

Sant Gadge Baba Amravati University, Amravati

NEP Syllabus

UG Programme

Faculty : Science and Technology

Programme : B.Sc. (Microbiology)

POs:

Students of undergraduate general degree programme at the time of graduation would be able to

- **PO1.** Critical Thinking : Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
- **PO2.** Effective Communication : Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
- **PO3.** Social Interaction : Elicit views of others, mediate disagreements and help reach conclusions in group settings.
- **PO4.:** Effective Citizenship : Demonstrate empathetic social concern and equity centre national development ,and the ability to act with an informed awareness of issues and participate in civil life through volunteering
- **PO5.** Ethics : Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
- **PO6.** Environment and Sustainability : Understand the issues of environmental contexts and sustainable development.
- **PO7.** Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest contexts socio-technological changes.

PSOs:

Upon completion of the program me successfully, The students would be able to

- **PSO 1** Gain insight of Microbiology starting from history and fundamental knowledge about the microorganisms.
- **PSO 2** Acquire the skill in the use and care of basic microbiological equipment and can

perform basic laboratory procedures in microbiology.

- **PSO 3** Be well-informative about the integral role of microorganisms and different branches of Microbiology.
- **PSO 4** Be acquainted with the basic concept of prokaryotes, their taxonomy, their differentiation from eukaryotes.

➤ **Employability Potential of the Programme:**

Microbiology is a branch of science that deals with study of microorganisms. The microbiological study has wide range of scope ranging from basic sciences to applied sciences. Microbiological study is mainly focused on causative agents of various diseases, microorganisms of agricultural, environmental and industrial use. The production of antimicrobial drugs to cure various diseases is covered in this discipline. Here is an overview of job opportunities where microbiology students have explored and would be helpful for upcoming students as well.

Medical Microbiology refers to the use of Microbiology in the Healthcare Industry. Microbiology firms are at the heart of the Healthcare Industry, whether they're developing diagnostic kits, vaccines, biologics, pharmaceuticals, or medical gear. Microbiology fields such as Molecular Biology, Cell Biology, Recombinant Technology, and immune therapeutics benefited from the medical sector's evolution. For those interested in a career in Medical Microbiology, there are numerous career prospects in Research and Development, Pharmaceutical Companies, Hospitals, Diagnostic Centers, Manufacturing Sector of Microbiology, and Academic Sector. Many of microbiology students have joined as Microbiologist at renowned pharmaceutical companies. Microbiology students have also joined COVID-19 diagnostic laboratories across various districts, thus helping the society. Beside these students have also joined vaccine manufacturing institutions.

Previously, this field only focused with the discovery and development of small molecules (drugs), but the industry has evolved throughout time. This industry's horizon has widened. Biopharmaceutics has added a new dimension to the industry. The use of Microbiology in drug research and discovery has always been a component of the process, but the addition of biologics as therapeutic elements has resulted in a rise of biotech businesses in the pharmaceutical sector. To begin, consider cell-based treatments, monoclonal antibodies, vaccinations, and other medicines. In this regard microbiology students has got jobs in various pharmaceutical industries.

Low crop yield, crop quality deterioration, weeds, loss of soil fertility, abiotic stress, and biotic stress are just a few of the issues that have plagued agriculture. Microorganisms are also

helpful in enhancing the crop productivity. Microbiology students are entrepreneur in this field. The biofertilizers are produced in bulk and are commercialized by few of our students. Incidentally biofertilizers are ecofriendly.

Food Microbiology overcomes challenges in food production, processing, and preservation. The production of value-added food products are the greatest examples. Almost all food industries need pure water. The bacterial quality of water is tested by Microbiologist. Food industry provides large scope for microbiologist. Microbiology students have occupied jobs at different food industries. Microbiology always helps in introducing technology which aims to enhance the production, processing, packaging and preservation of food also.

Environmental Microbiology aims to restore the balance between nature, ecology and human interest. Bioremediation and biological intervention is only possible by the way of utilization of techniques of Microbiology. All these issues are now being addressed by using Biotech processes. Microbes like bacteria, fungi algae and plants are being used in the process of bioremediation.

Beside job opportunities in the sector of agriculture, pharmaceutical and food industries microbiology students are working as research fellow at various National Institutes. Many students are working as Assistant Professor in colleges, Laboratory Technicians at Government and private pathological laboratories.

