North Maharashtra University, Jalgaon

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

Structure of syllabus for

B. Sc. [Microbiology]

F.Y.B.Sc.

Choice Based Credit System (CBCS)

[2018-19]

F. Y. B. Sc. Microbiology (CBCS STRUCTURE)

Prelude

The cumulative demand for trained and skilled manpower in the area of Microbiology requires in depth functional knowledge of the subject through hands-on training to the students. The syllabus has been prepared keeping in view the unique requirements of B.Sc. Microbiology students under CBCS Program. The contents have been drawn to accommodate the widening horizons of the Microbiology discipline and reflects the changing needs of the students. The detailed syllabus for each paper is appended with a list of suggested readings.

The degree of Bachelor of Science in Microbiology (Choice Based Credit System) aims to introduce various aspects of Microbiology to the students. The program in Microbiology as one of the core subject is designed to cultivate a scientific attitude and interest towards the modern areas of Microbiology in particular. This will help the students to become critical and curious in their outlook. The courses are designed to impart the essential basics in Biochemistry, Chemistry, and Microbiology at the initial level of graduation. The basic courses are infused with current application in modern life sciences, and awareness on Microbiology and its influence in human life. The integration of various courses in the program is aimed to develop proficiency in the theory as well as practical experiments, common equipment, laboratory, along with the collection and interpretation and presentation of scientific data in proper manner. Beside this, the students will be equipped with knowledge in the newer areas of Microbiology and its application in medical science, agriculture, industry, proteomics, genomics, metabolomics, bioinformatics, nano-biotechnology etc. This will create zeal and zest about Microbiology which will pave a newer path for the development of society. At the end of the course, the students are expected to have good working knowledge in the field of Microbiology. Students will surely have an urge to continue higher studies in Microbiology and contribute significantly in the development.

The present syllabi is restructured anticipating the future needs of Microbiology in research, industry Sector with more emphasis on imparting hands-on skills. The core thrust is laid on making syllabus compatible with developments in Education, Research and Industrial sectors. The Theory and Practical course in new restructured course will lead to impart skill-set essentials to further microbiology.

Hence, Board of Studies in Life Sciences in its meeting held on 23/06/2018 resolved to accept the revised syllabus for F.Y.B.Sc. (Microbiology) based on Choice Based Credit System (CBCS) of UGC guidelines.

Scheme for B.Sc. program (Faculty of Science and Technology)

		First Year				Second Year				Third Year				Total Credit value
		Semester I		Semester II		Semester III		Semester IV		Semester V		Semester VI		
1	**Core courses (16)**	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	
	(i) Theory	4	4	4	4	4	3	4	3					4 X 14=56
	(ii) Practical	2	4	2	4	2	3	2	3					2 X 14=28
2	**Ability enhancement compulsory course (AECC) (2)**	2	1	2	1									2 X 2 =04
3	**Skill Enhancement Course (SEC)** (4)					2	1	2	1	2	1	2	1	2 X 4 = 16
4	**Discipline Specific Elective DSE (6)**													
	(i) Theory									4	3	4	3	4 X 6 =24
	(ii) Practical									2	3	2	3	2 X 6 =12
	Total Credit value (Credit x No. of Courses)	**26**		**26**		**20**		**20**		**20**		**20**		**132**

Course Structure:

Duration: The duration of B.Sc. (Microbiology) degree program shall be three years.

Medium of instruction: The medium of instruction for the course shall be English.

The present syllabus has been prepared to (i) accommodate the advanced topic on the Microbiology discipline, (ii) build the basic science knowledge at the level of first year of Microbiology and (iii) reflect the changing needs of the students. The detailed syllabus for each paper is appended with a list of suggested readings.

At first year of under-graduation, students are given exposure to basic science to build the foundation of advance Microbiology. For this purpose, more focus on relevant experimentation on the topics are included in practical course. In practical course, students will be trained in preparing laboratory manuals, standard operating practices and log books.

At second year under-graduation, students will be introduced to different areas necessary to form the basis of microbiology like genetics, immunology, enzymology, and bioprocess biotechnology. The relevant practicals are included to enrich their knowledge.

