

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's  
**New Arts, Commerce, and Science College**  
**Ahmednagar (Autonomous)**  
(Affiliated to Savitribai Phule Pune University, Pune)



**National Education Policy (NEP)**  
**Choice Based Credit System (CBCS)**

**Programme Framework**  
**B. Sc. - I (Microbiology)**

**Implemented from**  
**Academic Year 2024-25**

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's  
**New Arts, Commerce and Science College, Ahmednagar**  
**(Autonomous)**  
**Board of Studies in Microbiology**

<b>Sr. No.</b>	<b>Name</b>	<b>Designation</b>
<b>1.</b>	Ms. Giramkar Dipali D.	Chairman
<b>2.</b>	Mr. Shaikh Sajid H.	Member
<b>3.</b>	Ms. Pansare Ragini P.	Member
<b>4.</b>	Ms. Shinde Ashwini A.	Member
<b>5.</b>	Ms. Mehetre Vidya S.	Member
<b>6.</b>	Ms. Sarode Dhanashree S.	Member
<b>7.</b>	Ms. Suryavanshu Amruta P.	Member
<b>8.</b>	Dr. Gahile Yogesh R.	Member
<b>9.</b>	Mr. Wani Ashish S.	Member
<b>10.</b>	Dr. Patil Ulhas K.	Member(Co-Opt)
<b>11.</b>	Dr. Dixit Prashant P.	Academic Council Nominee
<b>12.</b>	Dr. Naphade Bhushan S.	Academic Council Nominee
<b>13.</b>	Mr. Choure Rajendra G.	Vice-Chancellor Nominee
<b>14.</b>	Mr. Yewatkar Saikiran	Alumni
<b>15.</b>	Mr. Dube Chandrakant G.	Industry Expert

## **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 NEP-2020 offers an opportunity to effect paradigm shift from a teacher-centric to student-centric higher education system in India. It caters skill based education where the graduate attributes are first kept in mind to reverse-design the programs, courses and supplementary activities to attain the graduate attributes and learning attributes. The learning outcomes-based curriculum framework for a degree in B.Sc. (Honours) Microbiology is intended to provide a comprehensive foundation to the subject and to help students develop the ability to successfully continue with further studies and research in the subject while they are equipped with required skills at various stages. Effort has been made to integrate use of

recent technology and use of MOOCs to assist teaching-learning process among students. The framework is designed to equip students with valuable cognitive abilities and skills so that they are successful in meeting diverse needs of professional careers in a developing and knowledge-based society. The curriculum framework takes into account the need to maintain globally competitive standards of achievement in terms of knowledge and skills in Microbiology and allied courses, as well develop scientific orientation, spirit of enquiry, problem solving skills, human and professional values which foster rational and critical thinking in the students. This course serves a plethora of opportunities in different fields right from classical to applied aspects in Microbiology. Some of the characteristic attributes a graduate in Microbiology should possess are:

- Disciplinary knowledge and skills • Skilled communication
- Critical thinking and problem solving capacity • Logical thinking and reasoning
- Team Spirit & Leadership Quality • Digital efficiency • Ethical awareness / reasoning
- National and international perspective • Lifelong learning

## **2. Programme Outcomes (POs)**

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.

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

**B. Sc. Programme Framework: Credit Distribution**

Level/ Difficulty	Sem	Subject-1 (Selected as Major)						Subject-2		Subject-3		(SEC)	GE/OE		IKS	AEC	VEC	CC	Total	
		T		P				T	P	P	T	P	T	P						
Certificate 4.5 / 100	I	02		02				02	02	02	02	-	02		02	02	02	02	22	
	II	02		02				02	02	02	02	02	-	02		--	02	02	02	22
		Credits Related to Major						Selected as Minor												
		Core		Elective		VSC	FP / OJT/ CEP/RP													
		T	P	T	P	P	P	T	P	-	P	T	P	-	-	-	-	-	-	
Diploma 5.0 / 200	III	04	02	--		02	02	02	02	-	02	02		-	02	-	02	22		
	IV	04	02	--		02	02	02	02	-	02		02	--	02	-	02	22		
Degree 5.5 / 300	V	06	04	02	02	2	2	02	-	-	-	-	-	02	-	-	-	22		
	VI	06	04	02	02	2	4	02	-	-	-	-	-	-	-	-	-	22		
<b>Total</b>		<b>24</b>	<b>16</b>	<b>04</b>	<b>04</b>	<b>08</b>	<b>10</b>	<b>10</b>	<b>08</b>	<b>04</b>	<b>04</b>	<b>06</b>	<b>08</b>	<b>04</b>	<b>08</b>	<b>04</b>	<b>08</b>	<b>132</b>		
6.0/400 Honours	VII	08	06	02	02	-	RM-04											22		
	VIII	08	06	02	02		OJT-04											22		
6.0/400 Honours with Research	VII	06	04	02	02		RM-04 RM-04											22		
	VIII	06	04	02	02		RM-08											22		
<b>Total</b>		<b>40/36</b>	<b>28/24</b>	<b>08</b>	<b>08</b>	<b>08</b>	<b>18/26</b>	<b>10</b>	<b>08</b>	<b>04</b>	<b>04</b>	<b>06</b>	<b>04</b>	<b>04</b>	<b>04</b>	<b>08</b>	<b>04</b>	<b>08</b>	<b>176</b>	