➤ **Transferable Skills:**

During the course student will develop skills other than laboratory skills that are transferable across the number of career areas. These are:

- Analytical skill
- Report writing skill
- Presentation skill
- Time management
- Creative thinking
- Problem solving
- Planning
- Observational skill

- **Job Opportunities:** After successful completion of B.Sc. in Microbiology student may continue further studies like M.Sc. in Microbiology and then Ph.D. in Microbiology and make career in research field. Students have opportunities in private as well as public sectors.

- **Private Sector:** Microbiologist can work in quality control, quality assurance and R & D divisions of companies like- Biotech companies, pharmaceutical companies, Chemical manufacturing companies, Food and Drink (includes brewing), Health and Beauty Care, Medical Instrument companies, Agricultural companies, Research Companies and Laboratories etc.
- **Public Sectors:** Blood Service, Cancer research institutes, Environmental Pollution Control, Forensic Science, Hospitals, National Blood Services, Overseas Development, Public Health Entities, Public Health Laboratories, Agriculture and fisheries etc.
- **Government Sector:** Syllabus has been design keeping in view that students can apply for various government post filled by Maharashtra Public Service Commission (MPSC), Union Public Service Commission (UPSC), Food Corporation of India, Forensic department, Health department and Food and Drug Administration. These departments recruit successful candidates for the post of Food safety officers in food and drug administration, Assistant Chemical Analyzers in forensic laboratories of Maharashtra and other states all over India, Laboratory Technicians in Clinical pathology laboratories Health department and Food Corporation of India, Sanitary Inspectors for schools etc.
- **Job profiles:** Microbiologist, Biochemist, Biologist, Biomedical Scientist, Biotechnologist, Chemical Examiners, Chemist, Clinical Scientist, Food Scientist, Forensic Scientist, Laboratory Technician, Microbiologist, Research Associates, Research Officers, and Research Scientist etc.

Thus syllabus has been prepared anticipating the requirements of B.Sc. Microbiology students under NEP Program. The contents have been drawn to accommodate the widening horizons of the Microbiology discipline and reflect the changing needs of the students.

Hence, Board of Studies in Biochemistry (Including Microbiology and Food Science) in its meeting held on **16.12.2023** resolved to accept the revised syllabus for B.Sc. I Sem. I and II (Microbiology) based on NEP as per UGC guidelines. The detailed syllabus for each paper is appended with a list of suggested readings.

Teaching and Learning Scheme: for the Degree of Bachelor of Science

(Three Years- Six Semesters Bachelor's Degree Programme)

FIRST YEAR: SEMESTER – I

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload (Hrs/Week)
Classroom Teaching / Lab Work (Practical)/ Outdoor/Field	a.	Major Microbiology 127	Theory1	127200	Introductory Microbiology	2	2	6
			Lab/ Practical-1	127201	Basic techniques and Study of microbes	2	4	
	b.	Major/ Minor	Theory1	-	-	2	2	6
			Lab/ Practical-2	-	-	2	4	
	c.	Generic/ Open Elective 127	Theory1	127202	Communicable diseases and their control	2	2	4
			Theory2	127203	Food preservation and Food safety	2	2	
	d.	SEC	Lab/ Practical-3	127204	Microscopy and Staining for microbes	2	4	4
	e.	AEC - English	Theory			1	1	6
		AEC –MIL	Theory			1	1	
		IKS-Generic	Theory			2	2	
		VEC	Theory			2	2	
	f.	CC	Outdoor			2	4	4
		TOTAL				22	30	30

Course : B. Sc I Semester I (Microbiology)

127200 Theory 1: Introductory Microbiology							
Level	Semester	Course code	Course Name	Credits	Teaching Hours	Exam Duration	Maximum marks
4.5	I	127200	Introductory Microbiology	2	30	2Hrs	30

Course Objectives

- To make the students aware about history and modern developments in microbiology.
- To impart knowledge about scope of microbiology with its branches and applications.
- To educate the students about occurrence and general features of different types of microorganisms
- To make the students understand the principles and working of different types of microscopes and have the knowledge of staining techniques.

Course outcome

Upon completion of this course successfully, students would be able to

- Explain the historical developments in microbiology and their importance as well as application in different sectors concerned with life on this planet.
- Differentiate the microbes on the basis of their characteristics and apply the classification scheme for identification.
- Discuss the similarities and differences in structures of prokaryotic and eukaryotic cells. and illustrate mutual relationship on the basis of three domain system.
- Illustrate different types of microscopes and staining techniques.

