Program Structure

Program: M.Sc. (Microbiology)

Program Code: SBR0413

Batch: 2018-20

Department of Life Sciences

School of Basic Science & Research

Vision, Mission and Core Values of the University

Vision of the University

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

Mission of the University

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

Core Values

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

Vision and Mission of the School

Vision of the School

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

Mission of the School

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

Vision and Mission of Department of Life Sciences

Vision of Life Sciences Department

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

Mission of Life Sciences Department

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

Program Educational Objectives (PEO)

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

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

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

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

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

Map PEOs with Mission Statements:

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

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

Map PEOs with Department Mission Statements:

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

Program Outcomes (PO's)

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

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

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

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

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

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

Mapping of Program Outcome Vs Program Educational Objectives

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

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

M.Sc.

in

Microbiology

COURSE STRUCTURE & SYLLABI

(Academic Session 2018-19 onwards)

Department of Life Science
School of Basics Sciences and Research
SHARDA UNIVERSITY

SUMMARY SHEET

Teaching Department	**:**	Life Science
School	**:**	School of Basic Sciences and Research
Name of Course	**:**	M.Sc. in Microbiology
Duration	**:**	Two Years
Total number of Credits	**:**	86

Term I

S. No.	Subject Code	Subjects	Teaching Load			Credits
			L	T	P	
THEORY SUBJECTS						
1	MMB101	Microbial Diversity	4	0	0	4
2	MMB102	Molecular Biology	4	0	0	4
3	MMB103	Microbial Metabolism	4	0	0	4
4	MMB104	Enzymology	4	0	0	4
5	MST111	Biostatistics	2	0	0	2
PRACTICALS						
1	MMB153	Microbial Diversity Lab	0	0	3	2
2	MMB154	Microbial Metabolism Lab	0	0	3	2
3	MMB157	Molecular Biology lab	0	0	3	2
TOTAL						**24**

Term II

S. No.	Subject Code	Subjects	Teaching Load			Credits
			L	T	P	
THEORY SUBJECTS						
1	MMB106	Mycology and Phycology	4	0	0	4
2	MMB109	Virology	4	0	0	4
3	MMB108	Recombinant-DNA Technology	4	0	0	4
4	MMB107	Bacteriology	4	0	0	4
5	MSB120	Bioinformatics	2	0	0	2
PRACTICALS						
1	MMB155	Virology Lab	0	0	3	2
2	MMB156	RDT Lab	0	0	3	2
3	MMB158	Mycology and Phycology Lab	0	0	3	2
TOTAL						**24**

Term III

S. No.	Subject Code	Subjects	Teaching Load			Credits
			L	T	P	
THEORY SUBJECTS						
1	MMB201	Environmental Microbiology & Waste Management	4	0	0	4
2	MMB202	Infection, Immunity and Diagnostics	4	0	0	4
3	MMB206	Microbial Genomics	4	0	0	4
4	MSB203	Intellectual Property Rights and Ethical Issues (GE)	4	0	0	4
PRACTICALS						
1	MMB256	Environmental Microbiology Lab	0	0	3	2
2	MMB255	Immunology lab	0	0	3	2
3	MMB252	Dissertation Part I	0	0	4	4
TOTAL						**24**

Term IV

S. No.	Subject Code	Subjects	Teaching Load			Credits
			L	T	P	
1	MMB253	Dissertation Part II	0	0	6	6
2	MMB204	Food Microbiology (DSE)	4	0	0	4
3	MMB205	Fermentation Technology	4	0	0	4
TOTAL						**14**

MMB101: Microbial Diversity

L-T-P: 4-0-0 **Credit – 4**

School: SBSR		**Batch: 2018-20**	
Program: M.Sc.		**Current Academic Year: 2018-19**	
Branch: Microbiology		**Semester: 01**	
1	Course Code	**MMB101**	
2	Course Title	**Microbial Diversity**	
3	Credits	4	
4	Contact Hrs (L-T-P)	4-0-0	
	Course Status	**Compulsory**/Elective/Open Elective	
5	Course Objective	1. Diversity of Microbial World 2. Classification system of microorganisms 3. General characteristic features of archaea, eubacteria, algae and fungi 4. Mode of reproduction of eubacteria, algae and fungi	
6	Course Outcomes	After studying this course, students will be able to CO1: Determine general characteristics of acellular and cellular microorganisms, classification system as well as difference between prokaryotes and eukaryotes CO2: Summarize the diversity, characteristic features and significance of archaea CO3: Describe the diversity, characteristic features and significance of eubacteria CO4: Determine the general characteristics, cellular structure as well as potential applications of algae CO5: Analyze the general characteristics, mode of reproduction as well as mode of reproduction in fungi CO6: Compare the characteristic features, mode of reproduction and significance of various microbial living systems	
7	Course Description	The course comprises of general and characteristic features of diverse microbial living systems such as acellular and cellular microbes, archaebacteria, eubacteria, algae and fungi.	
8	Outline syllabus		CO Mapping
	Unit 1	**Diversity of Microbial World and Microbial Classification**	
	a	General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and cellular microorganisms (Bacteria, Algae, Fungi and Protozoa)	CO1, CO6
	b	Systems of classification. Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility	CO1, CO6
	c	Difference between prokaryotic and eukaryotic microorganisms	CO1, CO6
	Unit 2	**Archaea**	
	a	Occurrence, diversity	CO2, CO6
	b	Characteristic features, significance	CO2, CO6
	c	Potential applications of different groups of archaebacteria (e.g. methane generation, ultrafiltration membranes, desulphurization of coal and crude oil, bioleaching of metals, enzymes, compatible solutes and others)	CO2, CO6
	Unit 3	**Bacteria**	
	a	Occurrence, diversity, characteristic features	CO3, CO6
	b	Significance and potential applications of various groups of bacteria	CO3, CO6
	c	Very precise account of typical eubacteria	CO3, CO6

	Unit 4	**Algae**			
	a	General characteristics of algae including occurrence, thallus organization			CO4, CO6
	b	algae cell ultra-structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction			CO4, CO6
	c	potential applications (e.g. Importance of algae in production of algal pigments, biofuels, hydrogen production, important bioactive molecules, role of algae in sustainable environment)			CO4, CO6
	Unit 5	**Fungi**			
	a	General characteristics of fungi including habitat, distribution, nutritional requirements,			CO5, CO6
	b	fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis			CO5, CO6
	c	asexual reproduction and sexual reproduction. Potential applications of different groups of fungi			CO5, CO6
	Mode of examination	**Theory**			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	1. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.			
	Other References	1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T. Brown Publishers. 2. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press. 3. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4th edition. John and Sons, Inc.			

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

MMB102: Molecular Biology

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

School: SBSR		**Batch: 2018-20**	
Program: M.Sc.		**Current Academic Year: 2018-19**	
Branch: Microbiology		**Semester: 01**	
1	Course Code	**MMB102**	
2	Course Title	**MOLECULAR BIOLOGY**	
3	Credits	4	
4	Contact H (L-T-P)	4-0-0	
	Course Status	**Compulsory** /Elective/Open Elective	
5	Course Objective	1. Understand DNA as genetic information carrier, its evolution, structure, synthesis and packaging. 2. Describe various mechanisms involved in gene expression at transcriptional and translational levels. 3. Observe different perspectives of gene regulation for therapeutic applications.	
6	Course Outcomes	CO1: Understand DNA as genetic information carrier, its evolution, structure, synthesis and packaging. CO2: Examine RNA structure, its types and significance of the mechanisms involved in its complete synthesis. CO3: Describe key players in regulation of gene expression and post transcriptional modifications. CO4: Elaborate protein synthesis, post translational modifications and protein trafficking. CO5: Identify the roles of oncogenes and tumour suppressor genes in cancer development and thus finding the therapeutic molecular mechanisms for cancer treatment. CO6: Observe different perspectives of gene regulation in life processes at molecular level inside cell.	
7	Course Description	This course will cover the major topics in Molecular Biology, including “DNA as genetic information carrier, its evolution, structure, synthesis and packaging”, “RNA structure, its types and significance of the mechanisms involved in its complete synthesis”, “key players in regulation of gene expression and post transcriptional modifications”, “Elaborate protein synthesis, post translational modifications and protein trafficking”, “Identify the roles of oncogenes and tumour suppressor genes in cancer development and thus finding the therapeutic molecular mechanisms for cancer treatment”.	
8	Outline syllabus		CO Mapping
	Unit 1	**Nucleic Acids as Genetic Information Carrier**	CO1, CO6
	A	Experimental evidence. DNA structure: historical aspects and current concepts	
	B	Melting of DNA, Replication: general principles, various modes of replication, isolation and properties of DNA polymerases, proof reading, continuous and discontinuous synthesis, Asymmetric & dimeric nature of DNA polymerases, synthesis of leading and lagging stands	
	C	Superhelicity in DNA, linking number, topological properties, mechanism of action of topoisomerases	
	Unit 2	**Transcription**	CO2, CO6
	A	General principles, basic apparatus, types of RNA polymerases, steps: initiation, elongation and termination	
	B	Structural features of RNA (rRNA, tRNA and mRNA) and relation to function. Peptidyl transferase activity of 23S tRNA. Polycistronic and monocistronic RNAs	
	C	Control of transcription by interaction between RNA polymerases	

		and parameter regions, use of alternate sigma factors, controlled termination: attenuation and ant-termination			
	Unit 3	**Regulation of Gene Expression**			CO3, CO6
	A	Operon concept, catabolite repression instability of bacterial RNA, positive and negative regulation, inducers and co-repressors			
	B	Negative regulation - *E. coli* lac operon, positive regulation. *E. coli* ara operon; his and trp operons			
	C	Maturation and processing of RNA, methylation, cutting and trimming of rRNA; capping, polyadenylation and splicing of m RNA; cutting and modification of tRNA degradation system. Catalytic RNA group I and group II, intron splicing RNase P			
	Unit 4	**Translation**			CO4, CO6
	A	Prokaryotic and eukaryotic translation, mechanisms of initiation, elongation and termination, regulation of translation			
	B	Post-translational modifications of proteins			
	C	Protein localization, synthesis of secretory and membrane proteins, intracellular transportation of different proteins			
	Unit 5	**Oncogenes and Tumor Suppressor Genes**			CO5, CO6
	A	Homologous recombination, Holiday junction			
	B	DNA repair mechanisms			
	C	Oncogenes and Tumor suppressor genes- Viral and cellular oncogenes, tumor suppressor genes, structure, function and mechanism of tumor suppressor proteins; Role of p53 and other proteins in cancer, carcinogens and other transforming agents			
	Mode of examination	**Theory**/Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	Molecular biology of the Gene (4th Edition),J .D. Watson, N. H. Hopkins, J. W. Roberts,J.A. Steitz and A.M.			

