



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, behavioural 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 centred 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
Department of Microbiology**

**First Year Undergraduate Curriculum as per NEP 2020
Course Structure**

Semester	Paper Code	Paper Title	Credits
I	MIC-100 (Major)	Practical Course based on Introduction to the Microbial World	2
	MIC-101 (Major)	Introduction to the Microbial World	4
	MIC-120 (GE/OE)	Microbiology in Everyday Life	2
	MIC-121 (GE/OE)	Human - Microbe Interactions	2
	MIC-130 (VSC)	Biofertilizers	2
	MIC-140 (SEC)	Techniques in Haematology	2
	IKS-101 (IKS)	Indian Knowledge Systems	2
II	MIC-150 (Major)	Practical course based on Techniques in Bacteriology	2
	MIC-151 (Major)	Essential Methods in Bacteriology	4
	MIC-161 (Minor)	Fundamentals of Microbiology	2
	MIC-165 (Minor)	Fundamentals of Microbial Sciences (For students of Biotechnology Major)	2
	MIC-170 (GE/OE)	Human Defence against Microbial Infections	2
	MIC-171 (GE/OE)	Prebiotics and Probiotics	2
	MIC-180 (VSC)	Fermented Foods	2
	MIC-190 (SEC)	Clinical Biochemistry	2

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)

Title of the Course and Course Code	MIC - 100: Practical Course based on Introduction to the Microbial World	Number of Credits: 02
Course Outcome (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.	
CO4	Measure the dimensions of different biological cells.	
CO6	Design experiments to study the effect of disinfection methods on microflora.	
Unit No	Title of Unit and Contents	
I	A. Introduction to Microbiology laboratory i. GLP and Biosafety 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. B. Preparation and sterilization of culture media 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 A. Aseptic Transfer Techniques i. tube to tube transfer ii. flask to tube transfer B. Assessment of Sterility i. Assessment of sterility of glassware and nutritional media (Hot air oven and Autoclave) ii. Sterilization by membrane filtration and sterility assessment C. Primary demonstration of effect of disinfectants on skin microflora
II	A. Cultivation of photosynthetic organisms using Winogradsky's column B. 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>Paramoecium</i>, <i>Plasmodium</i>, <i>Entamoeba</i> C. Observation of actinomycetes by slide culture technique and coverslip technique. D. Demonstration of microflora from air and preservation of bacterial and fungal cultures. E. Measurement of cell dimension by Micrometry

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

Title of the Course and Course Code	MIC - 101: Introduction to the Microbial World	Number of Credits: 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Describe the evolution of the microbiology field and the scientific discoveries relating to each field.	
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. Outline different methods of sterilization and explain mode of action and application of various sterilizing agents.	
CO3	Classify different species according to the six kingdom classification system and write about the morphological and differential characteristics of different groups of microorganisms.	
CO4	Describe the role of microorganisms in different fields and interdisciplinary approach. Recall the fundamental principles in Microbiology or science.	
CO4	Discuss the history and discovery of different types of microscopes. Diagrammatically explain and compare the principle, working and applications of different types of advanced microscopic techniques	
CO6	Specify the mode of action and application of different disinfectants. Validate sterilization efficiency of different instruments and evaluate disinfectants using biological and chemical indicators.	
Unit No.	Title of Unit and Contents	
I	A. Fundamental principles in Microbiology and microscopy 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 B. Microscopy	

	i. History of microscopy ii. Terms in microscopy – Magnification, Refractive index, Numerical aperture, Resolving power iii. Aberrations in lenses iv. Principle, working, ray diagram and applications of Bright field microscopy. v. Principle and applications of: a. Dark field microscopy b. Phase contrast microscopy c. Fluorescence microscopy d. Confocal microscopy e. Electron microscopy – SEM, TEM
II	Origin and history of microbial world A. Origin of Microbial life i. Biogenesis Vs Abiogenesis (Hypothesis and experiments) ii. Miller’s experiments, Ubiquitous nature of microbial life. iii. Development from simple to complex life forms. B. History of Microbiology Significance of Scientific contributions in development in Microbiology as a discipline: 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.
III	Diversity of Microbial World i. Six kingdom classification system. ii. Introduction to different groups microorganisms with respect to Morphological and differential characteristics, Nutrition and cultivation 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

	Mention modern methods of taxonomy, evolution of taxonomy
IV	Sterilization and disinfection A. Physical agents: Mode of action and application of – i. Heat a. factors affecting sterilization b. concept of decimal reduction time c. sterilization using dry heat d. sterilization using moist heat ii. Radiation a. ionizing radiation b. non-ionizing radiation iii. Filtration a. earthenware filters b. glass filters c. membrane filters d. HEPA filters B. Chemical agents 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.