At third year under-graduation, six theory and three practical papers each for two semesters are included to uncover all applied areas of microbiology. The courses codes and titles for the courses are as given below: MB: Microbiology

Core Courses [CC] (12 Courses)

Semester	CC -A and B	Paper I	Paper II	Practical Paper
I	CC A I	MB101: Microbial Diversity	MB102: Microscopy and Basic Bacteriology	MB 103:Practical Paper I
II	CC A II	MB201: Basic Biochemistry and Cytology	MB202: Microbial Techniques	MB203:Practical Paper II
III	CC A III	MB301: Enzymology	MB302: Microscopy and Basic Immunology	MB303:Practical Paper III
IV	CC A IV	MB401: Basic Genetics	MB402: Industrial Microbiology	MB403:Practical Paper IV

Discipline Specific Elective [DSE] (06 Theory and 3 Practicals each semester)

	DSE	Paper I	Paper II	Microbiology Practical Paper
V	A I	MB 501: Microbial Genetics	MB 502: Molecular Biology	MB 503:Practical Paper V
	A II	MB 504: Fermentation Technology	MB 505: Industrial Biotechnology	MB 506:Practical Paper VI
	A III	MB 507: Microbial Physiology	MB 508: Microbial Metabolism	MB 509:Practical Paper VII
VI	A IV	MB 601: Medical Microbiology	MB 602: Diagnostic Microbiology	MB 603: Practical Paper VIII
	A V	MB 604: Immunology	MB 605: Pharmaceutical Microbiology	MB 606: Practical Paper IX
	A VI	MB 607: Applied Microbiology	MB 608: Environmental Microbiology	MB 609: Practical Paper X

More Options to Discipline Specific Elective

	Paper I	Paper II	Practical Paper
DSE 4	rDNA Technology I	rDNA Technology II	Practical Paper
DSE 5	Microbes in Sustainable Agriculture	Plant Pathology	Practical Paper
DSE 6	Biostatistics	Bioinformatics	Practical Paper
DSE 7	Bio-Instrumentation	Research Methodology	Practical Paper
DSE 8	Project Dissertation Course		

Skill enhancement courses (SEC) (any Four):

Student has choice to study any four courses from respective semester subject to the availability of particular course at respective college

Semester	SEC	Course Title	SEC	Course Title
III	SEC I	Microbiological Analysis of Air, Water and Soil	SEC II	Microbial Diversity Study from Ecosystem
IV	SEC III	Food Fermentation Techniques	SEC IV	Biofertilizers and Bio-pesticides
V	SEC V	Microbial Quality Control of food and pharmaceutical products	SEC VI	Epidemiology of Human Microbial Diseases
VI	SEC VII	Advanced techniques in diagnostic sciences	SEC VIII	Intellectual Property Rights

Scheme for F. Y. B. Sc. (Microbiology)

Semester	CORE COURSE				Ability Enhancement Compulsory Course (AECC)		
	DSC		Credits	Lectures		Credits	Lectures
I	DSC - 1 A: Core Course I: **Microbiology**	Paper I Paper II Practical Paper	2 2 2	30 30 60	**AECC** 1: English/Marathi/ Communication	2	60
	DSC - 2 A: Core Course II	Paper I Paper II Practical Paper	2 2 2	30 30 60			
	DSC - 3 A: Core Course III	Paper I Paper II Practical Paper	2 2 2	30 30 60			
	DSC - 4 A: Core Course IV	Paper I Paper II Practical Paper	2 2 2	30 30 60			
II	DSC - 1 B Core Course I :**Microbiology**	Paper I Paper II Practical Paper	2 2 2	30 30 60	**AECC** 2: Environmental Science	2	60
	DSC- 2 B Core Course II	Paper I Paper II Practical Paper	2 2 2	30 30 60			
	DSC- 3 B: Core Course III	Paper I Paper II Practical Paper	2 2 2	30 30 60			
	DSC- 4 B: Core Course IV	Paper I Paper II Practical Paper	2 2 2	30 30 60			

Student has choice to study three subsidiary subjects for **CC 2, CC 3 and CC 4** from such as Chemistry/ Botany/ Zoology /Geography during I, II, III and IV semester; subject to availability of particular course at respective college.

Duration of Lecture: 30 Lectures of 60 minutes or 36 Lectures of 50 min. Each theory and practical course has to complete in 30 and 60 lectures, respectively of 60 min duration,

Each theory and practical course will be of 100 marks comprising of 40 marks internal (20 marks of 2 internal examinations) and 60 marks external examination.

