FACULTY OF

SCIENCE

COURSE STRUCTURE & SYLLABUS

M.SC. MICROBIOLOGY

Effective from Academic Year: 2022-23

Opp. Shastri Maidan, Beside BVM College, Vallabh Vidyanagar, Dist: Anand, Gujarat - 388120
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Faculty Name: SCIENCE

Programme Name: M.SC. MICROBIOLOGY

Programme Structure Summary

SEMESTER 1											
Course Group	Course Name	Cr	Teaching Scheme				INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
			T	P	Tu	Cont. Hrs					
CORE	Molecular Biology	4	3		1	4	50/20	50/20			100/40
CORE	Bioanalytical Techniques and Instrumentation	4	3		1	4	50/20	50/20			100/40
CORE	Cell Biology	4	3		1	4	50/20	50/20			100/40
CORE	Lab I (Molecular Biology & Bioanalytical Techniques and Instrumentation)	4		8		8			50/20	50/20	100/40
CORE	Lab II (Cell Biology & Elective course)	4		8		8			50/20	50/20	100/40
ELECTIVE (Any One)	Fundamentals of Biochemistry and Bioenergetics	4	3		1	4	50/20	50/20			100/40
	Food Microbiology	4	3		1	4	50/20	50/20			100/40
	Microbial Physiology	4	3		1	4	50/20	50/20			100/40
	Virology	4	3		1	4	50/20	50/20			100/40
Viva-voce	Comprehensive Viva	1								50/20	50/20
	Total	**25**									

SEMESTER 2											
Course Group	Course Name	Cr	Teaching Scheme				INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
			T	P	Tu	Cont. Hrs					
CORE	Fermentation Technology	4	3		1	4	50/20	50/20			100/40
CORE	Basics of Microbial Genetics	4	3		1	4	50/20	50/20			100/40
CORE	Immunology	4	3		1	4	50/20	50/20			100/40
CORE	Lab I (Fermentation Technology & Basics of Microbial Genetics)	4		8		8			50/20	50/20	100/40
CORE	Lab II (Immunology & Elective course)	4		8		8			50/20	50/20	100/40
ELECTIVE (Any One)	Biostatistics	4	3		1	4	50/20	50/20			100/40
	Microtechniques	4	3		1	4	50/20	50/20			100/40
	Omics and Computational Biology	4	3		1	4	50/20	50/20			100/40
	Medical Microbiology	4	3		1	4	50/20	50/20			100/40
Viva-voce	Comprehensive Viva	1								50/20	50/20
	Total	**25**									

Faculty Name: SCIENCE

Programme Name: M.SC. MICROBIOLOGY

SEMESTER 3											
Course Group	Course Name	Cr	Teaching Scheme				INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
			T	P	Tu	Cont. Hrs					
CORE	Microbial Biotechnology	4	3		1	4	50/20	50/20			100/40
CORE	Environmental and Agricultural Microbiology	4	3		1	4	50/20	50/20			100/40
CORE	Enzyme Kinetics and Mechanisms	4	3		1	4	50/20	50/20			100/40
CORE	Lab I (Microbial Biotechnology & Environmental and Agricultural Microbiology)	4		8		8			50/20	50/20	100/40
CORE	Lab II (Enzyme Kinetics and Mechanisms & Elective course)	4		8		8			50/20	50/20	100/40
ELECTIVE (Any One)	Bioinformatics	4	3		1	4	50/20	50/20			100/40
	Advanced Immunology	4	3		1	4	50/20	50/20			100/40
	Medical Biochemistry	4	3		1	4	50/20	50/20			100/40
	Marine Biotechnology	4	3		1	4	50/20	50/20			100/40
VIVA-VOCE	Comprehensive Viva	1								50/20	50/20
		25									

SEMESTER 4											
Course Group	Course Name	Cr	Teaching Scheme				INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
			T	P	Tu	Cont. Hrs					
CORE	Gene regulation and recombinant DNA Technology	4	3		1	4	50/20	50/20			100/40
CORE	Environmental Biotechnology	4	3		1	4	50/20	50/20			100/40
CORE	Lab I (Gene regulation and recombinant DNA Technology & Environmental Biotechnology)	4	3		1	4	50/20	50/20			100/40
VIVA-VOCE	Comprehensive Viva	1								50/20	50/20
ELECTIVE	Dissertation	12								300/120	300/120
	OR										
ELECTIVE	Developmental Biology	4	3		1	4	50/20	50/20			100/40
ELECTIVE	IPR and Biosafety	4	3		1	4	50/20	50/20			100/40
ELECTIVE	Lab II (Developmental Biology & IPR and Biosafety)	4	3		1	4	50/20	50/20			100/40

Faculty Name: SCIENCE

Programme Name: M.SC. MICROBIOLOGY

PROGRAMME OUTCOMES

PO-1	At the end of the two-year programme, the student will develop extensive knowledge in various areas of Microbiology.
PO-2	Through the stimulus of scholarly progression and intellectual development the programme aims to equip students with excellence in education and skills, thus enabling the student to pursue a career of his/her choice
PO-3	At the end of the two-year programme, the student will be able to explain about various applications of Microbiology such as Environmental Microbiology, Industrial Microbiology, Food Microbiology, and Medical Microbiology.
PO-4	He/she will be able to design and execute experiments related to Basic Microbiology, Immunology, Molecular Biology, Recombinant DNA Technology, Microbial Genetics, and Bioinformatics tools will be able to execute a short research project incorporating techniques of Basic and Advanced Microbiology under supervision.
PO-5	By cultivating talents and promoting all round personality development through multi-dimensional education a spirit of self-confidence and self-reliance will be infused in the student.
PO-6	The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.
PO-7	The student will be instilled with values of professional ethics and be made ready to contribute to society as responsible individuals.

PROGRAMME SPECIFIC OUTCOMES

PSO-1	Understand the importance of different branches of Microbiology.
PSO-2	The student will able to explain about various applications of Microbiology such as Environmental Microbiology, Industrial Microbiology, Food Microbiology and Medical Microbiology.
PSO-3	He/she will be able to design and execute experiments related to Basic Microbiology, Immunology, and Molecular Biology. Recombinant DNA Technology, Microbial Genetics, and Bioinformatics tools will be able to execute a short research project incorporating techniques of Basic and Advanced Microbiology under supervision.
PSO-4	The student will be able to get suitable opportunity in academia or industry.

Faculty Name: SCIENCE

Programme Name: M.Sc MICROBIOLOGY

Semester: 1 Academic Batch: 2022-23

Course Group	Board of Studies / Faculty Ownership	Course Code	Course Name	Cr	Teaching Scheme				Assessment /Evaluation Type		External Exam Duration (Hrs.)		INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
					T	P	Tu	Cont. Hrs	T	P	T	P					
CORE	BIOLOGICAL SCIENCES	201430101	Molecular Biology	4	3		1	4	T		2		50/20	50/20			100/40
CORE	BIOLOGICAL SCIENCES	201300111	Bioanalytical Techniques and Instrumentation	4	3		1	4	T		2		50/20	50/20			100/40
CORE	BIOLOGICAL SCIENCES	201300112	Cell Biology	4	3		1	4	T		2		50/20	50/20			100/40
CORE	BIOLOGICAL SCIENCES	201430104	Lab I (Molecular Biology & Bioanalytical Techniques and Instrumentation)	4		8		8		p		3			50/20	50/20	100/40
CORE	BIOLOGICAL SCIENCES	201300115	Lab II (Cell Biology & Elective course)	4		8		8		p		3			50/20	50/20	100/40
ELECTIVE (Any One)	BIOLOGICAL SCIENCES	201300117	Fundamentals of Biochemistry and Bioenergetics	4	3		1	4	T		2		50/20	50/20			100/40
	BIOLOGICAL SCIENCES	201300119	Food Microbiology	4	3		1	4	T		2		50/20	50/20			100/40
	BIOLOGICAL SCIENCES	201430109	Microbial Physiology	4	3		1	4	T		2		50/20	50/20			100/40
	BIOLOGICAL SCIENCES	201300120	Virology	4	3		1	4	T		2		50/20	50/20			100/40
VIVA-VOCE	BIOLOGICAL SCIENCES	201300116	Comprehensive Viva	1												50/20	50/20
			Total	**25**													

 # T = Theory, P = Practical, Tu = Tutorial

Name & Sign [Chairman - Board of Studies]: Dr. Shilpa Gupte

Name & Sign [Dean / Director]: Dr. Basudeb Bakshi

FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **I**

Course Code: **201430101**

Course Title: **MOLECULAR BIOLOGY**

Course Group: **CORE**

Course Objectives:

The objectives of this course are to make students understand how molecular machines are constructed and regulated so that they can accurately copy, repair, and interpret genomic information in prokaryotes and eukaryotic cells. Further, to appreciate the subject of molecular biology as a dynamic and ever-changing experimental science.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	DNA structure Chemistry of DNA, DNA structure, Different conformations of DNA (B, A and Z), Denaturation and Renaturation (Cot curves) of DNA. DNA topology: Supercoiling, Biology of Supercoiled DNA, DNA topoisomerases and their mechanism of action. DNA-protein interactions: General features, Sequence specific DNA binding protein motifs, ssDNA binding proteins	15

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2	Organization of genome and its replication Packaging of DNA and organization of chromosome in bacterial cells; Packaging of DNA in eukaryotic nucleosome and chromatin condensation, assembly of nucleosomes upon replication, chromatin modification. Mechanism of DNA polymerase catalyzed synthesis of DNA, Types of DNA polymerases in bacteria, Initiation of DNA replication and its regulation in prokaryotes, assembly of replisome and progress of replication fork, termination of replication. DNA replication in eukaryotes and archaea. Inhibitors of DNA replication.	**15**
3	Transcription RNA polymerases, features of prokaryotic and eukaryotic promoters, assembly of transcription initiation complex in prokaryotes and eukaryotes, and its regulation; synthesis and processing of prokaryotic and eukaryotic transcripts.	**15**
4	Translation & Processing of proteome Structure and role of t-RNA in protein synthesis, ribosome structure, basic features of genetic code and its deciphering, translation (initiation, elongation and termination in detail in prokaryotes as well as eukaryotes). Post-translational processing of proteins (protein folding, processing by proteolytic cleavage, processing by chemical modification, Inteins), Protein degradation	**15**

Reference Books:

1	Molecular Genetic of Bacteria 3rd Edition: Snyder and Champness
2	Molecular Biology of the Gene 6th Edition: Watson et al
3	Lewin's Genes X: Jocelyn E. Krebs
4	Molecular Biology: Genes to Proteins, 4th Edition: Burton E Tropp
5	Principles of Genetics 6th Edition: Snustad and Simmons
6	Genomes, 3rd Edition: T.A. Brown

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
3	e-PATHSHALA (https://epathshala.nic.in/)
4	DIKSHA (https://diksha.gov.in/)

Pedagogy:
Direct classroom Teaching
Audio-visual
Assignment/ Quizzes
Continuous assessment
Interactive participative method
Seminar Presentation

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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	% weightage
CO-1	Students should be able to acquire basic knowledge on DNA structure, different conformations of DNA, supercoiling and DNA-protein interactions.	25
CO-2	Students should be clear about organization of prokaryotic and eukaryotic genomes and should learn various molecular events that lead to duplication of DNA.	25
CO-3	Students should have understood the process of transcription in prokaryotic and eukaryotic cells. They should have clear understanding of pre and post transcriptional modifications happening in the cells.	25
CO-4	Student should have learnt protein synthesis in prokaryotic and eukaryotic cell along with processing of proteome in cell.	25

Curriculum Revision:	
Version:	2nd
Drafted on (Month-Year):	June 2022
Last Reviewed on (Month-Year):	Sept 2022
Next Review on (Month-Year):	April 2023

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **I**

Course Code: **201300111**

Course Title: **BIOANALYTICAL TECHNIQUES AND INSTRUMENTATION**

Course Group: **CORE**

Course Objectives:

The course will enable the students to understand the principle and working of visualization techniques, separation techniques, spectroscopic techniques for analysis of the samples and principles and applications of tracer techniques in biology. Principles and applications of different types of microscopy, principle & application of cytophotometry and flow cytometry, centrifugation, electrophoresis chromatography, spectroscopy, radioactivity, radiation counters, x-ray diffraction will be known to the students.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Visualization techniques: Principle of working and applications of bright field & dark field microscopy, phase contrast microscopy, fluorescence microscopy, confocal microscopy, scanning and transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy. Principle and applications of cytophotometry and flow cytometry.	15

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2	Separation techniques: Basic principle and application of analytical and preparative centrifugation, settling time & velocity, types of rotor, sedimentation coefficient, relative centrifugal force (RCF) differential, density and ultracentrifugation. Principle and applications agarose and 2D gel electrophoresis. Capillary electrophoresis and its applications. Native-PAGE, SDS-PAGE Principle, methodology and applications of gel–filtration, ion–exchange and affinity chromatography; Thin layer and High-Performance Thin Layer Chromatography. Gas chromatography, High performance liquid chromatography and FPLC.	**15**
3	Spectroscopy Basic principle of electromagnetic radiation, instrumentation and applications of UV, Visible, IR (including FTIR and ATR), AAS, NMR, Mass, MALDI-TOF, fluorescence and CD spectroscopy.	**15**
4	Principle and applications of tracer technique in biology: Concept of radioactivity, rate of radioactive decay; units of radioactivity- uses of radioisotopes in life sciences and biotechnology; autoradiography; cerenkov radiation; radiation dosimetry; ionization and scintillation-based detection of radioactivity. Principle of biophysical methods used for analysis of biopolymer structure: X-ray diffraction	**15**

Reference Books:

1	Instrumental method of chemical analysis: Sharma B K
2	Instrumental methods of analysis: D A Skoog
3	An introduction to practical Biochemistry: Plummer
4	Instrumentation: Chatwal and Anand
5	Modern experimental Biology: Boyer
6	Freifelder D. M. Physical Biochemistry- Application to Biochemistry and Molecular Biology, 2nd ed., W.H. Freeman, 1982.
7	Wilson & Walker. Principles and Techniques in Practical Biochemistry. 5th ed. Cambridge Univ. Press, 2000.
8	West & Todd. Biochemistry. 4th ed. Oxford and IBH.
9	Horst Friebolin. Basic One and Two-dimensional spectroscopy. VCH Publ, 1991.
10	Murphy D. B. Fundamental of Light Microscopy & Electron Imaging. 1st ed. Wiley-Liss, 2001.
11	R. Marimuthu – Microscopy and Microtechnique, MJP Publishers, 2015.

