



## **Choice Based Credit System (CBCS)**

### **Framework for Syllabus**

## **Bachelor of Science (B.Sc.)**

### **Syllabus of**

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

**Implemented from**

**Academic year 2021 -22**

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

**New Arts, Commerce and Science College, Ahmednagar  
(Autonomous)**

**Board of Studies in Microbiology**

Sr. No.	Name	Designation
1.	Mr. Kukreja Girish P.	Chairman
2.	Ms. Giramkar Dipali D.	Member
3.	Dr. Dixit Prashant P.	Academic Council Nominee
4.	Dr. Naphade Bhushan S.	Academic Council Nominee
5.	Mr.Choure Rajendra G.	Vice Chancellor Nominee
6.	Mr. Yewatkar Saikiran	Alumni
7.	Mr. Dube Chandrakant G.	Industry Expert
8.	Dr. Patil Ulhas K.	Member (co-opt)
9.	Mr.Shaikh Sajid H.	Member (co-opt)
10.	Dr. Gahile Yogesh R.	Member (co-opt)
11.	Mr.Wani Ashish S.	Member (co-opt)

## 1. Prologue/ Introduction of the Programme:

Microbiology is a broad discipline of Biology which encompasses five groups of microorganisms i.e. bacteria, protozoa, algae, fungi and viruses. It studies the interaction of microorganisms with their environments as well as how these organisms are harnessed in human endeavor and their impact on society. The study has its extensions in various other conventional and advanced fields of biology by employing microbes as study models.

Since inception of Microbiology as a branch of Science, it has remained an ever-expanding field of active research, broadly categorized as Pure and Applied Science. Different branches of Pure Microbiology based on taxonomy are Bacteriology, Mycology, Protozoology and Parasitology, Phycology and Virology; with considerable overlap between these specific branches over each other and also with other disciplines of Life Sciences, like Botany, Zoology, Cell Biology, Biochemistry, Biotechnology, Nanotechnology, Bioinformatics, etc. Areas in the applied Microbial Sciences can be identified as: Medical, Pharmaceutical, Industrial (Fermentation, Pollution Control), Air, Water, Food and Dairy, Agriculture (Plant Pathology and Soil Microbiology), Veterinary, Environmental (Ecology, Geomicrobiology); and the technological aspects of these areas.

Knowledge of different aspects of Microbiology has become crucial and indispensable to the society. Study of microbes has become an integral part of education and human progress. The science of Microbiology has an important role to play in health, agriculture, environment and industry. Several discoveries in the last two to three decades, which significantly impact these areas, have put Microbiology on the center stage of teaching, research and development all over the world. There is a continuous demand for microbiologists as work force – education, industry and research. Career opportunities for the graduate students are available in industry and research equally.

In the post globalization world higher education has to play a significant role in creation of skilled human resources for the well-being of humanity. The barriers among the academic fields seem to have dissolved. However, the disparities in the field of curriculum aspect, evaluation and mobility exist. With the changing scenario at local and global level, the syllabus restructuring should keep pace with developments in the education sector. Choice Based Credit System (CBCS) is being adopted and implemented to address the issues related to traditional system and

it also aims to maintain the best of earlier curriculum. The student is at the center of CBCS. The present curriculum focuses on students' needs, skill development, interdisciplinary approach to learning and enhancing employability.

Microbiology curricula are offered at two levels viz. undergraduate and postgraduate. The undergraduate curricula are prepared to impart basic knowledge of the respective subject from all possible angles. The students trained under this curriculum will have the required attributes of knowledge, skills, temperament and ethics related to the subject of Microbiology.

## **2. Programme Outcomes (POs) (B.Sc. Microbiology)**

Students enrolled in the program will complete a curriculum that exposes and trains students in a full range of essential skills and abilities. Theory supplemented with extensive practical skill sets will help a graduate student to avail the opportunities in the applied fields (research, industry or institutions), without any additional training.

They will have the opportunity to master the following objectives.