**B.Sc. Programme Framework: Course Distribution**

Level / Difficulty	Sem	Subject-1 (Selected as Major)						Subject-2		Subject-3		(SEC)	GE/OE		IKS	AEC	VEC	CC	Total
		T		P				T	P	P	T	P	T	P					
Certificate 4.5 / 100	I	01		01				01	01	01	01	-	01		01	01	01	01	11
	II	01		01				01	01	01	01	01	-	01	--	01	01	01	11
		Credits Related to Major						Selected as Minor											
		Core		Elective		VSC	FP / OJT / CEP / RP												
		T	P	T	P	P	P	T	P	-	P	T	P	-	-	-	-	-	
Diploma 5.0 / 200	III	02	01	--		01	FP-01	01	01	-	01	01		-	01	-	01	11	
	IV	02	01	--		01	CEP-01	01	01	-	01		01	--	01	-	01	11	
Degree 5.5 / 300	V	03	02	01	01	01	FP-01	01	-	-	-	-		01	-	-	-	11	
	VI	03	02	01	01	01	OJT-01	01	-	-	-	-		-	-	-	-	10	
<b>Total</b>		<b>12</b>	<b>08</b>	<b>02</b>	<b>02</b>	<b>04</b>	<b>04</b>			<b>02</b>	<b>02</b>	<b>03</b>	<b>04</b>	<b>02</b>	<b>04</b>	<b>02</b>	<b>04</b>	<b>65</b>	
6.0/400 Honours	VII	03	03	01	01	-	RM-01											09	
	VIII	03	03	01	01		OJT-01											09	
6.0/400 Honours with Research	VII	02	02	01	01		RM-01 RM-01											08	
	VIII	02	02	01	01		RM-01											07	
<b>Total</b>		<b>18/16</b>	<b>14/12</b>	<b>04</b>	<b>04</b>	<b>04</b>	<b>06/07</b>	<b>06</b>	<b>04</b>	<b>02</b>	<b>02</b>	<b>03</b>	<b>04</b>	<b>02</b>	<b>04</b>	<b>02</b>	<b>04</b>	<b>83/80</b>	

**B. Sc. -Microbiology: Credit and Course Distribution in Brackets**

Level / Difficulty	Sem	Subject-1							Total
		T		P					
4.5	I	02 (01)		02 (01)				04(02)	
	II	02 (01)		02 (01)				04(02)	
		Credits Related to Major							
		Core		Elective		VSC	FP / OJT/ CEP	IKS	
		T	P	T	P	P	P	T	
5.0	III	04(02)	02(01)	--		02(01)	FP-02(01)		10(05)
	IV	04(02)	02(01)	--		02(01)	CEP-02(01)		10(05)
5.5	V	06(03)	04(02)	02(01)	02(01)	02(01)	FP-02(01)	02(01)	20 (10)
	VI	06(03)	04(02)	02(01)	02(01)	02(01)	OJT-04(01)		20(09)
<b>Total</b>		<b>12</b>	<b>08</b>	<b>(02)</b>	<b>(02)</b>	<b>04</b>	<b>04</b>	<b>(01)</b>	<b>33</b>
6.0	VII	03	03	(01)	(01)	-	RM-04(01)		22(09)
	VIII	03	03	(01)	(01)		OJT-04(01)		22(09)
6.0	VII	(02)	(02)	(01)	(01)		RM-04(01) RP-04(01)		22(08)
	VIII	(02)	(02)	(01)	(01)		RM-08(01)		22(07)
		<b>18/16</b>	<b>14/12</b>	<b>04</b>	<b>04</b>	<b>04</b>	<b>06/07</b>	<b>(01)</b>	<b>51/48</b>

