



SAVITRIBAI PHULE PUNE UNIVERSITY

(Formerly University of Pune)

Four Year B.Sc. Degree Program in Microbiology

(Faculty of Science and Technology)

Choice-Based Credit System Syllabus (2024 Pattern)

(As Per NEP 2020)

First Year B. Sc

To be implemented from Academic Year 2024-2025

Prepared by: B.O.S. MICROBIOLOGY, SPPU

Recommended by: Faculty, Science and Technology

Approved by: Academic Council, SPPU

(For Colleges Affiliated to Savitribai Phule Pune University, Pune)

Title of the Program: B.Sc. (Microbiology)

Preamble:

Microbiology is a wide-ranging discipline of biology. It covers five major groups of microorganisms i.e., bacteria, protozoa, algae, fungi, viruses. In this subject, the interactions of these microorganisms with their surroundings are studied systematically. This also focuses on how the potential of these organisms can be tapped in improving human life and their impact on society and civilization. Being a branch of biology, microbes are used as a study model in different conventional and modern areas of biology. Microbiology has a great legacy of active research in pure and applied science from its establishment as a separate subject. Though the microorganisms were discovered by human over five hundred years ago, there are huge opportunities to explore their wide diversity. In the changing scenario of the world and environment, systematic knowledge of microbiology has become quintessential and crucial. There is always a demand for skilled and knowledgeable persons in education, research and industry. Students who graduate by taking this subject as a major are employable in industry and research.

Introduction: In the post-globalization world, higher education has to play a significant role in the creation of skilled human resources for the well-being of humanity and the environment. The barriers among the academic fields seem to have dissolved. However, disparities in the field of curriculum aspect, evaluation and mobility exist. With the changing situations at local and global levels, the syllabus restructuring should keep pace with developments in the education sector. National Education Policy (NEP) is being adopted and implemented to address the issues related to the traditional system and it also aims to maintain the best of the earlier curriculum. The student is at the centre of NEP-2020. The present curriculum focuses on students' needs, skill development, interdisciplinary approach to learning and enhancing employability. Microbiology curricula are offered at two levels viz. undergraduate and postgraduate. The undergraduate curricula are prepared to impart basic knowledge of the respective subject from all possible angles. In addition, students are to be trained to apply this knowledge in day-to-day applications and to get a glimpse of research.

Objectives to be achieved:

- To enrich students' knowledge and train them in the pure microbial sciences
- To introduce the concepts of application and research in Microbiology

- To inculcate a sense of scientific responsibility and social and environmental awareness
- To help students build up a progressive and successful career

Eligibility for Admission:**First Year B.Sc.:**

- a. Higher Secondary School Certificate (10+2) or its equivalent Examination with English and Biology; and two of the science subjects such as Physics, Chemistry, Mathematics, Geography, Geology, etc.

OR

- b. Three Years Diploma in Pharmacy Course of Board of Technical Education conducted by Government of Maharashtra or its equivalent.

OR

- c. Higher Secondary School Certificate (10+2) Examination with English and vocational subject of + 2 level (MCVC) - Medical Lab. Technician (Subject Code = P1/P2/P3)

Admissions will be given as per the selection procedure / policies adopted by the respective college keeping in accordance with conditions laid down by the University of Pune.

Reservation and relaxation will be as per the Government rules.

Medium of Instruction: English

Board of Studies (BoS) in Microbiology**From 2023-24 to 27-28**

Sr. No.	Name	Designation
1.	Dr. Pawar Sunil Trimbak	Chairman
2.	Dr. Pardesi Karishma Rajendra	Member
3.	Dr. Pabale Anupama Ashok	Member
4.	Dr. Wagh Pratima Pandit	Member
5.	Dr. Abhyankar Pragati Sunil	Member
6	Dr. Pathak Leena Pradeep	Member
7	Dr. Kulkarni Snehal V.	Member
8.	Dr. Kale Avinash Sudhakar	Member
9.	Dr. Marathe Rajendra Jagannath	Member
10.	Dr. Puranik Pravin R.	Member
11	Dr. Rajwade Jyotika Milind	Member
12.	Dr.Mali Gajanan Vishnu	Member
13	Dr. Shete Ashiwini Monish	Member
14	Dr. Patil Hemant jagatrao	Member

