

University of Mumbai



No. AAMS_UGS/ICC/2024-25/187

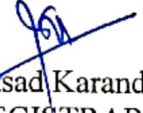
CIRCULAR:-

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 Board of Studies in Microbiology at its meeting held on 17th August, 2024 and subsequently passed by the Board of Deans at its meeting held on 23rd October, 2024 vide item No. 6.3 (R) 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 **revised syllabus of M.Sc. (Microbiology) Sem – I & II** as per appendix 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/6.3(R)/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, Institute of Distance and Open Learning (IDOL Admin), 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
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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 directr@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. – 6.3 (R)**

As Per NEP 2020

University of Mumbai



**Revised Syllabus for
M.Sc. (Microbiology)**

Syllabus for

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

(With effect from the academic year 2024-25)



(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: _____	Attached herewith
5	Semesters	Sem. I & II
6	Program Academic Level	6.0
7	Pattern	Semester
8	Status	Revised
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

1) Introduction

The existing syllabus is re-constructed following the intent and objectives of National Education Policy (NEP) 2020 and National Credit Framework (NCrF). 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. In order to enhance employability of students in various allied areas, curricula focusing on understanding of theoretical foundations and practical techniques required in R & D, quality control. It also envisages to enhance the employability of students in various allied areas, curricula focus on understanding of theoretical foundations and practical techniques required in R & D and quality control department in the industries. The program encourages students to engage in research, developing their ability to design experiments, analyze data, and interpret results in the context of microbiological studies. This comprehensive approach ensures the preparedness of students for advanced research, professional work in microbiology, or further academic higher pursuits.

2) Aims and Objectives

The main objective of this syllabus is to equip students with the latest advancements in Microbiology and its related fields. It also seeks to inspire and empower them to tackle societal and national challenges that fall within the scope of Microbiology, such as Molecular Biology, Eukaryotic Genetics, Medical Microbiology, Microbial Biochemistry, Applied Immunology, Bioinformatics, Industrial Microbiology, Food Microbiology, Environmental Microbiology, Epidemiology and Research Methodology. The syllabus content is designed to cultivate research skills and aptitude necessary for conducting research projects in Microbiology. The On-Job Training/Field Project in the second semester aims to bridge the gap between academia and industry. 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. Additionally, the syllabus is designed to stimulate curiosity and a passion for learning in students.

3) Learning Outcomes

The learners will be able to- i) Understand Recent Advances in Microbiology and gain in-depth knowledge of the latest developments in Microbiology and related disciplines, including Molecular Genetics, Medical Microbiology, Immunology, Bioinformatics etc. ii) Incorporate critical thinking into their study to carry out scientific investigation objectively. iii) Acquire Practical Skills and Techniques essential for research and development, quality control, and other professional practices in the microbiology industry. iv) Understand industrial processes and immunodiagnostic methods. v) Learn to apply microbiological principles to address societal and national challenges in various fields, including emerging diseases and their management, environmental, industrial, clinical, and food microbiology. vi) Understand processes and techniques used in development of biotechnology products vi) acquaint with advanced techniques developed for studying molecular biology vii) equip with skills to analyze problems, formulate a hypothesis, evaluate and validate results, and draw reasonable conclusions thereof viii) prepare for pursuing research careers in industry in area of Microbial technology ix) Prepare for Diverse Career Paths with the knowledge and skills necessary to pursue careers in industry, research, teaching, medical science, and entrepreneurship in the field of Microbiology. x) continue to acquire practical experience through On-Job Training/Field Projects that connects academic learning with industry demands, thereby improving employability. xi) Ignite a passion for continuous learning and exploration in the field of Microbiology, encouraging students to remain curious and engaged throughout their academic and professional careers.

4) Any Other Point (If Any)

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 like Research institutions/Food industry/ compulsorily for understanding the practical aspects of the subject.

1) Credit Structure of the Program (Sem I & II) (Table as per Parishisht 1 with sign of

NEP Syllabus -Microbiology - MSc -Part 1-Semester I and II

Year (2 Yr PG)	Level	Sem. (2 Yr)	Major		RM	OJT / FP	RP	Cum. Cr.	Degree
			Mandatory*	Electives Anyone					
I	6.0	Sem I	<u>Course 1</u> <u>PSMB101</u> Molecular basis of genetic disorders Credits 4	<u>Course 5</u> <u>PSMB105</u> Microorganisms in Food technology Credits 2				22	PG Diploma (after 3 Year Degree)
			<u>Course 2</u> <u>PSMB102</u> Medical Microbiology Credits 4	<u>Course 6</u> <u>PSMB106</u> Practicals based on Course 5 Credits 2					
			<u>Course 3-</u> <u>PSMB103</u> Microbial Biochemistry and Bioinformatics Credits 2	OR					
			<u>Course 4-</u> <u>PSMB104</u> Practicals in Microbiology (based on Course 1, 2 and 3) Credits 4						
				<u>Course 7</u> <u>PSMB107</u> Microbial Biotechnology Credits 2					
				<u>Course 8</u> <u>PSMB108</u> Practicals based on Course 7 Credits 2					
		Sem-II	<u>Course 1-</u> <u>PSMB201</u> Eukaryotic gene expression Credits 4	<u>Course 5</u> <u>PSMB205</u> Environmental Microbiology Credits 2		<u>Course 9</u> <u>PSMB209</u> OJT / FP Credits 4		22	
				<u>Course 6</u> <u>PSMB206</u> Practicals based on Course 5 Credits 2					

			<u>Course 2 -</u> PSMB202 Clinical Microbiology and Applied Immunology Credits 4	OR					
			<u>Course 3-</u> PSMB203 Applied Biochemistry and Molecular Biology Credits 2	<u>Course 7-</u> PSMB207 Advances in industrial microbiology Credits 2					
				<u>Course 8</u> PSMB208 Practicals based on Course 7 Credits 2					
			<u>Course 4-</u> PSMB204 Practicals based on Course 1, 2 and 3 Credits 4						
Cum. Cr. For PG Diploma			28	8	4	4	-	44	

Exit option: PG Diploma (44 Credits) after Three Year UG Degree						
Cum. Cr. for 1 Yr PG Degree	26	8			10	44
Cum. Cr. for 2 Yr PG Degree	54	16	4	4	10	88
Coordinator BOS, Microbiology Dean Science and Technology						

M. Sc. (Microbiology) Part 1: Semester I

Sr.No.	Heading	Particulars
1	Description the course : Including but Not limited to:	This course is designed to deepen the understanding of genetic disorders, medical microbiology, microbial biochemistry, bioinformatics and food technology. The course places a strong emphasis on the essential aspects of research, data analysis and the significance of scientific writing and knowledge of research ethics and plagiarism tools. The course aims to broaden the knowledge of microbial biotechnology particularly in the synthesis of vital metabolites and advancements in food technology. The knowledge and skills acquired through this course would not only equip the learners to tackle real-world challenges but also prepare to thrive in the competitive 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	
Molecular basis of genetic disorders		1. To understand the molecular basis of genetic traits that contribute to phenotypic changes and the effect of genetic exchange. 2. To acquaint with knowledge on transposable elements and DNA repair mechanisms in eukaryotes. 3. To understand the key molecular aspects concerning cancer genetics along with tumor suppressor mechanisms. 4. To understand the molecular basis of different genetic disorders and screening tests.
Medical Microbiology		1. To introduce the students to molecular mechanisms and regulation of pathogenesis. 2. To understand the concept of the Microbiome in health and diseases. 3. To acquaint the student with emerging and re-emerging diseases in India.
Microbial Biochemistry and Bioinformatics		1. To strengthen the fundamental concepts of biochemistry. 2. To understand the basic concept of Bioinformatics.
Microorganisms in Food Technology		1. To understand the significance of microbes in different fermentation.