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

MMB103: Microbial Metabolism

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

School: SBSR		**Batch: 2018-20**	
Program: M.Sc.		**Current Academic Year: 2018-19**	
Branch: Microbiology		**Semester: 01**	
1	Course Code	**MMB103**	
2	Course Title	**Microbial Metabolism**	
3	Credits	4	
4	Contact Hrs (L-T-P)	4-0-0	
	Course Status	**Compulsory** /Elective/Open Elective	
5	Course Objective	1. Metabolic pathways in microorganisms, study of bioenergetics, nature and significance of central metabolic pathways and also their regulation. 2. Central metabolic pathways as the backbone of other metabolic events in the cell, such as metabolism of nucleotide, lipids and protein. 3. Integration of all metabolic pathways. 4. Photosynthetic fixation of carbon and assimilation of some of the vital inorganic metals such as phosphorous, sulphur and nitrogen.	
6	Course Outcomes	After studying this course, students will be able to CO1: Determine standard free energy, hydrolysis of ATP and its role. Further the significance of metabolic regulation CO2: Evaluate metabolism of carbohydrates by different pathways CO3: Interpret the structure, functions and metabolism of different types of lipids CO4: Differentiate between de novo and salvage pathways for biosynthesis of purines and pyrimidines CO5: Determine photosynthetic fixation of carbon. CO6: Analyze and study various metabolic pathways in microorganisms	
7	Course Description	This course contains various metabolic pathways inside a microorganism such as metabolism of carbohydrates, lipids, nucleic acids and also carbon dioxide fixation. After studying course, students will be able to learn various metabolic processes going inside the body of microbes.	
8	Outline syllabus		CO Mapping
	Unit 1	**Energy, Enzymes and Regulation**	
	a	Energy and work, Laws of thermodynamics, Free energy and reactions	CO1, CO6
	b	Role of ATP in metabolism, Oxidation-reduction reactions and electron carrier	CO1, CO6
	c	Nature and significance of metabolic regulation, Metabolic channelling	CO1, CO6
	Unit 2	**Carbohydrate Metabolism**	
	a	Carbohydrates: Central pathways of metabolism - regulatory mechanisms, Bioenergetics and significance - EMP and alternate pathways: Entner-Doudoroff	CO2, CO6
	b	HMP and oxidative pentose phosphate, TCA cycle, Glyoxylate cycle	CO2, CO6
	c	Utilization of sugars and polysaccharides, Gluconeogenesis from TCA intermediates / amino acids / acetyl-CoA; Electron Transport Chain	CO2, CO6
	Unit 3	**Lipid Metabolism**	
	a	Lipids: fatty acids - structure, properties; classification of lipids, structure, properties, lipid composition of microorganisms	CO3, CO6

	b	Catabolism: Bioenergetics of β-oxidation of fatty acids, long chain fatty acids			CO3, CO6
	c	Anabolism: Biosynthesis of fatty acids: saturated, unsaturated, Biosynthesis of triglycerides, phospholipids, sterols			CO3, CO6
	Unit 4	**Nucleotide Biosynthesis**			
	a	Synthesis of purines, pyrimidines and nucleotides			CO4, CO6
	b	Purine biosynthesis, Pyrimidine biosynthesis			CO4, CO6
	c	Biosynthesis of nucleotide coenzymes			CO4, CO6
	Unit 5	**Use of Energy in Biosynthesis**			
	a	Photosynthetic fixation of CO_2, Carboxylation phase, Reduction phase, Regeneration phase			CO5, CO6
	b	Synthesis of sugars and polysaccharides, Assimilation of inorganic phosphorus, sulphur and nitrogen			CO5, CO6
	c	Nitrogen fixation, Synthesis of amino acids, Anaplerotic reactions			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	Nelson D.L., Cox M. M., "Principles of Biochemistry" W. H. Freeman, 2012.			
	Other References	Stryer L., "Biochemistry", W. H. Freeman, 2010. Jain JL., "Principles of Biochemistry", S. Chand Publications.			

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

MMB104: Enzymology

L-T-P: 4-0-0 Credit – 4

School: SBSR		**Batch: 2018-20**	
Program: M.Sc.		**Current Academic Year: 2018-19**	
Branch: Microbiology		**Semester: 1**	
1	Course Code	**MMB 104**	
2	Course Title	**Enzymology**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	With this Course the students 1. will acquire knowledge fundamental Knowledge of Enzymes 2. Will get useful exploitation of enzymes physical and kinetic properties 3. Use Enzymes biocatalysts in the biotransformation 4. Know the Industrial, Research and Therapeutic applications of Enzymes.	
6	Course Outcomes	After successfully completion of this course students will be able to: CO1: Define and Classify Enzymes and its fundamentals properties CO2: Examine Enzyme Kinetics, Perform and calculate enzyme specificity and activity CO3: Evaluate Enzyme Inhibition and its types, Competitive and Non-competitive inhibition and its significance CO4: Understand Allosteric Enzymes regulation, Covalent modification, Determine the role of co-enzymes, Enzyme constitution and immobilization CO5: Evaluate Applications of Enzymes in industry, Enzymes in clinical diagnostics. sensors for clinical processes and environmental, Microbial analyses, Engineered Enzymes. CO6: To analyse Enzymes principles, properties, Kinetics, Inhibition, Allosterism, Co-Enzymes, Engineered Enzymes, Application of Enzymes in various industries, research and therapeutic aspects	
7	Course Description	This course covers fundamentals to applications necessary for the useful exploitation of enzymes both as tools for the enzymatic analyses and as biocatalysts in the biotransformations on the unique structural-functional properties of enzymes and its microbial industrial and research utilization.	
8	Outline syllabus		CO Mapping
	Unit 1	**Properties of Enzymes**	CO1,6
	A	Classification of enzymes, Structural conformations of enzyme proteins	CO1,6
	B	Enzymes as biocatalysts, Catalytic power, Activation energy	CO1,6
	C	Substrate specificity, Mechanisms of enzyme action, Ribozymes and abzymes.	CO1,6
	Unit 2	**Enzyme Kinetics**	CO2,6
	A	Factors affecting rates of enzymatic reactions (pH, temperature, substrate concentration, enzyme concentration and reaction time)	CO2,6
	B	Overview of Michaelis-Menten equation and its transformation, Lineweaver-Burke plot	CO2,6
	C	Evaluation of kinetic parameters (K_M, V_{max}).	CO2,6
	Unit 3	**Enzyme Inhibition**	CO3,6
	A	Irreversible and reversible inhibition	CO3,6
	B	Competitive, non-competitive and un-competitive inhibition	CO3,6
	C	Enzyme inhibition kinetic studies, Determination of k_{cat}.	CO3,6
	Unit 4	**Regulation of Enzyme Activity**	CO4,6
	A	Allosterism, Kinetic analysis of allosteric enzymes	CO4,6

	B	Covalent modification, Feed-back inhibition, Membrane bound enzymes			CO4,6
	C	Isoenzymes and marker enzymes, Constitutive and inducible enzymes.			CO4,6
	Unit 5	**Applications of Microbial Enzymes**			CO5,6
	A	Microbial enzymes in textile, leather, wood industries and detergents			CO5,6
	B	Enzymes in clinical diagnostics and Enzyme sensors for clinical processes and environmental analyses			CO5,6
	C	Engineered enzymes, Enzymes as therapeutic agents.			CO5,6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	Palmer T., Bonner P. L., "Enzymes: Biochemistry, Biotechnology, Clinical Chemistry", Woodhead Publishing, 2007.			
	Other References	1. Copeland R. A., "Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis", Wiley, 2006. 2. Guisán J. M., "Immobilization of Enzymes and Cells (Methods in Biotechnology)", Humana Press, 2010.			