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
3	e-PATHSHALA (https://epathshala.nic.in/)
4	DIKSHA (https://diksha.gov.in/)

Pedagogy:

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Direct classroom Teaching Audio-visual Assignment/ Quizzes Continuous assessment Interactive participative method Seminar Presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

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R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Deals with the knowledge of different types of microscopes such as Light microscope, Compound microscope, Dark field, Bright field, Stereo microscope, Confocal, Phase contrast microscope, Fluorescent microscope, Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM). It also deals with the principle and application of cytophotometry and flow cytometry.	25
CO-2	Enrich the concept and application for separation of molecules by different types of centrifugation techniques. Knowledge of separation by horizontal and vertical gel electrophoresis is also anticipated. The separation of molecules by different types of chromatographic techniques will be learnt.	25
CO-3	Explore the consideration of principle and analysis of samples by different spectroscopic techniques such as UV, Visible, IR (including FTIR and ATR), AAS, NMR, Mass, MALDI-TOF, fluorescence, CD spectroscopy etc. will be learnt.	25
CO-4	Gather the concept of radioactivity autoradiography, different types of counters used to trace the radiation will be studied. The principle and application of x-ray diffraction methods to study the structure of biopolymer will be known.	25

Curriculum Revision:	
Version:	2nd
Drafted on (Month-Year):	June 2022
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **I**

Course Code: **201300112**

Course Title: **CELL BIOLOGY**

Course Group: **CORE**

Course Objectives:

The major objective of this paper is to develop clear understanding of various aspects of cell biology along with diverse metabolic pathways existing at cellular level in relation to survival and propagation. This course enables the students to understand the structure and function of cell organelles, protein transport mechanism, intracellular signalling mechanism and acquainted with cell cycle, its regulation and apoptosis.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	The origin and Evolution of cells: Evolution of metabolism, Diversity of cell size and shapes, Structure of Prokaryotic and Eukaryotic cells, Single cell to multicellular organism The Structure of cell membrane: The fluid Mosaic Model, Membrane lipids and Proteins, The Glycocalyx, Transport across plasma membrane. Endocytosis: Phagocytosis and Receptor mediated endocytosis) Cell walls and extracellular matrix & Cell Matrix Interactions Cell-Cell interactions: Adhesion protein, Tight junctions, gap junctions and plasmodesmata.	15

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2	Cell Organelles: Molecular organization of Mitochondria, Chloroplast, Ultrastructure and Functions of Nucleus Molecular Organization and functions of Endoplasmic reticulum, Golgi complex, Lysosomes (Protein sorting and transport, Types of vesicular transport and their functions), Microbodies: Peroxisomes, Ribosomes.	**15**
3	The cytoskeleton: The nature of cytoskeleton, Intermediate filaments, Microtubules: Organization of tubules, assembly and organization within the cells, microtubule motors and movements, cilia and flagella: structure and function. Cell signalling: Signalling molecules and their receptors, Functions of cell surface receptors, pathways of intracellular signal transduction, signal transduction and cytoskeleton.	**15**
4	Cell growth and division: Overview of the Cell cycle and its control, the molecular mechanisms for regulating mitotic events, Cell cycle control in mammalian cells, Checkpoints in cell cycle regulation, regulators of cell cycle progression-MPF, cyclins and CDKs, Inhibitors of cell cycle progression; M-phase and cytokinesis. Programmed Cell Death: Difference between necrosis, apoptosis and necroptosis, Caspases, Central regulators of apoptosis (Bcl-2 family), signalling pathways that regulate apoptosis.	**15**

Reference Books:

1	The Cell: A Molecular Approach (5th Edition) by -Geoffrey M Cooper and Robert E. Hausman. ASM Press. ISBN: 978-0-87893-300-6.
2	Cell and Molecular Biology: Concepts and Experiments (4t Edition) by Gerald Karp. John Wiley and Sons Inc. ISBN: 0471-46580-1.
3	Molecular Biology of the Cell (5th Edition) by Alberts Johnson, Lewis Raff and Roberts Walter. Published by Gerland Science. ISBN: 978-0-8153-4105-5.
4	Molecular Cell Biology (6th Edition) by Lodish Berk, Kaiser Krieger, Scott Bretscher, Ploegh Matsudaria. W. H. Freemen and Company. ISBN: 978-0-7167-7601-7.

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
3	e-PATHSHALA (https://epathshala.nic.in/)
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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

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R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	The students will understand the evolution of the cell, Cell as a unit of living organisms. They will learn structural details of prokaryotic and eukaryotic cells, their cell wall, cell membrane and other outer appendages.	25
CO-2	The students can gain knowledge for molecular organization of Mitochondria, Chloroplast. Will know the ultrastructure and functions of Nucleus, Endoplasmic reticulum, Golgi complex, Lysosomes and other microbodies. They will also gain the knowledge of Protein sorting: organelle biogenesis and protein secretion, synthesis and its intracellular traffic, vesicular traffic in the secretary pathways	25
CO-3	Will get the information for cytoskeleton topography which include the role of Microtubule and its dynamics, motor proteins, Microfilament and its functions, Intermediate filaments and their functions, Cilia and centrioles	25
CO-4	Will be acquainted with overview of the Cell cycle and its control, the molecular mechanisms for regulating mitotic events, checkpoints in cell cycle regulation and signalling pathways which regulate apoptosis process	25

Curriculum Revision:	
Version:	2nd
Drafted on (Month-Year):	June 2022
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **I**

Course Code: **201430104**

Course Title: **LAB – I(MOLECULAR BIOLOGY & BIOANALYTICAL TECHNIQUES AND INSTRUMENTATION)**

Course Group: **CORE**

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
		8	4			50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

List of Practicals

1	Amino acid titration curve
2	DNA estimation by DPA method and UV absorption
3	RNA estimation by orcinol method
4	Isolation of chromosomal DNA
5	Separation of proteins by PAGE
6	Introduction to pH, buffer preparation, molar, normal and % solutions
7	Calculations for making stock solution
8	Separation of amino acids by TLC
9	Separation of cells by density gradient centrifugation
10	Determination of partition coefficient

Reference Books:

1	Molecular cloning : a laboratory manual by Joseph Sambrook; E F Fritsch; Tom Maniatis, 2nd Edition, Cold Spring Harbor Laboratory, 1989.
2	Standard Methods of Biochemical Analysis-By S.R. Thimmaiah, Kalyani Publishers, New Delhi, 1999, ISBN-10. 9327264460.

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Pedagogy: Direct Teaching Interactive participative method Hands on training

Curriculum Revision:	
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **I**

Course Code: **201300115**

Course Title: **LAB – II(CELL BIOLOGY & ELECTIVE COURSE)**

Course Group: **CORE**

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
		8	4			50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

List of Practicals

1	Estimation of Reducing Sugar in Jaggery by Cole's Method
2	Estimation of Protein by Folin-Lowry Method
3	Estimation of Reducing Sugar by DNS Method
4	Total Sugar Estimation by Phenol Sulphuric acid estimation
5	Estimation of RNA by Orcinol Method
6	Localization of Cell Organelle and Determination of Chlorophyll and Carotenoids
7	Estimation of Amino Acid (Proline)
8	Estimation of Amino Acid (Methionine from Food Grains)
9	To study function of various parts of Compound microscope.
10	To visualize prokaryotic (Bacterial) cells using Gram's Staining.
11	To prepare a temporary mount of Onion peel and study the cells.
12	To study and identify the chloroplast from plant cell.
13	To Localize nucleus from human cheek cells.
14	To visualize mammalian germ cells (Spermatozoa) by eosin-negrosin stain.
15	To study various stages of mitotic cell division using onion root tip.
18	To study various stages of meiotic cell division using Tradescantia flower bud.

Reference Books:

1	An Introduction to Practical Biochemistry-By David T Plummer, ISBN: 9780070994874

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2	Standard Methods of Biochemical Analysis-By S.R. Thimmaiah, Kalyani Publishers, New Delhi, 1999, ISBN-10. 9327264460.

Pedagogy:
Direct Teaching
Interactive participative method
Hands on training

Curriculum Revision:	
Version:	2nd
Drafted on (Month-Year):	June 2022
Last Reviewed on (Month-Year):	Sept 2022
Next Review on (Month-Year):	April 2023

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **I**

Course Code: **201300117**

Course Title: **FUNDAMENTALS OF BIOCHEMISTRY AND BIOENERGETICS**

Course Group: **ELECTIVE**

Course Objectives:

The major objective of this paper is to develop clear understanding of various aspects of biochemistry which includes properties of biomolecules, their metabolism and regulation. This course content enables students to better understand concept of bioenergetics and its importance in cellular metabolism. Moreover, useful to understand key role of water in metabolism which maintain acid base equilibrium at cellular level as well as an importance of physiological buffers. The objectives of this course are to make students understand how molecular machines are constructed and regulated so that they can accurately copy, repair, and interpret genomic information in prokaryotes and eukaryotic cells. Further, to appreciate the subject of molecular biology as a dynamic and ever-changing experimental science.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

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Detailed Syllabus:

Sr.	Contents	Hours
1	**Carbohydrates and Glycobiology:** Monosaccharide - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and nonreducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides). **Carbohydrate metabolism:** Glycolysis, Gluconeogenesis, PP Pathway, Citric acid cycle- steps involved, amphibolic nature, anaplerotic reactions, Coordinated regulation of glycolysis and gluconeogenesis, Glycogen synthesis	**15**
2	**Amino acids:** Structure of amino acids, physical, chemical and optical properties of amino acids, Classification of amino acids, Peptides and Proteins, Secondary, tertiary and Quaternary structure of proteins **Protein metabolism:** Nitrogen metabolism, Biosynthesis of amino acids, molecules derived from the amino acids, amino acid oxidation and production of urea **Nucleotides and Nucleic acids:** Structure of major species of RNA - mRNA, tRNA and rRNA. Nucleic acid chemistry – UV absorption, effect of acid and alkali on DNA. **Nucleotides metabolism:** Biosynthesis and Degradation of Nucleotides	**15**
3	**Lipids -** fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes, Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids, Lipids as signals, cofactors and pigments **Lipid Metabolism:** Biosynthesis of fatty acids, Triacylglycerol, membrane lipids and cholesterol, Fatty acid catabolism	**15**
4	**Bioenergetics:** The laws of thermodynamics, concept of entropy and free energy; ATP synthesis and hydrolysis, Biological oxidation: oxygenases, hydrolases, dehydrogenases, free energy changes and redox potentials, Gibbs energy The mitochondrial respiratory chain, order and organization of carriers, proton gradient, iron sulphur proteins, cytochromes and their characterization, ATP-synthetase complex, Chemiosmotic theory of Energy Coupling, Inhibitors of ETC **Water and Acid-Base Equilibrium:** Ionization of Water, Weak Acids, and Weak Bases, buffering against pH Changes in Biological Systems: Henderson and Hassebach equation, Buffers and their importance, pKa of amino acid and their relevance, Importance of discontinuous buffer system used in SDS PAGE, Water as a Reactant	**15**

Reference Books

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1	Lehninger's Principles of Biochemistry: D. L. Nelson and M. M. Cox, Macmillan, 4th Edition, Worth Pub. Inc., NY., English; ISBN: 1-4039-4876-3
2	Chemistry of Biomolecules by S. P. Bhutani, 2nd Edition, Imprint CRC Press ; DOI https://doi.org/10.1201/9780429266423 ; Pages 474 ; eBook ISBN 9780429266423
3	Biochemistry: Lubert Stryer, 7th Edition, WH Freeman & Co., NY., ISBN 13: 9781429229364. ISBN 10: 1429229365.
4	Harper's Biochemistry: R. K. Murray and others. Appleton and Lange, Stanford, ISBN: 0838536905 25 edition (pb) 2000. 8.

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
3	e-PATHSHALA (https://epathshala.nic.in/)
4	DIKSHA (https://diksha.gov.in/)

Pedagogy:
Direct classroom Teaching
Audio-visual
Assignment/ Quizzes
Continuous assessment
Interactive participative method
Seminar Presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Will have learnt carbohydrates, their types and properties. Further, will be acquainted with central metabolic pathways for carbon metabolism in bacteria enlisting differences with eukaryotic systems and their regulation in diverse physiological conditions.	25
CO-2	Understands types of amino acids and their properties. Moreover, will have gathered understanding of inorganic and organic nitrogen assimilation and its regulation. Also knows role of glutathione in cellular redox regulation and biochemistry of glutamate overproducing strains. Will understand biochemical basis of nucleotides and its metabolism.	25

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CO-3	Will understand details of lipid, its metabolism and regulation along with biochemical basis of lipid accumulation at cellular level.	25
CO-4	Will have learnt basic concepts of bioenergetics and its importance in cellular metabolism. The students will be aware with different electron carriers compounds and their role in ATP generation. Moreover, gain in depth knowledge of Water and Acid-Base Equilibrium.	25

Curriculum Revision:	
Version:	2nd
Drafted on (Month-Year):	June 2022
Last Reviewed on (Month-Year):	Sept 2022
Next Review on (Month-Year):	April 2023

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **I**

Course Code: **201300119**

Course Title: **FOOD MICROBIOLOGY**

Course Group: **ELECTIVE**

Course Objectives:

The course will enable students to understand the taxonomical classification, phenotypic and biochemical identification of food associated molds, yeasts, yeast-like fungi and bacteria. The course will teach the strategies to develop fermented and non-fermented milk products, fermented plant-based products, malt beverages, distilled liquors, etc. The role of microbes in food spoilage, preservation and various food borne diseases can be discussed.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Microbiology of food Microorganisms important in food microbiology a) Food associated bacteria, yeasts and molds. Microbiome of food material. b) Factors influencing microbial growth in food. Microbial spoilage of foods a) Spoilage of cereals and its products, vegetables, fruits, meat and meat products, milk and milk products, canned and sugar products, fish, seafood and poultry Study of microbes responsible for spoilage and brief insights into chemical and physical spoilage of foods.	15

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2	Food borne infections a) Bacterial food borne infections and intoxications-*Brucella, Campylobacter, Clostridium, Escherichia* (ETEC/EHEC/EPEC/EAEC), *Salmonella, Shigella, Listeria, Vibrio, and Yersinia.* b) Non- bacterial food borne infections and intoxications- Nematodes, protozoa, algae, fungi, and viruses. c) General methods for diagnosis of infections, intoxications and preventive measures.	**15**
3	Food preservation General principles of food preservation – Classical, Physical, chemical and biological food preservation methods Fermentative food products Starter cultures for fermented foods, Fermented milk products: Yogurt, Cheese, Kefir, etc Oriental fermented foods: Shoyu, Temph, Kimchi, etc, Fermented vegetables – Sauerkraut Food beverages: Malt beverages, wines, vinegar Role of Probiotics, prebiotics and nutraceuticals	**15**
4	Molecular techniques in detection of food pathogens and GM foods. Biosensors in food Food research organizations/institutes in India Food sanitation – Microbiology of food plant sanitation, water and milk testing Food laws and quality control – HACCP, Codex alimentarius, PFA, FPO, MFPO, BIS, AGMARK	**15**

Reference Books:

1	Food Microbiology by W.C. Frazier, D.C. Westhoff, K.N. Vanitha. 5th edition. McGraw Hill Education. 2013.
2	Fundamental Food Microbiology by B. Rayand A. Bhunia. 5th edition. CRC press. 2013.
3	Food Microbiology by M. R. Adams, M. O. Moss, P. McClure. 4th edition. Royal Society of Chemistry. 2015.
4	Food Microbiology: Fundamentals and Frontiers by M. P. Doyle, L. R. Beuchat. 3rd Edition
5	Dairy Microbiology by Robinson. Volume II and I

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
3	e-PATHSHALA (https://epathshala.nic.in/)
4	DIKSHA (https://diksha.gov.in/)

Pedagogy:
Direct classroom Teaching
Audio-visual
Assignment/ Quizzes

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Continuous assessment Interactive participative method Seminar Presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Will know about production and evaluation of the quality of starter cultures and fermented milk products. They will understand the role of microbes in food spoilage and how different factors affect this process.	25
CO-2	Gathers information regarding microbes causing food intoxications and food-borne infections. The students will learn different diagnostics methods and preventive measures.	25
CO-3	Knows traditional food preservation techniques including drying, salting, refrigeration, vacuum packaging, canning/bottling, chemical preservation and irradiation. The students will also learn use of modern techniques viz. high-pressure processing (HHP), bacteriocins, manosonication (MS), etc. They will be aware of fermentation protocols of different food products and understands the use and production of probiotics, prebiotics and nutraceuticals.	25
CO-4	Gains knowledge about conventional methods for food quality analysis and is able to use the most recent and non-invasive techniques of quantification and detection of food borne microbes. Understands the relevance of microbial standards for food safety, quality assurance programs that revolutionize food safety	25

Curriculum Revision:	
Version:	2nd
Drafted on (Month-Year):	June 2022
Last Reviewed on (Month-Year):	Sept 2022
Next Review on (Month-Year):	April 2023

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **I**

Course Code: **201430109**

Course Title: **MICROBIAL PHYSIOLOGY**

Course Group: **ELECTIVE**

Course Objectives:

The major objective of this paper is to develop clear understanding of various aspects of microbial physiology along with diverse metabolic pathways existing in bacteria in relation to its survival and propagation. This course enables the students to understand stress responses, intracellular signaling mechanism and acquainted with different protective resistance microbial responses.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Bacterial Cell Structure and its type, Bacterial Cell wall structure function and synthesis Membrane transport in procaryotes-simple, group translocation, ABC transporters, Protein export in bacteria–Type 1,2,3,4, Protein export pathways. 2. Permeation- Primary Active transport, secondary active transport, Co transport Transport of ions across the membrane V-type, F-type and p-type ATPases Bacterial organs for locomotion: Flagella: structure, synthesis, function and mechanism of locomotion, Swarming motility, Motility in spirochetes, Gliding motility, Twitching. Chemotaxis: Molecular mechanism and physiological significance. Two component signal transduction in prokaryotes	15

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2	Bacterial cell division: molecular mechanisms involved in formation of Z-ring, Cell division machinery. Bacterial differentiation: endospore formation, physiological and genetic aspects of sporulation, Sporulation inducing signals & events in sporulation Microbial stress responses: Heat shock, pH, aerobic-anaerobic shifts- Arc and Fnr system, Oxygen toxicity: Mechanism of oxygen toxicity and its mechanism to overcome toxicity-catalase, peroxidase and superoxide dismutase, Osmotic pressure, Osmolarity regulation in *E.coli* (Omp system), Phosphate assimilation in *E.coli* (Pho system).	**15**
3	Quorum sensing process in microorganisms Bioluminescence process, biochemistry, genetics and significance. Bacterial biofilms formation steps, dispersion and control strategies Siderophores; structure, function and significance Microbial fuel cells: Energy generation principle and application. Production of Hydrogen.	**15**
4	Mechanism of drug resistance. Bacteriocins: Structure, Classification and physiological significance of it. Host Parasite interactions: Structures and functions involved in Host-parasite interactions, Bacterial damages to host upon infection. Structure and Mechanism of Endotoxin, Exotoxin and Exoenzymes formed by bacteria. The prokaryotic "immune system", CRISPR/Cas	**15**

Reference Books:

1	Microbial Physiology by A.G. Moat, J. W. Foster, M. P. Spector. 3rd Edition. John Wiley & Sons. 2002
2	The Physiology and Biochemistry of prokaryotes, David White
3	Bacterial signalling, Kramar and Jung
4	Bacterial physiology: A molecular approach, W. E. Sharoud

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
3	e-PATHSHALA (https://epathshala.nic.in/)
4	DIKSHA (https://diksha.gov.in/)

Pedagogy:
Direct classroom Teaching
Audio-visual
Assignment/ Quizzes
Continuous assessment
Interactive participative method
Seminar Presentation

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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	The students will understand the structural details of cell wall, cell membrane and other outer appendages. Will have gained an in-depth knowledge of primary, secondary and group translocation transport systems existing in bacteria, simultaneously learning membrane transport proteins and kinetics of solute transport. Moreover, it will be useful to understand motility types and mechanism of microbial cells.	25
CO-2	Will be acquainted with methods of measuring microbial growth, calculating growth kinetic parameters with understanding of steady state and continuous growth. Understands various microbial stress mechanisms and responses	25
CO-3	Is conversant with intracellular signalling in bacteria in response to various nutritional and physiological stresses. Helpful to understand role of signalling compounds, its regulation and its response for quorum sensing, biofilm formation and bioluminescence process.	25
CO-4	Will be acquainted with different mechanisms of drug resistance, various protective mechanisms of microbes upon infections. Moreover, make the students well aware with bacterial immune system, CRISPR/Cas	25

Curriculum Revision:	
Version:	2nd
Drafted on (Month-Year):	June 2022
Last Reviewed on (Month-Year):	Sept 2022
Next Review on (Month-Year):	April 2023

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **I**

Course Code: **201300120**

Course Title: **VIROLOGY**

Course Group: **ELECTIVE**

Course Objectives:

The main objective of the course is to make students to understand the taxonomical classification, phenotypic and biochemical identification of various viruses. The course will teach the strategies to develop isolation and preservation of viruses and their life cycle for development of antiviral compounds for the viral infections and the role of various viruses in the development of vaccines etc.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Prokaryotic Viruses Discovery of bacteriophages, Structure and composition of bacteriophages, Classification system of Baltimore & ICTV Phage biodiversity, Genome diversity and host- specific interactions Isolation and purification by filtration, ultracentrifugation and affinity chromatography Plaque assays One step growth, single burst and eclipse experiments	15
2	Life cycle of model bacteriophages infecting *E coli* – λ (lytic lysogenic) Life cycle of model bacteriophages: ϕ X 174, M13 Life cycle of model bacteriophages: T4, T7 Life cycle of model bacteriophages: Qß, Mu Applications of phages - therapy; Concern over phage contamination in industry (dairy)	15

3	Eukaryotic Viruses Discovery and classification of plant and animal viruses, structure of viruses, viroids, virusoids Classification of viruses – ICTV and Baltimore classifications Host – viruses interactions, permissive/non – permissive hosts; Cytopathic effects Isolation and purification of viruses, Cultivation and propagation Assay methods – pock assay, hemagglutination assay, transformation assay. Structure, Life cycle and Pathogenicity of Gemini virus Structure, Life cycle and Pathogenicity of TMV Structure, Life cycle and Pathogenicity of Adenovirus Structure, Life cycle and Pathogenicity of Rotavirus Structure, Life cycle and Pathogenicity of Rubella, Influenza and Measles viruses Structure, Life cycle and Pathogenicity of HIV and Hepatitis B Virus	**15**
4	Prevention & control of viral diseases Antiviral compounds and their mode of action Interferon and their mode of action. General principles of viral vaccination Applications of Virology: Use of viral vectors in cloning and expression, Gene therapy and Phage display	**15**

Reference Books:

1	Microbial Physiology by A.G. Moat, J. W. Foster, M. P. Spector. 3rd Edition. John Wiley & Sons. 2002
2	The Physiology and Biochemistry of prokaryotes, David White
3	Bacterial signalling, Kramar and Jung
4	Bacterial physiology: A molecular approach, W. E. Sharoud

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
3	e-PATHSHALA (https://epathshala.nic.in/)
4	DIKSHA (https://diksha.gov.in/)

Pedagogy:
Direct classroom Teaching
Audio-visual
Assignment/ Quizzes
Continuous assessment
Interactive participative method
Seminar Presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Student will be able to describe the defining viral attributes, the general properties of viruses, and steps in virus infection cycle. The principle of virus classification, list the virus families, and describe methods of study virus infection. General overview of viral genomes and their types as well as isolation & preservation of viruses.	25
CO-2	Student will be able to receive information regarding various bacteriophages life cycles, which are model viruses for the study. Applications of phages in therapy; Concern over phage contamination in food & fermentation industry.	25
CO-3	Students will be able to know various plant and animal viruses and their isolation, preservation and classifications. Student will be able to describe host defense against virus infection and able to describe general characteristics of acute viral infections, pathogenesis of Influenza virus, Polio virus, Measles virus, and Rotavirus infection. Student will be able to describe general characteristics of chronic, persistent, latent infections	25
CO-4	Student will be able to describe how different antiviral drugs and their mode of action of viruses, student knows how live viral vaccines are made, how inactivated viral vaccines are made, Polio vaccine and story of polio eradication. Student is able to describe antiviral drug discovery process, mechanism of drug resistance and use of interferons for viral infections.	25

Curriculum Revision:	
Version:	2nd
Drafted on (Month-Year):	June 2022
Last Reviewed on (Month-Year):	Sept 2022
Next Review on (Month-Year):	April 2023

Faculty Name: SCIENCE

Programme Name: M.Sc MICROBIOLOGY

Semester: 2 Academic Batch: 2022-23

Course Group	Board of Studies / Faculty Ownership	Course Code	Course Name	Cr	Teaching Scheme				Assessment/Evaluation Type		External Exam Duration (Hrs.)		INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
					T	P	Tu	Cont. Hrs	T	P	T	P					
CORE	BIOLOGICAL SCIENCES	201430201	Fermentation Technology	4	3		1	4	T		2		50/20	50/20			100/40
CORE	BIOLOGICAL SCIENCES	201300211	Basics of Microbial Genetics	4	3		1	4	T		2		50/20	50/20			100/40
CORE	BIOLOGICAL SCIENCES	201300212	Immunology	4	3		1	4	T		2		50/20	50/20			100/40
CORE	BIOLOGICAL SCIENCES	201430204	Lab I(Fermentation Technology & Basics of Microbial Genetics)	4		8		8		p		3			50/20	50/20	100/40
CORE	BIOLOGICAL SCIENCES	201430205	Lab II (Immunology & Elective course)	4		8		8		p		3			50/20	50/20	100/40
ELECTIVE (Any One)	BIOLOGICAL SCIENCES	201300213	Biostatistics	4	3		1	4	T		2		50/20	50/20			100/40
	BIOLOGICAL SCIENCES	201300214	Microtechniques	4	3		1	4	T		2		50/20	50/20			100/40
	BIOLOGICAL SCIENCES	201300215	Omics and Computational Biology	4	3		1	4	T		2		50/20	50/20			100/40
	BIOLOGICAL SCIENCES	201430210	Medical Microbiology	4	3		1	4	T		2		50/20	50/20			100/40
VIVA-VOCE	BIOLOGICAL SCIENCES	201430206	Comprehensive Viva	1												50/20	50/20
			Total	**25**													

 # T = Theory, P = Practical, Tu = Tutorial

Name & Sign [Chairman - Board of Studies]: Dr. Shilpa Gupte

Name & Sign [Dean / Director]: Dr. Basudeb Bakshi

FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **II**

Course Code: **201430201**

Course Title: **FERMENTATION TECHNOLOGY**

Course Group: **CORE**

Course Objectives:

The major objective of this paper is to impart knowledge about fermentation processes and its relevant aspects. The course will teach strain improvement strategies, preservation methods, sterilization of media and air. It will be useful to understand various bioreactors and their applications. This course will enable the students to understand aeration-agitation concept, its importance in fermentation process and growth kinetics. Lastly, useful to understand downstream processes of the fermentation process.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Isolation, Screening: Primary and Secondary, Preservation and maintenance of Industrially important microorganisms Strain Improvement of industrially important microbes: Isolation of mutant producing primary and secondary metabolites, isolation and use of auxotrophic mutants, isolation and use of revertant mutants and use of recombination systems Media for industrial fermentation processes: Energy sources, antifoam agents and medium optimization	15

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2	Sterilization methods and principles: Media sterilization, mathematical modelling of sterilization processes, Arrhenius equation, Del factor, effect of sterilization on media quality and yield coefficients, batch and continuous sterilization, filter and steam sterilization at industrial scale Design of fermenter and reactors: Basic components of a fermenter, laboratory and industrial scale fermenters, mechanical, Types of fermenter like stirred tank, bubble column, airlift, packed beds, fluidized beds, perfusion cultures, photo-bioreactors and animal cell culture bioreactor, Plug flow reactors, Immobilized enzyme reactors. Bioprocess Control parameters: Instrumentation for monitoring bioreactor and fermentation processes, Sensors, Controllers, fermentation control systems and architecture, Incubation and sequence control, advanced control Scale up and Scale down and containment.	**15**
3	Microbial Growth kinetics: Kinetics of growth and substrate utilization in batch, fed batch and continuous systems. Inoculum development, aseptic inoculation and sampling. Agitation and aeration: Mass transfer of oxygen, Determination of K_La, factors affecting K_La, fluid rheology, Newtonian and non-Newtonian fluids, Bingham plastic, pseudo plastic, power number, Reynolds number.	**15**
4	Recovery and Purification of fermentation Products: Bio separation: filtration, centrifugation, sedimentation, flocculation, cell disruption, liquid-liquid extraction. Purification by chromatographic techniques, Membrane Processes, drying, crystallization, storage and packaging. Fermentation Economics	**15**

Reference Books:

1	Principles of Fermentation Technology by Whitekar & Stanbury, 3rd Edition
2	Comprehensive Biotechnology : Murray Moo Young
3	Methods in Industrial Microbiology : Sikyta
4	Fermentation Microbiology and Biotechnology, El Mansi and Bryc

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
3	e-PATHSHALA (https://epathshala.nic.in/)
4	DIKSHA (https://diksha.gov.in/)

Pedagogy:
Direct classroom Teaching
Audio-visual
Assignment/ Quizzes
Continuous assessment
Interactive participative method
Seminar Presentation

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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Is able to describe the role of microbes in fermentation processes. The students will understand different strategies of strain improvement. It will also useful to understand the role of medium components on product formation.	25
CO-2	Understands aseptic environment, sterilization and its various methods. Will know fermenter design, its components and its variable control parameters.	25
CO-3	Understands microbial growth, it's kinetics and association of product formation with growth. The students will understand the concept of mass transfer and various methods to determine Kla.	25
CO-4	Is able to describe various methods of product recovery. Will know the role of various chromatography in product purification. Moreover, makes the student aware of desalting, drying and crystallization processes.	25

Curriculum Revision:	
Version:	2nd
Drafted on (Month-Year):	June 2022
Last Reviewed on (Month-Year):	Sept 2022
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **II**

Course Code: **201300211**

Course Title: **BASICS OF MICROBIAL GENETICS**

Course Group: **CORE**

Course Objectives:

The objectives of this course are to take students through basics of microbial genetics covering different types of mutations, plasmid biology, prokaryotic genetics and agrobacterium genetics. On covering the course the student will be exposed to concepts of mutation, DNA damage and repair, plasmid biology, microbial and phage genetics.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Mutation, DNA damage and Repair Spontaneous mutations (Random v/s Adaptive nature of mutation; Mutation rate and its determination, Types of DNA damage and their consequences (spontaneous and chemical induced deamination, radiation induced DNA damage, loss of nitrogen bases, alkylation, intra and inter strand cross linking) , DNA repair pathways (Mis-match repair in prokaryotes and eukaryotes, Nucleotide excision repair in prokaryotes and in eukaryotes, base excision repair, recombinational repair, SOS pathway, specific repair of oxidative DNA damage, repair of pyrimidine dimers, repair of alkylation induced damage and adaptive response and other specific repair mechanisms).	15

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2	Plasmid Biology, Phage Genetics & Recombination Types of plasmids, compatibility, regulation of plasmid copy number & plasmid segregation T-series, complementation and Fine structure analysis, biology of lambda phages. Types of recombination, Different models of recombination, Molecular mechanism of homologous recombination in eukaryotes, Mating type switching, Site specific recombination and its biological significance.	**15**
3	Genetic exchange in prokaryotes Natural transformation in *Bacillus subtilis*, Transformation by inducing artificial competence, Gene linkage and mapping by transformation. Generalized transduction in T4 bacteriophage, Specialized transduction, homologous recombination with recipient's chromosome, measuring transduction (co-transduction of markers, marker effects, abortive transduction, transduction of plasmids). Applications of transduction. F-factor mediated Conjugation in *E. coli*, Hfr conjugation and chromosomal transfer, F-prime conjugation and merodiploids, Conjugation of fertility inhibited F-like plasmids, Non conjugative mobilizable plasmids, chromosomal mobilization of non-F plasmids, Interrupted mating and conjugational mapping.	**15**
4	Agrobacterium genetics, Restriction Modification Systems, Transposable Elements Ti plasmid, Interkingdom gene transfer (Key early experiments, vir regulon, protein secretion apparatus, conjugation model of T-DNA transfer, Integration products) Types of RM systems, Role of RM systems, salient features and insights into evolution of diverse types of Restriction endonucleases and Methyl transferases, Regulation of RM systems. Types of bacterial transposable elements; Structure, genetic organization and mechanism of transposition of Tn5, Tn3, phage Mu, Tn7, IS911, Integrons, Retrotransposons, conjugative and mobilizable transposons, Assays of transposition.	**15**

Reference Books:

1	Lewin's Genes X: Jocelyn E. Krebs
2	Molecular Biology of the Gene 6th Edition-Watson et al.
3	Modern Microbial Genetics 2nd Edition-Uldis Streips and Ronald Yasbin
4	Microbial genetics 2nd Edition-Stanley Molay, John Cronan and David Freifelder.
5	Molecular Genetics of Bacteria 3rd Edition-Snyder and Champness.
6	Molecular Genetics: An Introductory Narrative 2nd Edition-Stent and Calender
7	Principles of Genetics 6th Edition- Snustad and Simmons
8	Molecular Biology of the Cell 5th Edition-Alberts et al.

