

As Per NEP 2020

University of Mumbai



Title of the program

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|---|---|--|
| A- P.G. Diploma in Microbiology | } | <div style="border: 1px solid black; padding: 2px 10px;">2023-24</div> |
| B- MSc (Microbiology) (Two years) | | |
| C- MSc (Microbiology) (One year) - 2027-28 | | |

Syllabus for

Semester – Sem I and Sem II

Ref: GR dated 16th May 2023 for Credit Structure of PG

(With effect from the academic year 2023-24)

Preamble

1) Introduction

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 of the program.

Students are required to undergo an on-job training program/field project and take up online courses as a part of their internal evaluation. The student should study microbiological aspects in the industry and submit their report. They will also have to write a literature survey, a scientific report, and a research proposal for internal evaluation. This will prepare them well for the Research Project 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.

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

NEP Syllabus -Microbiology - MSC -Part 1-Semester I						
Semester	Course Number	Course Title	Course code	Credits		Cumulative Credits
Level 6.0		Major -Core courses		Theory	Practical	
I	I	Microbial Genetics -I	Microbial Genetics - I	02	02	04
I	II	Medical Microbiology and Immunology	Medical Microbiology and Immunology	02	02	04
I	III	Microbial Biochemistry	Microbial Biochemistry	02	02	04
I	IV	Bioinformatics & Biostatistics	Bioinformatics & Biostatistics	02	-	02
I	V	Discipline-Specific Electives (Any one) Role of microorganisms in Food technology OR Microbial Biotechnology	Role of microorganisms in Food technology OR Microbial Biotechnology	02	02	04
I	VI	Research Methodology	Research Methodology	04		04
		Online Job Training / Field Project	-	-		
		Research Project	-	-		
		Cumulative Credits		14	08	22

NEP Syllabus -Microbiology - MSC -Part 1-Semester II

Semester	Course Number	Course Title	Course code	Credits		Cumulative Credits
II	I	Microbial Genetics-II	Microbial Genetics-II	02	02	04
II	II	Microbial Pathogenesis and Applied Immunology	Microbial Pathogenesis and Applied Immunology	02	02	04
II	III	Applied Biochemistry	Applied Biochemistry	02	02	04
II	IV	Environmental Microbiology	Environmental Microbiology	02	-	02
II	V	Discipline-Specific Electives (Anyone) Molecular biology tools and Immunodiagnosics OR Advances in industrial microbiology	Molecular biology tools and Immunodiagnosics OR Advances in industrial microbiology	02	02	04
II	VI	Research Methodology	Research Methodology	-	-	
		On-Job Training (OJT) /Field Project (FP)	-	04	-	
		Research Project	-	-	-	
		Cumulative Credits for PG Diploma		14	08	22

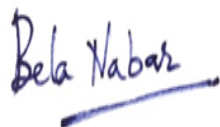
Exit Option: PG Diploma (44 credits) after Three Year UG Degree

NEP Syllabus -Microbiology - MSC -Part II-Semester III						
Semester	Course Number	Course Title	Course code	Credits		Cumulative Credits
		Major -Core courses		Theory	Practical	
III	I	Pharmaceutical & Cosmetic Microbiology	Pharmaceutical & Cosmetic Microbiology	02	02	04
III	II	Cell Biology	Cell Biology	02	02	04
III	III	Advances in Biotechnology Biological sample preparation and Modified analytical techniques	Advances in Biotechnology Biological sample preparation and Modified analytical techniques	02	02	04
III	IV	Tools and Techniques in Microbiology	Tools and Techniques in Microbiology	02	-	02
III	V	Discipline Specific Electives Algal technology and bacteriophages	Algal technology and bacteriophages	02	02	04
1	VI	Research Methodology	Research Methodology	04		04
		Research Proposal	-	-		
		Cumulative Credits		14	08	22

NEP Syllabus -Microbiology - MSc -Part II-Semester IV

Seme ster	Course Number	Course Title	Course code	Credit s		Cumulative Credits
IV	I	Industrial & Food Microbiology	Industrial and Food Microbiolog y	02	02	04
II	II	Applied Microbiology	Applied Microbiolog y	02	02	04
II	III	Plant, Agriculture, and Animal Biotechnology	Plant, Agriculture, and Animal Biotechnolo gy	02	02	04
II	IV	Mycology, Virology & Protozoology	Mycology, Virology and Protozoolog y	02	-	02
II	V	Discipline Specific Electives (any one)/Skill based training program /Online Job Training /Field Project/ Research Project	Application s of microbial technology in food processing	08		04
		Discipline Specific Electives Applications of microbial technology in food processing	-	-	-	
		CumulativeCredits for PG Diploma		14	08	22

Exit Option: PG Diploma (44 credits) after Three Year UG Degree



Head of the Department
Department in Microbiology



Dean, Science and Technology
University of Mumbai

University of Mumbai
NEP -Microbiology _Syllabus Framing Committee

Post Graduate program

NEP Syllabus -Microbiology - MSc -Part 1-Semester I						
Semester	Course Number	Course Title	Course code	Credits		Cumulative Credits
Level 6.0		Major -Core courses		Theory	Practical	
I	I	Microbial Genetics -I	Microbial Genetics -I	02	02	04
I	II	Medical Microbiology and Immunology	Medical Microbiology and Immunology	02	02	04
I	III	Microbial Biochemistry	Microbial Biochemistry	02	02	04
I	IV	Bioinformatics & Biostatistics	Bioinformatic & Biostatistics	02	-	02
I	V	Discipline-Specific Electives (Any one) A.Role of microorganisms in Food technology OR B. Microbial Biotechnology	Role of microorganisms in Food technology OR Microbial Biotechnology	02	02	04
I	VI	Research Methodology	Research Methodology	04		04
		Online Job Training / Field Project	-	-		
		Research Project	-	-		
		Cumulative Credits		14	08	22
NEP Syllabus -Microbiology - MSc -Part 1-Semester II						
Semester	Course Number	Course Title	Course code	Credits		Cumulative Credits
II	I	Microbial Genetics-II	Microbial Genetics-II	02	02	04
II	II	Microbial Pathogenesis and	Microbial Pathogenesis and	02	02	04

