academic Year: 2026-27	
Branch: Microbiology		Semester: 07	
1	Course Code	BBT406	
2	Course Title	Cell signaling and cancer biology	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	CC	
5	Course Objective	The objective of this course is to learn general principles of signal transduction and to learn the principles of cancer biology and identify the main cellular and molecular mechanisms underlying the initiation and progression of neoplastic growth.	
6	Course Outcomes	The students at the completion of the course will be able to: CO1. Understand the basic principles of signal transduction mechanisms, in particular the concepts of response specificity, signal amplitude and duration, signal integration and intracellular location CO2. Students will be able to interpret cancer biology as a discipline, the technologies used in cancer research and translational research approaches. CO3. Students will articulate hypotheses, design experiments; collect scientific data related to their research area and analyze, interpret and critique the data. CO4. Students will effectively connect the scientific findings and the significance and impact of these findings, through oral presentations. CO5. Students will effectively reframe scientific findings and the significance and impact of these findings, through written works including published articles in peer-reviewed journals. CO6. Students will design and modify the ethical and professional responsibility and integrity in research as required by the National Institutes of Health.	
7.	Course description	It focuses on the mechanisms that underlie fundamental processes such as cell growth, the transformation of normal cells to cancer cells, and the spread (metastasis) of cancer cells. How the disturbance in cell signaling results in initiation and progression of cancer in the body.	
8.	Outline syllabus		CO Mapping
	Unit 1	**Cell signaling**	
	A	Signal Transduction and G Protein– Coupled Receptors- Signaling Molecules Can Act Locally or at a Distance. Receptors Bind Only a Single Type of Hormone or a Group of Closely Related Hormones.	CO1, CO6

	B	Protein Kinases and Phosphatases Are Employed in Many Signaling Pathways. GTP-Binding Proteins Are Frequently Used in Signal Transduction Pathways as on/Off Switches.	
	C	Intracellular "Second Messengers" Transmit Signals from Many Receptors Signal Transduction Pathways Can Amplify the Effects of Extracellular Signals	
	Unit 2	**Studying Cell-Surface Receptors and Signal Transduction Proteins**	
	A	G Protein–Coupled Receptors: Structure and Mechanism. Protein–Coupled Receptors That Regulate Ion Channels.	CO2, CO6
	B	G Protein–Coupled Receptors That Activate or Inhibit Adenylyl Cyclase	
	C	G Protein–Coupled Receptors That Trigger Elevations in Cytosolic and Mitochondrial Calcium	
	Unit 3	**Signaling Pathways That Control Gene Expression**	
	A	Receptor Serine Kinases That Activate Smads , Cytokine Receptors and the JAK/STAT Signaling Pathway.	CO3, CO6
	B	Receptor Tyrosine Kinases, The Ras/MAP Kinase Pathway, Phosphoinositide Signaling Pathways.	
	C	Signaling Pathways Controlled by Ubiquitinoylation and Protein Degradation: Wnt, Hedgehog, and NF-κB	
	Unit 4	**Cancer- Fundamentals of cancer biology**	
	A	Introduction to Cancer Biology, Modulation of cell cycle in cancer	CO4, CO6
	B	Different forms of cancers, Cancer screening and early detection, De, action using biochemical assays tumour markers molecular tools for early diagnosis of cancer	
	C	**Principles of carcinogenesis** Theory of Carcinogenesis, Chemical carcinogenesis, Principles of physical carcinogenesis, Mechanisms of radiation carcinogenesis, Nutrition and Cancer.	
	Unit 5	**Principles of molecular cell biology of cancer**	
	A	Signal targets and cancer Activation of kinases Proto oncogenes and oncogenes activity	CO5, CO6
	B	Identification of oncogenes, Retroviruses and oncogenes	
	C	Detection of oncogenes, Growth factors related to transformation, Telomerases Tumour suppressor genes. Single Nucleotide Polymorphism (SNP) in cancer. Molecular tools for identifying cancer	

		genes.		
	Mode of examination	Theory		
	Weightage Distribution	CA+MSE	ESE	
		25%	75%	
	Text book/s*	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.		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	1	-	1	1	-	-	1	-	1	2	2
CO2	2	1	1	-	1	1	-	-	1	-	1	2	2
CO3	1	1	1	-	1	1	1	-	1	1	2	2	2
CO4	1	1	1	-	2	2	-	-	2	1	1	2	2
CO5	1	1	1	-	2	2	-	-	1	2	2	2	2
CO6	1	1	1	-	2	2	1	-	2	2	2	3	2
Avg	1.17	1.00	1.00	-	1.50	1.50	1.00	-	1.33	1.50	1.50	2.17	2.00