Unit System	Contents	Workload Allotted in hours	Weightage of Marks Allotted	Pedagogy
Unit I History and Development of Microbiology	➤ Discovery of Microscope- Contribution of Antony von Leeuwenhoek ➤ Controversy over Spontaneous generation: Contributions of Redi, Schulze and Schwan, Schroder & Van Dusch, Louis Pasteur ➤ Contribution of pioneers in development of Microbiology Louis Pasteur (fermentation & Vaccine) Alexander Fleming (Antibiotic) Joseph Lister (Antiseptic surgery),	8 Hrs	8 Marks	Chalk & Board, Power Point Presentation, Videos

	Edward Jenner (Small pox Vaccine) Robert Koch (Germ theory of diseases, Koch postulates) ➤ Modern developments of microbiology including Immunology, Recombinant DNA technology, Biotechnology. Contributions of Watson and Crick, Jacob and Monod, Hargobind Khorana, Ruska, Kary Mullis, Temin and Baltimore, Hamilton Smith			
Unit II Scope of Microbiology	➤ Occurrence of microorganisms ➤ Applied branches of microbiology ➤ Microorganisms for human welfare ➤ Microorganisms for environment and sustainability. ➤ Detrimental activities of microorganisms ➤ Microorganisms and human diseases, Biological weapons ➤ Microorganisms and diseases of animals ➤ Microorganisms and diseases of plants ➤ Microorganisms and spoilage	7 Hrs	7 Marks	Power Point Presentation, Group Discussion, Assignment
Unit III The world of Microbes	➤ Concept of prokaryotes and eukaryotes ➤ Structural differences in prokaryotic and eukaryotic cell ➤ Types of microorganisms ➤ Bacteria-Eubacteria and archaea ➤ Fungi, protozoa, algae viruses ➤ Basic branches of microbiology ➤ Woese system of 3 domain classification of microbes	8 Hrs	8 Marks	Chalk & Board, Power Point Presentation, Assignment

Unit IV Microscopy and Staining	A. Microscopy: ➤ Definition: Magnification, Resolving power, numerical aperture, focallength ➤ Principles, construction, ray diagram and applications: ➤ Compound Microscope ➤ Dark field microscope ➤ Electron Microscope. Staining: ➤ Dyes and Stains- auxochromes, chromophore, mordant ➤ Principles and Methods of the following techniques: ➤ Simple staining ➤ Differential staining- Gram stain, Acid fast staining and Endospore staining ➤ Capsule staining	7 Hrs	7 Marks	Chalk & Board, Power Point Presentation, Charts,
References	➤ Microbiology : Pelczar, Chan, Krieg.(TMH) ➤ Text Book of Microbiology : Dubey & Maheshwari (S.Chand, Publication) ➤ Fundamental of Microbiology : Frobisher ➤ General Microbiology Vol. I & II : Power & Dagainawala. (Himalaya Publication) ➤ Fundamentals Principles of : A.J. Salle. bacteriology ➤ Elementary Microbiology : Modi (Akta Prakashan) Vol. I & II			
Model Questions	Short Answer Questions 1. Contribution of Antony von Leeuwenhoek 2. How will you disprove spontaneous generation explain with suitable example 3. Contribution of Schulze and Schwan 4. Contribution of Louis Pasteur in the field of fermentation 5. Contribution of pioneer in the development of antibiotics 6. Write any two applied branches of Microbiology 7. Explain any two diseases of animal caused by microorganism 8. Explain any two diseases of human caused by microorganism 9. Explain any two diseases of plants caused by microorganism 10. Illustrate the role of microorganisms for human welfare 11. Explain with suitable example how microorganisms causes spoilage? 12. Differentiate between prokaryotes and eukaryotes 13. Discuss about various types of microorganisms 14. Explain various branches of microbiology 15. Write a note on algae and fungi 16. Define resolving power and numerical aperture 17. Discuss on electron microscope 18. Give the schematic explanation about simple staining			

19. Discuss any one method of differential staining
20. Give the schematic explanation about Dorner's method of endospore staining
21. Sketch ray diagram of dark field microscope
22. Differentiate between dyes and stain
23. What are the components of compound microscope
24. Explain Dyes and Stains
25. Differentiate between Simple staining and Gram staining
26. Illustrate the different parts of compound microscope

Long answer questions

1. Who disproves the spontaneous generation?
2. What was the contribution of pioneers in development of Microbiology?
3. Explain the 3 domain classification of microbes
4. With the help of labeled diagram differentiate in prokaryotes and eukaryotes
5. Discuss in detail acid fast staining
6. Discuss in detail endospore staining
7. Discuss in detail construction, ray diagram and applications of TEM
8. Explain with suitable example different applied branches of microbiology