		Applied Immunology	Applied Immunology			
II	III	Applied Biochemistry	Applied Biochemistry	02	02	04
II	IV	Environmental Microbiology	Environmental Microbiology	02	-	02
II	V	Discipline-Specific Electives Molecular biology tools and Immunodiagnostics OR Advances in industrial microbiology	Molecular biology tools and Immunodiagnostics OR Advances in industrial microbiology	02	02	04
I	VI	Research Methodology	Research Methodology	-	-	
		On-Job Training (OJT) /Field Project (FP)	-	04	-	
		Research Project	-	-	-	
		Cumulative Credits for PG Diploma		14	08	22
Exit Option: PG Diploma (44 credits) after Three Year UG Degree						

2) Aims and Objectives

Course Code	Title
	Microbial Genetics -I
Aims and Objectives	To provide insights to the transfer of genes, genetic exchange and DNA repair. To understand the regulation of gene expression in prokaryotes. To understand the genetic basis of Cancer
	Medical Microbiology and Immunology
Aims and Objectives	Modern techniques have helped to elucidate mechanisms of pathogenicity expression, evasion of host defense and better understanding of disease mechanisms. Microbes too are devising new mechanisms to overpower the antibiotics used as therapeutics, compelling us to understand and combat the threat of antibiotic resistance. The curriculum will touch upon the recent growing interest on the concept of Microbiome. To introduce the students to molecular mechanisms of pathogenesis, their regulation and mechanisms of delivery.

	• To introduce to the student the concept of the Microbiome- its significance in health and disease • To acquaint the student to emerging/ re-emerging diseases in India
	Microbial Biochemistry
Aims and Objectives	To understand the broad domains of biochemistry and strengthen the basic concepts of Biochemistry. To undertake training of students, so as to design and carry out various projects. To improve the practical biochemistry knowledge while preparing media for the experiments and to reason out chemical reactions observed during experiments. To improve their logical skills so as to efficiently find solutions to problems encountered during research activity.
	Bioinformatics and Biostatistics
Aims and Objectives	To equip the learners to carry out hypothesis testing for normal distributed and distribution-free data To understand the importance and make use of different test of significance To make use of different parametric and nonparametric tests in research Proper selection of test of significance Choose the proper test of significance
	Discipline Specific Electives Role of microorganisms in Food technology
Aims and Objectives	To understand the significance of microbes in different fermentations. The learner would develop insights into certain basic food fermentations Acquire knowledge about probiotics and prebiotics and their application
	Discipline Specific Electives Microbial Biotechnology
Aims and Objectives	• To understand importance and scope of microbial biotechnology in different fields and the importance of microorganisms in the production of valuable metabolites. • To explain the concept of molecular cloning
	Research Methodology
Aims and Objectives	• To introduce the importance of research, process of research and analysis of data to draw correct conclusions. • To explain the concept of scientific writing.

Learning Outcomes

Course Code	Title
	Microbial Genetics -I
Learning Outcome	The learner will be appraised with The molecular mechanism of DNA transfer, and Homologous recombination in <i>E.coli</i> and in eukaryotes that will enable the learner to have a complete view of genetic transfer and exchange mechanisms. To reason out the correlation between Oncogenes, Cellular Proto-Oncogenes, and Tumor Suppressor Genes and thus realizes their role in the development of Cancer To understand the molecular levels the different types of operons in <i>E.coli</i> work Transposable elements in eukaryotes
	Medical Microbiology and Immunology
Learning Outcome	• Student will be able to correlate molecular mechanisms of virulence expression, regulation and secretion to disease by different pathogens that cause chronic infections, toxin associated, and biofilm mediated infections • Students will be able to reason out the threat of antibiotic resistance and can create awareness the importance of microbiome and can be equipped to research on it • Student will be well informed about Emerging and re-emerging diseases in India and clinical lab practices in bacteriology like QC and AST
	Microbial Biochemistry
Learning Outcome	Student will be able to: Perform better in competitive exams Learn practical skills to gain employability in the industry and take on research-oriented careers. Think independently and work in the laboratory
	Bioinformatics and Biostatistics
Learning Outcome	The learner would be able to understand the concept and procedure of hypothesis testing. Importance of parametric and nonparametric tests in research Selection of statistical tests of significance for research data Use bioinformatic tools in various aspects of research
	Discipline Specific Electives
	Role of microorganisms in Food technology
Learning Outcome	To develop employable skills concurrently with an understanding of various fermentation process.

	To develop the skill for the production & assessment of probiotic microbes.
	Discipline Specific Electives Microbial Biotechnology
Learning Outcome	- Students will be able to comprehend the value of microbial biotechnology in various domains and the significance of microorganisms in the synthesis of important metabolites. - Students will be able to understand the principle and procedure of molecular cloning.
	Research Methodology
Learning Outcome	- Students will be able to understand the fundamentals of Research, process of research. - Students will learn to write research proposals and Scientific writing.

SEMESTER I DETAIL SYLLABUS

Semester 1

Course Code		Unit	Sub unit	Title	No of lectures	Credits
				Molecular Genetics-1		
	Theory	1	1.1.1	Transformation: Development of Competence in Gram positive bacteria and Gram-negative bacteria.	07L	01
			1.1.2	Role of natural transformation- Nutrition, Repair, Recombination. Importance of natural		
			1.1.3	transformation for forward and reverse genetics. Artificially induced competence- Calcium ion induction, transformation of plasmids, transfection by phage DNA, and Electroporation.		
				Homologous Recombination at the Molecular Level	08L	
			1.2.1	: Single Stranded and double stranded Models for Homologous recombination		
			1.2.1	: Homologous recombination in E. coli (RecBCD pathway)		
			1.2.3	: Homologous recombination in eukaryotes (overview)		
			1.2.4	Site Specific recombination		

			Operon Systems (Detailed Molecular structure of repressor and operator sites)		
		1.3.1	The E. coli Lac Operon		
		1.3.2	The Trp Operon	15 L	
	2		Genetic Basis Of Cancer		01
		2.1.1	: Cancer: A Genetic Disease, Forms of Cancer, Cancer, and the Cell Cycle	07L	
		2.1.2	Oncogenes: Tumor-Inducing Retroviruses and Viral Oncogenes, Cellular ProtoOncogenes, protein products of protooncogenes, Changing cellular protooncogenes into oncogenes, Chromosome Rearrangement and Cancer.		
		2.1.3	Tumor Suppressor Genes: the Retinoblastoma tumor suppressor gene- RB, P53, Breast cancer tumor suppressor genes,		
		2.1.4	The multistep nature of cancer		
			DNA repair Eukaryotic Nucleotide Excision repair, Mismatch repair mechanism in humans		
		2.2.1	Mismatch repair mechanism in humans		
		2.2.2	2.2.3 non-homologous end joining (NHEJ) pathway for repairing double-stranded breaks		
			Transposable genetic elements in eukaryotes: : Transposable Ac and Ds Elements in Maize, P Elements and Hybrid Dysgenesis in Drosophila.	08L	
		2.3.1	Retrovirus and Retrotransposons: Retovirus,		
		2.3.2	Retrovirus-like elements, Retroposons		
		2.3.3	Transposable elements in Humans		
		2.3.4	The Genetic and Evolutionary Significance of Transposable Elements: Transposons as mutagens, Genetic transformation with transposons , Transposons and Genome organization, Evolutionary Issues Concerning Transposable Elements		
		2.3.5	.	15 L	
	Practical		PRACTICALS BASED ON PSMB 101 1. Isolation of plasmid DNA using miniprep and maxiprep 2.Detection of plasmid DNA using Agarose Gel Electrophoresis	60L	02