Semester/Level	Course Type	Course Code	Theory/Practical	Title/Course Name	Credits
SEM-I/4.5	Subject 1	MB-101-T	Theory	Introduction to Microbiology	2
	Subject 1	MB-101-P	Practical	Laboratory Techniques in Microbiology-I	2
	Subject 2	-	Theory	-	2
	Subject 2	-	Practical	-	2
	Subject 3	-	Theory	-	2
	Subject 3	-	Practical	-	2
	Open Elective	OE-101-MB	Theory	Microorganisms and Human Life	2
	Skill enhancement Course	SEC-101-MB	Practical	Basic Skills in Microbiology Laboratory –I	2
	Indian Knowledge System	IKS-100-T	Theory	IKS Generic	2
	Ability Enhancement Course	AEC-101-MB	Theory	English/Hindi/Marathi	2
	Value Education Course	VEC-101-MB	Theory	Environmental science	2
					Total (22)
SEM-II/4.5	Subject 1	MB-151- T	Theory	Basic Microbiology	2
	Subject 1	MB-151-P	Practical	Laboratory Techniques in Microbiology-II	2
	Subject 2	-	Theory	-	2
	Subject 2	-	Practical	-	2
	Subject 3	-	Theory	-	2
	Subject 3	-	Practical	-	2
	Open Elective	OE -151-MB	Practical	Dealing With Microorganisms	2
	Skill enhancement Course	SEC- 151-MB	Practical	Basic Skills in Microbiology Laboratory-II	2
	Ability Enhancement Course	AEC-151-MB	Theory	English/Hindi/Marathi	2
	Value Education Course	VEC-151-MB	Theory	Environmental science	2
	Certificate course	CC-151-MB	-	PE/NSS/NCC	2
					Total (22)

Credit framework for First Year (UG)

Exit options, Award of credits, Evaluation pattern and ATKT rules are as per the SPPU

External Students

There shall be no external students.

University Terms

Dates for the commencement and the conclusion of the first and second terms will be declared by the University authorities. Terms can be kept by only duly admitted students. The term shall be granted only on a minimum of 80 percent attendance at theory and practical courses and satisfactory performance during the term.

Current curriculum orientation

To accommodate more advanced topics in the syllabi, it is necessary to understand the basic science knowledge level of the students who have chosen the microbiology discipline. Curricula of courses of state and central boards of higher secondary level were reviewed to avoid reiterations of previous syllabi.

Qualification of Teachers:

With a minimum undergraduate and postgraduate degree in microbiology (B.Sc. and M.Sc. Microbiology) and qualified as per UGC regulations.

Semester I**Paper I****MB-101-T: Introduction to Microbiology**

Total: 2 Credits Work-load: - 15 hrs/credit

(Total Workload: 2 credits $\times$ 15 hrs =30 hrs in semester)

Course Objectives	
1	To enrich the knowledge of undergraduate science faculty students about the different areas of microbiology.
2	To allow students to understand the mysterious world of microorganisms.
3	To explain the various categories of microorganisms and their general characteristics.
4	To make students understand the role of beneficial microorganisms present in different habitats.
5	To allow students to understand the general classification scheme of living things.
6	To understand the historical developments in the field of microbiology.
7	To enrich students' knowledge about recent inventions and discoveries in microbiology.

Course Outcomes (COs)	
On completion of the course, the students will be able to:	
CO1	Describe the origin of microbial life on earth by outlining the experiment relating to the formation of organic matter in a laboratory set-up.
CO2	Explain the evolution of the microbiology field and the scientific discoveries relating to each field.
CO3	Outline the relatedness of the different upcoming areas of biological sciences to the field of microbiology.
CO4	Classify different species according to the different classification systems.
CO5	Review the differences between the basic types of cells found in all biological systems.
CO6	Write about the morphological and differential characteristics of different groups of microorganisms.

