K. J. Somaiya College of Science and Commerce, Vidyavihar, Mumbai

Autonomous- Affiliated to University of Mumbai

Syllabus for F. Y. B.Sc.

Program: B.Sc.

Course: Microbiology

(Choice based Credit System

with effect from

the Academic year 2018–2019)

Revised F. Y. B.Sc. Autonomous Syllabus to be implemented from 2018-2019

Semester I and II	Course Number	Course Title	Course Code	Credits	Hours	Period	Module per Course	Lectures per Module	Examination		
									Internal Marks	External Marks	Total Marks
Theory											
Core Courses Semester I											
	I	Basic Concepts of Microbiology	18USIMBI	2	30	36	3	12	40	60	100
	II	Applied Microbiology1 8	18USIMB2	2	30	36	3	12	40	60	100
Core Courses Semester II											
	I	Fundamentals of Microbiology	18US2MBI	2	30	36	3	12	40	60	100
	II	Introduction to Environmental and Industrial Microbiology	18US2MB2	2	30	36	3	12	40	60	100
Practical											
Core Courses											
Sem I	I and II		18USIMBP	1	30 and 30	36 and 36	3 and 3	--	--	100	100
Sem II	I and II		18US2MBP	1	30 and 30	36 and 36	3 and 3	--	--	100	100

Preamble

To the common man, Microbiology means the study of invisible mini wonders that only cause disease. In reality, the vast majority of microorganisms co-exist alongside us without causing any harm. On the contrary, many of them are required for our survival. Microbiology is a study of this microscopic world. It is a research oriented subject and plays a pivotal role in our daily lives.

After introducing the basics of Microbiology in Semester I and Semester II, syllabus progresses to include the topics of Immunology, Genetics, Biochemistry, Virology, Taxonomy, Dairy and Food Microbiology, basic and advanced Instrumentation in Semester III and Semester IV.

Semester V and Semester VI while focusing on the depth and applications of the above topics will also include new topics of Population genetics, Emerging infectious diseases, Bioinformatics, Biostatistics, Advanced Virology and basic Nanotechnology.

As mentioned in the syllabus at the F. Y. B.Sc. level all the two courses of theory & practical are compulsory to B.Sc. Microbiology students (Semester I and II).

The syllabi for the three-year undergraduate programme are designed to enable the students to understand and select an area of their interest to pursue further studies for post-graduation.

F.Y. B. Sc. (Microbiology) Semester I

Course- I

COURSE TITLE: Basic Concepts of Microbiology

COURSE CODE: 18USIMBI

[CREDITS - 02]

Course Outcomes: After the successful completion of the Course, the learner should be able to:

1) State the basic concepts of Microbiology.
2) Perform the basic techniques in Microbiology.

Course Specific Outcomes:

After the successful completion of the Course, the learner should be able to:

1) State the significant historical events in Microbiology along with basic concepts of biomolecules.
2) Perform basic experiments to cultivate and isolate bacteria and fungi.
3) Describe structure and function of a prokaryotic cell.
4) Tabulate microorganisms on the basis of nutrition.

Module	Title and Content	No. of Lectures
1	**Introduction to Microbiology and Chemical basis of Life** **Learning Objectives:** 1) To state the significant events in ancient, golden and modern age of Microbiology. 2) To recognize the applications of microorganisms. 3) To list the properties of different chemical bonds in biomolecules. 4) To describe the structure and role of water, carbohydrates, lipids, amino acids, proteins and nucleic acids. **Learning Outcomes:** After the successful completion of the Module, the learner should be able to: 1) Cite the contributions of different scientists and discoveries in Microbiology. 2) State the role of microorganisms in environment, medicine and industrial fields. 3) Compare the different types of chemical bonds in biomolecules. 4) Describe the structural attributes and significance of water, carbohydrates, lipids, amino acids, proteins and nucleic acids.	12

1	**History & Scope of Microbiology:**	
1.1.a.	**Brief History of Microbiology:** First observations Debate over spontaneous generation	1L
1.1.b.	**Golden age of Microbiology:** The Birth of Modern Chemotherapy	
1.1.c.	**Modern Developments in Microbiology:** Microbes and human welfare (in brief) Only names of few emerging infections and their causative agents	1L
1.2	**Chemical basis of life:** Revision of basic chemical structure of an atom and different chemical bonds **Types of Chemical bonds and their relevance in biomolecules:** a) Ionic bond b) Covalent bond c) Hydrogen bond	1L
1.3	**Definition, general characteristic & functions of biomolecules:**	

