



**Fergusson College (Autonomous)**

**Pune**

**Learning Outcomes-Based Curriculum**  
**for**

**F. Y. B. Sc. Microbiology**

**With effect from June 2019**

<b>Program Outcomes (POs) for B. Sc. Programme</b>	
<b>PO1</b>	<b>Disciplinary Knowledge:</b> 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.
<b>PO2</b>	<b>Critical Thinking and Problem solving:</b> Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closely and design the solutions.
<b>PO3</b>	<b>Social competence:</b> Display the understanding, behavioural skills needed for successful social adaptation , work in groups, exhibits thoughts and ideas effectively in writing and orally.
<b>PO4</b>	<b>Research-related skills and Scientific temper:</b> 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.
<b>PO5</b>	<b>Trans-disciplinary knowledge:</b> Integrate different disciplines to uplift the domains of cognitive abilities and transcend beyond discipline-specific approaches to address a common problem.
<b>PO6</b>	<b>Personal and professional competence:</b> 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.
<b>PO7</b>	<b>Effective Citizenship and Ethics:</b> 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.
<b>PO8</b>	<b>Environment and Sustainability:</b> Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
<b>PO9</b>	<b>Self-directed and Life-long learning:</b> Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

PSO No.	<b>Program Specific Outcomes(PSOs)</b>  <b>Upon completion of this programme the student will be able to</b>
<b>PSO1</b>	<b>Academic competence:</b> (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
<b>PSO2</b>	<b>Personal and Professional Competence:</b> (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.
<b>PSO3</b>	<b>Research Competence:</b> (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.
<b>PSO4</b>	<b>Entrepreneurial and Social competence:</b> (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

## Programme Structure

Year	Course Code	Title of Paper	Type of Paper	No. of Credits
<b>F.Y. B. Sc.</b>	<b>Semester I</b>			
	MIC1101	Introduction to Microbial world	CORE-1	2
	MIC1102	Basic techniques in Microbiology	CORE- 2	2
	MIC1103	Practicals based on “Introduction to Microbiology”	PCORE-1	2
	<b>Semester II</b>			
	MIC1201	Diversity of Microbial World	CORE-3	2
	MIC1202	Bacteriology	CORE-4	2
	MIC1203	Microbiology Practical - II	PCORE-2	2

Year	Name of Paper	Paper Code	Title of Paper	No. of Credits
<b>S.Y. B.Sc.</b>	<b>Semester III</b>			
	Theory Paper - 1	MIC2301	Microbial Genetics	2
	Theory Paper - 2	MIC2302	Microbial Metabolism	2
	Practical Paper - 1	MIC2303	Microbiology Practical-III	2
	<b>Semester IV</b>			
	Theory Paper - 3	MIC2401	Environmental Microbiology	2
	Theory Paper - 4	MIC2402	Industrial Microbiology	2
	Practical Paper - 2	MIC2403	Microbiology Practical-IV	2

Year	Paper No.	Course code	Title	Credits	CE Maximum Marks	ESE Maximum Marks	Total maximum Marks
<b>T. Y. B. Sc.</b>	<b>Semester V</b>						
	DSE-1A	MIC3501	Medical Microbiology	2	50	50	100
	DSE-1B	MIC3502	DNA functioning and transfer in bacteria	2	50	50	100
	DSE-2A	MIC3503	Enzymology	2	50	50	100
	DSE-2B	MIC3504	Fundamentals of Immunology	2	50	50	100
	DSE-3A	MIC3505	Principles of fermentation technology	2	50	50	100
	DSE-3B	MIC3506	Agricultural Microbiology and Bio nanotechnology	2	50	50	100
	DSE-1	MIC3507	Microbiology Practical I	2	50	50	100
	DSE-2	MIC3508	Microbiology Practical II	2	50	50	100
	DSE-3	MIC3509	Microbiology Practical III	2	50	50	100
	SEC-1*	MIC3511	Clinical Biochemistry and Diagnostic Microbiology	2	50	50	100
	SEC-2*	MIC3512	Epidemiological Principles and Experimental Analysis	2	50	50	100

