Sri Dev Suman Uttarakhand University

Badshahithaul, Tehri Garhwal, Uttarakhand

NATIONALEDUCATION POLICY-2020

Syllabus

for

Undergraduate and Post-graduate

in

Microbiology

(***w.e.f. 2025-26***)

Sri Dev Suman Uttarakhand University Badshahithaul, Tehri Garhwal, Uttarakhand

NATIONALEDUCATION POLICY-2020

Syllabus for Undergraduate and Post-graduate

In Subject MICROBIOLOGY

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List of Papers (DSC, DSE, GE) with Semester Wise Titles for 'Microbiology '

(DSC-Discipline Specific Course; DSE-Discipline Specific Elective; GE-Generic Elective)

Year	Semester	Course	Paper Title	Theory/ Practical	Credits
Undergraduate Certificate in Microbiology					
FIRST YEAR	I	MIC DSC 1	General Microbiology	Theory	3
		MIC DSC 1P	Practical/Lab Course MIC DSC 1P	Practical	1
		MIC GE 1	Microorganisms for Human Welfare	Theory	4
		MIC SEC-1	Tools And Techniques	Theory	1
		MIC SEC- 1P	Practical/Lab Course MIC SEC-1p	Practical	1
	II	MIC DSC 2	Environmental and Agriculture Microbiology	Theory	3
		MIC DSC 2P	Practical/Lab Course MIC DSC 2P	Practical	1
		MIC GE 2	Microbial Diagnosis in Health Clinics	Theory	4
		MIC SEC-2	Food Fermentation Technology	Theory	1
		MIC SEC- 2P	Practical/Lab Course MIC SEC-2p	Practical	1
Undergraduate Diploma in Microbiology					
SECOND YEAR	III	MIC DSC3	Microbial Physiology and Metabolism	Theory	3
		MIC DSC3P	Practical/Lab Course MIC DSC 3P	Practical	1
		MIC DSE 1	Microbes in Sustainable Agriculture and Development	Theory	4
		MICGE 3	Management of Human Microbial Diseases	Theory	4
		MIC SEC-3	Microbiological Analysis Of Air And Water	Theory	1
		MIC SEC-3P	Practical/Lab Course MIC SEC-3P	Practical	1
	IV	MIC DSC4	Molecular Biology and Microbial Genetics	Theory	3
		MIC DSC4P	Practical/Lab Course MIC DSC 4P	Practical	1
		MIC DSE 2	Plant Pathology	Theory	4
		MIC GE 4	Microbial Biotechnology	Theory	4
		MIC SEC-4	Microbial Quality Control In Food And Pharmaceutical Industries	Theory	1
		MIC SEC- 4P	Practical/Lab Course MIC SEC-4P	Practical	1
Bachelor in Microbiology					
THIRD YEAR	V	MIC DSC5	Medical Microbiology and Immunology	Theory	3
		MIC DSC5P	Practical/Lab Course MIC DSC 5P	Practical	1
		MIC DSE 3	Pharmaceutical Microbiology	Theory	4
		MIC GE 5	Introduction and Scope of Microbiology	Theory	4
		MIC IAPC	Internship/Apprenticeship / Project/ Community Outreach	Theory/ Practical	2
		MIC SEC-5	Food Processing, Preservation and Packaging	Theory	1
		MIC SEC- 5P	Practical/Lab Course MIC SEC-5P	Practical	1
		MIC DSC6	Industrial Microbiology	Theory	3
		MIC DSC6P	Practical/Lab Course MIC DSC 6P	Practical	1

	VI	MIC DSE 4	Food and Dairy Microbiology	Theory	4
		MIC GE 6	Industrial and Food Microbiology	Theory	4
		MIC IAPC	Internship/Apprenticeship / Project/ Community Outreach	Theory/ Practical	2
		MIC SEC-6	Biofertilizers and Biopesticides	Theory	1
		MIC SEC- 6P	Practical/Lab Course MIC SEC-6P	Practical	1