Credit no.	Unit/ Topic details	No. of hours
I	Development of microbiology	15
	1. Discovery of Microscope and Microorganisms • Anton von Leeuwenhoek • Robert Hooke	1
	2. Abiogenesis v/s biogenesis • Aristotle's notion about spontaneous generation, • Francesco Redi's experiment	2
	3. Golden Era of Microbiology • Louis Pasteur (Rabies, Pasteurization) • Robert Koch (Koch's Postulates, Germ theory of disease) • Discovery of viruses (TMV) • Paul Ehrlich (Chemotherapy) • Edward Jenner (Vaccination) • Alexander Fleming (Penicillin)	4
	4. Modern Era of Microbiology- Carl Woese classification based on 16S rRNA. Significance and application of Human Microbiome. Nano-biotechnology and Space Microbiology.	3
	5. Types of Microorganism and their differentiating characters – Prokaryotes, Eukaryotes, three domain and five domain system of classification – • Bacteria (Eubacteria and Archaeobacteria) • Protozoa • Fungi • Algae • Viruses, Viroids, Prions and Actinomycetes.	5

II	Basic Techniques in Microbiology	15
	1. Microscopy- 1.1 - Bright field microscopy [BFM]: • Electromagnetic spectrum of light • Structure, working and ray diagram of a compound light microscope; concepts of magnification, numerical aperture and resolving power. • Types, ray diagram and functions of – Condensers (Abbe and cardioid) eyepieces and objectives • Concept of aberrations in lenses - spherical, chromatic, comma and astigmatism • Units of measurements of microorganisms	5
	2. Staining Techniques: • Definition of Stain; Types of stains (Basic and Acidic), • Properties and role of Fixatives, Mordants, Decolourisers and Accentuators. • Monochrome staining and Negative (Relief) staining • Differential staining - Gram staining • Special staining- Capsule, Spore	5
	3. Sterilization and Disinfection- • Sterilization: Physical Agents - Heat, Radiation, Filtration. • Disinfection: Chemical agents and their mode of action – Aldehydes, Halogens, Quaternary ammonium compounds, Phenol and phenolic compounds, Heavy metals, Alcohol, Dyes, Detergents and Ethylene oxide. • Characteristics of an ideal disinfectant.	5

References:

1. Atlas R. M. (1988, Digitized 2010). Experimental Microbiology: Fundamentals and Applications. United States: Macmillan.
2. Atlas R. M. (2005). Handbook of Media for Environmental Microbiology. United States: Taylor and Francis.
3. Atlas R. M. (2010). Handbook of Microbiological Media. Ukraine: Taylor and Francis.
4. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part A: Introductory Essays. Garrity G. editor. Springer. ISBN 978-0-387-24143-2.
5. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part B: The Gammaproteobacteria. Garrity G. Brenner D. J., Krieg N. R., and Staley J. R. (Eds.). Springer. ISBN 978-0-387-24144-9
6. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part C: The Proteobacteria. Garrity G. Brenner D. J., Krieg N. R., and Staley J. R. (Eds.). Springer. ISBN 978-0-387-24145-6
7. Berry A. And Watson J. D. (2009). DNA: The Secret of Life. United States: Knopf Doubleday Publishing Group.
8. Bisen P.S. and Varma K. (2009). Handbook of Microbiology. CBS Publishers and Distributors, New Delhi. India
9. Biswas S. B. and Biswas A. (2006) Introduction to viruses. Vikas Publishing House Private Limited, New Delhi, India
10. Dubey H. C. (2004). A textbook of fungi, bacteria and Viruses. Vikas Publishing House Private Limited. New Delhi, India
11. Dubey R. C. and D. K. Maheshwari. (2012). A textbook of Microbiology. S Chand and Company. New Delhi, India
12. Gunasekaran P. (2007). Laboratory Manual in Microbiology. New Age International Private Limited, New Delhi, India.
13. Kapoor K. K., Tauro P. and Yadav K. S. (2016). An Introduction to Microbiology. New Age International (P) Limited, New Delhi, India.
14. Klein D. A., Harley J. P. And Prescott L. (2001). Microbiology. United Kingdom: McGraw Hill Higher Education.