	2. To understand the significance probiotics and prebiotics along with their applications
Microbial Biotechnology	1. To familiarize the importance and scope of microbial biotechnology in the production of valuable metabolites. 2. To explain the concept of molecular cloning.
Research Methodology	1. To understand the fundamental elements of research. 2. Gain knowledge about sampling and use of tests of significance for drawing valid conclusions. 3. Understand the importance of scientific writing. 4. To impart knowledge about scientific communication, publications and research tools.
8	Course Outcome On completion of this course learner will be able to
Molecular basis of genetic disorders	1. Apply the knowledge gained about genetic traits and its implications on phenotypic expressions. 2. Correlate the impact of transposable elements in controlling phenotypic traits along with mechanisms to repair mutations. 3. Understand the different types of cancer. 4. Acquaintance with the occurrence and development of different genetic disorders.
Medical Microbiology	1. Correlate molecular mechanisms of virulence associated with biofilm mediated infections and toxins. 2. Understand the mechanism of antibiotic resistance in the microbiome. 3. Awareness about emerging and re-emerging diseases and clinical laboratory practices in bacteriology.
Microbial Biochemistry and Bioinformatics	1. Understand the broad domains of biochemistry. 2. Explore different biological databases and tools. 3. Apply algorithms for searching the biological databases, Categorize sequence alignment methods. 4. Implement phylogenetic tree construction algorithms. 5. Predict gene and protein secondary structure.
Microorganisms in Food Technology	1. Develop insights into basic food fermentations 2. Acquire knowledge about of healthy bacteria in human health
Microbial Biotechnology	1. Understand the broad domains of microbial biotechnology and significance of microorganisms in the synthesis of important metabolites. 2. Acquire knowledge to understand the principle and procedure of molecular cloning.
Research Methodology	1. Formulate research problems and understand the steps involved in research.

	2. Choose appropriate sampling method data collection and effectively implement the test of significance in a research study. 3. Analyze research data using appropriate tools and techniques, interpret the results, and draw logical conclusions that address the research questions or hypotheses. 4. Present research findings and defend project results by applying a scientific writing style.
9	Modules:- Core Course - 04 /02 credits / Course DSE - 04 credits/Course

SEMESTER I SYLLABUS DETAILS

Course Code	Title of the paper		No of lectures	Credits
PSMB 101	MOLECULAR BASIS OF GENETIC DISORDERS		60	4
Theory	Unit 1	Mendelian Genetics and Transformation	15	01
	1.1	Mendelian Genetics in Humans Rediscovery of Mendel's principles Pedigree Analysis Recessive Traits Dominant Traits	7	01
	1.2	Transformation Development of Competence in Gram positive bacteria and Gram-negative bacteria. Role of natural transformation- Nutrition, Repair, Recombination. Importance of natural transformation for forward and reverse genetics. Artificially induced competence- Calcium ion induction, transformation of plasmids, transfection by phage DNA and Electroporation.	8	
	Unit 2	DNA repair and transposable elements	15	01
	2.1	DNA repair in Eukaryotes Eukaryotic Nucleotide Excision repair, Mismatch repair mechanism in humans Non-homologous end joining (NHEJ) pathway for repairing double-stranded breaks	5	01
	2.2	Transposable genetic elements in eukaryotes Transposable Ac and Ds Elements in Maize, P Elements and Hybrid Dysgenesis in Drosophila. Retrovirus and Retrotransposons Transposable elements in Humans The Genetic and Evolutionary Significance of Transposable Elements: Transposons as mutagens, Genetic transformation with transposons, Transposons and Genome organization, Evolutionary Issues Concerning Transposable Elements	10	

	Unit 3	Molecular Basis Of Cancer	15 L	01
	3.1	Cancer: A Genetic Disease, Forms of Cancer, Cancer and the Cell Cycle Oncogenes: Tumor-Inducing Retroviruses and Viral Oncogenes, Cellular ProtoOncogenes, protein products of protooncogenes, Changing cellular protooncogenes into oncogenes, Chromosome Rearrangement and Cancer.	9	01
	3.2	Tumor Suppressor Genes: the Retinoblastoma tumor suppressor gene- RB, P53, Breast cancer tumor suppressor genes, The multistep nature of cancer	6	
	Unit 4	Molecular basis of genetic Disorders	15	01
	4.1	Phenylketonuria Albinism	5	01
	4.2	Tay Sachs disease Kartagener syndrome Sickle cell anemia Cystic Fibrosis	8	
	4.3	Genetic Counselling Fetal cell analysis	2	
References		1.Russell, P.J., “iGenetics- A Molecular Approach”, Third Edition, Pearson International Edition 2.Genetics: A Conceptual Approach, 3rd Edition by Benjamin Pierce 3.Gene X – Lewin 4.Trun, Trempey, “Fundamental Bacterial Genetics”, Blackwell Publishing 5.Snustad & Simmons, “Principles of Genetics”, Third Edition, John Wiley & Sons Inc.		

Course Code	Title of the paper		No of lectures	Credits
PSMB 102	MEDICAL MICROBIOLOGY		60	4
Theory	Unit 1	Mechanisms of Pathogenesis-1	15	01
	1.1	Overview of bacterial mechanisms of evading host defense.	03	01
	1.2	Bacterial persistence within the host- i. Surviving phagocytosis eg: Legionella, Salmonella, and Mycobacterium. ii. Chronic infections eg: Brucellosis and typhoid fever.	06	
	1.3	Bacterial toxins and intoxication Diphtheria and Botulism- regulation and mode of action.	06	
	Unit 2	Microbial biofilms and Antibiotic Resistance	15	01
	2.1	Microbial biofilms i. Structure, properties and formation ii. Role of Quorum Sensing in Microbial Infections and Biofilm Formation iii. Microbial Social Interactions in Biofilm	05	01
	2.2	i. Perspective of Quorum Sensing Mechanism in <i>Candida albicans</i> ii. Quorum Sensing in <i>Helicobacter pylori</i> : Role of Biofilm and Its Implications for Antibiotic Resistance and Immune Evasion	04	
	2.3	Antibiotic Resistance i. Genetic Basis of antimicrobial resistance ii. Mechanistic basis of antimicrobial resistance- modification of antibiotic molecules, decreased penetration and efflux, changes in target sites, Resistance Due to Global Cell Adaptations. iii. Pathogenesis and Antibiotic Resistance of <i>Staphylococcus aureus</i>	06	