	Theory	1	1.1. 1.2. 1.3. 1.4	Bioorganic molecules Protein Chemistry: peptides and the peptide bond, protein structures, protein types, factors determining structure, Chaperonins, prion motifs, and domains Coenzymes, antioxidants, and metals Carbohydrates: derivatives of monosaccharides, glycoconjugates, and carbohydrates as informational molecules. Lipids: structural lipids, lipids as signal, cofactors, and pigments	6L 2L 4L 3L 15 L	01
		2	2.1 2.2 2.3 2.4	Degradation and transformation of organic molecules Biotic reactions, mechanistic aspects Environmental factors affecting biodegradation Persistence and biomagnification of xenobiotics Transformation of aromatic compounds: monocyclic, polycyclic, carboxylates, and related compounds. Transformation of halogenated hydrocarbons	4L 3L 4L 4L 15 L	01
	Practical			1. Extraction, isolation, partial purification (if necessary), calculation of percentage yield, and performing a confirmatory test for the following: a. lactose from milk b. Albumins and globulins from egg white By protein estimation method 2. Interpretation of Ramachandran plot 3. Degradation of aromatic compounds	 60L	02

				1. Enrichment and isolation of a monocyclic/polycyclic aromatic compound 2. Study of phenol degradation / (enrichment, isolation, and degradation) of phenol from various samples		
				Bioinformatics and Biostatistics		
	Theory	1	1.1	Biological databases-nucleic acid sequence databases- GenBank/ EMBL/ DDBJ	02L	01
			1.2	Protein sequence databases- (UniProtKB), Derived databases (Prosite, BLOCKS, Pfam/Prodom) Structural databases (PDB, NDB) and Enzyme databases	02L	
			1.3	The concept in sequence analysis- Needleman & Wunsch, Smith & Waterman alignment algorithms	02L	
			1.4	Scoring Matrix for nucleic acids and protein- MDM.BLOSUM.CSW	01L	
			1.5	Alignment: Pairwise BLAST, FASTA	02L	
			1.6	Multiple sequence alignment, PRAS, CLUSTAL W	02L	
			1.7	Structure predictions for proteins- Basic approaches for protein structure predictions, comparative modeling, fold recognition	02L	
			1.8	Chemo-informatics- Introduction, applications in pharmaceutical industries, Immuno-informatics- Overview, Revers	15 L	
			2		Hypothesis testing and test of significance	
		1	Normal Distribution: Properties of standard normal distribution	01		
		2.	Parametric or Standard Tests of Hypotheses i. Basic concepts concerning the testing of hypotheses ii. Hypothesis testing of means iii. Large sample Tests: Testing significance of	08		

				single population mean, two population mean iv. Small sample Tests: Testing significance of single population mean, Testing difference between two independent normal population mean, two correlated normal population mean, Testing significance of correlation coefficient, F-test and ANOVA	03	
				1. χ^2 test I. Testing single population variance ii. Testing Goodness of fit iii. Testing association between two attributes	03	
				2. Nonparametric or Distribution-free Tests i. Important Nonparametric Test ii. Characteristics of Non-parametric Tests		
					15 L	

Discipline-Specific Electives (Any one)

				Role of microorganisms in Food technology		
	Theory	1		Role of microorganisms in Food technology		01
			1.1.1	Starter culture of bacteria, yeast and mold used in food fermentation		
			1.1.2	Fermented Foods: - General methods of fermented food production	07	
			1.1.3	Fermented cereals: - Bread production		
			1.1.4	Fermented vegetables: - Sauerkraut production.		
			1.1.5	Production of microbial flavoring compounds: - Vanilla flavor		
				Prebiotic and Probiotic		
			1.2.1	Probiotics		
			1.2.2	Screening of Potential Probiotics	08	
			1.2.3	Industrial Aspects of Probiotic Production		
				Prebiotics		
					15 L	

		2	2.1.1	Microbial production of Rosmeric acid & Caffeic acid		01
			2.1.2	Production of bacterial polysaccharides &	07	
			2.1.3	Commercially produced Polysaccharides		
			2.1.4	Microbial Production of Riboflavin	08	
			2.1.5	Microbial Production of Antibiotics:- Cephalosporin, Tetracycline		
					15 L	
	Practical			1. Isolation & Characterization of organisms with probiotic potential from food samples. 2. Effect of prebiotic and probiotic culture 3. Sauerkraut preparation and Microbiological analysis 4. Production of antibiotic and assay	60L	02
				Microbial Biotechnology		
	Theory	1		Importance and Scope of Microbial Biotechnology 1.1 Importance of Biotechnology: Biotechnology as an interdisciplinary area, Global impact and current excitements of Biotechnology, 1.2 Biodiversity, and its preservation. 1.2 Scope of Microbial biotechnology. 1.3 Microbial production and applications of primary metabolites: Citric acid, Ethanol, L Glutamic acid, L Lysine, Vitamins B 1.4 Industrially important microbial enzymes: Types, mode of action and industrial applications of microbial amylases and proteases.	05L 05L 05L 15 L	01

				restriction gene map. 6. Gel electrophoresis of DNA 7. Isolation of genomic DNA (bacterial / yeast or onion) 8. PAGE for proteins. 9. Quantitation of DNA and Protein using U.V absorption.		
				Research Methodology		
	Theory	1		Fundamentals of Research i. Significance of Research ii. General characteristics of research iii. Objectives of research iv. Classification and types of research v. Types of research methods vi. Research and Scientific methods vii. Criteria of good research viii. Identification and formulation of research problem ix. Study design	07 08 15 L	1
		2		DATA COLLECTION AND PROCESSING i. Definition, scope and limitations of data collection and processing ii. Sampling – sampling frame, importance of probability sampling, simple random sampling, systemic sampling, stratified random sampling, cluster sampling. iii. Types of data, collection of data, classification and tabulation – diagrammatical and graphical representation, primary data, secondary data. iv. Measurement scales, variables and their measurements v. Validity, effect measure and choice of statistical test HYPOTHESIS WRITING i. Meaning, nature of hypothesis	07	1