**Programme Framework (Courses and Credits): B. Sc. Microbiology**

Sr. No.	Year	Semester	Level	Course Type	Course Code	Title	Credits
1.	I	I	4.5	DSC-01	BS-MR 111T(A)	Introduction To Microbiology	02
2.	I	I	4.5	DSC-01	BS-MR 111T(B)	Introduction To Microbiology World	02
3.	I	I	4.5	DSC-02	BS-MR 112P(A)	Microbiology Practical Course I	02
4.	I	I	4.5	DSC-02	BS-MR 112P(B)	Practicals Based on Basic Microbiology	02
5.	I	II	4.5	DSC-03	BS-MR 121T(A)	Microbial Growth And Control	02
6.	I	II	4.5	DSC-03	BS-MR 121T(B)	Industrial Microbiology	02
7.	I	II	4.5	DSC-04	BS-MR 122P(A)	Microbiology Practical Course II	02



8.	I	II	4.5	DSC-04	BS-MR 122P(B)	Practicals based on Industrial Microbiology	02
9.	II	III	5.0	DSC-05	BS-MR 231T	Medical Microbiology And Immunology	02
10.	II	III	5.0	DSC-06	BS-MR 231T	Bacterial Physiology And Metabolism	02
11.	II	III	5.0	DSC-07	BS-MR 231P	Practical Course Based On Theory Paper I And II	02
12.	II	III	5.0	VSC-01	BS-MR 234P	Labrotory Practices In Microbiology	02
13.	II	III	5.0	FP-01	BS-MR 235T	Field Project	02
14.	II	IV	5.0	DSC-08	BS-MR 241T	Bacterial Genetics	02
15.	II	IV	5.0	DSC-09	BS-MR 242T	Air ,Water And Soil Microbiology	02
16.	II	IV	5.0	DSC-10	BS-MR 243P	Practical Course Based On Theory Paper I And II	02
17.	II	IV	5.0	VSC-02	BS-MR 243P	Indurtrial Microbiology	02
18.	II	IV	5.0	CEP-01	BS-MR 245P	Community Engagement Project	02
19.	III	V	5.5	DSC-11	BS-MR 351T	Medical Microbiology	02
20.	III	V	5.5	DSC-12	BS-MR 352T	Molecular Biology I	02
21.	III	V	5.5	DSC-13	BS-MR 353T	Enzymology	02
22.	III	V	5.5	DSC-14	BS-MR 354P	Microbiology Practical Course I	02
23.	III	V	5.5	DSC-15	BS-MR 355P	Microbiology Practical Course II	02
24.	III	V	5.5	DSE-01	BS-MR 356T	Applied Microbiology	02
25.	III	V	5.5	DSE-02	BS-MR 357P	Practical Course Base On Applied Microbiology	02
26.	III	V	5.5	VSC-03	BS-MR 358P	Nanobiotechnology	02
27.	III	V	5.5	FP-02	BS-MR 359P	Filed Project	02
28.	III	V	5.5	IKS-02	BS-MR 360T	Vedic Microbiology	02
29.	III	VI	5.5	DSC-16	BS-MR 361T	Immunology	02
30.	III	VI	5.5	DSC-17	BS-MR 362T	Fermentation Technology	02
31.	III	VI	5.5	DSC-18	BS-MR 363T	Molecular Biology II	02
32.	III	VI	5.5	DSC-19	BS-MR 364P	Microbiology Practical Course I	02
33.	III	VI	5.5	DSC-20	BS-MR 365P	Microbiology Practical Course II	02
34.	III	VI	5.5	DSE-03	BS-MR 366T	Food And Dairy Microbiology	02
35.	III	VI	5.5	DSE-04	BS-MR 367P	Practical Course Based On Food And Dairy Microbiology	02
36.	III	VI	5.5	VSC-04	BS-MR 368P	Cilincal Pathology And Biochemistry	02
37.	III	VI	5.5	OJT-01	BS-MR 369T	On Job Training	04

## B. Sc. Microbiology (Honours)

38.	IV	VII	6.0	DSC-21	BS-MR 471T	Microbial Cell Organization And Biochemistry	03
39.	IV	VII	6.0	DSC-22	BS-MR 472T	Quantitative Biology	03
40.	IV	VII	6.0	DSC-23	BS-MR 473T	Microbial Systematics	02
41.	IV	VII	6.0	DSC-24	BS-MR 474P	Practical Course Based On Biochemical Techniques	02
42.	IV	VII	6.0	DSC-25	BS-MR 475P	Practical Course Based On Biostatistics And Bioinformatics	02
43.	IV	VII	6.0	DSC-26	BS-MR 476TP	Practical Course Based On Developmental Biology And Microbial Diversity	02
44.	IV	VII	6.0	DSE-05	BS-MR 477T	Virology	02
45.	IV	VII	6.0	DSE-06	BS-MR 478T	Practical Course Based On Virology	02
46.	IV	VII	6.0	RM-01	BS-MR 479T	Research Methodology	04
47.	IV	VIII	6.0	DSC-27	BS-MR 481T	Instrumentation And Molecular Biophysics	03
48.	IV	VIII	6.0	DSC-28	BS-MR 482T	Molecular Biology	03
49.	IV	VIII	6.0	DSC-29	BS-MR 483T	Nitrogen Metabolism And Photosynthesis	02
50.	IV	VIII	6.0	DSC-30	BS-MR 484T	Practical Course Based On Instrumentation Techniques	02
51.	IV	VIII	6.0	DSC-31	BS-MR 485T	Practical Course Based On Molecular Biology	02
52.	IV	VIII	6.0	DSC-32	BS-MR 486T	Practical Course Based On Nitrogen Metabolism And Photosynthesis	02
53.	IV	VIII	6.0	DSE-07	BS-MR 487T	Enzymology And Bioenergetics	02
54.	IV	VIII	6.0	DSE-08	BS-MR 488T	Practical Course Based On Enzymology	02
55.	IV	VIII	6.0	OJT-02	BS-MR 489T	On Job Training	04

