Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

Structure of syllabus

B. Sc. [Microbiology]

F. Y. B. Sc.

Choice Based Credit System (CBCS)

With effect from June

[2022 - 23]

C-1 A: Paper I (Section A)

MB 101: Microbial History, Diversity and Taxonomy (Theory)

Total Hours **30 Credits: 2**

Unit	Title	Topic Particular	Lectures
Course Objective	To complement the students with the basic knowledge about microbial growth and microscopy		
Course Outcome (CO)	After successful completion of this course students are expected to: ▪ Understand the basic microbial structure and study the comparative characteristics of prokaryotes and eukaryotes and also Understand the structural similarities and differences among various physiological groups of bacteria/archaea ▪ Know general bacteriology and microbial aspects pertinent to bacteria, fungi and algae ▪ How the subject emerged as new branch of biology ▪ Learn ancient view about life continuity and concept of experiment ▪ Aware about historical developments and their applications as technology ▪ Cognizant about contribution of various pioneers of microbiology ▪ Aware about diversity of microorganism ▪ Study impact of microbes on earth atmosphere, health and technology development ▪ Recognize the scope of microbiology in all spheres of life and industrial sector ▪ Analyze the ways to classify the living system ▪ Understand the taxonomy (identification, binomial nomenclature, and Classification schemes/keys) and comprehend the various approaches of microbial taxonomy.		

UNIT-I	Historical developments and Scope of Microbiology -	▪ Spontaneous generation (abiogenesis) – Concept and experimental evidences to prove it ▪ Concept of Prokaryotic (Microorganisms) and Eukaryotic cells ▪ Discovery of Microscope ▪ Germ theory of Fermentation ▪ Germ theory of Disease: Koch's and Revere's postulate ▪ Development of pure culture methods and preparation of Decimal Dilution, solidifying agent (potato, gelatin, agar agar) ▪ Contribution(s) of the following scientists in the development of microbiology Antonie von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman, Paul Ehrlich, Elie Metchnikoff, Edward Jenner ▪ Development and scope of microbiology in the following disciplines - ▪ Soil microbiology, Geomicrobiology, Microbial Ecology, Food and Agricultural Microbiology, Immunology, Medical Microbiology, Pharmaceutical Microbiology, Chemotherapy and Molecular Biology, Industrial Microbiology, Nano-technology and Bioinformatics, etc.	10
Unit-II	Microbial Diversity	▪ Concept of microbial diversity, ecology and its importance and ecological interactions ▪ General characteristics, Morphological features and Significance of - Viruses, Virion and Prions Bacteria (Eubacteria, Rickettsia, Mycoplasma, Actimomycetes), Archaebacteria, Cyanobacteria ▪ Algae, ▪ Fungi and ▪ Protozoa	10
Unit III	Microbial Taxonomy	▪ Whitakers' Five Kingdom system ▪ Carl Woese's three Domain system ▪ Binomial Nomenclature and basic rules ▪ Methods in microbial taxonomy: Cultural, Biochemical and molecular characteristics-Ribotyping, G=C ratio ▪ Numerical taxonomy and Chemotaxonomy ▪ Bergey's System of Bacterial Classification: structure, scheme and overview ▪ Introduction to classification of algae, fungi and	10

Suggested readings
1) Tortora GJ, Funke BR and Case CL (2008). Microbiology: An Introduction, 9th edition, Pearson Education, New Delhi
2) Talaro K and Chess B (2012) Foundations in Microbiology, 8th edition, The McGraw-Hill Companies, Inc., New York
3) Tortora, Funke, and Case (2010) Microbiology, 10th edition, Brenjamin Cummings Inc., California.
4) Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2016). Foundations in Microbiology, 9 th edition, Nirali Prakashan, Pune
5) Frobisher M. Hinsdill, Crabtree, and Goodheart, (1974). Fundamentals of Microbiology, 9th edition, WB Saunder's Co., USA.

