



Fergusson College (Autonomous)

Pune

Learning Outcomes-Based Curriculum

for

F. Y. B. Sc. Microbiology

With effect from June 2019

Program Structure

Particulars	Course Code	Title of Paper	Type of Paper	No. of Credits
F.Y. Semester I	MIC1101	Introduction to Microbial world	CORE-1	2
	MIC1102	Basic techniques in Microbiology	CORE- 2	2
	MIC1103	Microbiology Practical - I	PCORE-1	2
F.Y. Semester II	MIC1201	Diversity of Microbial World	CORE-3	2
	MIC1202	Bacteriology	CORE-4	2
	MIC1203	Microbiology Practical - II	PCORE-2	2
S.Y. Semester III	MIC2301	Microbial Genetics	CORE-5	3
	MIC2302	Biochemistry	CORE-6	3
	MIC2303	Practicals based on Genetics and Biochemistry	PCORE-3	2
S.Y. Semester IV	MIC2401	Environmental Microbiology	CORE-7	3
	MIC2402	Industrial Microbiology	CORE-8	3
	MIC2403	Practicals based on Environmental and Industrial Microbiology	PCORE-4	2
T.Y. Semester V	MIC3501	Medical Microbiology	CORE-9	3
	MIC3502	Molecular Biology	CORE-10	3
	MIC3503	Immunology	CORE-11	3
	MIC3504	Fermentation	DSE-1	3
	MIC3505	Microbial physiology	DSE-2	3
	MIC3506	Microbial metabolism	DSE-3	3
	MIC3507	Food and Dairy Microbiology	DSE-4	3
	MIC3508	Instrumentation and biotechniques	DSE-5	3
	MIC3509	Practicals based on Medical microbiology and Immunology	PCORE-5	3
	MIC3510	Practicals based on molecular biology and Microbial metabolism	PCORE-6	3
	MIC3511	Practicals based on fermentation and food and	PCORE-7	3

Particulars	Course Code	Title of Paper	Type of Paper	No. of Credits
		dairy microbiology		
T.Y. Semester VI	MIC3601	Cell biology	CORE-12	3
	MIC3602	Microbes in environment	CORE-13	3
	MIC3603	Microbial biotechnology	CORE-14	3
	MIC3604	Recombinant DNA technology	DSE-6	3
	MIC3605	Medical microbiology and immunology	DSE-7	3
	MIC3606	Microbial diagnosis in health clinics	DSE-8	3
	MIC3607	Management of human microbial diseases	DSE-9	3
	MIC3608	Genetic engineering and biotechnology	DSE-10	3
	MIC3609	Practicals based on Cell biology & Recombinant DNA technology	PCORE-8	3
	MIC3610	Practicals based on Diagnostic microbiology	PCORE-9	3
	MIC3611	Practicals based on Microbial biotechnology & environmental microbiology	PCORE-10	3

Program learning outcomes

PO1	<p>Subject skills –</p> <ul style="list-style-type: none"> • Basic techniques in Microbiology: Understanding the concepts of diversity of microbial world that includes classification and reproduction of various groups such as algae, fungi, protozoa, viruses and bacteria and practicals based on it. It also involves learning the principle and applications of different types of microscope including the advanced microscope such as Confocal Microscope, Electron Microscope and Fluorescence Microscope. • Industrial Microbiology and Fermentation Technology: It mainly deals with learning the concepts of screening of microorganisms having potential of producing the desired industrial products, bio-molecules. It also involves different types of bioreactors, various types of fermentations like organic acids, vitamins, antibiotics, single cell protein etc., process monitoring and optimization, downstream processing etc. The practicals based on certain pharmaceutical techniques such as Sterility testing, Vitamin and antibiotic assay are included. • Molecular Microbiology: The physiology, biochemistry, and genetics of microorganisms (prokaryotic and eukaryotic) is studied. In addition to this, practicals such as isolation of genomic DNA, transformation, Electrophoresis, Chromatographic techniques, enzyme assay, Clinical Biochemistry etc. are included. • Microbial Pathogenesis: The immune response and disease-causing microorganisms, including aspects of the humoral, cell-mediated and non-specific immune responses, as well as the molecular basis for pathogenesis; • Applied Microbiology: Mainly deals with the study of occurrence of various types of microbes in Air, Soil and Water Microbiology, their role in pathogenesis and nutrient cycling, disinfection methods. It also deals with Food Microbiology in which topics like food spoilage, food preservation methods are studied. • Nanobiotechnology: Synthesis of various types of nano particles using microorganisms and their applications in different fields is studied. ➤ During Concurrent Evaluation methods, the students have developed their communication skills by participating in class presentations, group discussion, epidemiological survey etc. ➤ By arranging visits to places like Dairy industry, Fermentation industry, Waste Water Treatment plant, Blood Bank etc. students get exposure to practical knowledge.
PO2	<p>Specialized Knowledge: Students graduating with a B.Sc. degree in Microbiology will be able to:</p> <ol style="list-style-type: none"> 1. define/explain within multiple microbiology disciplines the core theories and practices; 2. describe/explain the processes used by microorganisms for their replication, survival, and interaction with their environment, hosts, and host populations; 3. explain the theoretical basis of the tools, technologies and methods common to microbiology; and 4. demonstrate practical skills in the use of tools, technologies and methods common to microbiology, and apply the scientific method and hypothesis testing in the design and execution of experiments.