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

MST111: BIO-STATISTICS

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

School: SBSR		**Batch: 2018-20**
Program: M.Sc.		**Current Academic Year: 2018-19**
Branch: Microbiology		**Semester: 1**
1	Course Code.	MST111
2	Course Title	BIO-STATISTICS
3	Credits	2
4	Contact Hours (L-T-P)	2-0-0
	Course status	Compulsory
5	Course Objectives	To make students familiar with the concept of Probability and Statistics with emphasis on some standard probability distributions and sampling distributions.
6	Course Outcomes	CO1: Describe the concept of Statistics and statistical inference and calculate find the measures of central tendency and dispersion of a data. (K1,K2,K3) CO2: Explain the concept of probability and evaluate the probability of various events in a random experiment, theorem on probability, conditional probability. (K2,K4,K5) CO3: Discuss the concept of random variable and its distributions for evaluate relevant probabilities. (K1,K2,K5) CO4: Discuss about confidence interval and evaluate population parameters from the statistics of samples.(K1,K2,K5) CO5: Explain and evaluate statistical hypothesis using large and small samples. (K2,K4,K5)
7	Course Description	In this introductory statistics course we will explore the use of statistical methodology in designing, analyzing, interpreting, and presenting biological experiments and observations. We will cover descriptive statistics, probability, and hypothesis testing and statistical inference.
8	Outline syllabus:	
UNIT 1	**Introduction and descriptive statistics.**	CO Mapping
A	Representation of data: Frequency distribution, Measures of central tendency, mean, median, mode and mean of combined data.	CO1
B	Dispersion: mean deviation, standard deviation	CO1
C	Moments, Skewness and Kurtosis.	CO1
UNIT 2	**Probability.**	
A	Random experiment, sample space, events.	CO2
B	Mutually exclusive events, independent events, conditional probability.	CO2
C	Baye's theorem.	CO2
UNIT 3	**Random variables and its Distribution.**	
A	Random variables, expectation and variance of a random variable.	CO3
B	Binomial Distribution.	CO3
C	Normal Distribution	CO3

UNIT 4	**Sampling Distribution**			
A	Sampling distribution of sample mean (Small Sample).			CO4
B	Sampling distribution of difference of two sample means (Small Sample).			CO4
C	Sampling distribution of sample means and difference of two sample means. (large samples.).			CO4
UNIT 5	**Testing of hypothesis.**			
A	Testing of hypothesis: single population mean for small sample.			CO5
B	Testing of hypothesis: difference of two population means for small sample.			CO5
C	Testing of hypothesis: single population mean and difference of two population means for large sample.			CO5
	Mode of Examination	Theory		
	Weightage distribution	CA	MTE	ETE
		30%	20%	50%
	Text books	1. Gupta,S.C and Kapoor,V.K, "Fundamental of Mathematical Statistics".		
	Other references	1. Daniel,Wayne W.,"Biostatistics": Basic concept and Methodology for Health Science. 2. Grewal,B.S, "Higher Engineering Mathematics". 3. Probability and Statistics for Engineers and Scientists, Walpole R. E., Mayers R. H., S. I., Ye. K. 7th Edition, Pearson, 2002. 4. Statistics for Biologists, Campbell R. C., Cambridge University Press 1988. 5. The Principles of Scientific Research, Freedman P., Pergamon Press, New York.		

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

MMB153: Microbial Diversity Lab

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

School: SBSR		**Batch: 2018-20**			
Program: M.Sc.		**Current Academic Year: 2018-19**			
Branch: Microbiology		**Semester: 01**			
1	Course Code	**MMB153**			
2	Course Title	**Microbial Diversity Lab**			
3	Credits	2			
4	Contact Hours (L-T-P)	0-0-3			
	Course Status	**Compulsory/Elective**			
5	Course Objective	To learn methods of cell isolation from tissues and determine enzyme activity and inhibition of different proteins.			
6	Course Outcomes	CO1: Perform detection of protein from the given samples. CO2: Carry out an experiment for the detection of starch. CO3: Distinguish glucose from the given sample with the help of designed experiment. CO4: Design and conduct the experiment. CO5: Protein separation by chromatographic techniques. CO6: Plan and carry out the experiment.			
7	Course Description	To Plan and carry out the experiment and to learn methods of cell isolation from tissues and determine enzyme activity and inhibition of different proteins. Design and conduct the experiment.			
8	Outline syllabus				CO Mapping
	Unit 1	Isolation of individual cells from mixed culture			CO4,CO6
		Characterization based on shape and size of microbial colonies			CO3
	Unit 2	Gram Stain Technique			CO1, CO3, CO6
		Differential and Cytological Staining			CO4,CO5,CO6
	Unit 3	Acid Fast Staining			CO2,CO5,CO6
		Catalase Test			CO1,CO5,CO6
	Unit 4	Carbohydrate Fermentation Test			CO4,CO5,CO6
		Bacterial Growth Curve			CO3
	Unit 5	Methylene Blue Reductase Test			CO5,CO6
		Urease Test			CO6
	Mode of exam	Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	Textbook/s*	Practical manual of Biotechnology by Ritu Mahajan, Jitendar Sharma, RK Mahajan, Vayu Education of India			
	Other References	Practical Microbiology by DK Maheshwari, S Chand Publications.			

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

MMB157: Molecular Biology Lab

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

School: SBSR		**Batch: 2018-20**	
Program: M.Sc.		**Current Academic Year: 2018-19**	
Branch: Microbiology		**Semester - 01**	
1	Course Code	MMB152	
2	Course Title	Molecular Biology Lab	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-3	
	Course Status	Compulsory	
5	Course Objective	1. To familiarize students with sterilization techniques and solution/media preparations etc. 2. To motivate students towards molecular techniques for better genome understanding. 3. To acquaint with principles, technical requirement, scientific and commercial applications in molecular biology. 4. Design and manage techniques for understanding interplay amongst macromolecules.	
6	Course Outcomes	CO1: Demonstrate safe laboratory practices and handle the equipment safely. CO2: Estimate the quality and quantity of nucleic acids. CO3: Amalgamation of tools for plasmid vectors and DNA uptake. CO4: Perform *in silico* analysis for studying genome. CO5: To design primers and carry out amplification of DNA by PCR. CO6: Complete acquaintance with principles, technical requirement, scientific and commercial applications in molecular biology.	
7	Course Description	The aim of this course is to acquaint the students about the versatile tools and techniques employed in molecular biotechnology. The course will also provide students with a hands-on understanding of how modern DNA-sequencing technology, along with bioinformatics tools, can be used to discover genetic differences and understand molecular function.	
8	Outline syllabus		CO Mapping
	Unit 1	**Practical based on introduction to molecular biology lab**	**CO1**
	A	Good lab practices in molecular biology laboratory.	
	B & C	Preparation of standard solutions for molecular biology experiments	
	Unit 2	**Isolation of Nucleic acids and quantification**	**CO2**
	A	Isolation of DNA from bacteria	
	B	Isolation of RNA from bacteria	
	C	Gel electrophoresis	
	Unit 3	**Practical related to preparation of plasmids and transformations**	**CO3**
	A	Plasmid isolation	
	B	Preparation of competent cells	
	C	Transformation of plasmid into competent cells	
	Unit 4	**Practical related to in silico analysis of genome**	**CO4**
	A	Sequence similarity search with freely available tools	
	B	Construction of phylogenetic tree	
	C	Identification of motifs and domain in sequences	
	Unit 5	**Practical related to gene amplification**	**CO5**

	A & B	Designing of primers for CDs and partial sequences			
	C	Performing PCR reactions			
	Mode of examination	Practical and/or Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	Textbook/s	Michael, R. G., Sambrook. J., "Molecular Cloning-A Laboratory Manual", 4th edition, Cold Spring Harbor Laboratory Press, 2012.			
	Other References	1. Davis, L. (2012). Basic methods in molecular biology. Elsevier. 2. Chard, T., Work, T. S., & Work, E. (1987). Laboratory techniques in biochemistry and molecular biology. Elsevier, Amsterdam.			

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

MMB154: Microbial Metabolism Lab

L-T-P **0-0-3**

School: SBSR		**Batch: 2018-20**			
Program: M.Sc.		**Current Academic Year: 2018-19**			
Branch: Microbiology		**Semester: 01**			
1	Course Code				
2	Course Title	**Microbial Metabolism Lab**			
3	Credits	2			
4	Contact Hours (L-T-P)	0-0-3			
	Course Status	**Compulsory**			
5	Course Objective	To give students a thorough understanding of enzymes and enzyme kinetics. To make students learn the working and operation of enzymes as well as measurement of enzyme activity			
6	Course Outcomes	CO1: To understand the mode of action of salivary amylase CO2: Preparation of standard curve for calculation of enzyme activity. CO3: Assaying the activity of industrially important amylase enzyme using 3,5-Dinitrosalicylic acid method. CO4: To determine the pH optima of amylase enzyme CO5: To determine the temperature optima of amylase enzyme CO6: To understand the metabolism of microorganisms			
7	Course Description	This course is designed to make students learn about enzymes, measurement of their activity in terms of IU and katal as well as understanding the kinetics of enzymes.			
8	Outline syllabus				CO Mapping
	Unit 1	**Salivary amylase**			CO1
		Mode of action of α-amylase on starch			CO1
	Unit 2	**Calculation of Enzyme Activity**			CO2
		Preparation of standard curve			CO2
	Unit 3	**Assaying the activity of industrially important amylase**			CO3
		3’5’- Dinitrosalicylic acid method			CO3
	Unit 4	**pH optima**			CO4
		To determine the pH optima of amylase enzyme			CO4
	Unit 5	**Temperature optima**			CO5
		To determine the temperature optima of amylase enzyme			CO5
	Mode of exam	Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	Textbook/s*				
	Other References				

