University of Mumbai

No. AAMS_UGS/ICC/2024-25/186

CIRCULAR:-

Attention of all the Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head University Departments is invited to this office Circular No. AAMS_UGS/ICC/2023-24/23 dated 08th September, 2023 relating to the NEP UG & PG Syllabus.

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Microbiology at its meeting held on 30th September, 2024 and subsequently passed by the Board of Deans at its meeting held on 23rd October, 2024 **vide** item No. 6.4 (N) has been accepted by the Hon'ble Vice Chancellor as per the powers confirmed upon him under Section 12(7) of the Maharashtra Public Universities Act, 2016 and that in accordance therewith syllabus for **M.Sc. (Microbiology) Sem – III & IV** is introduced as per appendix (NEP 2020) with effect from the academic year 2024-25.

(The said circular is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
08th November, 2024

(Dr. Prasad Karande)
REGISTRAR

To,

The Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head, University Departments.

BOD/6.4 (N)/23/10/2024

Copy forwarded with Compliments for information to:-

1) The Chairman, Board of Deans,
2) The Dean, Faculty of Science & Technology,
3) The Chairman, Board of Studies in **Microbiology,**
4) The Director, Board of Examinations and Evaluation,
5) The Director, Department of Students Development,
6) The Director, Department of Information & Communication Technology,
7) The Director, Centre for Distance and Online Education (CDOE), Vidyanagari,
8) The Deputy Registrar, Admissions, Enrolment, Eligibility & Migration Department (AEM).

Copy forwarded for information and necessary action to :-	
1	The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Dept)(AEM), dr@eligi.mu.ac.in
2	The Deputy Registrar, Result unit, Vidyanagari drresults@exam.mu.ac.in
3	The Deputy Registrar, Marks and Certificate Unit,. Vidyanagari dr.verification@mu.ac.in
4	The Deputy Registrar, Appointment Unit, Vidyanagari dr.appointment@exam.mu.ac.in
5	The Deputy Registrar, CAP Unit, Vidyanagari cap.exam@mu.ac.in
6	The Deputy Registrar, College Affiliations & Development Department (CAD), deputyregistrar.uni@gmail.com
7	The Deputy Registrar, PRO, Fort, (Publication Section), Pro@mu.ac.in
8	The Deputy Registrar, Executive Authorities Section (EA) eau120@fort.mu.ac.in He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to the above circular.
9	The Deputy Registrar, Research Administration & Promotion Cell (RAPC), rapc@mu.ac.in
10	The Deputy Registrar, Academic Appointments & Quality Assurance (AAQA) dy.registrar.tau.fort.mu.ac.in ar.tau@fort.mu.ac.in
11	The Deputy Registrar, College Teachers Approval Unit (CTA), concolsection@gmail.com
12	The Deputy Registrars, Finance & Accounts Section, fort draccounts@fort.mu.ac.in
13	The Deputy Registrar, Election Section, Fort drelection@election.mu.ac.in
14	The Assistant Registrar, Administrative Sub-Campus Thane, thanesubcampus@mu.ac.in
15	The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan, ar.seask@mu.ac.in
16	The Assistant Registrar, Ratnagiri Sub-centre, Ratnagiri, ratnagirisubcentre@gmail.com
17	The Director, Centre for Distance and Online Education (CDOE), Vidyanagari, director@idol.mu.ac.in
18	Director, Innovation, Incubation and Linkages, Dr. Sachin Laddha pinkumanno@gmail.com
19	Director, Department of Lifelong Learning and Extension (DLLE), Dlleuniversityofmumbai@gmail.com

Copy for information :-	
1	P.A to Hon'ble Vice-Chancellor, vice-chancellor@mu.ac.in
2	P.A to Pro-Vice-Chancellor pvc@fort.mu.ac.in
3	P.A to Registrar, registrar@fort.mu.ac.in
4	P.A to all Deans of all Faculties
5	P.A to Finance & Account Officers, (F & A.O), camu@accounts.mu.ac.in

To,

1	The Chairman, Board of Deans pvc@fort.mu.ac.in
2	**Faculty of Humanities,** **Dean** 1. Prof.Anil Singh Dranilsingh129@gmail.com **Associate Dean** 2. Dr.Suchitra Naik Naiksuchitra27@gmail.com 3.Prof.Manisha Karne mkarne@economics.mu.ac.in
	Faculty of Commerce & Management, **Dean** 1. Dr.Kavita Laghate kavitalaghate@jbims.mu.ac.in **Associate Dean** 2. Dr.Ravikant Balkrishna Sangurde Ravikant.s.@somaiya.edu 3. Prin.Kishori Bhagat kishoribhagat@rediffmail.com

	Faculty of Science & Technology **Dean** 1. Prof. Shivram Garje ssgarje@chem.mu.ac.in **Associate Dean** 2. Dr. Madhav R. Rajwade Madhavr64@gmail.com 3. Prin. Deven Shah sir.deven@gmail.com
	Faculty of Inter-Disciplinary Studies, **Dean** 1.Dr. Anil K. Singh aksingh@trcl.org.in **Associate Dean** 2.Prin.Chadrashekhar Ashok Chakradeo cachakradeo@gmail.com
3	Chairman, Board of Studies,
4	The Director, Board of Examinations and Evaluation, dboee@exam.mu.ac.in
5	The Director, Board of Students Development, dsd@mu.ac.in@gmail.com DSW direcotr@dsw.mu.ac.in
6	The Director, Department of Information & Communication Technology, director.dict@mu.ac.in

BOD – 23/10/2024
12 (7) of M.P.U.A. 2016
Item No. – 6.4 (N)

As Per NEP 2020

University of Mumbai

Title of the P.G. Program

M.Sc. (Microbiology)

Syllabus for

Semester – Sem.- III & IV
Ref: GR dated 16th May, 2023 for Credit Structure of PG

(With effect from the academic year 2024-25)

University of Mumbai

(As per NEP 2020)

Sr. No.	Heading	Particulars
1	Title of program O:_____	M.Sc. (Microbiology)
2	Scheme of Examination R: _____	NEP 50% Internal 50% External, Semester End Examination Individual Passing in Internal and External Examination
3	Standards of Passing R: _____	40%
4	Credit Structure R: SP-75 B	Attached herewith
5	Semesters	Sem. III & IV
6	Program Academic Level	6.5
7	Pattern	Semester
8	Status	New
9	To be implemented from Academic Year	2024-25

Sign of the BOS Coordinator
Dr. Aparna Dubhashi
BOS in Microbiology

Sign of the Offg. Associate Dean
Dr. Madhav R. Rajwade
Faculty of Science & Technology

Sign of the Offg. Dean
Prof. Shivram S. Garje
Faculty of Science & Technology

Preamble

This two-year M. Sc. program is designed to develop competent Microbiologists who can progress in diverse fields of microbiological interests that include industry, research, teaching, medical science, and entrepreneurship. The course is aimed at adding to the knowledge base of Microbiology graduates through significant inputs of the latest information on the subject. It also envisages that the students read original research publications and develop the ability of critical evaluation of the study.

The aims of the course will enhance the basic knowledge of microbiology graduates. The course ensures that the learners develop the habit of reading original research papers and hence the ability of critical analysis of the study. The main objective of this program is the planning and execution of laboratory work as well as teamwork. It will help the students to develop communication skills and creative minds. In the core courses, the students study the basics of Microbiology along with the basics of subjects allied to and useful in Microbiology. The specializations and subject-specific elective courses include topics such as Cell Biology, Genetics, Molecular Biology, Biochemistry, Medical Microbiology, Environmental and Food microbiology, proteomics, bioanalytical instrumentation, and Immunology in the first year and second year of the program.

Students are required to undergo during summer vacation in the first year for 120 Hrs. on-job training program/field project and take up online courses as a part of their internal evaluation for Sem. I,II,III &IV. The student should study microbiological aspects in the industry and submit their report. They will also have to write a research proposal in Sem.III as a part of their curricula. This will prepare them well for the Research Project to be taken in the final Semester. Students will have to undertake an educational tour organized by the Department each year) to diverse places of Microbiological interest /Research institutions compulsorily for understanding the practical aspects of the subject.