Multiple choice Questions

1. Father of microbiology is

a. Louis Pasteur	b. Lister
c. A.V. Leeuwenhock	d. Robert Koch
2. The antiseptic method was first demonstrated by

a. Lwanowski	b. Lord Lister
c. Edward Jenner	d. Beijerinck
3. Small pox vaccine was first discovered by

a. Robert Koch	b. Louis Pasteur
c. Lister	d. Edward Jenner
4. Father of Medical Microbiology is

a. Pasteur	b. Jenner
c. Koch	d. A. L. Hock
5. Electron microscope gives magnification upto

a. 100 X	b. 2000 X
c. 50,000 X	d. 2,00,000 X
6. Compound Microscope was discovered by

a. A.V. Lewenhoek	b. Pasteur
c. Janssen and Hans	d. None of these
7. Acridine dyes are more effective against

a. Gram positive	b. Gram negative
c. Ricke Hsia	d. Mycoplasma
8. The procedure of differential staining of bacteria was developed by

a. A.H. Gram	b. H.C. Gram
c. N.C. Gram	d. H.A. Gram

The distribution of marks for the Continues Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks
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MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc (any two activity 5 mark each)		10 Marks
Total		20 Marks

127201 Lab 1 : Basic techniques and Study of Microbes							
Level	Semester	Course code	Course Name	Credits	Teaching Hours	Exam Duration	Maximum marks
4.5	I	127201	Lab1 : Basic Techniques and Study of Microbes	2	60	2Hrs	25+25

Course Objectives

- To train the students for basic techniques in microbiology.
- To introduce the students with handling and working of common equipments used in microbiology laboratory.
- To educate the students about microscopic and identifying characteristics of different types of microorganisms

Course outcomes

Upon completion of this course successfully, students would be able to

- Work in microbiology laboratory using basic techniques and by following safety and precautionary measures.
- Apply the knowledge of media preparation and inoculation for culturing bacteria in basic nutrient media using incubator.
- Use basic laboratory instruments viz. incubator, pH meter, colorimeter and laminar air flow cabinet.
- Demonstrate basic staining technique.
- Apply the knowledge of microscopic features for identification of the microbes.

Sr.No.	Contents of Practical (List of Laboratory Experiments/ Activities etc.)
1	Standard operating procedures for microbiology laboratory Disinfection, safety measures. Glassware washing, disposal of media.
2	Basic techniques of microbiology Petri plate wrapping, cotton plug preparation, Use of rubber bulbs and micropipettes Swabs preparation, use of inoculating loop
3	Study of incubator, spectrophotometer/colorimeter, centrifuge, laminar air flow system.
4	Use of Spectrophotometer/ colorimeter with any stain
5	Use of Centrifuge for centrifugation of microbial cultural/soil suspension
6	Use and care of microscope
7	Use of pH meter and Measurement of pH
8	Simple staining of yeast
9	Gram staining technique for bacterial culture
10	Negative staining technique
11	Study of bacteria using permanent slides and pictures of stained bacteria.
12	Study of moulds using permanent slides

13	study of yeast using permanent slides
14	study of eukaryotic algae using permanent slides
15	study of cyanobacteria using permanent slides
16	study of protozoa using permanent slides
17	study of viruses using electron microscopic photographs and photographs of plaques
References	➤ Microbiology, A laboratory manual by James D. Cappuccino and Natalie Sherman Addison Wesley publication, ➤ Practical Microbiology(Revised edition R.C.Dubey and D.K.Maheshwari Published by-S.Chand ➤ A textbook of Practical Microbiology (B Sc Sem 1 & 2): Dr. R. R. Pachori, P.S.Sadar, Dr. A. M. Pande, 2nd Edition. ➤ Microbes in Action :Seely, Wander Mark Tarporewala, Bombay ➤ A Mannual of Microbiology : A.J. Salle. ➤ Microbiology Methods : Collins ➤ Bacteriological Techniques :F.J.Baker ➤ Introduction to Microbial Techniques :Gunasekaran ➤ Laboratory Fundamentals of Microbiology : Alcamo, I.E., Jones and Bartlett Publishers. ➤ Practical Microbiology(Revised edition R.C.Dubey and D.K.Maheshwari Published by-S.Chand ➤ Textbook of Microbiology(Fourth edition) Prof. C P Baveja Published by Arya ➤ publications

The distribution of marks for the practical examination shall be as follows:

External Evaluation		Internal Evaluation based on CAT	
Performance of any two experiments	20 marks	Attendance & Students performance	10 Marks
Viva-voce	05 marks	Practical Record Book	05 Marks
		MCQ/ Spotting	10 Marks
Total	25 Marks	Total	25 Marks

127204 SEC Lab Practical 3 : : Microscopy and Staining for microbes							
Level	Semester	Course code	Course Name	Credits	Teaching Hours	Exam Duration	Maximum marks
4.5	I	127204	SEC : Microscopy and Staining for microbes	2	60	2Hrs	50

Course Objectives

- To train the students for basic skills of using compound microscope for study of microorganisms.
- To impart the skill of application of staining techniques for study of microorganisms.
- To educate the students about applications of different types of microscopes.

