



**Karmaveer Bhaurao Patil University, Satara**

**Syllabus for**

**B. Sc. I Microbiology**

**Under**

**Faculty of Science and Technology**

**(As per NEP 2020)**

**With effect from Academic Year 2024-2025**

**CONTENT**

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## Syllabus for B.Sc. I Microbiology

**• PREAMBLE:**

This syllabus is framed to give sound knowledge with understanding of Microbiology to undergraduate students at first year of four years of B.Sc. degree course. Students learn Microbiology as a separate subject from B.Sc. I. The goal of the syllabus is to make the study of Microbiology popular, interesting and encouraging to the students for higher studies including research. The new and updated syllabus is based on a basic and applied approach with vigor and depth. The syllabus meets the needs of industries and research. The syllabus is prepared after long discussion with number of faculty members of the subject and experts from industries and research fields. The units of the syllabus are well defined, taking into consideration the level and capacity of students.

**• PROGRAMME OBJECTIVES:**

1. To nurture academicians with focus and commitment to their subject.
2. To create a skilled work force to match the requirements of the industries and research.
3. To develop scientific attitude is the major objective so as to make students open minded, critical and curious.
4. To develop skill in practical work, experiments and laboratory materials and equipment along with the collection and interpretation of scientific data to contribute to science.

**• PROGRAMME OUTCOMES:**

1. The students will graduate with proficiency in the subject of their choice.
2. The students will be eligible to continue higher studies in abroad.
3. The students will be eligible to pursue higher position in industries.
4. The students will be eligible for jobs in government organizations.

- **PROGRAMME SPECIFIC OBJECTIVES:**

Students should be able...

1. To learn fundamental techniques in Microbiology such as culturing microbes, maintaining microbes, safety issues related to handling of microbes, Good Microbiological practices etc
2. To acquire practical skills through the laboratory work, exposure to industries and interaction with industry experts.
3. To develop moderately advanced skills in working with microbes such as pilot scale culturing, downstream processes, diagnostics and advanced techniques in molecular biology etc.
4. To be familiarized with the applicability of knowledge and Interdisciplinary approach in everyday life as well as in various other fields like agriculture, environment, industries such as food and dairy industries, distilleries, pharmaceutical industries, immunology and medical microbiology etc.
5. To become informed citizens who can understand and evaluate the impact of new research discoveries in the life sciences and will be able to pursue a wide range of careers, including biological and medical research in higher education institutions as well as careers in public and global health, scientific writing, environmental organizations, and food, pharmaceuticals and biotechnology industries.

- **PROGRAMME SPECIFIC OUTCOMES (PSO):**

After successful completion of B.Sc. Microbiology Course student will be able to:

1. Explain applications of microorganisms in various field such as agriculture, environment, industries such as food and dairy industries, distilleries, pharmaceutical industries, immunology and medical microbiology etc.
2. Describe the characteristics of different types of microorganisms and methods of their classification, methods of visualizing microorganisms, controlling growth of microorganisms, isolation and maintenance of bacterial cultures immunological concepts with reference to infection and immunity.
3. Apply subject knowledge to solve issues like bioremediation, waste management and diagnostics or to design and execute experiments related to Microbiology, immunology, molecular Biology, recombinant DNA technology, microbial genetics etc.
4. Pursue higher studies in different branches of Microbiology like Medical Microbiology, Industrial Microbiology, Virology, Marine Microbiology, Food Microbiology, etc.
5. Take up a suitable position in myriad sectors like academia, research and development, government sector or in industries like pharmaceuticals, food and beverages, bakery, winery, water testing and treatment, etc.

**Structure of B.Sc. I Microbiology**

<b>Semester</b>	<b>Course Code</b>	<b>Course title</b>
I	BMiT 111	Introduction to Microbiology
	BMiT 112	Techniques in Microbiology
	BMiP 113	Practical Course I (Based on BMiT 111 and BMiT 112)
II	BMiT 121	Microbial Growth
	BMiT 122	Biomolecules
	BMiP 123	Practical Course II (Based on BMiT 121 and BMiT 122 )

## B.Sc. I SEMESTER I

## COURSE I: BMiT 111- Introduction to Microbiology

**Course objectives:**

The students should be able to ...

1. understand the contribution of scientists in development of microbiology.
2. know scope of microbiology in upcoming areas of biological sciences.
3. study morphological and differential characteristics of different groups of microorganisms.
4. learn the structure and functions of different parts of typical bacterial cell.

