



Deccan Education Society's
Fergusson College (Autonomous)
Pune

Learning Outcomes-Based Curriculum
for 3/4 years B.Sc. / B. Sc. (Honours) Programme
as per guidelines of
NEP-2020

for
F. Y. B. Sc. (Microbiology)
With effect from Academic Year
2023-2024

Program Outcomes (POs) for B.Sc. Microbiology	
PO1	Disciplinary Knowledge: Demonstrate comprehensive knowledge of the disciplines that form a part of an graduate programme. Execute strong theoretical and practical understanding generated from the specific graduate programme in the area of work.
PO2	Critical Thinking and Problem solving: Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closely and design the solutions.
PO3	Social competence: Display the understanding, behavioral skills needed for successful social adaptation, work in groups, exhibits thoughts and ideas effectively in writing and orally.
PO4	Research-related skills and Scientific temper: Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.
PO5	Trans-disciplinary knowledge: Integrate different disciplines to uplift the domains of cognitive abilities and transcend beyond discipline-specific approaches to address a common problem.
PO6	Personal and professional competence: Performing dependently and also collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	Effective Citizenship and Ethics: Demonstrate empathetic social concern and equity centered national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	Environment and Sustainability: Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	Self-directed and Life-long learning: Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

PSO No.	Program Specific Outcomes (PSOs) Upon completion of this programme the student will be able to
PSO1	Academic competence: (i) Understand fundamental concepts, principles and processes underlying the field of Microbiology, its different subfields and its linkage with related disciplinary areas/subjects. (ii) Demonstrate an understanding of a wide range of Microbiological techniques (e.g., basic microscopy, sterilization and disinfection methods, cultivation of microorganisms, isolation techniques, characterization of pathogens, blood grouping, microbiological assays of antibiotics and vitamins, enzyme kinetics, chromatography, electrophoresis, immunological assays.
PSO2	Personal and Professional Competence: (i) Carry out laboratory-orientated numerical calculations and be capable in data visualization and interpretation. (ii) Analyse biochemical data (e.g., in enzyme kinetics, biochemical analysis of serum components, sterility of pharmaceutical products). (iii) Formulate ideas, write scientific reports, demonstrate effective presentation and communication skills.
PSO3	Research Competence: (i) Apply microbiological methodology in order to conduct research and demonstrate appropriate skill to seek solutions to problems that emerge in various fields of Microbiology and interdisciplinary fields. (ii) Integrate informatics and statistical skills to explore and authenticate biological data for experimental and research purposes. (iii) Exhibit awareness of ethical issues in research with emphasis on academic and research ethics, scientific misconduct, intellectual property rights and issues of plagiarism.
PSO4	Entrepreneurial and Social competence: (i) Employ skills in specific areas related to Microbiology such as industrial production, technology development, clinical, health, agriculture and ensure multilevel commitment to health and human welfare.

Deccan Education Society's
Fergusson College (Autonomous), Pune
First Year Curriculum as per NEP 2020
Department of Microbiology
Course Structure

Semester	Paper	Paper Code	Paper Title	Type	Credits
I	Major	MIC-101	Introduction to the Microbial World	Theory	4
		MIC-100	Microbiology Practical-1	Practical	2
	Minor	MIC-111	Fundamentals of Microbial Sciences	Theory	2
		MIC -112	Microbiology Practical-1	Practical	2
	OE-1	MIC-120	Microbiology in Everyday Life	Theory	2
	OE-2	MIC-121	Human - Microbe Interactions	Theory	2
	SEC -1	MIC-140	Techniques in Haematology	Theory	2
II	Major	MIC-151	Essential methods in Bacteriology	Theory	4
		MIC-150	Microbiology Practical-2	Practical	2
	Minor	MIC-161	Physiology of bacterial growth and nutrition	Theory	2
		MIC-162	Microbiology Practical-2	Practical	2
	OE-3	MIC-170	Microbial infections and human defence mechanisms	Theory	2
	OE-4	MIC-171	Prebiotics and probiotics	Theory	2

**OE – Open Elective, SEC- Skill Enhancement Course*

Teaching and Evaluation (Only for FORMAL education courses)

Course Credits	No. of Hours per Semester Theory/Practical	No. of Hours per Week Theory/Practical	Maximum Marks	CE 40 %	ESE 60%
1	15 / 30	1 / 2	25	10	15
2	30 / 60	2 / 4	50	20	30
3	45 / 90	3 / 6	75	30	45
4	60 / 120	4 / 8	100	40	60

Eligibility: As per the rules and regulations of Savitribai Phule Pune University (SPPU)

F. Y. B. Sc. Semester 1		
MIC - 101	Introduction to the Microbial World (Major- Theory)	Credits: 04 Hours : 60
Course Outcome (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Describe the evolution of the microbiology field and the scientific discoveries relating to each field. Identify the role of microorganisms in different fields and interdisciplinary approach. Define various terms involved in fundamental principles in Microbiology and microscopy.	1
CO2	Discuss the origin of microbial life on Earth by outlining the experiment relating to formation of organic matter in a laboratory set up. Explain early contributions in the field of microbiology. Give examples of different methods of sterilization and explain mode of action and application of various sterilizing agents.	2
CO3	Classify different species according to the six kingdom classification system and write about the morphological and differential characteristics of different groups of microorganisms.	3
CO4	Diagrammatically explain and compare the principle, working and applications of different types of microscopic techniques.	4
CO5	Compare the mode of action and application of different disinfectants. Validate sterilization efficiency of autoclave using biological and chemical indicators and evaluate efficiency of disinfectants	5
CO6	Write about aberrations in objective lenses. Revise the fundamental principles in Microbiology or science.	6