15. Miller A. D. and Tanner J. (2013). Essentials of Chemical Biology: Structure and Dynamics of Biological Macromolecules. Germany: Wiley.
16. Parasher Y. K. (2006). Modern Microbiology. Campus Books International, New Delhi, India.
17. Pelczar M. J. Jr., Chan E.C.S. and Krieg N. R. (2010). Microbiology: An application-based Approach. McGraw-Hill Education (India) Private Limited, New Delhi, India.
18. Powar C. B. and Daginawala H. I. (2005). General microbiology Volume I. Himalaya Publishing House Private Limited, Pune, India.
19. Powar C. B. and Daginawala H. I. (2005). General microbiology Volume II. Himalaya Publishing House, Private Limited, Pune, India.
20. Purohit S. S. (2006). Microbiology: Fundamentals and Applications. AGROBIOS, Jodhpur, Rajasthan, India.
21. Roush R., Wise J. and Fowler, S. (2018). Concepts of Biology. Hong Kong: Samurai Media Limited.
22. Singh R. P. (2012). Microbiology. Kalyani Publishers, New Delhi, India.
23. Singh R. P. and Singh B. D. (2009). Microbial Physiology and Microbial Genetics: (Microbiology). Kalyani Publishers, New Delhi, India.
24. Stanier R. Y. (2003). General Microbiology. United Kingdom: Palgrave Macmillan Limited.
25. Tortora G. J., Funke B. R. and Case C. L. (2016). Microbiology: an Introduction. Twelfth edition. Pearson, London.
26. Tsai C. S. (2007). Biomacromolecules: Introduction to Structure, Function and Informatics. Germany: Wiley.
27. Yadav M. (2017). Microbiology. Discovery Publishing House, New Delhi, India. ISBN 13: 9788171417315.

Semester I
Paper II
MB-101-P - Laboratory Techniques in Microbiology I
(2 Credits)

Course Objectives	
1	To enrich students' knowledge and train them in core Microbiology.
2	To provide students with hands-on experience in microbial staining techniques for microscopic examination.
3	Students will get acquainted with skills of aseptic culture technique
4	To introduce students to the techniques of microbial enumeration and quantification
5	To make students proficient at laboratory skills and safety procedures.
6	Students will develop critical thinking and problem-solving

Course Outcomes (COs) On completion of the course, the students will be able to:	
CO1	Describe the good lab practices and biosafety measures to be adopted while working in a microbiology lab and identify different instruments commonly used for microbiological experiments.
CO2	Give examples of different nutrient media popularly used in culturing microorganisms and compare different methods of sterilizing them.
CO3	Demonstrate different cultivation methods for different microbial groups.
CO4	Explain morphological characteristics of different microbial life forms by microscopic observation.
CO5	Measure the dimensions of different biological cells.
CO6	Design experiments to study the effect of sanitation methods on microflora

1 Practical credit = 30 hours	1 Practical = 4 hours
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Expt. No	Title	No. of Practicals
1	i. Safety measures and Good Laboratory Practices in Microbiology laboratory ii. Introduction, operation, precautions and use of common Microbiology laboratory instruments: Incubator, Hot air oven, Autoclave, Colorimeter, Laminar air flow hood, Clinical centrifuge	3
2	i. Construction (mechanical and optical), working and care of bright field microscope. ii. Permanent slide observation: Algae, Fungi and Protozoa	4

	iii. Wet mount preparation and its observation for: Bacteria, Algae, Fungi and Protozoa	
3	i. Introduction and use of common laboratory glassware: Test tubes, culture tubes, suspension tubes, screw capped tubes, Petri plates, pipettes (Mohr and serological) micropipettes, Pasteur pipettes, Erlenmeyer flask, volumetric flask, glass spreader, Durham's tube, Cragie's tube and inoculating needles (wire loop, stab needles) ii. Biological waste disposal (autoclaving)	2
4	Basic staining techniques: i. Monochrome staining ii. Negative staining iii. Gram staining of bacteria	3
5	Observation of motility in bacteria using: Hanging drop and swarming growth method	2
6	Checking of efficacy of chemical disinfectant: Determination of Phenol Coefficient by Rideal–Walker method (demonstration)	1
	Total	15

References:

1. Aneja K. R. (2007). Experiments in Microbiology, Plant Pathology And Biotechnology. New Age International, New Delhi, India
2. Smith H. and Brown A. (2023). Benson's Microbiological Applications, Laboratory Manual, 15th Edition. McGraw Hill.
3. Cappuccino J. G. and Welsh C. T. (2016). Microbiology: A Laboratory Manual. Pearson Education
4. Deshmukh A. M. (2007). Handbook of Media Stains Reagents Microbiology. Oxford Book Company
5. Garratt D. C. (2012). The Quantitative Analysis of Drugs: 3rd Edition. United Kingdom: Springer US.