			ii. iii. iv. v. vi.	Function of hypothesis Importance of hypothesis Kinds of hypothesis Characteristics of good hypothesis Formulation of hypothesis	08 15 L	
	3		STATISTICS IN RESEARCH i. Measures of central tendency – mean, median, mode, geometric mean ii. Measures of dispersion – range, Q.D., M.D., variance, standard deviation iii. Correlation and Regression analysis- • Correlation and regressions relation between two variables, • Scatter diagram, • Definition of correlation and their equations, • Interpretation of regression coefficients, • Principles of least squares, • Two regression lines, • Curve fitting Karl Pearson’s coefficient of correlation, • Spearman’s coefficient of correlation.		06 09 15 L	1
	4		COMMUNICATION & SCIENTIFIC WRITING i. The importance of communication through English ii. The process of communication and factors that influence communication sender, receiver, channel, code, topic, message, context, feedback, noise, filters, and barriers. iii. Verbal and non-verbal communication: Body language iv. Comparison of general communication and business communication, science communication v. Presentation skills –the structurethe of presentation, types of presentation, oral, PowerPoint- Handling power point, slides organization, content, body language,		09	1

				gastures, voice modulation		
				Research Proposal and Publications - Research Proposal and different funding agencies - Types and impact factors of the journal - UGC care list, Peer reviewed and Refereed Journals - Research paper/dissertation/thesis writing	06	
					15 L	

Sem 1: References

Microbial Genetics -I	- iGenetics- A Molecular Approach, Russell, P.J., 3rd edition, 2010, Pearson International edition - Fundamental Bacterial Genetics, Trun Trempy, 1s edition, 2004, Blackwell Publishing - Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, 7th edition, 2007, Pearson Education - Genes IX, Lewin, B., 2006, Jones and Bartlett Publishers - Genetics: A Conceptual Approach, Benjamin Pierce 4th edition, 2008, W. H. Freeman & Co - Principals of Genetics, Snustad & Simmons, 6th edition, 2012, John Wiley & Sons Inc - Molecular biology –Genes to proteins 3rd ed. by Burton E. Tropp (Jones & Bartlett publishers) - Molecular Genetics of bacteria, 3rd Edition by Larry Snyder and Wendy Champness (ASM Press)
Medical Microbiology and Immunology	Text Books: - Bacterial Pathogenesis- A Molecular Approach by Brenda Wilson, Abigail Saylers et al, Third ed, ASM Press, 2011 - Virulence Mechanisms of Bacterial Pathogens, by Indira Kudva, Nancy Cornick et al, Fifth ed, ASM Press, 2016 - Medical Biofilms-Detection Prevention and Control by Jana Jass,

	Susanne Surman et al, Wiley, 2003 4. The Human Microbiota and Microbiome ed by Julian Marchesi, Advances in Molecular and Cellular Microbiology 25, CAB International, 2014. 5. Understanding emerging and re-emerging infectious diseases by Suparna Duggal and Jyoti Mantri Himalaya Publishing House 6. Handbook of Microbiological Quality Control, Pharmaceutical and Medical Devices- Rosamund M Baird. (CRC Press) 8. Ananthanarayan and Paniker's Textbook of Microbiology, by Reba Kanungo, 10th Universities Press; Tenth edition, 2017 REFERENCE ARTICLES 1. Micromanagement in the gut: micro environmental factors govern colon mucosal biofilm structure and functionality by Rosemarie De Weirde and Tom Van de Wiele, Biofilms and Microbiomes (2015) 1, 15026; doi:10.1038/npjbiofilms.2015.26 2. Clinical and Pathophysiological Overview of Acinetobacter Infections: a Century of Challenges, Clin Microbiol Rev 30:409–447. https://doi.org/10.1128/CMR.00058-16. Published on 14th Dec, 2016 4. Special Article on Quality Assurance in Microbiology by D.R. Arora- Indian Journal of Medical Microbiology, (2004) 22 (2) : 81-86.
Microbial Biochemistry	Unit I: 1. Biochemistry 3rd edition, Mathew, Van Holde, and Ahern, Pearson Education 2. Lehninger-Principles of Biochemistry, Michael M. Cox and David L. Nelson, 5th Edition. W.H. Freeman and Company, New York reprinted 2008. 3. Biochemistry, Voet D. and Voet J.G., 4th edition, 1995, John Wiley and Sons Inc. Unit II: 1. Lehninger-Principles of Biochemistry, Michael M. Cox and David L. Nelson, 5th Edition. W.H. Freeman and Company, New York reprinted 2008. 2. Biochemistry, Voet D. and Voet J.G., 4th edition, 1995, John Wiley and Sons Inc. 3. Biochemistry 3rd edition, Mathew, Van Holde, and Ahern, Pearson Education Unit III 1. Environmental degradation and transformation of organic chemicals- Alasdair H. Neilson and Ann-Safie Allard. CRC Press, 2008

	2. Environmental Microbiology. Raina M. Maier, Ian L. Pepper, Charles P. Gerba. Academic Press (Elsevier) 2000 Unit IV: 1. Biotransformations: Microbial degradation of health-risk compounds edited by Ved Pal Singh. Elsevier 1995. 2. Microbial Ecology: Fundamentals and Applications 4th ed. Ronald H. Atlas and Richard Bartha. Reprint 2005. Pearson Education. ADDITIONAL READING MATERIAL 1. Biochemistry and Physiology of anaerobic bacteria. Lars G. Ljungdahl, Michael Adams, Larry L. Barton et al. 2003 Springer-Verlag New York, Inc. 2. Principles of Biochemistry, Zubay, G., 4th edition, 1998, Wm.C. Brown Publishers. 15
Bioinformatics & Biostatistics	1. Fundamentals of Research methodology and statistics- Yogesh Kumar Singh, New Age International Publishers 2. Biostatistics: A foundation for analysis in health sciences. Daniel WW, Cross CL. 10th Edn, Wiley.2013 3. Research Methodology: A guide for Researchers in Agricultural Science, Social Science and other related fields. Pradip kumar Sahu. Springer 2006 4. Ranjit Kumar, 2005 Research Methodology- A step-by-step Guide for beginners, 3rd edition, Sage publications. 1. Mount, D. W. (2001) Bioinformatics: sequence and genome analysis. Cold Spring Harbor Laboratory Press, New York. 2. Introduction to Bioinformatics T.K. Attwood and D.J Perry-Smith 3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Baxevanis A.D. and Ouellette, Third Edition. John Wiley and Son Inc., 2005
Discipline-Specific Electives Role of microorganisms in Food technology OR	1. Petra Foerst, Chalat Santivarangkna 2016 Advances in Probiotic Technology ,CRC Press A Science Publishers Book 2. Prescott and Dunn's ‘‘Industrial Microbiology’’.1982 4th Edition, McMillan Publishers 3. Okafor Nkuda 2007 ‘‘Modern Industrial Microbiology and Biotechnology’’, Science Publications Enfield, NH, USA. 4. Wilfried Schwab, Bernd Markus Lange, Bernd Markus Lange