Unit No	Title of Unit and Contents	No of Lectures
I	<p>A. Fundamental principles in Microbiology and microscopy</p> <p>i. Interdisciplinary approach ii. SI units of measurements – (Length, Volume, Weight) iii. Properties of light, Spectrum, Wavelength, Frequency, Amplitude iv. Molar and Normal solutions, Avogadro's Number</p> <p>B. Microscopy</p> <p>i. History of microscopy ii. Terms in microscopy – Magnification, Refractive index, Numerical aperture, Resolving power iii. Aberrations in lenses</p>	15

	<p>iv. Principle, working, ray diagram and applications of Bright field microscopy.</p> <p>v. Principle and applications of:</p> <p>a. Dark field microscopy b. Phase contrast microscopy c. Fluorescence microscopy d. Confocal microscopy e. Electron microscopy – SEM, TEM</p>	
II	<p>Origin and history of microbial world</p> <p>A. Origin of Microbial life</p> <p>i. Biogenesis Vs Abiogenesis (Hypothesis and experiments) ii. Miller’s experiments, Ubiquitous nature of microbial life. iii. Development from simple to complex life forms.</p> <p>B. History of Microbiology</p> <p>Significance of Scientific contributions in development in Microbiology as adiscipline:</p> <p>i. Early contributions: Robert Hook, Anton Van Leeuwenhoek,Louis Pasteur, Robert Koch, John Tyndall. ii. Scientific contribution leading to diversification of Microbiology: Recent milestone discoveries in the field of microbiology. a. Medical Microbiology and Immunology: Edward Jenner, Paul Ehrlich, Ellie Metchnikoff, Joseph Lister b. Food Microbiology and Fermentation: Alexander Fleming, Louis Pasteur, Selman Waksman c. Soil Microbiology: Sergei Winogradsky, Martinus Beijerinck d. Microbial Genetics: Watson and Crick, Hargobind Khurana,Griffith, Avery, McCarty, and Macloed.</p>	15
III	<p>Diversity of Microbial World</p> <p>i. Six kingdom classification system. ii. Introduction to different groups microorganisms with respect to Morphological and differential characteristics, Nutrition andcultivation methods, habitats, classification, economic importance, harmful and beneficial activities: - a. Bacteria and Actinomycetes b. Yeast c. Fungi d. Algae e. Viruses f. Protozoa/ parasites g. Viroids and Prions</p> <p>Mention modern methods of taxonomy, evolution of taxonomy</p>	15
IV	Sterilization and disinfection	

	<p>A. Physical agents: Mode of action and application of –</p> <ul style="list-style-type: none"> i. Heat <ul style="list-style-type: none"> a. factors affecting sterilization b. concept of decimal reduction time c. sterilization using dry heat d. sterilization using moist heat ii. Radiation <ul style="list-style-type: none"> a. ionizing radiation b. non-ionizing radiation iii. Filtration <ul style="list-style-type: none"> a. earthenware filters b. glass filters c. membrane filters d. HEPA filters <p>B. Chemical agents</p> <ul style="list-style-type: none"> i. Characteristics of an ideal disinfectant ii. Mode of action and application of Aldehydes, Halogens, Quaternary ammonium compounds, Phenol and Phenolic compounds, Heavy metals, Alcohols, Dyes, Detergents and Ethylene oxide. iii. Checking the efficiency of sterilization: Biological and Chemical indicators. iv. Checking efficiency of disinfectant: Phenol coefficient - Rideal Walker coefficient, Chick Martin test. 	15
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Learning resources:

1. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology. 3rd Edition. Thomson Brooks / Cole.
2. Daniel Lim, Microbiology, 2nd Edition; McGraw-Hill Publication
3. Michael J Pelczar, JR. E.C.S. Chan, Noel R. Krieg. (1993) Microbiology, 5th Edition, Tata McGraw Hill Press.
4. Prescott L.M., Harley J.P., and Klein D.A. (2005). Microbiology, 6th Edition. McGraw Hill Companies Inc.
5. Prescott, Lancing. M., John, P. Harley and Donald, A. Klein (2006). Microbiology, 6th Edition, McGraw Hill Higher Education
6. Salle A.J. (1971) Fundamental Principles of Bacteriology.7th Edition. Tata McGraw Hill Publishing Co.

F. Y. B. Sc. Semester 1		
MIC - 100	Microbiology Practical-1 (Major-Practical)	Credits: 02 Hours : 60
Course Outcome (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Describe the good lab practices and biosafety measures to be adopted while working in a microbiology lab. Identify and observe different types of microorganisms from natural samples.	1
CO2	Give examples of different nutrient media popularly used in culturing microorganisms and compare different methods of sterilizing them. Explain principle and applications of instruments used in microbiology laboratory.	2
CO3	Demonstrate different types of organisms present in air. Examine the effect of disinfectants on skin microflora. Carry out aseptic transfer techniques.	3
CO4	Classify bacteria based on their nutritional requirements and explain various methods to cultivate them.	4
CO5	Validate different methods of sterilization. Measure dimensions of microorganisms using micrometry.	5
CO6	Write standard operating procedure of various instruments used in microbiology laboratory.	6