PO3	Intellectual Skills – Communication Fluency: <ul style="list-style-type: none">• Within the framework of specialized knowledge developed in our courses, our students will communicate science as assessed by their ability to:• utilize microbiological concepts to summarize, analyze, and synthesize scientific and microbiology-related literature,• describe methodological information,• apply microbiological concepts and basic research findings through description, interpretation, and analysis,• articulate conclusions and implications of research, and• communicate with both specialist and non-specialist audiences using genres commonly used in microbiology
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MIC1101 - Introduction to Microbial World

Credits: 3

Learning Outcomes	Suggested Pedagogical Processes
The student will be able to understand the origin of microbial life with different hypothesis and experiments	Context based teaching using traditional chalk-and-board method
The student will be able to know the significance of scientific contributions in development in microbiology as a discipline	Class presentations by students
The student will be acquainted with the frontiers in microbiology	Post lesson teacher questionnaire
The student will be able to classify and differentiate various groups of microorganisms	ICT based teaching
The student will be aware of morphological and differential characteristics, Nutrition and cultivation methods, habitats, economic importance, harmful and beneficial activities	Comparative account of different microorganisms

Unit No.	Title of Unit and Contents
I	Origin of Microbial life: Biogenesis Vs Abiogenesis (Hypothesis and experiments) Miller's experiments, Ubiquitous nature of microbial life. Development from simple to complex life forms.
II	Significance of Scientific contributions in development in Microbiology as a discipline: A. Early contributions Robert Hook, Anton Van Leeuwenhoek, Louis Pasteur, Robert Koch, John Tyndall. B. Scientific contribution leading to diversification of Microbiology 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 MacLeod. C. Frontiers in Microbiology Nanobiotechnology, rDNA Technology, Bioinformatics, Proteomics, Genomics, Neutraceuticals.
III	Diversity of Microbial World: A. Systems of Classification- Binomial nomenclature, three kingdom, five kingdom classification and utility. B. Differences in Cellular and Acellular microorganisms Differences in prokaryotic and eukaryotic (Occurrence, morphology, mode of reproduction and economic importance)

C. Different groups microorganisms- Bacteria, Yeast, Fungi, Actinomycetes, Algae, Viruses, Protozoa, Viroids and Prions (Morphological and differential characteristics, Nutrition and cultivation methods, habitats, economic importance, harmful and beneficial activities)

Learning Resources

1. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology. 3rd Edition. Thomson Brooks / Cole.
2. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.
3. 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. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGraw Hill Publishing Co.
8. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987) General Microbiology, 5th Edition. Macmillan Press Ltd.
9. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8th Edition. Pearson Education Inc.

MIC1102 - Basic techniques in Microbiology
Credits: 3

Learning Outcomes	Suggested Pedagogical Processes
Students will understand the scope and fundamental principles in Microbiology.	Context based teaching
Students will understand the principle and working of different types of microscopy.	ICT based teaching and use of physical models
Students will learn the history and discovery of various types of microscopes.	Teacher constructed concept maps
Students will understand the detailed mechanism of staining techniques to observe different types of organisms.	Post lesson teacher questionnaire
Students will understand the mode of action of physical and chemical agents used in sterilization.	Group student experimental activities
Students will understand how biological and chemical indicators are used in checking sterilization efficiency of various instruments.	Illustrations and analogies in diverse forms