CC-1 A: Paper II (Section B)

MB 102: Microscopy and Basic Bacteriology (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Topic Particular	Lectures
Course Objectiv	To complement the students with the basic knowledge about microbial growth and microscopy		
Course Outcome (CO)	After successful completion of this course students are expected to - ▪ Demonstrate theory in microscopy and their handling techniques and staining procedures ▪ Know various culture media and their applications and also understand various physical and chemical means of sterilization ▪ Know general bacteriology and microbial techniques for isolation of pure cultures of bacteria, fungi and algae ▪ Learn aseptic techniques and be able to perform routine culture handling tasks safely and effectively ▪ Comprehend the various methods for identification of unknown microorganisms ▪ Understand the modes of nutrition in microbial metabolism and able to classify the bacteria based on nutrition ▪ Know the various Physical and Chemical growth requirements of bacteria and get equipped with various methods of bacterial growth measurement.		
UNIT-I	Microscopy and Staining	▪ Basics of Microscopy: Magnification, Resolution, Numerical Aperture ▪ Compound Microscope: Construction, Working Principle with Ray diagram ▪ Concept of Bright field and Dark filed Microscope ▪ Aberrations: Concept and types ▪ Oil immersion objective ▪ Concept of stain (Acidic and Basic) ▪ Smear preparation, Mordant and fixative ▪ Methods of staining: Simple (Monochrome and Negative) and Differential (Gram's and Acid fast)	10

Unit-II	Growth and Reproduction of Bacteria	▪ Concept of Growth and Reproduction, Mechanism of binary fission, Fragmentation, budding ▪ Mathematical expression for Growth, Growth rate and Generation time (Illustration with problem). ▪ Typical growth curve of bacterial population and its significance ▪ Batch culture, Diauxic growth ▪ Quantitative measurement of bacterial growth ▪ Synchronous and Continuous Growth Culture with applications in microbiology	10
Unit III	Cultivation of Bacteria	▪ Physical parameters: Effect of pH, temperature, water activity, Oxygen on growth and cultivation ▪ Types of bacteria, mode of their adaptations w.r.t. a) Temperature requirement (psychrophiles, b) mesophiles, thermophiles, thermodurics, psychrotrophs), c) pH requirement (acidophiles, alkaliphiles), d) Salt/solute and water activity (halophiles, xerophiles, osmophilic), e) Oxygen requirement (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), f) Pressure (barophile). ▪ Media ingredients (water, peptone, malt extract, meat extract, yeast extract, trace elements, growth factor) ▪ Types of media: complex, synthetic, selective, differential, enriched media ▪ Enrichment culture technique ▪ Concept Auxotroph and Prototroph ▪ Classification of bacteria based on nutrition: Phototroph (Phto-autotroph, Photo-heterotroph) and chemotroph (Chemo-autotroph, Chemo- heterotroph)	10

Suggested readings

1) Wiley, JM, Sherwood, LM and Woolverton, CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International, New York
2) Frobisher M. Hinsdill, Crabtree and Goodheart (1974). Fundamentals of Microbiology, 9th edition, WB Saunder's Co. USA.
3) Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms, 14th edition, Pearson International Edition, New Delhi
4) Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company, New York
5) Tortora, Funke and Case (2010). Microbiology, 10th edition, Brenjamin Cummings Inc, California.
6) Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2016). Foundations in Microbiology 9th edition, Nirali Prakashan, Pune
7) Modi, H. A. (2014) Elementary Microbiology, Vol. 1 and 2, Akshar Prakashan, Ahmedabad

CC-1 A: Practical Paper I

MB 103: Microbiology Practical Paper - I (Practical)

Total Hours: 60 **Credits: 2**

Sr. No.	Title of the Practical	Hours
Course objectives	To introduce various microorganisms present in the ecosystem and acquaint with common equipment used in routine microbiology laboratory	
Course outcomes (CO)	After successful completion of this course students are expected to: Inculcate the ability to apply the process of science ▪ Demonstrate ability to formulate hypotheses and design experiments based on the scientific method. ▪ To analyse and interpret results from a variety of microbiological methods and apply these methods to analogous situations. ▪ Develop ability to use quantitative reasoning to solve problems in microbiology ▪ Communicate and collaborate with other disciplines ▪ To effectively communicate fundamental concepts of microbiology in written and oral format. ▪ To identify credible scientific sources and interpret and evaluate the information therein. ▪ Understand the relationship between science and society ▪ Demonstrate theory and practical skills in microscopy and their handling techniques and staining procedures ▪ Understand the basic microbial practices and study the comparative characteristics of prokaryotes and eukaryotes ▪ Comprehend the various methods for identification of microorganisms adopted in Bergey's Manual and able to classify the bacteria ▪ Know the various Physical growth requirements of bacteria ▪ Prepare and view specimens under bright field microscope. ▪ Aware and train in aseptic handling of microbial specimens. Practice safe microbiology, using appropriate protective and emergency procedures. ▪ Use appropriate microbiological and molecular lab equipment and methods. ▪ Document and report experimental protocols, results and conclusions	
1	Microbiology Good Laboratory practices and Biosafety	4
2	To study the principle, working and application of instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, pH meter, colorimeter) used in the microbiology laboratory	4
3	Acquainting basic microbiology tools: Cleaning and washing of Glassware, Wrapping the items prior to sterilization, Cotton Plugging, Aseptic handling (LAF/Bunsen burner), Inoculation of bacterial culture and inoculating needle, Microbial culture and biological waste Disposal	4
4	Use and Care of Compound Microscope with functions of each par	4
5	Study of fungi using temporary mounts and permanent slides (e.g. *Rhizopus*/ *Penicillium* /*Aspergillus*/ *Fusarium*)	4
6	Study of Algae/BGA temporary mounts and permanent slides (e,g. *Spirogyra* /*Anabaena* / *Nostoc*/ Cyanobacteria)	4
7	Study of the protozoans using temporary and permanent mounts (e.g. *Amoeba/Entamoeba/ Paramecium / Plasmodium*)	4
8	Preparation of culture media for bacterial cultivation.(Nutrient broth and nutrient agar/ MacConky's broth and MacConky's agar	4
9	Study of colony characteristics of different bacteria (e.g. *Escherichia coli*, *Staphylococcus aurous*, *Actinomycetes*)	4
10	Study of bacterial morphology using Monochrome staining	4