- **Theory examination** (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each). The pattern of question papers shall be:
  - **Question 1** (12 marks): 9 sub-questions, each of 2 marks; answerable in 2 -3 line and based on entire syllabus, attempt any 6 out of 9 questions.
  - **Question 2, 3 and 4** (12 marks each): based from Unit I, II, and III, respectively, each question has 3 sub-questions of 6 marks each and answer only 2 sub-questions from each Q2, Q3, and Q4 in brief.
  - **Question 5** (12 marks): answer only 3 out of 5 in brief, based from all 3 units, Each 4 marks.

- **Internal examination** (40 marks each semester): Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions.
- **Practical Examination**: Practical examination shall be conducted by the respective college at the end of the semester. Practical examination will be of minimum 5 – 6 hours duration and shall be conducted as per schedule (10 am to 5 pm on schedule date or can be scheduled 10 am -1pm/ 2 – 5 pm for 2 consecutive days) in case of microbiology practicals where incubation condition, allied aspect are essential. There shall be 5 marks for laboratory log book and well written journal, 10 marks for viva-voce and minimum three experiments (major and minor). Certified journal is compulsory to appear for practical examination. There shall be one expert and two examiners (external and internal) per batch for the practical examination

Equivalence for F.Y. B.Sc. (Microbiology) is furnished in the following table:

Old Syllabus (w. e f. June 2015 - 2016) (Semester pattern 60:40)	**New Syllabus (w. e. f. June 2018 -19) CBCS pattern (Semester pattern 60:40)**
MB-111: Elementary Microbiology	MB -101 : Microbial Diversity
MB-112 : Microscopy and Basic Biochemistry	MB -102 : Microscopy and Basic Bacteriology
MB-121 :Cell Biology of Microorganism	MB -201 : Basic Biochemistry and Cytology
MB-122 : Methods in Microbiology	MB -202 : Microbial Techniques

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

Semester	CC -A and B	Paper code	Paper I	Paper code	Paper II	Paper code	Microbiology Practical Paper
I	CC A I	MB 101	Microbial Diversity	MB 102	Microscopy and Basic Bacteriology	MB 103	Practical paper I
II	CC A II	MB 201	Basic Biochemistry and Cytology	MB 202	Microbial Techniques	MB 203	Practical paper II

C-1 A: Paper I (Section A)
MB 101: Microbial Diversity (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Topic Particular	Lectures
Course objective	**To acquaint students with basic concepts of microbial diversity and how the microbe concept emerged**		
Learning outcome	**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 emerge 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** ▪ **Impact of microbes on earth atmosphere, health and technology development** ▪ **Recognise the scope of microbiology in all spheres of life and industrial sector** ▪ **Ways to classify the living system** ▪ **Understand the taxonomy (identification, binomial nomenclature, and Classifications schemes/keys) and comprehend the various approaches of microbial taxonomy.**		
Unit I	**Historical developments and Scope of Microbiology**	▪ Concept of Spontaneous generation (abiogenesis) and biogenesis. ▪ Concept of Microorganisms, prokaryotic and eukaryotic cell ▪ 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, gelatine, agar agar) ▪ Contribution(s) of: 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	**10**