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Supplementary learning Material:	
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Pedagogy:
Direct classroom Teaching
Audio-visual
Assignment/ Quizzes
Continuous assessment
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Seminar Presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Students will know that genome is transient and mutation keeps on happening. They will know the types mutation and different mechanisms involved in their repair.	25
CO-2	Students should be clear about types of plasmids, their compatibility regulation of copy number and segregation. Students will also learn about phage genetics and recombination.	25
CO-3	Students should have understood the types and process of transformation, conjugation and transduction at the end of this unit	25
CO-4	Here student should have learnt Agrobacterium genetics, types of restriction modification systems and different types of transposable elements	25

Curriculum Revision:	
Version:	2nd
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **II**

Course Code: **201300212**

Course Title: **IMMUNOLOGY**

Course Group: **CORE**

Course Objectives:

The objective of this course is to understand various components of the host immune system; their structure, organization and role in defence mechanism. The student will gain knowledge to understand the operational mechanisms which underlie the host defence system. It would make them clear to understand genetic organization and expression of receptors to show immune response. They will also learn the role of immune system in health and diseases.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Immunity: Innate and Adaptive, Cells of the Immune system: Haematopoiesis and its regulation Cells and organs of the immune system: Primary and secondary lymphoid organs Induced Innate immunity: receptors of the innate immunity (TLR and sensing of PAMPs, CLR,RLR and CLR); Inflammatory responses, Natural Killer cells Antigens: Immunogenicity versus antigenicity, Epitopes, Haptens. Complement system: The Major Pathways of Complement Activation: Classical, alternative and lectin complement pathways, functions of complement, regulation of complement, complement deficiencies, microbial complement evasion strategies.	15

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2	Antibody: Structure of immunoglobulin; classes of immunoglobulins, Signal transduction pathways emanating from the BCR The Organization and Expression of Lymphocyte Receptor Genes: Hozumi and Tonegawa's Experiment, Multigene organization of Ig Gene, Mechanism of VDJ recombination, B cell receptor expression: Allelic exclusion,B cell isotype switching and somatic hypermutation; expression of membrane bound and soluble immunoglobulin; T cell receptor genes and expression Basics of Antigen-antibody interactions: Immunoprecipitation and agglutination based techniques, Methods to determine affinity of antigen-antibody interactions, Immunofluroscence, FACS.	**15**
3	The Major Histocompatibility Complex and Antigen Presentation: The structure and function of MHC molecules, general organization and inheritance of MHC genes, The role and expression Pattern of MHC, Endogenous and exogenous pathway of antigen processing and presentation; presentation of non-peptide antigens. B Cell activation: T dependent and T independent B cell responses and memory generation T Cell activation: Two signal hypothesis, superantigens, activation and differentiation of T cell into effector and memory cells.T_H1 and T_H2 responses.	**15**
4	Cell mediated effector response (Generation of effector CTL's, Granzyme and Perforin Mediated Cytolysis, Fas-FasL Mediated Cytolysis, NK cell mediated cytolysis Cytokines: properties, receptors, associated diseases, therapeutic applications, cytokine signalling pathways: JAK-STAT and FAS-FASL signalling pathways Immune response to infection by viruses, bacteria, fungi and parasite: Mechanism of Immune response and evasion by pathogen.	**15**

Reference Books:

1	Owen, J. A., Punt, J., &Stranford, S. A. (2013). Kuby immunology (7thEdn). New York: WH Freeman.
2	Murphy, K., & Weaver, C. (2016). Janeway's immunobiology (9thEdn) Garland Science.
3	Male, D., Brostoff, J., Roth, D., & Roitt, I. (2012). Immunology(8thEdn) With STUDENT CONSULT Online Access. Elsevier Health Sciences.
4	Abbas, A. K., Lichtman, A. H., & Pillai, S. (2014). Cellular and molecular immunology (6thEdn) Elsevier Health Sciences.

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
3	e-PATHSHALA (https://epathshala.nic.in/)
4	DIKSHA (https://diksha.gov.in/)

Pedagogy:
Direct classroom Teaching
Audio-visual

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Assignment/ Quizzes Continuous assessment Interactive participative method Seminar Presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Will be able to understand the types of immunity and basic components of immune system; the role played by complement system as an interface between innate and adaptive immunity.	25
CO-2	Will be able to understand the genetic organization of the genes meant for expression of immune cell receptors and the basis of the generation of their diversity. The principle of antigen-antibody interactions and methods to measure them will become clear to students.	25
CO-3	Will be able to understand the importance of MHC molecule in an individual's immunity to various antigens, the mechanism of antigen processing and presentation. They will be able to understand the mechanism of B and T cell activation and memory generation.	25
CO-4	The students will gain knowledge about the mechanism of cell mediated immunity. They will learn about the cytokines, important biopharmaceuticals and their role in modulation of immune response. The students will also learn how body shows different kinds of immune response to different infections.	25

Curriculum Revision:	
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **II**

Course Code: **201430204**

Course Title: **LAB – I(FERMENTATION TECHNOLOGY & BASICS OF MICROBIAL GENETICS)**

Course Group: **CORE**

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
		8	4			50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

List of Practicals

1	Optimization of centrifugation for separation of cells
2	Measurement of growth by various methods (Absorbance, SPC, Direct count, Wet weight, Dry weight, Indirect method)
3	Determination of KLa by sulfite oxidation method
4	Demonstration of laboratory scale fermenter
5	Production of ethanol by yeast cells
6	Production of penicillin and its recovery
7	Recovery of citric acid
8	Partial purification of proteins by precipitation
9	Conjugation in *E. coli*.
10	Transduction in *E. coli*
11	Transposon assay
12	β-galactosidase induction and assay
13	Isolation and enumeration of bacteriophage
14	Demonstration of Lysogeny

Reference Books:

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1	Standard Methods of Biochemical Analysis-By S.R. Thimmaiah
2	Experimental Microbiology-By Rakesh J. Patel, Volume-1, Fifth Edition
3	Comprehensive Biotechnology : Murray Moo Young
4	Experiments in microbiology, Plant Pathology and Biotechnology, K.R. Aneja New Age International Publishers, New Delhi, ISBN 978-81-224-1494-3
5	Microbiological Techniques by N, Murugalatha, lali Growther, J. Vimalin Hena, N. Hema Shenpagam, R. Anitha, D. Kanchana Devi, G. Rajalakshmi, ISBN: 9788180941078
6	Practical Pharmaceutical Analytical Chemistry, Alam MM, Akhtar Mymoona, Husain Asif, Shaquiquzzaman M. Elsevier India. ISBN: 9788131225363
7	Research articles

Pedagogy:
Direct Teaching
Interactive participative method
Hands on Training

Curriculum Revision:	
Version:	2nd
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **II**

Course Code: **201430205**

Course Title: **LAB – II(IMMUNOLOGY & ELECTIVE COURSE)**

Course Group: **CORE**

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
		8	4			50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

List of Practicals

1	To perform total WBC count using Haemocytometer
2	To Perform Differential Leukocyte count
3	To learn the technique of Ouchterlony Double Diffusion
4	To learn the technique of Radial Immunodiffusion
5	To learn the technique of Immunoelectrophoresis
6	To perform sandwich Dot ELISA test for antigen
7	To learn the technique of latex -agglutination
8	To separate lymphocytes by density gradient method
9	To convert ungrouped data in to grouped data using Sturge's formula.
10	To study representation of data by one dimensional diagram.
11	To study representation of data by two dimensional diagram.
12	To study representation of data by means of graphs. (Histogram & frequency polygon).
13	To study the data representation by graphs (Frequency polygon & frequency curve).
14	To study how to calculate descriptive statistics for the given data. (Mean mode, median, standard deviation and mean deviation).
15	To study the concept of permutation and combination in practical counting problems.
16	To study the concept of normal distribution and apply it to practical problems.
17	To study the concept of estimation (point estimation and interval estimation).

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18	To apply the concept of skewness in the field of biosciences.
19	To apply the concept of F- test for biological problems.
20	To apply the concept of χ^2 – test for biological problems.

Reference Books: Practical

1	Fundamentals of Mathematical Statistics (A Modern Approach), 10th Edition by S.C. Gupta and V.K. Kapoor. Sultan Chand & Sons Educational Publishers, New Delhi (2000) ISBN 81-7014-791-3
2	Principles of biostatistics, 2nd edition by Kimberlee Gauvreau and Marcello Pagano. CRC Press (2018) ISBN 13: 978-1-138-59314-5
3	Biostatistics A Foundation for Analysis in the Health Sciences, 10th edition by Wayne W. Daniel and Chad L. Cross. Wiley (2013) ISBN 978-1-118-30279-8
4	Mahajan's Methods in Biostatistics for Medical Students and Research Workers, 8th Edition by Arun Bhadra Khanal. Jaypee Brothers Medical Publishers (P) Ltd. ISBN 978-93-5152-909-5
5	Experimental Microbiology Vol. 1 and Vol. 2 by Rakesh Patel

Pedagogy:
Direct Teaching
Interactive participative method
Hands on Training

Curriculum Revision:	
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **II**

Course Code: **201300213**

Course Title: **BIOSTATISTICS**

Course Group: **ELECTIVE**

Course Objectives:
The course aims to develop competency and expertise in the application of statistical methods applied to biological data obtained in experimental techniques.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Data Collection and Presentation Types of Biological Data: Qualitative Data -Nominal, Ordinal, Ranked; Quantitative Data: Discrete and Continuous. Understanding of Population and sample Methods of Collection of Data: (i) Experimental Data and (ii) Survey Data- Simple random Sample (with and without replacement), stratified sampling and cluster sampling. Tables: Frequency Distributions, Relative Frequencies. Graphical Presentation: Bar charts, Histograms, Frequency Polygons, One way scatter plots, Box plots, two-way scatter plots, line graphs.	15

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2	Descriptive Statistics Measures of Central Tendency: Mean, Median and Mode, quartiles, deciles and percentiles (both for raw data and grouped data) Measures of Dispersion: Range, Interquartile Range, Variance, Standard Deviation and Coefficient of Variation. Measures of Skewness and Kurtosis.	**15**
3	Statistical hypotheses: Null and Alternative hypotheses. Statistical Tests: Acceptance region and Rejection Region. Types of errors and power of the test. Goodness of fit tests. Random Variables: Discrete and Continuous. Some examples from biological sciences. Probability Distributions: General Normal Distribution, Standard Normal Distribution ; Sampling Distributions- t, chi-square and F distributions. Significance Tests for Normal Distribution: One sample tests for mean – z test and t-test. Two sample tests for normal distributions: Tests for means (i) when variances are known (ii) when variances are unknown. Tests for equality of variances. Paired t-test for equality of means. Confidence Intervals	**15**
4	Correlation: Covariance, Calculation of covariance, correlation analysis and correlation Coefficient calculated from ungrouped data. Regression: Simple linear regressions analysis, regression coefficients, Linear regression line or equation Analysis of Variance: Completely Randomized Design, Randomized Block Design.	**15**

Reference Books: Theory

1	Fundamentals of Mathematical Statistics (A Modern Approach), 10th Edition by S.C. Gupta and V.K. Kapoor. Sultan Chand & Sons Educational Publishers, New Delhi (2000) ISBN 81-7014-791-3
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Pedagogy:
Direct classroom Teaching
Audio-visual
Assignment/ Quizzes
Continuous assessment
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Seminar Presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Student will be able to know about basic terms and use in biostatistics. They will understand types of data, their organization and various graphical representation methods to represent data and will enable students to understand the basic statistics and its importance in research.	25
CO-2	Student will be able to calculate various measures of central tendencies, measure of dispersion and measure of kurtosis and skewness and its importance.	25
CO-3	To understand the exact method of data analysis for the problem under investigation. Student will be able to perform various hypothesis testing like T-test, F-test, and chi square tests and its application in biological sciences.	25
CO-4	Understanding for drawing valid inferences and to plan for future investigations. Student will be able to perform Correlation & regression calculations and its application in Biological sciences. Student will able to perform ANOVA testing.	25

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **II**

Course Code: **201300214**

Course Title: **MICROTECHNIQUES**

Course Group: **ELECTIVE**

Course Objectives:

The course will enable the students to understand the principle of microscopy types of microscopy used to explore the knowledge of Microtechniques. The measurement of size of microorganisms, sanctioning of the bigger specimens by using microtome, preparation of temporary and permanent slides of the specimen will be known.

Curriculum Revision:	
Version:	2nd
Drafted on (Month-Year):	June 2022
Last Reviewed on (Month-Year):	Sept 2022
Next Review on (Month-Year):	April 2023

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Principles of microscopy – eyepiece lens and objective lenses; Magnification, Resolving power, numerical aperture. Mechanical components: base, pillar, stage, sub stage, body tube, focusing knobs, nose pieces. Optical components: mirror, objectives, ocular lens, condenser, Focussing slides under low/ high power and oil immersion.	15
2	Types of microscopes: Light microscope, Compound microscope, Dark field, Bright field, Interference microscope (Stereo microscope), Confocal, Inverted microscope, Phase contrast microscope, Fluorescent microscope, Electron microscope: Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM)	15

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3	Measurement of Microorganisms- Micrometry – Stage micrometer, Ocular micrometer, Calibration and working. Preparation of illustrations using camera lucida, digital camera and photomicrography.	**15**
4	Killing and fixation agents - carnoy's formula, F. A. A. Dehydration– general account of dehydration (Ethanol, Isopropyl alcohol, Acetone, Glycerine). Ethanol – Xylene series and Tertiary Butyl Alcohol Series Infiltration – paraffin wax method, Embedding Free hand sectioning- Microtome (Rotary and sledge) serial sectioning and its significance. Mounting- A brief account on whole mounting, maceration, smears and squash preparation, application of permanent whole mounts, permanent sections. Staining- Classification: natural dyes, coal tar dyes, double staining, vital staining; simple, Gram staining, negative staining, capsule staining, spore staining, flagellar staining, nuclear staining and acid-fast staining, stains: saffranin, hematoxylin, acetocarmine.	**15**

Reference Books:

1	Plant Microtehnique, Johansen D.A. 1940, Mc Graw – Hill Book Company, Inc. New York. Manual of Microbiology – Tools and Techniques, Kanika S. 2007, Ane's student edition.
2	Botanical Microtechnique; principles and Practice, Khasim S.K., 2002, Capital Publishing Company New Delhi.
3	Essentials of botanical microtechnique, Toji T. 2004, Apex Infotec Publ.
4	Murphy D. B. Fundamental of Light Microscopy & Electron Imaging. 1st ed. Wiley-Liss, 2001.
5	R. Marimuthu – Microscopy and Microtechnique, MJP Publishers, 2015.