1.3.a.	**Structure and Role of water:** Polar nature of water and its four characteristics,	1L
1.3.b.	**Carbohydrates:** Description of structure and functions of: a) Monosaccharides (Hexoses, pentoses), b) Disaccharides (lactose, maltose), c) Polysaccharides (function of: glycogen, cellulose, dextran, chitin and starch)	2L
1.3.c.	**Amino- acids and Proteins:** a) 20 standard amino acids and their classification. b) Basic stereochemistry c) Nature of a Peptide bond d) Levels of structure of proteins: e) Brief description of structure of proteins: Primary Secondary Tertiary Quaternary	3L
1.3.d.	**Lipids:** Structure and function of": a) Simple lipids b) Complex lipids	1L

1.3.e.	**Nucleic acids:** Structure and function of DNA and RNA Nitrogenous bases and structures	2L

2	**Prokaryotic Cell structure- functions:** 12 **Learning Objectives:** 1) To understand the structural composition of a prokaryotic cell. 2) To analyse the relationship between structure and function of different parts of a bacterial cell. **Learning Outcomes:** After the successful completion of the Module, the learner should be able to: 1) Describe the different components of a prokaryotic cell. 2) Draw and label parts of a typical prokaryotic cell, cell wall, cell membrane. 3) Describe the structure and function of internal and external cellular structures. 4) Analyse the significance of cell-wall, plasma membrane. 5) Distinguish between Gram positive and Gram negative cell walls. 6) Describe the structure and role of bacterial endospores.	

2.1	Morphology of Prokaryotic cells: Size, Shape and Arrangement	1L
2.2	Plasma Membrane: The Fluid Mosaic model, Functions	2L
2.3	Cytoplasmic matrix – Inclusion bodies- types and significance of each, Ribosomes	2L
2.4	Bacterial chromosome (Nucleoid)	1L
2.5	Cell wall structure: Peptidoglycan Structure, Gram-Positive and Gram-Negative Cell Walls, Lipopolysaccharide layer, Functions of the cell wall.	2L
2.6	Components external to cell wall- capsule, slime layer, flagella, fimbriae and pili Tactic Responses (Definitions)	3L
2.7	Bacterial endospores – structure and significance, stages in endospore formation.	1L

3	**Microbial Nutrition, Cultivation and Isolation: 12** **Learning Objectives:** 1) To categorize the nutrients required for growth of microorganisms. 2) To describe the utilization of growth factors. 3) To tabulate different nutritional types of microorganisms. 4) To state types of culture media required for microbial growth. 5) To investigate the methods to isolate microorganisms. **Learning Outcomes:** After the successful completion of the Module, the learner should be able to: 1) Describe Macronutrients and Micronutrients required for microbial growth. 2) Explain the utilization of different growth factors. 3) Present an outline in a tabulation mode to represent different nutritional types of microorganisms. 4) State different types of culture media, their features and significance. 5) Apply viable count methods to obtain a pure culture.

3.1	**Nutritional requirements:** Macronutrients and Micronutrients	1L
3.2	**Utilization of Elements:** Nitrogen, Phosphorous and sulphur Growth Factors	2L
3.3	**Nutritional types of microorganisms**	2L
3.3.a	**Characteristic features of:** **Photoautotrophs:** a) Photo organoheterotrophs b) Photolithoautotrophs	
3.3.b	**Heterotrophs:** a) Chemoheterotrophs b) Chemo organoheterotrophs c) Chemo-lithoautotrophs	
3.4	**Types of Culture media with examples:** a) Liquid and Solid media b) Selective media c) Differential media d) Enriched media e) Enrichment media	5L

3.5	**Isolation of microorganisms & pure culture techniques:** Isolation on solid media by streak plate methods- T-streak, Side streak Viable count methods: Pour plate Spread plate	2L

References:

Module I:

1. Microbiology. (2016),10th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.

2. Microbiology-An Introduction. (1998) 6th Edition. Tortora Funke and Case. Addison Weseley Longman Inc.

Module II:

1. Microbiology. (2016),10th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.

Module III:

1. Microbiology. (2016),10th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.

2. Fundamentals of Microbiology. (1974) 9th Edition. M. Frobisher. W.B. Saunders Company.

3. Microbiology. (2001) 5th Edition, Michael Pelczar. Tata Mc Graw hill Education.

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F. Y. B. Sc. (Microbiology)

Semester I - Practical

Based on Course-I: Basic Concepts of Microbiology

COURSE CODE: 18USIMBP

Credit- 01

Experiment Sr. No.	Title	Number of hours
1	Safety Precautions in a Microbiology laboratory and disposal of biological waste	02
2	Qualitative test for Carbohydrates	2.5
3	Qualitative test for Proteins and Amino acids	2.5
4	Qualitative test for Nucleic acids– DNA, RNA	2.5
5	Study of cell structures	
	a) Monochrome staining	2.5
	b) Negative staining	2.5
6	Preparation of Culture media	

	a) Liquid media (Nutrient broth)	O2
	b) Solid media (Nutrient agar, Sabouraud agar)	O2
	c) Preparation of slants, butts and plates	2.5
7.	Inoculation techniques and study of growth	
	a) Liquid medium (Nutrient broth)	O2
	b) Solid media –slants, butts and plates	O2
	c) Study of colony characteristics of bacteria on Nutrient agar	2.5
	d) Use of differential (MacConkey agar), selective (Salt Mannitol Agar) and enriched media (Superimposed Blood agar-Demonstration)	2.5

F.Y. B. Sc. (Microbiology) Semester I

Course- II

COURSE TITLE: Applied Microbiology

COURSE CODE: 18US1MB2

[CREDITS - 02]

Course Outcomes: After the successful completion of the course, the learner should be able to:

1) State the basic concepts of Microbiology.
2) Perform the basic techniques in Microbiology.

Course Specific Outcomes:

After successful completion of the Course, the learner should be able to:

1) Apply the basic principles of Microscopy and staining to observe bacterial cells.
2) Cultivate yeasts, fungi, molds and algae at laboratory level.
3) Recognize the economic significance of yeasts, fungi, molds and algae.
4) Control the growth of microorganisms by applying an appropriate physical or a chemical method.

Module	Title and Content	No. of Lectures
1	**Microscopy:**	12

Learning Objectives:

1) To define the basic terms related to Microscopy.
2) To explore parts of Bright-field Microscope and their functions.
3) To analyse the significance of Resolution and Numerical aperture.
4) To state the principle and brief working of Phase-contrast Microscope and Differential Interference Contrast Microscope.
5) To describe basic concepts of staining.

Learning Outcomes: After the successful completion of the Module the learner should be able to:

1) Define the basic terms related to Microscopy.
2) Draw and label the parts of Bright-field Microscope.
3) Analyse the significance of Resolution and numerical aperture in Microscopy.
4) Describe principle and working of Phase-contrast Microscope and Differential Interference Contrast Microscope.
5) Apply the principles of staining in experiments to study cytology of a bacterial cell.

1.1	**Basic Terminology of Microscopy:** **Terms:** Focal length Refraction, Reflection and Magnification **The Light Microscope:** Components; their features and functions Descriptions of Resolution and Numerical aperture	5L
1.2	**Introduction to the Principle and brief working of:** a) Dark Field Microscope b) Phase Contrast Microscope c) Differential interference contrast Microscope	2L
1.3	**Staining of Specimens:** a) Fixation. b) Dyes and Simple staining c) Differential staining	5L

2	**Eukaryotic Cell Structure and Function:**	12

Learning Objectives:

1) To differentiate between prokaryotes and eukaryotic cells.
2) To list the morphological characteristics of yeasts, fungi, molds and algae.
3) To state the economic significance of yeasts, fungi, molds and algae.
4) To describe the cultivation and reproduction of yeasts, fungi, molds and algae.
5) To obtain an introductory account of features of protozoa.

Learning Outcomes: After the successful completion of the module, the learner should be able to:

1) List the morphological features of yeasts, fungi, molds and algae.
2) Compare and contrast between sexual and asexual methods of reproduction in fungi.
3) Explore the economic importance of yeasts, fungi, molds and algae.
4) Perform experiments to cultivate bacteria and fungi using suitable media at laboratory level.
5) Describe the characteristics of yeasts, fungi, molds, algae and protozoa.