Unit No	Title of Unit and Contents	No of Practicals
I	<p>A. Introduction to Microbiology laboratory</p> <p>i. GLP and Biosafety</p> <p>To study Principle and applications of instruments: Microscope (observation of slides under oil immersion objective), Autoclave, Hot- air oven, Centrifuge, pH meter, Incubator, Refrigerator, Distillation apparatus, Laminar Air-flow system, Water-bath, Colorimeter, Spectrophotometer and SOP writing.</p> <p>B. Preparation and sterilization of culture media</p> <p>i. liquid media ii. solid media iii. preparation of nutrient broth and agar iv. preparation of MacConkey broth and agar v. preparation of Saboraud's broth and agar vi. sterilization of media using autoclave</p>	5

	<p>C. Aseptic Transfer Techniques</p> <ul style="list-style-type: none"> i. tube to tube transfer ii. flask to tube transfer <p>D. Assessment of Sterility</p> <ul style="list-style-type: none"> i. Assessment of sterility of glassware and nutritional media (Hot air oven and Autoclave). ii. Sterilization by membrane filtration and sterility assessment. <p>E. Primary demonstration of effect of disinfectants on skin microflora</p>	
<p>II</p>	<p>A. Cultivation of photosynthetic organisms using Winogradsky's column</p> <p>B.</p> <ul style="list-style-type: none"> a. Observation of organisms: <i>Rhizopus</i>, <i>Penicillium</i>, <i>Aspergillus</i> using different natural samples b. Observation of permanent slides of Protozoans: <i>Amoeba</i>, <i>Paramecium</i>, <i>Plasmodium</i>, <i>Entamoeba</i>. <p>C. Observation of actinomycetes by slide culture technique and coverslip technique.</p> <p>D. Demonstration of microflora from air and preservation of bacterial and fungal cultures.</p> <p>E. Measurement of cell dimension by Micrometry.</p>	<p>5</p>

Learning Resources:

1. Fundamental Principles of Bacteriology by Salle, A.J. McGraw Hill Book Company Inc.
2. Experiments in Microbiology, Plant Pathology and Biotechnology Aneja, K.R.
3. Benson's Microbiological Applications, Laboratory Manual in General Microbiology, Short Version Alfred Brown; Heidi Smith
4. Microbiology: A Laboratory Manual, 10th Edition James G. Cappuccino
5. Handbook Media Stains Reagents Microbiology by A. M. Deshmukh.

F. Y. B. Sc. Semester 1		
MIC-111	Fundamentals of Microbial Sciences (Minor 1 –Theory)	Credits: 02 Hours : 30
Course Outcome (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall important developments leading to major discoveries in the pre-golden, golden, and post-golden eras. Memorize different types of microorganisms and their structural characteristics. Outline the history of microscopy and the related staining techniques.	1
CO2	Explain the historical context of major discoveries in the specified eras. Comprehend the differences in characteristics among various types of microorganisms by gaining an understanding of the working of a microscope and its use in staining the bacterial cells.	2
CO3	Apply the knowledge of classification to identify the microorganisms using the principle of bright field microscopy. Illustrate the differences between different cell wall contents of bacteria.	3
CO4	Analyze the role of fixatives, mordants, decolorizers, and accentuators in staining processes to help contrast between the bacterial structures and their functions.	4
CO5	Evaluate the relationships between the characteristics of different types of microorganisms and their ecological roles. Review the applications of bright field microscopy to highlight specific structural features of bacterial cells.	5
CO6	Compile potential applications of knowledge about microorganisms in various fields, such as medicine, agriculture, and industry.	6

Unit	Topic	No. of Lectures
I	History: Important developments leading to major discoveries: (pre golden, golden and post golden era)	2
II	Types and characteristics of microorganisms	6
III	STUDIES ON STRUCTURE, CHEMICAL COMPOSITION AND FUNCTIONS OF THE FOLLOWING COMPONENTS IN BACTERIAL CELL: A. Size, shape and arrangement of bacterial cells B. Structures External to Cell Wall: Cell wall (Gram Positive, Gram Negative, Archaea), Glycocalyx, Capsule, Flagella, Fimbriae and Pili, Axial Filaments C. Structures Internal to Cell Wall: Cell membrane (Gram Positive, Gram Negative, Archaea), Cell inclusion bodies Endospores Formation and Germination MICROSCOPY A. History of microscopy, B. Terms in microscopy –Magnification, Refractive index, Numerical aperture, Resolving power	12

	C. Principle, working, ray diagram and applications of Bright field microscope	
IV	Staining techniques: A. Definitions of Stain; Types of stains (Basic and Acidic), Leucocompounds, Properties and role of Fixatives, Mordants, Decolorizers and Accentuators B. Principles of staining techniques for following: Monochrome staining and Negative (Relief) staining, Differential staining - Gram staining	10

Learning resources:

1. Brock Biology of Microorganisms, Michael.T.Madigan, John.M.Martinko, Paul V. Dunlap,David P. Clark-12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.
2. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology. 3rdEdition.Thomson Brooks / Cole.
3. Michael J Pelczar, JR. E.C.S. Chan, Noel R. Krieg. (1993) Microbiology, 5th Edition, Tata MacGraw Hill Press.
4. Prescott, Lancing. M., John, P. Harley and Donald, A. Klein (2006) Microbiology, 6th Edition,McGraw Hill Higher Education
5. Willey J. M., Sherwood L. M. and Woolverton C. J. (2013) Prescott’s Microbiology, 8thEdition, McGraw-Hill Higher Education
6. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGrawHillPublishing Co.
7. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987) General Microbiology, 5th Edition.Macmillan Press Ltd.
8. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8th Edition. Pearson Education Inc