	Unit 3	Superficial, subcutaneous and systemic mycoses	15 L	01
	3.1	Superficial mycoses Dermatophytosis, Superficial Candidiasis, Pityriasis versicolor.	05	01
	3.2	Subcutaneous infections: Mycetoma, Chromoblastomycosis, Sporotrichosis.	05	
	3.3	Systemic mycoses Coccidioidomycosis, Aspergillosis, Invasive Candidiasis.	05	
	Unit 4	Emerging Infectious Diseases	15	01
	4.1	Emerging Viral Infectious Diseases i. Severe Acute Respiratory Syndrome ii. Avian Influenza iii. H1N1 Influenza	06	01
	4.2	Emerging Bacterial Infections Drug Resistance	05	
	4.3	Emerging Fungal Infections Emergence of new and resistant fungal infectious diseases.	04	
	References	Unit 1	1. Bacterial Pathogenesis : A Molecular Approach by Wilson, Salyers, Whitt, Winkler, Third Edition. (Pg no 239-251, 510-523)	
Unit 2		1. Implication of Quorum Sensing System in Bio lm Formation and Virulence. Edited by Pallaval Veera Bramhachari. Springer Nature Singapore Pte Ltd. ISBN 978-981-13-2428-4 pg- 29-39, 195-205, 277-286 2. Model Organisms for Microbial Pathogenesis, Biofilm Formation and Antimicrobial Drug Discovery. Edited by Busi Siddhardha. Springer Nature Singapore Pte Ltd. 2020 ISBN 978-981-15-1694-8 Pg 99-11. 61-78		
Unit 3		1. Medical Microbiology: A guide to microbial infections: pathogenesis, immunity, laboratory diagnosis and control, Edited by- David Greenwood, Mike Barer, Richard Slack, Will Irving. 2012 Elsevier Ltd, Eighteenth edition, ISBN: 9780702040894		

	Unit 4	1. Immunology and Immuno technology, Ashim K. Chakravarty, Oxford University Press, Page number 353-376.
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Course Code	Title of the paper		No of lectures	Credits
PSMB 103	Microbial Biochemistry and Bioinformatics		60	4
Theory	Unit 1	Bioorganic molecules	15	01
	1.1	Lipids: structural lipids, lipids as signal, cofactors and pigments. Coenzymes, antioxidants and metals Proteins:Chaperonins, prion motifs and domains	8 L	01
	1.2	Carbohydrates: derivatives of monosaccharides, glycoconjugates, carbohydrates as informational molecules. Functional carbohydrates and hydrocolloids Cereal β Glucans, modified starch, microbial Polysaccharides, Chitosan	7L	
	Unit 2	Basic Bioinformatics	15	01
	2.1	Biological databases i. Nucleic acid sequence databases- GenBank, EMBL, DDBJ, GSA, dbSNP ii. Protein Database Protein sequence databases- PIR, SWISS-PROT, TrEMBL, Protein Structure Database-PDB, SCOP, CATH, Protein Pattern and Profile Databases- InterPro, PROSITE Metabolic Pathway Databases- MetaCyc, ENZYME, KEGG Structure predictions for proteins- Basic approaches for protein structure predictions, comparative modeling, fold recognition Primer designing: Basic Principles and Bioinformatic tools	07	01
	2.2	The concept in sequence analysis i. Needleman and Wunsch algorithm ii. Smith and Waterman alignment algorithm	08	

		iii. Scoring Matrix for nucleic acids and protein iv. Substitution Scoring Matrix- PAM matrix and BLOSUM Matrix Sequence alignment i. Global and Local alignment ii. Pairwise alignment-BLAST, FASTA iii. Multiple sequence alignment- COBALT, CLUSTAL W Phylogenetic tree construction and analysis		
References	Unit 1	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 Willey and Sons Inc. 4. Functional food carbohydrates. Costas G. Biliaderis and Marta S. Izydorczyk. CRC press 2007. 5. Handbook of hydrocolloids. 2nd edition. Ed G.O. Phillips and P.A. Williams. CRC Press. Woodhead Publishing Limited [ISBN-978-1-84569-587-3] ADDITIONAL READING MATERIAL 1. 6. Laboratory manual in biochemistry by Jayaraman J. , New Age International Publishers. 2. 7. An introduction to Practical biochemistry 3rd edition, David T Plummer, Tata McGraw Hill edition 1998		
	Unit 2	1. Basic Bioinformatics , S. Ignacimuthu. 2. Substitution scoring matrices for proteins: An overview. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7586916/ 3. Mount, D. W. (2001) Bioinformatics: sequence and genome analysis. Cold Spring Harbor Laboratory Press, New York. 4. Introduction to Bioinformatics T.K. Attwood and D.J Perry-Smith. 5. 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.		

Course Code	Title		No. of lectures	Credits
PSMB 104	Practicals in Microbiology (Based on course 1, 2 and 3)		120	4
Practical	1.	Isolation of plasmid DNA using miniprep method		

	2.	Preparation of competent <i>E. coli</i> cells
	3.	Transformation of competent cells using plasmid DNA
	4.	Detection of plasmid DNA using Agarose Gel Electrophoresis
	5.	Problems on Pedigree Analysis
	6.	Microbial Biofilm formation on various surfaces.
	7.	Determination of Minimum Biofilm Inhibition Concentration of an Antibiotic.
	8.	Detection of specific types of Antibiotic Resistance. 1. MRSA 2. VRE
	9.	Antibiotic susceptibility testing- Determination of MIC.
	10.	Isolation of fungal pathogens and study of morphology using wet mount.
	11.	Extraction, isolation, partial purification, calculation of percentage yield and performing a confirmatory test for the following: i. lactose from milk ii. Albumins and globulins from egg white
	12.	Primer designing using bioinformatic tools.
	13.	Multiple sequence alignment of given sequences and construction of phylogenetic tree.
	14.	Assignment 1: Molecular basis of Genetic Disorder OR Molecular basis of any one type of Cancer.
	15.	Assignment 2: Emerging Infectious Diseases OR Biological databases.

DISCIPLINE SPECIFIC ELECTIVES (ANY ONE)

Course Code	Title of the paper		No of lectures	Credits
PSMB 105	Microorganisms in Food Technology		30	2
Theory	Unit1	Role of microorganisms in Food technology	15	01

	1.1	Starter culture used in food fermentation Bacteria, yeast and mold	2	01
	1.2	Fermented food Production Fermented cereals: - Bread production Fermented vegetables: - Sauerkraut production. Microbial flavoring compound Production: Vanilla flavor	7	
	1.3	Prebiotic and Probiotic Required Probiotic Properties Industrial Aspects of Probiotic Production Prebiotics	6	
	Unit 2	Microbial production	15	01
	2.1	Acid: Rosmeric acid, Caffeic acid	3	01
	2.2	Bacterial polysaccharides: Dextran and Xanthan	5	
	2.3	Vitamin: Riboflavin	2	
	2.4	Antibiotics: Cephalosporin, Tetracycline	5	
References	Unit 1	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. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology". Vol 1 &2 , Academic Press. 5. Semih Otles. " Probiotics and Prebiotics in Food, Health and Nutrition". Taylor and Francis, CRC Press.		
	Unit 2	1. Adams and Moss , Food Microbiology, 3rd edition, RSC Publishing (2008). 2. Robert E.C. Wildman 2nd Ed. " Handbook of Nutraceuticals & Functional Foods " CRC Press A SCIENCE PUBLISHERS BOOK. 3. Prescott and Dunn's "Industrial Microbiology".1982 4th Edition, McMillan Publishers. 4. Ronald Ross Watson, Victor R. Preedy 1st Edition 2010 "Bioactive Foods in Promoting Health. 5. Wilfried Schwab, Bernd Markus Lange, Bernd Markus Lange "Biotechnology of natural products" Springer International Publishing, 6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7693651/		

		7. https://www.longdom.org/open-access-pdfs/cephalosporin-c-production-from-acremonium-chrysogenum-2329-6674-1000159.pdf
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Course Code	Title		No. of lectures	Credits
PSMB 106	Practicals: Microorganisms in Food Technology		60	2
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 Bioassay.		
	5.	Assignment: Current market overview concerning probiotic products.		
	6.	Visit to the food processing Unit/Industry.		