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
3	e-PATHSHALA (https://epathshala.nic.in/)
4	DIKSHA (https://diksha.gov.in/)

Pedagogy:
Direct classroom Teaching
Audio-visual
Assignment/ Quizzes
Continuous assessment
Interactive participative method
Seminar Presentation

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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Deals with the concept and principle of microscopy. It provides the understanding of different optical components of microscopy	25
CO-2	Enrich the knowledge of different types of microscopes such as Light microscope, Compound microscope, Dark field, Bright field, Stereo microscope, Confocal, Phase contrast microscope, Fluorescent microscope, Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM)	25
CO-3	Explore the need and methods of measurement of microorganisms by micrometry. The calibration and working with the stage and ocular micrometer. Illustrations and concept of photomicrography will also be known	25
CO-4	The concept of killing and fixation agents, dehydration of the specimens, embedding of specimens in paraffin wax, free hand sanctioning, mounting of sanctioned specimen on slide, staining of specimens and different types of staining will be known	25

Curriculum Revision:	
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **II**

Course Code: **201300215**

Course Title: **OMICS AND COMPUTATIONAL BIOLOGY**

Course Group: **ELECTIVE**

Course Objectives:

The course will enable the students to understand the concept of genome mapping, genome sequencing, functional genomics, basic concepts of proteomics tools, data mining, basic concepts and tools of lipidomics, glycomics and phosphoproteomics. Storage and retrieval of various types of databases collection and storing of sequence data will be understood by the students. Students will also be able to know the local and global alignment through scoring matrices, gene prediction methods, RNA fold analysis, splice site identification.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Genome, Genomics & Transcriptomics: Genome mapping: Physical and Genetic Map, Genome Sequencing, Next generation sequencing methods, Genome Annotation, Functional Genomics. Transcription factor binding sites, RNA-Seq, Microarrays, Regulatory RNAs: small or large, Computational prediction of miRNA target genes, RNA Dark matter	15

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2	Proteomics, Metabolomics & Lipidomics: Basic concepts, Tools of proteomics- SDS PAGE, 2D PAGE, Liquid chromatography, Mass Spectrometry (ESI and MALDI), Protein identification by peptide mass fingerprinting, Applications of proteomics. Fundamental concept, data integration and data mining; Tools of metabolomics- Capillary electrophoresis, Gas chromatography, Electrochemical detectors. Basic concepts and tools of lipidomics, glycomics and phosphoproteomics	**15**
3	Biological Literature Information access, storage and retrieval systems- Primary and secondary databases of genomics, trascriptomics, proteomics and metabolomics. Knowledge on freeware and commercial software. Importance of hardware and software creations. Collecting and Storing Sequence Data: Sequence assembly; Submission of Sequences; Sequence accuracy; Sequence databases; Sequence formats; Annotation and Archival	**15**
4	Sequence alignment and applications: Uses: Choice to be made for alignment; Scoring matrices; Homology and related concepts; Dot Matrix methods; Dynamic programming methods for global and local alignments tools- FASTA, BLAST, statistical and Biological significance. Nucleic acid sequence analysis: Reading frames; Codon Usage analysis; Translational and transcriptional signals; Splice site identification; Gene prediction methods; RNA fold analysis	**15**

Reference Books:

1	Introduction to Proteomics -Tools for the New Biology by Daniel C. Liebler, Humana Press.
2	Mass Spectrometry for Biotechnology by Gary Siuzdak, Academic Press.
3	Proteomics for Biological Discovery by Timothy Veenstra and John Yates, Wiley.
4	Metabolomics- Methods and Protocols by Wolfram Weckwerth, Humana Press.
5	Lipidomics- Technologies and Applications by Kim Ekroos, Wiley-VCH.
6	Transcriptomics: Expression Pattern Analysis, Virendra Gomase, Somnath Tagore; VDM Publishing, 2009 – Science.
7	Current Protocols in Bioinformatics, Edited by A.D. Baxevanis et al, Wiley Publishers. 2005.
8	Bioinformatics by David W. Mount, Cold Spring Harbor Laboratory Press. 2001.
9	Fundamental concepts of Bioinformatics by D.E. Krane and M.L Raymer, Pearson Education. 2003.
10	Bioinformatics and Functional Genomics by Pevsner, J., John Wiley and Sons, New Jersey, USA. 2003
11	Principles of Genome Analysis and Genomics (3rd Ed.) by Primrose, S.B. and Twyman, R.M., Blackwell Publishing Company, Oxford, UK. 2003.
12	Introduction to proteomics – Tools for the new biology (1st Ed.) by Liebler, D.C., 2002, Human Press Inc., New Jersey, USA.
13	Bioinformatics: Sequence and Genome Analysis by Mount, D., Cold Spring Harbor Laboratory Press, New York. 2004.

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Supplementary learning Material:	
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Pedagogy:
Direct classroom Teaching
Audio-visual
Assignment/ Quizzes
Continuous assessment
Interactive participative method
Seminar Presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Deals with genome, genomics and transcriptomics. The concept and application of physical map, genetic map, genome sequencing, functional genomics, small or large regulatory RNAs and dark matter will be known.	25
CO-2	Gathers information regarding concept of proteomics, metabolomics and lipidomics. The basic tools of proteomics, metabolomics, lipidomics and their applications will be learnt by the students.	25
CO-3	Deals with the primary and secondary databases, collection, storage and retrieval of databases, knowledge of freeware, software and hardware. The sequence databases, sequence format, annotation and archival of databases will be understood.	25
CO-4	Accords the sequence alignment and applications. The choice of alignment, local alignment, global alignment scoring matrices, codon usages analysis, RNA fold analysis, splice site identification will also be studied by the students.	25

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Curriculum Revision:	
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **II**

Course Code: **201430210**

Course Title: **MEDICAL MICROBIOLOGY**

Course Group: **ELECTIVE**

Course Objectives:

The objective of this course is to make the students understand various attributes which make the microbes pathogenic or disease-causing, the emergence of newer pathogens with relevance to India and the various tools for their local or global spread. The students would also learn the mechanisms of resistance of bacteria to antibiotics and role of newer vaccines in controlling infectious diseases. The course would also enable students to describe the diagnostic methods and automated equipment which may be used for diagnosis of diseases caused by microorganisms.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Basics in Medical Microbiology Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS Nonspecific host defences, virulence factors, normal flora and gnotobiology Epidemiology: Infectious diseases, disease cycle, epidemiological methods, diagnostic principles, control, prevention, antimicrobial therapy.	15
2	**Bacterial Diseases** Morphology, Cultural Characteristics, Antigenic structures, Pathogenesis, Laboratory Diagnosis of following bacteria: *Staphylococcus, Streptococcus including Pneumococcus, Corynebacterium, Clostridium, Mycobacteria, E. coli, Salmonella, Shighella, Spirochaetes, Neisseria*	15

3	**Viral Diseases** The Nature and classification of viruses, Morphology: virus structure and Virus replication. General properties, diseases caused, lab diagnosis and prevention of Herpes (HSV), Hepatitis (HAV & HAB), Picorna (Polio virus), Orthomyxo (Influenza), Paramyxo (Mumps and Measles), Rabdo (Rabies), Ebola, Zika and HIV virus. Viral vaccines and antiviral agents.	**15**
4	**Fungal and Protozoal Diseases** Fungal Morphology, diseases caused and lab diagnosis of: Opportunistic fungi – Candida and Aspergillus Fungi causing Cutaneous mycoses- *Dermatophytes* Subcutaneous mycoses - *Mycetoma* Systemic mycoses- *Histoplasma* Protozoal Morphology, life cycle, laboratory diagnosis of following parasites Parasites: Entamoeba, Giardia, Leishmania, Plasmodium.	**15**

Reference Books:

1	Textbook of Microbiology by Surinder Kumar
2	Medical Parasitology by R. Karyakarte
3	P. B. Godkar. Text Books of Medical Laboratory Technology
4	Anathanarayana & Panikar – A Text Book of Medical Microbiology
5	P. Chakraborthy- A Text Book of Microbiology
6	Chatterjee, KD – Parasitology
7	Danial Greenwood et al, Medical Microbiology, A guide to Microbial Infections, Pathogenesis, Immunity, Laboratory Diagnosis and control.
8	Jagdish Chander, Textbook of medical mycology.
9	Teri Shores- Understanding Viruses.

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
3	e-PATHSHALA (https://epathshala.nic.in/)
4	DIKSHA (https://diksha.gov.in/)

Pedagogy:
Direct classroom Teaching
Audio-visual
Assignment/ Quizzes
Continuous assessment
Interactive participative method
Seminar Presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Understands infection, its types and various host pathogen interaction. The students will be able to know the operation and the mechanisms which underlie the immune response to understand the phenomena like host defence. Useful to study various tools available to work on epidemiology.	25
CO-2	Will gain in depth knowledge of Morphology, Cultural Characteristics, Antigenic structures, Pathogenesis, Laboratory Diagnosis of certain prominent and newer disease-causing bacteria.	25
CO-3	Will get the information of different significant viral diseases, their characteristics, pathogenicity, antigenic properties, diagnosis and its preventive and control measures.	25
CO-4	Understands different fungal and protozoal infections, their life cycles, and pathogenesis. Also useful to study and evaluate preventive and control mechanisms.	25

Curriculum Revision:	
Version:	2nd
Drafted on (Month-Year):	June 2022
Last Reviewed on (Month-Year):	Sept 2022
Next Review on (Month-Year):	April 2023

Faculty Name: SCIENCE

Programme Name: M.Sc MICROBIOLOGY

Semester: 3 Academic Batch: 2022-23

 # T = Theory, P = Practical, Tu = Tutorial

Course Group	Board of Studies / Faculty Ownership	Course Code	Course Name	Cr	Teaching Scheme				Assessment/ Evaluation Type		External Exam Duration (Hrs.)		INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
					T	P	Tu	Cont. Hrs	T	P	T	P					
CORE	BIOLOGICAL SCIENCES		Microbial Biotechnology	4	3		1	4	T		2		50/20	50/20			100/40
CORE	BIOLOGICAL SCIENCES		Environmental and Agricultural Microbiology	4	3		1	4	T		2		50/20	50/20			100/40
CORE	BIOLOGICAL SCIENCES		Enzyme Kinetics and Mechanisms	4	3		1	4	T		2		50/20	50/20			100/40
CORE	BIOLOGICAL SCIENCES		Lab I (Microbial Biotechnology & Environmental and Agricultural Microbiology)	4		8		8		p		3			50/20	50/20	100/40
CORE	BIOLOGICAL SCIENCES		Lab II (Enzyme Kinetics and Mechanisms & Elective Course)	4		8		8		p		3			50/20	50/20	100/40
ELECTIVE (Any One)	BIOLOGICAL SCIENCES		Bioinformatics	4	3		1	4	T		2		50/20	50/20			100/40
	BIOLOGICAL SCIENCES		Advanced Immunology	4	3		1	4	T		2		50/20	50/20			100/40
	BIOLOGICAL SCIENCES		Medical Biochemistry	4	3		1	4	T		2		50/20	50/20			100/40
	BIOLOGICAL SCIENCES		Marine Biotechnology	4	3		1	4	T		2		50/20	50/20			100/40
VIVA-VOCE	BIOLOGICAL SCIENCES		Comprehensive Viva	1												50/20	50/20
			Total	**25**													

Name & Sign [Chairman - Board of Studies]: Dr. Shilpa Gupte

Name & Sign [Dean / Director]: Dr. Basudeb Bakshi

FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **III**

Course Code:

Course Title: **MICROBIAL BIOTECHNOLOGY**

Course Group: **CORE**

Course Objectives:

The main aim of course is to make students understand the importance of industrially important organism and the fermentation processes involved in the production of various microbial products with focus on the current trends in fermentation technology. Students will be to differentiate between batch, fed-batch and continuous cultivation systems and their optimization strategies for the economical production of different fermented products used in various industries like food industry, pharmaceutical applications etc.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Unit 1: Microbial production of organic acids, solvents and beverages** Organic acids: citric acid, acetic acid Industrial Solvents: ethanol, acetone-butanol Beverages: beer, wine	15

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2	**Unit 2: Microbial production of therapeutic agents** Streptomycin, cephalosporin Anticancer agents- Anthracyclines Ergot alkaloids	**15**
3	**Unit 3: Microbial production of enzymes, vitamins and amino acids** Enzymes: proteases, amylases and lipases Vitamins: B_2 and B_{12} Amino acids: lysine, glutamic acid	**15**
4	**Unit 4: Other microbial products** Microbial polysaccharides: Xanthan and Dextran Steroid biotransformation Polyhydroxyalkonates: PHA and PHB	**15**

Reference Books:

1	Comprehensive biotechnology. Murray MooYoung, Editor in Chief. Pergamon Press, Oxford, 1985, 4 volume set. Volume 3 — The Practice of Biotechnology: Bulk Commodity Products. Volume Editors - Harvey W. Blanch, Stephen Drew and Daniel I.C. Wang, ISBN 10: 008026204X ISBN 13: 9780080262048
2	Microbial Technology - Second Edition, Volume I - Microbial Processes, Edited by Henry. J. Peppler and D. Perlman, ACADEMIC PRESS, New York San Francisco London 1979. ISBN 0-12-551501-4
3	Microbial Technology - Second Edition, Volume II - Fermentation Technology, Edited by Henry. J. Peppler and D. Perlman, ACADEMIC PRESS, New York San Francisco London 1979. ISBN 0-12-551502-2 (v. 2) Hardcover ISBN: 9780125515023, eBook ISBN: 9781483268279, Paperback ISBN: 9781483244693
4	Biotechnology: a multi volume comprehensive treatise edited by H. J. Rehm and G. Reed in cooperation with A. Puhler and P. Stadler. – Second edition, completely revised edition. – VCH, (Weinheim) volume 6: Products of Primary metabolism and volume 7: Products of secondary metabolism ISBN 3-527-28310-2
5	Microbiology and Technology of Fermented Foods, Second Edition, editor- Robert W. Hutkins, Wiley-Blackwell Publishing, ISBN: 978-1-119-02744-7
6	Modern Industrial Microbiology and Biotechnology, Second edition, editors - Nduka Okafor, Benedict C. Okeke (2017), CRC Press, ISBN 97803677816

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Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
3	e-PATHSHALA (https://epathshala.nic.in/)
4	DIKSHA (https://diksha.gov.in/)

Pedagogy:

Direct teaching
Audio visual
Continuous Assessment, Assignments / quiz
Project
Feedback
Interactive Participative method
Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	**Course Outcome Statements**	**%weightage**
CO-1	Students will be able to know about production of various primary metabolites of economic importance. They will understand the role of microbes in production of these primary metabolites.	**25**
CO-2	Gathers information regarding microbial biotechnology and its application in microbial processes. Understand about strain development and selection of hyper producing industrially relevant strains for production of microbial products like antibiotics, anticancer agents and ergot alkaloids.	**25**
CO-3	Knows the production of various enzymes, amino acids and vitamins production using fermentation processes and their industrial use.	**25**
CO-4	Gains knowledge about production of bioplastics and exopolysaccharides. Students will be able understand the biotransformation of steroids for therapeutic purposes. Student will be able to understand various bioinsecticides and their production	**25**

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Curriculum Revision:	
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **III**

Course Code:

Course Title: **ENVIRONMENTAL AND AGRICULTURE MICROBIOLOGY**

Course Group: **CORE**

Course Objectives:

The major objective of this paper is to impart knowledge about structure, composition and functioning of microbial communities in a diverse environment. The use of microbial population in agriculture, mineral recovery, management of various types of pollutants and conversion processes of various types of wastes into value added products will be discussed.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Unit 1** ● Biogeochemical cycles: Carbon, Nitrogen, Sulphur and Phosphorus cycles. ○ Detrimental effects of diverted biogeochemical cycles: Acid mine drainage, nitrous oxide emission, nitrate pollution of groundwater, Eutrophication ● Biological Nitrogen Fixation in detail: ○ Asymbiotic, symbiotic and associative nitrogen fixation. ○ Structure, function, and genetic regulation of nitrogenases.	15

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2	**Unit 2** ● Global environmental problems: Global warming, causes of global warming, Ozone depletion, Impact of global warming and strategies to solve global warming, Acid rain ● Bioleaching of metals: Characteristics of commercially important microbes, Mechanisms of bioleaching, factors affecting bioleaching processes. Biobeneficiation of gold ores. ● Bio desulfurization of coal: Removal of organic and inorganic sulphur from the coal, ● Microbially enhanced oil recovery. ● Biodeterioration of wood and metals: Role of micro-organisms, mechanisms and control	**15**
3	**Unit 3** ● Microbial diversity in extreme environments: ○ Characteristics of extreme environments ○ Microbial diversity, habitats and adaptive strategies of thermophiles and hyperthermophiles, psychrophiles and psychrotrophs, halophiles, acidophiles and alkalophiles. ○ Biotechnological applications of extremophiles ● Methods to study microbial diversity in the environment: ● Culture-dependent and culture-independent approaches: Phenotypic detection, Biochemical assays, Analysis by FAME, measuring metabolic capabilities using BIOLOG, G+C analysis, community fingerprinting, and fluorescent in situ hybridization, metagenomic analysis of solid and aquatic sediments, Microbial diversity indices	**15**
4	**Unit 4** ● Microbial communities and ecosystems: ○ Microbial community dynamics, Structure of microbial communities, Ecosystems, Structure and function of some microbial communities in nature. ● Interactions between microorganisms and plant: ○ Mycorrhizae ○ Plant growth promoting rhizobacteria ● Biofertilizers: Applications of nitrogen fixing, phosphate solubilizing and cellulolytic biofertilizer ● Microbial Insecticides: Bacterial and viral insecticides in pest management	**15**