Bachelor in Microbiology with Honours

FOURTH YEAR	VII	MIC DSC7	Microbial Diversity- Prokaryotes And Viruses	Theory	3
		MIC DSC7P	Practical/Lab Course MIC DSC 7P	Practical	1
		MIC DSE 5	Microbiological Tools and Technique	Theory	4
		MIC DSE 6	Algal and Fungal Biology	Theory	4
		MIC DSE 7	History and Scope of Microbiology	Theory	4
		MIC GE 7	Biostatistics, Computer Applications and Bioinformatics	Theory	4
		MIC GE 8	Bacteriology and Virology	Theory	4
		Hands on Training based on theory papers	Experiments related to all Papers (Minimum 30 experiments)	Practical	06
	VIII	MIC DSC8	Microbial Biochemistry	Theory	3
		MIC DSC8P	Practical/Lab Course MIC DSC 8P	Practical	1
		MIC DSE 8	Techniques of Microbial Genetics and Molecular Biology	Theory	4
		MIC DSE 9	Microbial Environmental Technologies	Theory	4
		MICDSE 10	Recombinant DNA Technology	Theory	4
		MIC GE 9	Food Borne Diseases and Food Preservation	Theory	4
		MIC GE 10	Genetic Engineering and Biotechnology	Theory	4
		Hands on Training based on theory papers	Experiments related to all Papers (Minimum 30 experiments)	Practical	06

Master's in Microbiology

		MIC DSC9	Medical Microbiology	Theory	3
		MIC DSC9P	Practical/Lab Course MIC DSC 9P	Practical	1
		MIC DSE 11	Fermentation Technology and Microbial Products	Theory	4
		MICDSE 12	Pharmaceutical and Food Microbiology	Theory	4
		MIC DSE 13	Molecular Immunology	Theory	4

FIFTH YEAR	IX	MIC GE 11	Applied Microbiology	Theory	4
		MIC GE 12	Microbial Quality Control in Food and Pharmaceutical Industries	Theory	4
		Hands on Training based on theory papers	Experiments related to all Papers (Minimum 30 experiments)	Practical	06
		Training/ Dissertation/ Project Report/Presentation	Project Report/Presentation	Dissertation/Report (Minimum 3 Months Duration)	

COURSE INTRODUCTION

The new curriculum of Microbiology offers essential knowledge and technical skills to study microbes in a holistic manner. Students would be trained in all areas of Microbiology using a unique combination of core, elective and skill development papers with significant inter- disciplinary components. Students would be exposed to cutting-edge technologies that are currently being used in the study of Microbial life forms, their evolution and interactions with other organisms within the ecosystem. Students would also become aware of the social and environmental significance of microbes and their relevance to the human welfare .

B.Sc. and M.Sc Microbiology Programme covers academic activities within the classroom sessions along with practical concepts in laboratory sessions. Outstation activities, and projects will also be organized to provide real-life experiences and learning opportunities. Candidates with a curiosity about the Microbial kingdom and ecosystems, a passion for exploring exotic places, and a desire to work as researchers or in professions such as Microbiologist, Food industry , Agriculture, Medicinal, Industrial and pharmaceutical etc. can choose B.Sc. and M.Sc Microbiology course.

SCHEME OF EXAMINATION
AND
COURSE OF STUDY AS PER NEW EDUCATION POLICY (NEP 2020)

IN

MICROBIOLOGY

Bachelor of Science and Master of Science

(Year - I, II, III, IV and V)

(w.e.f. Session 2025-26 onwards)

SRIDEV SUMAN UTTRAKHAND UNIVERSITY
TEHRI GARHWAL
AUGUST, 2022

COURSE STRUCTURE

NOTE: Questions of theory paper are to be set under two sections i.e., A and B. In section A, the student has to answer any six out of ten **short answer questions** (150 words) uniformly distributed from the entire syllabus. In Section B, the student has to answer any 3 questions out of Six **long answer questions/descriptive** questions uniformly distributed from the entire syllabus are to be set for section B. Section A and B will be of 30, and 45 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper

Subject prerequisite

To study MICROBIOLOGY at undergraduate, a student must have Biology in Class 12.

Programme Objectives (POs)

1. The programme has been designed in such a way so that the students get exposed to strong theoretical and practical background on various domains of Microbiology.
2. The programme includes details of important microorganisms of agricultural, medical and industrial importance, biomolecules, tools and techniques, enzymes, immunology, cell biology, molecular biology genetic engineering to make the study of microbiology for sustainable development of human society.
3. The practical courses have been designed to equip the students with the laboratory skills in microbiology. Students will able to design and conduct experiments, as well as to analyze and interpret scientific data
4. The programme will provide students with the knowledge and skill base that would enable them to undertake

further studies in microbiology and related areas or in multidisciplinary areas that involve microbiology, biochemistry, industrial, Pharmaceutical, Dairy, biotechnology and molecular biology and help develop a range of generic skills that are relevant in enhancing entrepreneurship skills among students.