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

MMB106: Mycology and Phycology

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

School: SBSR		**Batch : 2018-21**	
Program: M.Sc.		**Current Academic Year: 2018-19**	
Branch: Microbiology		**Semester: Term 2**	
1	Course Code	**MMB106**	
2	Course Title	**Mycology and Phycology**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. To prepare students with a basic understanding of fungal and algal characteristics 2. To help the students understand the vegetative, asexual and sexual stages of life cycles of these organisms. 3. To impart knowledge to students about economically important organisms 4. To explain the role of the organisms in the ecosystem	
6	Course Outcomes	CO1: Identify structure and properties of fungi CO2: Distinguish between life cycles of selected fungi. CO3: Describe general characteristics of algae CO4: Compare life cycles of different algal species CO5: Discuss the role of fungi and algae in economy CO6: Develop an overall idea of fungal and algal species, their life stages and their economic importance	
7	Course Description	The course gives an insight into the morphology and physiology of selected algae and fungi, their role in the environment, agriculture, biotechnology, industry and disease. It provides a foundation for careers in microbiology, food industry, environment and biotechnology.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Mycology**	CO1, CO6
	A	Occurrence and distribution, somatic structure, Cell wall composition, hyphal growth	
	B	Nutrition, Thallus organization; heterothallism; Role of fungi in ecosystem	
	C	Saprophytic parasitic, mutualistic and symbiotic relationship with plants and animals; Classification of fungi	
	Unit 2	**Characteristics of Fungi**	CO2, CO6
	A	Characteristics, ecology, thallus organization, life cycle , reproduction with reference to *Olpidium, Rhizopus, Neurospora,*	
	B	*Peziza, Puccinia* (Physiological Specialization),	
	C	*Agaricus, Phytophthora*; Status of Slime molds	
	Unit 3	**Introduction to Phycology**	CO3, CO6
	A	Occurrence and distribution, thallus organization	
	B	Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella	
	C	Methods of reproduction; Significant contributions of important phycologists.	
	Unit 4	**Life cycle of algae**	CO4, CO6
	A	Morphology and life-cycle of *Nostoc and Chlamydomonas*	
	B	*Chara, Vaucheria, Ectocarpus*	
	C	*Fucus* and *Polysiphonia*	
	Unit 5	**Economic Importance of Algae and Fungi**	CO5, CO6

	A	Algae as food supplement; Role of cyanobacteria and selected microalgae in agriculture- biofertilizer; Production of algal pigments, biofuels and hydrogen.			
	B	Role of algae in the environment, agriculture, biotechnology and industry; Role of fungi in biotechnology			
	C	Application of fungi in food industry; Secondary metabolites; Agriculture (Biofertilizers); Mycotoxins			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition. 2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.			
	Other References	Websites as mentioned in slides			

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

MMB109: Virology

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

School: SBSR		**Batch : 2018-20**	
Program: M.Sc.		**Current Academic Year: 2018-19**	
Branch: Microbiology		**Semester: 02**	
1	Course Code	MMB109	
2	Course Title	**Virology**	
3	Credits	4	
4	Contact Hours (L-T-P)	**4-0-0**	
	Course Status	Compulsory	
5	Course Objective	1. To prepare students with a basic understanding of algal, fungal and viral characteristics 2. To help the students understand the vegetative, asexual and sexual stages of life cycles in algae and fungi as well as lytic and lysogenic mode of reproduction in virus. 3. To impart knowledge to students about different types of viruses and their applications 4. To explain the economic importance of algae and fungi in the ecosystem	
6	Course Outcomes	After successfully completion of this course students will be able to: CO1: To understand the basics of phycology, mycology and virology CO2: To understand the mechanism of reproduction in algae, fungi and viruses CO3: Describe the life cycle of Animal Viruses, Bacterial and Plant Viruses CO4: Detailed overview on Modes of diagnosis of viruses and their applications CO5: Economic Importance of Algae and fungi CO6: Detailed overview of viruses	
7	Course Description	The course gives an insight into the morphology, physiology and mode of reproduction of selected algae, fungi and viruses as well as 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	**Unit I: Introduction to virology**	CO1
	A	Occurrence and distribution, physiology, pigment systems	
	B	Introduction to Mycology: Occurrence and distribution, General characteristics, Nutrition	
	C	Introduction to Viruses: Properties of virus: morphology and ultra-structure; Classification and nomenclature of viruses; Concept of viroids, virusoids, and prions	
	Unit 2	**Reproduction in viruses**	CO2
	A	Reproduction: Reproduction and life cycle of any three representative species from the various classes of algae	
	B	Reproduction in fungi: Generalized life cycle of any three representative members from various classes of fungi	
	C	Replication strategies in viruses: Concept of early and late proteins; Mode of transmission in plants and animals; Cell to cell transmission, Persistent and non-persistent mode of transmission	
	Unit 3	**Animal Viruses, Bacterial and Plant Viruses**	CO3
	A	Animal Viruses: Lifecycle of DNA viruses (Adenoviruses, Parvoviruses); Lifecycle of RNA viruses (Paramyxo, Toga, Rota); Lifecycle of retroviruses; Oncogenic viruse, Viral vaccines.	

	B	Bacterial: Bacteriophages: lifecycle- Lytic and Lysogenic;			
	C	Plant Viruses: Lifecycle of DNA viruses (Geminivirus); Lifecycle of RNA virus (Tobacco mosaic virus).			
	Unit 4	**Modes of diagnosis of viruses and their applications**			CO4
	A	Methods of assay: Microscopy, Histopathological changes			
	B	Infectivity assay (plague method, end point method); Serology based assay; Nucleic acid-based assay.			
	C	Application of viral vectors in cloning and expression.			
	Unit 5	**Economic Importance of Algae and fungi**			CO5
	A	Algae as pollution indicators, eutrophication agent and role in bioremediation; Role of algae in global warming and environmental sustainability			
	B	Role of cyanobacteria and selected microalgae in agriculture-biofertilizer; Production of algal pigments, biofuels and hydrogen.			
	C	Economic Importance of Fungi: Mycorrhiza: ecto-, endo-, ectendo-VAM; Fungi as insect symbionts, fungi as biocontrol agents; Potential application in Agriculture, environment, industry; Role of fungi in Biodeterioration of wood, paper, textile; Myxotoxins,			
	Mode of examination	Theory/Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	1. Alexopoulos, C.J. and C.W. Mims 1979. Introduction to Mycology (3rd Ed.) Wiley Eastern Ltd N.Delhi 2. Lee, R.E. 2008. Phycology, Fourth Edition, Cambridge University Press, USA.			
	Other References	3. Kumar, H.D. 1999. Introductory Phycology. Aff. East-west Press Pvt ltd., Delhi. 4. Webster, J. and Weber, R. 2007 Introduction to Fungi. 3rd edition, Cambridge University Press, Cambridge. 5. Carter J. and Saunders V., (2007) "Virology: Principles and Applications", Wiley			

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

MMB107: Bacteriology

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

School: SBSR		**Batch: 2018-20**	
Program: M.Sc.		**Current Academic Year: 2018-19**	
Branch: Microbiology		**Semester: 02**	
1	Course Code	**MMB107**	
2	Course Title	**BACTERIOLOGY**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	**Compulsory** /Elective/Open Elective	
5	Course Objective	1. Understand the bacterial size, shape, arrangement and internal & external structures, bacterial growth under optimized conditions and its qualitative/ quantitate analysis, 2. Describe different modes of reproduction found in bacteria, genetic changes occurring in bacteria as evolutionary mechanisms, 3. Identify the applications of beneficial bacteria and control overgrowth of harmful bacteria.	
6	Course Outcomes	CO1: Identify bacteria on the basis of size, shape, arrangement and internal & external structures. CO2: Demonstrate bacterial growth under optimized conditions and analyse it on qualitative & quantitate parameters. CO3: Understand different modes of reproduction found in bacteria. CO4: Examine the different possibilities of genetic changes occurred in bacteria as evolutionary mechanisms. CO5: Analyse the application of beneficial bacteria and control overgrowth of harmful bacteria. CO6: Understand different aspects of bacterial life systems and relate these aspects with importance in live practices.	
7	Course Description	This course will cover the major topics in bacteriology, including bacterial size, shape, arrangement and internal & external structures, bacterial growth under optimized conditions and its qualitative/ quantitate analysis, different modes of reproduction found in bacteria, genetic changes occurring in bacteria as evolutionary mechanisms, the application of beneficial bacteria and control over growth of harmful bacteria.	
8	Outline syllabus		CO Mapping
	Unit 1	**Morphology and Fine structure of Bacteria**	CO1, CO6
	A	Size, shape and arrangement of bacterial cells	
	B	Structures external to the bacterial cell wall; cell wall composition of Gram Positive and Gram-Negative Bacteria	
	C	Other organelles internal to cell wall; spore and cysts.	
	Unit 2	**Growth and Nutrition of Bacteria**	CO2, CO6
	A	Normal growth cycle (growth curve) of Bacteria; Factors responsible for bacterial growth, synchronous growth; Continuous culture, Chemostat.	
	B	Quantitative measurement of bacterial growth (direct microscopic, plate count method); Method of isolating pure culture, pour plate and spread plate technique	
	C	Nutritional requirements and types of bacteria.	
	Unit 3	**Reproduction**	CO3, CO6
	A	Bacterial reproduction-asexual and sexual	
	B	Modes of cell division; Binary fission; Budding, fragmentation	
	C	Formation of conidiophores; septum formation.	
	Unit 4	**Bacterial Genetics**	CO4, CO6

	A	Phenotypic changes due to environmental Alterations; Genotypic changes; Mutation Types; Bacterial Recombination; Conjugation			
	B	Molecular mechanism of gene transfer by conjugation; Hfr strains, mapping bacterial genomes using Hfr strains; Transduction; Bacterial Transformation, Natural transformation and competence			
	C	Ti plasmid transfer system and its application in creating transgenics.			
	Unit 5	**Hypersensitivity and Autoimmunity**			CO5, CO6
	A	Microbes and Human welfare (medical, chemical and food industry)			
	B	Physical and chemical methods of control of Bacteria			
	C	Mode of action of Anti-microbial agents, factors responsible for controlling microbes, Physical and chemical agents.			
	Mode of examination	**Theory**/Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	*Pelezar*, M.J. Reid, R.D. and E.C.S. Chan, (1986*) Microbiology* - Tata Mc Graw Hill, New Delhi.			
	Other References	Mackie and McCartney (1996) Medical Microbiology, Churchill Livingstone			