Unit No.	Title of Unit and Contents
I	<p>Scope and fundamental principles in Microbiology</p> <ul style="list-style-type: none"> • Interdisciplinary approach • SI units of measurements – (Length , Volume, Weight) • Properties of light, Spectrum, Wavelength, Frequency, Amplitude • Molar and Normal solutions, Avogadro’s Number
II	<p>Microscopy and Staining Techniques</p> <p>A) Microscopy</p> <ul style="list-style-type: none"> • History of microscopy • Terms in microscopy – Magnification, Refractive index, Numerical aperture ,Resolving power • Aberrations in lenses • Principle, working, ray diagram and applications of <ol style="list-style-type: none"> 1. Bright field microscopy 2. Dark field microscopy 3. Phase contrast microscopy 4. Fluorescence microscopy • Introduction to <ol style="list-style-type: none"> 1. Confocal microscopy 2. Electron microscopy – SEM, TEM <p>B) Stain and staining techniques</p> <ul style="list-style-type: none"> • Stain – Definition, Concept of chromophore and auxochrome group, Acidic and basic stains • Role of fixatives, accentuators, mordants and decolorisers • Principle and applications of <ol style="list-style-type: none"> 1. Negative staining

	<ol style="list-style-type: none"> 2. Monochrome staining 3. Differential staining – Gram’s staining and Acid fast staining <p style="text-align: center;">Special staining – Capsule staining</p>
III	<p>Sterilization and disinfection</p> <p>A)Physical agents – Mode of action and application of</p> <ol style="list-style-type: none"> 1.Heat 2. Radiation 3.Filtration <p>B)Chemical agents -</p> <ol style="list-style-type: none"> a)Characteristics of an ideal disinfectant b)Mode of action and application of - Aldehydes , Halogens, Quaternary ammonium compounds , Phenol and Phenolic compounds, Heavy metals, Alcohols, Dyes , Detergents and Ethylene oxide <ul style="list-style-type: none"> • Checking of efficiency of sterilization – Biological and Chemical indicators <p>Checking efficiency of disinfectant – Phenol coefficient- Rideal Walker coefficient,Chick Martin test.</p>

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. 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

MIC1103 - Microbiology Practical - I**Credits: 2**

Learning Outcomes	Suggested Pedagogical Processes
Students will get to know the principle and working of basic instruments in a microbiology laboratory.	Demonstration of working of instruments and writing SOPs
Students will be acquainted to the principle, structure, working and handling of compound microscopes.	ICT based teaching and use of physical models
Students will understand the safety precautions and disposal of laboratory wastes	Good laboratory Practices
Students will understand the differences between the structure and cultivation methods of different microorganisms.	Formulation of bacteriological media, use of permanent slides, natural samples and microscopical observation
Determination of sterilization efficiency of various sterilization equipments.	Demonstration and observation

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 - a. <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>
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

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

MIC1201 - Diversity of Microbial World
Credits: 3

Learning Outcomes	Suggested Pedagogical Processes
The student will be able to understand Interdisciplinary approach, recent developments in the field of microbiology.	Context based teaching using traditional chalk-and-board method
The student will be introduced to infection disease, resistance and host defense,	ICT based teaching, Class presentations by students
The student will be able to know factors influencing resistance.	ICT based teaching, Class presentations by students
The student will be able to understand morphology, physiology, cultivation, classification and importance of with reference to fungi, algae and protozoa.	Comparatives account of different microorganisms
The student will be able to understand morphology, physiology, cultivation, classification and importance of with reference to viruses and bacteriophages	Comparatives account of different microorganisms

Unit No.	Title of Unit and Contents
I	Interdisciplinary approach of Microbiology, Recent developments in Microbiology. Associations in Microorganisms
II	<p>A. Difference between infection & disease. 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: Microbial factors: adherence, invasion, role of virulence factors in invasion, colonization & its effects. Host factors: natural resistance, species resistance, racial resistance.</p> <p>C. Individual resistance : Factors influencing individual resistance: Age, nutrition, personal hygiene, stress, hormones, Addiction to drugs/ alcohol. Interaction between Microbes & host is dynamic.</p> <p>D. Host defense against infection: Overview</p> <p>i. First line of Defence: for skin, respiratory tract, gastrointestinal tract, genitourinary tract, eyes.</p> <p>ii. Second line of defence: Biological barriers: Phagocytosis, Inflammation</p> <p>iii. Third line of defence: Brief introduction to antibody mediated & cell mediated immunity.</p>
III	<p>A. Fungi : Morphology, physiology, cultivation, classification and importance</p> <p>B. Algae : Morphology, physiology, cultivation, classification and importance</p> <p>C. Protozoa : Morphology, physiology, cultivation, classification and importance</p> <p>D. Virus:</p>