Reference Books:

1	Environmental Microbiology by R. M. Maier, I. L. Pepper & C. P. Gerba, 2nd Edition, Academic Press, 2009, Elesvier
2	Comprehensive Biotechnology Vol-4, Murray Moo Young, 3rd Edition, Elesvier, 2019, ISBN: 0446404709
3	Microbial Ecology: Fundamentals and Applications- Atlas & Bartha, fourth edition, Pearson Education.
4	Environmental science by B. J. Nebel and R. T. Wright, 8th Edition

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5	The prokaryotes- Ecophysiology and Biochemistry, volume 2, 3rd Edition
6	Brock Biology of microorganisms by Madigan, Martinko, Dunlap, and Clark, 15th edition, ISBN: 9781292235103, 2018, Published by Pearson Higher Ed USA
7	Physiology and biochemistry of Extremophiles by Charles Gerday, 2007 by ASM Press

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
3	e-PATHSHALA (https://epathshala.nic.in/)
4	DIKSHA (https://diksha.gov.in/)

Pedagogy:

Direct teaching
Audio visual
Continuous Assessment, Assignments / quiz
Project
Feedback
Interactive Participative method
Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	**Course Outcome Statements**	**%weightage**
CO-1	Will be able to describe the role of soil microbes in nutrient transformation and plant-microbe interactions and certain hazardous effects of diverted geochemical cycles. It covers the nitrogen fixation process, it's biochemistry and regulation.	**25**
CO-2	Will have an overview of the till date developments in the field of environmental microbiology with special emphasis on the role of microbes in mitigating environment pollution. The beneficial and applied aspects of microbes is emphasized.	**25**

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CO-3	Will be knowledgeable about the diversity, adaptations and biotechnological applications of microbes of extreme environment. The students will be acquainted with various cultural, biochemical and molecular techniques used in understanding microbial diversity.	**25**
CO-4	Understands microbial ecosystems and its various interactions. The student will understand the plant-microbe interaction and how microbes play an important role to increase soil fertility.	**25**

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Version:	2nd
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **III**

Course Code:

Course Title: **ENZYME KINETICS AND MECHANISMS**

Course Group: **CORE**

Course Objectives:

The course will enable students to understand the Enzyme and their classification, structure of enzyme and their action & purification. The course will teach the enzyme kinetics, mechanisms of enzyme catalysis and Methods to study enzymes and its mechanisms of regulations using suitable examples of enzymes in the cell.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Unit 1** Introduction to enzymology and historical developments in enzymology Protein Structure: Primary, secondary, tertiary and quaternary structure, techniques used in enzyme characterization Enzyme classification: IUB enzyme classification. Enzyme Activity: Principle and techniques of enzymatic analysis, factors affecting enzyme Activity, Extraction and Purification of enzyme: Objectives and strategy, separation techniques, test of purity	15

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2	**Unit 2** Enzyme Kinetics: Chemical reaction kinetics and catalysis Single substrate kinetics: Equilibrium and Steady state kinetics, significance of Km, Vmax & Kcat, enzyme efficiency Multisubstrate kinetics: General rate equation, compulsory order, random order and ping-pong mechanisms and their primary and secondary plots. Enzyme inhibition and its kinetics: Reversible and irreversible inhibition, competitive, non-competitive and uncompetitive, mixed, partial, substrate and allosteric inhibition. Thermal kinetics: Effect of temperature on reaction rate, enzyme stability, Arrhenius equation and activation energy.	**15**
3	**Unit 3** Mechanism of Enzyme Action: Enzyme mechanisms: Factors affecting catalytic efficiency, Mechanism of Lysozyme, Chymotrypsin, Carboxypeptidase, Restriction endonuclease, Aspartate transcarbomylase. Allosteric enzymes and sigmoidal kinetics: Protein ligand binding, Co-operativity, MWC & KNF models, Multienzyme enzyme complexes	**15**
4	**Unit 4** Methods to study enzymes and its mechanisms Enzyme engineering: Chemical modification of enzymes: methods of modification of primary structure, catalytic and allosteric properties, use of group specific reagents. Enzyme Immobilization Enzymes in non-conventional media, Enzymes as analytical reagents. Isoenzymes and its physiological significance, Ribozymes and Abzymes	**15**

Reference Books:

1	Understanding Enzymes, Third edition, editor - Trevor Palmer, 1st Published by Ellis Horwood ltd., England, 1991, ISBN 0-13-932534-4
2	Enzyme Kinetics - Principles and Methods, 2nd edition Revised, editor- Hans Bisswanger, (Wiley, 2008), Print ISBN:9783527319572, Online ISBN:9783527622023
3	Fundamentals Of Enzymology, 3rd Edition, edited by Nicholes C. Price and Lewis Stevens, Published by Oxford University Press, Incorporated (1989). ISBN 10: 0198552963ISBN 13: 9780198552963.
4	Structure and mechanism in protein science: a guide to enzyme catalysis and protein folding, editor Alan Fersht, Published W. H. Freeman and Company, New York (1999), ISBN 0-7167-3268-8
5	Biochemistry, 8th edition editors - Jeremy Mark Berg, Gregory Joseph Gatto, Lubert Stryer, John L Tymoczko] - (2015, W. H. Freeman), ISBN-10: 1-4641-2610-0
6	Proteins: Structures and molecular properties, 2nd edition editor - Thomas E. Creighton, Published by W. H. Freeman, New York, 1992, ISBN 071677030X
7	ENZYME KINETICS A Modern Approach by Alejandro G. Marangoni. John Wiley & Sons, Inc., Hoboken, New Jersey.

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8	Enzyme Technology, edited by Anusha Bhaskar and V.G. Vidhya, MJP Publishers, Chennai, India
9	Enzymes, 3rd Edition, editors - M. DIXON, E. C. WEBB, C. J. R. THORNE, K. F. TIPTON. Longman Group Ltd. London 1979
10	Biochemistry, Fourth edition, edited by D Voet and J Voet, , published by John Wiley Publishers

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
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4	DIKSHA (https://diksha.gov.in/)

Pedagogy:

Direct teaching

Audio visual

Continuous Assessment, Assignments / quiz

Project

Feedback

Interactive Participative method

Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	**Course Outcome Statements**	**%weightage**
CO-1	Students will be able to know about the introduction of enzyme and its structure. The classification of enzyme and enzyme purification strategies from a variety of sources and to study the purity of enzymes.	**25**

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CO-2	Students will be able to understand the enzyme kinetics with respect to presence of Substrate, inhibitors and activators and significance of Km, Vmax & Kcat, enzyme efficiency.	**25**
CO-3	Students will be able know the mechanisms of different enzyme actions. Mechanism of action allosteric enzymes.	**25**
CO-4	Gains knowledge about conventional methods for enzyme analysis and is able to use the most recent and non-invasive techniques of quantification and detection. Understands the relevance of Isoenzymes and its physiological significance, enzyme immobilization techniques. Enzyme engineering.	**25**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **III**

Course Code:

Course Title: **LAB - I (Microbial Biotechnology and Environmental and Agricultural Microbiology)**

Course Group: **CORE**

Course Objectives:

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
		8	4			50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Lab-I Syllabus:

List of Practicals / Tutorials:

1	Production of cellulase enzyme by solid state fermentation.
2	Saccharification of agro-waste by cellulase enzyme.
3	Bioassay of antibiotics
4	Production of acetic acid / citric acid by submerged fermentation
5	Production of amylase / protease / Lipase by submerged fermentation
6	Development of Mutants for fermentation using Physical and chemical mutagens
7	Screening of Amylase Producers
8	Screening of Organic Acid Producers
9	Isolation and Characterization of Actinomycetes
10	Isolation and Characterization of *Azotobacter Species*

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11	Isolation and Characterization of *Rhizobium Species*
12	Isolation of Phosphate Solubilizer *Species*
13	Study of Pure Culture

Reference Books: Practical

1	Experiments in microbiology, Plant Pathology and Biotechnology, K.R. Aneja New Age International Publishers, New Delhi, ISBN 978-81-224-1494-3
2	Practical Pharmaceutical Analytical Chemistry, Alam MM, Akhtar Mymoona, Husain Asif, Shaquiquzzaman M. Elsevier India. ISBN: 9788131225363
3	Microbiological Techniques, N Murugalatha, Lali Growther, J Vimalin Hena, N Hema Shenpagam, R Anitha , D Kanchana Devi, G Rajalakshmi - MJP PUBLISHERS (2019). ISBN: 9788180941078
4	Experimental Microbiology by Rakesh Patel, Volume 1 & 2

Pedagogy:

Direct teaching
Interactive Participative method
Hands on training

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **III**

Course Code:

Course Title: **LAB – II(Enzyme Kinetics and Mechanisms and Elective Course)**

Course Group: **CORE**

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
		8	4			50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Lab-II Syllabus

List of Practicals / Tutorials:

1	Estimation of Reducing Sugar by DNS method
2	Substrate saturation curve
3	Determination pH optimum of invertase enzyme
4	Determination temperature optimum of invertase enzyme
5	Determination time optimum of invertase enzyme
6	Determination of type of inhibition of invertase enzyme
7	Introduction of different database of NCBI
8	Introduction of PIR, ExPasy, EMBL, SCOP,CATH
9	Database introduction- Pfam, Prodom
10	Use of L-ALIGN
11	Clustal-W and Phylogenetic Analysis

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12	Protein Sequence Databases and visualization by RASMOL & SPDBV
13	Homology modeling, structure validation and quality of protein structure
14	*In Silico* study of ligand protein interaction
15	Introduction to Reactome and iPath3 (Metabolic Pathway Databases)

Pedagogy:

Direct teaching
Interactive Participative method
Hands on training

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **III**

Course Code:

Course Title: **BIOINFORMATICS**

Course Group: **ELECTIVE**

Course Objectives:

The course will enable the students to understand the concept of bioinformatics, various types of databases and their importance. This course will enable students to form algorithms and concept of sequence alignments, understanding the phylogenetic relationship among the organisms in evolution. Students will also be able to know the 2D structure and 3D structure of protein which ultimately enable the students to understand the active site prediction, drug design & development.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

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Detailed Syllabus:

Sr.	Contents	Hours
1	**UNIT 1** **Introduction to Bioinformatics:** Overview, Internet and bioinformatics and Applications Introduction and Bioinformatics Resources: Knowledge of various databases and bioinformatics tools available at these resources, the major content of the databases, Literature databases: Nucleic acid sequence databases: GenBank, EMBL, DDBJ Protein sequence databases: SWISS-PROT, PDB, SCOP, CATH Genome Databases at NCBI, EBI Other Databases of Patterns/Motifs/System Biology (Gene and protein network database and resources) Various file formats for bio-molecular sequences: genbank, fasta, gcg, msf, nbrfpir etc. Basic concepts of sequence similarity, identity and homology, Definitions of homologues, orthologues, paralogues, xenologus.	**15**
2	**UNIT 2** **Sequence analysis**: Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series. Sequence-based Database Searches: what are sequence-based database searches, BLAST and FASTA algorithms, various versions of basic BLAST and FASTA. Pairwise and Multiple sequence alignments: basic concepts of sequence alignment, Needleman & Wuncsh, Smith & Waterman algorithms for pairwise alignments, Progressive and hierarchical algorithms for MSA.	**15**
3	**UNIT 3** **Functional genomics** Use of pairwise alignments and Multiple sequence alignment for analysis of Nucleic acid and protein sequences and interpretation of results. Multiple sequence Alignment: CLUSTAL W Definition and description of phylogenetic trees and various types of trees, Molecular basis of evolution, Method of construction of Phylogenetic trees: Distance based method (UPGMA, NJ), Character Based Method (Maximum Parsimony and Maximum Likelihood method)	**15**

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4	**UNIT 4** **Molecular Modeling** Structural classification of proteins, Protein structure analysis, Classes, folds, motif, domain Secondary structure and evaluation: algorithms of Chou Fasman, GOR methods. Tertiary Structure: basic principles and protocols, Methods to study 3D structure. Active site prediction, Protein folding, Protein modeling and drug design	**15**

Reference Books:

1	Bioinformatics: Sequence and Genome Analysis: Mount DW, (2nd edition) (2004). Cold Spring Harbor Laboratory Press, U.S. ISBN: 978-087969712-9
2	Introduction to Bioinformatics by Arthur Lesk 5th edition (2019), Oxford University Press ISBN: 9780198794141
3	Bioinformatics: Methods and Applications: (Genomics, Proteomics and Drug Discovery) S. C. Rastogi, Namita Mendiratta, Parag Rastogi, 4th Edition, (2013). ASIN: B015DY3IJW
4	Ghosh Z and Mallick B, Bioinformatics-Principles and Applications, Oxford University. Press (First Print: 2008; Second Print: 2009). ISBN-13: 978-0-19-56-9230-3
5	Proteins: Structures and molecular properties by Thomas Creighton, 2nd edition (1992), W. H. Freeman, New York ISBN: 9780716723172
6	Molecular Modeling: Principles and Application, (1996), Leach AR, Addison Wesley Longman Limited: Essex, England. ISBN-10 : 0582382106
7	Bioinformatics and functional genomics 3rd edition (2015), John Wiley & Sons, Ltd, UK. ISBN 978-1-118-58178-0
8	Computational Molecular Biology, An Algorithmic Approach Pevzner PA (2000), Springer.

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
3	e-PATHSHALA (https://epathshala.nic.in/)
4	DIKSHA (https://diksha.gov.in/)

Pedagogy:
Direct teaching
Audio visual
Continuous Assessment, Assignments / quiz

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Project Feedback Interactive Participative method Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	**Course Outcome Statements**	**%weightage**
CO-1	Envisages about the concept of bioinformatics and its application. It provides the knowledge of various databases, nucleic acid databases, protein sequence databases, formats of various databases and their importance.	**25**
CO-2	Gathers information regarding concept of scoring matrix, search of databases, algorithms of the BLAST and FASTA. The students will learn the basic concepts of pairwise sequence alignment and multiple sequence alignments.	**25**
CO-3	Deals with the pairwise and multiple sequence alignment for analysis of nucleic acid and proteins sequences. The students will also learn to construct the phylogenetic trees, molecular basis of evolution using different methods	**25**
CO-4	Accords to gain the knowledge of structure of protein, prediction of 2-dimentional, 3-dimentional structure of protein and their algorithms. Students will enable to predict the active site of protein, folding of protein, protein modeling and drug design using software.	**25**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **III**

Course Code:

Course Title: **ADVANCED IMMUNOLOGY**

Course Group: **ELECTIVE**

Course Objectives:

The objective of the course is to give an extension to the basic knowledge of immunology acquired by students earlier as a core subject with emphasis on the applied aspect of the subject. The course provides an insight into the developments in the diagnostic field based on antigen-antibody reaction; the role of the immune system in transplantation and disease development including cancer and autoimmunity and immunodeficiency.