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

MMB108: Recombinant DNA Technology

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

School : SBSR		**Batch : 2018-20**	
Program: M.Sc.		**Current Academic Year: 2018-19**	
Branch: Microbiology		**Semester: 02**	
1	Course Code	**MMB108**	
2	Course Title	**Recombinant DNA Technology**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	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.	
6	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 analysing manipulations and expression.	
7	Course Description	The aim of this core-course is to acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology. A sound knowledge on methodological repertoire allows students to innovatively apply these in basic and applied fields of biological research. This course provides theoretical bases to properties and applications of versatile DNA modifying enzymes, cloning strategies, vector types, host genotype specificities for selection and screening of recombinants and/or recombinant transformants. Students will also be introduced to prominent nucleic acid labeling techniques. Introduction to various types of vectors viz. cloning, transformation, expression; and also vectors for genomic and cDNA library and whole genome sequencing will be provided. A critical appraisal of methods for sequencing of cloned genomic fragments will also be covered. This course may be deemed as a platform for introduction of more advanced cutting-edge technologies that essentially are an amalgamation of basic techniques combined in diverse forms.	
8	Outline syllabus		CO Mapping
	Unit 1	**Enzymes in r-DNA Technology**	**CO1, CO6**
	A	Introduction to gene cloning, Restriction endonucleases, ligases, alkaline phosophatase	CO1
	B	Polynucleotide kinase, terminal deoxynucleotidyl transferase, S1 nuclease, DNA polymerase I Holoenzyme, DNA polymerase III, Klenow fragment	CO1
	C	Taq DNA polymerase, RNases, ribonuclease, reverse transcriptase, poly (A) polymerase, deoxyribonuclease	CO1, CO6
	Unit 2	**Vectors for Gene Cloning and Expression**	**CO2, CO6**

	A	Essential requirements of cloning vector, Plasmids, Isolation of plasmid DNA; criteria for plasmid cloning			CO2
	B	Cloning vectors based on bacterial plasmids, bacteriophage vector for *E. Coli*, lambda replacement and insertion vectors, M13 bacteriophage			CO2
	C	Phagemids and cosmid vectors and their use vector for plant cells-Ti Plasmid; shuttle vectors; expression vectors			CO2, CO6
	Unit 3	**DNA Libraries**			**CO3, CO6**
	A	Generation of sticky and blunt ends for cloning, Linkers and adaptors, construction of genomic library			CO3
	B	construction of cDNA libraries; probe construction and labelling			CO3
	C	Methods for gene transfer-electroporation, gene gun, microinjection, liposome mediated, heat shock			CO3, CO6
	Unit 4	**Screening and Selection**			**CO4**
	A	Methods of selection and screening of recombinant DNA			CO4
	B	Introduction to antisense technology, Molecular mechanism of anti-sense technology			CO4
	C	Application of anti-sensing technology; Ribozymes and their significance in cloning			CO4, CO6
	Unit 5	**Techniques in Genetic Engineering**			**CO5, CO6**
	A	Different types of blotting techniques-Southern, northern and western			CO5
	B	RAPD, RFLP, micro array			CO5
	C	Nucleic acid sequencing (Maxam-Gilbert method and Sanger's method), Polymerase Chain Reaction and its applications			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	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, Blackwell Scientific Publications.Oxford. 3. Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten (2010) Molecular Biotechnology Principles and Applications of Recombinant DNA, American Society for Microbiology.			

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

MSB120: BIOINFORMATICS

L-T-P: 4-0-0 **Credit – 4**

School: SBSR	**Batch: 2018-20**			
Program: M.Sc.	**Current Academic Year: 2018-19**			
Branch: Microbiology	**Semester: 02**			
1	Course Code			
2	Course Title	**Bioinformatics**		
3	Credits	4		
4	Contact Hours (L-T-P)	4-0-0		
5	Course Objective	To acquire an advanced knowledge of bioinformatics tools used for designing and analyzing *in silico* experiments and different techniques used for molecular modeling.		
6	Course Outcomes	After successfully completion of this course students will be able to: **CO1:** Understand about overview of bioinformatics scope and their disciplines. Generation of large-scale data in the field of molecular biology. **CO2:** Review of database source, database management system, Biological databases and their classification. Sequences databases and specialized databases. **CO3:** To attain knowledge about data storage model/format, retrieval of information and integration. **CO4:** Understanding about different sequence formats. Perform sequence alignment and phylogenetic prediction with different tools/software with algorithm. **CO5:** To apply different techniques for gene prediction, motif search and genome sequencing analysis. **CO6:** Basic knowledge of various bioinformatics concepts, scope, database usage, tools and software used for each application along with their algorithms.		
7	Outline syllabus:			CO Mapping
7.01	**Unit A**		**Introduction to Bioinformatics**	CO1, CO6
7.02	Unit A Topic 1		Scope and importance	
7.03	Unit A Topic 2		Large scale generation of molecular biology data	
7.04	Unit A Topic 3		Different fields in bioinformatics	
7.05	**Unit B**		**Biological Databases**	CO2, CO6
7.06	Unit B Topic 1		Introduction of Biological Databases	
7.07	Unit B Topic 2		Structural and Sequence database	
7.08	Unit B Topic 3		Specialized Genome databases and Structure databases	
7.09	**Unit C**		**Data Storage and retrieval**	CO3, CO6
7.10	Unit C Topic 1		Controlled vocabulary	
7.11	Unit C Topic 2		Introduction to Metadata; File Storage, File Format (FASTA, GenBank, Swiss-Prot, DDBJ and PDB)	
7.12	Unit C Topic 3		Boolean Search and Fuzzy Search	
7.13	**Unit D**		**Sequence-alignment Related Problems**	CO4, CO6

7.14	Unit D Topic 1		Sequence databases, Similarity matrices, pairwise alignment and BLAST	
7.15	Unit D Topic 2		Sequence assembly and multiple sequence alignment	
7.16	Unit D Topic 3		Clustal and phylogenetics, distance based approaches, parsimony	
7.17	**Unit E**		**Sequence pattern analysis & System-wide Analysis**	CO5, CO6
7.18	Unit E Topic 1		Structure of Prokaryotic and Eukaryotic gene, Basic and advanced sequencing (Maxam–Gilbert sequencing, Sanger sequencing, NGS, Pyrosequencing)	
7.19	Unit E Topic 2		Gene finding, composition-based finding, sequence motif-based finding	
7.20	Unit E Topic 3		Pattern Matching, Regular expression, Transcriptomics, Microarray technology and expression profiles	
8	Course Evaluation			
8.1	Course work: 30%marks			
8.11	Attendance	None		
8.12	Homework	Three best out of 4 assignments: 20 marks		
8.13	Quizzes	Two 30-minutes surprise quizzes in lecture hours: 10 marks		
8.14	Projects	None		
8.15	Presentations	None		
8.16	Any other	None		
8.2	MTE	One, 20 percent		
8.3	End-term examination: 50 percent			
9	References			
9.1	Text book	Jin X., “Essential Bioinformatics”, Cambridge University Press, 2006.		
9.2	Other References	1. Mount D.W., “Bioinformatics: Sequence and Genome Analysis”, Cold Spring Harbor Laboratory Press, 2004. 2. Baxevanis A., Ouellette F.B.F., “Bioinformatics: A practical guide to the analysis of genes and proteins”, Wiley-Interscience, 2004. 3. Bourne P.E., Gu J., “Structural Bioinformatics”, Wiley-Blackwell, 2009.		

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

MMB156: Recombinant DNA Technology Lab

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

School: SBSR		**Batch: 2018-20**	
Program: M.Sc.		**Current Academic Year: 2018-19**	
Branch: Microbiology		**Semester: 2**	
1	Course Code	**MMB156**	
2	Course Title	**Recombinant DNA Technology Lab**	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-3	
	Course Status	Compulsory	
5	Course Objective	1. To illustrate creative utility of modern tools and techniques for manipulation of genomic sequences. 2. To expose students to application of recombinant DNA technology in biotechnological research. 3. To train students in strategizing research methodologies employing genetic engineering techniques. 4. To acquaint the students for analyzing modification carried out in genomic sequences.	
6	Course Outcomes	CO1: Development of an ability to design and conduct genetic engineering experiments. CO2: Development of an ability to analyze and interpret data of modified genomic/proteomic nature. CO3: Amalgamation of tools for creating diversification in genome. CO4: Perform time course analysis of gene expression CO5: Development of research aptitude and technical skills to secure a job in genetic engineering. CO6: To isolate RNA and make cDNA	
7	Course Description	The aim of this course is to acquaint the students about versatile tools and techniques employed in genetic engineering. A sound knowledge on methodological repertoire allows students to innovatively apply these in basic and applied fields of biological research. This course provides applied part of the theory by utilizing DNA modifying enzymes, cloning strategies, vector types, host genotype specificities for selection and screening of recombinants and/or recombinant transformants. This course may be deemed as a foundation course serving as a platform for introduction of more advanced cutting-edge technologies that essentially are an amalgamation of basic techniques combined in diverse forms and sequence.	
8	Outline syllabus		CO Mapping
	Unit 1	**Practical based on introduction to genetic engineering lab**	**CO1**
	A	Aseptic conditions maintenance in laboratory	
	B & C	Conditions optimization for growth of bacterial culture for experiments	
	Unit 2	**Practical related to preparation of plasmids and transformations**	**CO2**
	A	Plasmid isolation	
	B	Preparation of competent cells	
	C	Transformation of plasmid into competent cells	

	Unit 3	**Practical related generation of cohesive and blunt ends**			**CO3**
	A & B	Restriction of plasmid with cohesive end and blunt cutters a			
	C	Analysing the generated blunt/sticky ends using electrophoresis			
	Unit 4	**Practical related to in silico analysis of genome**			**CO4**
	A	Sequence similarity search with freely available tools			
	B	Construction of phylogenetic tree			
	C	Identification of motifs and domain in sequences			
	Unit 5	**Practical related to PCR**			**CO5**
	A & B	Designing of primers for CDs and partial sequences			
	C	Performing PCR reactions			
	Mode of examination	Practical and/or Viva			
	Weightage Distribution	CA	MTE	ETE	
		60 %	0%	40%	
	Textbook/s	Michael, R. G., Sambrook. J., "Molecular Cloning-A Laboratory Manual", 4th edition, Cold Spring Harbor Laboratory Press, 2012.			
	Other References	Frederick. M., Ausubel., Brent R., Kingston. R. E., Moore D.D., Seidman J. G., John A. Smith and Kevin Struhl, "Current Protocols in Molecular Biology", John Wiley& Son, Inc., 2003.			