1) Credit Structure of the Program (Sem I, II, III & IV) (Table as per Parishisht 1 with sign of BOS, Microbiology and Dean)

NEP Syllabus -Microbiology - MSC -Part 1-Semester I					
Semester	**Course Number**	**Course Title**	**Credits**		**Cumulative Credits**
Level 6.0		Major -Core courses	Theory	Practical	
I	I	Molecular basis of genetic disorders	04	–	04
I	II	Medical Microbiology	04	–	04
I	III	Microbial Biochemistry and Bioinformatics	02	–	02
I	IV	Practicals based on Course 1, 2 and 3	–	04	04
I	V	DSE (Any One)-Role of microorganisms in Food technology	02		02
I	VI	Practicals Based on DSE- Role of microorganisms in Food technology **OR**		02	02
I	VII	DSE (Any One)- Microbial Biotechnology	02		02
I	VIII	Practicals based on Microbial Biotechnology		02	02
I	IX	Research Methodology	04		04
		Cumulative Credits	**16**	**06**	**22**

NEP Syllabus -Microbiology - MSC -Part 1-Semester II					
Semester	Course Number	Course Title	Credits		Cumulative Credits
			Theory	Practicals	
II	I	Eukaryotic gene expression	04	–	04
II	II	Clinical Microbiology and Applied Immunology	04	–	04
II	III	Applied Biochemistry and Molecular Biology	02	–	02
II	IV	Practicals based on Course 1, 2 and 3	–	4	04
II	V	DSE (Any One)- Environmental Microbiology	02	–	02
II	VI	Practicals based on Environmental Microbiology **OR**	–	02	02
II	VII	DSE(Any One)- Advances in Industrial Microbiology	02	–	02
II	VIII	Practical based on Advances in Industrial Microbiology	–	02	02
II	IX	On-Job Training (OJT) /Field Project (FP)		04	04
		Cumulative Credits for PG Diploma	**12**	**10**	**22**
Exit Option: PG Diploma (44 credits) after Three Year UG Degree					

R: SP-75 B

NEP Syllabus -Microbiology - MSC -Part II-Semester III					
Semester	**Course Number**	**Course Title**	**Credits**		**Cumulative Credits**
		Major -Core courses	Theory	Practicals	
III	I	Pharmaceutical & Cosmetic Microbiology	04	-	04
III	II	Cell Biology	04	-	04
III	III	Tools and Techniques in Microbiology	02	-	02
III	IV	Practicals Based on Pharmaceutical & Cosmetic Microbiology, Cell Biology and Tools and Techniques in Microbiology	-	04	04
III	V	DSE (Any One) Algal Technology and Bacteriophages	02	–	02
III	VI	Practicals based on Algal Technology and Bacteriophages **OR**	–	02	02
III	VII	DSE(Any One)- Advances in Biotechnology	02	–	02
III	VIII	Practicals based on Advances in Biotechnology	–	02	02
III	IX	Research Proposal		04	04
III		**Cumulative Credits**	**12**	**10**	**22**

NEP Syllabus -Microbiology - MSC -Part II-Semester IV					
Semester	**Course Number**	**Course Title**	**Credits**		**Cumulative Credits**
			Theory	Pract	
IV	I	Industrial & Food Microbiology	04	-	04
IV	II	Applied Microbiology and Agriculture	04	-	04
IV	III	Practicals Based on Industrial, Food and Applied Microbiology & Agriculture	–	04	04
IV	IV	DSE (any one)- Applications of Microbial technology in food processing	02	–	02
IV	V	Practicals based on Applications of Microbial technology in food processing **OR**	–	02	02
IV	VI	DSE (Any One)-Plant and Animal Biotechnology	02	–	02
IV	VII	Practicals based on Plant and Animal Biotechnology	–	02	02
IV	VIII	Research Project	–	06	06
IV		**Cumulative Credits**	**10**	**12**	**22**
Exit Option: PG Diploma (44 credits) after Three Year UG Degree					

Coordinator
BOS, Microbiology

Dean,
Science and Technology
University of Mumbai

Sr.No.	Heading	Particulars
1	**Description the course : Including but Not limited to:**	The course aims at the different process and work culture in the Cosmetic, Pharmaceutical, Food industries, providing depth knowledge wrt regulations and audit procedures, understanding cellular structures, the significance of IPR and patents in Biotechnology, acquire knowledge about probiotics and prebiotics, role of microbiology in pollution control and remediation, novel uses of microorganisms and their products. The contribution of the subject will be awareness of the Microbiology applications, skill development and prepare the students for job market.
2	**Vertical :**	Major and DSE
3	**Type :**	Theory / Practical
4	**Credits :**	44 Credits (1 Credit=15 Hrs. for Theory or 30 Hrs. of Practical work in a semester)
5	**Hours Allotted :**	Core :60 Hrs. / 120 Hrs. Minor / DSE : 30 Hrs./60 Hrs.
6	**Marks Allotted:**	Core : 100 Mks. Minor / DSE- 50 Mks.
7	**Course Objectives**	
	Course Objectives- Pharmaceutical & Cosmetic Microbiology 1.To understand different processes and work culture in the pharmaceutical & cosmetic Industry. 2. Providing in-depth knowledge with respect to regulations and audit procedures carried out in an industry. **Course Objectives- Cell Biology** 1.Understand basic cellular structures. 2.Understand advanced cellular processes in eukaryotes. 3.Understand protein transport and export in prokaryotes and eukaryotes, molecular basis of cell division, signalling pathways. **Course Objectives- Tools and Techniques in Microbiology** 1.Describing the methods of chromatography and their applications to achieve understanding of advanced analytical techniques used in analysis of biological samples. 2.Understanding the current scenario of identification of microbial species using different molecular techniques. **Course Objectives- DSE - Algal Technology and Bacteriophages**	

	1.To understand the importance of algal biotechnology. 2.To study different phages infecting bacteria, fungi and algae **Course Objectives- DSE- Advances in Biotechnology** 1. To develop a comprehensive understanding of fundamental concepts in Intellectual Property Rights (IPR) and Bioethics. 2. To comprehend the various types of IPR and the fundamental steps involved in filing a patent. 3. Evaluate bioethical issues related to genetic engineering, cloning, and bioprospecting, and their intersections with IPR. 4. To learn the principles of nanobiotechnology.
8	**On completion of this course learner will be able to:** **Course Outcome- Pharmaceutical & Cosmetic Microbiology** Equipped with risk assessment tools and process understanding to make them skilled and competent as per job requirement **Course Outcome-Cell Biology** 1.-Understand the structure and compartmentalisation of organelles, protein export, protein sorting. 2.-Understand the events of cell cycle and its regulation. 3.- Explain the communications of cells with other cells and to the environment **Course Outcome- Tools and Techniques in Microbiology** 1.Be able to learn instrumentation which will help them in their professional career. 2.Be able to gain analytical and interpretative skills which is critical for working in the laboratory. **Course Outcome- Applied Microbiology and Agriculture** 1.To understand the role of microbiology in pollution control and remediation. 2.To study the applications of various enzymes and biomolecules. 3.To assess the novel uses of microorganisms and microbial products **Course Outcome- DSE- -Algal Technology and Bacteriophages** 1.Learn the culturing and application of algal technology. 2.Understand replication of different microbial phages **Course Outcome- DSE- Advances in Biotechnology** 1.To equip students with both theoretical knowledge and practical skills, enabling them to navigate the complexities of IPR and bioethics in various Professional contexts Learn the bioethical guidelines in Biotechnology and Microbiology. 2. Relate to various applications of nano biotechnology
9	**Modules:- Modules:- Sem. III -** Core Course - Credits - 04+04+02+04 DSE - Credits - 02+02 Research Proposal - 04 **Sem. IV -** Core Course - Credits - 04+04+04 DSE - Credits - 02+02 Research Project - Credits - 06 ● 1 Module=1 Credit = 15 Hrs. Theory / 30 Hrs. Practical

Sem.III	**Course -I**	**Pharmaceutical & Cosmetic Microbiology**		**60 Lec.**	**4 Credits**
		Module I	Introduction to Pharmaceutical Microbiology	15 Lec.	1 Credit
		Module 2	Pharmaceutical Analysis and Regulation	15 Lec.	1 Credit
		Module 3	Cosmetic Microbiology	15 Lec.	1 Credit
		Module 4	Audit, Validation & Documentation	15 Lec.	1 Credit
Sem. III	**Course -I**	**Modules**	**Description**	**Lec.**	**Credits**
		Module 1	**Introduction to Pharmaceutical Microbiology**	**15 Lec.**	**1 Credit**
		1.1	Role of microbiology in pharmaceutical industry	3	
		1.2	GMP and Regulation	2	
		1.3	Laboratory management and guidelines for documentation in pharmaceutical industry	5	
		1.4	Bioburden determination and Microbiology laboratory techniques	2	
		1.5	Specified and objectionable microorganisms and media for their cultivation	3	
		Module 2	**Pharmaceutical Analysis and Regulation**	**15 Lec.**	**1 Credit**