Teaching & Examination Scheme:

11.5			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**UNIT 1** Experimental systems and methods for diagnostics and therapy: Antibody production (polyclonal, monoclonal), Methods to Determine the Affinity (Equilibrium dialysis, surface Plasmon resonance), Microscopic visualization of cells and subcellular structures (Immunocytochemistry, Immunohistochemistry, Immunoelectron microscopy), Immunofluorescence-Based Imaging Techniques of Antigen-Antibody Interactions (Flow cytometry, Magnetic activated cell sorting, cell cycle analysis, assays of cell death).	15

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2	**UNIT 2** T cell Development: Early Thymocyte Development, Positive and Negative Selection, Lineage Commitment, Exit from the Thymus and Final Maturation, Other Mechanisms That Maintain Self-Tolerance, Apoptosis B cell Development: The Site of Hematopoiesis, B-Cell Development in the Bone Marrow, The Development of B-1 and Marginal-Zone B Cells, Comparison of B- and T-Cell Development T-Cell Activation, Differentiation, and Memory: T-Cell Activation and the Two Signal Hypothesis, T-Cell Differentiation, T-Cell Memory B-Cell Activation, Differentiation, and Memory generation: T-Dependent B-Cell Responses, T-Independent B Cell Responses, Negative Regulation of B Cells.	**15**
3	**UNIT 3** Allergy, Hypersensitivity and Chronic inflammation: Allergy: A Type I Hypersensitivity Reaction, Antibody-Mediated (Type II) Hypersensitivity Reactions, Immune Complex-Mediated (Type III) Hypersensitivity, Delayed-Type (Type IV) Hypersensitivity (DTH), Chronic Inflammation Transplantation immunology: Immunological principles of graft rejection, Role of T cells in graft rejection, Role of Blood Group and MHC Antigens in Graft Tolerance, Predictable clinical course of graft rejection, General and target specific immunosuppressive therapy	**15**
4	**UNIT 4** Immunodeficiency disorders: Primary and secondary immunodeficiencies Tolerance and autoimmunity: Establishment and maintenance of tolerance (antigen sequestration, central tolerance, peripheral tolerance), Autoimmunity (Organ specific autoimmune disease, systemic autoimmune disease, intrinsic and extrinsic factors that can favour susceptibility to autoimmune disease, proposed mechanisms for induction of autoimmunity, treatment of autoimmune diseases). Cancer and immune system: Terminology and Common types of cancer, Malignant transformation of cells, Tumor antigens, The Immune Response to Cancer, Cancer immunotherapy.	**15**

Reference Books:

1	Owen, J. A., Punt, J., & Stranford, S. A. (2013). Kuby immunology (7th Edn). New York: WH Freeman
2	I. Kannan (2007), Immunology. MJP Publisher, Chennai.
3	Murphy, K., & Weaver, C. (2016). Janeway's immunobiology(9th Edn) Garland Science
4	Male, D., Brostoff, J., Roth, D., & Roitt, I. (2012). Immunology(8th Edn) With STUDENT CONSULT Online Access. Elsevier Health Sciences

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5	Abbas, A. K., Lichtman, A. H., & Pillai, S. (2014). Cellular and molecular immunology (6th Edn) Elsevier Health Sciences
6	Molecular Modeling: Principles and Application, (1996), Leach AR, Addison Wesley Longman Limited: Essex, England. ISBN-10 : 0582382106

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
3	e-PATHSHALA (https://epathshala.nic.in/)
4	DIKSHA (https://diksha.gov.in/)

Pedagogy:

Direct teaching
Audio visual
Continuous Assessment, Assignments / quiz
Project
Feedback
Interactive Participative method
Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
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Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

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Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	The students will learn about the various methods for antibody production and antibody engineering, which can be then used for diagnostic or treatment purposes. The laboratory/diagnostics techniques based on antigen-antibody reaction, methods to determine antibody affinity etc. The students will also learn about the basis of vaccination and developments in the vaccine production.	**25**
CO-2	The students will learn about the development, differentiation and maturation of B and T lymphocytes, positive and negative selection to rule out self- reactive lymphocytes and memory generation.	**25**
CO-3	The students will learn about the types of the hypersensitivity reactions, factors triggering them and the consequences. They will also learn about the role of the immune system in acceptance or rejection of a graft, in particular MHC and different immunotherapies available to extend the life of a graft.	**25**
CO-4	The students will learn about the types of immunodeficiency and the specific defect in the immune system causing a particular immunodeficiency. The students will also learn about the selection of self-tolerant cells and development of autoimmune diseases due to breakdown of tolerance.	**25**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **III**

Course Code:

Course Title: **MEDICAL BIOCHEMISTRY**

Course Group: **ELECTIVE**

Course Objectives:
The course will enable the students to understand the concept of diagnostics enzymes for different diseases like liver, heart, kidney diseases etc. This course will enable the students in understanding of the concept of organ function tests, biochemistry of diabetes, neurological disorders, cardiovascular problems, AIDS etc.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**UNIT 1** Principles of Diagnostic Enzymology: Serum Enzyme in heart disease, Liver disease, GI tract disease, muscle disease, bone diseases and in Malignancy, clinical importance of Isoenzyme (creatinine kinase and lactate dehydrogenase, Alkaline phosphatise) Disorders of mineral metabolism: Hypercalcaemia, hypocalcaemia, normocalcaemia, hypophosphataemia and hyperphosphataemia. Vitamin : Dietary sources, biochemical functions and specific deficiency diseases Hormones:- Communication among cells & tissues. Hormone - General mechanism of action of hormones, & thyroid hormones. Chemistry & functions of hormones of pancreas, parathyroid and Local hormones. Clinical disorders of hormones, Hormones receptors.	**15**

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2	**UNIT 2** Organ function tests: Liver function tests - Bile pigment metabolism - Jaundice and its types Blood coagulation disorder- Haemoglobinopathies, sickle cell anaemia. Functions of Kidney, Urine formation and renal function tests disease of kidney – Renal Calculi, Theory of formation and analysis, chronic renal failure Gastric Analysis - Composition of gastric juice, concepts of free and bound acid, Fractional Test Meal, Gastric function tests Pancreatic function tests; Thyroid function tests, Cardiac function test, Adrenal function tests.	**15**
3	**UNIT 3** Lifestyle Diseases: Biochemistry of Diabetes mellitus, Atherosclerosis, Fatty liver, and obesity Cardiovascular Problems- Systemic Hypertension and Arteriosclerosis, Stroke Neurological Disorders - Epilepsy, Sleep Disorders, Alzheimer's disease, Parkinson Disease, Huntington's disease. Cancer biology- Mechanism of carcinogenesis, tumor suppressor genes and oncogene, Cancer markers.	**15**
4	**UNIT 4** Infectious Diseases: Introduces the basic methods for infectious disease epidemiology, important disease syndromes and entities Relation between normal microbiota and host, opportunistic microorganisms, Spreading of infectious diseases. Respiratory tract infection- Tuberculosis, Gastrointestinal tract infection, hepatitis (B & C), infective endocarditis and intravascular infections, central nervous system infections. Biochemistry of AIDS.	**15**

Reference Books:

1	Textbook of Medical Biochemistry; (Eight Edition), By Dr (Brig) MN Chatterjea, Rana Shinde; Jaypee Brothers Medical Publishers (P) Ltd. ISBN 10: 9350254840
2	Clinical Biochemistry- Metabolic and Clinical aspects By-William J. Marshall & Stephen K. Angert. Taylor & Francis Group ISBN: 9780824796433
3	Textbook of Biochemistry for Medical Students: D.M. Vasudevan and Sreekumari, S, 6th Edition, 2010, Jaypee Brothers Medical Publishers, New Delhi.

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4	Tietz Textbook of Clinical Chemistry, Third Edition. Carl A. Burtis and Edward R. Ashwood, 4th edition, (2006) ISBN-10 : 0721644724
5	Harper's Illustrated Biochemistry- R.K.Murray, D.K.Grannes and V.W.Rodwell, 26th edition (2000), The McGraw Hill Company. ISBN-0-07-121766-5
6	Infectious Disease Epidemiology: Theory and Practice - Kenrad E. Nelson and Carolyn Masters Williams, 3rd Eds. Printed in the USA. ISBN: 978-1-4496-8379-5

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
3	e-PATHSHALA (https://epathshala.nic.in/)
4	DIKSHA (https://diksha.gov.in/)

Pedagogy:

Direct teaching

Audio visual

Continuous Assessment, Assignments / quiz

Project

Feedback

Interactive Participative method

Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

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Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Deals with the concept of enzymes associated with heart, liver, GI tract muscle diseases. It provides the idea about vitamin, hormones and clinical disorders of hormones and its receptors.	**25**
CO-2	This will enrich the knowledge of different organ function tests like liver, kidney, pancreases, cardiac function test, adrenal function etc.	**25**
CO-3	Explore the consideration of lifestyle diseases such as diabetes, fatty liver, obesity, neurological disorders.	**25**
CO-4	Gather the idea of Infectious disease, host pathogen interaction, infection of respiratory tracts, GI tract infection, hepatitis, AIDS and cancer.	**25**

Curriculum Revision:	
Version:	2nd
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CVM UNIVERSITY
Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **III**

Course Code:

Course Title: **MARINE BIOTECHNOLOGY**

Course Group: **ELECTIVE**

Course Objectives:

The course will enable the students to understand the concept of diagnostics enzymes for different diseases like liver, heart, kidney diseases etc. This course will enable the students in understanding of the concept of organ function tests, biochemistry of diabetes, neurological disorders, cardiovascular problems, AIDS etc.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**UNIT 1** **Fundamentals of Marine Biology:** Biological divisions of the sea- estuaries and backwaters, lagoons, mangroves, coastal waters, inshore, offshore, deep sea/oceanic; Biodiversity of the oceans; marine flora and fauna; Plankton - diversity and their role in the food chain; Plankton blooms and impact on fisheries; Harmful algal blooms; Nekton – abundance, distribution, geographic ranges and patterns of migration; diversity and distribution of Marine reptiles, birds and mammals; Benthos – intertidal and subtidal zones; Marine boring and fouling organisms; marine microorganisms.	15

2	**UNIT 2** **Ocean as a source of food and feed:** Marine food chain and food web, Microbial loop and viral shunt, Ocean as a source of food, Fisheries of Indian seas; marine fish production in India; recent developments in survey of marine fishery resources; concept of sustainable fisheries, fisheries of the important species/groups– demersal, pelagic and deep sea; Decline in fisheries and the need for diversification of mariculture and aquaculture.	**15**
3	**UNIT 3** **Marine natural products:** Isolation and separation of marine natural products (MNP) from marine flora and fauna; Diversity of marine derived compounds - Alkaloid, Terpenoids and steroides, nucleoside, amino acids, Marine Toxins, Marine Enzymes- protease, lipase, chitinase, glucanase. Marine biominerals; Biominerelized structures and Composites-skeletal formations, macro- and microscleres, spicules, spines, bristles, cell walls, cyst walls, loricae; Non-mineralized Structures-bioelastomers like abductin, resilin, gorgonin, spongin; antipathin; Applications of marine natural products.	**15**
4	**UNIT 4** **Algal bioenergy technology:** Bioenergy from micro- and macro-algae, selection of species, biomass processing, bioethanol production, butanol production, Hydrogen production, methane production Biochemical genetic and metabolic engineering of the lipid metabolism; By-products from algal biofuel production; Economic analysis of algal biofuel production; Concept of biorefinery.	**15**

Reference Books:

1	Invitation to Oceanography by Pinet P.R. 2nd edition (2000), Jones and Bartlett Publishers, Sudbury. ISBN: 9780763709143
2	Functional Marine Biomaterials: Properties and Applications, Se-Kwon Kim (Ed.) (2015), CRC Press. ISBN: 9781782420866
3	Textbook of Biochemistry for Medical Students: D.M. Vasudevan and Sreekumari, S, 6th Edition, 2010, Jaypee Brothers Medical Publishers, New Delhi.
4	Tietz Textbook of Clinical Chemistry, Third Edition. Carl A. Burtis and Edward R. Ashwood, 4th edition, (2006) ISBN-10 : 0721644724
5	Harper's Illustrated Biochemistry- R.K.Murray, D.K.Grannes and V.W.Rodwell, 26th edition (2000), The McGraw Hill Company. ISBN-0-07-121766-5
6	Infectious Disease Epidemiology: Theory and Practice - Kenrad E. Nelson and Carolyn Masters Williams, 3rd Eds. Printed in the USA. ISBN: 978-1-4496-8379-5

Supplementary learning Material:	
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4	DIKSHA (https://diksha.gov.in/)

Pedagogy:

Direct teaching
Audio visual
Continuous Assessment, Assignments / quiz
Project
Feedback
Interactive Participative method
Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	**Course Outcome Statements**	**%weightage**
CO-1	Deals with the concept of enzymes associated with heart, liver, GI tract muscle diseases. It provides the idea about vitamin, hormones and clinical disorders of hormones and its receptors.	**25**
CO-2	This will enrich the knowledge of different organ function tests like liver, kidney, pancreases, cardiac function test, adrenal function etc.	**25**
CO-3	Explore the consideration of lifestyle diseases such as diabetes, fatty liver, obesity, neurological disorders.	**25**
CO-4	Gather the idea of Infectious disease, host pathogen interaction, infection of respiratory tracts, GI tract infection, hepatitis, AIDS and cancer.	**25**

CVM UNIVERSITY
Aegis: Charutar Vidya Mandal (Estd.1945)

Curriculum Revision:	
Version:	2nd
Drafted on (Month-Year):	June 2022
Last Reviewed on (Month-Year):	Sept 2022
Next Review on (Month-Year):	April 2023

Faculty Name: SCIENCE

Programme Name: M.Sc MICROBIOLOGY

Semester: 4 Academic Batch: 2022-23

Course Group	Board of Studies / Faculty Ownership	Course Code	Course Name	Cr	Teaching Scheme				Assessment/Evaluation Type		External Exam Duration (Hrs.)		INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
					T	P	Tu	Cont. Hrs	T	P	T	P					
CORE	BIOLOGICAL SCIENCES		Gene regulation and recombinant DNA Technology	4	3		1	4	T		2		50/20	50/20			100/40
CORE	BIOLOGICAL SCIENCES		Environmental Biotechnology	4	3		1	4	T		2		50/20	50/20			100/40
CORE	BIOLOGICAL SCIENCES		Lab I (Gene regulation and recombinant DNA Technology & Environmental Biotechnology)	4		8		8		p		3			50/20	50/20	100/40
VIVA-VOCE	BIOLOGICAL SCIENCES		Comprehensive Viva	1						p						50/20	50/20
ELECTIVE	BIOLOGICAL SCIENCES		Dissertation	12						p						300/120	300/120
	OR																
ELECTIVE	BIOLOGICAL SCIENCES		Developmental Biology	4	3		1	4	T		2		50/20	50/20			100/40
ELECTIVE	BIOLOGICAL SCIENCES		IPR and Biosafety	4	3		1	4	T		2		50/20	50/20			100/40
ELECTIVE	BIOLOGICAL SCIENCES		Lab II (Developmental Biology & IPR and Biosafety)	4		8		8		p		3			50/20	50/20	100/40
			Total	**25**													

 # T = Theory, P = Practical, Tu = Tutorial

Name & Sign [Chairman - Board of Studies]: Dr. Shilpa Gupte

Name & Sign [Dean / Director]: Dr. Basudeb Bakshi

FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **IV**

Course Code:

Course Title: **GENE REGULATION AND RECOMBINANT DNA TECHNOLOGY**

Course Group: **CORE**

Course Objectives:

The objective of this course is to make students understand the transcriptional, translational, and processing level control of gene expression in prokaryotes. This knowledge will then be used to meet the main objective of this course, which is to make the student understand the process of cloning, screening, and expression of genes in heterologous systems.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**UNIT – 1** **Regulation of gene expression** Regulation of gene expression in prokaryotes: Operon concept, positive and negative regulation. Examples of lac and trp operon regulation; global regulatory responses. Regulation of gene expression in eukaryotes: Transcriptional, translational, and processing level control mechanisms.	15