- To enrich students' knowledge and train them in the pure microbial sciences
- To Acquire knowledge and understanding of the microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food etc.
- To introduce the concepts of application and research in Microbiology
- To inculcate sense of scientific responsibilities and social and environment awareness
- To help students build-up a progressive and successful career

**Programme Structure and Course Titles**

Sr. No.	Class	Semester	Course Code	Course Title	Credits
1.	F.Y. B.Sc.	I	BSC-MR 101 T	Introduction to Microbiology	02
2.	F.Y. B.Sc.	I	BSC-MR 102 T	Basic Techniques in Microbiology	02
3.	F.Y. B.Sc.	I	BSC-MR 103 P	Practical Course based on Theory Paper I and II	1.5
4.	F.Y. B.Sc.	II	BSC-MR 201 T	Cell Biology of Microorganisms	02
5.	F.Y. B.Sc.	II	BSC-MR 202 T	Microbial Cultivation and Growth	02
6.	F.Y. B.Sc.	II	BSC-MR 203 P	Practical Course based on Theory Paper I and II	1.5
7.	S.Y. B.Sc.	III	BSC-MR 301 T	Medical Microbiology and Immunology	02
8.	S.Y. B.Sc.	III	BSC-MR 302 T	Bacterial Physiology and Fermentation Technology	02
9.	S.Y. B.Sc.	III	BSC-MR 303 P	Practical Course based on Theory Paper I and II	02
10.	S.Y. B.Sc.	IV	BSC-MR 401 T	Bacterial Genetics	02
11.	S.Y. B.Sc.	IV	BSC-MR 402 T	Air ,Water & Soil Microbiology	02
12.	S.Y. B.Sc.	IV	BSC-MR 403 P	Practical Course based on Theory Paper I and II	02
13.	T.Y. B.Sc.	V	BSC-MR 501 T	Medical Microbiology I	02

14.	T.Y. B.Sc.	V	BSC-MR 502 T	Immunology I	02
15.	T.Y. B.Sc.	V	BSC-MR 503 T	Enzymology	02
16.	T.Y. B.Sc.	V	BSC-MR 504 T	Genetics and Molecular Biology I	02
17.	T.Y. B.Sc.	V	BSC-MR 505 T	Fermentation Technology I	02
18.	T.Y. B.Sc.	V	BSC-MR 506 T	Applied Microbiology I	02
19.	T.Y. B.Sc.	V	BSC-MR 507 T	Nanotechnology	02
20.	T.Y. B.Sc.	V	BSC-MR 508 P	Practical Course I- Diagnostic Microbiology and Immunology	02
21.	T.Y. B.Sc.	V	BSC-MR 509 P	Practical Course II- Biochemistry and Molecular Biology	02
22.	T.Y. B.Sc.	V	BSC-MR 510 P	Practical Course III- Fermentation Technology and Applied Microbiology	02
23.	T.Y. B.Sc.	V	BSC-MR 511 P	Practical Course based on Nanotechnology	02
24.	T.Y. B.Sc.	VI	BSC-MR 601 T	Medical Microbiology II	02
25.	T.Y. B.Sc.	VI	BSC-MR 602 T	Immunology II	02
26.	T.Y. B.Sc.	VI	BSC-MR 603 T	Metabolism	02
27.	T.Y. B.Sc.	VI	BSC-MR 604 T	Genetics and Molecular Biology II	02
28.	T.Y. B.Sc.	VI	BSC-MR 605 T	Fermentation Technology II	02
29.	T.Y. B.Sc.	VI	BSC-MR 606 T	Applied Microbiology II	02
30.	T.Y. B.Sc.	VI	BSC-MR 607 T	Molecular and Biochemical Techniques	02

31.	T.Y. B.Sc.	VI	BSC-MR 608 P	Practical Course I- Diagnostic Microbiology and Immunology	02
32.	T.Y. B.Sc.	VI	BSC-MR 609 P	Practical Course II- Biochemistry and Molecular Biology	02
33.	T.Y. B.Sc.	VI	BSC-MR 610 P	Practical Course III- Fermentation Technology and Applied Microbiology	02
34.	T.Y. B.Sc.	VI	BSC-MR 611 P	Project /Practical course based on Molecular and Biochemical Techniques	02

**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's  
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**Syllabus of F. Y. B. Sc. Microbiology  
Under  
Faculty of Science and Technology**

<b>Semester -I</b>	<b>Theory Paper -I</b>
<b>Course Code: BSC-MR 101 T</b>	<b>Title of the Course :</b> <b>Introduction to Microbiology</b>
<b>Credits: 02</b>	<b>Total Lectures: 30 Hrs.</b>

**Course Outcomes (Cos)**

1. Students will learn the historical developments in Microbiology from the discovery of microbes to the role of microbes in various fields and get acquainted with the work of Nobel Laurates
2. Students will understand the Diversity of microbes like bacteria, algae, fungi, viruses and protozoa, and know their distinguishing features
3. Students will understand the nature and scope of Microbiology and its applications to mankind like Normal flora, Bio fertilizers, Probiotics, etc.