Course Code	Title of the paper		No of lectures	Credits
PSMB 107	Microbial Biotechnology		30	2
Theory	Unit 1	Importance and Scope of Microbial Biotechnology	15	01
	1.1	Importance of Biotechnology: Biotechnology as an interdisciplinary area, Global impact and current excitements of Biotechnology.	03	
	1.2	Biodiversity and its preservation Scope of Microbial biotechnology	02	
	1.3	Cryopreservation Cryopreservation of plant stock cells - Methods of Cryopreservation, establishment of Germplasm Bank.	05	

		Cryopreservation of animal stock cells - Selection of cell line and standardisation of culture condition, stages of cryopreservation and cell banks.		
	1.4	Industrially important microbial enzymes Types, mode of action and industrial applications of microbial amylases and proteases.	05	
	Unit 2	Tools and Techniques in Genetic Engineering	15	01
	2.1	Enzymes for Cutting and joining of DNA Exonucleases, Endonucleases, Restriction Endonucleases (Type I, II, III). DNA ligases, Alkaline Phosphatases, DNA polymerases, Use of Linkers and Adaptors.	05	01
	2.2	Cloning Vectors Properties of good vector, Cloning and Expression vectors. <i>E. coli</i> vectors –Plasmid, Cosmid, Bacteriophage vectors. Shuttle vectors.	05	
	2.3	Steps in gene cloning Isolation of desired gene, cDNA library, Genomic library, Chemical synthesis of gene. Gene amplification by PCR. Introduction of vector into suitable bacterial host (various transformation methods). Selection of recombinant clones, Selection of clones containing recombinant vector, selection of clones containing specific DNA inserts, colony hybridization test.	05	
References	Unit 1	1. R.C Dubey B: A TextBook Of Biotechnology, S. Chand Publishers.		
	Unit 2	1. Molecular Biotechnology - Principles and Applications of Recombinant DNA (3rd, Third Edition) By Bernard R. Glick. 2. B.D. Singh Kalyani Publishers, 2010 - Biotechnology.		

Course Code	Title	No. of lectures	Credits
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PSMB 108	Practicals: Microbial Biotechnology		60	2
Practical	1.	Enrichment and isolation of Amylase and protease producer.		
	2.	Production, purification of amylase and enzyme kinetic study of amylase.		
	3.	Extraction and quantification of bacterial DNA by UV spectrophotometer.		
	4.	Gene amplification by Polymerase chain reaction-Demonstration		
	5	Demonstration of Restriction endonuclease enzyme action for cutting of DNA.		
	5.	Assignment: Impact of Genetic Engineering on human life.		
References	1.	R. C. Dubey. A Textbook of Biotechnology. 2006 S. Chand and Company Ltd.		
	2.	S. B. Primrose. Modern Biotechnology 1989. Blackwell Scientific Publ.		
	3.	Aluizino Borent. Understanding Biotechnology. 2004 Pearson Education.		
	4.	Bernard R Glick and Jack J Pasternak. Molecular Biotechnology: Principles and Applications of recombinant DNA. 3rd Edition.		
	5.	Primrose. Principles of Gene manipulations. 6th edition. 2004 Blackwell Science.		
	6.	James Watson. Recombinant DNA. 2001. Scientific American Books.		

Course Code	Title of the paper		No of lectures	Credits
PSMB 109	Research Methodology		60	4
Theory	Unit 1	Basic Elements of Research	15	01
	1.1	Introduction to Research i. Purpose and types of Research ii. Research Process iii. Research Design iv. Research Problem	07	01
	1.2	Sampling and Data collection Methods i. Sampling frame ii. Methods of sampling: Probability and non probability sampling iii. Steps involved in sampling iv. Types, sources and methods of data collection	08	

		Primary and Secondary Data		
	Unit 2	Hypothesis and Test of significance	15	01
	2.1	Hypothesis i. Features and types of Hypotheses ii. Null and alternative hypothesis iii. Steps involved in testing of Hypothesis	05	01
	2.2	Tools for testing of Hypothesis Parametric Tests i. Z test ii. t test iii. χ^2 test iv. ANOVA Nonparametric test: Features and examples	10	
	Unit 3	Scientific Writing and Research Ethics	15 L	01
	3.1	Scientific Writing; Overview of Research Report i. Title ii. Abstract iii. Introduction iv. Methodology v. Results & Discussion vi. Reference citation	08	01
	3.2	Ethics in Research and Plagiarism i. Research Ethics ii. Plagiarism -Types, causes and how to avoid iii. Plagiarism checking tools ● Plagium ● Copy tracker ● Turnitin ● Urkund	07	
	Unit 4	Scientific Communication and Research Funding	15	01
	4.1	Scientific Communication	12	01

		i. Scientific Papers - Types and Organization ii. Review Paper iii. Book Review iv. Book Chapter / Book v. Thesis vi. Conference Communication - Oral / Poster		
	4.2	Research proposal and funding agencies i. Research grant Proposal ii. Research Funding agencies iii. Introduction to advance research tools	03	
References	Unit 1	1. Research Methodology: Tools And Techniques Dr. Prabhat Pandey Dr. Meenu Mishra Pandey 2. Research Methodology, Shhradhha Bhome, Nishikant Jha,, Vinod Chandwani, Seethalaksmi Iyer, Swati Desai, Archana Prabhudesai, Suryakant D Koshti, Himalaya Publishing House, 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 ed., Sage publications.		
	Unit 2	1. Research Methodology: Tools And Techniques Dr. Prabhat Pandey Dr. Meenu Mishra Pandey. Bridge Center 2015. 2. Research Methodology, Shhradhha Bhome, Nishikant Jha,, Vinod Chandwani, Seethalaksmi Iyer, Swati Desai, Archana Prabhudesai, Suryakant D Koshti, Himalaya Publishing House, 2013. 3. Fundamentals of Research Methodology and statistics-Yogesh Kumar Singh, New Age International Publishers		
	Unit 3	1. Barbara Gastel and Robert A. Day (2017), How to write and publish a scientific paper, 9th ed., Greenwood, ABC-CLIO.LLC, California. 2. Gupta, Sobhagyawati. (2017). Plagiarism Detection Software: an Overview. In book: Emerging Trends and Technology in Knowledge Management. Publisher: Prateeksha Publications, Jaipur. 3. Yam Bhadur Roka, Plagiarism, Types and causes and how to avoid this worldwide problem, Nepal Journal of Neuroscience ,14(3), 2-6.		
	Unit 4	1. Barbara Gastel and Robert A. Day (2017), How to write and publish a scientific paper, 9th ed., Greenwood, ABC-CLIO.LLC, California. 2. Yam Bhadur Roka, Review Article, Plagiarism: Types, causes & How to avoid this, worldwide problem, <i>Nepal Journal of Neuroscience</i> , 14(3), 2-6.		