		in the development of microbiology ▪ Development and scope of microbiology in: Soil microbiology, Geomicrobiology, Microbial Ecology, Food and Agricultural Microbiology, Immunology, Molecular Biology, Industrial Microbiology, Pharmaceutical Microbiology, Chemotherapy and Health, Nano-technology and Bioinformatics, etc.	
Unit II	**Microbial Diversity**	▪ Concept of microbial diversity, ecology and its importance and ecological interactions ▪ General characteristics, Morphological features and Significance: • Viruses, Virion and Prions • Bacteria (Eubacteria, Rickettsia, Mycoplasma, Actimomycetes,) and wall less bacteria, Cyanobacteria, • Archae, • 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, Numerical taxonomy and Chemotaxanomy ▪ Bergey's System of Bacterial Classification: structure, scheme and overview ▪ Introduction to classification of algae, fungi and viruses	**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, 9th 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 objective	To complement the students with the basic knowledge about microbial growth and microscopy		
Learning outcome	**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.**		
I	**Microscopy and Staining**	▪ Basics of Microscopy: Magnification, Resolution, Numerical Aperture, Illumination system. ▪ Compound Microscope: Principle with Ray diagram, Working and Significance of Bright field and Dark filed Microscope ▪ Concept and types of aberrations, correction for aberrations ▪ Oil immersion objective ▪ Dyes and Stains (Acidic and Basic) ▪ Mordant and fixative ▪ Methods of staining: Simple (Monochrome and Negative) and Differential (Gram and Acid fast)	**10**
Unit II	**Growth and Reproduction of Bacteria**	▪ Concept of Growth and Reproduction, Mechanism of binary fission, Fragmentation, budding ▪ Mathematical expression of Growth, Growth rate and Generation time (Illustration with problem). ▪ Batch culture, typical growth curve of bacterial population and its significance, Diauxic growth ▪ Quantitative measurement of bacterial growth ▪ Synchronous and continuous culture growth with applications in microbiology	**10**
Unit III	**Cultivation of Bacteria**	▪ Physical parameters: pH, temperature, water activity, Oxygen ▪ Types of bacteria, mode of their adaptations with respect to o Temperature requirement (psychrophiles, mesophiles, thermophiles, thermodurics, psychrotrophs),	**10**

		○ pH requirement (acidophiles, alkaliphiles), ○ Salt/solute and water activity (halophiles, xerophiles, osmophilic), ○ Oxygen requirement (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), ○ Pressure (barophile). ▪ Nutrition: C, N, S, P, salts, growth factors etc. requirements with their significance. ▪ Media ingredients (water, peptone, malt extract, meat extract, yeast extract, trace elements, growth factor) ▪ Types of media: complex, synthetic, natural, 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)	
	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 objective	**To introduce various microorganisms present in the ecosystem and acquaint with common equipment used in routine microbiology laboratory**	
Learning outcome	**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.** ○ **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** ○ **Effectively communicate fundamental concepts of microbiology in written and oral format.** ○ **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 using microscopy (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 on 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, light microscope, pH meter) 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 part	**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 /Anabena / 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/ MacConkeys broth and MacConkes agar	**4**
9.	▪ Study of colony characteristics of different bacteria (e.g. *Escherichia coli, Staphylococcus aurous, Actimomycetes*)	**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 charactristics 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 identification key adopted in: Bergey's Manuals of Systematic Bacteriology: structure, basis, scheme in general	**4**
Suggested readings	▪ Atlas, R. M. (1997) Principles of Microbiology, 2nd edition, WM.T.Brown Publishers, Dubuque, USA. ▪ Cappucino J and Sherman N. (2010) Microbiology: A Laboratory Manual, 9th edition, Pearson Education Limited, New Delhi ▪ Parija S.C. (2005) Text Book of Practical Microbiology, 1st edition, Ahuja Publishing House, New Delhi. ▪ Dubey RC and Maheshwari DK (2004) Practical Microbiology, 1st edition, S. Chand and Co., Delhi. ▪ Harley, J. P. and Prescott L. M. (2002) Laboratory Exercises in Microbiology, 5th edition, The McGraw-Hill Co., New York ▪ Benson H. (2001) Microbiological Applications Lab Manual, 8th edition, The McGraw-Hill Companies, New York ▪ Aneja K.R. (1996) Experiments in Microbiology, 3rd edition, Wishwa Prakashan, New Delhi.	

Note: Mandatory to perform at least 12-13 practicals

SEMESTER –II
CC-1 B: Paper I (Section A)
MB 201: Basic Biochemistry and Cytology (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Topic Particular	Lectures
Course objective	**To acquaint students with basic concepts in biochemistry and familiarize with cellular architecture**		
Learning outcome	**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**		
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	**12**

		(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 ▪ Chemistry of 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	
Unit II	**Anatomy of Prokaryotic cell**	▪ Ultra-structure of bacterial cell. Cell size, shape and arrangement, ▪ Structure, Function and Chemical Composition of: 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 : Flagella, Cell wall, Nucleus, Mitochondria, Chloroplast, Golgi bodies, Ribosome, Lysosome	**08**
	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: Microbial Techniques (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**		
Learning outcome	**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**		
I	**Isolation and Cultivation of Microbes**	▪ Pure culture technique for bacteria: Streak plate, Pour plate, Spread plate, agar droplet, Mile's and Misra's Method ▪ Cultivation of anaerobes: Roll tube method, anaerobic jar and anaerobic cabinet/chamber ▪ Enrichment methods for bacteria (photoautotroph, photoheterotroph, chemoautotroph, chemoheterotroph) ▪ 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**	▪ Aseptic condition - necessity and application ▪ Disinfection: Concept of disinfectant and characters of an ideal disinfectant, Phenol coefficient ▪ Concept of: Antiseptic, Sanitizer, Germicide, Antibiotics, Microbiocide, Microbiostasis. ▪ Pasteurization (HTST, UHT) ▪ Control of microbes by Ultraviolet light, gamma	**10**