**Detailed Syllabus**

<b>Unit No.</b>	<b>Topic</b>	<b>No. of Hours</b>
<b>Unit 1</b>	<p><b>Amazing world of Microbiology</b></p> <p><b>1.Development of microbiology as a discipline –</b></p> <ul style="list-style-type: none"> <li>• Discovery of microscope and Microorganisms (Anton von Leeuwenhoek and Robert Hooke),</li> <li>• Abiogenesis v/s biogenesis (Aristotle's notion about</li> </ul>	15



spontaneous generation, Francesco Redi's experiment, Schulze and Shawn Experiment, Louis Pasteur's & Tyndall's experiments)

## 2. Golden Era of Microbiology

### ➤ Contributions of –

- Louis Pasteur (Fermentation, Rabies, Pasteurization and Cholera vaccine-fowl cholera experiment)
- Robert Koch (Koch's Postulates, Germ theory of disease, Tuberculosis and Cholera-isolation and staining techniques of causative agent)
- Ferdinand Cohn (Endospore discovery),
- Discovery of viruses (TMV and Bacteriophages),
- River's Postulates

➤ Contribution of Joseph Lister (antiseptic surgery), Paul Ehrlich (Chemotherapy), Elie Metchnikoff (Phagocytosis), Edward Jenner (Vaccination) and Alexander Fleming (Penicillin) in establishment of fields of medical microbiology and immunology, Discovery of Streptomycin by Waksman

➤ Contribution of Martinus W. Beijerinck (Enrichment culture technique, Rhizobium), Sergei N. Winogradsky (Nitrogen fixation and Chemo-lithotrophy) in the development of the field of soil microbiology

## 3. Modern Era of Microbiology-

- Carl Woese classification based on 16S rRNA
- Signification and Application of Human Microbiome,
- Nano-biotechnology and Space Microbiology

## 4. Nobel laureates in Life Sciences of 21<sup>st</sup> Century - Physiology or Medicine, Chemistry

<p><b>Unit 2</b></p>	<p><b>1.Types of Microorganism and their differentiating characters –</b></p> <ul style="list-style-type: none"> <li>• Three domain classification and five kingdom system of classification</li> <li>• Bacteria (Eubacteria and Archaea)</li> <li>• Protozoa</li> <li>• Fungi</li> <li>• Algae</li> <li>• Viruses, Viroids and Prions</li> </ul> <p><b>2.Beneficial and Harmful effects of microorganisms:</b></p> <ul style="list-style-type: none"> <li>• <b>Medical Microbiology</b> (Enlist diseases caused by various microorganisms, vaccines and antibiotics)</li> <li>• <b>Environmental Microbiology</b> (Eutrophication, red tide, Sewage treatment, bioremediation)</li> <li>• <b>Food and Dairy Microbiology</b> (Food spoilage, food borne diseases, Probiotics and fermented food)</li> <li>• <b>Agriculture Microbiology</b> (Plant diseases and Biofertilizers and Bio-control agents)</li> <li>• <b>Industrial Microbiology</b> (Production of antibiotics, enzymes, solvents and contaminants-bacteria and phages)</li> <li>• <b>Immunology</b> (Normal flora, Three lines of defense)</li> <li>• <b>Scope and application of Microbiology</b></li> </ul>	<p>15</p>
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**Suggested Readings:**

1. Daniel L., (1998). Microbiology, 2<sup>nd</sup> Edition, McGraw-Hill Publication.
2. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology, 3<sup>rd</sup> Edition, Thomson

Brooks/Cole.

3. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11<sup>th</sup> Edition. Pearson Education Inc.
4. Pelczar M.J., Chan JR. E.C.S., Noel R. K. (1993). Microbiology, 5<sup>th</sup> Edition, TataMcGraw Hill Press.
5. Prescott L.M., Harley J.P., and Klein D.A. (2005). Microbiology, 6<sup>th</sup> Edition. McGraw Hill Companies Inc.
6. Prescott, Lancing. M., John, P. Harley and Donald, A. Klein (2006). Microbiology, 6<sup>th</sup> Edition, McGraw Hill Higher Education.
7. Willey J. M., Sherwood L. M. and Woolverton C. J. (2013). Prescott's Microbiology, 8<sup>th</sup> Edition, McGraw-Hill Higher Education.
8. Salle A.J. (1971). Fundamental Principles of Bacteriology. 7<sup>th</sup> Edition, Tata McGraw HillPublishing Co.
9. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987). General Microbiology, 5<sup>th</sup> Edition, Macmillan Press Ltd.
10. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8<sup>th</sup> Edition, Pearson Education Inc.

<b>Semester –I</b>	<b>Theory Paper -II</b>
<b>Course Code: BSC-MR 102 T</b>	<b>Title of the Course : Basic Techniques in Microbiology</b>
<b>Credits: 02</b>	<b>Total Lectures: 30 Hrs.</b>

### Course outcomes (Cos)

1. Students will learn, Principle and working of bright field microscopy, phase contrast microscopy, fluorescence microscopy, electron microscopy.
2. Students will learn the staining techniques like monochrome staining, negative staining, differential staining and special staining.
3. Students will learn the different methods of sterilization and Disinfection.

### Detailed Syllabus

<b>Unit No.</b>	<b>Topic</b>	<b>No. of Hours</b>
<b>Unit 1</b>	<b>Microscopy</b> <b>1. Units of measurement</b> – Introduction to Modern SI units <b>2. Bright field microscopy:</b> <ul style="list-style-type: none"> <li>• Electromagnetic spectrum of light</li> <li>• Structure, working of and ray diagram of a compound light microscope; concepts of magnification, numerical aperture and resolving power.</li> <li>• Types, ray diagram and functions of – condensers (Abbe and cardioid) eyepieces and objectives</li> <li>• Concept of aberrations in lenses - spherical, chromatic, comma and astigmatism</li> </ul>	15

	<p><b>3.Principle, working and ray diagram of</b></p> <ul style="list-style-type: none"> <li>• Phase contrast microscope</li> <li>• Fluorescence Microscope</li> <li>• Electron Microscope – TEM, SEM</li> </ul>	
	<p><b>4.Staining Techniques:</b></p> <ul style="list-style-type: none"> <li>• Definition of Stain; Types of stains (Basic and Acidic), Properties and role of Fixatives, Mordants, Decolourisers and Accentuators</li> <li>• Monochrome staining and Negative (Relief) staining</li> <li>• Differential staining - Gram staining and Acid-fast staining</li> <li>• Special staining- Capsule, Cell wall, Spore, Flagella, Lipid granules, metachromatic granules</li> </ul>	
<b>Unit 2</b>	<p><b>Sterilization and Disinfection</b></p> <p><b>1. Sterilization</b></p> <ul style="list-style-type: none"> <li>• Physical Agents - Heat, Radiation, Filtration</li> <li>• Chemical agents –ethylene oxide ,formaldehyde</li> <li>• Checking of efficiency of sterilization (Dry and Moist) – Biological and Chemical Indicators</li> </ul> <p><b>2. Disinfection:</b></p> <ul style="list-style-type: none"> <li>• Chemical agents - mode of action and application of: Aldehydes, Halogens, Quaternary ammonium compounds, Phenol and phenolic compounds, Heavy metals, Alcohol, Dyes, Detergents and Ethylene oxide.</li> <li>• Characteristics of an ideal disinfectant</li> <li>• Checking of efficiency of disinfectant - Phenol Coefficient (Rideal–Walker method)</li> </ul>	15

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1. Daniel L., (1998). Microbiology, 2<sup>nd</sup> Edition, McGraw-Hill Publication.
2. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology, 3<sup>rd</sup> Edition, Thomson

Brooks/Cole.

3. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11<sup>th</sup> Edition. Pearson Education Inc.
4. Pelczar M.J., Chan JR. E.C.S., Noel R. K. (1993). Microbiology, 5<sup>th</sup> Edition, TataMcGraw Hill Press.
5. Prescott L.M., Harley J.P., and Klein D.A. (2005). Microbiology, 6<sup>th</sup> Edition. McGraw Hill Companies Inc.
6. Prescott, Lancing. M., John, P. Harley and Donald, A. Klein (2006). Microbiology, 6<sup>th</sup> Edition, McGraw Hill Higher Education.
7. Willey J. M., Sherwood L. M. and Woolverton C. J. (2013). Prescott's Microbiology, 8<sup>th</sup> Edition, McGraw-Hill Higher Education.
8. Salle A.J. (1971). Fundamental Principles of Bacteriology. 7<sup>th</sup> Edition, Tata McGraw HillPublishing Co.
9. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987). General Microbiology, 5<sup>th</sup> Edition, Macmillan Press Ltd.
10. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8<sup>th</sup> Edition, Pearson Education Inc.

<b>Semester -I</b>	<b>Practical</b>
<b>Course Code: BSC-MR 103 P</b>	<b>Title of the Course : Practical Course based on theory paper I and II</b>
<b>Credits: 1.5</b>	<b>Total Lectures: 45 Hrs.</b>

### Course outcome (Cos)

1. Students will learn the Good Laboratory Practices for common Microbiology Laboratory instruments.
2. Students will learn construction, working and observation of microorganisms using compound microscope.
3. Students will learn different techniques of staining and motility of microorganism.
4. To understand basic techniques in laboratory such as handling, wrapping, plugging of laboratory glasswares etc. and the aseptic transfer techniques

<b>Sr.No.</b>	<b>Title of the Experiment</b>	<b>No. of Practical</b>
1.	Safety measures and Good Laboratory Practices in microbiology laboratory	1
2.	Introduction, working principle, operation, precautions and use of common microbiology laboratory instruments: Analytical balance ,Incubator, Hot airoven, Autoclave, Colorimeter/ spectrophotometer , Laminar air flow hood/biosafety cabinet ,centrifuge, Distillation unit , pH meter	2
3.	Construction (mechanical and optical), working and care of compound microscope.	1
4.	Permanent slide observation : Algae, Fungi and Protozoa	1

5.	Wet mount slide preparation and its observation for: Bacteria, Algae, Fungi and Protozoa.	1
6.	Introduction and use of common laboratory wares: Test tubes, culture tubes, suspension tubes, screw capped tubes, Petri plates, pipettes (Mohr and serological) micropipettes, Pasteur pipettes, Erlenmeyer flask, volumetric flask, glass spreader, Durham's tube, Cragie's tube and inoculating needles (wire loop, stab needles), dessicator, anaerobic jar	1
7.	Learning basic techniques in Microbiology: Wrapping of glassware, cotton plugging, cleaning and washing of glassware, biological waste disposal.	1
8.	Aseptic transfer technique (Aseptic Behavior in the clean room or in the LAF (while working))	1
9.	Basic staining techniques: i. Monochrome staining ii. Negative staining	2
10.	Differential staining: i. Gram staining of bacteria ii. Acid Fast Staining	2
11.	Observation of motility in bacteria using: Hanging drop method and swarming growth method.	2

### Suggested readings:

1. Harley, J.P. and Prescott, L.M., (2002). Laboratory Exercises in Microbiology, 5<sup>th</sup> Edition, The McGraw-Hill Companies.
2. Saravanan R., Dhachinamoorthi D., Prasada Rao CH.MM., (2013). 1<sup>st</sup> Edition, A Handbook of Practical Microbiology, LAP LAMBERT Academic Publishing.
3. Goldmanand E., Green H.L. (2015) Practical Handbook of Microbiology 3<sup>rd</sup> Edition, ,CRC Press.



<b>Semester -II</b>	<b>Theory Paper -I</b>
<b>Course Code: BSC-MR 201 T</b>	<b>Title of the Course : Cell Biology of Microorganisms</b>
<b>Credits: 02</b>	<b>Total Lectures: 30 Hrs.</b>

### Course outcome (Cos)

1. Students will learn the structure and the function of each part of Bacterial cell
2. Students will have a brief overview of Bacterial classification and ICTV for viral classification
3. Students will understand the Biochemistry of bacterial cell