11	Study of morphological features of bacteria using Negative Staining	4
12	Study of Gram characteristics of bacteria using Gram's staining	4
13	Study of acid fast characteristics of bacteria using Acid fast staining (*Nocardia* spp./ Atypical mycobacteria)	4
14	Effect of pH and temperature on growth of bacteria	4
15	Demonstration of bacterial growth by spectrophotometer	4

CC 1 A: Paper II (Section A)

MB 201: Basic Biochemistry and Cytology (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Topic Particular	Lectures
Course objective	To complement the students with cultivation and control of microbe with physical and chemical approach		
Course outcomes	After successful completion of this course students are expected to: ▪ Understand the basic microbial structure and function and study the comparative characteristics of prokaryotes and eukaryotes and also Understand the structural architecture and differences among bacteria/archaea ▪ Know basic knowledge pertinent to cell biomolecules as such		
UNIT-I	**Biomolecules**	▪ **Proteins and amino acids -** Concept, general structure and properties of amino acids, Classification of amino acids, Classification of protein based on shape, composition, solubility and functions, Chemical bonds in protein structure (Covalent, hydrogen, hydrophobic, electrostatic, van der Waal's forces), Structural levels of protein organization: Primary, secondary, tertiary and quartnary, Protein denaturation ▪ **Carbohydrates -** Concept and properties, Classification of carbohydrates, Structure of common carbohydrates (Glucose, lactose, starch and peptidoglycan) and biological significance ▪ **Lipids -** Concept, function and classification of lipids, Fatty acids (Definition, nomenclature, saturated and unsaturated), Structure and biological significance of phospholipids and sterols ▪ **Nucleic acids -** Concept and structural constituents of Nucleic acids (nucleoside, nucleotide, polynucleotide, purines and pyrimidines. DNA: Structure (Watson and Crick Model), Chargaff's Rule, RNA: Structure and significance of: mRNA, tRNA and rRNA, hnRNA, Forms of DNA: A, B and Z (structure and differences) and unusual structures of DNA	10

Unit II	**Anatomy of Prokaryotic cell**	▪ Ultra-structure of bacterial cell. Cell size, shape and arrangement ▪ Structure, Function and Chemical Composition of the following Glycocalyx/capsule, Flagella, endoflagella, Pilli, Cell wall, sphaeroplasts, protoplasts, and L-forms ▪ Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell ▪ Nucleolus, Nucleoid Mesosomes, Plasmid, phasmid, Ribosome, ▪ Cytoplasmic inclusions (volutin granules, PHB granule, glycogen, carbohydrates, Magnetosomes, gas vesicles, carboxysomes, chlorosome and sulphur granules) and Endospore structure and formation	10
Unit III	**Anatomy of Eukaryotic cell**	▪ Ultra-structure of Fungal, Algal and Protozoal Cell ▪ Structure, Function and Chemical Composition of the following Flagella, Cell wall, Nucleus, Mitochondria, Chloroplast, Golgi bodies, Ribosome, Lysosome	10

Suggested readings

1) Black, JG. (2008) Microbiology: Principles and Explorations, 7th edition, Prentice Hall, New Jersey.

2) Madigan, MT and Martinko, JM. (2014). Brock Biology of Micro-organisms, 14th edition, Parker J. Prentice Hall International, Inc., New Jersey.