2.1	**Difference between Prokaryotes and Eukaryotes** -Tabulation	1L
2.2	**Classification, Morphological characteristics, Cultivation, reproduction and economic significance of:** a) Yeasts, fungi and Molds.	3L
	b) Life cycle of *Saccharomyces cerevisiae, Schizosaccharomyces* and *Rhizopus stolonifera*	2L
	c) Algae and life cycle of *Chlamydomonas*	4L
2.3	**Introduction to Protozoa**	2L

3	**Control of Microorganisms:**	12

Learning Objectives:

1) To define the basic terminology related to antimicrobial techniques.
2) To explore the physical and chemical methods of controlling microbial growth.
3) To evaluate the effectiveness of the antimicrobial agent.

Learning Outcomes: After the successful completion of the Module, the learner should be able to:

1) Define the terms related to control of microbial growth.
2) Analyse the different methods to control microbial growth.
3) Differentiate between the concepts of bacteriostatic and bactericidal agents.
4) Implement the different physical and chemical methods at laboratory level and domestic level to control microbial growth.
5) Evaluate the effectiveness of the antimicrobial agent by a suitable laboratory technique.

3.1	**Basic Terminology:** Definition; Conditions influencing the effectiveness of antimicrobial agents	1L
3.2	**Physical methods of microbial control. Mode of action of:** a) Heat: Moist & dry b) Low temperature c) Filtration d) High pressure e) Radiation f) Desiccation g) Osmotic Pressure	5L
3.3	**Chemical methods of microbial control: Mode of action of:** a) Phenolics b) Biguanides (Chlorhexidine) c) Alcohols d) Halogens e) Heavy metals f) Quaternary ammonium compounds g) Surface active agents h) Aldehydes i) Sterilizing Gases j) Peroxygens	5L
3.4	**Evaluation of Effectiveness of Chemical Antimicrobial Agents:** Phenol co-efficient	1L

References:

Module I:

1. Microbiology. (2016),10th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.

2. Fundamental Principles of Bacteriology. (1984) A.J. Salle. Tata McGraw-Hill Education.

3. Microbiology-An Introduction. (1998) 6th Edition. Tortora Funke and Case. Addison Weseley Longman Inc.

Module II:

1. Microbiology. (2001) 5th Edition, Michael Pelczar. Tata Mc Graw hill Education.

Module III:

1. Microbiology. (2005),6th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.

F. Y. B. Sc. (Microbiology)

Semester I - Practical

Based on Course-II: Applied Microbiology

COURSE CODE: Based on 18USIMBP

Credit-01

Experiment Sr. No.	Title and Number of credits	Number of hours
1	Care of Microscope.	01
2	Study of Compound Light Microscope	2.5
3	Differential staining-Gram staining	2.5
4	Physical methods of control of microorganisms	2.5
	a) Heat: Autoclaving Fractional sterilization, dry heat	01
	b) Bacteria Proof Filtration (Demonstration of membrane filtration)	2.5
	c) Effect of UV rays (Demonstration)	2.5

	d) Effect of Desiccation	01
5	Evaluation of a disinfectant by paper disc diffusion method (Phenolics as a representative example)	02
6	Effect of soap as a disinfectant	01
7	Study of oligodynamic action	01
8	Effect of storage of water in copper vessel group experiment)	01
9	Cultivation of yeasts and molds	01
	a) Cultivation on Sabouraud agar	01
	b) Fungal wet mounts and study of morphological characteristics	2.5
10	Cultivation and Permanent slides of:	
	a) Blue-green algae	2.5
	b) Protozoa	2.5

Evaluation Pattern: Theory

External Evaluation – Semester End Examination (60 M)- Duration: 2 hours

Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	30	20
2	II	30	20
3	III	30	20

Internal Evaluation - (40 M)

Probable options which could be incorporated:

1) Plickers
2) Testmoz
3) Moodle
4) Google Form
5) Objective-MCQ test
6) Short answer test

F.Y. B. Sc. (Microbiology) Semester II

Course- I

COURSE TITLE: Fundamentals of Microbiology

COURSE CODE: 18US2MBI

[CREDITS - 02]

Course Outcomes: After the successful completion of the course, the learner should be able to:

1) State the basic concepts of Microbiology.
2) Perform the basic techniques in Microbiology.