Semester I
Open Elective
OE-101-MB-Microorganisms and Human Life

Total: 2 Credits Workload:15hrs/credit
 (Total Workload:2 credits × 15 hrs =30 hrs in semester)

Course Objectives	
This course is designed for students from non-microbiology background	
1	Introduction to the invisible world of living organisms
2	Understand distribution, diversity and differentiating characteristics of microorganisms
3	Awareness about use useful and harmful microorganisms

Course Outcomes	
After studying this course students will be able to	
CO1	Understand concept of microorganism with respect to its size, shape, occurrence and types
CO2	Differentiate between different types of microorganisms
CO3	Understand principle and use of compound microscope and staining techniques to observe microorganisms
CO4	Understand types of useful and harmful microorganisms
CO5	Correlate the knowledge of microbiology in the day-to-day life for better living

Credit	Unit/ topic details	Number of Hours
I	1. Introduction to Microbial World - Discovery of microorganisms – Antony van Leuwenhoek - Discovery of microscope – Leuwenhoek and Robert Hooke - Diversity of microorganisms – Bacteria, Fungi, Algae, Protozoa, Viruses - Types of bacteria (shapes and arrangements), morphological characteristics and habitat	3
	2. Microscopy Principle and working of bright field microscope	1

	3. Staining of Microorganisms i. Purpose of staining ii. Monochrome staining iii. Negative staining	2
	4. Cultivation of Microorganisms i. Nutritional Classes of Microorganisms ii. Ingredients of Cultivation Media iii. Types of Media – Natural media (Coconut and Potato Slices) and Laboratory media (Nutrient Medium and Potato Dextrose Medium)	4
	5. Sterilization and Disinfection i. Sterilization – Definition and Agents (Physical and Chemical) ii. Pasteurization – Definition and Methods (Principle and Applications) iii. Disinfection - Definition and Chemical Agents	5
II	6. Beneficial and Harmful Effects of Microorganisms: a. Medical Microbiology (Vaccines – BCG & MMR and Antibiotics – Pencillin & Streptomycin)	3
	b. Environmental Microbiology (Sewage Treatment and Bioremediation)	3
	c. Food and Dairy Microbiology (Food spoilage, Food-borne Diseases, Probiotics and Fermented foods)	3
	d. Agriculture Microbiology (Plant Diseases and Bioinoculants)	3
	e. Industrial Microbiology (Overview on Production of Antibiotics and Enzymes)	3

References:

1. Ananthnarayanan, R and Jeyaram Panicker, C. K. (2010). Textbooks of Microbiology. Orient Longman. 17th edition.
2. Madigan, M.T., Martinko, J.M., Dunlap, P.V. and Clark, D.P. (2009). Brock Biology of Microorganisms, 12th edition, Pearson International edition, Pearson Benjamin Cummings.
3. Pelczar M. J. Jr., Chan E.C.S. and Krieg N. R. (2010). Microbiology: An Application based Approach. McGraw-Hill Education (India) Private Limited, New Delhi, India.
4. Willey, J. M., Sherwood L.M and Woolverton C.J., Prescott, (2013). Harley and Klein's. Microbiology. McGraw Hill Higher education. 9th Edition.

Semester I
Skill Enhancement Course [Practical]
SEC-101-MB -Basic Skills in Microbiology Laboratory I

Total: 2 Credits Workload: 30hrs/credit

(Total Workload: 2 credits $\times$ 30 hrs = 60 hrs in a semester) **1 Practical = 4 hours**

Course Objectives	
This Course is designed to	
1	Develop and enhance basic skills needed in microbiology laboratory for the beginners
2	Get hands on and job specific training of various instruments, glassware, chemicals and reagents used in the microbiology laboratory
3	Become more capable, competent, and confident in their performance

Course Objectives	
After studying this topic students will be able to.	
CO1	Understand principle, working and calibration of various instruments used in microbiology laboratory and their SOPs
CO2	Perform aseptic transfer of cultures
CO3	Differentiate between different forms of microorganisms depending upon their microscopic and cultural characteristics
CO4	Able to cultivate microorganisms on various natural and laboratory media
CO5	Apply their knowledge and skills in clinical, pathological, food testing, environmental testing, etc.