F. Y. B. Sc. Semester 1		
MIC -112	Microbiology Practical – 1 (Minor 1-Practical)	Credits: 02 Hours : 60
Course Outcome (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall biosafety practices and rules involved in microbiology laboratory work. List common microbiology laboratory instruments and their uses and identify the microorganisms that can be observed using a bright field microscope.	1
CO2	Understand the importance of following standard operating procedures (SOPs) in a microbiology laboratory and comprehend the principles behind different staining techniques	2
CO3	Demonstrate the proper use and care of common microbiology laboratory instruments and apply staining techniques to prepare slides for microscopic examination of various types of microorganisms.	3
CO4	Analyze the potential consequences of not adhering to biosafety practices in a microbiology laboratory and the impact of environmental conditions on the observed microorganisms.	4
CO5	Evaluate the importance of accurate observation in microbiological research.	5
CO6	Create a comprehensive SOP for a specific microbiology laboratory procedure.	6

Unit No	Title of Unit and Contents	No of Practicals
I	Biosafety in the Microbiology Laboratory- practices and rules involved A. Introduction to Microbiology Laboratory and common microbiology laboratory instruments e.g., Incubator, Hot Air Oven, Autoclave, Colorimeter, pH Meter, Distillation Unit, Chemical Balance, Laminar air flow hood, Clinical Centrifuge B.SOP writing C.Use and care of bright field microscope	5
II	Observation of microorganisms using bright field microscope – A Bacteria, Protozoa, Molds and Yeasts, Algae – from natural habitat B. Observation of microorganisms using staining techniques: 1. Monochrome staining 2. Negative /Relief staining 3. Gram staining of bacteria, 4. Staining of yeast and fungi	5

Learning Resources:

1. Fundamental Principles of Bacteriology by Salle, A.J. McGraw Hill Book Company Inc.
2. Experiments in Microbiology, Plant Pathology and Biotechnology Aneja, K.R.
3. Benson's Microbiological Applications, Laboratory Manual in General microbiology, Short Version Alfred Brown; Heidi Smith.
4. Microbiology: A Laboratory Manual, 10th Edition James G. Cappuccino.
5. Handbook Media Stains Reagents Microbiology by A. M. Deshmukh.

F. Y. B. Sc. Semester 1 OE 1		
MIC- 120	Microbiology in everydaylife (OE 1)	Credits: 02 Hours : 30
Course Outcome (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Cite examples of various types of useful and harmful microorganisms and their ubiquitous nature.	1
CO2	Discuss the applications of microorganisms in various fields.	2
CO3	Outline the relatedness of the different upcoming areas of biological sciences to the field of Microbiology.	3
CO4	Classify the microorganisms into different types and compare their characteristic features.	4
CO5	Review the role of a microbiologist to solve a range of problems affecting humans and nature.	5
CO6	Specify the use of microorganisms in day-to-day life.	6

Unit No	Title of Unit and Contents	No of Lectures
I	i. Introduction, Definition of Microbiology, Useful microorganisms, Harmful microorganisms, Microorganisms are everywhere (ubiquitous nature of microorganisms), Applications in various fields. ii. Types of Microorganisms: Bacteria (including actinomycetes), Archaea, Fungi, Algae, Protozoa and Viruses	15
II	i. Role of Microbiologists- to solve a range of problems affecting our health, environment, food, agriculture and defense. ii. Microbes used in day-to-day life, Use of sanitizers and disinfectants, Role of antimicrobials in toothpaste and cosmetics, antimicrobial activity of kitchen spices, Role of microorganisms in making fermented food like curd, idli and dosa. Role of microorganisms in spoilage of food.	15

Learning Resources:

1. Bender K.S., Buckley D. H., Stahl D. A., Sattley W. M. And Madigan M. T. (2017). Brock Biology of Microorganisms. E-Book, Global Edition. United Kingdom: Pearson Education.
2. Dubey H. C. (2004). A textbook of fungi, bacteria and Viruses. Vikas Publishing House Private Limited. New Delhi, India
3. Dubey R. C. and D. K. Maheshwary. (2012). A textbook of Microbiology. S Chand and Company. New Delhi, India
4. Goettel M. S. and Wilcks A. (2012). Beneficial Microorganisms in Agriculture, Food and the Environment: Safety Assessment and Regulation. United Kingdom: CAB International.
5. Jain A. and Jain P. (2019). Essentials of Microbiology. Elsevier- India.
6. Ananthanarayan and Paniker's Textbook of Microbiology. 10th edition. Universities Press, Hyderabad, India
7. Klein D. A., Harley J. P. And Prescott L. (2001). Microbiology. United Kingdom: McGraw-Hill Higher Education.
8. Lagerkvist U. (2003). Pioneers of Microbiology and The Nobel Prize. Singapore: World Scientific Publishing Company.
9. Mehrotra R. S. (2009). Principles of Microbiology. India: McGraw-Hill Education (India) Private Limited.
10. Mishra B. B. and Nayak S. K. (2020). Frontiers in Soil and Environmental Microbiology. United States: CRC Press.
11. Pareek R. P. and Pareek N. (2019). Agricultural Microbiology. Scientific Publishers, Jodhpur, Rajasthan, India
12. Sherwood L., Woolverton C. J. and Willey J. (2016). Prescott's Microbiology. Singapore: McGraw-Hill Education.
13. Stanier R. Y. (2003). General Microbiology. United Kingdom: Palgrave Macmillan Limited.
14. Subba Rao N. S. (2016). Advances in Agricultural Microbiology. Netherlands: Elsevier Science.