M. Sc. (Microbiology) Part 1: Semester II		
Sr.No.	Heading	Particulars

1	Description the course : Including but not limited to:	This course is crafted to sharpen expertise in eukaryotic genetics, applied immunology, epidemiology, advanced molecular biology techniques and environmental microbiology. It offers an enriched learning journey through an On-the-Job Training (OJT) program, designed to equip students with a well-rounded skill set—both technical and non-technical—crucial for thriving in the industry. The hands-on experience will not only enhance competence and confidence but also prepare students for successful professional careers. The course seeks to ignite a passion for the subject, foster a scientific mindset and shape students into highly capable professionals, whether in industry or as independent researchers.
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	
Eukaryotic gene expression	1. To understand the concept of Population genetics and its impact on genetic disorders. 2. To give an overview of the Transcription and translation process in Eukaryotes. 3. To demonstrate the impact of environmental factors on Eukaryotic gene expression. 4. To gain knowledge about the genetics of organelle DNA.	
Clinical Microbiology and Applied Immunology	1. To give an overview of adversarial strategies during infection, Immunodeficiency and autoimmune Diseases. 2. To demonstrate the Viral survival strategies. 3. To learn the Advances in Allergy and other hypersensitivity Reactions. 4. To understand the concept of observational and experimental Epidemiology.	
Applied Biochemistry and Molecular Biology	1. To open the domains of applied biochemistry and train students to understand the challenges and problems encountered while dealing with bio-molecules. 2. To understand the advanced techniques of molecular biology.	
Environmental Microbiology	1. To develop basic knowledge of Microbial diversity and potential pathogens in environmental samples. 2. Analyze the evolutionary implications of life in extreme environments, including the origin of life on Earth and the possibility of life on other planets.	

Advances in industrial Microbiology	1. To develop the knowledge and skills to study the techniques used in different phases of Industrial Microbiology. 2. To understand the methods for assaying microbial metabolites as new drugs.
OJT / FP	1. Provide students with real world experience and align classroom learning with the workplace. 2. Foster research skills, including knowledge discovery, analytical tools, methodologies and ethical conduct. 3. Strengthen student's entrepreneurial skills and encourage professional skill development.
8	Course Outcome On completion of this course learner will be able to
Eukaryotic gene expression	1. Acquire knowledge regarding probability concerning genetic disorders. 2. Knowledge regarding molecular aspects of transcription and translation will be acquired. 3. Understand different aspects related to eukaryotic gene expression. 4. The learner will be acquainted with knowledge of functioning of the mitochondrial DNA.
Clinical Microbiology and Applied Immunology	1. Correlate the causes, principles involved and treatment of immunodeficiency disorders, hypersensitivity Reactions and autoimmune diseases. 2. Apply the knowledge gained about graft rejection and Blood Transfusion in the healthcare sector. 3. Acquire understanding about the scope and potential errors in epidemiological studies. 4. Deepen the knowledge of epidemiology and applied immunology.
Applied Biochemistry and Molecular Biology	1. Apply the biological processes for production and synthesis of bioactive molecules of commercial significance. 2. Open new avenues for research based on unusual bio-molecules, bioactive compounds and advanced techniques to the young scientists.
Environmental Microbiology	1. Learners will be able to understand microbial diversity of different samples by using culture dependent and culture-independent techniques. 2. Learners will be able to get broad knowledge transmission of different pathogens including bacteria, parasites and viruses present in the environment. 3. Get knowledge of different environmentally transmitted pathogens. 4. Articulate the competence in basic research methodologies for studying extremophiles and complexities of extraterrestrial environments and space research.
Advances in industrial Microbiology	1. Develop skills and applications of microbes in Industries. 2. Learn newer methods like involvement of the computers in Biotechnology and bioinformatics.

OJT / FP	1. Development of job specific skills leading to increased competence. 2. Insight exposure into the challenges, opportunities and requirements of different workplace preparing students for future employment. 3. Learn to work in a team, solve job-specific problems, leading to better decision-making and effective learning.
9	Modules:- Core Course - 04 /02 credits / Course DSE - 04 credits/Course

Course Code	Title of the paper		No of lectures	Credits
PSMB 201	Eukaryotic Gene Expression		60	4
Theory	Unit 1	Population genetics and Organelle DNA	15	01
	1.1	Genetic structure of population Hardy-Weinberg Law - Genetic variation in space and time Genetic variation in Natural population	5	01
	1.2	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. Assortative mating vii. Inbreeding	5	
	1.3	The genetics of organelle encoded traits The endosymbiotic theory, 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	5	

	Unit 2	Transcription in Eukaryotes	15	01
	2.1	Transcription and nucleosome structure Promoters and Polymerases Initiation Elongation Termination	7	01
	2.2	Transcription in Archae bacteria i. Differences in transcription in prokaryotes, Eukaryotes and Archae bacteria. ii. RNA Processing for Intron Removal iii. RNA Splicing in Eukaryotes iv. RNA editing in Eukaryotes	8	
	Unit 3	Translation in Eukaryotes	15 L	01
	3.1	Structure, function and Modifications Eukaryotic tRNA Eukaryotic Ribosome	5	01
	3.2	Mechanism of Translation i. Binding of Amino Acids to Transfer RNAs ii. Assembly of Amino Acids into a Protein	5	
	3.3	Elongation of Eukaryotic mRNA Additional Properties of Eukaryotic RNA Ribosomes Affect Protein Synthesis	5	
	Unit 4	Genes Expression and the Environment	15	01
	4.1	Multiple Alleles Essential and lethal genes Penetrance and expressivity	7	01
	4.2	Effect of the environment on gene expression Age of Onset, Gender, Temperature, Exposure to chemicals Nature versus Nurture Maternal effect	8	

		Exceptions to maternal inheritance		
References		1. iGenetics- A Molecular Approach, Russell, P.J., 3rd edition, 2010, Pearson International Edition. 2. Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, 7th edition, 2007, Pearson Education. 3. Genes IX, Lewin, B., 2006, Jones and Bartlett Publishers Genetics: A Conceptual Approach, Benjamin Pierce 4th edition, 2008, W. H. Freeman & Co. 4. Principles of Genetics, Snustad & Simmons, 6th edition, 2012, John Wiley & Sons Inc.		

Course Code	Title of the paper		No of lectures	Credits
PSMB 202	Clinical Microbiology and Applied Immunology		60	4
Theory	Unit 1	Adversarial strategies during infection	15	01
	1.1	Bacterial survival strategies i. Evading complement ii. Evading killing by macrophages		01
	1.2	The host counter attack against bacteria i. Toxin neutralization ii. Opsonization of bacteria		
	1.3	The habitat of intracellular bacteria i. Defence against intracellular bacteria. ii. Role of activated Macrophages.		
	1.4	Viral survival strategies i. Antigenic variations. ii. Nonfunctional T- cell epitopes. iii. Interference with antigen processing and/ or Presentation iv. Interference with immune effector mechanism. v. Immunity to Fungi.		

	Unit 2	Advances in Allergy and other hypersensitivities	15	01
	2.1	Hypersensitivities i. Type –I hypersensitivity ii. Type –II hypersensitivity iii. Type –III hypersensitivity iv. Type –IV hypersensitivity v. Type -V hypersensitivity	7	01
	2.2	Transplantation and Transfusion Immunology i. Types of Graft ii. Types of graft rejection iii. Blood transfusion iv. Blood grouping and cross matching v. Transfusion reactions vi. Criteria for selection and rejection of Blood Donor	5	
	2.3	Autoimmune diseases i. Causes ii. Mechanisms iii. Pathogenic effects of autoantibody iv. Pathogenic effects of complexes with auto antigens	3	
	Unit 3	Immunodeficiency Diseases	15 L	01
	3.1	Primary Immunodeficiencies	01	01
	3.2	Lymphoid Immunodeficiencies i. Severe Combined Immunodeficiency (SCID) ii. Wiskott-Aldrich Syndrome (WAS) iii. Interferon-Gamma–Receptor defect X-linked hyper IgM syndrome iv. X-linked Agammaglobulinemia v. Common variable immunodeficiency (CVI) vi. Immune disorders involving the thymus vii. Chronic granulomatous disease (CGD) viii. Chediak-Higashi syndrome ix. Leukocyte Adhesion Deficiency (LAD).	09	
	3.3	AIDS and Other Acquired Immunodeficiencies	05	
	Unit 4	Epidemiology	15	01
	4.1	Epidemiology: Key concepts	5	01