COs

Upon completion of this course successfully, students would be able to

- Do focusing with all the three objectives of compound microscope.
- Illustrate different types of microscopes and staining techniques.
- Apply different staining and microscopic techniques for study of microorganisms

S.N.	Contents of Practical (List of Laboratory Experiments/ Activities etc.)
1	Study of compound microscope with ray diagram.
2	Focusing with compound microscope using low power and high power objectives
3	Focusing with compound microscope using oil immersion objective.
4	Preparation of stains and other staining solutions.
5	Simple staining of yeast cells
6	Negative staining
7	Gram staining of <i>S. aureus</i>
8	Gram staining of <i>E. coli</i>
9	Gram staining of <i>Bacillus</i>
10	Endospore staining by Scheffer's and Fullton's method
11	Endospore staining by Dornor's method
12	Acid fast staining
13	Dark field microscopy with ray diagram
14	Hanging drop method for motility
15	Study of fungi using lacto phenol cotton blue staining
16	Fluorescence microscopy with ray diagram
17	Wet Mount of algae/algae staining
18	Study of Electron microscope using virtual lab / Videos

References	➤ Microbiology, A laboratory manual by James D. Cappuccino and Natalie Sherman Addison Wesley publication, ➤ Practical Microbiology(Revised edition R.C.Dubey and D.K.Maheshwari Published by-S.Chand ➤ A Text book of Practical microbiology by Sadar and pandey,Ed.Rachana Pachori(Sharma), Dnyanpath Publication. ➤ General Microbiology Vol. I & II : Power & Dagainawala. (Himalaya Publication) ➤ Fundamentals Principles of : A.J. Salle. bacteriology ➤ Elementary Microbiology : Modi (Akta Prakashan) Vol. I & II ➤ Practical Microbiology(Revised edition R.C.Dubey and D.K.Maheshwari Published by-S.Chand ➤ Textbook of Microbiology(Fourth edition) Prof. C P Baveja Published by Arya publications
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Internal Evaluation for SEC	
Attendance	10 Marks
Practical performance	20 Marks
MCQ/ Spotting	10 Marks
Practical Record book	10 Marks
Total	50 Marks

Teaching and Learning Scheme: for the Degree of Bachelor of Science

(Three Years- Six Semesters Bachelor's Degree Programme)

FIRST YEAR: SEMESTER – II

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload (Hrs/Week)
Classroom Teaching / Lab Work (Practical)/ Outdoor/ Field	a.	Major /Minor Microbiology 127	Theory2	127205	Bacteriology and Microbial control	2	2	6
			Lab/ Practical 4	127206	Techniques for culturing Bacteria	2	4	
	b.	Major/ Minor	Theory2	-	-	2	2	6
			Lab/ Practical-5	-	-	2	4	
	c.	Generic/ Open Elective 127	Theory3	127207	Microbes for Sustainable Agriculture	2	2	4
			Theory4	127208	Composting and Biogas Technology	2	2	
	d.	VSC	Lab/ Practical-6	127209	Microbial Control	2	4	8
		SEC	Lab/ Practical 7	127210	Isolation and Morphological Characterization of Bacteria	2	4	
	e.	AEC - English	Theory			1	1	4
		AEC –MIL	Theory			1	1	
		VEC	Theory			2	2	
	f.	CC	Outdoor			2	4	4
		TOTAL				22	32	32

127205 Theory 2 : Bacteriology and Microbial Control							
Level	Semester	Course code	Course Name	Credits	Teaching Hours	Exam Duration	Maximum Marks
4.5	II	127205	Bacteriology and Microbial control	2	30	2Hrs	30