Total Credits-2	SEMESTER-I COURSE I: BMiT 111- Introduction to Microbiology	No. of hours per unit
UNIT I	<b>History and Development of Microbiology</b>	8
	a) Theory of abiogenesis and biogenesis b) Contributions of Anton Van Leeuwenhoek, Louis Pasteur, Robert Koch, John Tyndall, Martinus W. Beijerinck, Sergei N. Winogradsky, Paul Ehrlich, Edward Jenner, Joseph Lister.	
UNIT II	<b>Scope and Branches of Microbiology</b>	8
	a) Air Microbiology, Water Microbiology, Sewage Microbiology, Agricultural Microbiology, Food & dairy Microbiology, Industrial Microbiology, Medical Microbiology b) Advanced branches in Microbiology: Pharmaceutical microbiology, Geomicrobiology, Nano-biotechnology and Space Microbiology, Bioinformatics.	
UNIT III	<b>Microbial Diversity</b>	6

	a) 5 kingdom system b) Differences in prokaryotic and eukaryotic organisms b) General characteristics of different groups– acellular microorganisms. (Viruses, Viroids and Prions) and cellular microorganisms (Bacteria, Archaeobacteria, Rickettsia, Algae, Fungi and Protozoa) with emphasis on occurrence and economic importance.	
<b>UNIT IV</b>	<b>Bacterial Cell Organization</b>	<b>8</b>
	<b>Structures of typical bacterial cell</b> a) Cell wall: Structure, function and chemical composition b) Cell membrane: Structure, function and chemical composition c) Capsule and slime layer: Structure, composition and function d) Flagella: Structure, composition and function e) Pili: Structure, composition and function f) Cytoplasm: Ribosomes, mesosomes, nucleoid material	

### Course outcomes:

The student will be able to...

1. explain the contribution of scientists in development of microbiology.
2. describe the scope of microbiology in upcoming areas of biological sciences.
3. examine morphological and differential characteristics of different groups of microorganisms.
4. evaluate the structure and functions of different parts of typical bacterial cell.

### Reference Books:

1. Willey J. M., Sherwood L. M. and Woolverton C. J. (2013) Prescott's Microbiology. 8th Edition. McGraw-Hill Higher Education.
2. Powar, C.B., Daginawala H.F. (2010). General Microbiology. Himalaya Publications.
3. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.
4. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8th Edition. Pearson Education Inc.
5. Prescott, Lancing. M., John, P. Harley and Donald, A. Klein (2006) Microbiology. 6th Edition. McGraw Hill Higher Education.
6. Prescott L.M., Harley J.P., and Klein D.A. (2005). Microbiology, 6th Edition. MacGraw Hill

Companies Inc.

7. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology. 3rd Edition. Thomson Brooks / Cole.
8. Michael J Pelczar, JR. E.C.S. Chan, Noel R. Krieg. (1993) Microbiology. 5th Edition, Tata MacGraw Hill Press.
9. Stanier R. Y., Adelberg E.A. and Ingraham J.L. (1987) General Microbiology. 5th Edition. Macmillan Press Ltd.
10. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGraw Hill Publishing Co.
11. Frobisher M, Fundamentals of Microbiology (1962) W. B. Saunders, Philadelphia. 7th edition.



## B.Sc. I SEMESTER I

## COURSE II : BMiT 112-Techniques in Microbiology

**Course objectives:**

The students should be able to...

1. understand the principle, working and applications of light and electron microscopic techniques.
2. study various morphological forms of bacteria using simple and special staining techniques.
3. learn the mode of action and application of different sterilizing agents and disinfectants.
4. know principle and working of chromatography, colorimeter and electrophoresis.

<b>Total Credits -2</b>	<b>SEMESTER-I</b> <b>COURSE II : BMiT 112-</b> <b>Techniques in Microbiology</b>	<b>No. of hours per unit</b>
<b>UNIT I</b>	<b>Microscopy</b>	<b>8</b>
	a) Terms in microscopy - Magnification, Refractive index, Numerical aperture, Resolving power b) Types of Microscopes - i) Light Microscope - Types: Bright field, Dark field, Phase contrast, fluorescent microscope Compound Microscope: Parts, image formation, Ray diagram and applications. ii) Electron Microscope -TEM and SEM - Parts, principle of image formation, Ray diagram and applications. iii) Comparativestudyof compound and electronmicroscope.	
<b>UNIT II</b>	<b>Stain and Staining Techniques</b>	<b>8</b>
	a) Definition of dye, stain, fixative, mordant, accentuators, decolorizing agent. Classification of stain: acidic, basic and neutral. b) Common staining techniques-Principle, procedure, mechanism and application of simple staining, negative staining, differential staining- Gram and acid-fast staining, impregnation method. c) Special staining methods - Cell wall, Capsule and Volutin granules	