Practical No.	Experiment Title	No. of Practicals
1	Cleaning of laboratory glassware	1
2	Aseptic transfer techniques: Broth, Slant, Butt, Plate	1
3	Checking efficiency of autoclave (Chemical indicator)	1
4	Preparation of percent solutions (Volumetric flask)	1

5	Enumeration of yeasts using improved Neubauer chamber	1
6	Calibration of pH meter & checking of pH of natural samples - Fruit juices, milk, nutrient broth, distilled water, rain water, etc.	1
7	Preparation of laboratory media – Milk agar and potato dextrose agar (PDA)	1
8	Growth of microorganisms on natural surfaces – coconut, potato, bread	1
9	Cultivation and observation of protozoa – Hay infusion broth	1
10	Cultivation and observation of microorganisms from fermented foods (Idli batter, curd) through 100x objective – Monochrome staining	2
11	Check motility using Craige's tube method	1
12	Lipid granule staining	1
13	Demonstration of antibiotic sensitivity by disc diffusion method	1
14	Learning basic techniques in microbiology: Wrapping of glassware, making cotton plugs and plugging different glassware, cleaning and washing of glassware	1
	TOTAL	15

References:

1. Baunthiyal M., Saxena J. and Ravi I. (2015). Laboratory Manual of Microbiology, Biochemistry and Molecular Biology. Scientific Publishers, Jodhpur, Rajasthan, India.
2. Bisen P. S. (2014). Laboratory Protocols in Applied Life Sciences. United Kingdom: CRC Press.
3. Cappuccino J. and Welsh C. (2019). Microbiology: A Laboratory Manual, Loose Leaf Edition. United Kingdom: Pearson Education.
4. Dubey R. C. and Maheshwari D. K. (2012). Practical Microbiology. S. Chand and Company Limited, New Delhi, India
5. Gunasekaran P. (2007). Laboratory Manual in Microbiology. New Age International Private Limited, New Delhi, India.

Semester -II**Paper I****MB-151-T – Basics of Microbiology**

Total: 2 Credits Workload:15 hrs/credit

(Total Workload:2 credits × 15 hrs =30 hrs in semester)

Course Outcome After studying this course students will be able to	
1.	Understand the structure and functions of bacterial cells.
2.	Acquire basic knowledge of biochemistry.
3.	Develop an understanding of structure-function relationships in bio-molecules.
4.	Learn the basics of the classification of bacteria and viruses
5	Understand, categorize, and differentiate nutritional classes, of microorganisms and apply them for nutrition cultivation, isolation, and preservation of different microorganisms
6	Relate, and apply knowledge of the life cycle stages of bacteria and growth behavior under different environmental conditions with various fields like fermentation technology, genetics, metabolism, pathogenesis, etc.

Credits	Unit/ Topic	No. of Hours (30)
	1. Bacterial Cytology Morphology –[Cell size, shape and arrangements of Bacteria]	10

I	Structure, chemical composition, and functions of the following components in the bacterial cell: - Cell wall (Gram positive, Gram negative) - Concept of Mycoplasma, Spheroplast, protoplast, L-form - Cell membrane - Endospore (spore formation and stages of sporulation) - Capsule - Flagella - Fimbriae and Pili - Ribosomes - Chromosomal & extra-chromosomal material - Cell inclusion bodies.	
	2. Chemical Basis of Microbiology - Atom, Biomolecules, types of bonds (covalent, co-ordinate bond, non-covalent) and linkages (ester, phospho-diester, peptide and glycosidic) - Biomolecules: Classification, Structure, organization and functions of the following biomolecules - Carbohydrates - Proteins - Lipids - Nucleic acids	3
	Classification of Bacteria: Introduction to Bergey's Manual of Determinative Bacteriology	1
	Characteristics & Classification of Viruses: ICTV nomenclature	1
	1. Cultivation of Microorganisms: - Nutritional requirements and nutritional classification. - Design and preparation of media: Common media ingredients and media types.	7

II	c. Methods for cultivating photosynthetic, extremophilic, and chemo-lithotrophic bacteria, anaerobic bacteria, algae, fungi, actinomycetes, and viruses. d. Concept of Enrichment, Pure Culture, Isolation of culture by streak plate, pour plate, spread plate. e. Maintenance of bacterial and fungal cultures using different techniques. f. Culture collection centers and their role.- Requirements and guidelines of the National Biodiversity Authority for culture collection centers.	8
	2. Bacterial growth: a. Kinetics of bacterial growth (Exponential growth model) b. Growth curve and Generation time c. Diauxic growth d. Measurement of bacterial growth- Methods of enumeration: i. Microscopic methods (Direct microscopic count, counting cells using improved Neubauer, Petroff-Hausser's chamber) ii. Plate counts (Total viable count) iii. Turbidometric methods (including Nephelometry) iv. Estimation of biomass (Dry mass, Packed cell volume) v. Chemical methods (Cell carbon and nitrogen estimation) e. Factors affecting bacterial growth [pH, Temperature, Solute e. Concentration (Salt and Sugar)] and Heavy metals(oligodynamic action)	

References:

1. Atlas R. M. (1988, Digitized 2010). Experimental Microbiology: Fundamentals and Applications. United States: Macmillan.
2. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part A: Introductory Essays. Garrity G. editor. Springer. ISBN 978-0- 387-24143-2.

3. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part B: The Gammaproteobacteria. Garrity G. Brenner D. J., Krieg N. R., and Staley J. R. (Eds.). Springer. ISBN 978-0-387-24144-9
4. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part C: The Proteobacteria. Garrity G. Brenner D. J., Krieg N. R., and Staley J. R. (Eds.). Springer. ISBN 978-0-387-24145-6
5. Bergey's Manual of Systematic Bacteriology. (2009). Volume Three: The Firmicutes. Part C: The Proteobacteria. Vos, P., Garrity, G., Jones, D., Krieg, N.R., Ludwig, W., Rainey, F.A., Schleifer, K.-H., Whitman, W. (Eds.). Springer. ISBN 978-0-387-95041-9 Bisen P.S. and Varma K. (2009). Handbook of Microbiology. CBS Publishers and Distributors, New Delhi. India
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7. Dubey R. C. and D. K. Maheshwary. (2012). A textbook of Microbiology. S Chand and Company. New Delhi, India
8. Klein D. A., Harley J. P. And Prescott L. (2001). Microbiology. United Kingdom: McGraw-Hill Higher Education.
9. Luria S. (2018). General Virology. Creative Media Partners, LLC. USA
10. Pelczar M. J. Jr., Chan E.C.S. and Krieg N. R. (2010). Microbiology: An Application based Approach. McGraw-Hill Education (India) Private Limited, New Delhi, India.
11. Powar C. B. and Dagainawala H. I. (2005). General microbiology Volume I. Himalaya Publishing House Private Limited, Pune, India.
12. Powar C. B. and Dagainawala H. I. (2005). General microbiology Volume II. Himalaya Publishing House, Private Limited, Pune, India
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15. Tortora G. J., Funke B. R. and Case C. L. (2016). Microbiology: an Introduction. Twelfth edition. Pearson, London.
16. Yadav M. (2017). Microbiology. Discovery Publishing House, New Delhi, India. ISBN 13: 9788171417315

Semester -II**MB-151-P: Laboratory Techniques in Microbiology II**

Total: 2 Credits Work-load:-30hrs/credit

(Total Workload:-2 credits x 30hrs =60 hrs in semester) **1 Practical = 4 hours**

Course Outcome After Completion of this course students will be able to	
CO1.	Learn techniques of the cultivation of various types of organisms including skin microflora
CO2.	Understand the methods of bacterial enumeration from food, water or soil samples
CO3.	Acquainted and correlate the effects of various parameters including pH, salt concentration, temperature and heavy metal on bacterial growth

Expt No.	Topics	No. of Practicals
1	i. Preparation of simple laboratory nutrient media (Nutrient agar/broth, MacConkey's agar).	1
	ii. Checking sterilization efficiency of autoclave using a biological indicator (<i>B. stearothermophilus</i>)	1
	iii. Preparation of Winogradsky's column and observation of different types of microorganisms using bright field microscope.	1
2	Special staining techniques: i. Endospore staining ii. Capsule staining	2
3	Isolation of bacteria: Streak plate technique (Colony and cultural characteristics)	1
4	Enumeration of bacteria from fermented food / soil / water by: i. Spread plate method ii. Pour plate method	2

5	Study of normal flora of skin: i. Cultivating and observing different morpho-forms of bacteria from skin. ii. Study of effect of washing on skin with soap and disinfectant on it's microflora.	2
6	To study the effect of different parameters on growth of <i>E. coli</i>: i. pH, temperature, sodium chloride concentration ii. Study of oligodynamic action of heavy metal	3
7	Preservation of cultures on: Slants, soil and on grain surfaces; revival of these cultures.	2
	TOTAL	15

References:

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Semester II
Open Elective
OEP-151-MB -Dealing with Microorganisms

Total: 2 Credits Workload: 30hrs/credit
 (Total Workload: 2 credits $\times$ 30 hrs = 60 hrs in semester) **1 Practical = 4.25 hours**