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

Course Code: BMB403 Course Title: Study of Viruses

School: SBSR		Batch: 2023-27
Programme: B.Sc.		Current Academic Year: 2026-27
Branch: Microbiology		Semester: 07
1	Course Code	BMB403
2	Course Title	Study of Viruses
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
5	Course Status	CC
6	Course objective	The course will give an overview on viruses families, their replication strategies and mechanisms for development of viral infectious diseases.
7	Course outcomes	The students at the completion of the course will be able to: CO1: Understand the basic concepts of Nature and Properties of Viruses CO2: Paraphrase about the Bacteriophages. CO3: Discover about Viral Transmission, Salient features of viral nucleic acids and Replication CO4: Give illustration on the Viruses and Cancer CO5: Rewrite about prevention & control of viral diseases and applications of Virology CO6: To understand the concept of virology.
8	Course Description	This course will offer deep knowledge about Viruses, its nature, properties, multiplication and its applications.

Unit	Topic	CO mapping
Unit I	**Nature and Properties of Viruses**	
A	Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroid's, virusoids, satellite viruses and Prions.	**CO1,CO6**
B	Theories of viral origin Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses	
C	Isolation, purification and cultivation of viruses. Viral taxonomy: Classification and nomenclature of different groups of viruses	
Unit II	**Bacteriophages**	
A	Diversity, classification, one step multiplication curve,	**CO2**
B	lytic and lysogenic phages (lambda phage) concept of early and late proteins	**CO2**
C	regulation of transcription in lambda phage	**CO2**
Unit III	**Viral Transmission, Salient features of viral nucleic acids and Replication**	

A	Modes of viral transmission: Persistent, non-persistent	**CO3**	
B	vertical and horizontal Salient features of viral Nucleic acid: Unusual bases (TMV, T4 phage), overlapping genes (ϕX174, Hepatitis B virus)	**CO3**	
C	Alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV) Viral multiplication and replication strategies	**CO3**	
Unit IV	**Viruses and Cancer**		
A	Introduction to oncogenic viruses	CO4, CO6	
B	Types of oncogenic DNA and RNA viruses:		
C	Concepts of oncogenes and proto-oncogenes		
Unit V	**Prevention & control of viral diseases and Applications of Virology**		
A	Antiviral compounds and their mode of action	CO5, CO6	
B	Interferon and their mode of action. General principles of viral vaccination		
C	Use of viral vectors in cloning and expression, Gene therapy and Phage display		
Mode of action	Theory		
Weightage distribution	CA+MSE: 25%	ESE: 75%	
Textbook/s*	Virology: Principles and Applications by John Carter		

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	1	-	2	1	2	1	2	2	2	1	2
CO2	2	1	1	-	2	1	2	1	2	2	2	2	2
CO3	2	1	1	-	2	1	2	1	2	2	2	2	2
CO4	2	1	1	-	2	1	2	1	2	2	2	2	2
CO5	2	1	1	-	2	1	2	1	2	2	2	2	2
CO6	2	1	1	-	2	1	2	-	2	2	2	2	2
Avg	1.83	1.00	1.00	-	2.00	1.00	2.00	1.00	2.00	2.00	2.00	1.83	2.00