Microbial Biotechnology	“Biotechnology of natural products” Springer International Publishing, 5. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology". Vol 1 &2 , Academic Press 6. Adams and Moss , Food Microbiology, 3rd edition, RSC Publishing (2008) 7. Robert E.C. , Wildman 2nd Ed. “ Handbook of Nutraceuticals & Functional Foods “ CRC Press A SCIENCE PUBLISHERS BOOK 8. Ronald Ross Watson, Victor R. Preedy 1st Edition 2010 “Bioactive Foods in Promoting Health: Probiotics and Prebiotics” Academic Press is an imprint of 9. Semih Otles. “ Probiotics and Prebiotics in Food, Health and Nutrition”. Taylor and Francis, CRC Press.
Research Methodology	1. R. C. Dubey. A Textbook of Biotechnology. 2006 S. Chand and Company Ltd. 2. Bernard R Glick and Jack J Pasternak. Molecular Biotechnology: Principles and Applications of recombinant DNA. 3rd Edition. 3. B. D. Singh. Biotechnology. Kalyani Publishers. 4. S. B. Primrose. Modern Biotechnology 1989. Blackwell Scientific Publ. 5. Primrose. Principles of Gene manipulations. 6th edition. 2004 Blackwell Science. 6. Aluizino Borent. Understanding Biotechnology. 2004 Pearson Education. 7. James Watson. Recombinant DNA. 2001. Scientific American Books.

SEMESTER II DETAIL SYLLABUS

	Title
	Microbial Genetics -II
Learning Objectives	The learner will know about different model organisms used for studying the genetic basis of Life. The learner will be understanding the translation and transcription process in procaryotes and Eucaryotes. The learner will also be conversant about Population genetics Hardy-Weinberg Law and related topics. The learner will get elaborate knowledge about Polymerase Chain Reaction
Learning Outcome	The learner will be appraised with Model organisms developmental stages which are the traditional geneticist's and embryologist 's tool. Prokaryotic translation and replication process in eukaryotes The role of genetics in conservation Biology Significance of Organelle DNA
	Microbial Pathogenesis and Applied Immunology
Learning Objectives	One of the most important areas of immunology is Applied Immunology which encompasses the study of Adversarial strategies during various infections, Immunodeficiency disorders, Immune Tolerance, Advances in Allergy and other hypersensitivities, Autoimmune diseases that are enlisted and properly covered in the syllabus. This course will help students to build on the advance information regarding the applications of the basic immunology they have studied during their undergraduate course.
Learning Outcome	Students should be able to- • Comment on the organs, tissue transplantation and blood transfusion-principle involved, types of transfusion reactions and their control, tests to be performed for safe transplantation. • Correlate the causes, principles involved, examples, control and treatment of immunodeficiency disorders, hypersensitivity reactions, autoimmune diseases and cancer. • Give details of the adversarial strategies during various infections, recent advances in vaccine production and difficulties encountered in it.

	Applied Biochemistry
Learning Objectives	To open the domains of applied biochemistry. To gain an insight in the multifaceted field of enzymology. To practically train students to understand the challenges and problems encountered while dealing with biomolecules like proteins. Commercial outcomes are understood through pharmaceutical products and proteomics-an already established field with extensive applications in diverse fields of biological sciences.
Learning Outcome	At the end of the course learners will be able to Understand and relate to metabolic and physiological complexities shown by living organisms. Apply the biological processes at molecular level for production and synthesis of bioactive molecules of commercial significance. Learning the unusual bio-molecules and bioactive compounds will open new avenues for research to the young scientists. Obtain Knowledge of Proteomics which will give them a new perspective about diagnosis of diseases and make them competent to handle new challenges if they are employed in modern diagnostic laboratories. Undertake advanced studies on enzyme kinetics will help them alter conditions favorably to increase industrial productions.
	Environmental Microbiology
Learning Objectives	● To Develop the understanding about microbial Life in extreme environments ● To know the physiological and molecular adaptation on extremophiles
Learning Outcome	● Biotechnological application of the metabolites of extremophiles ● Understanding the world of exobiology and geo microbiology would open the new doors
	Discipline Specific Electives Molecular biology tools and Immuno diagnostics
Learning Objectives	● To know the fundamentals of the PCR technique and its types ● Molecular tools for studying genes and gene activity ● To achieve the theoretical understanding of immunodiagnostic techniques
Learning Outcome	● The knowledge of advanced molecular tools would help the student to perceive the jobs in molecular biology laboratories
	Discipline Specific Electives Advances in industrial microbiology
Learning	● Develop the learner's ability to study the techniques used in different phases

					15 L	
		2	2.1.1 2.1.2 2.1.3	Population genetics - Genetic structure of population - Hardy-Weinberg Law - Genetic variation in space and time - Genetic variation in Natural population. Forces that change gene frequencies in populations: i. Mutation, ii. Random genetic drift iii. Migration iv. Natural selection v. Balance between mutation and selection vi. Assertive mating vii. Inbreeding Summary of the effects of evolutionary forces on the genetic structure of population - The role of genetics in conservation Biology Polymerase Chain Reaction- Fundamentals of the PCR, Variations/ Modifications of PCR: 2.2.2. Reverse transcriptase PCR, Differential display PCR, 2.2.3. Real time Fluorescent PCR, Hot- Start PCR, Multiplex PCR, Nested PCR, 2.2.4. PCR Applications and Advantages Organelle DNA: - 2.3.1.The genetics of organelle encoded traits, - The endosymbiotic theory, 2.3.2. Mitochondrial DNA - The gene structure and organization of mitochondrial DNA, - Non universal codons in Mitochondrial DNA, replication, transcription and translation of Mitochondrial DNA, Evolution of Mitochondrial DNA, 2.3.3 Chloroplast DNA - Properties similar to Eubacterial DNA - Gene structure and	05 05	01