Year	Paper No.	Course code	Title	Credits	CE Maximum Marks	ESE Maximum Marks	Total maximum Marks
<b>T. Y. B. Sc.</b>	<b>Semester VI</b>						
	DSE-4A	MIC3601	Metabolic activities of Microorganisms	2	50	50	100
	DSE-4B	MIC3602	Immunological processes	2	50	50	100
	DSE-5A	MIC3603	Large scale bioprocess	2	50	50	100
	DSE-5B	MIC3604	Food and dairy Microbiology	2	50	50	100
	DSE-6A	MIC3605	Antimicrobial Therapy and Prevention	2	50	50	100
	DSE-6B	MIC3606	Recombination and gene manipulation	2	50	50	100
	DSE-4	MIC3607	Microbiology Practical IV	2	50	50	100
	DSE-5	MIC3608	Microbiology Practical V	2	50	50	100
	DSE-6	MIC3609	Microbiology Practical VI	2	50	50	100
	SEC-3*	MIC3611	Marine Microbiology	2	50	50	100
	SEC-4*	MIC3612	Prebiotics and Probiotics	2	50	50	100

F.Y. B.Sc. Semester I		
<b>Title of the Course and Course Code</b>	<b>Introduction to Microbial World MIC1101</b>	<b>Number of Credits : 02</b>
<b>Course Outcomes (COs)</b> <b>On completion of the course, the students will be able to:</b>		
CO1	Describe the origin of microbial life on Earth by outlining the experiment relating to 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.	

<b>Unit No.</b>	<b>Title of Unit and Contents</b>	<b>No. of Lectures</b>
I	<b>Origin of Microbial life:</b> Biogenesis Vs Abiogenesis (Hypothesis and experiments) Miller's experiments, Ubiquitous nature of microbial life. Development from simple to complex life forms.	6
II	<b>Significance of Scientific contributions in development in Microbiology as a discipline:</b> <b>A. Early contributions</b> Robert Hook, Anton Van Leeuwenhoek, Louis Pasteur, Robert Koch, John Tyndall. <b>B. Scientific contribution leading to diversification of Microbiology</b> i. Medical Microbiology and Immunology- Edward Jenner, Paul Ehrlich, Ellie Metchnikoff, Lister. ii. Food Microbiology and Fermentation- Alexander Fleming, Louis Pasteur, Selman Waksman iii. Soil Microbiology- Winogradsky, Martinus Beijerinck iv. Microbial Genetics – Watson and Crick, Hargobind Khurana, Griffith, Avery, McCarty, and Macloed. <b>C. Frontiers in Microbiology</b> Nanobiotechnology, rDNA Technology, Bioinformatics, Proteomics, Genomics, Neutraceuticals.	15
III	<b>Diversity of Microbial World:</b> <b>A.</b> Systems of Classification- Binomial nomenclature, three kingdom, five kingdom classification and utility. <b>B.</b> Differences in Cellular and Acellular microorganisms Differences in prokaryotic and eukaryotic (Occurrence, morphology, mode of reproduction and economic importance) <b>C.</b> Different groups microorganisms- Bacteria, Yeast, Fungi,	15

	Actinomycetes, Algae, Viruses, Protozoa, Viroids and Prions (Morphological and differential characteristics, Nutrition and cultivation methods, habitats, economic importance, harmful and beneficial activities)	
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### References:

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. and 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
13. David T. Plummer (1993) An Introduction To Practical Biochemistry, 3rd Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.

<b>Title of the Course and Course Code</b>	<b>Basic techniques in Microbiology MIC1102</b>	<b>Number of Credits : 02</b>
<b>Course Outcomes (COs)</b>		
<b>On completion of the course, the students will be able to:</b>		
CO1	Describe the role of microorganisms in different fields and interdisciplinary approach. Recall the fundamental principles in Microbiology or science.	
CO2	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.	
CO3	Classify and differentiate various morphological forms of bacteria using differential staining and special staining techniques.	
CO4	Explain different methods of sterilization, disinfections and their applications.	
CO5	Validate sterilization efficiency of different instruments and evaluate disinfectants using biological and chemical indicators.	
CO6	Specify the mode of action and application of different sterilizing agents and disinfectants.	