		2.1	Assessment of pharmaceutical water systems and Endotoxin and pyrogen testing	4	
		2.2	Cleaning, disinfection, sterilization, Clean rooms and environmental monitoring	3	
		2.3	Rapid microbiological methods	3	
		2.4	Risk assessment, Use of Biological indicators for measuring sterilization	2	
		2.5	Good manufacturing practices for pharmaceutical products, Pharmaceutical Legislation & Regulation and quality control in the pharmaceutical industry.	3	
		Module 3	**Cosmetic Microbiology**	**15 Lec.**	**1 Credit**
		3.1	History of Cosmetic Microbiology, Preservation of cosmetics	2	
		3.2	Antimicrobial preservative efficacy & microbial content testing	3	
		3.3	Microbiology Laboratory methods in support of sterility Assurance System	3	
		3.4	Bio burden testing &	3	

			Environmental monitoring		
		3.5	Sampling: Principles and Practice	4	
		Module 4	**Audit, Validation & Documentation**	**15 Lec.**	**1 Credit**
		4.1	Microbiological hazard analysis & audit Validation	3	
		4.2	IS and ISO standards: 9000, 17025.	3	
		4.3	Introduction to Validation and documentation	5	
		4.4	Auditing sterilization processes and facilities	4	
		References	**Module 1.-** 1. Pharmaceutical Microbiology: Essentials for Quality Assurance and Quality Control Tim Sandle. Woodhead Publishing 2. WHO Guidelines for preparing a laboratory information file **Module 2.-** 1. Pharmaceutical Microbiology: Essentials for Quality Assurance and Quality Control Tim Sandle. Woodhead Publishing 2. WHO good practices for pharmaceutical quality control laboratories:Annexure 1		

			3.WHO good manufacturing practices for pharmaceutical products: main principles1:Annexure 2 **Module 3.-** 1. Cosmetic Microbiology: A practical Approach, 2nd edition. Philip A Geiss. Taylor & Francis group. 2. Microbiology in Cosmetics – Challenges inCosmetic Manufacturing DONALD J. ENGLISH **Module 4.-** 1. Handbook of Microbiological Quality Control for Pharmaceuticals and Medical Devices, Rosamund M.Baird, Stephen P.Denyer, Norman Hodges 2. International standard ISO/IEC-17025 ,Third edition,2017-11 3. Validation Standard Operating Procedures - A Step-by-Step Guide for Achieving Compliance in the Pharmaceutical, Medical Device, and Biotech Industries by Syed Imtiaz Haider, 4. Sterility, sterilization and sterility assurance for pharmaceuticals. by Tim Sandle		

Sem.III	**Course II**	**Cell Biology**		**60 Lec.**	**4 Credits**
		Module 1	Cytoplasmic Membrane Systems and Membrane Trafficking	15 Lec.	1 Credit
		Module 2	Cytoskeleton and cellular Interactions	15 Lec.	1 Credit
		Module3	Cell Cycle, Cell Division and Cell Junctions	15 Lec.	1 Credit
		Module 4	Cell Communication and Multicellular Cell Development	15 Lec.	1 Credit
Sem.III	**Course II**	**Modules**	**Description**	**Lec.**	**Credits**
		Module 1	**Cytoplasmic Membrane Systems and Membrane Trafficking**	**15 Lec.**	**1 Credit**
		1.1	Overview of the Endomembrane System, Approaches to the Study of Endomembranes	3	
		1.2	Endoplasmic Reticulum, Functions of the Rough Endoplasmic Reticulum, The Golgi Complex, Destruction of Misfolded Proteins, Lysosomes, Plant Cell Vacuoles, Peroxisomes	5	
		1.3	Types of Vesicle Transport, Exocytosis, Endocytosis, Endocytic Pathway, Phagocytosis	4	
		1.4	Posttranslational Uptake of Proteins by	3	

			Peroxisomes, Mitochondria, and Chloroplasts		
		Module 2	**Cytoskeleton and cellular Interactions**	**15 Lec.**	**1 Credit**
		2.1	Overview of the Major Functions of the Cytoskeleton, Structure and Function of Microtubules, Motor Proteins: Kinesins and Dyneins, Structure and Function of Cilia and Flagella, Intermediate Filaments, Actin and Myosin	8	
		2.2	Overview of Extracellular Interactions, The Extracellular Matrix, Components of the Extracellular Matrix, Dynamic Properties of the Extracellular Matrix, Integrins, Anchoring Cells to Their Substratum, Interactions of Cells with Other Cells, Cell Walls	7	
		Module3	**Cell Cycle, Cell Division and Cell Junctions**	**15 Lec.**	**1 Credit**
		3.1	Cell Cycle and Cell Division:Phases of the Cell Cycle, Regulation of the Cell Cycle, Control of the Cell Cycle Checkpoints, Mitosis and Cytokinesis, Meiosis, Genetic Recombination during	5	

			Meiosis		
		3.2	Cell Junctions: Adhesion Junctions, Tight Junctions, Gap Junctions, Plasmodesmata.	5	
		3.3	Cell cycle and Programmed cell death: The Extrinsic Pathway of Apoptosis, The Intrinsic Pathway of Apoptosis, Necroptosis, Signalling Cell Survival.	5	
		Module 4	**Cell Communication and Multicellular Cell Development**	**15 Lec.**	**1 Credit**
		4.1	Cell Communication: The Basic Elements of Cell Signaling Systems, Extracellular messengers and their Receptors, Signal Transduction by G Protein-Coupled Receptors.	5	
		4.2	Cell Signalling: Protein-Tyrosine Phosphorylation as a Mechanism for Signal Transduction, Ras- MAP Kinase Pathway, Signaling by the insulin receptor, The role of NO as an intercellular messenger	5	
		4.3	Signaling Pathways: Signaling Pathways in Plants, Role of Calcium as an intracellular messenger, Convergence,	5	

			Divergence, and Cross-Talk among different signaling pathways.		
		References	**Module 1.-** 1.Karp G. (2008). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons 2.Molecular Biology of the Cell – Alberts, Johnson, Lewis, Raff, Roberts &Walter, 6th edition. 3.Cooper, G.M., Hausman R.E. (2009) The Cell: A Molecular Approach- 6th edition. **Module 2.-** 1.Karp G. (2008). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons 2.Molecular Biology of the Cell – Alberts, Johnson, Lewis, Raff, Roberts &Walter, 6th edition. 3.Cooper, G.M., Hausman R.E. (2009) The Cell: A Molecular Approach- 6th edition. **Module 3.-** 1.Cooper, G.M., Hausman R.E. (2009) The Cell: A Molecular Approach- 6th edition.		

			2.Karp G. (2008). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. **Module 4.-** 1.Karp G. (2008). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons 2.Molecular Biology of the Cell – Alberts, Johnson, Lewis, Raff, Roberts &Walter, 6th edition.		
Sem.III	**Course III**	**Tools and Techniques in Microbiology**		**30 Lec.**	**2 Credits**
		Module 1	Advanced Spectroscopic and Chromatography Techniques: Principle, working and applications	15 Lec.	1 Credit
		Module 2	Identification methods in microbiology	15 Lec.	1 Credit
Sem.III	**Course III**	**Modules**	**Description**	**Lec.**	**Credits**
		Module 1	**Advanced Spectroscopic and Chromatography Techniques: Principle, working and applications**	**15 Lec.**	**1 Credit**
		1.1	Mass Spectroscopy : MALDI - MS	3	

		1.2	NMR : Approach to determine structure of Carbohydrate by NMR	3	
		1.3	FTIR	2	
		1.4	HPTLC	3	
		1.5	Ion exchange chromatography	2	
		1.5	Gel filtration chromatography	2	
		Module 2	**Identification methods in microbiology**	**15 Lec.**	**1 Credit**
		2.1	Culture dependent analysis of microbial communities: Laser Tweezer, Flow cytometry, FAME analysis. Classification & identification through Phenotypic analysis using VITEK and BIOLOG	5	
		2.2	Culture independent methods Methods for DNA / RNA extraction Gene sequence analysis 1.Amplification of 16S rRNA gene for prokaryotes. 2.Multi-locus sequence typing 3.Genome fingerprinting (Multi gene and whole genome)	5	
		2.3	Sequencing genomes 1. First generation - Sanger sequencing and sequence analysis using	5	

			different tools 2.Second generation - Amplicon sequencing Illumina 3.Third and fourth generation		
		References	**Module 1.-** 1.Peter Jomo Walla , Modern Biophysical Chemistry, Detection and Analysis of Biomolecules, Second, Updated and Expanded Edition (2014) Wiley-VCH Verlag GmbH & Co. KGaA, Boschstr. 12, 69469 Weinheim, Germany 2.Oliver Zerbe and Simon Jurt, Applied NMR Spectroscopy for Chemists and Life Scientists(2014) Wiley-VCH Verlag GmbH & Co. KGaA, Boschstr. 12, 69469 Weinheim, Germany 3.https://shodhganga.inflibnet.ac.in/bitstream/10603/83415/8/08_chapter3.pdf Chapter 3: Characterization techniques and Instrumentation 4.Techniques and Instrumentation in Analytical Chemistry Volume 18, 1997, Chapter 4 Fourier transform infrared spectroscopy: Principles		