<b>UNIT III</b>	<b>Control of microorganisms</b>	<b>8</b>
	a) Definitions- sterilization, disinfection, Antiseptic, Germicide, Microbiostasis, Antisepsis & sanitization. b) Physical agents of control of microorganisms- Temperature (dry heat and moist heat), Filtration -asbestos and membrane filter, Radiations- U.V Rays, Gamma Rays Checking of efficiency of Sterilization Biological and Chemical indicators c) Chemical agents for control of microorganisms- mode of action, applications and advantages of Phenolic and phenolic compound, Alcohol (Ethyl alcohol), Halogen compounds (Chlorine & Iodine), Heavy metal (Cu and Hg)	
<b>Unit IV</b>	<b>Analytical techniques</b>	<b>6</b>
	Principle, working and applications of a) Chromatography (Paper and Thin layer chromatography) b) Colorimeter and Spectrophotometer c) Electrophoresis	

### Course outcomes:

The students will be able to ...

1. compare the principle, working and applications of light and electron microscopic techniques.
2. identify various morphological forms of bacteria using simple and special staining techniques.
3. specify the mode of action and application of different sterilizing agents and disinfectants.
4. analyze different samples of biomolecules by using chromatography, colorimeter and electrophoresis.

### Reference Books:

1. Willey J. M., Sherwood L. M. and Woolverton C. J. (2013) Prescott's Microbiology, 8<sup>th</sup> Edition, McGraw-Hill Higher Education
2. Powar, C.B., Dagainawala H.F. (2010) General Microbiology, Himalaya Publications.
3. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.
4. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8th Edition. Pearson Education Inc
5. Prescott, Lancing. M., John, P. Harley and Donald, A. Klein (2006) Microbiology, 6th Edition, McGraw Hill Higher Education.

6. Prescott L.M., Harley J.P., and Klein D.A. (2005). Microbiology, 6th Edition. MacGraw Hill Companies Inc.
7. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology. 3rd Edition. Thomson Brooks / Cole.
8. Michael J Pelczar, JR. E.C.S. Chan, Noel R. Krieg. (1993) Microbiology, 5th Edition, Tata MacGraw Hill Press.
9. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987) General Microbiology, 5th Edition. Macmillan Press Ltd.
10. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGraw Hill Publishing Co.
11. Frobisher M, Fundamentals of Microbiology (1962) 7th edition. W. B. Saunders, Philadelphia.

**B.Sc.I Semester I**  
**BMiP 113-Practical Course I**

**Course objective:**

Students should be able to...

1. learn the safety measures while working in the microbiology laboratory and handling of microscope.
2. know preparation of stains, buffer, reagents & physiological saline.
3. study bacterial morphology using various staining procedures.
4. understand the observations of all experiments.

<b>Total Credits-2</b>	<b>SEMESTER-I</b> <b>BMiP 113- Practical Course I</b> <b>(Based on BMiT 111 and BMiT 112)</b>	<b>No. of hours (60 )</b>
	<ol style="list-style-type: none"> <li>1) Demonstration of basic techniques in Microbiology: Wrapping of glassware, cotton plugging, cleaning and washing glassware, biological waste disposal.</li> <li>2) Introduction and use of common laboratory glass ware: Test tubes, culture tubes, suspension tubes, screw capped tubes, Petri Plates, pipettes, Erlenmeyer flask, Volumetric Flask, Glass spreader, Durham's Tube, Cragie's Tube, inoculating needles (Wire Loop, stab needles)</li> <li>3) Study of biosafety- aseptic techniques, table disinfection, hand washing, use of apron, proper disposal of used material, cleaning and sterilization of glassware</li> <li>4) Use, care and study of compound microscope.</li> <li>5) Demonstration/Working principle and application of laboratory equipments - Incubator, Autoclave, Hot air oven, Membrane filter, Distilled water plant</li> <li>6) Preparation of:               <ol style="list-style-type: none"> <li>a) Stains (0.5% basic fuchsin &amp; 0.5% crystal violet),</li> <li>b) Buffer (Phosphate buffer pH 7.0),</li> <li>c) Reagents (1N and 1M HCl and NaOH Solutions),</li> <li>d) Physiological Saline</li> </ol> </li> </ol>	