F. Y. B. Sc. Semester 1

MIC- 121	Human- Microbe Interactions (OE-2)	Credits: 02 Hours : 30
Course Outcome (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Describe the normal flora of the human body. Define the various types of associations between host and microorganisms.	1
CO2	Give examples of different pathogens. Cite the significance of immune-privileged sites in the human body	2
CO3	Explain the origin and importance of normal flora of the human body. Chart different routes of transmission of diseases	3
CO4	Differentiate between different types of host- microbe interactions. Compare and contrast between air- borne and water-borne infections, food borne, zoonotic and vector borne infections.	4

Unit No.	Title of Unit and Contents	No. of lectures
I	<p>A. Microorganisms residing on and in human body: Importance of normal flora</p> <p>B. Normal flora of skin, gastro - intestinal tract, genitourinary tract, respiratory tract</p> <p>C. Immune - privileged sites: eye, brain, reproductive system</p> <p>D. Associations: symbiosis, parasitism, commensalism</p>	15
II	<p>A. How do humans catch infections?</p> <p>B. Host defence against infections: Overview</p> <p>i. Importance of Public Health Microbiology</p> <p>i. Microorganisms infecting our body when immunity lowers down-skin infections, disorders of the digestive system</p> <p>ii. Infections of our body after visiting a hospital- Respiratory tract infection</p> <p>iv. Pathogens infecting our body through air- Upper and Lower Respiratory tract infections</p> <p>i. Pathogens infecting our body through contaminated water- Disorders of the gastro- intestinal system</p>	15

Learning resources:

1. Tortora, G.J., Funke, B.R., Case, C.L, 2016. Microbiology: An introduction. 12th Edition, Benjamin Pub. Co. NY
2. Indira T. Kudva, Nancy A. Cornick, Paul J. Plummer, Qijing Zhang, Tracy L. Nicholson, John P. Bannantine, Bryan H. Bellair 2016. Virulence mechanisms of bacterial pathogens. 5th edition. ISBN: 978-1-555-81927-9.
3. Ananthanarayan, R. and C.E, Jayaram Panikar, 2020. Ananthnarayan and Panikar's Textbook of Microbiology, 10th edition, Universities Press.
4. Cruickshank K.R., 2005, Medical Microbiology Vol I & II Livingstone, Longman. (Topic II AND IV)
5. Chakraborty P. 2009, Textbook of Medical Parasitology, Central Publications, Kolkata, India.

F. Y. B. Sc. Semester 1		
MIC- 140	Techniques in Haematology (SEC-1)	Credits: 02 Hours : 30
Course Outcome (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Describe steps involved in blood collection and storage, define different blood components and state their uses	1
CO2	Identify and interpret different blood groups in human beings, Summarize different blood group systems in humans	2
CO3	Demonstrate hemoglobin estimation, determination of ESR, PCV and blood group classification	3
CO4	Explain biochemistry of blood group antigens	4
CO5	Assess and analyze presence of pathogens from body fluids using rapid diagnostic tests	5
CO6	Compile the hematological data and prepare the report	6

Unit No.	Title of Unit and Contents	No. of lectures
I	Principles of immunohematology: A. Blood group antigens B. Biochemistry of blood group antigens C. Human Blood group systems -ABO, Rh system of blood grouping D. Other blood group systems E. Components of blood F. ESR, PCV, Hemoglobin estimation	15
II	Routine practices during blood collection A. Preparation for blood collection B. Blood transportation after collection C. Storage of blood D. Preparation and use of blood components E. Tests for pathogens after blood collection	15

Learning resources:

1. Chakraborty, P., 2003. A textbook of Microbiology, 2nd Edition New Central Book Agency, India.
2. R.S. Satoskar, S.D. Bhandarkar, 2007. Pharmacology and pharmacotherapeutics, Popular Prakashan, 20th edition.
3. Kanai L. Mukherjee, 2006. Medical laboratory technology.
4. Medical Physiology by John E. Hall and Michel E. Hall 3rd South Asia Edition, Elsevier Publications.

F. Y. B. Sc. Semester II

MIC- 151	Essential methods in bacteriology (Major- Theory)	Credits: 04 Hours : 60
Course Outcome (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Define different terms involved in nutrition of bacteria and describe various methods of cultivation of bacteria using different media. Outline the basic concepts of bacterial growth.	1
CO2	Diagrammatically illustrate and compare the structure of eubacterial and archaebacterial cells. Discuss the composition and functions of different organelles.	2
CO3	Outline various methods of measurement of bacterial growth. Illustrate various patterns of growth of bacteria and factors affecting.	3
CO4	Explain concept of staining, types of stains and role of various reagents used.	4
CO5	Determine various morphological forms of bacteria using differential staining and special staining techniques.	5
CO6	Specify different patterns of growth of bacteria and write the effect of environmental parameters on the growth of bacteria. Write about measurement of the growth of bacteria using different microbiological and chemical methods. Design specific growth medium for a particular group of bacteria.	6