		Definition, scope, and uses of epidemiology, Epidemiology and public health. Achievements in epidemiology		
	4.2	Measuring health and disease Defining health and disease, Measuring disease frequency, Using available information to measure health and disease, Death rates, Morbidity, Comparing disease occurrence.	5	
	4.3	Types of studies Observations and experiments, Observational epidemiology, Experimental epidemiology, Potential errors in epidemiological studies.	5	
References	Unit 1	1.Bacterial Pathogenesis: A Molecular Approach by Wilson, Salyers, Whitt, Winkler, Third Edition. (Pg no 326-344)		
	Unit 2	1.Kuby Immunology 6th Ed – W. H. Freeman and Company, New York 2.Ananthanarayan and Paniker's Textbook of Microbiology, by Reba Kanungo, 10th ed Universities Press.		
	Unit 3	1.Kuby Immunology 6th Ed – W. H. Freeman and Company, New York.		
	Unit 4	1.Basic epidemiology. Authors: R. Bonita, R. Beaglehole, T. Kjellström. 2nd edition. World Health Organization. ISBN 92 4 154707 3		

Course Code	Title of the paper		No of lectures	Credits
PSMB 203	Applied Biochemistry and Molecular Biology		30	2
Theory	Unit 1	Natural and Unusual bio-molecules	15	01
	1.1	Bioactive proteins and peptides i. Peptides as bioactive agents ii. Peptides with anti-oxidative activity iii. Antimicrobial peptides iv. Enzyme-based antimicrobial proteins v. Non-enzyme-based antimicrobial proteins vi. Commercialization of antimicrobial proteins and peptides.	7 L	01
	1.2	Unusual bio-molecules: Lectins, surfactants, albumin, cryoprotectants, lyoprotectants	2L	

	1.3	Classes of Natural Products: polyketides, terpenes & steroids, alkaloids, phenylpropanoids, Flavonoids. Non coding RNAs	6 L	
	Unit 2	Techniques in Molecular Biology	15	01
	2.1	Basic techniques in protein analysis Protein separation: SDS PAGE, Isoelectric Focussing, High-performance liquid chromatography, Thin-layer chromatography Protein Purification and Characterization: Ion-Exchange Chromatography, Gel Filtration Chromatography, Affinity Chromatography, Polyacrylamide Gel Electrophoresis, Two-dimensional gel electrophoresis, Mass Spectrometry, X-ray crystallography, Nuclear Magnetic Resonance, Protein Microarrays	8	01
	2.2	Advance techniques in molecular biology CRISPR-Cas9 Technology, Single-Cell Sequencing, Nanopore Sequencing, Optogenetics, CAR-T therapy, Microarray Technology, Gene silencing	7	
References	Unit 1	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. Chemistry of Natural products by SV Bhat, BA Nagasampagi & M Sivakumar, Berlin Springer (2005) (ISBN 3-540-40669-7).		
	Unit 2	1. Principles and Techniques of Biochemistry and Molecular Biology Seventh edition Edited by Keith Wilson and John Walker. 2. Karp’s Cell and Molecular Biology – Concepts and Experiments (8th Ed.) By Gerald Karp, Janet Iwasa and Wallace Marshall. 3. Molecular Biology, 5/e by Robert Weaver.		

Course Code	Title	No. of lectures	Credits
PSMB 204	Practicals in Microbiology (Based on course 1, 2 and 3)	120	4

Practical	1.	Effect of non-ionizing radiation on the growth of <i>S. cerevisiae</i> .
	2.	Effect of non-ionizing radiation on the growth of <i>E. coli</i> .
	3.	Study different phases of mitosis.
	4.	Study of different environmental parameters on growth of <i>Arabidopsis thaliana</i> or <i>Brassica nigra</i>
	5.	Problems on population genetics.
	6.	Hemoglobin estimation by Cyanmethaemoglobin method using Drabkin's Fluid / Sahli's haemoglobinometer.
	7.	Blood grouping and Compatibility testing /cross matching of blood for safe blood transfusion.
	8.	Determination of Quality Assurance of laboratory media, reagents.
	9.	Separation of mononuclear cells by Ficoll hypaque density gradient centrifugation and Field Staining.
	10.	Problems on Epidemiology
	11.	Preparation of herbal extract and qualitative screening of photochemicals.
	12.	Isolation and detection of amylopectin and amylose from potato starch, Lycopene from tomatoes and lectin from plant source and its application
	13.	Separation and detection of amino acids using Thin Layer Chromatography (TLC).
	14.	Assignment on Significance of mitochondrial DNA/ Immunodeficiency Diseases.
	15.	Assignment on Advance techniques of molecular biology/Visit to Molecular biology Lab

DISCIPLINE SPECIFIC ELECTIVES (ANY ONE)

Course Code	Title of the paper		No of lectures	Credits
PSMB 205	Environmental Microbiology		30	2
Theory	Unit 1	Microbial diversity and environmentally transmitted pathogens	15	01

	1.1	Overview of microbial diversity in different environments i. Methods for Measurement of Microbial Diversity ii. Culture-dependent methods iii. Newer approaches for exploring uncultivable bacteria: culture-independent molecular methods iv. Metagenomics approach	7	01
	1.2	Environmentally Transmitted Pathogens i. Bacteria : <i>Salmonella</i> , <i>Escherichia coli</i> , <i>Shigella</i> , <i>Campylobacter</i> , <i>Yersinia</i> , <i>Vibrio</i> , <i>Helicobacter</i> , <i>Legionella</i> , Opportunistic Bacterial Pathogens, Blue-Green Algae ii. Parasite : Protozoa, Nematodes, Cestodes (<i>Taenia saginata</i>), Trematodes (<i>Schistosoma mansoni</i>) iii. Viruses : Enteric Viruses, Respiratory Viruses	8	
	Unit 2	Microbial Life In Extreme Environments	15	01
	2.1	Physiology and Biochemistry of i. Thermophiles ii. Psychrophiles iii. Halophiles iv. Acidophiles v. Alkaliphiles	10	01
	2.2	Microbial Life in Space i. Search strategy for life in the universe ii. Microbial Experiments iii. Microbial Life in Stratosphere iv. Microbial diversity in International Space Station v. Applications of Micro-organism in Space	05	
References	Unit 1	1. Environmental Microbiology Second Edition, Raina M. Maier 2. Microbial diversity and bioprospecting by Alan T Bull 3. Microbial diversity – Exploration and Bioprospecting by S Ram Reddy, M A Singara Charya and Girisham , Scientific publishers (India) 4. Review Microbial Diversity: The Gap between the Estimated and the Known Luciana Cristina Vitorino https://pdfs.semanticscholar.org/f2d9/70d4ca8a5069cf95df1da44322dcaa01353a.p df 5. https://biomed.brown.edu/Courses/BIO48/20.SpeciesConcepts.HTML 6. https://www.researchgate.net/publication/264238213_Bioprospecting-download the pdf 7. Exploring Bacterial Diversity: How Far Have We Reached? https://sciendo.com/article/10.2478/am-2023-0011		