	<ol style="list-style-type: none"><li>7) Observation of morphology of bacteria by -Monochrome staining method</li><li>8) Observation of morphology of bacteria by -Negative staining method</li><li>9) Study of gram nature of bacteria by Gram staining.</li><li>10) Observation of motility by Hanging droptechnique.</li><li>11) Demonstration of Acid fast staining- Permanent slideonly.</li><li>12) Observation of bacterial capsule stainingby Maneval's method</li><li>13) Observation of bacterial cell wall stainingby Chance'smethod.</li><li>14) Observation of bacterial volutin granule staining byAlbert's method</li><li>15) Wetmount preparation of fungus.</li></ol>	
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**Course outcomes:**

Students will be able to...

1. demonstrate the safety measures in the microbiology laboratory and handling of microscope and laboratory instruments.
2. demonstrate basic techniques in microbiology like wrapping of glasswares, cotton plugging etc.
3. prepare stains, buffer, reagents & physiological saline.
4. examine bacterial morphology usingvariousstaining procedures.

**Reference Books:**

1. Arora B. and Arora D. R. (2020). Practical Microbiology. CBS Publishers and Distributors, New Delhi, India.
2. Dubey R. C. and Maheshwari D. K. (2012). Practical Microbiology. S. Chand and Company Limited, New Delhi, India
3. Atlas R. M. (2010). Handbook of Microbiological Media. Ukraine: Taylor and Francis.
4. Patel R. (2009) Experimental Microbiology. Aditya Book Centre 5<sup>th</sup> edition, Vol. I and Vol.II,
5. Goldman E., and Green L. (2008) Practical Handbook of Microbiology, Taylor & Francis.
6. Cruick S.R., Dugaid, J.P., Marmion, B.P. and Swain, R.H. (1980) Medical Microbiology, Churchill Livingstone Publishing, Edinburgh, Vol. 1 & 2, 12th Edition.
7. Baker F. J. (1967) Bacteriologicaltechniques, Butter worth & Co Publishers Ltd.

## B.Sc.I SEMESTER II

## COURSE III: BMiT 121 Microbial growth

**Course objectives**

The students should be able to...

1. understand different phases and pattern of microbial growth and enumerate microorganisms by different methods.
2. learn the classification of microorganisms on basis of their nutritional requirements.
3. know the composition of culture medium for bacteria.
4. study isolation and preservation of microorganisms by suitable methods.

<b>Total Credits=4</b>	<b>SEMESTER-II</b> <b>Course III: BMiT 121 Microbial growth</b>	<b>No. of hours per unit</b>
<b>UNIT I</b>	<b>Microbial growth</b>	<b>8</b>
	a) Modes of cell division: Binary division, budding, fragmentation b) Growth curve- phases, Diauxic growth and Synchronous growth c) Kinetics of bacterial growth (Exponential growth model) d) Measurement of bacterial growth- Microscopic methods -Direct microscopic count, counting cells using improved Neubauer chamber, Plate counts (Total viable count), Turbidometric methods	
<b>UNIT II</b>	<b>Microbial Nutrition</b>	<b>8</b>
	a) Nutritionrequirementofmicroorganisms-Water, Macronutrients and Micronutrients b) Types of microorganisms depending on growth factors – auxotrophs, prototrophs, fastidious organisms. c) Nutritional types ofmicroorganisms dependingon carbon and energy source.	
<b>Unit III</b>	<b>Culture Media:</b>	<b>8</b>

	a) Common components of culture media and their functions. b) Types of media based on consistency – Liquid, Solid, Semisolid, Biphasic c) Types of culture media – Natural and Synthetic, Semisynthetic, Differential, Enriched, Enrichment, Selective, Transport, Indicator media.	
<b>Unit IV</b>	<b>Cultivation of Microorganisms</b>	<b>6</b>
	a) Pure culture techniques - Serial dilution technique, streak plate technique, spread plate technique, pour Plate technique b) Cultivation of an aerobic bacteria by using media components and by exclusion of air or oxygen. c) Preservation of microbial culture - sub culturing, overlaying with mineral oils, Lyophilization	

### Course outcomes

The students will be able to...

1. compare different phases and pattern of microbial growth.
2. classify the microorganisms on basis of their nutritional requirements.
3. design specific growth medium for a particular group of bacteria.
4. isolate and preserve the pure culture by using suitable techniques.