### Detailed syllabus

<b>Unit No.</b>	<b>Topic</b>	<b>No. of Hours</b>
<b>Unit 1</b>	<p><b>Ultrastructure of bacterial cell</b></p> <p><b>1.Bacterial Cytology</b> - Microbial cell size, shape and arrangements</p> <p><b>2.Structure, chemical composition and functions of the following components in bacterial cell:</b></p> <ul style="list-style-type: none"> <li>• Cell wall (Gram positive, Gram negative)</li> <li>• Concept of Mycoplasma, Spheroplast, protoplast, L-form</li> <li>• Cell membrane</li> <li>• Endospore (spore formation and stages of sporulation)</li> <li>• Capsule</li> <li>• Flagella</li> <li>• Fimbriae and Pili</li> <li>• Ribosomes</li> <li>• Chromosomal &amp; extra-chromosomal material</li> </ul>	15

	<ul style="list-style-type: none"> <li>• Cell inclusions (Gas vesicles, carboxysomes, PHB granules, metachromatic granules, glycogen bodies, starch granules, magnetosomes, sulfur granules, chlorosomes)</li> </ul>	
<b>Unit 2</b>	<p><b>1. Chemical Basis of Microbiology</b></p> <p>Atom, Biomolecules, types of bonds (covalent, co-ordinate bond, non-covalent) and linkages (ester, phospho-diester, peptide, glycosidic)</p> <p><b>2. Chemistry of Biomolecules:</b></p> <ul style="list-style-type: none"> <li>• Structure, organization and functions Carbohydrates: Definition, classification</li> <li>• Monosaccharides: Classification based on aldehyde and ketone groups; structure of Ribose, Deoxyribose, Glucose, Galactose and Fructose.</li> <li>• Disaccharides: Glyosidic bond, structure of lactose and sucrose.</li> <li>• Polysaccharides: Structure and types (Examples-Starch, glycogen, Peptidoglycan, chitin)</li> </ul> <p><b>3. Lipids: Definition, classification</b></p> <ul style="list-style-type: none"> <li>• Simple lipids – Triglycerides, Fats and oils, waxes.</li> <li>• Compound lipids – Phospholipid, Glycolipids</li> <li>• Derived lipids – Steroids, Cholesterol</li> </ul> <p><b>4. Proteins: Definition, classification</b></p> <ul style="list-style-type: none"> <li>• General structure of amino acids, peptide bond</li> <li>• Types of amino acids based on R group</li> <li>• Structural levels of proteins: primary, secondary, tertiary and quaternary</li> </ul>	15

	<ul style="list-style-type: none"> <li>• Study of Hemoglobin, flagellin and cytoskeletal proteins</li> </ul> <p><b>5. Nucleic acids: Definition, classification</b></p> <ul style="list-style-type: none"> <li>• DNA – structure and composition</li> <li>• RNA – Types (m-RNA, t-RNA, r-RNA), structure and functions.</li> </ul> <p><b>6. Classification of Bacteria</b> - Introduction to Bergey's Manual of Determinative and Systemic Bacteriology</p> <p><b>Classification of Viruses: ICTV nomenclature</b></p>	
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### Suggested Readings:

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

<b>Semester -II</b>	<b>Theory Paper -II</b>
<b>Course Code: BSC-MR 202 T</b>	<b>Title of the Course : Microbial cultivation and growth</b>
<b>Credits: 02</b>	<b>Total hours: 30 Hrs.</b>

### Course outcome (Cos)

1. Students will understand nutritional classification of microorganisms along with design and preparation of different types of culture media for cultivation of different types of microorganism
2. Students will learn the concept of pure culture, enrichment, isolation and preservation technique
3. Students will learn the bacterial growth kinetics with methods of enumeration of bacterial growth and factors affecting bacterial growth

### Detailed syllabus

<b>Unit No.</b>	<b>Topic</b>	<b>No. of Hours</b>
<b>Unit 1</b>	<p><b>Cultivation of Microorganisms:</b></p> <ol style="list-style-type: none"> <li>1. Nutritional requirements and nutritional classification</li> <li>2. Design and preparation of media: Common ingredients of culture media and types of media</li> <li>3. Methods for cultivating photosynthetic, extremophilic and chemolithotrophic bacteria, anaerobic bacteria, algae, fungi, actinomycetes and viruses</li> <li>4. Concept of Enrichment, Pure Culture, Isolation of culture by streak plate, pour plate, spread plate</li> <li>5. Maintenance of bacterial and fungal cultures using different techniques</li> <li>6. Culture collection centres and their role</li> </ol>	15