3) Stanier, RY, Ingraham, JL, Wheelis, ML and Painter, PR. (2005) General Microbiology, 5th edition, McMillan, London

4) Salle, S.J. (1974) Fundamental Principals of Bacteriology, 2nd edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

5) Willey, JM, Sherwood, LM, and Woolverton, CJ. (2013) Prescott's Microbiology, 9th edition, McGraw Hill Higher Education, New Delhi.

6) Patil, UK., Kulkarni, JS., Chaudhari, AB. and Chincholkar, SB. (2016) Foundation in Microbiology, 9th edition, Nirali Prakashan, Pune

CC 1 B: Paper II (Section B)

MB 202: Microbiological Techniques (Theory)

Total Hours: 3 **Credits: 2**

Unit	Title	Topic Particular	Lectures
Course objective	To complement the students with cultivation and control of microbe with physical and chemical approach		
Course outcomes	After successful completion of this course students are expected to: ▪ Know general bacteriology and introduce microbial techniques for isolation of pure cultures of bacteria, fungi, algae and virus ▪ Demonstrate theory and practical skills in handling microbial culture ▪ Know various bacteria based on nutritional needs and also understand various physical and chemical means of sterilization ▪ Discern knowledge about sterility assessment of sterilizing agents		
UNIT-I	Isolation and Cultivation of Microbes	▪ Pure culture technique for bacteria - Streak, Pour plate, Spread plate ▪ Cultivation of anaerobes: Roll tube method, anaerobic jar and anaerobic cabinet/chamber ▪ Cultivation of fungi, Blue green algae, algae ▪ Cultivation of animal and plant viruses (living animals, embryonated eggs and cell line cultures) , ▪ Cultivation of bacteriophage	10
Unit II	Control of Microbes-I	▪ Aseptic condition - necessity and application ▪ Concept of - Antiseptic, Sanitizer, Germicide, Antibiotics, Microbiocide, Microbiostasis ▪ Disinfection: Concept of disinfectant and characters of an ideal disinfectant ▪ Mode of action and applications of Phenol and Phenolic compounds, Alcohols, Halogens, Heavy metals and their compounds, Dyes, Detergents, Quaternary ammonium compounds, H_2O_2. ▪ Pasteurization - Concept and Methods - LTH, HTST, and UHT	10
Unit III	Control of microbes-II	▪ Concept of sterilization and parameters, TDT, TDR ▪ Physical methods: Dry heat (Hot air oven, Incineration), Moist heat (Autoclave, Tyndallisation) and Radiation- (X-rays, Gamma rays and UV rays) ▪ Sterilization by Filtration: Membrane filter, LAF (HEPA), Nucleopore filters ▪ Chemical methods - Ethylene oxide and Formaldehyde ▪ Chemical and Biological Indicators of Sterilization ▪ Validation of sterility in autoclave and LAF ▪ Control of microbes by Low Temperature, Desiccation, Osmotic pressure, Surface tension etc.	10

Suggested readings

1. Pawar, CB, & Daginawala HF. (1998) General Microbiology, Vol. I & II, Himalaya Publ., House, Mumbai.
2. Black, JG. (2008) Microbiology: Principles and Explorations, 7th edition, Prentice Hall, New Jersey.
3. Madigan, MT and Martinko, JM. (2014) Brock Biology of Micro-organisms, 14th edition, Parker J. Prentice Hall International, Inc., New Jersey.
4. Frobisher, M. Hinsdill, R., Crabtree, KT., and Goodheart, CR. (1974) Fundamentals of Microbiology, 9th edition, WB Saunder's Co., Many, USA.
5. Pelczar MJ, Chan, ECS and Krieg, NR. (1993) Microbiology. 5th edition. McGraw Hill Book Company, Penguin, USA
6. Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2016) Foundations in Microbiology, 9th edition, Nirali Prakashan, Pune.
7. Modi, H. A. (2014) Elementary Microbiology, Vol. 1 and 2, Akshar Prakashan, Ahmedabad

CC-1 A: Practical Paper I

MB 203: Microbiology Practical Paper - II (Practical)