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's  
**New Arts, Commerce and Science College, Ahmednagar**  
 (Autonomous)  
**Syllabus**  
**B. Sc. –I Microbiology**

Title of the Course: Introduction to Microbiology								
Year: I				Semester: I				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
<b>DSC-01</b>	<b>BS-MR 111T(A)</b>	02	00	02	30	15	35	50

**Learning Objectives:** The objective of this course is 1.to introduce the students to the subject of Microbiology, different braches of Microbiology 2.to make aware the students about history and development of Microbiology as well as bacterial cytology and Tecnique.

**Course Outcomes (Cos)**

1. Students will learn classification system and different types of microorganism
2. Students will learn the historical developments in Microbiology from the discovery of microbes to the role of microbes in various fields
3. Students will learn the Principle, working and application of bright field microscopy, phase contrast microscopy, fluorescence microscopy, electron microscopy.
4. Students will learn the staining techniques like monochrome staining, negative staining, differential staining and special staining.
5. Students will be learn bacterial cytology Structure, chemical composition and functions of the components in bacterial cell.

**Detailed Syllabus:**

Unit No	Topic	No. of Hours
<b>Unit I</b>	<b>Introduction to Microbiology</b> <b>Beneficial and Harmful effects of microorganisms</b> <ul style="list-style-type: none"> <li>• Scope and application of Microbiology</li> <li>• Medical Microbiology , Environmental Microbiology ,Food and Dairy Microbiology,Agricultural Microbiology,Industrial Microbiology , Immunology</li> <li>• Morphological and differentiating characters of</li> </ul>	<b>05</b>

	<p>microorganisms</p> <ol style="list-style-type: none"> <li>1. Bacteria (Eubacteria , Archaea, Actinomycetes)</li> <li>2. Rickettsia</li> <li>3. Protozoa</li> <li>4. Fungi</li> <li>5. Algae</li> <li>6. Viruses, Viroids and Prions</li> </ol> <ul style="list-style-type: none"> <li>• <b>Classification systems</b>-Three domain classification and Five kingdom system of classification\</li> <li>• Introduction to Bergey’s Manual of Determinative and Systemic Bacteriology</li> </ul>	
<b>Unit II</b>	<p><b>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</li> <li>• <b>Golden Era of Microbiology</b> Contributions of –</li> <li>• Louis Pasteur (Fermentation, Rabies, Pasteurization and Cholera vaccine-fowl cholera experiment)</li> <li>• Robert Koch (Koch’s Postulates, Germ theory of disease, Discovery of viruses (TMV and Bacteriophages),</li> <li>• River’s Postulates</li> <li>• Contribution of Joseph Lister (antiseptic surgery), Paul Ehrlich (Chemotherapy), Edward Jenner (Vaccination) and Alexander Fleming (Penicillin)</li> </ul>	<b>08</b>
<b>Unit III</b>	<p><b>Bacterial Cytology</b></p> <ul style="list-style-type: none"> <li>• Microbial cell size, shape and arrangements</li> </ul> <p><b>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>• 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> <li>• Cell inclusions</li> </ul>	<b>07</b>
<b>Unit IV</b>	<p><b>Microscopy and Staining method</b></p> <p><b>A. Microscopy:</b> Principle, working and application of different types of Microscopes:</p>	<b>10</b>

	<p>Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Scanning and Transmission Electron Microscope.</p> <p><b>B. Staining Methods:</b></p> <ol style="list-style-type: none"> <li>a. Definition and types of stains (acidic and basic stains)</li> <li>b. Role of Mordant, fixatives, accentuators and decolourizers</li> <li>c. Simple (Monochrome) staining and negative staining,</li> <li>d. Differential staining- Gram staining, and acid-fast staining.</li> <li>e. Special staining-Endospore staining, capsule staining, cell wall.</li> </ol>	
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**Suggested Readings/Material:**