Course Objectives ➤ To impart knowledge about structural features and components of bacterial cell. ➤ To impart knowledge about various methods of controlling the growth of microorganisms. ➤ To educate the students about nutritional aspects of microbial cultivation. ➤ To explain classification scheme of bacteria and characteristics of different taxonomic groups of bacteria.				
COs Upon completion of this course successfully, students would be able to ➤ Describe structural features and components of bacterial cell. ➤ Apply the knowledge of microbial nutrition for culturing microorganisms in laboratory ➤ Select the method of microbial control depending on the objective while working. ➤ Illustrate classification of bacteria and characteristics of different taxonomic groups of bacteria.				
Unit System	Contents	Workload Allotted in hours	Weightage of Marks Allotted	Pedegogy
Unit I Structural Organization of bacteria	➤ Typical Bacterial cell ➤ Shape, Size, and Arrangement of Bacteria ➤ Structure and functions of following ➤ Capsule and slime layer ➤ Cell wall- Gram positive and Gram negative bacteria. ➤ Cytoplasmic membrane- fluid mosaic model ➤ Flagella- Arrangement, Mechanism of flagellar movement. ➤ Pili- Arrangement and function ➤ Ribosomes-	8 Hrs	8 Marks	Chalk & Board, Power Point Presentation, Videos

	Prokaryotic and Eukaryotic ➤ Plasmid- Definition, General characters, classes ➤ Bacterial chromosome ➤ ix. Endospores- Structure and arrangements			
Unit II Microbial Nutrition:	Microbial Nutrition: ➤ Basic Nutritional Requirements: Sources of C, N,O, P, S, Energy, Macronutrients, Growth factors, water etc. ➤ Media, Synthetic, Nonsynthetic, Liquid and Solid, Semisolid, Differential, Enriched, Selective media. Role of beef extract, yeast extract, peptone, agar in nutrient media. ➤ Determination of nutritional requirements: Auxanographic technique, Replica plating technique. ➤ Nutritional classification on the basis of source of carbon and energy	7 Hrs	7 Marks	Power Point Presentation, Group Discussion, Assignment
Unit III Microbial control	➤ Definition and Terms Sterilization, disinfection, Antiseptic, Sanitizer, Germicide, Microbiostatis, Antimicrobial agent. ➤ Physical Control Temperature, osmotic pressure, Radiation, filtration. ➤ Chemical Control	8 Hrs	8 Marks	Chalk & Board, Power Point Presentation, Videos

	Chemistry and mode of action of halogens, heavy metals and their derivatives, Alcohols, Detergents and Gaseous Sterilization			
Unit IV Bacterial Systematics	➤ Taxonomy, Classification, , Identification, Nomenclature ➤ Identification criteria: Morphological, biochemical, cultural, serological ➤ Methods of classification: numerical taxonomy , r-DNA sequencing , phylogenetic tree ➤ Outline of Bergey's manual of systematic Bacteriology ➤ (2nd Edition) (Vol. I to V – 2001-2012) ➤ Introduction of Online Bergey's manual of systematic of Archea & Bacteria (1st Edition 2015) ➤ iv) Selected prokaryotes from domain bacteria ➤ Proteobacteria and its five types, Non proteobacteria- Cyanobacteria, Chlorobi and Chloroflexi, ➤ Firmicutes (low G+C gram+ve bacteria) – Clostridiales, Mycoplasmales, Bacillales, ➤ Lactobacillales, Actinobacteria-High G+C gram+ve bacteria), Chlamidia, Spirochetes, Bacteroids, Fusobacteria, Domain Archaea	7 Hrs	7 Marks	Power Point Presentation, Group Discussion, Assignment
References	➤ Microbiology : Pelczar, Chan, Krieg.(TMH) ➤ Text Book of Microbiology : Dubey & Maheshwari (S.Chand,			