Unit No.	Title of Unit and Contents	No. of Lectures
I	<b>Scope and fundamental principles in Microbiology</b> <ul style="list-style-type: none"> <li>• Interdisciplinary approach</li> <li>• SI units of measurements – (Length, Volume, Weight)</li> <li>• Properties of light, Spectrum, Wavelength, Frequency, Amplitude</li> <li>• Molar and Normal solutions, Avogadro's Number</li> </ul>	6
II	<b>Microscopy and Staining Techniques</b> <p><b>A) Microscopy</b></p> <ul style="list-style-type: none"> <li>• History of microscopy</li> <li>• Terms in microscopy – Magnification, Refractive index, Numerical aperture, Resolving power</li> <li>• Aberrations in lenses</li> <li>• Principle, working, ray diagram and applications of               <ol style="list-style-type: none"> <li>1. Bright field microscopy</li> <li>2. Dark field microscopy</li> <li>3. Phase contrast microscopy</li> <li>4. Fluorescence microscopy</li> </ol> </li> <li>• Introduction to               <ol style="list-style-type: none"> <li>1. Confocal microscopy</li> <li>2. Electron microscopy – SEM, TEM</li> </ol> </li> </ul> <p><b>B) Stain and staining techniques</b></p> <ul style="list-style-type: none"> <li>• Stain – Definition, Concept of chromophore and auxochrome group, Acidic and basic stains</li> <li>• Role of fixatives, accentuators, mordants and decolorisers</li> <li>• Principle and applications of               <ol style="list-style-type: none"> <li>1. Negative staining</li> <li>2. Monochrome staining</li> <li>3. Differential staining – Gram's staining and Acid fast staining</li> </ol> </li> </ul> <p>Special staining – Capsule staining</p>	15
III	<b>Sterilization and disinfection</b> <p>Physical agents – Mode of action and application of Heat, Radiation, Filtration</p> <p>Chemical agents - Characteristics of an ideal disinfectant</p> <p>Mode of action and application of - Aldehydes, Halogens, Quaternary ammonium compounds, Phenol and Phenolic compounds, Heavy metals, Alcohols, Dyes, Detergents and Ethylene oxide</p> <p>Checking of efficiency of sterilization – Biological and Chemical indicators</p> <p>Checking efficiency of disinfectant – Phenol coefficient- Rideal Walker coefficient, Chick Martin test.</p>	15

**Note : Numericals and problem solving related to topics will be conducted**

**References:**

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. and 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
13. David T. Plummer (1993) An Introduction To Practical Biochemistry, 3rd Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi

<b>Title of the Course and Course Code</b>	<b>Practicals based on Introduction to Microbial World - MIC1103</b>	<b>Number of Credits : 02</b>
<b>Course Outcomes (COs)</b>		
<b>On completion of the course, the students will be able to:</b>		
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.	

Unit No.	Title of Unit and Contents
1	Introduction to Microbiology laboratory – a. GLP and Biosafety b. To study Principle and applications of instruments: Microscope, Autoclave, Hot-air oven, Centrifuge, pH meter, Incubator, Refrigerator, Distillation apparatus, Laminar Air-flow system, Water-bath, Colorimeter, Spectrophotometer and SOP writing
2	Preparation and sterilization of culture media
3	Aseptic Transfer Techniques
4	Assessment of Sterility - a. Assessment of sterility of glassware and nutritional media (Hot air oven and Autoclave) b. Sterilization by membrane filtration and sterility assessment
5	Cultivation of photosynthetic organisms using Winogradsky's column
6	Observation of organisms - <i>Rhizopus</i> , <i>Penicillium</i> , <i>Aspergillus</i> using different natural samples Observation of permanent slides of Protozoans: <i>Amoeba</i> , <i>Paramoecium</i> , <i>Plasmodium</i> , <i>Entamoeba</i>
7	Observation of actinomycetes by slide culture technique and coverslip technique.
8	Demonstration of microflora from air and preservation of bacterial and fungal cultures.
9	Primary demonstration of effect of sanitizers on microflora
10	Measurement of cell dimension by Micrometry