Unit No	Title of Unit and Contents	No of Lectures
I	<p>Bacterial nutrition and cultivation</p> <p>A. Nutrition</p> <p>i. Diversity of bacteria based on nutrition and environmental conditions</p> <p>ii. Nutritional requirements and nutritional classification (Fastidious organisms)</p> <p>iii. Extremophiles and their significance</p> <p>B. Cultivation</p> <p>Design and preparation of media: Common ingredients</p> <p>C. Types of media used for the cultivation of bacteria</p> <p>i. General (Synthetic and complex media)</p> <p>ii. Selective media</p> <p>iii. Differential media</p> <p>iv. Enriched media</p> <p>v. Enrichment media</p>	15

	vi. Minimal and complete media vii. Preparation of buffer solutions	
II	<p>Bacterial growth</p> <p>A. Definition of binary fission, growth, generation time, growth rate, specific growth rate</p> <p>B. Batch culture - Growth curve and growth kinetics</p> <p>C. Factors affecting growth- pH, temperature, solute concentration (salt and sugar) and heavy metals</p> <p>D. Methods of enumeration: Merits and demerits of each method</p> <p>i. Microscopic methods</p> <p>ii. Plate count methods</p> <p>iii. Estimation of biomass: Dry mass and wet mass.</p> <p>iv. Optical density measurement (Mac-Farland standard)</p> <p>v. Miscellaneous methods</p> <p>vi. Chemical methods - cell carbon and nitrogen estimation, ATP,PCV</p> <p>E. Different patterns of growth</p> <p>i. Continuous growth:- concept of chemostat and turbidostat</p> <p>ii. Diauxic growth</p> <p>iii. Synchronous growth</p>	15
III	<p>Stain and staining techniques</p> <p>A. Stain: Definition, Concept of chromophore and auxochrome group, Acidic and basic stains Role of fixatives, accentuators, mordants and decolorisers.</p> <p>B. Principle and applications of :</p> <p>i. Negative staining</p> <p>ii. Monochrome staining</p> <p>iii. Differential staining – Gram’s staining and Acid fast staining</p> <p>iv. Special staining:</p> <p>a. Capsule demonstration and capsule staining</p> <p>b. Spore staining</p> <p>c. Flagella staining</p>	15
IV	<p>Bacterial Cytology</p> <p>A. Cell wall: Composition and detailed structure of Gram positive and Gram negative cell walls, archaeobacterial cell wall, Lipopolysaccharide, Sphaeroplasts, protoplasts and L: forms. Effect of antibiotics and enzymes on the cell wall.</p> <p>B. Cell membrane: Structure, function and chemical composition of bacterial and archael cell membranes.</p> <p>C. Endospore: Structure, formation and stages of sporulation</p> <p>D. Capsule: Structure, composition and function.</p> <p>E. Flagella: Structure, composition and function F. Fimbriae and pili: structure, composition and function</p> <p>G. Cytoplasm: Ribosomes, mesosomes, nucleoid, chromosome and plasmids.</p> <p>H. Cell inclusions: Gas vesicles, carboxysomes, PHB granules, metachromatic granules and glycogen bodies.</p>	15

Learning resources:

1. Daniel Lim, Microbiology, 2nd Edition; McGraw-Hill Publication
2. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology. 3rd Edition. Thomson Brooks / Cole.
3. Madigan M.T. Martinko J.M. (2006). Brock's Biology of Microorganisms. 11th Edition.. Pearson Education Inc.
4. Michael J Pelczar, JR. E.C.S. Chan, Noel R. Krieg. (1993) Microbiology, 5th Edition, Tata MacGraw Hill Press.
5. Prescott L.M., Harley J.P., and Klein D.A. (2005). Microbiology, 6th Edition. MacGrawHill Companies Inc.
6. Prescott, Lansing. M., John, P. Harley and Donald, A. Klein (2006) Microbiology, 6th Edition, McGraw Hill Higher Education.
7. Willey J.M., Sherwood L.M., Woolverton C.J. (2013) Prescott's Microbiology 8th Edition, McGraw-Hill Higher Education.
8. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGrawHill Publishing Co.
9. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987) General Microbiology, 5th Edition. Macmillan Press Ltd.
10. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8th Edition. Pearson Education Inc
11. Wilson K. and Walker J.M. (2005) Principles and Techniques of Biochemistry and Molecular Biology. 6th Edition. Cambridge University Press.
12. Hans G. Schlegel (1993) General Microbiology, 8th Edition, Cambridge University Press
David T. Plummer (1993) An Introduction to Practical Biochemistry, 3rd Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.

F. Y. B. Sc. Semester II

MIC – 150	Microbiology Practical-2 (Major-Practical)	Credits: 02 Hours : 60
Course Outcome (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Show an experiment to isolate the bacteria and determine the total count of bacteria from different environmental samples using different plate methods.	1
CO2	Differentiate bacteria based on their cell wall composition using differential staining techniques.	2
CO3	Examine morphological characteristics of bacteria by different staining techniques.	3
CO4	Detect the phototaxis and chemotaxis in bacteria.	4
CO5	Determine the growth curve of bacteria in batch culture under standard environmental conditions.	5
CO6	Design experiments to determine the effect of different environmental parameters on the growth of bacteria.	6

Unit No	Title of Unit and Contents	No of Practicals
I	Isolation, enumeration and motility A. Purification of bacteria by streak plate technique and study of colony characteristics B. Enumeration of bacteria TVC: Spread plate C. Enumeration of bacteria TVC: Pour plate technique D. Enumeration of yeasts cells / bacterial cells using counting chamber E. Observation of bacterial motility by i. Hanging drop technique (Using cavity slide / clay method) ii. Swarming growth on agar surface iii. Craigie's tube method	5
II	Staining and growth A. Observation of morphology of bacteria by Negative staining technique, Monochrome staining technique. B. Differential staining: Gram staining technique, Acid fast staining C. Growth curve of bacteria. D. Effect of environmental parameters on bacterial growth: pH and temperature E. Effect of environmental parameters on bacterial growth: Salt and Heavy metals.	5