	Publication) ➤ Fundamental of Microbiology : Frobisher ➤ General Microbiology Vol. I & II : Power & Dagainawala. (Himalaya Publication) ➤ Fundamentals Principles of : A.J. Salle. bacteriology ➤ Elementary Microbiology : Modi (Akta Prakashan) Vol. I & II
	Short Answer Questions 1. Draw well labeled diagram of typical bacterial cell 2. Characterize the bacteria on the basis of shape size and arrangement 3. Discuss the structure of capsule with their function 4. Differentiate between Gram positive and Gram negative cell wall of bacteria 5. With the help of diagram discuss fluid mosaic model 6. Illustrate the mechanism of flagellar movement 7. Give the characteristics of plasmid 8. What are basic nutrients required for the growth of bacteria 9. Differentiate between synthetic and non synthetic media 10. Differentiate between solid and liquid media 11. Discuss various selective media 12. Explain the role of peptone and beef extract 13. Give detail account on Auxanography technique 14. Give detail account on Replica plating technique 15. Explain different types of media 16. Define Sterilization , disinfectant 17. Define antiseptic and Germicide 18. Define micro biostatic and antimicrobial agent 19. Explain radiation used to control microorganism 20. How will you control microbial population by using osmotic pressure 21. Write the mode of action of heavy metals 22. Explain any two methods of chemical control 23. Write any two terminologies to control microbial growth 24. Give the outline of Outline of Bergey's manual of systematic bacteriology 24. Explain low G+C Gram positive bacteria 25. Explain high G+C Gram positive bacteria 26. Define and explain numerical taxonomy and r-DNA technology 27. Define the terms: Taxonomy and classification Long Answer Questions 1. Give the outline nutritional classification on the basis of carbon source 2. Give the outline nutritional classification on the basis of energy source 3. Discuss in detail control of microorganisms by physical control 4. Discuss in detail control of microorganisms by chemical control 5. Explain the cell wall of Gram positive and Gram negative bacterial cell 6. With the help of labelled diagram of typical bacterial cell explain any four organelles of it. 7. Explain any two prokaryotes from domain bacteria 8. Explain in detail identification criteria Multiple choice Questions 1. Which of the following is a function of cryoprotective agent

127206 Lab 4 : Techniques for culturing Bacteria							
Level	Semester	Course code	Course Name	Credits	Teaching Hours	Exam Duration	Maximum marks
4.5	II	127206	Lab1 : Techniques for culturing Bacteria	2	60	2Hrs	25+25

Course Objectives

- To study the handling of different laboratory instruments
- To know the proper method for preparation of laboratory media for cultivation of organisms
- To study the effect of different environmental factors which affect the growth of microorganisms
- To practice the storage techniques of pure cultures of an organisms

Course outcomes

Upon completion of this course successfully, students would be able to

- Acquire the skill in the use and care of basic Microbiological equipment.
- Get employment in diagnostic laboratories.
- Analyze the effect of different parameters on growth of bacteria.
- Determine the nutritional requirement of microorganisms

Sr.No.	Contents of Practical (List of Laboratory Experiments/ Activities etc.)
1.	To study the Principles and Operation of a) Autoclave – Sterilization of Water (Sterility Test) b) Oven – Glassware c) Incubator d) Laminar air flow
2.	
3.	To prepare nutrient media a) Nutrient broth b) Nutrient agar c) PDA
4.	
5.	Isolation of bacteria from soil suspension using inoculating needle
6.	Isolation of bacteria from rotting vegetables by Pour plate method
	Isolation of bacteria from water sample by Spread plate method
7.	Isolation of bacteria from human body surface/ mobile phones using cotton swabs
8.	Cultivation of bacteria on slants
9.	Cultivation of Bacteria using nutrient broth
10	Study of permanent / freshly prepared slides of Spirocheates, Mycobacterium , Actinomycetes, bacterial flagella, lactobacillus,

11	Isolation of bacteria using selective media
References:	➤ Microbes in Action : Seely, Wander Mark Tarporewala, Bombay ➤ A Manual of Microbiology : A.J. Salle. Methods ➤ Medical Microbiology Vol. II : R. Cruickshank ➤ Microbiology Methods : Collins ➤ Difco manual ➤ Bacteriological Techniques : F.J.Baker ➤ Introduction to Microbial : Gunasekaran Techniques ➤ Biochemical methods : Sadashivam & Manickam ➤ Laboratory Fundamentals of : Alcamo, I.E., Jones and Microbiology Bartlett Publishers. ➤ A textbook of Practical Microbiology (B Sc Sem 1 & 2) Dr. R. R. Pachori, P.S.Sadar, Dr. A. M. Pande, 2nd Edition

The distribution of marks for the practical examination shall be as follows:

External Evaluation		Internal Evaluation based on CAT	
Performance of any two experiments	20 marks	Attendance & Students performance	10 Marks
Viva-voce	05 marks	Practical Record Book	05 Marks
		MCQ/ Spotting	10 Marks
Total	25 Marks	Total	25 Marks

127209 VSC Lab Practical 6 : Microbial Control							
Level	Semester	Course code	Course Name	Credits	Teaching Hours	Exam Duration	Maximum marks
4.5	II	127209	VSC : Microbial control	2	60	2Hrs	50

Course Objectives

- To train the students in methods of sterilization using high temperature.
- To impart training of using and studying the effect of different methods of chemical control.
- To educate the students about applying filtration technique , gaseous sterilization and application of UV rays for microbial control.