5. The students will be exposed to a wide range of careers that combine microbiology, environment, industry and medical.

Certificate Course in Microbial Techniques

B. Sc. I Year Programme Specific Outcomes (PSOs)

- PSO1 Students will be able to acquire, articulate, retain, and apply specialized skills and knowledge relevant to microbiology.
- PSO2 Students will be able to appreciate the diversity of microorganisms and microbial communities inhabiting a multitude of habitats, understand their pathogenic as well beneficial significance to man and nature.
- PSO3 Students will acquire and demonstrate proficiency in good laboratory practices in a microbiological laboratory and be able to explain the theoretical basis and practical skills of the tools/technologies commonly used to study this field.
- PSO4 Students will gain fundamental knowledge about the various scopes on agricultural and environmental microbiology and their concepts.
- PSO5 The certificate course will enable students to apply for technical positions in government and private labs/institutes.

Diploma in Microbial Technology

B.Sc. II Year Programme based outcomes

- PSO 1 Students will develop familiarity and understanding of the microbiology concepts as relevant to various areas such as biochemistry, microbial physiology, molecular biology and genetics.
- PSO 2 Students will exhibit reasonable abilities in the utilization of instruments, advances and techniques common to microbiology, and apply the logical strategy and theory testing in the plan and execution of examinations.
- PSO3 Students will be adequately capable to utilize microbiology information and abilities to analyze problems involving microorganisms, articulate these with peers and undertake remedial measures.
- PSO4 Students will be able to describe how microorganisms obtain energy, metabolism, reproduction, survival, and interactions with their environment, hosts, and host populations.
- PSO5 Students will be able to work in a variety of fields, including biological and medical science in higher education institutions, public health, environmental organizations, and the food, dairy, pharmaceutical, and biotechnology industries.

Degree in Bachelor of Science

B.Sc III Year rogramme Specific Outcomes (PSOs)

- PSO1 Students of B.Sc. Microbiology Programme will learn to use scientific logic as they investigate a broad variety of contemporary subjects covering different areas of basic microbiology such as Bacteriology, Virology, Biochemistry, Microbial Physiology, Immunology, Cell Biology, Molecular Biology, Genetics, Immunology, and Microbial Genetics, as well as becoming aware of the importance of environmental microbiology.
- PSO2 Students will learn about various biotechnological applications of microorganisms as well as industrially relevant substances developed by microorganisms. They'll learn about the special role microbes play in genetic modification technologies.
- PSO3 Students will learn and develop good laboratory practices in a microbiological laboratory, as well as be able to explain the theoretical foundations and practical skills of the tools and technologies widely used in this area. Students can gain proficiency in the quantitative skills needed to analyze biological problems.
- PSO4 Students will learn about experimental methods, hypothesis creation and testing, and experiment design and execution. Students can develop their critical thinking skills as well as their ability to read and interpret scientific literature. Via successful presentation of experimental findings as well as workshops, students can acquire good oral and written communication skills.

- PSO5 The Degree courses will enable students to go for higher studies in Microbiology and Allied subjects leading to Post Graduation and Ph.D. degrees.

B.Sc. IV Year Honour/ M.Sc. I Year in Microbiology

- PSO1. Students of the B.Sc. (Honours) Microbiology programme will learn to use scientific logic as they explore a wide range of contemporary subjects spanning various aspects of basic microbiology such as Bacteriology,

  Virology, Biochemistry, Microbial Physiology, Immunology, Cell Biology, Molecular Biology, Genetics, Systems Biology, Immunology and Molecular biology, in addition to becoming aware of the applied aspects of microbiology such as Industrial Microbiology, Food and Dairy Microbiology, Environmental Microbiology and Medical Microbiology to name just a few.
- PSO2- Students will appreciate the biological diversity of microbial forms and be able to describe/explain the processes used by microorganisms for their replication, survival, and interaction with their environment, hosts, and host populations. They will become aware of the important role microorganisms play in maintenance of a clean and healthy environment. They will learn of the role of microorganisms in plant, animal and human health and disease
- PSO3- Students will acquire and demonstrate proficiency in good laboratory practices in a microbiological laboratory and be able to explain the theoretical basis and practical skills of the tools/technologies commonly used to study this field
- PSO4- Students will develop proficiency in the quantitative skills necessary to analyze biological problems (e.g., arithmetic, algebra, and statistical methods as applied to biology)
- PSO5- Graduates of the B.Sc. (Honors) Microbiology programme will be 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