	Unit 2	1. Physiology and Biochemistry of Extremophiles Editor(s): Charles Gerday, Nicolas Glansdorff First published: 24 April 2007 Print ISBN: 9781119738282 Online ISBN: 9781683671657 DOI: 10.1128/9781555815813 2. Pikuta, E. V., Hoover, R. B., & Tang, J. (2007). Microbial extremophiles at the limits of life. <i>Critical reviews in microbiology</i>, 33(3), 183-209. doi: 10.1080/10408410701451948. 3. Thombre R S, Kaur K, Jagtap S S, Dixit J, Vaishampayan P V Microbial Life In Space Journal: New Frontiers in Astrobiology, 2022, Publisher: Elsevier . 135-166 https://doi.org/10.1016/b978-0-12-824162-2.00013-0
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Course Code	Title		No. of lectures	Credits
PSMB 206	Practicals: Environmental Microbiology		60	2
Practical	1.	Comparison of different soil and water samples for microbial density.		
	2.	Enrichment and enumeration of coliphage from sewage sample.		
	3.	Enrichment and isolation of thermophiles, thermo tolerant and halophiles from environmental samples.		
	4.	Qualitative and quantitative detection of cellulose degrading enzymes from thermophilic organisms.		
	5.	Enrichment and isolation of halophiles. Extraction of membrane lipids of halophilic Archaea and its detection by TLC		
	6.	Assignment: Recent advances in Astromicrobiology/Newer approaches for exploring uncultivable bacteria		

Course Code	Title of the paper		No of lectures	Credits
PSMB 207	Advances in Industrial Microbiology		30	2
Theory	Unit 1	Selection, improvement, and applications of beneficial microorganisms	15	01
	1.1	i. Selection Enrichment, isolation and testing of Bioactive metabolite producers ii. Strain improvement		01

		iii. Application of genetic engineering - Enhanced production and activities of industrial enzymes - Engineered products/activities used for the enhancement of human health		
	1.2	i. Production of Biofuel : Types, Feedstock and Production Process ii. Industrial alcohol production: properties, uses, Manufacture and developments in alcohol production		
	Unit 2	Microbial drug discovery methods	15	01
	2.1	Conventional processes of drug discovery i. Cell-based assays ii. Receptor binding assays iii. Enzyme assays	7L	01
	2.2	Newer methods of drug discovery i. Computer-aided drug design ii. Combinatorial chemistry iii. Genomic methods in search of new drugs iv. Search for drugs among unculturable microorganisms v. Approval of new drugs by the regulatory agency	8 L	
References	Unit 1	1.Okafor Nakuda (2007), “Modern Industrial Microbiology and Biotechnology”, Science Publications Enfield, NH, USA.		
	Unit 2	1.Okafor Nakuda (2007), “Modern Industrial Microbiology and Biotechnology”, Science Publications Enfield, NH, USA. Ch.29– Pg. Nos. 423 – 434.		

Course Code	Title	No. of lectures	Credits
PSMB 208	Practicals: Advances in Industrial Microbiology	60	2

Practical	1.	Production of extracellular metabolites from bacteria and their assay.
	2.	Production of Industrially important enzymes by submerged fermentation.
	3.	Biofuel production and its assay.
	4.	Production of antimicrobial substances from lactic acid bacteria and their assay.
	5.	Assignment 1- Engineered products/activities used for the enhancement of human health/ Approval of new drugs by the regulatory agency. Assignment 2 - Search for drugs among unculturable microorganisms/Genomic methods in search of new drugs
	6.	Report on Industrial visit.

Course Code	Title	No. of lectures	Credits
PSMB 209	OJT/FP	120	4

Introduction	On-the-Job Training (OJT) is highly significant in the M.Sc. Microbiology program as it serves as a vital bridge between theoretical knowledge acquired in the classroom and practical application in real-world settings. • This essential component is designed to equip students with a comprehensive set of skills both technical and non-technical—that are vital for success in the industry. By participating in OJT, students can apply the concepts and theories learned during their coursework to real-life scenarios in Life Sciences, enhancing their problem-solving abilities and gaining a deeper understanding of industry practices. This hands-on experience not only builds their competence but also boosts their confidence, effectively preparing them for the challenges they will face in their professional careers. • Hosting OJT programs also benefits the organizations involved by gaining insights into the M.Sc. Microbiology curriculum, these organizations can provide valuable feedback on its relevance to industry needs. This collaboration ensures the program remains aligned with current industry demands, fostering graduates who are well-prepared for the competitive job market and can contribute effectively to the Microbiology field. Additionally, faculty members involved in OJT also reap significant benefits. This experience enables them to stay updated with the latest industry practices, enabling them to effectively impart relevant guidance and mentorship to students. By incorporating insights gained from OJT, faculty members play a crucial role in preparing students for successful careers in the dynamic and ever-evolving field of Microbiology.
Developing Practical Skills through OJT	On-the-Job Training (OJT) program within the M.Sc. Microbiology curriculum offers a valuable opportunity for students to enhance their practical skills. This program typically spans 4-6 weeks, requiring a minimum of 120 hours of physical presence at the organization. It is designed to ensure that the students actively apply their classroom learning in a professional work environment. • The aim is to expose students to diverse work environments outside of the home institution, allowing them to gain a comprehensive understanding of the industry to meet the demands of the industry. • The OJT program covers a wide range of subjects within the syllabus, providing students with the flexibility to align their OJT experience with their academic interests. This ensures that students can apply their theoretical knowledge to practical scenarios relevant to their chosen areas of specialization. • The OJT experience offers mutual benefits for both students and organizations. Students have the opportunity to apply their classroom learning in a real-world setting, fostering the development of both technical and non-technical skills. They gain valuable insights into the industry and are better prepared for successful careers in the field of Life Sciences. • Overall, the OJT program serves as a bridge between theoretical knowledge and practical application, equipping students with the necessary skills and experience to thrive in their future careers within the field of Microbiology.

OJT mentors	In order to enhance the learning experience and maintain the quality of the MSc program, each student participating in the On-the-Job Training (OJT) will be assigned two mentors: a faculty mentor from the institution and an industry mentor from the organization where the student is interning. Industry Mentor Role: The industry mentor plays a crucial role in guiding the student during the internship, ensuring that they fulfil the requirements of the organization and successfully meet the demands of the assigned project. Leveraging their expertise and experience, industry mentors provide valuable insights into real-world practices and industry expectations. Faculty Mentor Role: The faculty mentor serves as the overall coordinator of the OJT program. They oversee the entire internship process and evaluate the quality of the OJT in a consistent manner across all students. The faculty mentor ensures that the OJT aligns with the program's objectives and provides valuable learning opportunities for the students. They act as a liaison between the institution, industry mentor, and student, facilitating effective communication and ensuring a fruitful OJT experience. This dual mentoring approach ensures a well-rounded and rigorous OJT experience for every student in the program, bridging the gap between theoretical knowledge and practical application while preparing them for successful careers in the dynamic field of Microbiology.
Submission of Documentation for OJT	During the On-the-Job Training (OJT), students are required to note activity details and their internship experience in a diary on a daily basis to ensure proper documentation. Diary: As part of the OJT, students are expected to maintain an online diary to record their daily activities and learning experiences. The diary serves as a logbook that can be accessed by both the faculty mentor and industry mentor. Each daily entry should provide a brief account, typically consisting of 3-4 sentences, highlighting the key activities, learnings, and interactions of the day. The faculty mentor regularly monitors the diary entries to stay informed about the student's progress and engagement throughout the internship. OJT Report: Upon completion of the OJT, students are required to prepare a comprehensive report based on their experiences in the organization. The report should include the following components: - Certificate: A certificate in the prescribed format (given in Appendix II and Appendix III) should be obtained from the organization where the OJT was conducted. This certificate validates the student's participation and provides official recognition of their internship. - Title: The report should have a suitable title that succinctly reflects the nature of the work the student performed during the OJT. - Description of the Organization: A brief description of the organization where the student interned should be provided. This description gives an overview of the organization's purpose, scope, and relevance to the field of Life Sciences. - Description of the Activities: A detailed description of the activities conducted within the specific section or department where the intern was assigned. This section should provide insights into the type of tasks and responsibilities typically assigned to new employees in that particular area. - Work Allotted and Accomplished: A comprehensive account of the tasks and projects assigned to the intern, along with a detailed description of the work performed during the OJT period. This section should be a condensed and structured version of the daily reports maintained in the diary. - Self-Assessment: The report should include a self-assessment by the intern, reflecting on the technical and interpersonal skills acquired and developed throughout the OJT period. This self-assessment should highlight the key learnings, challenges overcome, and personal growth experienced during the internship. By submitting these documents, students provide a comprehensive overview of their OJT experience, allowing the mentors and evaluators to assess their engagement, learning outcomes, and overall performance during the internship. The