		rays, Low Temperature, Desiccation, Osmotic pressure, Surface tension,, chemical and biological. ▪ 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.	
Unit III	**Control of microbes by sterilization**	▪ 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 ▪ Indicators of Sterilization: Chemical and Biological system ▪ Validation of sterility in autoclave and LAF	**10**
	Suggested readings	1. Pawar, CB, and Daginawala, HF. (1998) General Microbiology, Vol. I and II, 1st edition, Himalaya Publishing 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 B: Practical Paper II
MB 203: Microbiology Practical -II (Practical)

Total Hours: 60 **Credits: 2**

Sr., no.	Title of the Practical	Hours
Course objective	**To instil practical skills about methods of isolation, characterization, control of microbes and familiarize with fundamental aspect of cellular chemistry**	
Learning outcome	**After successful completion of this course students are expected to:** **▪ Inculcate scientific thinking** **1. student can adapt the ability to apply the process of science** **a. 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** **2. Adapt quantitative reasoning and graphing skills to solve problems in microbiology** ▪ **B. Introduce microbiology Laboratory Skills** **1. Perform advanced staining methods** **2. Use pure culture and selective techniques to enrich and isolate microorganisms.** **3. Use appropriate methods to identify microorganisms (media-based)** **4. Estimate the number of microorganisms in a sample** **5. Become conversant in basic biochemistry methods and biochemical methods in microbiology** ▪ **Demonstrate practical skills in microscopy and their handling techniques and staining procedures** ▪ **Understand the bacterial growth and comprehend various physical and chemical means of sterilization** ▪ **Know General bacteriology and microbial techniques for isolation of pure cultures of bacteria, fungi and algae** ▪ **Practice aseptic techniques and 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.	▪ Study micro-flora of the air and water on nutrient agar plates	**4**
10	▪ Evaluation of skin disinfectant (alcohol/soap/Dettol)for disinfection	**4**
11.	▪ Qualitative tests for carbohydrate and lipids	**4**
12	▪ Qualitative tests for amino acids and proteins	**4**
13	▪ Slide culture technique for fungi	**4**
14	▪ Preparation of standard solutions (Normal/ Molar/ Percentage)	**4**
15	▪ Demonstration of bacterial growth by spectrophotometer	**4**
Suggested readings	1. Atlas, RM. (1997) Principles of Microbiology, 2nd edition, WM.T.Brown Publishers, 2. Cappucino J and Sherman N. (2010) Microbiology: A Laboratory Manual, 9th edition, Pearson Education Limited, New Jersey. 3. Parija, S.C. (2005) Text Book of Practical Microbiology, 1st edition, Ahuja Publishing House, New Delhi. 4. Harley, J. P. and Prescott, L. M. (2002) Laboratory Exercises in Microbiology, 5th edition, The McGraw-Hill Companies, London. 5. Benson, H. (2001) Microbiological Applications Lab Manual, 8th edition, The McGraw-Hill Companies, New Delhi 6. Aneja, K.R. (1996) Experiments in Microbiology, 3rd edition, Wishwa Prakashan, New Delhi.	

Note: Mandatory to perform at least 12-13 practical

Skills acquired and job prospectus for the microbiology students

Microbiologists study the world of tiny entities that are too small to be seen with the naked eye. It includes bacteria, viruses, algae, fungi, and parasites. Few microbe causes 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 the role in the environment. Initially, more focus is 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, microbiologist assist in quality and safety of vitamins, vaccines, antibiotics, antiseptics and identify harmful microorganisms in water, food, dairy, pharmaceutical and environmental products.

Technical representative 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 graduate in microbiology to wider range of career options such as teaching in College, scientific area, and 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 learning to interpret the data
- acquire laboratory safety skills and emergency procedures

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