			and application 5. ManMohan Srivastava. 2011. High-Performance Thin-Layer Chromatography(HPTLC) , Springer-Verlag Berlin Heidelberg 6. Jan-ChristerJanson. 2011. Protein Purification: Principles, High Resolution Methods, and Applications Third Edition John Wiley & Sons, Inc., Hoboken, New JerseyPg No. 94-131 7. Jan-ChristerJanson. 2011. Protein Purification: Principles, High Resolution Methods, and Applications Third Edition John Wiley & Sons, Inc., Hoboken, New JerseyPg No. 51-87 **Module 2.-** 1. https://www.ingentaconnect.com/contentone/aoac/jaoac/2017/00000100/00000006/art00004?crawler=true&mimetype=application/pdf Pg 5 2. https://jcm.asm.org/content/jcm/7/6/539.full.pdf 3. Brock Biology of microorganisms 14th ed.		

Sem. III	**Course IV**	**Practicals**	**Practicals based on Pharmaceutical Microbiology, Cosmetic Microbiology, Cell Biology and Tools and Techniques in Microbiology** 1. Preservative efficacy test as per ISO 11930 2.Bio burden test of finished Products 3. Quality control of microbial content of cosmetics as per IS 14648:2011 wrt to heterotrophic count , 4. Methods of detection of Specific Organisms specifically presence of *Pseudomonas* spps, *Staphyloccocci* spps and *Escherichia coli.*In cosmetics 5. MIC of an antibiotic by tube method using Indian Pharmacopeia protocol 6. Assignment: Study of stability and Shelf life of different cosmetic products. 7. Disruption of bacterial cells followed by characterization of cellular proteins by SDS-PAGE 8. Isolation of lymphocytes and its Viability staining using	**120 Lec.**	**4 Credits**

			trypan blue 9. Determination of cell viability of lymphocytes by MTT Assay & neutral red uptake assay 10. Isolation of mitochondria and check activity of respiratory enzyme succinate dehydrogenase 11. Isolation of chloroplast from spinach leaves and study Hill reaction spectrophotometrically 12. Extraction and separation of different pigments using TLC 13. Spectroscopic analysis of pigments 14. Study the working of NMR using virtual lab		
Sem.III	**Course V**	**DSE (Any One)**	**Algal Technology and Bacteriophages**	**30 lec.**	**2 Credits**
		Module 1	Algal Biotechnology	15 Lec.	1 Credit
		Module 2	Bacteriophages	15 Lec.	1 Credit
Sem.III	**Course V**	**Modules**	**Description**	**Lec.**	**Credits**
		Module1	**Algal Biotechnology**	**15 Lec.**	**1 Credit**

		1.1 1.2 1.3	Culture techniques and media for growth of freshwater algae:- Measurement of algal growth in culture - lag phase, log phase, stationary phase and death phase using biomass,chlorophyll content, Measurement of algal pigments. Culturing microalgae in Photobioreactors, Fermentor and Outdoor ponds: advantages and disadvantages Applications of Algal Biotechnology:Food Supplements and fertilizers,Bioactive compounds and cosmetics,Biofuel, high value commercial products, Bioplastics	5 5 5	
		Module 2	**Bacteriophages**	**15 Lec.**	**1 Credit**
		2.1	Intemperate and Temperate Bacteriophage a) Intemperate Bacteriophage – T2, T6, T1, T5, T3 and T7	09	

			Bacteriophages belonging to the F Group. Bacteriophages Infecting Bacillus subtilis - Bacteriophage SP01, Bacteriophage φ29 b) Temperate Bacteriophage – Other Lambdoid Phages- Bacteriophage P22, Bacteriophage P2 and P4, Bacteriophage P1, Bacteriophage Mu, SSV1 and SSV2. c) Study of bacteriophages by one step growth curve		
		2.2	Study of Mycobacteriophage -Phage therapy -therapeutic approach to Mycobacterial infections	02	
		2.3	Algal bacteriophage	02	
		2.4	Cultivation of bacteriophages from environment	02	
	Course VI	**Practicals**	**Practicals based on Algal Technology and Bacteriophages** 1. Preparation of growth culture medium for freshwater algae and study its diversity with respect to its type count and morphology 2. Counting algal Cells in Cultures with the Light Microscope.	**60 Lec.**	**2 Credits**

			3. Isolation, inoculation and growth of microalgae. 4. Enrichment of bacteriophages 5. Pilot assay of bacteriophage and enumeration of bacteriophages 6. One step growth curve of bacteriophages		
		References	**Module 1.-** 1. Bellinger, E. G. and Sigee, D. C. (2010). Freshwater algae: Identification and use as a bioindicators. Wiley-Blackwell (Pre-read Book) 2. Lee, R. E. (2008). Phycology. 4ed. Cambridge University Press (Pre-read Book) 3. Andersen, R. A. (2005). Algal culturing techniques. Elsevier Academic Press 4. Sahoo, D. and Seckbach, J. (2015). The Algae World. Springer 5. Prescott, G. W. (1954). How to Know Fresh-Water Algae. WM C. Brown Company (For practicals only) 6. Vuuren, S. J. (2006).		

			Easy identification of the most common freshwater algae. A guide for the identification of microscopic algae in South African freshwaters. DWAF and NWU (For practicals only) 7. Sharma, P., Sharma, N. (2017) Industrial and Biotechnological Applications of Algae: A Review. Journal of Advances in Plant Biology - 1(1):01-25. (Review Paper) 8. Barkia, I., Saari, N., Manning, S. R. (2019). Microalgae for High-Value Products Towards Human Health and Nutrition. Mar. Drugs 2019, 17, 304; doi:10.3390/ md 17050304 (Review Paper) 9. Rasul, I. et. al. (2017) Algae Biotechnology: A green light for engineered algae. From Algae Based Polymers, Blends and Composites. Elsevier (Book Chapter) 10. Barsanti, L. and Gualtieri P. (2014). Algae: Anatomy, Biochemistry, and Biotechnology, 2ed. CRC Press.		

			11.Richmond, A. and Hu, Q. (2013). Handbook of Microalgal Culture: Applied Phycology and Biotechnology, 2ed. John Wiley & Sons, Ltd. **Module 2.-** 1.Bacterial and Bacteriophage genetics - 5th edition, 2006, Edward A. Birge. 2.Advances in viral research. – Past, present and future. Said A. Ghabrial 3.Corina P. D. Brussaard and Joaquín Martínez Martínez, Algal bloom viruses Plant Viruses 2 (1), 1-13 ©2008 Global Science Books 4. Principles of Virology – Flint 2nd edition 5.Understanding Viruses – Teri Shors. Jones and Bartlett publication		
Sem.III	**Course VII**	**DSE**	**Advances in Biotechnology-**	**30 Lec.**	**2 Credits**
		Module 1	IPR and Bioethics	15 Lec.	1 Credit
		Module 2	Nanobiotechnology	15 Lec.	1 Credit
Sem III	**Course VII**	**Module**	**Description**	**Lec.**	**Credit**
		Module 1	**IPR and Bioethics**	**15 Lec.**	**1 Credit**

		1.1	Intellectual Property Rights 1.1.1 Types of IPR 1.1.2 Intellectual Property Rights Issues In Biotechnology Issues of Patentability Issues of Ownership Issues of Enforcement Issues of Sharing of Costs and Benefits Issues of Ethics 1.1.3 Overview of the Patenting Process Filing a Patent Application Maintenance of a Patent	8	
		1.2	Bioethics 1.2.1 Bioethics and biotechnology 1.2.2 Ethical issues and Perspectives in the Discipline of Microbiology 1.2.3 Bioethics, bioweapons and the microbiologist 1.2.4 Ethical guidelines for Biomedical research on Human subjects	7	
		Module 2	**Nano Biotechnology**	**15 Lec.**	**1 Credit**
		2.1	i.Basics of Nanotechnology. ii.Types of nano	03	

			materials. iii.Properties of nano materials.		
		2.2	Biosystems as nano factories - Bacteria as machinery for synthesis of nano metals- gold, silver, Zinc. - Fungi and Actinomycetes as fabricators of nano metals. -Plants as nano engineers. -Algae as nanotechnologists.	05	
		2.3	Nanomotors of biological systems - ATPsynthase: a nanoturbine. - Flagellar motors in bacteria.	04	
		2.4	Applications of nanotechnology – Nanomedicine, nano bio-devices, nanoimplants, applications in agriculture, food and cosmetics.	03	