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.

Title of the Course and Course Code	MIC- 120: MICROBIOLOGY IN EVERYDAY LIFE	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Describe various types of useful and harmful microorganisms and their ubiquitous nature.	
CO2	Explain the applications of microorganisms.	
CO3	Outline the relatedness of the different upcoming areas of biological sciences to the field of Microbiology.	
CO4	Classify the microorganisms into different types.	
CO4	Review the role of a microbiologist to solve a range of problems affecting humans and nature.	

CO6	Write the role of microorganisms used in day-to-day life.
Unit No.	Title of Unit and Contents
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
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.

Learning Resources:

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1. , 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.

15. Tortora G. J., Funke B. R. and Case C. L. (2016). Microbiology: An Introduction. Twelfth edition. Pearson, London.

	General/ Open Electives	
Title of the Course and Course Code	MIC- 121: Human- Microbe Interactions	Number of Credits: 02
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Describe the normal flora of the human body. Define the various types of associations between host and microorganisms.	
CO2	Give examples of different pathogens. Cite the significance of immune-privileged sites in the human body	
CO3	Explain the origin and importance of normal flora of the human body. Chart different routes of transmission of diseases	
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.	

Unit No.	Title of Unit and Contents
I	A. Microorganisms residing on and in human body: Importance of normal flora B. Normal flora of skin, gastro - intestinal tract, genitourinary tract, respiratory tract

	C. Immune - privileged sites: eye, brain, reproductive system D. Associations: symbiosis, parasitism, commensalism
II	A. How do humans catch infections? B. Host defence against infections: Overview i. Importance of Public Health Microbiology ii. Microorganisms infecting our body when immunity lowers down-skin infections, disorders of the digestive system iii. Infections of our body after visiting a hospital- Respiratory tract infections iv. Pathogens infecting our body through air- Upper and Lower Respiratory tract infections i. Pathogens infecting our body through contaminated water- Disorders of the gastro- intestinal system

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.

Title of the Course and Course Code	Vocational Skill Course	
	MIC130: Biofertilizers	Number of Credits: 02
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Describe Plant Growth Promoting Rhizobacteria and their roles	
CO2	Give examples of Nitrogen fixing, phosphate solubilizing, siderophore and IAA producing bacteria	
CO3	Explain the large scale production of biofertilizers	
CO4	Explain the importance of biofertilizers over chemical fertilizers	

Unit No.	Title of Unit and Contents
I	Isolation of Plant Growth Promoting Rhizobacteria (PGPRs) from soil A. Advantages of biofertilizers over chemical fertilizers B. Bacteriological Media used for cultivation of PGPRs C. Nitrogen fixing bacteria (symbiotic and non- symbiotic nitrogen fixing bacteria) D. Phosphate solubilizing bacteria E. Siderophore producing bacteria F. Indole Acetic Acid producing bacteria
II	Large scale production of biofertilizers:

	A. Use of carriers for bioinoculant B. Formulation of biofertilizers C. Pot trials of biofertilizers
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Learning resources

1. Soil Microbiology (Fourth Edition of Soil Microorganisms and Plant Growth), N. S. Subba Rao, Oxford and IBH Publishing Company Pvt. Limited, 2005 - 407 pages
2. Soil Microbiology, Ecology and Biochemistry, Eldor Paul, Elsevier, 4th Edition
3. Microbes as Biofertilizers and their production technology (2015). Prof. S. G. Borkar. Woodhead Publishing India in Agriculture.

	Skill Enhancement Course	
Title of the Course and Course Code	MIC- 140: Techniques in Haematology	Number of Credits : 02
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Identify different blood group systems in human beings	
CO2	Classify types of antibodies in immune response	
CO3	Understand different methods for antisera preparation	
CO4	Apply knowledge of blood grouping in hematological procedures	
CO5	Analyse presence of pathogens from body fluids using rapid diagnostic tests	

Unit No.	Title of Unit and Contents
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

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
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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 I		
IKS-101	Indian Knowledge Systems (IKS)	Credits: 2 Hours: 30
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Recall the basic concepts of Indian Knowledge System (IKS)	
CO2	Articulate the foundation of IKS and explain historical and cultural context of Indian knowledge systems	
CO3	Use the knowledge of IKS to understand discipline specific case studies.	
CO4	Develop critical thinking and problem-solving skills in the context of Indian knowledge systems.	