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

MMB155: Virology Lab

L-T-P: 0-0-3 **Credit – 2**

School: SBSR		**Batch: 2018-20**	
Program: M.Sc		**Current Academic Year: 2018-19**	
Branch: Microbiology		**Semester: 2**	
1	Course Code	**MMB155**	
2	Course Title	**Virology Lab**	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-3	
	Course Status	Compulsory	
5	Course Objective	● To train the students in microscopy of thallus structure of fungi and algae ● To develop understanding of reproductive structures of fungi and algae ● To learn about stages of cellular processes and cell cycle ● To understand economic importance of algae and fungi ● To develop knowledge of various viruses infecting plants ● To give students a thorough understanding of various techniques to detect viruses in infected plant tissues	
6	Course Outcomes	CO1: Understand the morphological characteristics of virus under microscope CO2: Recollect the methods of viral culture and extraction of bioactives CO3: Appreciate the industrial and social importance of virus CO4: Understand safety measures in Virology laboratory CO5: Understanding of various techniques to detect viruses in infected plant tissues CO6: Learn mechanical dissemination of plant viruses	
7	Course Description	The course gives an insight into the morphology and physiology of selected virus, their role in the environment, agriculture, biotechnology, industry and disease. It provides a practical foundation for careers in microbiology, food industry, environment and biotechnology. It also imparts knowledge of various viruses infecting plants and a thorough understanding of various techniques to detect viruses in infected plant tissues.	
8	Outline syllabus		CO Mapping
	Unit 1	**Experiment related to virus characteristics**	CO1
		To examine virus under the microscope	
		To compare morphological features (microscopic) of different classes of virus	
	Unit 2	**Experiment related to virus characteristics**	CO1
		To compare morphological features (microscopic) of different classes of virus	
	Unit 3	**Experiment explaining viral characteristics**	CO4
		Safety measures in virology lab Detecting virus antigens through ELISA/dot blots	
	Unit 4	**Experiment demonstrating virus infecting plants**	CO5, CO6
		Identification of various virus infected plant tissues	
		PCR to detect DNA of banana bunchy top DNA virus	
	Unit 5	**Experiment demonstrating economically important virus**	CO2, CO3
		To examine edible mushroom under the microscope	
		To inspect aquatic algae/extract economically important pigment from algae	

	Mode of examination	Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	Text book/s*	1. Lee, R.E. 2008. Phycology, Fourth Edition, Cambridge University Press, USA. 2. The Elements of Plant Virology- Basic Concepts and Practical Class Exercises by S.J. Kolte and A.K. Tewari			
	Other References	Lab manual			

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

MMB158: Mycology and Phycology Lab

L-T-P: 0-0-3 **Credit – 2**

School: SBSR		**Batch: 2018-20**	
Program: M.Sc		**Current Academic Year: 2018-19**	
Branch: Microbiology		**Semester: 2**	
1	Course Code	**MMB158**	
2	Course Title	**Mycology and Phycology Lab**	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-3	
	Course Status	Compulsory	
5	Course Objective	● To train the students in microscopy of thallus structure of fungi and algae ● To develop understanding of reproductive structures of fungi and algae ● To learn about stages of cellular processes and cell cycle ● To understand economic importance of algae and fungi ● To develop knowledge of various viruses infecting plants ● To give students a thorough understanding of various techniques to detect viruses in infected plant tissues	
6	Course Outcomes	CO1: Understand the morphological characteristics of algae and fungi under microscope CO2: Recollect the methods of algal and fungal culture and extraction of bioactives CO3: Appreciate the industrial and social importance of fungi and algae CO4: Understand safety measures in Virology laboratory CO5: Understanding of various techniques to detect viruses in infected plant tissues CO6: Learn mechanical dissemination of plant viruses	
7	Course Description	The course gives an insight into the morphology and physiology of selected algae and fungi, their role in the environment, agriculture, biotechnology, industry and disease. It provides a practical foundation for careers in microbiology, food industry, environment and biotechnology. It also imparts knowledge of various viruses infecting plants and a thorough understanding of various techniques to detect viruses in infected plant tissues.	
8	Outline syllabus		CO Mapping
	Unit 1	**Experiment related to fungal characteristics**	CO1
		To examine bread mould under the microscope	
		To compare morphological features (microscopic) of different classes of fungi	
	Unit 2	**Experiment related to algal characteristics**	CO1
		To compare morphological features (microscopic) of different classes of algae	
	Unit 3	**Experiment explaining viral characteristics**	CO4
		Safety measures in virology lab Detecting virus antigens through ELISA/dot blots	
	Unit 4	**Experiment demonstrating virus infecting plants**	CO5, CO6
		Identification of various virus infected plant tissues	
		PCR to detect DNA of banana bunchy top DNA virus	
	Unit 5	**Experiment demonstrating economically important fungi and algae**	CO2, CO3
		To examine edible mushroom under the microscope	
		To inspect aquatic algae/extract economically important pigment from algae	

	Mode of examination	Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	Text book/s*	1. Lee, R.E. 2008. Phycology, Fourth Edition, Cambridge University Press, USA. 2. The Elements of Plant Virology- Basic Concepts and Practical Class Exercises by S.J. Kolte and A.K. Tewari			
	Other References	Lab manual			

LIST OF EXPERIMENTS

1. To examine bread mould under the microscope
2. To examine edible mushroom under the microscope
3. To compare morphological features (microscopic) of different classes of fungi
4. To compare morphological features (microscopic) of different classes of algae
5. To inspect aquatic algae/extract economically important pigment from algae
6. Safety measures in virology lab
7. Identification of various virus infected plant tissues
8. Detecting virus antigens through ELISA/dot blots
9. PCR to detect DNA of banana bunchy top DNA virus

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

MMB201: Environmental Microbiology & Waste Management

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

School: SBSR		**Batch: 2018-20**
Program: M.Sc.		**Current Academic Year: 2018-19**
Branch: Microbiology		**Semester: 3**
1	Course Code	**MMB201**
2	Course Title	**Environmental Microbiology & Waste Management**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. This course provides a comprehensive introduction to microbial ecology and fundamentals of microbial diversity. 2. The course is designed to give students an up-to-date understanding of a wide array of applications of microorganisms in maintaining biogeochemical factors. 3. This course also focuses on concepts of applied environmental microbiology and how microbes can be used for various industrial/ research applications. 4. The course also highlights the modern methods of waste management and significant role of microorganisms in waste and resources management.
6	Course Outcomes	After the successful completion of this course students will be able to: CO1: Comprehend ecological interactions and role of microorganisms played in there and discuss microbial ecology concepts including methods of assessing microbial diversity and studying microbial populations. CO2: Analyze the role of microorganisms in biogeochemical cycles. CO3: Classify different methods of bioremediation and use of microorganisms and plasmids in bioremediation CO4: Explain the commercial application of microorganisms in extraction of metals, oil and in production of biogas. CO5: Identify different methods of waste management and how different microbial metabolic processes can assist in waste management. CO6: To provide a comprehensive introduction to microbial ecology and fundamentals of microbial diversity.
7	Course Description	The 'Environmental Microbiology and Waste Management' is a course designed to give students knowledge about basic concepts of environment/ ecosystem and the role microorganisms play in maintaining the ecosystem balance. This course throws light on various unconventional uses of microorganisms in various industries and environmental benefits of use of the microorganisms. This course also outlines various biological methods of waste management and application of microbes in bioremediation.
8	Outline syllabus		CO Mapping
®tr	**Unit 1**	**Microbial Ecology**	
	A	Ecological Concepts: Introduction to ecosystem; types of ecosystem; food chain and food web; biological magnification and eutrophication	CO1
	B	Microbial diversity: estimates of total number of species; Shannon and Simpsons indices of microbial diversity, Unculturable bacteria	
	C	Culture independent molecular methods for understanding microbial community- Partial and whole community analysis	
	Unit 2	**Role of Microorganisms in Environment**	

	A	Role of microbes in biogeochemical cycles: nitrogen cycle: different phases of nitrogen cycle, microbes involved in different stages of nitrogen cycle			CO2
	B	Carbon, Phosphorous and Sulphur cycle			
	C	Production of microbial bio-fertilizers, bio-pesticides, soil conditioners to enhance crop yields.			
	Unit 3	**Role of Microorganisms in Remediation**			
	A	Bioremediation- *in situ* and *ex situ* techniques			CO3
	B	Biodegradation of recalcitrant compounds-lignin, pesticides; Bioaccumulation of metal and detoxification			
	C	Degradation of xenobiotics by microorganisms; Degradative plasmids			
	Unit 4	**Role of Microorganisms in Mining and Energy Production**			
	A	Microbial technology in mining: Bioleaching; Biomining; Bio-beneficiation			CO4
	B	Recovery of oil and MEOR; Bioconversions			
	C	Microbial technology for energy production- Concept of microbial fuel cell- principle; types and applications, Use of microorganisms in the production of biogas			
	Unit 5	**Role of Microorganisms in Waste Management**			
	A	Landfill- structure and types, involvement of microbes in initial adjustment phase, transition phase, acid phase			CO5
	B	Methane formation and maturation phase of a landfill operation			
	C	Compositing- types; Design and operational consideration of microbial composting			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	**1. Environmental Science.** Ahluwalia VK, Malhotra S. Ane Books India @2006. ISBN 81-8052-023-4. **2. Environmental science.** Miller GT, SpoolMan ES. 14th Edition. Brooks/Cole @2013. ISBN 13: 978-81-315-2473-2.			
	Other References	**1. Environmental Biotechnology.** Fulekar MH. CRC Press @2014. ISBN 978-1-57808-528-8. **2. Fundamentals of Ecology.** Odum EPO and Barret W. Brooks/Cole @2005. ISBN 0534420664.			