2	**UNIT – 2** **Restriction enzymes & Vectors** General strategies and Steps involved in gene cloning, Extraction and purification of DNA from bacteria, plant and animal cells Restriction enzymes, DNA ligase and other enzymes involved in gene cloning Cloning and expression vectors- Plasmids, - bacteriophages, M-13 based vectors, Phagemids, Cosmids, YAC, BAC, PAC, HAC/MAC, etc. Expression of cloned gene in heterologous host.	**15**
3	**UNIT – 3** **Recombinant selection & screening** Introduction of DNA into the host system. Chemical synthesis of DNA, Construction of genomic and cDNA libraries, Recombinant selection and screening, Southern blotting & hybridization, Northern analysis, Western blot analysis, DNA sequencing, Nucleic Acid Microarray	**15**
4	**UNIT – 4** **Molecular Markers, PCR & Sequencing** Molecular markers (RFLP, RAPD, AFLP, SSR) Polymerase chain reaction (PCR), Types of PCR DNA sequencing and its assembly: Maxam -Gilbert and Sanger's methods, Shotgun sequencing, Next generation sequencing strategies for large genomes.	**15**

Reference Books:

1	Genetic Engineering by Smita Rastogi and Neelam Pathak, Oxford Higher Education, ISBN 0-19-569657-3
2	Molecular Genetics of Bacteria by Larry Snyder and Wendy Champness, 3rd Edition, ASM Press ISBN :1555813992
3	Genomes by T. A. Brown, 3rd Edition, 2007, Taylor and Francis (New York), ISBN 0815341385
4	Molecular Biotechnology: Principles and Applications of Recombinant DNA by Bernard R. Glick, Jack J. Pasternak and Cheryl L. Patten, 4th Edition, 2010, Wiley Publishers, ISBN 978-1-555-81498-4
5	Principles of Gene Manipulation and Genomics by S. B. Primrose & R. M. Twyman, 7th Edition, 2006, Wiley-Blackwell, ISBN 978-1-405-13544-3
6	Applied Molecular Genetics by Roger L. Miesfeld, 1999, Wiley, ISBN 978-0-471-15676-5
7	Textbook of Biotechnology by H. K. Das 4th Edition, 2010, Wiley ISBN-10 : 8126526513

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
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4	DIKSHA (https://diksha.gov.in/)

Pedagogy:

Direct teaching
Audio visual
Continuous Assessment, Assignments / quiz
Project
Feedback
Interactive Participative method
Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weight age
CO-1	Students should be able to acquire basic knowledge of regulation of prokaryotic gene expression at different levels.	**25**
CO-2	Students should know about different types of enzymes and vectors that are used in recombinant DNA technology.	**25**
CO-3	Students should have understood the process of transferring the cloned DNA in another host by different methods and various screening methods to select the transformed cells from the non-transformed cells.	**25**
CO-4	Students should have learnt advanced selection and screening techniques including molecular markers, PCR and sequencing.	**25**

Curriculum Revision:	
Version:	2nd
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CVM UNIVERSITY
Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **IV**

Course Code:

Course Title: **ENVIRONMENTAL BIOTECHNOLOGY**

Course Group: **CORE**

Course Objectives:

The major objective of this paper is to impart knowledge about waste water management. Different aerobic and anaerobic wastewater treatment plants are discussed. It covers different aspects of bioremediation in terms of various kinds of pollutants. Special emphasis is given on the role of microbes and their enzymes in toxicity analysis and role of GMOs.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**UNIT – 1** Wastewater treatment- Physical, Chemical and Biological characterization of Wastewater and its significance: Temperature, pH, Solids, Inorganic constituents, BOD, COD, TOC, TOD, biological components. Critical operating parameters like DO, hydraulic retention time, mean cell residence time, F/M ratio etc Wastewater treatment processes: Primary, secondary and tertiary treatment of wastewater. **Suspended growth processes:** Activated sludge process: Biology of activated sludge, flocculation and sludge settling, problems of sludge settling, modified processes for inorganic nitrogen and phosphorous removal, Oxidation ditches and Waste stabilization ponds. **Fixed film processes:** Biofilm formation, Trickling filters, Rotating biological contactors, fluidized bed and submerged aerated filters.	**15**
2	**UNIT – 2** Anaerobic digestion: Microbial and Biochemical fundamentals of anaerobic digestion process, factors influencing anaerobic digestion. Anaerobic wastewater treatments: Anaerobic Digesters, Up Flow Anaerobic Sludge Blanket (UASB), Rotating Biological Contactors (RBCs), anaerobic filters. Merits and demerits of anaerobic treatment of waste. Composting: Objectives, fundamentals, microbiology, factors influencing composting, composting systems, Compost quality and uses, Vermicomposting. Toxicity testing in wastewater treatment plants using microorganisms.	**15**
3	**UNIT – 3** Biodegradation of organic pollutants: Xenobiotic and recalcitrant organic compounds, mechanisms of biodegradation, factors affecting biodegradation, Acclimation phase in biodegradation. Biodegradation of simple aliphatic, aromatic, polycyclic aromatic hydrocarbons, halogenated hydrocarbons Microbial degradation of azo dyes and lignin	**15**

4	**UNIT – 4** Bioremediation approaches: Intrinsic bioremediation, Biostimulation, Bioaugmentation: Use of Genetically Modified Organisms (GMOs). *In situ* and *ex situ* bioremediation technologies with examples Bioremediation of heavy metal pollution, Phytoremediation Biological treatment of waste gas (polluted air): biofilters, bio scrubbers, bio trickling filters.	**15**

Reference Books:

1	Wastewater microbiology by Gabriel Bitton, 3rd Edition, Wiley & Sons INC Publication, ISBN- 0-471-65071-4
2	Biotechnology: Environmental Processes I, by H. J Rehm and G. Reed, Volume 11, 2nd Edition, Wiley & Sons INC Publication
3	Environmental Biotechnology: Concepts and Applications by Hans-Joachim Jördening and Josef Winter, Wiley & Sons INC Publication
4	Waste water treatment for pollution control by Soli J. Arceivala, 2nd edition.TataMcGrawHill Publishing Company Limited, ISBN: 0-07-463002-4.
5	Handbook of water and wastewater Microbiology by Doncan Mara and Nigel Horan, 1st Edition, Elsevier Publication

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
3	e-PATHSHALA (https://epathshala.nic.in/)
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Pedagogy:

Direct teaching
Audio visual
Continuous Assessment, Assignments / quiz
Project
Feedback
Interactive Participative method
Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						R: Remembering; U: Understanding; A: Applying; N: Analyzing; E: Evaluating; C: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Students should be able to describe the role of microbes in solid and liquid waste management, gaining knowledge of various methods employed in sewage treatment. Also knows about potability of water and its quality control.	**25**
CO-2	Students should Understand the role of anaerobic microbes in management of wastewater treatment plants. It will be helpful to apply knowledge in designing microbe-based processes for preparation of compost or manure. The content becomes useful under the role of microbes or its enzymes in toxicity analysis.	**25**
CO-3	Students should understand the role of microbes in bioremediation of environmental pollutants like aliphatic, aromatic, polyaromatic hydrocarbons, pesticides, dyes etc.	**25**
CO-4	Students should understand various bioremediation approaches, use of GMO in bioremediation. The content will make the students aware of the role of plants in heavy metal removal and how microbes can be useful for the treatment of waste gases.	**25**

Curriculum Revision:	
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Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **IV**

Course Code:

Course Title: **LAB - I ((Gene regulation and recombinant DNA Technology & Environmental Biotechnology)**

Course Group: **CORE**

Course Objectives:

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
		8	4			50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Lab- I Syllabus:

List of Practicals :

1	Isolation of plasmid DNA by boiling lysis method.
2	Isolation of plasmid DNA by Alkaline lysis method.
3	Large scale preparation of plasmid with chloramphenicol amplification.
4	Preparation of competent cells of *E.coli*
5	Transformation of artificially induced competent cells of *E.coli* by
6	plasmid DNA.
7	Cloning of gene in *E.coli*
8	Expression of cloned gene.
9	Restriction digestion.
10	Demonstration of DNA amplification by PCR
11	Alkalinity and Acidity

12	Estimation of Dissolved Oxygen (DO)
13	Determination of BOD of sewage
14	Determination of COD sewage
15	Estimation of Total Solids (TS)
16	Estimation of Total Suspended Solids (TSS)
17	Estimation of Total Dissolved Solids (TDS)
18	Estimation of available phosphorous by Stannous chloride method.
19	Estimation of Nitrate-Nitrogen (NO_3-N) by Brucine Sulfate method.
20	Estimation of Nitrite-Nitrogen (NO_2-N) by colorimetric method.
21	Estimation of Ammonia (NH_4^+ -N) by Nitroprusside Method.

Reference Books:

1	Handbook of Methods in Environmental Studies, Vol:1 Water and Wastewater Analysis by S.K. Maiti, ABD Publishers, Jaipur (India), 2nd Edition, ISBN: 81-8577-34-0
2	Standard Methods for the Examination of water and wastewater, 20th Edition, Prepared and published jointly by American Public Health Association, American water works association and Water Environment Federation

Pedagogy:

Direct teaching

Interactive Participative method

Hands On training

Curriculum Revision:	
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CVM UNIVERSITY
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **IV**

Course Code:

Course Title: **DEVELOPMENTAL BIOLOGY**

Course Group: **ELECTIVE**

Course Objectives:

The major objective of this paper is to impart knowledge about the process of embryogenesis, organogenesis and role of different stem cells. It covers the role of protooncogenes, effect of oncogenes and aging process. Special emphasis will be given to understand gene expression during mammalian development and different genetic disorders.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**UNIT – 1** **Overview of embryogenesis in mammals** Structures of spermatozoa and ovum Fertilization, Cleavage and blastulation, Gastrulation Organogenesis and Stem cells Sex determination in mammals, Types and functions of stem cells Development of human brain Epidermis and the origin of cutaneous structures	15
2	**UNIT – 2** **Teratogenesis and Aging** Teratogenic agents, Classification of teratomas, Tumerogenesis Overview of tumor suppressor genes, protooncogenes and oncogenes Causes and genetic regulation of aging, Promoting longevity	15

3	**UNIT – 3** **Gene expression during Developmental** Differential gene expression during development RNA localization techniques Determination of functions of genes Overview of transcriptional factors and human development	**15**
4	**UNIT – 4** **Medical implications of Developmental biology** Genetic errors of human development, Identification of defective genes Nature of human syndromes, Gene expression and human diseases Infertility	**15**

Reference Books:

1	Scott F Gilbert, Developmental Biology, 8th edition, Sinauer Associates Inc., USA. ISBN 0-87893-250-X
2	Shastry and Shukal, Developmental Biology, Rastogi Publications, ISBN 81-7133-734-1
3	Klug W. S. & Cummings M. R. Concepts of Genetics. 7th edition. Pearson Education. ISBN 81-317-0811-X
4	Fundamentals of Genetics by B D Singh.
5	P. K. Gupta, Genetics. Rastogi Publications, Meerut, India, ISBN: 81-7133-842-9.
6	Gardner E. J., Simmons M. J. & Snustad D. P. Principles of Genetics. 8th edition. John Wiley & Sons Inc. ISBN 9971-51-346-3.
7	Elements of Breeding and breeds of cattle and Buffalo- P Kanakraj, Jaypee Brothers Medical, ISBN:978-8180618420

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
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Pedagogy:

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Feedback
Interactive Participative method
Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	**Course Outcome Statements**	**%weightage**
CO-1	The student will know the process of embryogenesis, organogenesis and role of different stem cells.	**25**
CO-2	The student is able to understand classification teratomas and teratogenesis. They will also know the role of tumor suppressor genes, protooncogenes, oncogenes and how the aging process is regulated.	**25**
CO-3	The student will be able to understand gene expression during mammalian development. They will come to know the functions of different genes, transcriptional factors, and their role in human development.	**25**
CO-4	The student will know about different genetic errors that occur at the time of human development. They will know the nature of human syndrome, Gene expression and different human diseases related to Infertility.	**25**

Curriculum Revision:	
Version:	2nd
Drafted on (Month-Year):	June 2022
Last Reviewed on (Month-Year):	Sept 2022
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **IV**

Course Code:

Course Title: **IPR AND BIOSAFETY**

Course Group: **ELECTIVE**

Course Objectives:

The objectives of this course are to provide basic knowledge on intellectual property rights and their implications in biological research and product development. This course enables the student to become familiar with India's IPR Policy to learn biosafety and risk assessment of products derived from biotechnology and regulation of such products.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**UNIT – 1** **Need for Intellectual Property Rights** Introduction to history of ITO, GATT, WTO, WIPO and TRIPS; plant variety protection and farmer's rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation	15
2	**UNIT – 2** **Intellectual Property Rights & Its Types** Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP.	15

3	**UNIT – 3** **Patenting** Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting - disclosure/non-disclosure - patent application - forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and conventional patent applications; international patenting-requirement, procedures and costs; financial assistance for Patenting introduction to existing schemes	**15**
4	**UNIT – 4** **Biosafety** Biosafety and Biosecurity - introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops.	**15**

Reference Books:

1	Bioethics and Biosafety, M.K. Sateesh. I.K. International Pvt. Ltd., ISBN 8190675702
2	Bioethic and Biosafety in Biotechnology by V. Sree Krishna. New Age International Publishers, ISBN (10) : 81-224-2248-9.
3	IPR, Biosafety and Bioethics by Deepa Goel, Shomini Parashar
4	Biotechnology IPRs Biodiversity by Manjula Guru, M. B. Rao. Pearson Longman, ISBN 9788131701355.
5	Patent, Copyright Trademark An Intellectual Property Desk Reference by Richard Stim Attorney 9th Edition Nolo Publishers
6	The Patents Act 1970
7	WIPO Intellectual Property Handbook: Policy, Law and Use by World Intellectual Property Organization. WIPO 2004 2nd Ed, ISBN 92-805-1291-7
8	An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology by Padma Nambisan, Academic Press, ISBN: 978-0-12-809231-6

9	Intellectual Property Rights: Text and Cases by Dr. R Radhakrishnan and Dr. S Balasubramanian, Excel Books
10	WTO and Intellectual Property Rights by Talwar Sabanna, Serials Publications.

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
3	e-PATHSHALA (https://epathshala.nic.in/)
4	DIKSHA (https://diksha.gov.in/)

Pedagogy:

Direct teaching
Audio visual
Continuous Assessment, Assignments / quiz
Project
Feedback
Interactive Participative method
Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

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R	**U**	**A**	**N**	**E**	**C**	
25	25	15	15	15	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	**Course Outcome Statements**	**%weightage**
CO-1	Students should know the origin of IPR and its relevant history along with different organizations which led to the current state of IPR in order to better appreciate it.	**25**
CO-2	Students should be able to understand the IPR, its types and the type of legal rights it provides to the owner.	**25**
CO-3	Students should know about different types of Patents, procedure for filing a patent, their rights and different organizations across the globe who accepts patents.	**25**

CO-4	Students should have understood the concept of Biosafety, Biological and Physical level of containment, Risk assessment, GLP, GMP etc.	**25**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.SC. MICROBIOLOGY**

Semester: **IV**

Course Code:

Course Title: **LAB - II (Developmental Biology and IPR and Biosafety)**

Course Group: **ELECTIVE**

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
		8	4			50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Lab-II Syllabus:

List of Practicals :

1	To study the morphology and motility of sperm.
2	To study the viability of sperm.
3	To perform Acrosomal integrity tests.
4	To study different stages of embryogenesis.
5	To study different developmental stages of frog embryos.
6	To study different developmental stages of the chick embryo.
7	Design of r-DNA laboratory
8	Various methods to discard the bio-hazardous waste
9	Introduction to intellectual property
10	Method to handle the recombinants
11	Patent case study

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Reference Books:

1	Molecular cloning : a laboratory manual by Joseph Sambrook; E F Fritsch; Tom Maniatis, 2nd Edition, Cold Spring Harbor Laboratory, 1989.
2	https://rcb.res.in/upload/Biosafety_Guidelines.pdf
3	https://dbtindia.gov.in/guidelines-biosafety
4	https://ipindia.gov.in

Pedagogy:
Direct teaching Interactive Participative method Case Study Hands on training

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