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

Course Code: CHE101 **Course Title: Fundamentals of Chemistry**

School: SBSR		**Batch:**2023-27	
Programmeme: B.Sc.		**Current Academic Year:2026-27**	
Branch: Microbiology			
1	**Course Code**	CHE101	
2	**Course Title**	**Fundamentals of Chemistry**	
3	**Credits**	4	
4	**Contact Hours (L-T-P)**	4-0-0	
5	**Course Type**	OE	
6	**Course Objective**	Students will gain an understanding of 7. Molecular polarity and weak chemical forces. 8. Current bonding models for simple inorganic and organic molecules in order to predict structures and important bonding parameters. 9. Periodic properties of elements. 10. The basics of organic chemistry give the most primary and utmost important knowledge and concepts of organic Chemistry, theoretical picture in multiple stages in an overall chemical reaction. 11. Reactive intermediates, transition states and states of all the bonds broken and formed, reaction mechanism. 12. Stereochemistry of simple organic molecules.	
7	**Course Outcomes**	The student will be able to CO1: explain molecular polarity and weak chemical forces CO2: describe simple bonding theories of molecules. CO3: discuss periodic properties of elements and recapitulate basics of Organic Chemistry CO4: explain mechanism of organic reactions. CO5: illustrate stereochemistry of simple organic molecules. CO6: apply the knowledge to solve simple scientific problems.	
8	**Course Description**	This course includes introduction to Indian ancient Chemistry and the contribution of Indian Chemists, describes molecular polarity, weak chemical forces, chemical bonding, periodic properties of elements, organic reaction intermediate, reaction mechanism, stereochemistry.	
9	**Outline Syllabus**		CO Mapping
	Unit 1		
	A	Introduction to Indian Ancient Chemistry and contribution of Indian Chemists. **Molecular Polarity and Weak Chemical Forces** Formal charge, Van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction, dipole moment and molecular Structure (Diatomic and polyatomic molecules), Percentage ionic character from dipole moment.	CO1
	B	Polarizing power and polarizability. Fajan's rules and consequences of polarization. Hydrogen bonding.	CO1, CO6

	C	Effects of weak chemical forces, melting and boiling points, solubility, energetics of dissolution process. Lattice energy and Born-Haber cycle, solvation energy, and solubility of ionic solids.	CO1, CO6
	Unit 2	**Simple Bonding theories of Molecules**	
	A	Atomic orbitals, Aufbau principle, multiple bonding (σ and π bond approach), valence bond theory (VBT), Concept of hybridization, hybrid orbitals and molecular geometry.	CO2, CO6
	B	Bent's rule, Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O, NH_3, PCl_5, SF_6, SF_4, ClF_3, I_3^-, ClF_2^{--}.	CO2, CO6
	C	Molecular orbital theory (MOT). Molecular orbital diagrams, bond orders of homonuclear and heteronuclear diatomic molecules and ions (N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions).	CO2, CO6
	Unit 3		
	A	**Periodic Properties of Elements** Brief discussion, factors affecting and variation trends of following properties in groups and periods. Effective nuclear charge, shielding or screening effect, Slater rules, Atomic and ionic radii, Electronegativity, Pauling's/ Allred Rochow's scales, Ionization enthalpy, Electron gain enthalpy.	CO3, CO6
	B	**Recapitulation of Basics of Organic Chemistry** Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bonding, Van der Waals interactions, inclusion compounds, Clathrates, Charge transfer complexes, hyperconjugation, Dipole moment	CO3, CO6
	C	Electronic Displacements: Inductive, electromeric, resonance, mesomeric effects and their applications	CO3 , CO6
	Unit 4		
	A	**Mechanism of Organic Reactions** Curved arrow notation, drawing electron movements with allows, half-headed and double-headed arrows, homolytic and heterolytic bond fission, Types of reagents – electrophiles and nucleophiles.	CO4
	B	Reactive intermediates – Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples).	CO4, CO6
	C	Types of organic reactions, Energy considerations.	CO4, CO6
	Unit 5		
	A	Concept of isomerism, Types of isomerism; Optical isomerism – elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro diastereomers, Newman projection and Sawhorse formulae, Fischer and flying wedge formulae, Difference between configuration and conformation.	CO5, CO6

	B	Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometric isomerism – determination of configuration of geometric isomers, E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds.	CO5, CO6
	C	Conformational isomerism – conformational analysis of ethane and n-butane; conformations of cyclohexane, axial and equatorial bonds	CO5, CO6
	Mode of examination	Theory	
	Weightage Distribution	CA+MSE: 25%	ESE: 75%
	Text Book/s *	1. Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010. 2. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 3. Graham Solomons, T.W., Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc.	
	Other References	1. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970. 2. Carey, F. A., Guiliano, R. M.Organic Chemistry, Eighth edition, McGraw Hill Education, 2012. 3. Clayden, J., Greeves, N. &Warren, S. Organic Chemistry, 2nd edition, Oxford University Press, 2012. 4. Shriver, D.D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press, 1994.	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	-	1	1	-	1	1	1	-	1	2	1	1	1
CO2	-	1	1	-	1	1	1	-	1	2	1	1	1
CO3	-	1	1	-	1	1	1	-	1	2	1	1	1
CO4	1	1	1	-	1	-	-	-	1	2	1	2	2
CO5	1	1	2	-	1	-	1	-	1	2	2	2	2
CO6	1	1	2	-	1	-	1	-	1	2	1	2	2
Avg	1.00	1.00	1.67	-	1.00	1.00	1.00	-	1.00	2.00	1.33	2.00	2.00