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

MMB202: Infection, Immunity and Diagnostics

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

School: SBSR		**Batch: 2018-20**	
Program: M.Sc.		**Current Academic Year: 2018-19**	
Branch: Microbiology		**Semester: 03**	
1	Course Code	**MMB202**	
2	Course Title	**Infection, Immunity and Diagnostics**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	**Compulsory**/Elective/Open Elective	
5	Course Objective	1. Understand the infection and cells and organs of the immune system 2. Understand cell receptors and immune responses. 3. Understand the structure and function of antigens and antibodies, Ag-Ab reactions and Diagnostic Methods	
6	Course Outcomes	CO1: To understand infectious diseases, host-parasite relationship and Immunity and its types against infectious agents; To understand immune response and complement system CO2: To understand the process haematopoiesis and maturation of cells and organs of the immune system. CO3: To understand the role of various cell receptors and activation of B and T lymphocytes; cell mediated cytotoxicity and Hypersensitivity. CO4: the structure and functions of antigen and antibodies; Hybridoma technology and vaccines CO5: To understand the Antigen-Antibody Reactions and Diagnostic Methods CO6: Understand the infection and cells and organs of the immune system	
7	Course Description	The objectives for the course are to acquire a fundamental working knowledge of the basic principles of immunology; to begin to understand how these principles apply to the process of immune function; and to develop the ability to solve problems in clinical immunology by making use of existing tools and techniques	
8	Outline syllabus		CO Mapping
	Unit 1	**Infection and Immune System**	
	A	Introduction to infectious diseases, host-parasite relationship, epidemiology, Immunity to infectious agents Bacteria, inter-cellular parasites, helminthes and viruses	CO1
	B	First, second and third line of defense; Immunity-innate and acquired immunity;	CO1
	C	Cell-mediated and humoral immunity; Phagocytosis; Complement system and inflammatory responses	CO1
	Unit 2	**Cells and Organs of the Immune System**	
	A	Haematopoesis and maturation of immune cells	CO2
	B	Organ and cells of the immune system-primary and secondary lymphoid organ	CO2
	C	B-lymphocytes, T-lymphocytes, macrophages, dendritic cells, langerhan cells, Natural killer cells, eiosinophils, basophils, neutrophils and mast cells	CO2
	Unit 3	**Cell Receptors and Immune Responses**	
	A	BCR, TCR and MHC; Activation of B and T- lymphocytes; Generation of humoral cell and cell mediated immune responses	CO3
	B	Cell-mediated cytotoxicity; Antibody-dependent cell mediated cytotoxicity; Macrophage-mediated cytotoxicity;	CO3

	C	Hypersensitivity; Autoimmunity; Cytokines and their role in immune regulation.			CO3
	Unit 4	**Antigen and Antibody**			
	A	Nature, biology and types of antigens and super antigens; epitopes; adjuvants			CO4
	B	Antibody structure, types and functions; Hybridoma technology and monoclonal antibodies			CO4
	C	Vaccine and type of vaccines.			CO4
	Unit 5	**Antigen-Antibody Reactions and Diagnostic Methods**			
	A	Antigen-antibody reactions-agglutination and precipitation			CO5
	B	Immunological methods-ELISA, RIA			CO5
	C	Immunodiffusion, Immunofluorescence, complement fixation test etc.			CO5
	Mode of examination	**Theory**/Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s*	Kindt T.J., Osborne B.A. and Goldsby R.A. (2006) Kuby Immunology, W. H. Freeman			
	Other References	1. Delves P.J, Martin S.J., Burton D.R. and Roitt I.M., (2011) Roitt's Essential Immunology, Wiley			

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

MSB203: Intellectual Property Rights and ethical issues

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

Branch: Microbiology		**Semester: 3**	
1	Course Code	MSB203	
2	Course Title	**Intellectual Property Rights and ethical issues**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	To elucidate the ways of protection of intellectual property and research with the help of WIPO and its different treaties. To correlate different instruments of IP protection and their enforcement in different countries. To understand different quality management issues related to biotechnology	
6	Course Outcomes	By the end of this course students will be able to: CO1: Administer and follow the guidelines of WIPO. CO2: Understand the patents, copyrights and trademarks. CO3: Understand the character merchandising and franchising. CO4: Understand the utility of IPRs in biotechnology. CO5: To correlate different instruments of IP protection and their enforcement in different countries. CO6: To elucidate the ways of protection of intellectual property and research with the help of WIPO and its different treaties.	
7	Course Description	*Intellectual property* (IP) includes intangible creations of the human intellect, and primarily encompasses copyrights, patents, and trademarks. It also includes other types of rights, such as trade secrets, publicity rights, moral rights, and rights against unfair competition. Present paper deals with knowledge of types and protection of different IPRs.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Intellectual Property Rights**	**CO1, CO4**
	A	The concept of intellectual property, Importance of IPR in biotechnology	
	B	WIPO- history, mission and activities, structure, administration.	
	C	Major International Instruments relating to the protection of IP; Berne Convention; Paris Convention; TRIPS	
	Unit 2	**Patents**	
	A	Patents-basic concepts; Non patentable inventions	CO2, CO3, CO4
	B	Procedure for registration , Term of patent , Rights of patentee	
	C	Patent Infringement and its remedy; Compulsory licenses and Government use of patent	
	Unit 3	**Copyrights**	**CO2, CO3, CO4,**
	A	Copyright and related rights;	
	B	Copyright piracy and infringement; Remedies of copyright piracy and infringement	
	C	Copyright Issues in Digital Environment	
	Unit 4	**Trademarks**	**CO2, CO3, CO4,**
	A	Definitions, Signs which serve as trademarks,	
	B	Trademark piracy, and counterfeiting; Character Merchandising.	
	C	Geographical Indication; Difference between GI and Trade Marks	
	Unit 5	**IPR in industries**	**CO3, CO4,**

	A	IPR strategies by different industries; E-Commerce and IPR issues			
	B	Case studies of Major IPR conflicts: Zara Vs Zara fashions; Yahoo Vs Yahoo India.			
	C	Case studies of Major IPR conflicts: AMUL Vs IMUL; Paytm Vs PayPal			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Managing intellectual capital: organizational, strategic and policy dimensions Oxford Univ. press 2005 Teece, David J.			
	Other References	2. Techniques used in Bio product analysis, Butterworth Heinemann Ltd, 2017. 3. Law relating to patents, trademarks, copyright designs geographical indications. Universal Law Publishing house by Wadehra, B.L.			

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

MMB206: Microbial Genomics

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

School: SBSR		**Batch : 2018-2020**	
Program: M.Sc.		**Current Academic Year: 2018-19**	
Branch: Microbiology		**Semester: 3**	
1	Course Code	MMB206	
2	Course Title	**Microbial Genomics**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Core	
5	Course Objectives	1. To comprehend the basic principles of genomics, so that may use it for understanding microbes and apply for human benefit.. 2. To acquire knowledge of techniques and strategies involved in understanding a genome	
6	Course Outcomes	After successfully completion of this course students will be able to: CO1. Comprehend the fundamentals of genomics and relate it to prokaryotic and the eukaryotic genome components CO2. Realize the diversity ofmicrobialgenome and importance of its analysis. CO3. Identify the advantages and disadvantages of various DNA sequencing methods and choose the appropriate whole genome pipeline. CO4. Comprehend the fundamentals of functional genomics and comparative genomics and apply it to solve problems CO5. Appreciate the power of microbial genome analysis and its application in industry, agriculture and medicine for human welfare. CO6. Be familiar withthe different techniques used in genome analysis and choose rationally the appropriate methodology for solving problems.	
7	Course Description		
8	Outline syllabus		CO Mapping
	Unit 1	**Genomic Diversity**	
	A	Concept of Genome	CO1, CO6
	B	Prokaryotic and eukaryotic genomes	CO1,
	C	Organellargenomes,Types of plasmids	CO1
	Unit 2	**Microbial Genomes**	
	A	Bacterial Genome (E. coli), Viral Genome (λ phage, Influenza virus)	CO2,
	B	Fungal Genome(*Saccharomyces*), Algal genome (*Chlamydomonas*)	CO2,
	C	Genome sizes – C value paradox	CO2, CO6
	Unit 3	**Whole Genome Sequencing**	
	A	Conventional methods, Automated DNA sequencing, Pyrosequencing, New generation Sequencing	CO3 , CO6
	B	Whole genome sequencing tools and methods, Clone contig method, whole genome shotgun method	CO3, CO6
	C	Metagenomics; Molecular markers; Genome maps	CO3, CO6
	Unit 4	**Functional GenomicsandComparative Genomics**	
	A	Concept of forward and reverse genomics	CO4, CO6
	B	Investigation ofgene function byreverse genomic tools, mutagenesis	CO4, CO6
	C	Comparative Genomics, Comparison of microbial with eukaryotic genomes	CO4, CO6
	Unit 5	**Application of Genomics**	
	A	Microbial genomics and its application in industry	CO5, CO6