### Reference Books:

1. Willey J. M., Sherwood L. M. and Woolverton C. J. (2013) Prescott's Microbiology, 8th Edition, McGraw-Hill Higher Education
2. Powar, C.B., Dagainawala H.F. (2010) General Microbiology, Himalaya Publications.
3. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.
4. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8th Edition. Pearson Education Inc
5. Prescott, Lancing. M., John, P. Harley and Donald, A. Klein (2006) Microbiology, 6th Edition, McGraw Hill Higher Education.
6. Prescott L.M., Harley J.P., and Klein D.A. (2005). Microbiology, 6th Edition. MacGraw Hill Companies Inc.

7. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology. 3rd Edition. Thomson Brooks / Cole.
8. Michael J Pelczar, JR. E.C.S. Chan, Noel R. Krieg. (1993) Microbiology, 5th Edition, Tata MacGraw Hill Press.
9. Stanier R. Y., Adelberg E.A. and Ingraham J.L. (1987) General Microbiology, 5th Edition. Macmillan Press Ltd.
10. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGraw Hill Publishing Co.
11. Frobisher M, Fundamentals of Microbiology (1962) W. B. Saunders, Philadelphia. 7th edition.



## B.Sc.I SEMESTER II

## COURSE IV: BMiT 122- Biomolecules

**Course objectives :**

The students should be able to ...

1. study the structures of different monosaccharides and polysaccharides.
2. learn the primary, secondary, tertiary and quaternary structures of protein.
3. understand Watson and Crick's double stranded model of DNA and study the structure and function of three forms.
4. know classification of lipids based on their composition.

Total Credits=2	SEMESTER-II Course IV:BMiT 122- Biomolecules	No. of hours per unit
<b>UNIT I</b>	<b>Carbohydrates</b>	<b>8</b>
	a) Definition, classifications and brief account of- Monosaccharides -Structure of glucose, fructose. Disaccharides - Structures of lactose and sucrose. Polysaccharides - Structures of starch and cellulose.	
<b>UNIT II</b>	<b>Proteins</b>	<b>8</b>
	a) Amino acids- the building blocks of proteins, General formula and classification of amino acids, concept of zwitterion. b) Structure of protein: Primary structure of proteins, secondary structure of proteins (alpha helix, $\beta$ pleated sheet), tertiary and quaternary structure of proteins. c) Enzyme: Definitions, Structure - Concept of apoenzyme, coenzyme, cofactor, prosthetic group and active site Types- extracellular, intracellular, constitutive and inducible enzyme	
<b>UNIT III</b>	<b>Nucleic Acids</b>	<b>8</b>
	a) <b>DNA:</b> Composition- Structure of Purines, Pyrimidines, Structure of nucleoside, nucleotide, Structure of DNA (Watson and Crick's double helical model), salient features	

	b) <b>RNA</b> - Composition, Structure and function of mRNA, tRNA, rRNA	
<b>UNIT IV</b>	<b>Lipids</b>	<b>6</b>
	a) Simple Lipids- Fats and oils, waxes b) Compound Lipids- Phospholipids, Glycolipids c) Derived lipids – Steroids, Terpenes	

**Course outcomes:**

Student will be able to...

1. draw the structures of different monosaccharides and polysaccharides.
2. compare the primary, secondary, tertiary and quaternary structures of protein.
3. describe Watson and Crick's double stranded model of DNA and compare structure and functions of three forms of RNA
4. classify lipids based on their composition.

**Reference Books:**

1. Satyanarayana U., Chakrapani U. (2013) Biochemistry. 4<sup>th</sup> Edition. Elsevier, India.
2. Berg, M.J. Tymoczko L.J., and Stryer L. (2010) Biochemistry. 7<sup>th</sup> edition. H Freeman, New York.
3. Nelson D.L. Lehninger A.L. Michael M.C. (2008.) Lehninger Principles of Biochemistry. 5<sup>th</sup> Edition .Palgrave Macmillan.
4. Sadasivam S. Manickam A (2007) Biochemical Methods, New Age International (P) Limited.
5. Powar C. B. and Daginawala H. I. (2005). General microbiology Volume I. Himalaya Publishing House Private Limited, Pune, India.
6. Powar C. B. and Daginawala H. I. (2005). General microbiology Volume II. Himalaya Publishing House, Private Limited, Pune, India

**B.Sc.I SEMESTER II**  
**BMiP 123 -Practical Course II**

**Course objectives:**

Student should be able to...