Sem.III	**Course VIII**	Practicals	**Practicals based on Advances in Biotechnology** 1. Case study Report writing i. IPR related issues in Biotechnology ii.Ethical issues related to Infectious diseases 2. Assignment Writing i.Ethical Issues in Genetic Engineering ii. Patent Law and Biotechnology 3. Preparation characterization of Silver Nanoparticles. 4. Survival Curve antibacterial activity of nano silver particles. 5. Study of nano silver coated gauze / textiles for anti-microbial effect on different bacteria	**60 Lec.**	**2 Credits**
		References	**Module 1.-** 1.Savale, Sagar. (2018). Intellectual Property Rights (IPR). World Journal of Pharmacy and Pharmaceutical Sciences . Volume 5, Issue 6, 2529-2559 DOI: 10.20959/wjpps20166-7102. 2. An Introduction to Ethical, Safety and Intellectual Property Rights Issues in		

			Biotechnology Chapter 13: Relevance of intellectual Property rights in Biotechnology. 291-308. DOI:http://dx.doi.org/10.1016/B978-0- 12-809231-6.00013-2 3. Bioethics and Biosafety in Biotechnology. V. Sree Krishna,. New Age International (P) Limited, 35-39. 4. O'Mathúna, Dónal. (2007). Bioethics and biotechnology. Cytotechnology. 53. 113-119. DOI:10.1007/s10616-007-9053-8 5. Gorea, Rakesh & Qamar, Shafqat & Hasan, Gulam & Gorea, Abhinav. (2015). Some Ethical Perspectives in the Discipline of Microbiology. International Journal of Ethics, Trauma & Victimology. 1. DOI:10.18099/ijetv.v1i2.6817 6. Bioethics, bioweapons and the microbiologist: Fernando Anaya-Velázquez*RevLatinoamMicrobiol2002; 44 (1): 38-45 7. Ethical guidelines For Biomedical research On Human subjects. National Institute of Tuberculosis and		

			Respiratory Diseases. Based on ICMR, CDSCO, GCP & International Ethical Guidelines. **Module 2.-** 1.Nanotechnology-Nanomaterials and Nanodevices G.Mohan Kumar .Narosa Publications. 2. Nanotechnology-Principles and Practices 2 nd edition Sulabha K. Kulkarni Capital Publishing Company. 3. Bionanotechnology –concepts and applications. Madhuri Sharon, Maheshwar Sharon, Sunil Pandey,Goldie Oza.		
	Course IX	**Research Proposal**	**Guidelines Attached in Appendix-1**		**4 Credits**

M.Sc.(II) Semester IV Microbiology NEP Syllabus	
Sem.IV	**Course Objectives & Learning Outcomes** **Course Objective- Industrial & Food Microbiology** 1.Understand the basic knowledge of food fermentation, along with advanced methods of food preservation, food analysis and food safety. 2.Understand the high throughput screening techniques used for fermentation microorganisms. **Course Objective- Applied Microbiology** 1.To promote integration of the concepts of Bioaugmentation, Biostimulation and Biocontrol in the field of Agriculture. 2.To acquaint with the concept and scope of Organic Farming **Course Objective-DSE- Applications of Microbial technology in food processing** 1. Study recent advances in food microbiology & industrial fermentation technology **Course Objective- DSE- Plant, Agriculture and Animal Biotechnology** 1.To familiarize the students with the new concepts and advanced research areas and applications of plant and animal biotechnology. 2. To offer an in-depth understanding of innovative strategies in crop improvement, equipping students for careers in research, agriculture, and the biotechnology industry. 3. To explore the role of biotechnology for the improvement of animal health, productivity, and biopharmaceuticals. _____ **Course Outcome- Industrial & Food Microbiology** 1.To develop skills for food preservation and pathogen detection. 2.To develop employable skills concurrently with an understanding of various fermentation process. **Course Outcome- Applied Microbiology** 1.Assess the importance of Vermicomposting and Biofertilizers in agriculture. 2. To understand the role of microbiologists in organic farming and its scope. 3.Evaluate the need for the use of Biocontrol agents in the field of a agriculture **Course Outcome-DSE- Applications of Microbial technology in food processing** 1. To develop employable skills concurrently with an understanding of various fermentation process. 2. To develop the skill for production & assessment of probiotic microbes. **Course Outcome- DSE- Plant, Agriculture and Animal Biotechnology** 1.Develop a comprehensive understanding of Intellectual Property Rights (IPR) and their critical role in protecting innovations in biotechnology. 2.Gain the knowledge to analyze and follow bioethical principles to real-world scenarios, ensuring responsible conduct in biotechnology research and development. 3.Acquire knowledge of nanobiotechnology's cutting-edge applications and their implications in various sectors.

Sem.IV	**Course I**	**Industrial and Food Microbiology**		**60 Lec.**	**4 Credits**
		Module 1	Conventional Methods for control of microbes in food	15 Lec.	1 Credit
		Module 2	Advanced methods for Control and detection of microbes in food.	15 Lec.	1 Credit
		Module 3	Strain improvement: Modern methods	15 Lec.	1 Credit
		Module 4	Fermentations of Microbial products for commercial use	15 Lec.	1 Credit
Sem IV	**Course I**	**Module**	**Description**	**Lec.**	**Credit**
		Module 1	**Conventional Methods for control of microbes in food**	**15 Lec.**	**1 Credit**
		1.1	Controlling microbial access to food - Introduction	1	
		1.2	Introduction, Objectives, Mechanism and Influencing factors for: Control by Heat Control by low Temperature, Control by Reduced Water Activity. Low pH and Organic Acids	7	
		1.3	Introduction, Objectives, Mechanisms and Influencing factors for: Control by Modified Atmosphere Control by Antimicrobial	6	

			Preservatives Control by Irradiation		
		1.4	Control by combination of methods (Hurdle concept) - Introduction	1	
		Module 2	**Advanced methods for Control and detection of microbes in food.**	**15 Lec.**	**1 Credit**
		2.1	Introduction and Summary of Processing Methods	1	
		2.2	Advanced methods of food preservation: Microwave Processing, Ohmic and Inductive Heating, Infrared Heating, Pulsed Electric Fields, High-Pressure Processing, Pulsed Light Technology Pulsed Electric Fields, Ultrasound Pulsed X-Rays Ozone, Plasma Technology, Antimicrobial Edible Films	7	
		2.3	Advanced methods of detection of microorganisms in food. Sampling plans and sample preparation Biosensors Fiber-Optic Biosensors Surface Plasmon Resonance Sensor Electrochemical Immunosensor Piezoelectric (PZ) Biosensor	7	

			Impedance-Based Biochip Sensor Fourier Transform Infrared Spectroscopy (FTIR) and Raman Spectroscopy Light Scattering Cell-Based Sensors		
		Module 3	**Strain improvement: Modern methods**	**15 Lec.**	**1 Credit**
		3.1	Advanced Screening methods and high throughput screening	3	
		3.2	Post genomics era- the influence of genomics, transcriptomics and proteomics on the improvement of primary metabolite producers	5	
		3.3	Use of recombination systems for increasing the yield of product -Parasexual cycle, Protoplast fusion, Applications of Recombinant DNA techniques	7	
		Module 4	**Fermentations of Microbial products for commercial use**	**15 Lec.**	**1 Credit**
		4.1	**Microbial Transformation** Types of bioconversion reactions, Procedure for biotransformation, Transformation of steroids and sterols	05	

		4.2	**Newer approaches to sewage treatment** Starter cultures for treatment process, Aerobic sewage treatment airlift process, Aeration with pure oxygen Methane Production	04	
		4.3	**Microbial Production of Oriental Fermented Foods** Soy Sauce Miso Idli	06	
		References	**Module 1-** 1.James Jay , M Loessner and D Golden (2005) Modern Food Microbiology 7th Ed. 2.Bibek Ray and Arun Bhunia (2008) Fundamental Food Microbiology. 4th Ed. CRC Press. 3.Srilakshami B (2010) Food Science. 5th Ed. New Age International Publishers. 4.N Shakuntala Manay and Shadaksharaswamy M (1985) Foods Facts and Principles. New Age International 5.Adams and Moss , Food Microbiology, 3rd edition, RSC Publishing (2008)		