- **Eligibility for admission:** Graduation in Science (Chemistry, Botany and Zoology) or Microbiology (Medical / Industrial) or Life Sciences or Medical Laboratory Technology B.Sc Biotecnology.
- **Marks requirement:** Minimum 50% of aggregate (General Category). Minimum 45% of aggregate (SC, ST Category) or as per university/Government norms.
- There shall be fifteen Theory Papers and 3 Laboratory Practical Examinations Comprising ot five Theory Papers and one Laboratory Practical Examinations in each of the three semesters as described in the following pages.
- Each of the theory and laboratory examinations shall be of 100 marks divided into two parts 1.e. Internal Assessment (25 marks) and End Term examination (75-marks). Total Credits 4
- Internal assessment shall be determined on the basis of mid term examination conducted by the respective institute after 6 weeks of start of the session.
- In the fourth semester project work/industrial training of 3-4 months duration will be carried out in any National laboratory or Industry (entrepreneurship). Or a Research Project will assign in department under the Supervision of a competent faculty member (having Ph.D. degree.)
- The student shall present the report of his / her research projects findings in the form of a seminar in the presence of external and internal examiners who shall evaluate the work and presentation and award marks on the basis of dissertation, presentation and viva-voce.
- The student shall deliver at least 2 seminar of each semester on a recent topic in the subject of microbiology as assigned by the Head of the Department.

M.Sc. II Year in Microbiology

- PSO1. Students of the Msc Microbiology programme will learn to use scientific logic as they explore a wide range of contemporary subjects spanning various aspects of basic microbiology such as Bacteriology, Virology, Biochemistry, Microbial Physiology, Immunology, Cell Biology, Molecular Biology, Genetics, Systems Biology, Immunology and Molecular biology, in addition to becoming aware of the applied aspects of microbiology such as Industrial Microbiology, Food and Dairy Microbiology, Environmental Microbiology and Medical Microbiology to name just a few.
- PSO2- Students will appreciate the biological diversity of microbial forms and be able to describe/explain the processes used by microorganisms for their replication, survival, and interaction with their environment, hosts, and host populations. They will become aware of the important role microorganisms play in maintenance of a clean and healthy environment. They will learn of the role of microorganisms in plant, animal and human health and disease
- PSO3- Students will acquire and demonstrate proficiency in good laboratory practices in a microbiological laboratory and be able to explain the theoretical basis and practical skills of the tools/technologies commonly used to study this field
- PSO4- Students will develop proficiency in the quantitative skills necessary to analyze biological problems (e.g., arithmetic, algebra, and statistical methods as applied to biology)
- PSO5- Post Graduates of Msc Microbiology programme will be 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.

Semester-I

DISCIPLINE SPECIFIC COURSE (DSC)- GENERAL MICROBIOLOGY

No. of Hours: 75 CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
GENERAL MICROBIOLOGY)	4	3	0	1	Passed Class XII with Biology	Nil

UNDERGRADUATE CERTIFICATE IN MICROBIOLOGY		
Programme : ***Undergraduate Certificate in Microbiology***	**Year: I**	**Semester: I**
Subject: Microbiology		

Course: MIC DSC 1	Course Title: GENERAL MICROBIOLOGY	
Programme : ***Undergraduate Certificate in Microbiology***	**Year: I**	**Semester: I**
Subject: Microbiology		
Course: MIC DSC 1	**Course Title Environmental and Agriculture Microbiology**	

Learning objectives:

- To understand the Microorganism in which there is description of different information related to microorganisms and also they will know how earth evolved and also know the landmarks discoveries of microbiology
- To acquire knowledge of different technique to stain microorganism and how they can visualize the microorganisms in different types of microscope.
- To acquire an overall knowledge on the morphology and functions of the structures with the prokaryotes and eukaryotes.
- To become familiar with general characteristic of prokaryotic and Eukaryotic microbes and also acquire Knowledge of cellular organization, life cycle and economic importance of prokaryotic

Learning outcomes:

At the end of course student will be able to

- At the end of course student will be able
- To know the different milestones in the history of microbiology, importance of Vedic microbiology and scope of microbiology
- To understand and know the application of techniques used in the field of Microbiology.
- Identify key constituent prokaryotes cell and their function.
- To classify the prokaryotic cell by conventional as well as modern methods.
- To stain the bacteria with simple, differential and special stain.
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Credits: 4	**Discipline Specific Course**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

UNIT–I

History, scope, spontaneous generation vs biogenesis, golden age of microbiology branches of microbiology and relevance of microbiology; germ theory of disease Contribution of Antony Van Leeuwenhoek, Edward Jenner, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Ivanowsky, Waksman,. 5 kingdom classification of Whittaker and 3 Domain System Classification .