Course Specific Outcomes: After the successful completion of the course, the learner should be able to:

1) Cultivate microorganisms by use of proper conditions.
2) Monitor the growth of microorganisms.
3) Enumerate microorganisms by different techniques
4) Compare and contrast between TEM and SEM.
5) Evaluate different cellular structures by specific staining methods.
6) Implement specimen preparation steps for advanced microscopic techniques.
7) Correlate the different advanced microscopic techniques.
8) Investigate the general characteristics and significance of viruses, *Rickettsia, Chlamydia,* Actinomycetes and Archaebacteria.

Module	Title and content	No. of Lectures
1	**Microbial Growth:** **Learning Objectives:** 1) To define the concept of microbial growth. 2) To analyse the basic growth kinetics. 3) To measure the growth of microorganisms. 4) To regulate the growth of microorganisms by controlling different environmental factors. **Learning Outcomes:** After the successful completion of the Module, the learner should be able to: 1) Determine the growth rate of microorganisms. 2) Analyse the microbial growth by direct and indirect methods. 3) Differentiate between viable and non-viable count methods. 4) Evaluate the influence of different environmental factors on growth.	12

1.1	**Basic growth Terminology:** Definition of growth, growth curve, give mathematical formulas	2L
1.2	**Measurement of growth:** a) Direct microscopic count, Haemocytometer b) Measurement of cell mass; growth yield c)Turbidity measurements - Nephelometric and Spectrophotometric techniques	4L
1.3	**Influence of environmental factors on growth:** a) pH b) Temperature c) Aeration	6L

2	**Advanced Microscopy:**	12

Learning Objectives:

1) To list different versions of Advanced Microscopy.
2) To state the principle of Fluorescence microscopy, TEM and SEM.
3) To describe the basic working of Fluorescence microscopy, TEM and SEM.
4) To introduce the newer techniques such as Confocal Microscopy, Scanning Probe, Scanning Tunnelling and Atomic Force Microscopy techniques.
5) To describe the steps of specimen preparation for different microscopic methods.
6) To state the principle and represent an outline of different staining methods for specific cellular structures.

Learning Outcomes: After the successful completion of the Module, the learner should be able to:

1) Compare and contrast between different advanced microscopic methods.
2) Analyse the significance of the newer techniques such as Confocal Microscopy, Scanning Probe, Scanning Tunnelling and Atomic Force Microscopy techniques.
3) Implement the steps of specimen preparation for different microscopic methods.
4) Incorporate the methods of staining of specific cellular structures to study cytology.

2.1	**Principle and working of:** Fluorescence Microscope	1L
2.2	**Specimen Preparation** in: Transmission Electron Microscope-TEM Scanning Electron Microscope- SEM Negative Staining, shadowing with metals, Freeze etching	3L
2.3	**The Electron Microscope:** Transmission Electron Microscope-TEM Scanning Electron Microscope- SEM	2L
2.4	**Newer techniques in Microscopy**: Confocal Microscopy Scanning probe Microscopy (Examples-The Scanning Tunnelling Microscope, The Atomic Force Microscope)	2L
2.5	**Staining of specific cellular structures:** Cell-wall, Capsule, Endospore, Metachromatic and Lipid granules, Flagella, Spirochete.	4L

3	Study of Viruses, *Rickettsia*, *Chlamydia*, Actinomycetes and Archaebacteria: 12 **Learning Objectives:** 1) To understand the characteristics of viruses in general and bacteriophages in particular. 2) To be introduced to the general characteristics and significance of *Rickettsia*, *Chlamydia*, Actinomycetes and Archaebacteria. **Learning Outcomes:** After the successful completion of the module, the learner should be able to: 1) Describe the structural features of viruses. 2) List the methods for cultivation of viruses. 3) Describe the lytic cycle of T even phages. 4) Explain concepts in lysogeny. 5) Differentiate between the general characteristics and significance of *Rickettsia* and *Chlamydia*. 6) Describe the general characteristics and significance of Actinomycetes. 7) Recognise the distinguishing characteristics of Archaebacteria. .

3.1	**Viruses:** General characteristics and structure, viral cultivation, Lytic cycle, and Lysogeny-definition with example	7L
3.2	***Rickettsia*** **and** ***Chlamydia*****:** General characteristics, diseases and vectors	2L
3.3	**Actinomycetes:** General Characteristics and Significance	2L
3.4	**Introduction to Archaebacteria**	1L

References:

Module I:

1. Microbiology. (2016),10th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.

2. General Microbiology. (2007) 5th Edition, R. Y. Stainier, J. Ingraham, M. Wheelis and P.R. Painter. Prentice Hall. New Jersey.