#### References:

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
5. Handbook Media Stains Reagents Microbiology by A. M. Deshmukh

F.Y. B.Sc. Semester II		
<b>Title of the Course and Course Code</b>	<b>Microbial World: A detailed study – MIC1201</b>	<b>Number of Credits : 02</b>
<b>Course Outcomes (COs)</b> <b>On completion of the course, the students will be able to:</b>		
CO1	Describe infection diseases, resistance, host defense and factors influencing resistance.	
CO2	Articulate interdisciplinary approach and recent developments in the field of microbiology.	
CO3	Infer morphology, physiology, cultivation, classification and importance with reference to viruses and bacteriophages.	
CO4	Categorize different interactions within microbial communities, microorganisms, plants and animals.	
CO5	Justify and explain the importance of microorganisms with reference to fungi, algae and protozoa.	
CO6	Write morphological, physiological characteristics and classify microorganisms with reference to fungi, algae and protozoa.	

<b>Unit No.</b>	<b>Title of Unit and Contents</b>	<b>No. of Lectures</b>
I	Interdisciplinary approach of Microbiology, Recent developments in Microbiology. Associations in Microorganisms	6
II	<b>Algae</b> History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultra structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of algae in agriculture, industry, environment and food. <b>Fungi</b> Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, Reproduction: Asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. <b>Fungal taxonomy</b> Economic importance of fungi with examples in agriculture, environment, industry, medicine, food, biodeterioration and mycotoxins.	15
III	<b>Protozoa</b> General characteristics with special reference to <i>Amoeba</i> , <i>Paramecium</i> , <i>Plasmodium</i> , <i>Leishmania</i> and <i>Giardia</i> <b>Virus</b> Viral taxonomy: Classification (ICTV and Baltimore) and nomenclature of	15

	different groups of viruses Modes of viral transmission: Persistent, non-persistent, vertical and horizontal, Salient features of viral Nucleic acid <b>Bacteriophages:</b> Diversity, classification, one step growth curve, lytic (T even and Todd Phages) and lysogenic phages (lambda phage), lysogenic conversion phenomenon(Diphtheria/Salmonella/Vibrio)	
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**Note: Numericals and problem solving related to topics will be conducted**

### **References:**

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

<b>Title of the Course and Course Code</b>	<b>Bacteriology - MIC1202</b>	<b>Number of Credits : 02</b>
<b>Course Outcomes (COs)</b>		
<b>On completion of the course, the students will be able to:</b>		
CO1	Recall basic concepts of bacteriology. Define different terms involved in nutrition of bacteria, types of growth medium for isolation, cultivation and identification of bacteria.	
CO2	Draw and compare the structure of eubacterial and archaeobacterial cells. Discuss the composition and functions of different organelles.	
CO3	Classify bacteria based on their nutritional requirements. Outline diversity of bacteria and their industrial and biotechnological applications.	
CO4	Explain different types of growth medium for isolation, cultivation and identification of bacteria.	
CO5	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.	
CO6	Design specific growth medium for a particular group of bacteria.	