1. Daniel L., (1998). Microbiology, 2nd Edition, McGraw-Hill Publication.
2. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology, 3rd Edition, Thomson Brooks/Cole.
3. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.
4. Pelczar M.J., Chan JR. E.C.S., Noel R. K. (1993). Microbiology, 5th Edition, Tata McGraw Hill Press.
5. Prescott L.M., Harley J.P., and Klein D.A. (2005). Microbiology, 6th Edition. McGraw Hill Companies Inc.
6. Prescott, Lancing. M., John, P. Harley and Donald, A. Klein (2006). Microbiology, 6th Edition, McGraw Hill Higher Education.
7. J. M., Sherwood L. M. and Woolverton C. J. (2013). Prescott's Microbiology, 8th Edition, McGraw-Hill Higher Education.
8. Salle A.J. (1971). Fundamental Principles of Bacteriology. 7th Edition, Tata McGraw Hill Publishing Co.
9. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987). General Microbiology, 5th Edition, Macmillan Press Ltd.
10. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8th Edition, Pearson Education Inc.

Title of the Course: Introduction to Microbiology World								
Year: I				Semester: I				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-01	BS-MR 111T(B)	02	00	02	30	15	35	50

**Learning Objectives:**

1. To gain knowledge about classification and characteristics of microorganisms.
2. To compare the anatomy and physiology of prokaryotic and eukaryotic cells.
3. To define the nutrition and types of microorganisms.
4. To explain the growth and reproduction of microbial populations.
5. To study microscopy and staining technique

**Course Outcomes (Cos)**

- a. Understand the history of Microbiology
- b. Study the contributions of phenomenal scientists in the field of Microbiology
- c. Study the branches of Microbiology
- d. Learn classification of microorganisms and bacterial cell structure analysis.

Unit No.	Topics	No. of Hours
<b>Unit -1.</b>	<b>Introduction, History, Branches and Scope of Microbiology:</b> Introduction to Microbiology and different concepts in Microbiology Pre golden era, Golden era and post golden era of Microbiology Contributions of scientists in the field of Microbiology Basic, applied branches of Microbiology and scope of Microbiology in various field	<b>05</b>
<b>Unit -2.</b>	<b>Types of cells, Classification of microorganisms and types of bacteria:</b> Prokaryotic and eukaryotic cells Classification of microorganisms- Bacteria, fungi, protozoa, algae Viruses, Viroid, Prions. Classification and types of bacteria- Archaeobacteria, Eubacteria Industrially important fungi- Molds and yeasts	<b>06</b>
<b>Unit -3.</b>	<b>Microbial Physiology and Microbial Growth:</b> Ultra structure of bacteria –Chromosomal and extrachromosomal DNA, ribosome, cell wall, cell membrane, capsule, endospore, flagella, Fimbriae, Pili Cell inclusions- Gas vesicles, carboxysomes, PHB granules, metachromatic granules, glycogen bodies, starch granules, magnetosomes, sulfur granules, chlorosomes etc. Growth curve, introduction to kinetics of growth, generation time, growth rate. Reproduction in microorganisms: sexual reproduction and asexual	<b>09</b>

	reproduction.	
<b>Unit -4.</b>	<b>Isolation, Characterization, Microscopy and Staining Techniques:</b> Isolation techniques- Serial dilutions, spread plate, pour plate and streak plate, colony and biochemical characterization Methods of enumeration: Microscopic methods (Direct microscopic count), Plate counts (Total viable count), Turbidometric methods. Overview of types of microscopy Principles and working of Microscopy- a) Bright field microscope and b) Dark field microscope Definitions of Stain; Types of stains Properties and role of Fixatives, Mordants, Decolourisers and Accentuators. Simple staining, differential staining and special staining	<b>10</b>

**Suggested Readings/Material:**

1. Brock Biology of Microorganisms (14th Edition) 14th Edition by Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl, Thomas Brock
2. Stanier, Y., Doudoroff, M., & Adelberg, E. A. (1958). General Microbiology. General Microbiology.
3. Prescott's Microbiology 10th Edition. By Joanne Willey and Linda Sherwood and Christopher J. Woolverton
4. Black, J. G. (2017). Microbiology: principles and explorations. John Wiley & Sons.
5. Talaro, K. P., & Chess, B. (2018). Foundations in Microbiology. McGraw-Hill.
6. Foster, J. W., & Slonczewski, J. L. (2017). Microbiology: an evolving science. WW NORTON.
7. Microbiology. by Michael J. Pelczar Jr., Roger D. Reid, et al.
8. Microbiology: An Introduction, Global Edition. Edited by Gerard J. Tortora

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's  
**New Arts, Commerce and Science College, Ahmednagar**  
**(Autonomous)**  
**Syllabus**  
**B. Sc. -I (Microbiology)**

Title of the Course: Microbiology Practical Course I								
Year: I				Semester: I				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-02	BS-MR 112P(A)	00	02	02	60	15	35	50

**Learning Objectives:** The objective of this course is 1.to make students familiar with basic working of Microbiology Laboratory and 2. To learn basic techniques such as Handling of instruments,glasswares,aseptic handling etc.3. to learn staining techniques.