	Morphology, physiology, cultivation, classification and importance E. Bacteriophages: Morphology, physiology, cultivation, classification and importance
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Learning Resources

1. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.
2. Michael J Pelczar, JR. E.C.S. Chan, Noel R. Krieg. (1993) Microbiology, 5th Edition, Tata MacGraw Hill Press.
3. Prescott L.M., Harley J.P., and Klein D.A. (2005). Microbiology, 6th Edition. MacGraw Hill Companies Inc.
4. Prescott, Lancing. M., John, P. Harley and Donald, A. Klein (2006) Microbiology, 6th Edition, McGraw Hill Higher Education
5. Salle A.J. (1971) Fundamental Principles of Bacteriology.7th Edition. Tata MacGraw Hill Publishing Co.
6. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8th Edition. Pearson Education Inc.

MIC1202 - Bacteriology

Credits: 3

Learning Outcomes	Suggested Pedagogical Processes
Understand the nutritional requirements of bacteria and nutritional classification	Context based teaching
Understand the structure of bacteria and different envelopes of the cell.	ICT based teaching and use of physical models
Learn structure composition and functions of various organelles present in eubacteria and archaeobacteria.	Teacher constructed concept maps
Understand the detailed mechanism of formation of inclusion bodies and their role in cell survival.	Post lesson teacher questionnaire
Understand the growth pattern of bacteria and determination of generation time.	Group student experimental activities
Understand how plate method and colorimetric methods are used to measure growth of bacteria.	Illustrations and analogies in diverse forms

Unit No.	Title of Unit and Contents
Unit –I	Diversity of bacteria based on nutrition and environmental conditions <ul style="list-style-type: none"> • Nutritional requirements and nutritional classification(Fastidious organisms) • Extremophiles and their significance
Unit –II	Bacterial Cytology <ul style="list-style-type: none"> • 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 • Cell membrane : Strucure , function and chemical composition of bacterial and archael cell membranes • Endospore :Structure , formation and stages of sporulation • Capsule : Structure , composition and function • Flagella : Structure , composition and function • Fimbriae and pili : structure , composition and function • Cytoplasm : Ribosomes, mesosomes, nucleoid, chromosome and plasmids, Cell inclusion - gas vesicles, carboxysomes , PHB granules , metachromatic granules and glycogen bodies
Unit –III	Bacterial growth and nutrition Nutrition : <ul style="list-style-type: none"> • Design and preparation of media :Common ingredients • Various media used for the cultivation of bacteria :General (Synthetic and complex media), Selective, differential , enriched, enrichment media, Minimal and complete media Bacterial growth - <ul style="list-style-type: none"> • Definition of growth, generation time, growth rate, specific growth rate. Growth curve and growth kinetics • Factors affecting growth – pH , temperature , solute concentration(

	<p>salt and sugar) and heavy metals</p> <p>Methods of enumeration, Merits and demerits of each method</p> <ol style="list-style-type: none"> 1. Microscopic 2. Plate counts 3. Estimation of biomass: Dry mass and wet mass. Merits and demerits 4. Optical density measurement (Mac-Ferland standard) 5. Miscellaneous methods (Chemical methods – cell carbon and nitrogen estimation, ATP, PCV) <ul style="list-style-type: none"> • Diauxic growth • Synchronous growth • Continuous growth – concept of chemostat and turbidostat
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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.
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13. David T. Plummer (1993) An Introduction To Practical Biochemistry, 3rd Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi

MIC1203 - Microbiology Practical - II
Credits: 2

Learning Outcomes	Suggested Pedagogical Processes
Students will learn the different methods of purification and enumeration of bacteria from natural/test samples.	Methods of isolation of bacteria such as streaking, spreading and pour plate methods
Students will learn to differentiate the different groups of bacteria based on cell wall composition.	ICT based teaching
Students will learn the different morphological forms of bacteria.	Staining techniques
Students will be able to observe phototactic and chemotactic movement of bacteria	Microscopy and cultural methods
Students will know the pattern of growth of bacteria in a batch culture and effect of various environmental parameters on growth.	Colorimetric methods

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 a. Negative staining technique b. 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

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