Unit	Contents	No. of hours
I	Overview of IKS - Survey of IKS Domains: A broad overview of disciplines included in the IKS, and historical developments. - Sources of IKS knowledge, classification of IKS texts, a survey of available primary texts, translated primary texts, and secondary resource materials. Differences between a sutra, bhashya, karika, and vartika texts. Fourteen/eighteen vidyasthanas, tantrayukti - Vocabulary of IKS: Introduction to Panchamahabhutas, concept of a sutra, introduction to the concepts of non-translatables (Ex. dharma, punya, aatma, karma, yagna, shakti, varna, jaati, moksha, loka, daana, itihaasa, puraana etc.) and importance of using the proper terminology. Terms such as praja, janata, loktantra, prajatantra, ganatantra, swariva, surajya, rashtra, desh. - Philosophical foundations of IKS: Introduction to Samkhya, vaisheshika and Nyaya - Methods in IKS: Introduction to the concept of building and testing hypothesis using the methods of tantrayukti. Introduction to pramanas and their validity, upapatti; Standards of argumentation in the vada traditions (introduction to concepts of vaada, samvaada, vivaada, jalpa, vitanda). Concept of poorvapaksha, uttarapaksha.	15
II	Case Studies (Few of these may be selected as appropriate) - Mathematics of Madhava, Nilakantha Somayaji - Astronomical models of Aryabhata - Wootz steel, Aranumula Mirrors, and lost wax process for bronze castings - Foundational aspects of Ayurveda - Foundational aspects of Ashtanga yoga - Foundational aspects of Sangeeta and Natva Shastra	10

	• Discipline Specific Case Study	
III	India and the World: Influence of IKS on the world, knowledge exchanges with other classical civilizations. and inter-civilizational exchanges	5

References:

1. An Introduction to Indian Knowledge Systems: Concepts and Applications, B Mahadevan, V R Bhat, and Nagendra Pavana R N; 2022 (Prentice Hall of India).
2. Indian Knowledge Systems: Vol I and II, Kapil Kapoor and A K Singh; 2005 (D.K. Print World Ltd).
3. The Beautiful Tree: Indigenous India Education in the Eighteenth Century. Dharampal, Biblia Impex, New Delhi, 1983. Reprinted by Keerthi Publishing House Pvt Ltd. Combatore, 1995.
4. Indian Science and Technology in the Eighteenth Century, Dharampal. Delhi: Impex India, 1971. The British Journal for the History of Science.
5. The Wonder That Was India, Arthur Llewellyn Basham, 1954, Sidgwick & Jackson.
6. The India they saw series (foreigner visitors on India in history from 5CE to 17th century), Ed. Meenakshi Jain and Sandhya Jain, Prabhat Prakashan

F. Y. B. Sc. Semester II		
Course title & course code	MIC- 150: Practicals based on Techniques in Bacteriology	Number of credits: 02
Course Outcomes (COs) On completion of the course, the students will be able to		
CO1	Show an experiment to isolate the bacteria and determine the total count of bacteria from different environmental samples using different plate methods.	
CO2	Differentiate bacteria based on their cell wall composition using differential staining techniques.	
CO3	Examine morphological characteristics of bacteria by different staining techniques.	
CO4	Detect the phototaxis and chemotaxis in bacteria.	
CO5	Measure the growth curve of bacteria in batch culture under standard environmental conditions.	
CO6	Design experiments to determine the effect of different environmental parameters on the growth of bacteria.	

Unit No	Title of Unit and Contents
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 and clay method) ii. Swarming growth on agar surface iii. Craigie's tube method
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.

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

F. Y. B. Sc. Semester II		
Course title & course code	MIC- 151: Essential methods in bacteriology	Number of credits: 04
Course Outcomes (COs) On completion of the course, the students will be able to		
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.	
CO2	Draw and compare the structure of eubacterial and archaeobacterial cells. Discuss the composition and functions of different organelles	
CO3	Explain various methods of measurement of bacterial growth. Outline patterns of growth of bacteria and factors affecting.	
CO4	Explain concept of staining, types of stains and role of various reagents used	
CO5	Classify and differentiate various morphological forms of bacteria using differential staining and special staining techniques.	
CO6	Compare different patterns of growth of bacteria and discuss the effect of environmental parameters on the growth of bacteria. Measure the growth of bacteria using different microbiological and chemical methods. Design specific growth medium for a particular group of bacteria	