	documentation ensures that students receive proper recognition for their efforts and allows them to reflect on their professional growth within the field of Microbiology.
Interaction between Mentors	To facilitate effective communication and ensure the successful implementation of the OJT, a mid-term review meeting involving the intern, industry mentor, and faculty mentor serves as a platform for all stakeholders to come together and discuss the progress and experiences of the intern during the internship period. • The mid-term review meeting can be conducted online to optimize time and resources. • By facilitating regular interactions between the mentors, the mid-term review meeting fosters effective communication, alignment of expectations, and the overall success of the OJT. • It serves as a platform for mentor collaboration and ensures a cohesive and supportive environment for the intern's professional growth and development in the field of Microbiology.
Reference	University of Mumbai, Guidelines for the Job Training (OJT) for Post Graduate Students As per NEP 2020 https://mu.ac.in/wp-content/uploads/2024/06/MU-OJT-Guidelines-Draft.pdf

Modality of Assessment

The examination pattern for all courses (Theory and Practical) offered in this syllabus will be 50% internal and 50% external (semester end).

Theory (For both Core and Elective courses)

50/25 Marks

A) Internal Assessment (Theory)- 50%

Sr. No.	Evaluation type	Total Marks (50)	Total Marks (25)
1	Review article writing /Book review writing/Case study/Lab instrument SOP writing and maintenance/Research paper Presentation /NPTEL Courses/Hands-on training (4 days cumulative)/Industrial/Research centre visit and its report/MCQs test/ Assignments (Any TWO for core course 1 and 2 and ONE for course 3 and DSE course)	30	15
2	Attendance – (0-25%=0 marks, 25-50%=1 mark,50-75%=3 marks and 75-100%= 5 marks) and Active participation in routine class instructional deliveries	10	05
3	Overall conduct as a responsible student, manners, skill in articulation, leadership qualities, co-Curricular participation, etc.	10	05

B) External Assessment (Semester End Theory Examination)- 50%

Semester end theory examination (for both semester I and II) shall be conducted as per the following pattern:

1. Core courses (Theory): Course I and II of 50 Marks each.

- 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. For each unit there will be one question and the last one will be based on the entire paper.
 - All questions shall be compulsory with internal choice within the question. Each question will be of 10 to 20 marks with options.
 - Questions may be subdivided into sub-questions a, b, c... and the allocation of marks depend on the weightage of the topic.

2. Core course (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 the entire paper.
 - All questions shall be compulsory with internal choice within the questions. Each question will be of 10 to 20 marks with options.
 - Questions may be subdivided into sub-questions a, b, c... and the allocation of marks depend on the weightage of the topic.

3. DSE (Theory): 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 the entire paper.
 - All questions shall be compulsory with internal choice within the questions. Each question will be of 10 to 20 marks with options.
 - Questions may be subdivided into sub-questions a, b, c... and the allocation of marks depend on the weightage of the topic.

4. Research Methodology course (Theory): 50 Marks

- i. Duration – This examination shall be of two hours duration.
- ii. Theory Question Paper Pattern:
 - There shall be five questions each of 10 marks. On each unit there will be one question and the last question will be based on the entire paper.
 - All questions shall be compulsory with internal choice within the questions. Each question will be of 10 to 20 marks with options.
 - Questions may be subdivided into sub-questions a, b, c... and the allocation of marks

depend on the weightage of the topic.

Practicals (For both Core and Elective Courses)

50/25 Marks

A) Internal Assessment (Practical)- 50%

Sr. No.	Evaluation type	Core Course Marks (50)		Core/ DSC courses Total Marks (25)	
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

B) External Assessment (Practical)- 50%

50/25 Marks

Sr. No.	Evaluation type	Core Course Marks (50)		Core /DSC courses Total Marks (25)	
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	Based on practicals	10	Based on practicals	05
3	Certified Journal		10		05

C. Evaluation of OJT/FP**100 Marks**

Evaluation of OJT by Industry Mentor (50%)	Evaluation of OJT by Faculty Mentor (50%)
Active participation and completion of assigned task (out of 20)	Weekly Reporting (out of 15)
Quality/Performance (out of 20)	Written Report (out of 20)
Punctuality/Regularity/completion of hours (out of 10)	Viva-Voce /Presentation (out of 15)
Total (out of 50)	Total (out of 50)

University of Mumbai**M.Sc.****(MICROBIOLOGY)****Semester I / Semester II EXAMINATION****Course PSMB (For 50 Marks Papers)****Maximum Marks: 50****Duration: 2.0 Hours****Marks Option: 100**

Questions	All questions are compulsory.		
	Based on	Any 2 out of 4 (a, b, c, d)	Marks
Q.1	Unit I	Any 2 out of 4 (a, b, c, d)	10
Q.2	Unit II	Any 2 out of 4 (a, b, c, d)	10
Q.3	Unit III	Any 2 out of 4 (a, b, c, d)	10
Q.4	Unit IV	Any 2 out of 4 (a, b, c, d)	10
Q.5	Unit I,II,III,IV	Any 2 out of 4 (a, b, c, d)	10

University of Mumbai
M.Sc.
(MICROBIOLOGY)
Semester I / Semester II EXAMINATION
Course PSMB (For 25 Marks Paper)

Maximum Marks: 25

Duration: 1.0 Hour

Marks Option: 50

Questions	All questions are compulsory.		
	Based on	Any 2 out of 4 (a, b, c, d)	Marks
Q.1	Unit I	Any 2 out of 4 (a, b, c, d)	10
Q.2	Unit II	Any 2 out of 4 (a, b, c, d)	10
Q.3	Unit I and II	Any 1 out of 2 (a, b)	05

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)
NEP -Microbiology Syllabus Framing Committee
Post Graduate Program

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7.	Dr. Nitinkumar P. Patil Assistant Professor, Department of Microbiology, Smt.Chandibai Himathmal Mansukhani College, Opposite Railway station, Ulhasnagar - 421003 Email: nitinkumarpatil1@gmail.com Contact No. –9822626862		8.	Ms. Renu N Jaisinghani Assistant Professor, Department of Microbiology, Smt.Chandibai Himathmal Mansukhani College, Opposite Railway station, Ulhasnagar - 421003 E-mail: chmmicrorj@gmail.com Contact No. – 7977174401	

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Offg. Dean