Learning Resources:

1. Fundamental Principles of Bacteriology by Salle, A.J. Publisher- McGraw Hill Book Company Inc.
2. Experiments in Microbiology, Plant Pathology and Biotechnology. Aneja, K.R.
3. Benson's Microbiological Applications, Laboratory Manual in General Microbiology, Short Version Alfred Brown; Heidi Smith
4. Microbiology: A Laboratory Manual, 10th Edition James G. Cappuccino. Handbook Media Stains, Reagents Microbiology by A. M. Deshmukh.
5. Microbiology: A Laboratory Manual, 10th Edition James G. Cappuccino.

F. Y. B. Sc. Semester II Minor 2-Theory		
MIC-161	Physiology of bacterial growth and nutrition	Credits: 02 Hours : 30
Course Outcome (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Define different terms involved in nutrition of bacteria and describe various methods of cultivation of bacteria using different media. Outline the basic concepts of bacterial growth.	1
CO2	Outline different methods of sterilization and explain mode of action and application of various sterilizing agents.	2
CO3	Compare different patterns of growth of bacteria	3
CO4	Classify bacteria based on their nutritional requirements.	4
CO5	Measure the growth of bacteria using different methods. Design specific growth medium for a particular group of bacteria	5
CO6	Specify the mode of action and application of different disinfectants.	6

Unit	Topic	No. of Lectures
I	Bacterial nutrition and cultivation A. Nutrition i. Nutritional requirements and nutritional classification of bacteria (Fastidious organisms) iii. Extremophiles and their significance B. Cultivation	10

	<p>Design and preparation of media: Common ingredients</p> <p>C. Types of media used for the cultivation of bacteria</p> <p>i. General (Synthetic and complex media)</p> <p>ii. Selective media</p> <p>iii. Differential media</p> <p>iv. Enriched media</p> <p>v. Enrichment media</p> <p>vi. Minimal and complete media</p>	
II	<p>Sterilization and disinfection</p> <p>A. Physical agents: Mode of action and application of –</p> <p>i. Heat</p> <p>a. Sterilization using dry heat</p> <p>b. Sterilization using moist heat</p> <p>ii. Radiation</p> <p>a. Ionizing radiation</p> <p>b. Non-ionizing radiation</p> <p>iii. Filtration</p> <p>a. Membrane filters</p> <p>b. HEPA filters</p> <p>B. Chemical agents</p> <p>i. Characteristics of an ideal disinfectant</p> <p>ii. Mode of action and application of Aldehydes, Halogens, Phenol and Phenolic compounds, Heavy metals, Alcohols, and Ethylene oxide.</p> <p>iii. Checking the efficiency of sterilization and disinfectants</p>	10
III	<p>Bacterial growth</p> <p>A. Definition of binary fission, growth, generation time, growth rate, specific growth rate</p> <p>B. Batch culture - Growth curve and growth kinetics</p> <p>C. Different patterns of growth</p> <p>i. Continuous growth :-concept of chemostat and turbidostat</p> <p>ii. Concept of diauxic growth and synchronous growth</p> <p>D. Methods of enumeration of growth: Merits and demerits of each method</p> <p>i. Direct methods</p> <p>ii. Indirect methods</p>	10

Learning resources:

1. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology. 3rd Edition. Thomson Brooks / Cole.
2. Daniel Lim, Microbiology, 2nd Edition; McGraw-Hill Publication
3. Michael J Pelczar, JR. E.C.S. Chan, Noel R. Krieg. (1993) Microbiology, 5th Edition, Tata McGraw Hill Press.
4. Prescott L.M., Harley J.P., and Klein D.A. (2005). Microbiology, 6th Edition. McGraw Hill Companies Inc.
5. Prescott, Lancing. M., John, P. Harley and Donald, A. Klein (2006). Microbiology, 6th Edition, McGraw Hill Higher Education.
6. Salle A.J. (1971) Fundamental Principles of Bacteriology.7th Edition. Tata McGraw Hill Publishing Co.
7. Tortora, G.J., Funke, B.R., Case, C.L, 2016. Microbiology: An introduction. 12th Edition, Benjamin Pub. Co. NY.
8. Madigan M.T.Martinko J.M.(2006). Brock's Biology of Microorganisms.11th Edition.. Pearson.

F. Y. B. Sc. Semester II		
MIC-162	Microbiology Practical-2 (Minor 2-Practical)	Credits: 02 Hours : 60
Course Outcome (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Show an experiment to isolate the bacteria from natural samples using various plate methods.	1
CO2	Classify bacteria based on their nutritional requirements and explain various methods to cultivate them.	2
CO3	Examine the effect of disinfectants on skin microflora. Carry out aseptic transfer techniques.	3
CO4	Detect the phototaxis and chemotaxis in bacteria	4
CO5	Measure the growth curve of bacteria in batch culture under standard environmental conditions.	5
CO6	Perform experiments to determine the total count of bacteria from different environmental samples using different plate methods.	6