SEMESTER VIII

B.Sc. (Hons. with research) in Microbiology

School: SBSR		Batch: 2023-27	
Programme: B.Sc.		Current Academic Year: 2026-27	
Branch: Microbiology		Semester: 08	
1	Course Code	BMB413	
2	Course Title	Bioreactors and downstream processing	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
5	Course Status	CC	
6	Course Objective	1. To enable students bridge the gap between theoretical concepts and practical aspects in industrial settings. 2. To have In-depth knowledge and hands-on laboratory/industrial skills required for employment or for creation of employment in desired product processing.	
7	Course Outcomes	After successfully completion of this course students will be able to: CO1: Improve the yield of products by improving fermentation efficiency by choosing correct mode of operation and nutritional requirement of microbes involved. CO2: Design bioreactors to achieve desired results (i.e. specified cell concentration, production rates, etc.). CO3: To separate different bio-products from any mixture keeping in mind the cost involved for the production. CO4: To extract product from extracellular/intracellular compartment of cells and carry out different membrane-based strategies for differentiating between the products of varying sizes. CO5: Choose various chromatographic techniques for separating pigments, drugs, amino acids and hormones etc. and carry out finishing of product for marketability. CO6: Create experiments for integrating separation, extraction and bioanalytical techniques for problem solving.	
8	Course Description	The challenge for biochemical engineers is to design compact and clear processes to make and efficiently separate instable products, such as recombinant proteins, from dilute complex fermentation broths to the required pharmaceutical degree of purity. Therefore, the quantitative systematic design of integrated bioreactors and downstream processes i the general theme of this course and helps the students in quantitatively and systematically design an integrated industrial process.	
9	Outline syllabus		CO Mapping
	Unit 1	**Fermentation process**	
	A	Introduction to fermentation process, Microbial growth kinetics, Industrial media/nutrients	CO1, CO6
	B	Modes of operation of fermenters- batch, continuous and fed batch mode	
	C	Inoculum development and transfer into fermenter	
	Unit 2	**Bioreactor design and operations**	
	A	Definition of bioreactor, Types of bioreactor- Continuous stirred tank bioreactor (CSTR)	CO2, CO6
	B	Tower reactor, Loop reactor, Anaerobic digester	

	C	Activated sludge bioreactor, Uses of bioreactor for biotechnological applications	
	Unit 3	**Bio-separation process in Biotechnology**	
	A	Range and characteristics of Bioproducts, Need for downstream processing	CO3, CO6
	B	Nature of bio-separation, Differences between chemical separation and bio-separation	
	C	Economic importance of bio-separation, RIPP Scheme, cost cutting strategies in downstream processing	
	Unit 4	**Membrane based separations and cell disruption**	
	A	Membrane based purification, Microfiltration, Dialysis	CO4, CO6
	B	Ultrafiltration, Filtration processes, Types of filtration equipments, Floatation	
	C	Mechanical and enzymatic based methods for cell disruption	
	Unit 5	**Resolution of products and case studies**	
	A	Centrifugation- Differential and Density gradient, Molecular sieve chromatography	CO5, CO6
	B	Affinity Chromatography, Ion-exchange chromatography, High performance liquid chromatography	
	C	Production and polishing of Glutamic acid, Citric acid, Penicillin	
	Mode of examination	Theory	
	Weightage Distribution	CA+MSE: 25% / ESE: 75%	
	Textbook/s*	Bioseperations: Principles and Techniques- B. Sivasankar, Published by PHI Learning Pvt. Ltd., 2006.	
	Other References	3. Principles and Techniques of Practical Biochemistry- Keith Wilson And John Walker, Cambridge Press. 4. Bioseparation Technology- Mishra Neeraj, Publisher: CRC Press, 2008.	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	-	2	2	2	2	2	2	2	2	3
CO2	2	2	2	-	2	2	2	3	2	2	2	3	3
CO3	2	2	2	-	2	2	2	3	3	2	2	3	3
CO4	2	2	2	-	2	2	3	3	3	2	2	3	3
CO5	2	2	2	-	2	2	3	3	3	2	2	3	3
CO6	2	2	3	-	2	2	3	3	3	2	2	3	3
Avg	1.83	2.00	2.17	-	2.00	2.00	2.50	2.83	2.67	2.00	2.00	2.83	3.00

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