	7. Requirements and guidelines of National Biodiversity Authority for culture collection centres	
<b>Unit 2</b>	<p><b>Bacterial growth:</b></p> <ol style="list-style-type: none"> <li>1. Kinetics of bacterial growth (Exponential growth model)</li> <li>2. Growth curve and Generation time</li> <li>3. Diauxic growth</li> <li>4. Measurement of bacterial growth- Methods of enumeration: <ul style="list-style-type: none"> <li>• Microscopic methods (Direct microscopic count, counting cells using improved Neubauer chamber, Petroff-Hausser counting chamber)</li> <li>• Plate counts (Total viable count)</li> <li>• Turbidometric methods (including Nephelometry)</li> <li>• Estimation of biomass (Dry mass, Packed cell volume)</li> </ul> </li> </ol> <p>Factors affecting bacterial growth {pH, Temperature, Solute Concentration (Salt and Sugar) and Heavy metals</p>	15

### Suggested Readings:

1. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11<sup>th</sup> Edition. Pearson Education Inc.
2. Pelczar M.J., Chan JR. E.C.S., Noel R. K. (1993). Microbiology, 5<sup>th</sup> Edition, TataMcGraw Hill Press.
3. Prescott, Lancing. M., John, P. Harley and Donald, A. Klein (2006). Microbiology, 6<sup>th</sup> Edition, McGraw Hill Higher Education.
4. Willey J. M., Sherwood L. M. and Woolverton C. J. (2013). Prescott's Microbiology, 8<sup>th</sup> Edition, McGraw-Hill Higher Education.
5. Salle A.J. (1971). Fundamental Principles of Bacteriology. 7<sup>th</sup> Edition, Tata McGraw HillPublishing Co.
6. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987). General Microbiology, 5<sup>th</sup> Edition, Macmillan Press Ltd.
7. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8<sup>th</sup> Edition, Pearson Education Inc.

Semester -I	Practical
Course Code: BSC-MR 203 P	Title of the Course : Practical Course based on theory paper I and II
Credits: 1.5	Total Lectures: 45 Hrs.

### Course outcome (Cos)

1. Student will be able to perform isolation and enumeration of bacteria by streak, spread, pours techniques , enrichment by Winogradsky column and Preservation of bacteria
2. Student will learn counting of yeast cells using a counting chamber.
3. Students will be able to perform special staining techniques ( endospore and capsule )
4. Student will be able to determine the effect of different parameter of growth on *E.coli* and oligo dynamic action of heavy metal.

### Detailed syllabus

Sr. No.	Title of the Experiment	No. of practical
1.	Preparation of simple laboratory nutrient media (Nutrient agar/broth, MacConkey's agar).	1
2.	Checking sterilization efficiency of autoclave using a biological indicator ( <i>Geobacillus stearothermophilus</i> )	1
3.	Preparation of Winogradsky's column and observation of different types of microorganisms using bright field microscope	1
4.	Special staining techniques: i. Endospore staining ii. Capsule staining	2
5.	Isolation of bacteria by streak plate technique (Colony and cultural characteristics)	1

6.	Enumeration of microorganism from fermented food / soil / water by: i. Spread plate method ii. Pour plate method	2
7.	Yeast cell enumeration using Improved Neubauer Chamber	1
8.	Study of effect of washing on skin microflora (soap and disinfectant )	1
9.	Study of the effect of different parameters on growth of bacteria ( pH, temperature, sodium chloride concentration)	3
10.	Study of oligodynamic action of heavy metal	1
11.	Preservation of cultures on slants, soil and on grain surfaces; revival of these cultures and lyophilized cultures.	1

**Suggested readings:**

1. Harley J.P., Prescott L.M., (2002), Laboratory Exercises in Microbiology 5<sup>th</sup> Edition, The McGraw-Hill Companies.
2. Saravanan R., Dhachinamoorthi D., Prasada Rao CH.MM., (2013). 1<sup>st</sup> Edition, A Handbook of Practical Microbiology, LAP LAMBERT Academic Publishing.
3. Goldmanand E., Green H.L. (2015) Practical Handbook of Microbiology 3<sup>rd</sup> Edition, ,CRC Press.