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

II	Bacterial growth A. Definition of binary fission, growth, generation time, growth rate, specific growth rate B. Batch culture - Growth curve and growth kinetics C. Factors affecting growth- pH,temperature, solute concentration(salt and sugar) and heavy metals D. Methods of enumeration: Merits and demerits of each method - Microscopic methods - Plate count methods - Estimation of biomass: Dry mass and wet mass. - Optical density measurement (Mac-Farland standard) - Miscellaneous methods - Chemical methods - cell carbon and nitrogen estimation, ATP,PCV E. Different patterns of growth - Continuous growth :-concept of chemostat and turbidostat - Diauxic growth iii. Synchronous growth
II	Stain and staining techniques A. Stain: Definition, Concept of chromophore and auxochrome group, Acidic and basic stains Role of fixatives, accentuators, mordants and decolorisers. B. Principle and applications of : - Negative staining - Monochrome staining - Differential staining – Gram’s staining and Acid fast staining - Special staining: - Capsule demonstration and capsule staining - Spore staining - Flagella staining

IV	Bacterial Cytology 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. B. Cell membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. C. Endospore: Structure, formation and stages of sporulation D. Capsule: Structure, composition and function. E. Flagella: Structure, composition and function F. Fimbriae and pili: structure, composition and function G. Cytoplasm: Ribosomes, mesosomes, nucleoid, chromosome and plasmids. H. Cell inclusions: Gas vesicles, carboxysomes, PHB granules, metachromatic granules and glycogen bodies.
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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, Lancing. 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
14. 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		
Course title & course code	MIC- 161: Fundamentals of microbiology	Number of credits: 02
Course Outcomes (COs) On completion of the course, the students will be able to		
CO1	Describe the evolution of the microbiology field and the scientific discoveries relating to each field.	
CO2	Discuss the morphological and differential characteristics of different groups of microorganisms.	
CO3	Discuss the history and discovery of microscopes. Diagrammatically explain the principle, working and applications of bright field microscope. Diagrammatically explain the cell cytology of bacteria and discuss functions of different parts of the cell.	
CO4	Explain different methods of sterilization, disinfections and their applications.	
CO5	Observe various morphological forms of bacteria using staining and classify bacteria using differential staining.	
CO6	Describe nutritional requirements of bacteria. Design specific growth medium for a particular group of bacteria.	

Unit No	Title of Unit and Contents
I	Introduction to microbiology A. Microscopy i. History of microscopy, Terms in microscopy – Magnification, Refractive index, Numerical aperture, Resolving power ii. Principle, working, ray diagram and applications of Bright field

	microscopy. B. Landmark contributions in the field of Microbiology Robert Hook, Anton Van Leeuwenhoek, Louis Pasteur, Robert Koch, John Tyndall, Edward Jenner, Alexander Fleming. Recent milestone discoveries in the field of Microbiology C. Bacterial cell structure and functions of different parts. D. Introduction to different groups microorganisms with respect to morphological characteristics, nutrition and cultivation methods, economic importance: i. Yeast ii. Fungi iii. Algae iv. Viruses v. Protozoa vi. Viroids and Prions
II	Basic techniques in microbiology A. Nutritional requirements of bacteria and various media used for the cultivation of bacteria i. General (Synthetic and complex media) ii. Selective media iii. Differential media iv. Enriched media v. Enrichment media vi. Minimal and complete media B. Concept of sterilization and disinfection i. Principle, working and application of autoclave, hot air oven, laminar air flow and membrane filters. ii. Mode of action of ethyl alcohol, Phenol and phenolic compounds, halogen compounds and ethylene oxide. C. Stain and staining techniques i. Stain: Definition, Concept of chromophore and auxochrome group, Acidic and basic stains

	ii. Role of fixatives, accentuators, mordants and decolorizers. iii. Principle and applications of: a. Negative staining b. Monochrome staining c. Differential staining – Gram’s staining
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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. MacGraw Hill Companies Inc.
6. Prescott, Lancing. 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 MacGraw Hill 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 MacGraw-Hill Publishing Company Limited, New Delhi.

	General/ Open Electives	
Title of the Course and Course Code	MIC-170: Human Defense against microbial infections	Number of Credits : 02
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Define important terminologies in infection biology. State the different lines of immunological defense exhibited by human body	
CO2	Classify the host and pathogen factors affecting infection. Describe how human body fights against infections	
CO3	Explain why some individuals fall ill more often? Write about inflammation and types of hypersensitivity	
CO4	Differentiate between different types of vaccines. Explain in detail factors affecting infection	

Unit No.	Title of Unit and Contents
I	Basics of Infection Biology A. Important terminology: Primary infection, secondary infection. Contagious infection, occupational disorder, clinical infection, subclinical infection, Zoonoses, genetic disorder, vector borne infection. B. Factors affecting infection: i. Microbial factors: adherence, invasion, role of virulence factors in invasion, colonization & its effects. ii. Host factors: natural resistance, species resistance, racial resistance, individual resistance 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.