	B	Application of comparative genomicsinGenome evolution studies, Pharmaco-genomics			CO5, CO6
	C	Personalized medicine, designing of vaccines and drugs.			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Brown T.A., *Genomes, 3rd Edition.* Wiley-Liss (2006).			
	Other References	1. Bioinformatics and Functional genomics by Jonathan Pevsner, 2nd edition, John Wiley and Sons (2008) 2. Introduction to genomics by Arthus M. Lesk, Oxford University Press (2007)			

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

MMB255: Immunology Lab

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

School : SBSR		**Batch : 2018-20**			
Program: M.Sc.		**Current Academic Year: 2018-19**			
Branch: Microbiology		**Semester: 3rd**			
1	Course Code	**MMB255**			
2	Course Title	**Immunology Lab**			
3	Credits	2			
4	Contact Hours (L-T-P)	0-0-3			
5	Course Status	Compulsory			
6	Course Objective	1) This course understanding provides a strong foundation and can prompt a greater enthusiasm for and an improved understanding of the complete immune response. 2) The Work involving human samples is enticing to students with clinical interests, and further detailed protocols, and analysis guidance may be appropriate for introductory immune response.			
7	Course Outcomes	After successfully completion of this course students will be able to: CO1: understand basic laboratory techniques of blood groups CO2: estimate the haemoglobin of its own blood CO3: practical knowledge of antigen antibody interactions CO4: isolate lymphocytes for further deep analysis CO5: prepare suspension solutions of spleen and bone marrow CO6: understanding provides a strong foundation and can prompt a greater enthusiasm for and an improved understanding of the complete immune response.			
8	Course Description	The aim of this course is to acquaint the students about the versatile tools and techniques employed in immunology. The course will also provide students with a hands-on understanding of how immunology can be used to discover various processes used by animals and humans for their self defence mechanism.			
9	Outline syllabus				CO Mapping
	Unit 1				**CO1**
	A	To study permanent slides of immune tissues and organs			
	B	To find the blood group of own blood			
	C	To find the Rh factor of own blood group			
	Unit 2				**CO2**
	A	To estimate the amount of Hb present in human blood			
	B	To perform Rocket immunoelectrophoresis			
	C	To perform Separation of lymphocytes			
	Unit 3				**CO3**
	A	To perform Sandwich enzyme linked immunosorbant assay			
	B	To perform DoT ELISA			
	C	To perform Haemagglutination test			
	Unit 4				**CO4**
	A	To perform Ouchlerlony's double immunodiffusion method.			
	B	To perform Radial Immunodiffusion			
	C	To perform RIA			
	Unit 5				**CO5**
	A	Preparation of single cell suspension of spleen.			
	B	Preparation of single cell suspension of bone marrow.			
	C				
	Mode of examination	Practical/or Viva			
	Weightage Distribution	CA	MTE	ETE	
		60%	0%	40%	
	Text book/s*	Kindt, T. J., Goldsby, R. A., Osborne, B. A., Kuby, J. (2006). VI Edition. Immunology. W.H. Freeman and Company.			

	Other References	Delves, P. J., Martin, S. J., Burton, D. R., Roitt, I.M. (2006). XI Edition. Roitt's Essential Immunology, Blackwell Publishing	

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

MMB204: Food Microbiology

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

School : SBSR		**Batch : 2018-20**			
Program: M.Sc.		**Current Academic Year: 2018-19**			
Branch: Microbiology		**Semester: 04**			
1	Course Code	MMB204			
2	Course Title	Food Microbiology			
3	Credits	2			
4	Contact Hours (L-T-P)	2-0-0			
	Course Status	Compulsory			
5	Course Objective	The course is designed to prepare students with a basic understanding of the microbes involved in biological processes such as fermentation and spoilage. The course provides a foundation for careers in microbiology, food microbiology, or research in all branches of food sciences.			
6	Course Outcomes	After the successful completion of this course students will be able to: CO1. Recognize and describe the characteristics of important pathogens and spoilage microorganisms in foods. CO2. Understand the role and significance of intrinsic and extrinsic factors on growth and response of microorganisms in foods. CO3. Identify ways to control microorganisms in foods. CO4. Identify the conditions under which the important pathogens and spoilage microorganisms are commonly inactivated, killed or made harmless in foods. CO5. Utilize laboratory techniques to detect, quantify, and identify microorganisms in foods. CO6.Understand the role of fermentation and preservation in food science.			
7	Course Description	The 'Food Microbiology' course outlines the basic principles of Microbiology. This course also sheds light upon fermentation and is designed to make student learn the preservation of food products. The course also further encompasses the concept of identification and quantification of microorganisms in foods.			
8	Outline syllabus				CO Mapping
	Unit 1	**History development and microbes in food**			
	A	Historical developments			CO1, CO2
	B	Important of Microorganisms in food			
	C	Factors affecting growth of microbes in food			
	Unit 2	**Spoilage of Foods**			
	A	Spoilage of meat			
	B	Spoilage of Milk and milk products			
	C	Spoilage and defects of fermented food products			CO3, CO4
	Unit 3	**Biological transformation of food**			
	A	Fermentation			
	B	Production of fermented products			
	C	Importance of fermentation			CO3, CO6
	Unit 4	**Preservation of food**			
	A	General principles of food preservation			
	B	Chemical Preservation of food			CO6
	C	Preservation of food by radiation			
	Unit 5	**Food Borne Diseases**			
	A	Bacterial and nonbacterial infection			
	B	Food borne diseases: Salmonellosis, Botulism, Listeriosis			CO4,CO5, CO6
	C	Detection of Microbes in food			
	Mode of examination	Theory			
		CA	MTE	ETE	

	Weightage Distribution	30%	20%	50%	
	Textbook/s*	1. Jay, J.M. (2008) Modern Food Microbiology (Sixth Edition). Aspen Publishers, Inc. Gaithersburg, Maryland.			
	Other References	2. Adams, M. R. and Moss, M. O. (2005) Food Microbiology (Second edition). Royal Society of Chemistry Publication, Cambridge. 3. Ray, B. (2005) Fundamental food microbiology (Third edition). CRC Press, New York, Washington D.C. 4. Frazier, W. C. and West off, D. C. (2007) Food Microbiology. Tata McGraw Hill Publishing Company Ltd. New Delhi. 5. Banwart G J. (1989). Basic Food Microbiology. AVI publication.			

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

MMB205: Fermentation Technology

L-T-P: 4-0-0 Credit – 4

School: SBSR		**Batch : 2018-20**	
Program: M.Sc.		**Current Academic Year: 2018-19**	
Branch: M.Sc. Microbiology		**Semester: 4**	
1	Course Code	**MMB205**	
2	Course Title	**Fermentation Technology**	
3	Credits	4	
4	Contact Hrs (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. To enable students bridge the gap between theoretical concepts and practical aspects in 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 downstream process.	
6	Course Outcomes	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, etc). CO3: Examine the mass transfer operation of various biochemical processes. CO4: Development of industrial fermentation process. Justify the use of different biochemical strategies for the production and separation of biologicals. CO5: To provide knowledge about the different processes being used to prepare various industrially important substances CO6: To enable students bridge the gap between theoretical concepts and practical aspects in fermentation technology	
7	Course Description		
8	Outline syllabus		CO Mapping
	Unit 1		**CO1**
	A	Fermentation, basic concept, submerged and solid state fermentation	
	B	Microbial growth kinetics, Microbial nutrient requirements,	
	C	Sterilization of media, air and equipments for fermentation	
	Unit 2		
	A	Batch, Continuous and Fed batch mode of operation	**CO2, CO3**
	B	Operational design of Bioreactor- vessel, agitator, sparger, baffles, types of Bioreactors- STR, CSTR, Airlift fermenter,	
	C	Fluidized bed reactor, Packed bed reactor, Immobilized cells and enzymes bioreactor	
	Unit 3		**CO2, CO3, CO4**
	A	Measurement, monitoring and control of physical, chemical and biological parameters in a bioreactor	
	B	Transport phenomena in bioreactor	
	C	Aeration and agitation in bioreactors; pH and temperature control in bioreactor	
	Unit 4		**CO2, CO3, CO4**
	A	Cell disruption methods for intracellular products-Osmotic and heat shock, Homogenization, Sonication, Freezing thawing, Enzyme digestion.	

	B	Centrifugation: basic principles, design characteristics and applications			
	C	Membrane based separation processes,			
	Unit 5				**CO3, CO4**
	A	Chromatographic techniques			
	B	Electrophoretic separation			
	C	Evaporation, drying and crystallization techniques.			
	Mode of examination	Theory/Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Textbook/s *	1. McNeil B. and Harvey L., "Practical Fermentation Technology", Wiley, 2008.			
	Other References	2. Doran P.M., "Bioprocess Engineering Principles", Academic Press, 2012. 3. Bioseparations Principles and Techniques, B. Sivasankar. Prentice hall of India Pvt. Ltd., 2007.			

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