<b>Unit No.</b>	<b>Title of Unit and Contents</b>	<b>No. of Lectures</b>
<b>I</b>	<b>Diversity of bacteria based on nutrition and environmental conditions</b> <ul style="list-style-type: none"> <li>Nutritional requirements and nutritional classification (Fastidious organisms)</li> <li>Extremophiles and their significance</li> </ul>	<b>6</b>
<b>II</b>	<b>Bacterial Cytology</b> <ul style="list-style-type: none"> <li>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</li> <li>Cell membrane : Structure , function and chemical composition of bacterial and archael cell membranes</li> <li>Endospore :Structure , formation and stages of sporulation</li> <li>Capsule : Structure , composition and function</li> <li>Flagella : Structure , composition and function</li> <li>Fimbriae and pili : structure , composition and function</li> <li>Cytoplasm : Ribosomes, mesosomes, nucleoid, chromosome and plasmids, Cell inclusion - gas vesicles, carboxysomes , PHB granules , metachromatic granules and glycogen bodies</li> </ul>	<b>15</b>
<b>III</b>	<b>Bacterial growth and nutrition</b> <p><b>Nutrition :</b></p> <ul style="list-style-type: none"> <li>Design and preparation of media :Common ingredients</li> <li>Various media used for the cultivation of bacteria :General (Synthetic</li> </ul>	<b>15</b>

	<p>and complex media), Selective, differential , enriched, enrichment media, Minimal and complete media</p> <p><b>Bacterial growth -</b></p> <ul style="list-style-type: none"> <li>• Definition of growth, generation time, growth rate, specific growth rate. Growth curve and growth kinetics</li> <li>• Factors affecting growth – pH , temperature , solute concentration( salt and sugar) and heavy metals</li> </ul> <p>Methods of enumeration, Merits and demerits of each method</p> <ol style="list-style-type: none"> <li>1. Microscopic</li> <li>2. Plate counts</li> <li>3. Estimation of biomass: Dry mass and wet mass. Merits and demerits</li> <li>4. Optical density measurement (Mac-Ferland standard)</li> <li>5. Miscellaneous methods(Chemical methods – cell carbon and nitrogen estimation,ATP,PCV )</li> </ol> <ul style="list-style-type: none"> <li>• Diauxic growth</li> <li>• Synchronous growth</li> <li>• Continuous growth – concept of chemostat and turbidostat</li> </ul>	
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**Note: Numericals and problem solving related to topics will be conducted**

References:

1. Daniel Lim, Microbiology, 2nd Edition; McGraw-Hill Publication
2. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology. 3<sup>rd</sup> Edition. Thomson Brooks / Cole.
3. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.
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5. Prescott L.M., Harley J.P., and Klein D.A. (2005). Microbiology, 6th Edition. MacGraw Hill Companies Inc.
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7. Willey J. M., Sherwood L. M. and Woolverton C. J. (2013) Prescott's Microbiology, 8<sup>th</sup> Edition, McGraw-Hill Higher Education
8. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGraw Hill Publishing Co.
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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. 6<sup>th</sup> Edition. Cambridge University Press.
12. Hans G. Schlegel (1993) General Microbiology, 8th Edition, Cambridge University Press
13. David T. Plummer (1993) An Introduction To Practical Biochemistry, 3<sup>rd</sup> Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi

Title of the Course and Course Code	Practicals based on “Basic Techniques in Microbial World” - MIC1203	Number of Credits : 02
<p align="center"><b>Course Outcomes (COs)</b></p> <p align="center"><b>On completion of the course, the students will be able to:</b></p>		
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 Experiment/ Practical
1	Purification of bacteria by streak plate technique and study of colony characteristics
2	Enumeration of bacteria TVC: Spread plate
3	Enumeration of bacteria TVC: Pour plate technique
4	Enumeration of yeasts cells / bacterial cells using counting chamber
5	Observation of morphology of bacteria by Negative staining technique Monochrome staining technique
6	Differential staining: Gram staining technique, Acid fast staining
7	Observation of bacterial motility by a. Hanging drop technique ( Using cavity slide and clay method) b. Swarming growth on agar surface c. Cragie’s tube method
8	Growth curve of bacteria
9	Effect of environmental parameters on bacterial growth: pH and temperature
10	Effect of environmental parameters on bacterial growth: Salt and Heavy metals

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4. Microbiology: A Laboratory Manual, 10th Edition James G. Cappuccino
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