1. know to weigh ingredients, adjust the pH of medium and operate the autoclave.
2. learn various techniques of isolation.
3. understand biochemical characteristics of bacteria.
4. study qualitative analysis of carbohydrate.

<b>Total credits =2</b>	<b>SEMESTER-II</b> <b>BMiP 123 -Practical Course II</b> <b>(Based on BMiT 121 and BMiT 122 )</b>	<b>No. of hours (60)</b>
	<ol style="list-style-type: none"> <li>1. Demonstration of laboratory equipments- Colorimeter, laminar air flow, anaerobic jar, pH meter, electronic balance, colony counter.</li> <li>2. Preparation and sterilization of nutrients broth, MacConkey's agar, Sabouraud's agar.</li> <li>3. Enumeration of bacteria from fermented food / soil / water samples by pour plate technique</li> <li>4. Enumeration of bacteria from fermented food / soil / water samples by spread plate technique.</li> <li>5. Isolation of bacteria by streak plate technique. (Colony and cultural characteristics)</li> <li>6. To detect the ability of bacteria to produce amylase enzyme.</li> <li>7. To detect the ability of bacteria to produce catalase enzyme.</li> <li>8. To detect the ability of bacteria to produce caseinase enzyme.</li> <li>9. To check the ability of microorganism to ferment sugar.</li> <li>10. To check the ability of microorganisms to produce H<sub>2</sub>S.</li> <li>11. Qualitative analysis of biomolecules Carbohydrate.               <ol style="list-style-type: none"> <li>i) General Test for Carbohydrate- Molisch Test</li> <li>ii) Test for Reducing Sugar – Benedict's Test</li> <li>iii) Test for Non reducing Sugar- Benedict's Test</li> <li>iv) Test for Starch- Iodine Test</li> </ol> </li> <li>12. Qualitative analysis of biomolecules</li> </ol>	

	Proteins. i) Detection of Protein by Biuret Test ii) Acetic Acid Test 13. Isolation of pure cultures of bacteria by four quadrant streaking method and study of colony characteristics, Gram Staining and motility of <i>E. coli</i> 14. Isolation of pure cultures of bacteria by four quadrant streaking method and study of colony characteristics, Gram Staining and motility of <i>Bacillus species</i> 15. Isolation of pure cultures of bacteria by four quadrant streaking method and study of colony characteristics, Gram Staining and motility of <i>Staphylococcus aureus</i> .	
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**Course outcomes:**

Students will be able to...

1. prepare and sterilize culture media.
2. perform various techniques of isolation of bacteria.
3. operate instruments in Microbiology laboratory.
4. detect protein and carbohydrates in samples.

**Reference Books:**

1. Arora B. and Arora D. R. (2020). Practical Microbiology. CBS Publishers and Distributors, New Delhi, India.
2. Dubey R. C. and Maheshwari D. K. (2012). Practical Microbiology. S. Chand and Company Limited, New Delhi, India
3. Shivashankara A.R., Ganesh M.K., Shivaraja Shankara Y.M. (2012) Laboratory Manual for Practical Biochemistry. India: Jaypee Brothers Medical Publisher Pvt. Ltd.
4. Jayraman J. (2011) Laboratory Manual of Biochemistry. India: New Age International publisher.
5. Atlas R. M. (2010). Handbook of Microbiological Media. Ukraine: Taylor and Francis.
6. Singh R., Sawhney S. K. (2005) Introductory Practical Biochemistry. UK: Alpha Science International.
7. David T. Plummer (1993) An Introduction to Practical Biochemistry, 3rd Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi

**Course outcomes:**

Student will be able to...

1. analyze different types of biological database.
2. use bioinformatics resources for easy searching of biological database.
3. apply the application of bioinformatics.
4. explain the concept of protein sequencing.

**Reference Books:**

1. Arthur L. (1988) Introduction to Bioinformatics Oxford University press.
2. Letovsky S. I. (1977) Bioinformatics: Databases and Systems.
3. Pevzner, (2002). Bioinformatics and functional genomics Wiley publication.
4. Rastogi S.C. (2013) Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery, 4 th edition, Phi publication.
5. Rajaraman V., (2001) Fundamentals of Computers, Phi Learning, ISBN:8120321758.
6. Tanenbaum Andrew S, (2003). Computer Networks, 4th Edition, Prentice Hall PTR, ISBN:8120321758.

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