Course outcomes

Upon completion of this course successfully, students would be able to

- Use techniques of sterilization using autoclave and oven.
- Apply the knowledge of chemical control in laboratory as well as day to day life.
- Use filtration technique and gaseous sterilization method in appropriate way.
- Make use of laminar air flow cabinet for microbiological experiments.

S.N.	Contents of Practical (List of Laboratory Experiments/ Activities etc.)
1	Sterilization of nutrient medium with autoclave
2	Sterility testing
3	Sterilization of glass ware using hot air oven
4	Sterilization of solution using filtration
5	Control of growth using salts-Effect of osmotic pressure on growth of bacteria
6	Determination of thermal death time of E.coli at 60 degree Celsius
7	Effect of heavy metals on growth of bacteria
8	Effect of chemical preservatives on growth of bacteria
9	Effect of antibiotics on growth of bacteria
	Effect of disinfectant application on inanimate/body surfaces
10	Effect of soap on growth of bacteria by studying the effectiveness of hand washing
11	Effect of antifungal agents on growth of fungi
12	Effect of low temperature on growth of bacteria
13	Use of laminar air flow
14	Gaseous sterilization
15	OT sterilization

References	➤ Microbiology, A laboratory manual by James D. Cappuccino and Natalie Sherman Addison Wesley publication, ➤ Practical Microbiology(Revised edition R.C.Dubey and D.K.Maheshwari Published by-S.Chand ➤ A Text book of Practical microbiology by Sadar and pandey,Ed.Rachana Pachori(Sharma), Dnyanpath Publication. ➤ General Microbiology Vol. I & II : Power & Dagainawala. (Himalaya Publication) ➤ Fundamentals Principles of : A.J. Salle. bacteriology ➤ Elementary Microbiology : Modi (Akta Prakashan) Vol. I & II ➤ Practical Microbiology(Revised edition R.C.Dubey and D.K.Maheshwari Published by-S.Chand ➤ Textbook of Microbiology(Fourth edition) Prof. C P Baveja Published by Arya publications
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Internal Evaluation for VSC	
Attendance	10 Marks
Practical performance	20 Marks
MCQ/ Spotting	10 Marks
Practical Record book	10 Marks
Total	50 Marks

127210 SEC -Lab Practical 7: Isolation and morphological characterization of bacteria**List of Laboratory Experiments/Activities etc.**

Level	Semester	Course code	Course Name	Credits	Teaching Hours	Exam Duration	Maximum marks
4.5	II	127210	Isolation and morphological characterization of bacteria	2	60	2Hrs	50

Course Objectives	➤ To train the students in methods of isolation of bacteria from different sources . ➤ To impart training of morphological characterization of bacterial colonies . ➤ To educate the students about choosing proper media for cultivation, and ➤ Staining techniques for morphological characterization of bacteria.
Course Outcomes	Upon completion of this course successfully, students would be able to ➤ Use techniques of isolation of bacteria from different sources . ➤ Apply the knowledge for morphological characterization of bacterial colonies ➤ Make use of different types of media for cultivation of various types of bacteria. ➤ Characterize different bacteria with respect to their shape, arrangement and gram character.
Sr.No.	Content of Practical (List of Laboratory Experiments/ Activities etc.)
1	Isolation and characterization of bacteria from soil
2	Isolation and characterization of bacteria using enrichment culture
3	Isolation and characterization of bacteria using selective media
4	Isolation and characterization of bacteria from mixed culture using differential media
5	Isolation and characterization of lactobacilli from curd
6	Isolation and characterization of bacteria from skin
7	Isolation and characterization of bacteria from teeth
8	Isolation and characterization of bacillus from air
9	Isolation of bacteria from sewage
References	➤ Microbiology, A laboratory manual by James D. Cappuccino and Natalie Sherman Addison Wesley publication, ➤ Practical Microbiology(Revised edition R.C.Dubey and D.K.Maheshwari Published by-S.Chand

- A Text book of Practical microbiology by Sadar and pandey,Ed.RachanaPachori(Sharma), Dnyanpath Publication.
- General Microbiology Vol. I & II : Power & Dagainawala. (Himalaya Publication)
- Fundamentals Principles of : A.J. Salle. bacteriology
- Elementary Microbiology : Modi (Akta Prakashan) Vol. I & II
- Practical Microbiology(Revised edition R.C.Dubey and D.K.MaheshwariPublished by-S.Chand
- Textbook of Microbiology(Fourth edition) Prof. C P Baveja Published by Arya publications

Internal Evaluation for SEC

Attendance	10 Marks
Practical performance	20 Marks
MCQ/ Spotting	10 Marks
Practical Record book	10 Marks
Total	50 Marks