**Course Outcomes (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 microorganisms.
4. Students will understand basic techniques in the laboratory such as handling, wrapping, plugging of laboratory glasswares etc.
5. Students will understand aseptic transfer techniques

**Detailed Syllabus:**

Sr.No.	Title of the Experiment	No. of Practical
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 air oven, 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.	Wet mount slide preparation and its observation for: Bacteria, Algae, Fungi and Protozoa.	1
5.	Permanent slide observation: 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 : Gram staining of bacteria	1
11.	Observation of motility in bacteria using: Hanging drop method and swarming growth method.	2

**Suggested Readings/Material:**

1. Laboratory Exercises in Microbiology(2002), 5<sup>th</sup> Edition, Harley–Prescott, The McGraw–Hill Companies,
2. A Handbook of Practical Microbiology(2013), R. Saravanan D. Dhachinamoorthi CH. MM. Prasada Rao LAP LAMBERT Academic Publishing
3. Practical Handbook of Microbiology (2015)3<sup>rd</sup> Edition, by Emanuel Goldman and Lorrence H Green, (Editor), CRC Press

Title of the Course: Practicals Based on Basic Microbiology								
Year: I				Semester: I				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-02	BS-MR 112P(B)	00	02	02	60	15	35	50

**Learning Objectives:**

1. To study glassware's used in Microbiology laboratory and its cleaning.
2. To study preparation of nutrient medium for isolation of microorganisms.
3. Isolation of microorganism by streak plate method, pour plate, spread plate method and Staining.
4. To study isolation, enumeration and staining techniques.

**Course Outcomes (Cos)**

1. Student will study good laboratory practices
2. Students will learn the isolation techniques
3. Students will learn the bacteria, algae and fungi isolation technique and its morphological study
4. Students will study different staining techniques used in Microbiology

Sr. No	Experiment Title	No. of Practicals
1.	Safety Measures and Good Laboratory Practices in Microbiology laboratory	1
2.	Preparation of Winogradsky column to study diverse bacterial communities	1
3.	Study of microscope and cell morphology by micrometry	1
4.	Hanging drop preparation for observation of motility	1
5.	Preparation of bacterial culture medium and aseptic transfer technique	1
6.	Isolation and enumeration of microorganisms by spread plate method	1
7.	Isolation and enumeration of microorganisms by pour plate method	1
8.	Isolation and characterisation of microorganisms by streak plate method	1
9.	Study of simple staining technique by monochrome staining	1
10.	Study of differential staining technique by Gram's Staining	1
11.	Study of special staining technique by endospore staining	1
12.	Biochemical characterisation of bacteria (catalase and oxidase test)	1

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**Syllabus**  
**B. Sc. -I (Microbiology)**

Title of the Course: <b>Microbial Growth and Control</b>								
Year: I				Semester: II				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-03	<b>BS-MR121T(A)</b>	02	00	02	30	15	35	50

**Learning Objectives:** The objective of this course is 1. To make students aware about the nutritional classification of microorganisms and the types of culture media employed to isolate the microorganisms 2. To learn the method for isolation and maintenance of pure cultures and 3. to learn the different methods of sterilization and disinfe

**Course Outcomes (Cos)**

1. Students will understand the nutritional requirement of a microbial cell and nutritional classification of microorganisms.
2. Students will learn the design and preparation of different types of culture media.
3. Students will learn the isolation and preservation technique and study different methods of enumeration of bacterial growth and about bacterial growth in response to environment factors.
4. Students will study different methods for microbial control such as sterilization, disinfection and their mode of action and their efficiency.