II	Human system to fight infection A. First line of Defense: for skin, respiratory tract, gastrointestinal tract, genitourinary tract, eyes. B. Second line of defense: Phagocytosis, Inflammation C. Third line of defense: Brief introduction to antibody mediated & cell mediated immunity. D. Inflammation and allergic reactions: Hallmarks of inflammation and types of hypersensitivity E. Vaccines and Immunization schedule
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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.

	General/ Open Elective	
Title of the Course and Course Code	MIC-171: Prebiotics and Probiotics	Number of Credits : 02
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Define prebiotics and probiotics.	
CO2	Discuss about the importance gut microflora in maintaining good health	
CO3	Infer the characteristics of probiotics for selection.	
CO4	Analyse various fermented products for their probiotic properties	

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

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.

	Vocational Skill Course	
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Title of the Course and Course Code	MIC-180: Fermented Foods	Number of Credits : 02
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Define fermented foods	
CO2	Describe different types of microorganisms used for preparation of fermented food.	
CO3	Illustrate the role of lactic acid bacteria in food preservation	
CO4	Producing different types of fermented products from vegetables, fruits, grains and meat	

Unit No.	Title of Unit and Contents
I	D. Introduction to fermented food, Types of microorganisms used for production of fermented foods, Significance of fermentation, E. Importance of Starter cultures, Role of Lactic Acid Bacteria (LAB) in preservation of food. Current trends in fermented food products
II	A. Fermented dairy products: Cheese, Yogurts, curd, butter milk and lassi. B. Fermented vegetables products: Sauerkraut, Tempeh, Natto and Miso. C. Fermented fruit products: Wine and Cider. D. Fermented meat products: Sucuk and Salami. E. Fermented grains products: Rice, Soy-based, Idli and Dosa. F. Fermented bakery products: Bread

Learning resources

1. Steinkraus K H, (1996). Handbook of Indigenous *Fermented Foods*. Marcel Decker Inc, New York. Anon, (1995), Food for Consumers, Food and Agriculture Organisation
2. Steinkraus, K.H. (1997) Classification of Fermented Foods: Worldwide Review of Household Fermentation Techniques. Food Control, 8, 311-317.
3. Predominant Lactic Acid Bacteria Involved in the Traditional Fermentation of *Fufu* and *Ogi*, Two Nigerian Fermented Food Products Food and nutrition sciences vol 11A.

4. Fermentation: Food Products, Encyclopedia of Agriculture and Food Systems Elsevier publications 2014.
5. Fermented Foods: Definitions and Characteristics, Impact on the Gut Microbiota and Effects on Gastrointestinal Health and Disease. Nutrients 2019 Aug 11(8).

	Vocational Skill Course	
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Title of the Course and Course Code	MIC-190: Clinical Biochemistry	Number of Credits : 02
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Describe the parameters that show an alteration in association with lifestyle disorders	
CO2	Categorize the various biochemical tests that need to be performed in various clinical conditions	
CO3	Illustrate the data obtained from biochemical analyses of samples such as whole blood, serum, urine etc. with clinical symptoms and possible pathologies	
CO4	Calculate the severity of the tissue damage or lifestyle disorder based on data generated through clinical biochemistry	

Unit No.	Title of Unit and Contents
I	Clinical Biochemistry I - Diabetes Mellitus : BSL(Fasting and PP), GTT, Hb A1C determination - Kidney function tests – Estimation of serum total protein & albumin - Estimation of serum urea & calculation of BUN - Estimation of uric acid - Estimation of serum creatinine - Estimation of blood cystatin C
II	Clinical Biochemistry II - Liver function tests - Bilirubin, SGPT, SGOT, Alkaline phosphatase - Lipid profile - Triglycerides, HDL, LDL, Cholesterol, - Ions Magnesium, Calcium, Sodium, Phosphorous, Chloride

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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. Practical Clinical Biochemistry, Harold Varley 4th Edition CBS Publishers and Distributors Pvt. Ltd. New Delhi.
5. Textbook of Biochemistry with clinical correlations Thomas Devlin (Editor); John Wiley and Sons.
6. Biochemistry by U. Satyanarayana and U. Chakrapani 5th Edition; Elsevier Publications.
7. Clinical Biochemistry by Nanda Maheshwari 2nd edition Jaypee Brothers Publications.
8. Medical Physiology by John E. Hall and Michel E. Hall 3rd South Asia Edition, Elsevier Publications.