			organization of chloroplast DNA, Replication, transcription and translation of chloroplast DNA	15 L	
	Practical		Use of E coli as a model organism to understand the effect of UV light on its growth. 2. Use of S cerevisiae as a model organism to understand the effect of UV light on its growth. 3. Pot experiment using model plant- Arabidopsis thaliana 4. PAGE for proteins 5. Western Blotting (Demonstration) 6. Design of primer & PCR 7. Problems on population genetics 8. Visit to research institute	60L	02
			Microbial Pathogenesis and Applied Immunology		
	Theory	1	Adversarial strategies during infection 1.1 Bacterial survival strategies - Evading complement, - Evading killing by macrophages 1.2 The host counter attack against bacteria - Toxin neutralization - Opsonization of bacteria 1.3 The habitat of intracellular bacteria: Bacterial survival strategies - Defence against intracellular bacteria - Role of activated Macrophages 1.4 Viral survival strategies - antigenic variations - nonfunctional T- cell epitopes	15 L 03L 03L 04L 05L	01

	Practical			1. Hemoglobin estimation by Cyanmethaemoglobin method using Drabkins Fluid as one of the criteria used for selection of blood donor during collection of blood for safe transfusion. 2. Blood grouping and Compatibility testing /cross matching of blood for safe blood transfusion. 3. Determination Of Enzymes Of Oxidative Stress (SOD And Catalase) 4. NBT Analysis Of Blood Sample 5. Serum Lysozyme Activity 6. Serum Myeloperoxidase Activity (MPO) 7. Rheumatoid factor test for laboratory diagnosis of Rheumatoid arthritis 8. RIST and RAST- Principle, Procedure and Significance to be explained during the practicals using power point presentation/ you tube.	60L	02
				Applied Biochemistry		
	Theory	1		Enzymes: the catalysts of Cells and Classes of Natural Products		01
			1.1	Information from kinetics, specificity of enzymatic action, mechanisms of catalysis	5L	
				Enzyme isolation and purification		
			1.2	Polyketides, terpenes and steroids, alkaloids,	3L	
			1.3	phenylpropanoids, Flavonoids. Noncoding RNAs	7L	
					15 L	

		2		Natural and Unusual bio-molecules and bioactive compounds and Proteomics Bioactive proteins and peptides: peptides as bioactive agents, peptides with anti-oxidative activity, antimicrobial peptides, enzyme-based antimicrobial proteins, non-enzyme-based antimicrobial proteins-Definition, and examples Commercialization of antimicrobial proteins and peptides. Lectins, surfactants, albumin, cryoprotectants, lyoprotectants Proteomics and the proteome, branches Applications: Disease diagnosis [cancer biology, autoimmune, allergic response], Glycomics, use of protein biomarkers	05 L 03L 04L 04L 15 L	01
	Practical			1. Isolation, partial purification, and study of enzyme kinetics of amylase. 2. Effect of substrate concentration, temperature, and pH on the activity of the enzyme 3. Isolation of amylopectin and amylose from potato starch. 4. Isolation of Lycopene from tomatoes 5. Preparation of lectin from a plant source and its application	60L	02
				Environmental Microbiology		

	Theory	1	1	Microbial Life in Extreme Environments Physiology, Molecular adaptation and biotechnological Applications of - Thermophiles Psychrophiles Halophiles Acidophiles Alkalophiles Piezophiles Radiation resistant organisms	09	01
			2	Extremophiles and Exobiology	01	
			3	Geo Microbiology Biocorrosion and Bioleaching	05	
					15L	
		2		Evolution and Microbial Diversity		01
			1	Evolution i) History of evolution Theories of organic evolution -Lamarckism - Darwinism -Modern synthetic theory -Germplasm theory -Mutation theory ii) Neutral theory of evolution - Polymorphism - Divergence - Near neutral theory of evolution	07	
			2	Microbial diversity: i) Estimates of total number of species, measures and indices of diversity, the species concept for prokaryotes and eukaryotes ii) Culture-dependent microbiology iii) Newer approaches for exploring uncultivable bacteria: Culture-independent molecular methods iv) Methods of extracting total bacterial DNA	08	

				from a habitat; the metagenomics approach	15 L	
Discipline-Specific Electives (Any one)						
				A. Molecular biology tools and Immunodiagnostics		
	Theory	1	1	Molecular biology tools Polymerase Chain Reaction- i. Fundamentals of the PCR ii. Variations/ Modifications of PCR: Reverse transcriptase PCR, Differential display PCR, Real time Fluorescent PCR, Hot- Start PCR, Multiplex PCR, Nested PCR, Applications	04	01
			2	Molecular tools for studying genes and gene activity i. Molecular separations: Gel electrophoresis, Two-dimensional gel electrophoresis ii. Labelled tracers: Autoradiography, Liquid scintillation counting Nonradioactive tracers iii. Using nucleic acid hybridization: Southern blots, DNA fingerprinting and DNA typing, In situ hybridization: Locating genes in chromosomes, Immunoblots iv. DNA sequencing and physical mapping: The Sanger Chain-Termination Sequencing method, High-throughput Sequencing, Restriction Mapping, Site-directed mutagenesis v. Mapping and quantifying transcripts, Northern blots, S1 mapping, Primer extension, Run-off transcription and G-less cassette transcription vi. Knockouts: Gene knock out in yeast, Knocking down expressed gene by RNA	11	

				interference (RNAi)	15L	
		2	1	Immunological Diagnostic Procedures Antibody generation	01	01
			2	Monoclonal Antibodies Formation and Selection of Hybrid Cells, Identification of Specific Antibody-Producing Hybrid Cell Lines (Mol Bio Glick 334-339) , Hybrid Human–Mouse Monoclonal Antibodies 403 Human Monoclonal Antibodies 406 (Glick) Detection of molecules using ELISA, RIA, western blot	04 04	
			3	Detection of molecules in living cells Immunoprecipitation	03	
			4	Flow cytometry Immunofluorescence microscopy	02	
			5	In situ localization of molecules by techniques such as FISH and GISH	01	
			6	Immune Quantitative Real-Time PCR	01	
					15L	
	Practical			1 Southern hybridization technique [Demonstration] 2 Northern Blotting Technique [Demonstration] 3 Western blotting [Demonstration] 4 Restriction digestion of DNA Restriction mapping (virtual mapping and problems Based on restriction mapping) 5 PCR [Demonstration] 6 Isolation and detection of plasmid DNA 7 Preparation of Antigen and its confirmation using standard	60L	02