			Module 2- 1. Okafor Nkuda 2007 ''Modern Industrial Microbiology and Biotechnology'', Science Publications Enfield, NH, USA. 2. Osman Erkmen, T. Faruk Bozoglu, Food Microbiology - Principles into Practice Volume I and II, John Wiley (2016) **Module 3-** 1. Stanbury P. F., Whitaker A. & HaII--S. J., 1997, "Principles of Fermentation Technology", 2nd and 3rd EditionAditya Books Pvt. Ltd, New Delhi. 2. Wilfried Schwab, Bernd Markus Lange, Bernd Markus Lange "Biotechnology of natural products" Springer International Publishing, **Module 4-** 1. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology''. Vol 1 &2 , Academic Press 2. Prescott and Dunn's ''Industrial Microbiology''.1982 4th Edition, McMillan Publishers 3. Wulf Crueger and Annelise Crueger: A textbook of industrial		

			microbiology, 2nd Edition, Panima Publishing Corporation.		
Sem. IV	**Course II**	**Applied Microbiology and Agriculture**		**60 Lec.**	**4 Credits**
		Module 1	Applications of Microbiology in bioremediation & pollution control	15 Lec.	1 Credit
		Module 2	Bio-augmentation and Biostimulation in Agriculture	15 Lec.	1 Credit
		Module 3	Microbial biomolecules in diagnostics and therapeutics	15 Lec.	1 Credit
		Module 4	Bio-control in Agriculture	15 Lec.	1 Credit
Sem. IV	**Course II**	**Modules**	**Description**	**Lec.**	**Credits**
		Module 1	**Applications of Microbiology in bioremediation & pollution control**	**15 Lec.**	**1 Credit**
		1.1	Introduction to Bioremediation strategies: Bioremediation of synthetic compounds, petrochemicals, inorganic waste.	5	
		1.2	Bioremediation strategies: Techniques in situ and	4	

			testing its efficacy and side effects		
		1.3	Approaches to bioremediation : Bioremediation of metals & gaseous ex situ, Environment modification for bioremediation, Microbial seeding & bioengineering using rDNA technology, Bioremediation of various ecosystems; Soil, aquifers, marine, air	06	
		Module 2	**Bio-augmentation and Biostimulation in Agriculture**	**15 Lec.**	**1 Credit**
		2.1 2.2 2.3 2.4	Introduction Vermicomposting Bio-intensive Nutrient Management, Use of Biofertilizers: Rhizobium, blue green algae, phosphate solubilizers, Mycorrhiza. Organic Farming and scope of organic farming in India	02 03 09 1	

		Module 3	**Microbial biomolecules in diagnostics and therapeutics**	**15 Lec.**	**1 Credit**
		3.1	Pharmaceuticals: Human Interferons, Human Growth Hormone, Tumor Necrosis Factor Alpha	3	
		3.2	Enzymes: DNase I, Alginate Lyase, Phenylalanine Ammonia Lyase, α1 -Antitrypsin, Glycosidases	4	
		3.3	Antibodies: Monoclonal Antibodies, Recombinant Antibodies, Anticancer Antibodies	4	
		3.4	Nucleic acids as therapeutic agents: antisense RNA, Antisense Oligonucleotides, Ribozymes, Deoxyribozymes, Aptamers.	4	
		Module 4	**Bio-control in Agriculture**	**15 Lec.**	**1 Credit**
		4.1	Biological control of Pests: Biological Control agent, mechanism of biocontrol, biopesticide, bioinsecticide, bioherbicide	5	
		4.2	Induced systemic resistance in Biocontrol of Plant diseases: a) Induction of systemic resistance by	4	

			Pseudomonas, Bacillus, Trichoderma, Fungi and others. b) Mechanism of Induced systemic resistance.		
		4.3	Microbial control strategies: Postharvest diseases of Fruits, Vegetables, Roots and Tubers a) Mode of action of biocontrol agents b) Extensive of use of biocontrol agents c) Enhancing biocontrol efficacy of Microbial Antagonist d) Biotechnological Approach	6	
		References	**Module 1-** 1.Environmental Biotechnology by Alan Scragg. **Module 2.-.** 1.A.K. Sharma. A handbook of Organic Farming. 2004. Agrobios India. 2.A. Singh, A. Parmar and R.C.Kuhad. Bioaugmentation, Biostimulation and Biocontrol. Soil Biology Volume 28. Springer **Module 3.-** 1.Molecular Biotechnology - Principles and		

			Applications of Recombinant DNA (3rd, Third Edition) By Bernard R. Glick. 2.B.D. Singh Kalyani Publishers, 2010 - Biotechnology. **Module 4.-.** 1.H. M. Gupta. Organic Farming and Sustainable Agriculture. 2005. ABD Publishers, Jaipur, India.		
Sem.IV	**Course III**	**Practicals**	**Practicals based on Industrial And Applied Microbiology** 1. Effect of antimicrobial preservatives in food products. 2. Detection of Pathogens in frozen food. 3. Screening of organic acid/amine producer 4. Study of Idli fermentation 5. Assignment: On Novel detection methods for food borne pathogens/ toxins. 6. Enrichment and isolation of Agarase producing bacteria 7. Isolation of pigment producing bacteria from	**120 Lec.**	**4 Credits**

			marine environment and extraction of pigments through solvent extraction procedures 8. Isolation of biopolymer producing bacteria and quantify the biopolymer produced 9. Removal of blood stains by using proteases/detergents 10. Residual starch degradation by amylase 11.Preparation of Vermicompost and microbiological analysis of vermicompost 12. Isolation of organisms producing plant growth promoting substances 13.Production and estimation of plant growth promoting substances (any one) 14.Qualitative and quantitative study of Phosphate solubilizers 15.Report on a visit to Biofertilizer and biopesticide production plants		

Sem.IV	**Course IV**	**DSE**	**Applications of Microbial technology in food processing**	**30 lec.**	**2 Credits**
		Module 1	Microbes in food	15 Lec.	1 Credit
		Module 2	Use of microbes in food	15 Lec.	1 Credit
		Module	**Description**	**Lec.**	**Credit**
		Module 1	**Microbes in foods** 1. Importance of microbes in food. 2. Sources of microbes in food. 3. Normal microbiological quality of food. 4. Factors influencing microbial growth in food.	**15 Lec.** 3 4 4 4	**1 Credit**
		Module 2	**Uses of microbes in food** 1. Microbial stress response in food. 2. Starter cultures. 3. Microbiology of fermented foods. General method of production 3.a. Cheese – Swiss and Blue cheese. 3.b.Fermented meat product – Sausage.	**15 Lec.** 2 2 2 3 3	**1 Credit**

			3.c.Fermented vegetable products – Pickles, soy product.	3	
	Course V	**Practicals**	**Practicals based on Applications of Microbial technology in food processing** 1. Microbiological study of fermented foods (Sausage and Pickles). 2. Microbiological load in Cheese and Soy products. 3. Assignment writing on uses of Microbial technology in food processing.	**60 Lec.**	**2 Credits**
		References	**Module 1** 1. Bibek Ray and Arun Bhunia (2008) Fundamental Food Microbiology 4th Ed. CRC Press. 2. Srilakshami B (2010) Food Science. 5th Ed. New Age International Publishers. 3. James Jay , M Loessner and D Golden (2005) Modern Food Microbiology 7th Ed. 4. Adams M R and Moss M O (2008) Food Microbiology 3rd Ed. RSC Publishing. 5. J Maud Kordylas (1991) Processing and		

			Preservation of tropical and subtropical foods. ELBS Macmillan. **Module 2** 1. Bibek Ray and Arun Bhunia (2008) Fundamental Food Microbiology 4th Ed. CRC Press. 2. Gerald Reed (2004) Prescott and Dunn's Industrial Microbiology 4th Ed. CBS Publishers. 3. J Maud Kordylas (1991) Processing and Preservation of tropical and subtropical foods. ELBS Macmillan.		
Sem.IV	**Course VI**	**DSE**	**Plant and Animal Biotechnology**	**30 lec.**	**2 Credits**
		Module 1	Plant Biotechnology	15 Lec.	1 Credit
		Module 2	Animal Biotechnology	15 Lec.	1 Credit
		Module	**Description**	**Lec.**	**Credit**
		Module 1	**Plant Biotechnology** 1. Genetic engineering of Plants i. Plant transformation with Ti plasmids of Agrobacterium tumefaciens ii. Ti plasmid derived vector systems,	**15 Lec.** 5	**01 Credit**

			iii. Physical methods of transferring genes to plants:, Microprojectile bombardment, Use of guns and electric shock to transfer DNA into plant cells, Chloroplast engineering iv. Use of reporter genes in transformed plant cells v. Manipulation of gene expression in plants facilitating protein purification: Oleosins, Rhizosecretion, Glysosylation 2. Genetically engineered plants to overcome Biotic and abiotic stress i. Insect resistance: Increasing expression of the B.thuringiensis protoxin ii.Virus resistance iii. Herbicide resistance iv. Fungus and bacterium resistance v. Oxidative stress 3. To improve plant quality i.Modification of plant nutritional content ii. Modification of plant	5 5	

			taste and appearance iii. Plants as bioreactors iv. Edible vaccines		
		Module 2	**Animal Biotechnology** 1. Transgenic animals: - Introduction to transgenic Mice. - Methodology: Retroviral Vector method, DNA microinjection method, The engineering embryonic stem cell method, RNA interference,Transgenesis with high capacity vectors. Transgenic Livestock, Cloning sheep by nuclear transfer 2.Uses of transgenic animals: Transgenic disease model: Alzheimer Disease Transgenic mice as test system, Conditional control of Cell Death. Production of pharmaceuticals, Production of Donor organs, Improving milk quality, Transgenic poultry and transgenic fish.	**15 Lec.** 8 7	**01 Credit**