3. Microbiology-An Introduction. (1998) 6th Edition. Tortora Funke and Case. Addison Weseley Longman Inc.

4. Fundamentals of Microbiology. (1974) 9th Edition. M. Frobisher. W.B. Saunders Company.

5. Fundamental Principles of Bacteriology. (1984) A.J. Salle. Tata McGraw-Hill Education.

6. Microbiology. (2001) 5th Edition, Michael Pelczar. Tata Mc Graw hill Education.

Module II:

1. Microbiology. (2016),10th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.

2. Microbiology-An Introduction. (1998) 6th Edition. Tortora Funke and Case. Addison Weseley Longman Inc.

3. Fundamental Principles of Bacteriology. (1984) A.J. Salle. Tata McGraw-Hill Education.

Module III:

1. Microbiology. (2016),10th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.

2. Microbiology. (2001) 5th Edition, Michael Pelczar. Tata Mc Graw hill Education.

F. Y. B. Sc. (Microbiology)

Semester II – Practical

Based om Course-I: Fundamentals of Microbiology

COURSE CODE: Based on 18US2MBP

Credit-01

Experiment Sr. No.	Title	Number of hours
1	Special Staining techniques	
	a) Cell wall staining	2.5
	b) Capsule staining	2.5
	c) Metachromatic staining	2.5
	d) Staining of lipid granules	2.5
	e) Staining of Endospore	2.5
	f) Flagella staining, (Demonstration)	2.5
2	Study of motility (Hanging drop preparation)	2.5

3	Determination of optimum growth conditions	
	a) Temperature	O2
	b) pH	2.5
4	Measurement of microbial growth	2.5
	a) Preparation of opacity tubes and determination of cell count	O1
	b) Growth curve of *E. coli* and determination of generation time (group experiment)	O2
5	Enrichment and isolation of coliphage from sewage. (Demonstration)	2.5

F.Y. B. Sc. (Microbiology) Semester II

Course- II

COURSE TITLE: Introduction to Environmental and Industrial Microbiology

COURSE CODE: 18US2MB2

[CREDITS - 02]

Course Outcomes: After the successful completion of the course, the learner should be able to:

1) State the basic concepts of Microbiology.
2) Perform the basic techniques in Microbiology.

Course Specific Outcomes: After the successful completion of the course, the learner should be able to:

1) Determine the quality of air with respect to the content of microorganisms.
2) Describe the microenvironment of the soil and their significance.
3) Give an outline of different microbial interactions.
4) Describe the microbiology of fresh water.
5) Represent the methods for water quality analysis and treatment of waste-water.
6) Compare and contrast between primary and secondary screening methods.
7) State the different microbial products from industrial processes.
8) Implement different methods for preservation of microorganisms.

Module	Title and Content	No. of Lectures
1	**Microorganisms in Air and Soil:** **Learning Objectives:** 1) To list and describe different techniques to enumerate microbes in air. 2) To describe the microenvironment of a soil. 3) To analyse the different microbial interactions. 4) To describe the characteristics of different microbial associations with vascular plants. **Learning Outcomes: After the successful completion of the module the learner should be able to:** 1) Quantify the microbial content of air. 2) Differentiate between different microorganisms in soil. 3) Analyse the ecological significance of different microbial interactions. 4) Describe the salient features of the associations of microbes with vascular plants.	12

1.1	**Air Microbiology:** a) Types and significance of organisms b) Techniques to enumerate air microflora	4L
1.2	**Microorganisms in Terrestrial environment.** Soil as an environment and its diversity	1L
1.3	**Types of Microbial interactions (concept and one example of each):** a) Mutualism b) Co-operation c) Commensalism d) predation e) Parasitism f) Amensalism g) Competition	3L
1.4	**Microbial Association with vascular plants:** a) Phyllosphere b) Rhizosphere c) Mycorrhizae d) Fungal and bacterial endophytes	4L

2	**Microorganisms in Water and Waste water:**	12

Learning Objectives:

1) To characterise water as a habitat.
2) To describe the method of water purification.
3) To analyse the quality of water.
4) To treat waste-water by different methods.