## Detailed Syllabus:

Unit No.	Topic	No. of Hours
<b>Unit I</b>	<p><b>A. Microbial Cultivation and Growth</b></p> <ol style="list-style-type: none"> <li>1. Nutritional requirements in bacteria and nutritional classification of microorganisms.</li> <li>2. Culture media: components of media, Types of media</li> <li>3. Pure culture techniques: Streak plate, spread plate and pour plate methods cultivation, maintenance and preservation of pure cultures.</li> <li>4. Asexual methods of reproduction, Bacterial growth curve, calculation of generation time and specific growth rate.</li> </ol> <p><b>. B. Measurement of bacterial growth- Methods of enumeration:</b></p> <ol style="list-style-type: none"> <li>1. Microscopic methods (Direct microscopic count, counting cells using improved Neubauer chamber, Petroff-Hausser counting chamber)</li> <li>2. Plate counts (Total viable count)</li> <li>3. Turbidometric methods (including Nephelometry)</li> <li>4. Estimation of biomass (Dry mass, Packed cell volume) <ul style="list-style-type: none"> <li>• Bacterial growth in response to environment (pH, Temperature, Salt and solute concentration, heavy metals)</li> </ul> </li> </ol>	<b>15</b>
<b>Unit II</b>	<p><b>Control of Microbial Growth</b></p> <ol style="list-style-type: none"> <li>1. Sterilization Mode of action and applications of- <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> </li> <li>2. Disinfection: Characteristics of an ideal disinfectant Mode of action and applications of- <ul style="list-style-type: none"> <li>• Chemical agents Aldehydes, Halogens, Quaternary ammonium compounds, Phenol and phenolic compounds, Heavy metals, Alcohol, Dyes, Detergents and Ethylene oxide.</li> <li>• Checking of efficiency of disinfectant - Phenol Coefficient (Rideal– Walker method)</li> </ul> </li> </ol>	<b>15</b>

**Suggested Readings/Material:**

1. Michael J Pelczar, JR. E.C.S. Chan, Noel R. Krieg. (1993) Microbiology, 5th Edition, Tata McGraw Hill Press.
2. Prescott, Lancing. M., John, P. Harley and Donald, A. Klein (2006), Microbiology, 6th Edition, McGraw Hill Higher Education
3. Willey J. M., Sherwood L. M. and Woolverton C. J. (2013) Prescott's Microbiology, 8th Edition, McGraw-Hill Higher Education
4. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata McGraw Hill Publishing Co.
5. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987) General Microbiology, 5th Edition. Macmillan Press Ltd.
6. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8th Edition. Pearson Education Inc

Title of the Course: Industrial Microbiology								
Year: I				Semester: II				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-03	BS-MR121T(B)	02	00	02	30	15	35	50

**Learning Objectives:**

1. To gain knowledge about Different concept in industrial Microbiology.
2. To study the types of fermentation.
3. To define the nutrition and types of microorganisms.
4. To explain the conventional method of optimization.
5. To study sterilization technique.

**Course Outcomes (Cos)**

- a. Learn isolation of industrially important microorganism.
- b. Understand the strain improvement and preservation.
- c. Understand process of the inoculum preparation.
- d. Learn different products produced by bacteria and yeast

**Detailed syllabus**

Unit No.	Topics	No. of Hours
<b>Unit- 1.</b>	<b>Introduction to Industrial Microbiology and Fermentation:</b> Definition of Industrial Microbiology Different concept in industrial Microbiology Historical development in fermentation industry Contribution of scientist in industrial Microbiology Scope of Industrial Microbiology Concept of fermentation Types of fermentation- Batch, fed- batch and continuous Design of typical fermenter, parts of fermenter with their function Overview of types of fermenter with examples.	05
<b>Unit- 2.</b>	<b>Fermentation Media:</b> Concept of media and types of media Role of nutrients in microbial growth Components of typical fermentation medium- Macro elements and microelements Crude sources of carbon and nitrogen in fermentation medium Water, buffer, precursor, inducer, inhibitor and antifoam agents Concept of optimization Conventional method of optimization Overview of statistical method of medium optimization	07
<b>Unit- 3.</b>	<b>Sterilization technique:</b> Concept of asepsis, disinfection & sterilization Sterilization by heat – Dry & moist heat Pasteurization methods and its types Sterilization by radiation- U.V. light & $\gamma$ radiation Filtration: Bacteriological filters, types and uses Chemical method of sterilization- Liquid and gases Disinfectant types, action & applications	06
<b>Unit -4.</b>	<b>Isolation of industrially important microorganism, Strain improvement and preservation:</b> Primary metabolites and secondary metabolites by microorganisms Concept of primary and secondary screening Strain improvement by mutation Stock cultures preservation and its maintenance Culture collection centres	06
<b>Unit -5.</b>	<b>Upstream &amp; downstream processing:</b> Concepts of upstream processes Inoculum preparation Concept of chemostat and turbidostat Fermentation process Basics of fermentation kinetics Concept of downstream processing Overview of downstreaming techniques Overview of different product produced by bacteria and yeast	06