Modality of Assessment

A. Internal Assessment- 50%

Sr. No.	Evaluation type	Total Marks
1	Review article/Book review/Case study/Research paper writing /NPTEL Courses/Hands-on training (4 days cumulative)/Industrial/Research centre visit and its report/MCQs	30
2	Seminar	10
3	Attendance – (0-25%=0 marks, 25-50%=1mark,50-75%=3 marks and 75-100%= 5 marks)	05
4	Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular, etc.	05

B. External examination- 50%

a) Semester End Theory Assessment- 50% 50 Marks

i. Duration – These examinations shall be of two hours duration for each paper.

ii. Theory Question Paper Pattern:

- There shall be five questions each of 10 marks. The last question will be based on the entire syllabus.
- All questions shall be compulsory with internal choice within the questions. Each question will be of 20 marks with options.
- Questions may be subdivided into sub-questions A, B, C and D and the allocation of marks will depend on the topic's weightage.

- **b) Practicals** **Total: 100 Marks**

University of Mumbai

M.Sc. (MICROBIOLOGY)

Semester III / Semester IV EXAMINATION

Maximum Marks: 50 **Duration: 2.0 Hours**

Question 1: Based on Module I

Question 2: Based on Module II

Question 3: Based on Module III

Question 4: Based on Module IV

Question 5: Based on Module I - IV (Mixed Questions)

University of Mumbai

M.Sc. (MICROBIOLOGY)

Semester III / Semester IV EXAMINATION

Maximum Marks: 50 **Duration: 2.0 Hours**

Instructions:

i. All questions are compulsory. ii. All questions carry equal marks.

iii. Draw neat and labelled diagrams wherever necessary.

1. Answer any two questions from the following. (10 Marks)

A)

B)

C)

D)

2. Answer any two questions from the following. (10 Marks)

A)

B)

C)

D)

3. Answer any two questions from the following. (10 Marks)

A)

B)

C)

D)

4. Answer any two questions from the following. (10 Marks)

A)

B)

C)

D)

5. Answer any two questions from the following (Based on all 4 Modules).

(10 Marks)

A)

B)

C)

D)

Core courses (Theory): Course III of 25 Marks.

i. Duration – These examinations shall be of one hour duration for each paper.

ii. Theory Question Paper Pattern:

- There shall be three questions of 10, 10 and 5 marks.
- On each unit there will be one question of 10 marks and the third question (with 05 marks) will be based on entire paper.
    - All questions shall be compulsory with internal choice within the questions. Each question will be of 10 to 20 marks with options.
    - Question may be subdivided into sub-questions a, b, c... and the allocation of marks depend on the weightage of the topic.

1. DSE / Minor courses (Theory): 25 Marks each

- Duration – These examinations shall be of one hour duration for each paper.
- Theory Question Paper Pattern:
    - There shall be three questions of 10, 10 and 5 marks. On each unit there will be one question of 10 marks and the third question (with 05 marks) will be based on entire paper.
    - All questions shall be compulsory with internal choice within the questions. Each question will be of 10 to 20 marks with options.
    - Question may be subdivided into sub-questions a, b, c... and the allocation of marks depend on the weightage of the topic.

UNIVERSITY OF MUMBAI

Maximum Marks: 25 **Duration: 1.0 Hour** **Marks Option: 50**

Question 1: Based on Module I

Question 2: Based on Module II

Question 3: Based on Module I and II (Mixed Questions)

Instructions:

i. All questions are compulsory.
ii. All questions carry equal marks.

1. Answer any two questions from the following. (Based on Module1). (10 Marks)

   A)
   B)
   C)
   D)

2. Answer any two questions from the following. (Based on Module 2). (10 Marks)

   A)
   B)
   C)
   D)

3. Answer any one question from the following. (Based on Module 1 & 2). (5 Marks)

   A)
   B)

Practicals (For both Core and Minor courses) 50/25 Marks

A) Internal Assessment (Practical)- 50%

Sr. No.	Evaluation type	Core Course Marks (50)		Minor courses Total Marks (50)	
1	Practical planning and performance/Problem solving activity	One Major Technique OR Two Minor techniques	30	One Minor Technique	15
2	Viva voce based on practicals and assignment	Based on practicals and assignment	10	Based on practicals	05
3	Attendance (0-25%= 0 Mark, 25-50%= 1 Marks, 50-75%=3 Marks, 75-100%=5 Marks.) and overall conduct as a responsible student		10		05

A)External Assessment (Practical)- 50% **25 Marks**

Semester End Practical Examination shall be based on the practical conducted (course wise) and shall be decided by the Chairperson concerned covering all the practical mentioned in the syllabus and without affecting integrity of the practical course.

Letter Grades and Grade Points:

Semester GPA/ Programme CGPA Semester/ Programme	% of Marks	Alpha-Sign/ Letter Grade Result
9.00 - 10.00	90.0 - 100	O (Outstanding)
8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)
7.00 - < 8.00	70.0 - < 80.0	A (Very Good)
6.00 - < 7.00	60.0 - < 70.0	B+ (Good)
5.50 - < 6.00	55.0 - < 60.0	B (Above Average)
5.00 - < 5.50	50.0 - < 55.0	C (Average)
4.00 - < 5.00	40.0 - < 50.0	P (Pass)
Below 4.00	Below 40.0	F (Fail)
Ab (Absent)	-	Absent

Syllabus M.Sc. (Microbiology) (Sem. III & IV)

NEP -Microbiology Syllabus Framing Committee

Post Graduate Program

	Teachers	Sign			Sign
1.	Dr. Sunil R. Jagiasi Associate Professor, R.K.T. College Mobile No. – 9850416645 e-mail ID – sunilrjagiasi@gmail.com		2.	Dr. Sandhya Mulchandani Associate Professor Smt. C.H.M. College Mobile No. – 9657944876 e-mail ID – bharti.mul@gmail.com	
3.	Dr. Ranjana Khade Associate Professor, R.K.T. College Mobile No. – 9969259379 e-mail ID – khaderanjana@gmail.com		4.	Dr. Rasika Pawar Assistant Professor Smt. C.H.M. College Mobile No. – 9869118328 e-mail ID – rasikapawarchm@gmail.com	
5.	Dr. Pranali Shete Assistant Professor Smt. C.H.M. College Mobile No. – 9869876636 e-mail ID – pranalikale2@gmail.com		6.	Dr. Ashish Jain Associate Professor, Smt. C.H.M. College Mobile No. – 7666059751 e-mail ID – microbiologyashish@gmail.com	
7.	Dr. Nitinkumar Patil Assistant Professor Smt. C.H.M. College Mobile No. – 9822626862 e-mail ID – nitinkumarpatil1@gmail.com		8.	Ms. Renu N Jaisinghani Assistant Professor Smt. C.H.M. College Mobile No. – 7977174401 e-mail ID – chmmicrorj@gmail.com	

Coordinator
BOS, Microbiology

Dean
Science and Technology

Appendix-1

Dissertation Research Proposal guidelines

The dissertation research proposal should adhere to the standard format outlined in this paper. The submission of the proposal is required for the purpose of presenting original research work. It is imperative to avoid any duplication or repetition of study work that has already been accepted or published. A significant portion of the research should focus on conducting experimental laboratory work in the specific discipline of Microbiology. The length of the study proposal must not exceed 25 pages. This pagination excludes the Title Page, Summary, and Appendices. In other words, the Introduction begins on a distinct page and is assigned page number 1. The proposal should be written in a manner that is comparable to the one provided for the dissertation write-up.

Format for Dissertation Research Proposals

1. Title Page

The title page should contain the usual information found on the title page of the dissertation, with the exception that the proposal should be identified as a dissertation proposal, rather than a completed dissertation. The title should be succinct, ideally limited to a maximum of 20 words.