				antibodies 8 Qualitative and quantitative detection of antibodies: Widal, VDRL, Coombs, forward and backward typing, Isoagglutinin titer 9 Assignment 1- Engineered products/activities used for the enhancement of human health 1 Assignment 2 - Search for 0 drugs among unculturable microorganisms 1 Report on Visit to Research 1 Laboratory		
				Advances in industrial microbiology		
	Theory	1	1. Isolation, enrichment and testing of organism-producing metabolites with bioactive activity 2. Strain improvement (Self-study topic) 3. Application of genetic engineering in Industrial Microbiology i. Production and enhancing the activities of industrial enzymes ii. Engineered products/activities used for the enhancement of human health 1. Production of Biofuel i. Biofuel – Types, feedstock and production processes ii. Industrial alcohol production-properties, uses, Denatured alcohol (Self-study topic) iii. Manufacture and developments in alcohol production 2. Production of Biofertilizers and Bioinsecticides i. Biofertilizers – types, mass production, applications	05 <		

[illegible]

				compound by Wilkins agar overlay method & Agar Strip method 7. Testing of drug using Kirby – Bauer method. 8. Bioassay of drugs (Ampicillin / Penicillin) 9. Assignment 1- Engineered products/activities used for the enhancement of human health 10. Assignment 2 - Search for drugs among unculturable microorganisms 11. Report on Industrial visit		
	VI	Research Methodology		On-Job Training (OJT) / Field Project (FP)		04

Sem 2: References

Microbial Genetics-II	1. iGenetics- A Molecular Approach, Russell, P.J., 3rd edition, 2010, Pearson International Edition 2. Fundamental Bacterial Genetics, Trun Trempy, 1s edition, 2004, Blackwell Publishing 3. Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, 7th edition, 2007, Pearson Education 4. Genes IX, Lewin, B., 2006, Jones and Bartlett Publishers 5. Genetics: A Conceptual Approach, Benjamin Pierce 4th edition, 2008, W. H. Freeman & Co 6. Principals of Genetics, Snustad & Simmons, 6th edition, 2012, John Wiley & Sons Inc 7. Molecular biology –Genes to proteins 3rd ed. by Burton E. Tropp (Jones & Bartlett publishers) 8. Molecular Genetics of bacteria, 3rd Edition by Larry Snyder and Wendy Champness (ASM Press) Recombinant DNA J.D. Watson 2nd ed
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	12. PCR, Clive R. Newton, Alex Graham. (1997); BIOS Scientific Publishers. 13. Molecular Biology by R. F. Weaver 3rd edition, McGraw-Hill international edition
Microbial Pathogenesis and Applied Immunology	Textbooks 1. Roitt's Essential Immunology 13th Ed. –Wiley Blackwell 2. Kuby Immunology 6th Ed – W. H. Freeman and Company, New York Reference Books: 1. Immunology –Essential and Fundamental – Sulbha Pathak, Urmi Palan,3rd Ed. Capital Publishing Company (New Delhi-Kolkata) 2. Kuby Immunology 7th Ed – W. H. Freeman and Company, New York 3. Elements of Immunology- Fahim Halim Khan –Pearson Education 4. Medical Laboratory Technology - Kanai Mukherjee vol. 1
Applied Biochemistry	REFERENCES Unit I 1. Biochemistry: The chemical reactions of living cells (Vol 1) David E. Metzler. Academic Press. 2. Fundamentals of enzymology. 2nd edition. Nicholas C. Price and Lewis Stevens. Oxford Science Publication. Reprint 1998. Unit II 1. Chemistry of Natural products by SV Bhat, BA Nagasampagi& M Sivakumar, Berlin Springer (2005) (ISBN 3-540-40669-7). Unit III 1. Bioactive food proteins & peptides Applications in human health, ed Navam S. Hettiarachchy, CRC Press, 2012 2. Natural products: the secondary metabolites. James R. Hansen. Royal Society of Chem. 3. Development & manufacture of Protein Pharmaceuticals. Ed Steven L. Nail and Michael J. Akers. Springer Science 2002 [ISBN 978-1-4615-0549-5] 4. Functional food carbohydrates. Costas G. Biliaderis and Marta S. Izydorczyk. CRC press 2007. 5. The physiology and biochemistry of prokaryotes, White D., Drummond, T. J. and Fuqua C., 3rd edition, 2007, Oxford University Press Unit IV 1. Introduction to proteomics Tools for the new Biology. Daniel C. Liebler. Humana Press 2002 2. OMICS Applications in Biomedical, Agricultural, and Environmental Sciences. Ed

	Debmalya Barh, Vasudeo Zambare, Vasco Azevedo. CRC press. 2013 REFERENCE BOOKS 1. Laboratory manual in biochemistry by Jayaraman J. , New Age International Publishers. 2. Enzymes 3rd edition. Malcolm Dixon and Edwin C. Webb. Longman Group 1979. 3. An introduction to practical biochemistry 3rd. edition, David T Plummer, Tata McGraw Hill edition 1998 4. Experimental biochemistry –A student companion, Rao Beedu, S. Deshpande, IK International Pvt. Ltd. 5. Laboratory manual in biochemistry, Immunology and Biotechnology, Nigam A and Ayyagiri A. Tata McGraw Hill edition 6. Source of Experiments for teaching Microbiology, Primrose and Wardlaw 7. Microbial Physiology and Biochemistry Laboratory manual: A quantitative approach, David White
Environmental Microbiology	1. Environmental Microbiology: Fundamentals and Applications Microbial Ecology, Jean-Claude Bertrand · Pierre Caumette Philippe Lebaron · Robert Matheron Philippe Normand · Télesphore Sime-Ngando Editors 2. Gerday, C., Glansdorff, N., & American Society for Microbiology. (2007). Physiology and biochemistry of extremophiles. Washington, D.C: ASM Press. 3. . Horikoshi, K., Antranikian, G., Bull, A.T., Robb, F.T., Stetter, K.O. (Eds.) (2011), Extremophiles Handbook. Springer 4. . Fred A. Rainey and Aharon Oren (2006). Methods in Microbiology - Volume 35, Extremophiles, 1st edi., Academic Press. 5. . S.K.Kawatra and K.A. Natarajan,“Mineral Biotechnology- Microbial Aspects of Mineral Beneficiation, Metal Extraction, and Environmental Control”, published by SME, Littleton, CO (USA) 2001 6. . S.W.Borenstein, Microbiologically influenced corrosion handbook, Woodhead pub. Ltd., Cambridge (1994) . Microorganisms In Biofouling and Biocorrosion: https://nptel.ac.in/courses/113108055/module7/lecture34.pdf
Discipline-Specific Electives Molecular biology tools and Immunodiagnosics	1 Molecular Biology by R. F. Weaver 3rd edition, McGraw-Hill International edition 2 Molecular Biotechnology Principles and applications of Recombinant DNA 4th edi Glick, Pasternak, Patten 3 iGenetics- A Molecular Approach, Russell, P.J., 3rd edition, 2010, Pearson International edition 4 Recombinant DNA J.D. Watson 2nd ed 12. PCR, Clive R. Newton, Alex Graham.