Unit No	Title of Unit and Contents	No of Practicals
I	A. Preparation and sterilization of culture media i. Preparation of nutrient broth and agar ii. Preparation of Mac Conkey broth and agar iii. Preparation of Saboraud's broth and agar iv. Sterilization of media using autoclave B. Cultivation of photosynthetic organisms using Winogradsky's column C. Aseptic Transfer Techniques i. Tube to tube transfer ii. Flask to tube transfer D. Primary demonstration of effect of disinfectants on skin microflora	5
II	A. Purification of bacteria by streak plate technique and study of colony characteristics B. Enumeration of bacteria TVC: Spread plate C. Enumeration of bacteria TVC: Pour plate technique D. Observation of bacterial motility E. Growth curve of bacteria.	5

Learning Resources:

1. Fundamental Principles of Bacteriology by Salle, A.J. McGraw Hill Book Company Inc.
2. Experiments in Microbiology, Plant Pathology and Biotechnology Aneja, K.R.
3. Benson's Microbiological Applications, Laboratory Manual in General Microbiology, Short Version Alfred Brown; Heidi Smith.
4. Microbiology: A Laboratory Manual, 10th Edition James G. Cappuccino.
5. Handbook Media Stains Reagents Microbiology by A. M. Deshmukh.

F. Y. B. Sc. Semester II		
MIC-170	Microbial infections and human defence mechanisms (OE-3)	Credits:02 Hours : 30
Course Outcome (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Define important terminologies in infection biology. State the different lines of immunological defense exhibited by human body.	1
CO2	Classify the host and pathogen factors affecting infection. Discuss how human body fights against infections.	2
CO3	Examine why some individuals fall ill more often? Outline types of hypersensitivity.	3
CO4	Differentiate between different types of vaccines. Explain in detail factors affecting infection.	4

Unit No	Title of Unit and Contents	No of Lectures
I	<p>Basics of Infection Biology</p> <p>A. Important terminology: Primary infection, secondary infection. Contagious infection, occupational disorder, clinical infection, subclinical infection, Zoonoses, genetic disorder, vector borne infection.</p> <p>B. Factors affecting infection:</p> <p>i. Microbial factors: adherence, invasion, role of virulence factors in invasion, colonization & its effects.</p> <p>ii. Host factors: natural resistance, species resistance, racial resistance, individual resistance.</p> <p>iii. Why do some individuals fall more sick often?: Age, nutrition, personal hygiene, stress, hormones, Addiction to drugs/ alcohol. Interaction between Microbes & hosts is dynamic.</p>	15
II	<p>Human system to fight infection</p> <p>A. First line of Defense: for skin, respiratory tract, gastrointestinal tract, genitourinary tract, eyes.</p> <p>B. Second line of defense: Phagocytosis, Inflammation</p> <p>C. Third line of defense: Brief introduction to antibody mediated & cell mediated immunity.</p> <p>D. Inflammation and allergic reactions: Hallmarks of inflammation and types of hypersensitivity</p> <p>E. Vaccines and Immunization schedule</p>	15

Learning Resources:

1. Tortora, G.J., Funke, B.R., Case, C.L, 2016. Microbiology: An introduction. 12th Edition, Benjamin Pub. Co. NY
2. Indira T. Kudva, Nancy A. Cornick, Paul J. Plummer, Qijing Zhang, Tracy L. Nicholson, John P. Bannantine, Bryan H. Bellair 2016. Virulence mechanisms of bacterial pathogens. 5th edition. ISBN: 978-1-555-81927-9.
3. Ananthnarayan, R. and C.E, Jayaram Panikar, 2020. Ananthnarayan and Panikar's Textbook of Microbiology, 10th edition, Universities Press.
4. Cruickshank K.R., 2005, Medical Microbiology Vol I & II Livingstone, Longman. (Topic II AND IV)
5. Chakraborty P. 2009, Textbook of Medical Parasitology, Central Publications, Kolkata,India.

F. Y. B. Sc. Semester II

MIC-171	Prebiotics and probiotics (OE-4)	Credits: 02 Hours : 30
Course Outcome (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Define prebiotics and probiotics.	1
CO2	Discuss about the importance gut microflora in maintaining good Health.	2
CO3	Infer the characteristics of probiotics for selection.	3
CO4	Analyse various fermented products for their probiotic properties	4

Unit No.	Title of Unit and Contents	No. of lectures
I	<p>Prebiotics:</p> <p>A. Concept, definition, criteria, types and sources of prebiotics, prebiotics and gut microflora.</p> <p>B. Health benefits of Prebiotics, Mineral absorption, immune response, cancer prevention, IBD, elderly health and infant health.</p>	15
II	<p>Probiotics:</p> <p>A. Concept, definition, criteria, history Probiotic microorganisms, safety of probiotic microorganisms, legal status of probiotics, Characteristics of Probiotics for selection.</p> <p>B. Tolerance to additives, stability during storage, stability during passage to intestinal sites, minimum effective dose, maintenance of probiotic microorganisms</p> <p>C. Role of probiotics in health and disease: Prevention and treatment of gastro-intestinal bacterial infection.</p>	15

Learning resources:

1. Salminen. S and Wright, A. V. 1998. Lactic Acid Bacteria, Marcel Dekker
2. Glenn R. G. Marcel R. 2008. Handbook of Prebiotics CRC press
3. Lee Y K, Salminen S 2009. Handbook of Probiotics and Prebiotics. A John Willey and Sons Inc. Publication.
4. Sandholm T. M. Saarela M. 2003. Functional Dairy Products CRC Woodhead Publishing Ltd