2. Summary

The proposal summary should be concise, with a maximum word limit of 450 words. It should provide a summary of the introduction, objectives, and proposed indicative approaches, as well as the expected outcomes.

3. Introduction

This part presents the scope of the study and offers a broad summary of the conditions, issues, and background that have led to the topic being investigated. The introduction part should encompass the following elements:

- **Background**
- **Rationale**
- **Objectives**

The section should be composed as a single paragraph, following the writing style of a journal article, with the exception of include subheadings, except for the objectives. When creating this section, it is important to include references for each assertion. The references should be placed in brackets, as specified in the reference section of this document. The statement will elucidate the rationale behind the current study proposal and the origin of the research topic. The overarching aim should be closely aligned with the title of the dissertation proposal. The specific objectives should be unambiguous, succinct, and precise.

4. Literature review

This section should include a concise and focused evaluation of recent and pertinent literature that is directly or closely connected to the study topic of the dissertation. The review should be critical in nature. The student is required to examine up-to-date and pertinent journal articles, books, and other materials such as dissertations and conference proceedings. Each statement should be referenced in a standard format as specified and should demonstrate the relevance of the proposed research.

5. Methodology

Research proposal should contain information regarding the type of study, the duration of the study, the laboratory settings, and the research design. These details are crucial for providing a comprehensive understanding of the study's methodology. Nevertheless, it is essential to provide a comprehensive description of samples and sampling methods, which may involve sample size calculation, experimental techniques, laboratory procedures, and data collection methods. These details should be presented with distinct subheadings if necessary. In order to achieve the study objectives, it is necessary to provide a thorough description of the experimental procedures. If the

experimental work will utilize the approaches previously mentioned, it is necessary to provide a reference for each desired method. The reference should be written in brackets, as specified in the reference section of this text. When necessary, it is important to provide a thorough account of the tools or methods utilized.

6. Expected outcome

The anticipated results of the planned research should be stated in this section. The expected outcomes of this study include an improvement in academic knowledge in the proposed field, the practical application of the research, and the direct or indirect advantages that may result from a significant discovery.

7. Work plan of the study

This part should include a chart outlining the planned time frame and activities for the study.

8. Budgeting

The budget should clearly outline the anticipated expenses for the proposed research, particularly the costs associated with consumables and laboratory supplies. Budgets can be categorized under many areas based on the nature of the intended study. Nevertheless, it is imperative that all items and their corresponding quantities in the budget are adequately explained.

9. References

It is necessary to list all referenced research in APA format when creating a proposal. Include just the sources that are cited in the text in the list of references.

10. Appendices (if necessary)

Any pertinent material that is not included in the main body of text is provided in the appendices. Students should contemplate utilizing Appendices to showcase stuff such as devices, consent documents, reagents, media, and any other extensive explanations.

If any of these documents are long, they may be shortened.

Dissertation Format

Technical Specification

1. Language

The dissertation must be written in the English language. The spelling should conform to either US English or British English, but not a combination of the two.

2. Dissertation length/volume

The standard length for a dissertation is often between 70 and 100 pages, with a minimum requirement of 70 pages. Excluded from the count are preliminary pages, pages without page numbers (such as photographs and figures without accompanying text), and appendices. The chapters Introduction and Objectives, Literature Review, Materials and Methods, Results, Discussion, Conclusion and Recommendations, and References of the dissertation should be numbered as paginated pages and indicated by Arabic numerals, while preserving the page numbers. Typically, the Introduction section should be limited to a maximum of 8 pages, while the Literature Review section should not surpass 15 pages. The Materials and Methods section should consist of a minimum of 5 pages. The Results section should have a minimum length of 15 pages. The Discussion part should not be shorter than 5 pages. The References section should also have a minimum length of 5 pages.

3. Paper quality

The dissertation should be composed on single-sided, high-quality white bond paper with A4 dimensions.

4. Production of dissertation

Dissertations must be printed using a high-quality printer. Only authentic originals or high-quality, pristine photocopies are permissible.

5. Fonts

The recommended typeface for the dissertation is Times New Roman. The text should have a font size of 12 points, and it should consistently use the same typeface. Font should not be stylized with script or italics, unless it is for scientific names or often used for scientific terms and terms in a different language. Chapter heads should be formatted using bold print, upper case letters, and a font size of 16 points. Sub-headings should be formatted using bold print, sentence case, and a font size of 14 points. Footnotes and text within tables, equations, and formulae should be entered using a font size of 10 points.

6. Margins

The margins on the top, bottom, and right side should measure 1 inch or 2.5 centimeters, while the left margin should measure 2 inches or 5 centimeters to account for any loss during binding. The right margin of the text should be aligned evenly.

7. Line Spacing

A line spacing of 1.5 is required between lines. Nevertheless, it is imperative to utilize double-line spacing when separating paragraphs and sections.

8. Pagination

Pages should be numbered centrally at the bottom margin.

9. Tables

The table in MS Word follows a straightforward and uncomplicated approach. The table number and corresponding title are positioned above the main content of the table and aligned to the left. Table numbers should be assigned in a consecutive manner (e.g. Table 1, Table 2, etc.). Table headings should be concise, informative, and succinct. If

required, a reduced font size can be employed to ensure that the complete table can be accommodated on a single page.

10. Figures

Figure captions should be positioned directly beneath the figure. This consists of the numerical representation (e.g., Figure 1) accompanied by a brief and explanatory remark. Figure numbers should be assigned in a consecutive manner (e.g. Figure 1, Figure 2, etc.). Graphs and maps can incorporate color. If color is utilized, it is necessary to furnish originals for every duplicate. Typically, a figure should be placed on its own page without a page number. Nevertheless, if the image is incorporated within a page of text along with a page number, there should be an ample amount of space both before and after the image to distinctly distinguish it from the surrounding text. When the data is observed, the paragraph should include a reference to a specific figure.

11. Citations of Literature

Consistency is the essential factor to consider when citing references in a writing. The American Psychological Association (APA) format is suggested for the purpose of facilitating readers in locating the sources of information mentioned in chosen references at the conclusion of a dissertation.

12. Binding

The dissertation's final copies must be permanently bound in a standard manner. The dissertation's final hardbound cover shall be black in color. The binding should be akin to that of a book, where the pages are affixed permanently. The cover page should be adorned with gold lettering using the Arial typeface and a font size of 18 points.

13. Plagiarism clearance certificate: Prior to submitting the dissertation, it is necessary for the student to acquire a plagiarism clearance certificate.

Order of dissertation contents

The following items must appear in this exact order

1. Preliminary Pages

- Cover Page
- Title Page
- Declaration and Recommendation
- Acknowledgements
- Plagiarism clearance certificate
- Abstract
- Table of Contents
- List of Tables
- List of Figures
- Abbreviations

2. The Text of the Dissertation

Introduction and

Literature Review

Objectives

Materials and Methods

Results

Discussion

Conclusion and Recommendations

3. References

4. Appendices

(Format of Cover and front pages)

TITLE OF THE DISSERTATION

A Dissertation Submitted to the

Department of Microbiology

Name of the Institute

Affiliated with University of Mumbai, in Partial Fulfillment of the Requirements for the Award of Degree of Master of Science in Microbiology (NEP 2020)

By

Name of the candidate

PRN No./ Seat No:

Academic Year:

DECLARATION

This dissertation entitled "Title of the dissertation....." has been submitted to the Department of Microbiology, Name of Institute, affiliated with University of Mumbai, for the partial fulfilment of the requirements to the degree of Master of Science in Microbiology (NEP-2020). This dissertation is conducted under the supervision of Name of supervisor. This is an original report of my own research, has been conducted entirely by myself, and not been submitted for any other degree or professional qualification. I have followed the current research ethics guidelines of University of Mumbai, and accept responsibility for the conduct of the procedures in accordance with the University's rules and regulations.

Signature of Student ……..…

Name of student:……

Academic Year: ……

PRN/ Seat No.: ……

Date: ……

RECOMMENDATION

This is to certify that..... **Name of the candidate**.... has completed this dissertation work entitled.... **"Title of the dissertation"**..... as a partial fulfillment of the requirements of M. Sc. degree in Microbiology (NEP 2020).

Supervisor **Examiner** **Head of the Department**

Academic Year:

Date:

Place:

Department/ Institute Stamp

Sign of the BOS Coordinator
Dr. Aparna Dubhashi
BOS in Microbiology

Sign of the Offg. Associate Dean
Dr. Madhav R. Rajwade
Faculty of Science & Technology

Sign of the Offg. Dean
Prof. Shivram S. Garje
Faculty of Science & Technology