**Suggested Readings/Material:**

1. Microbiology. by Michael J. Pelczar Jr., Roger D. Reid, et al.
2. Microbiology: An Introduction, Global Edition. Edited by Gerard J. Tortora
3. Brock Biology of Microorganisms (14th Edition) 14th Edition by Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl, Thomas Brock
4. Stanier, Y., Doudoroff, M., & Adelberg, E. A. (1958). General microbiology. General microbiology.
5. Prescott's Microbiology 10th Edition. By Joanne Willey and Linda Sherwood and Christopher J. Woolverton
6. Black, J. G. (2017). Microbiology: principles and explorations. John Wiley & Sons.
7. Talaro, K. P., & Chess, B. (2018). Foundations in microbiology. McGraw-Hill.
8. Foster, J. W., & Slonczewski, J. L. (2017). Microbiology: an evolving science. WW NORTON.
9. Patel, A.H. (2008). Industrial Microbiology. MaCmillan Publication, New Delhi.
10. Stanbury, Peter & Whitaker, A. (2008). Principal of Fermentation Technology. Butterworth Heinemann.
11. Casida L.E. (2005). Industrial Microbiology. New age International Publishers.
12. Srivastava, M.L. Fermentation Technology.
13. Singh, B.D. (2008). Biotechnology. New age International.



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**Syllabus**

**B. Sc. -I (Microbiology)**

Title of the Course: : Microbiology Practical Course II								
Year: I				Semester: II				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
<b>DSC-04</b>	<b>BS-MR 122 P(A)</b>	00	02	02	60	15	35	50

**Learning Objectives:** The objective of this course is 1.to develop the Microbiology skills in students like preparation and sterilization of media,2. To learn methods for isolation and cultivation and preservation of microorganisms.

**Course Outcomes (Cos):**

1. Students will be able to prepare and sterilize culture media and to check sterilization efficiency of autoclave.
2. Students will be able to perform isolation and enumeration of bacteria by streak, spread, pour plate techniques, observation of colony and cultural characteristics and enumeration using Direct Microscopic count
3. Students will understand the different methods of culture preservation.
4. Student will be able to determine the effect of different parameters on microbial growth

**Detailed Syllabus:**

Sr. No.	Title of the Experiment	No. of practical
1	Preparation and sterilization of different Microbiological culture media (Nutrient agar/broth, MacConkey's agar).	1
2	Checking sterilization efficiency of autoclave	1
3	Special staining techniques: i. Endospore staining	2

	ii. Capsule staining	
4	Isolation of bacteria by streak plate technique (observation of Colony and cultural characteristics)	1
5	Enumeration of microorganism from fermented food / soil / water by: i. Spread plate method ii. Pour plate method	2
6	Direct microscopic count: Yeast cell enumeration using Improved Neubauer Chamber	1
7	Study of the effect of different parameters on growth of bacteria ( pH, temperature, sodium chloride concentration, heavy metals )	3
8	To study enrichment technique with Winogradsky's column.	1
9	Preservation of cultures on slants, soil and on grain surfaces; revival of these cultures and lyophilized cultures.	1
10	Study of effect of washing on skin microflora (soap and disinfectant )	1

**Suggested Readings/Material:**

1. Laboratory Exercises in Microbiology (2002), 5<sup>th</sup> Edition, Harley–Prescott, The McGraw–Hill companies.
2. A Handbook of Practical Microbiology (2013), R. Saravanan D. Dhachinamoorthi CH. MM. Prasada Rao LAP LAMBERT Academic Publishing.
3. Practical Handbook of Microbiology (2015) 3<sup>rd</sup> Edition, by Emanuel Goldman and Lorrence H Green, (Editor) CRC Press.

Title of the Course: : Practicals based on Industrial Microbiology								
Year: I				Semester: II				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-04	BS-MR 122 P(B)	00	02	02	60	15	35	50

**Learning Objectives:**

1. To study working of laboratory bench top fermenter and CIP.
2. To study preparation of nutrient medium and sterility testing of medium.
3. To study Effect of nutrient concentration on microbial growth.
4. To study process of fermentation.

**Course Outcomes (Cos)**

1. Student will study CIPs.
2. Students will learn the screening techniques.
3. Students will learn the bacterial growth curve.
4. Students will study fermentation by Visiting to fermentation industry.

Sr. No	Experiment Title	No. of Practicals
1.	Study of parts and working of laboratory bench top fermenter and CIP	1
2.	Preparation of enriched/ enrichment/ differential/ selective/ minimal medium and sterility testing of medium	1
3.	Demonstration of fermentation by yeast/ bacteria	1
4.	Effect of salts concentration on microbial growth	1
5.	Effect of Temperature on Microbial Growth	1
6.	Effect of sugar concentration on microbial growth	1
7.	Effect of pH on Microbial Growth.	1
8.	Study of bacterial growth curve	1
9.	Primary screening for primary metabolite producer	1
10.	Secondary screening for primary metabolite producer	1
11.	Preparation of medium slant and preservation of isolate	1
12.	Visit to fermentation industry and report writing with photo documentation	1