OR	(1997); BIOS Scientific Publishers 5 Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, 7th edition, 2007, Pearson Education 6 Molecular biology -Understanding the Genetic Revolution by David P. Clark(Elsevier Academic press) 7 Molecular biology –Genes to proteins 3rd ed. by Burton E. Tropp (Jones & Bartlett publishers)
	1. Okafor Nakuda (2007), “Modern Industrial Microbiology and Biotechnology”, Science Publications Enfield, NH, USA. Unit 1 - Ch-7, Pg. Nos. 219-226 Unit 2 – Pg. Nos. 423 – 434 2. Agritech.tnau.ac.in/org_farm/orgfarm_biofertilizertechnology.html Unit 1- Biofertilizers 3. Biopesticides: An eco-friendly approach for pest control Journal Biopesticides 3(1 Special Issue) 186-188 (2010) 186, Suman Gupta and A.K.Dikshit. Unit 1- Biopesticides 4. Biopesticide Formulations, Possibility of Application and Future Trends, Slavica Gasic and Brankica, Pestic. Phytomed (Belgrade), 28(2), 2013, 97-102 Review Paper. Unit 1- Biopesticides 5. Agritech.tnau.ac.in/farm.enterpri. Unit 1- Biopesticides
Advances in industrial microbiology Research Methodology	

Modality of Assessment

A. Internal Assessment- 50%

Sr. No.	Evaluation type	Total Marks
1	Review article/Book review/Case study/Research paper writing /Presentation /NPTEL Courses/Hands-on training (4 days cumulative)/Industrial/Research centre visit and its report/MCQs	30
2	Active participation in routine class instructional deliveries	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 first question will be based on the entire syllabus.
- All questions shall be compulsory with internal choice within the questions. Each question will be 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** (All Courses)

Total: 100 Marks

University of Mumbai

M.Sc. (MICROBIOLOGY)

Semester I / Semester II EXAMINATION

Maximum Marks: 50

Duration: 2.0 Hours

Marks Option: 80

Question 1: Based on Units I to IV (Mixed Questions)

Question 2

Question 3

Question 4

Question 5

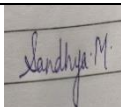
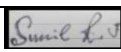
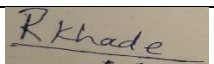
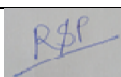
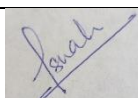
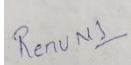
Instructions:

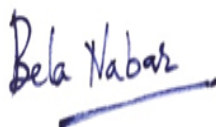
- i. All questions are compulsory.
 - ii. All questions carry equal marks.
 - iii. Draw neat and labelled diagrams wherever necessary.
1. Answer any two questions from the following (Based on all 4 units). (10 Marks)
 - A)
 - B)
 - C)
 - D)
 2. Answer any two questions from the following. (10 Marks)
 - 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. (10 Marks)
 - A)
 - B)
 - C)
 - D)

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. I & II)
Team for Creation of Syllabus
NEP -Microbiology _Syllabus Framing Committee
Post Graduate Program

No	Name		No	Name	
	Coordinator: Dr. Sandhya Mulchandani	Sign			Sign
1.	Dr. Sandhya Mulchandani Assistant Professor Smt. C.H.M. College Mobile No. – 9657944876 e-mail ID – bharti.mul@gmail.com		2.	Dr. Bela Nabar Professor, Smt. C.H.M. College, Ulhasnagar Mobile No. – 9322760417 e-mail ID – belamsn23@gmail.com	
3.	Dr. Sunil R. Jagiasi Associate Professor, R.K.T. College Mobile No. – 9850416645 e-mail ID – sunilrjagiasi@gmail.com		4.	Dr. Ranjana Khade Associate Professor, R.K.T. College Mobile No. – 9969259379 e-mail ID – khaderanjana@gmail.com	
5.	Dr. Rasika Pawar Assistant Professor Smt. C.H.M. College Mobile No. – 9869118328 e-mail ID – rasikapawarchm@gmail.com		6.	Dr. Pranali Shete Assistant Professor Smt. C.H.M. College Mobile No. – 9869876636 e-mail ID – pranalikale2@gmail.com	
7.	Dr. Ashish Jain Assistant Professor Smt. C.H.M. College Mobile No. – 7666059751 e-mail ID – ashishchm20@gmail.com		8.	Dr. Nitinkumar Patil Assistant Professor Smt. C.H.M. College Mobile No. – 9822626862 e-mail ID – nitinkumarpatil1@gmail.com	
9.	Ms. Renu N Jaisinghani Assistant Professor Smt. C.H.M. College Mobile No. – 7977174401 e-mail ID – chmmicrorj@gmail.com				



Head of the Department
Department in Microbiology



Dean, Science and Technology
University of Mumbai

Appendix B

Justification for M.Sc. (Microbiology)

1.	The necessity for starting the course:	To strengthen the capability of students by studying the latest updated courses so as to compete in various microbiological fields.
2.	Whether the UGC has recommended the course:	YES
3.	Whether all the courses have commenced from the academic year 2023-24	No UG courses will commence from 2024-2025
4.	The courses started by the University are self-financed, whether an adequate number of eligible permanent faculties are available?	Government aided YES
5.	To give details regarding the duration of the Course and is it possible to compress the course?	2 years No
6.	The intake capacity of each course and no. of admissions given in the current academic year:	As per the number of seats sanctioned by the University
7.	Opportunities of Employability / Employment available after undertaking these courses:	Will enhance the skill sets of students and employability prospects will ameliorate.



Head of the Department
Department in Microbiology



Dean, Science and Technology
University of Mumbai