Total Hours: 60 **Credits: 2**

Sr. No.	Title of the Practical	Hours
Course objectives	To instil practical skills about methods of isolation, characterization, control of microbes and familiarize with fundamental aspects of cellular chemistry	
Course outcomes (CO)	After successful completion of this course students are expected to: ▪ Inculcate scientific thinking: a. Student can adapt the ability to apply the process of science, demonstrate an ability to formulate hypotheses and design experiments based on the scientific method b. Analyze and interpret results from a variety of microbiological methods and apply these methods to analogous situations c. Adapt quantitative reasoning and graphing skills to solve problems in microbiology. ▪ Introduce microbiology Laboratory Skills, Perform advanced staining methods ▪ Use pure culture and selective techniques to isolate, enumerate, enrich and isolate microorganisms and to use appropriate methods to identify microorganisms (media-based) ▪ Become conversant in basic biochemical methods in microbiology ▪ Demonstrate practical skills in microscopy and their handling techniques and staining procedures ▪ Practice aseptic techniques and be able to perform routine culture handling tasks safely and effectively ▪ Understand preparation of standard solutions required in various assays.	
1	Demonstration of motility by hanging drop and swarming growth	4
2	Capsule staining	4
3	Endospore staining	4
4	Isolation of bacteria by Streak Plate technique	4
5	Isolation of bacteria by spread plate technique from water sample	4
6	Determination of Colony Forming Unit (cfu) by pour plate method from soil/water sample	4
7	Effect of heavy metal(s) on growth of bacteria and demonstration of oligodynamic action	4
8	Sterilization of heat sensitive material by membrane filtration	4

9	Evaluation of skin disinfectant (alcohol/soap/Dettol)for disinfection	
10	Study micro-flora of the air and water on nutrient agar plates	4
11	Qualitative tests for carbohydrate and lipids	4
12	Qualitative tests for amino acids and proteins	4
13	Qualitative tests for nucleic acid	
14	Slide culture technique for fungi	4
15	Preparation of standard solutions (Normal/ Molar/ Percentage)	4

Skills acquired and job prospects for the microbiology students: Microbiologists study the world of tiny entities that are too small to be seen with the naked eye. This includes bacteria, viruses, algae, fungi, and parasites. Few microbes cause infection to humans, animals, or plants, but many more contribute to beneficial nutrient cycling process in their ecological niches. Hence, microbiologists study the interaction of microorganisms with other living and nonliving world and how they affect our lives, as well as their role in the biome. Initially, more focus was given on the biology of microorganisms at both the cellular and molecular level, as well as their ecology. Now, microbiology is pervaded in all areas of life sciences, such as molecular biology, immunology and biochemistry as well as backbone of basic research, medicine, healthcare and food. Several microbiologists work in hospitals, universities, medical schools, government laboratories, and almost every industry, and array of fields from agriculture to the space industry. Accordingly, few job prospectus in microbiology are furnished below: Research assistant/fellow provides technical support to conduct research working in a team with leading scientists and work in an industrial, government, university, or medical laboratory as food, industrial or environmental microbiologists and quality assurance technologists. In industry & hospitals, microbiologists assist in quality and safety of vitamins, vaccines, antibiotics, antiseptics and identify harmful microorganisms in water, food, dairy, pharmaceutical and environmental products. Technical representatives provide information about pharmaceuticals and other medical or scientific products to prospective customers. Clinical and veterinary microbiologists, medical technologists generally work in veterinary clinics or hospitals to identify disease causing microorganisms in humans and animals. In addition, several career paths take the graduates in microbiology to a wider range of career options such as teaching in College, scientific area, science writing for the general public, public relations, or regulatory affairs. Bachelor's degree in microbiology also provides the necessary foundation to continue an education in the medical, veterinary, dental or legal fields. During the graduation in microbiology, the students acquire few skills to:

- demonstrate ability to handle a bright field light microscope to view and interpret slides
- prepare slides for microbiological examination
- transfer and handle microorganisms using aseptic techniques and instruments
- prepare microbiological media and test systems for cultivation and identification of microbes
- calibrate laboratory equipment
- acquaint with analytical and result communication with knowledge to interpret the data
- acquire laboratory safety skills and emergency procedures

Reference: ASM's curriculum recommendations: Microbiology Majors Program, www.asm.org)

Equivalence for FYBSc (Microbiology) Syllabus 2022-23:

Old Syllabus (w. e. f. June 2018-19) CBCS (Pattern 60:40)	**New Syllabus (w. e. f. June 2022-23) CBCS (Pattern 60:40)**
MB-101 : Microbial Diversity	MB-101: Microbial History, Diversity and Taxonomy
MB-102 : Microscopy and Basic Bacteriology	MB-102: Microscopy and Basic Bacteriology
MB-201 : Basic Biochemistry and Cytology	MB-201: Basic Biochemistry and Cytology
MB-202 : Microbial Techniques	MB-202: Microbiological Techniques