Learning Outcomes: After the successful completion of the module, the learner should be able to:

1) Cite the characteristics of water as a habitat.
2) State the different sources of water.
3) Analyse the methods for water purification.
4) Describe the steps for methods of water analysis.
5) Determine the quality of water, as per the standards.
6) Substantiate the method and steps for waste-water treatment.

2.1	**Fresh water Microbiology:** a) Water as a microbial habitat b) Nutrient cycling c) Fresh water environment 1.Glaciers and permanently frozen lakes 2.Streams and rivers 3.Lakes	5L
2.2	**Water purification and sanitary analysis:** Description of the method	3L
2.3	**Waste water microbiology:** a) Measurement of waste water quality. b) Waste water treatment: Description of the method	4L

3	**Industrial Microbiology:**	12

Learning Objectives:

1) To describe different microbial products obtained from industrial productions.
2) To illustrate the steps of primary and secondary screening.
3) To describe the basic design of a fermenter.
4) To list and describe the different methods of preservation of microorganisms.

Learning Outcomes: After the successful completion of the module, the learner should be able to:

1) State the significance of industrial processes and describe the different microbial products.
2) Recall the steps of primary and secondary screening.
3) Illustrate the components of a fermenter and state their function.
4) List and describe the different methods of preservation of microorganisms.

3.1	**Introduction to Industrial Microbiology** Microbial products in the field of Medicine, agriculture, chemicals, solvents, Enzymes, Food, Beverages etc. Prerequisites of an Industrial microbial process with respect to: The organism The medium The fermentation process Basic parts of a fermentation process (Upstream processing, Fermentation proper, Downstream processing)	4L
3.2	**Screening Methods for Industrially important strains** Primary screening: Crowded plate technique Secondary screening	3L
3.3	**Basic Fermenter design** Considerations in the design of a fermenter Study of different parts of a fermenter Types of fermenter based on size	2L
3.4	**Preservation of microorganisms** Aim of preservation	3L

	Methods of preservation: (Principle, Method, Advantages, limitations) Serial Subculture method Mineral oil Overlay Lyophilization Storage under liquid nitrogen Soil stock method	

References:

Module I:

1.Fundamental Principles of Bacteriology. (1984) A.J. Salle. Tata McGraw-Hill Education.

2. Microbiology. (2016),10th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.

Module II:

1. Microbiology. (2016),10th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.

2. Microbiology. (2001) 5th Edition, Michael Pelczar. Tata Mc Graw hill Education.

3. Fundamentals of Microbiology. (1974) 9th Edition. M. Frobisher. W.B. Saunders Company.

4. Microbiology-An Introduction. (1998) 6th Edition. Tortora Funke and Case. Addison Weseley Longman Inc.

5. Fundamental Principles of Bacteriology. (1984) A.J. Salle. Tata McGraw-Hill Education.

Module III:

1. Industrial Microbiology. (1984) A H Patel. MacMillan. New Delhi.

2. Principles of Fermentation Technology. (1997) 2nd Edition. Stanbury P. F., Whitaker A. & Hall--S. J. Aditya Books Pvt. Ltd, New Delhi.

3. Fermentation Technology. (2009). Volume I and II. H. A. Modi. Pointer Publication, Jaipur.

F. Y. B. Sc. (Microbiology)

Semester II - Practical

Based on Course-II: Introduction to Environmental and Industrial Microbiology

COURSE CODE: 18US2MBP

Credit-01

Experiment Sr. No.	Title and Number of credits	Number of hours
1	Study of air microflora and determination of sedimentation rate.	5
2	Isolation of antibiotic producer by crowded plate technique.	5
3	Study of Winogradsky's Column.	5
4	Bacteriological analysis of water	5
5	Preservation of microorganisms	
	a) Preservation by mineral oil overlay	5
	b) Preservation by soil stock method	2.5
	c) Preservation by Glycerol stock method	2.5

Evaluation Pattern: Theory

External Evaluation – Semester End Examination (60 M)- Duration: 2 hours

Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	30	20
2	II	30	20
3	III	30	20

Internal Evaluation - (40 M)

Probable options which could be incorporated:

1) Plickers
2) Testmoz
3) Moodle
4) Google Form
5) Objective-MCQ test
6) Short answer test