Course Objectives	
1	Students will get acquainted with skills of aseptic culture techniques
2	To introduce students to the techniques of microbial production and quantification
3	To make students proficient at laboratory skills.
4	Students will develop critical knowledge about the domestic microbial processes

Course Outcome After studying this course students will be able to	
CO1	Isolate and identify Nitrogen fixing bacteria from soil and leguminous plants and prepare biofertilizer from it
CO2	Perform primary screening of microorganisms of industrial importance
CO3	Develop skills for isolation and analysis of air & water bacteriologically
CO4	isolate and identify isolates from fermented foods
CO5	Analyse the results and interpret the observations

Practical no.	Title	No. of Practicals
1	Collection of various types of soils (activity-based)	1
2	Demonstration of Total Viable Count (TVC) of soil sample	2
3	Demonstration of antibiotic activity (Well-diffusion or disk-diffusion technique)	2
4	Microscopic observation of root nodule bacteria	2
5	Observation of air microflora	2
6	Demonstration of MPN for potability of water	2
7	Isolation of Lactic acid bacteria from fermented foods	2
8	Application of commercial bioinoculants (Pot study)	2
	Total	15

References:

1. Aneja K. R. (2007). Experiments in Microbiology, Plant Pathology And Biotechnology. New Age International, New Delhi, India
2. Cappuccino J. G. and Welsh C. T. (2016). Microbiology: A Laboratory Manual. Pearson Education
3. Deshmukh A. M. (2007). Handbook of Media Stains Reagents Microbiology. Oxford Book Company
4. Dubey R. C. and Maheswari D. K. (2000). Textbook of Microbiology S. Chand Publishing, New Delhi. ISBN: 9788121918039
5. Salle A. J. (1971). Fundamental Principles of Bacteriology. 7th Edition. Tata McGraw Publishing Co.
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Semester II
Skill Enhancement Course
SEC-151-MB: Basic Skills in Microbiology Laboratory II

Total: 2 Credits Workload: 30hrs/credit
 (Total Workload: 2 credits $\times$ 15hrs = 30 hrs in a semester)

Course Objectives	
1	To introduce students to the fundamental concepts and principles of microbiology and its practical applications.
2	To familiarize students with the basic laboratory techniques used in microbiology research and diagnostics.
3	To develop students' skills in aseptic technique and safe handling of microorganisms.
4	To enable students to understand and perform various methods of microbial cultivation
5	To teach students the principles and procedures involved in handling of instruments

Course Outcomes	
After studying this course students will be able to	
CO1	Handle compound microscope with objectives of different magnifications
CO2	Isolate bacteria and yeasts from fermented foods
CO3	Determine levels of contamination in various food products by counting methods
CO4	Learn methods of isolation and identification of various plant pathogens
CO5	Check antimicrobial activities of U.V light, various spices, condiments and herbs used in preparation of foods
CO6	Record observations, analyse the data, interpret results and draw conclusions

Sr. No. of expt.	Experiment	No. of practicals
1	Microscopic observation of mouth flora by monochrome staining	1
2	Check antimicrobial activity of U.V. light & efficiency of HEPA filters	1
3	Staining of fungi (using lactophenol cotton blue)	1

4	Isolation of yeast from natural sample and staining	2
5	Determination of microbial load of milk – standard plate count	1
6	Isolation and observation of bacterial plant pathogens from soft rot of potato/ citrus fruit.	1
7	Observation of plant pathogens from. 1. Black rust of wheat 2. Leaf curl of tomato 3. Downy mildew of grape 4. Red rot of sugarcane 5. Whip smut of Sugarcane (any two of the above)	2
8	Demonstration of Koch's postulates	1
9	Determination of antibacterial activity of – clove, pepper, garlic, onion (well/ disc diffusion method)	2
10	Check pasteurization efficiency of milk by phosphatase test	1
11	Check sterility of pharmaceutical products – fluids & powders	2
	TOTAL	15

References:

1. Aneja K. R. (2007). Experiments in Microbiology, Plant Pathology And Biotechnology. New Age International, New Delhi, India
2. Bisen P. S. (2014). Laboratory Protocols in Applied Life Sciences. United Kingdom: CRC Press.
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6. Karwa A.S., Rai M.K. and Singh H.B. (2012). Handbook of Techniques in Microbiology: A Laboratory Guide to Microbes. Scientific Publishers, Jodhpur, Rajasthan, India
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