(7 Lectures)

UNIT-II

Bacterial morphology Ultrastructure of bacterial cell, cell wall, plasma membrane, capsule, flagella, nucleoid,. General features of Archeobacteria, Rickettsia, Chlamydia, Mollicutes, Actinomycetes and Cynobacteria.

The viruses General properties nomenclature, Classification and Morphology structure of animal viruses: Influenza, HIV; plant viruses: TMV; bacterial viruses: Lambda Phage and T4 bacteriophage; general features of Prions and Viroids. Fungi General characteristics, classification & reproduction of Saccharomyces, Aspergllus. Protozoa General characteristics, classification & reproduction of Giardia, Entamoeba.

(10lecture)

UNIT III

Techniques in microbiology Principles of microscopy, construction and application ofCompound Microscope

Bright field Microscopy, Dark field Microscopy , Electron Microscopy- TEM and SEM, Principles, and application of Autoclave; BOD Incubator & Incubator, ; Laminar flow; Oven & Spectrophotometer (UV&Vis) **(10 Lectures)**

UNIT-IV

Sterilization techniques and control of microorganisms Definitions of terms- sterilization and disinfection; Sterilization by Physical methods- Use of moist heat- heat under pressure(autoclave), pasteurization, Use of dry heat- hot air oven, Filtration- membrane filter, HEPA filter; Radiation- Ionizing and non- ionizing; Chemical methods- (Alcohols, aldehydes, phenols, ethylene oxide). Culture media and its types; Methods for enumeration & isolation of microorganisms using pour plate, spread plate technique, Serial dilution and streak plate; Isolation of anaerobic microorganisms; Maintenance and preservation of pure culture. Staining techniques, principles, procedures and applications of Simple staining, negative staining; Differential staining- Gram's staining, acid fast staining, Leishman's staining, Giemsa's staining, Structural staining capsule, endospore and flagella staining.

(10Lectures)

UNIT-V

Biostatistics Introduction to biostatistics – definition statistical methods, biological measurement, kinds of biological data; Measure of central tendency – Mean, median, mode, standard deviation; Collection of data, sampling and sampling design, classification and tabulation, types of representation, graphic bio diagrams. Student T Test **(8 Lectures)**

MIC DSC 1P Experiments in General Microbiology Credit 1

1. Good laboratory practice in Microbiology and safety measures.
2. Cleaning and sterilization of glassware and equipments
3. Study of aseptic technique- preparation of cotton plug, wrapping of glassware, transfer of media and Inoculum
4. Principles and applications of microbiology laboratory instruments (Autoclave, Laminar Air Flow, Incubator, Hot Air Oven, and Light Microscope).
5. Perform simple and Gram staining of bacteria.
6. Perform Endospore staining of bacteria.
7. Perform Capsule staining by negative staining technique of bacteria.
8. Perform Flagella staining of bacteria.
9. Perform Negative staining of bacteria.
10. Isolation of microorganisms from soil by pour plate method.
11. Isolation of microorganisms from air , water , and soil
12. Effect of radiation.
13. Cultivation of bacteriophages.
14. To prepare the Nutrient Agar Medium.
15. To prepare the Potato Dextrose Agar Medium. **(Lecture-30)**

Suggested Reading

1. Dubey, R.C. 2021. *Vedic microbiology- A Scientific Approach* (English Version), Motilal Banarasidas International, Delhi– 110007.
2. Dubey, R.C. 2020. *Vedic microbiology- Ek Vaijnanik Drishti*(Hindi Version), Aastha Prakashan, Delhi-110053
3. Dubey R.C**.** and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p 1034. ISBN 81-219-2620-3
4. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2
5. Dubey, R.C**.** *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
6. Cappachino. Microbiology- A laboratory Manual, Pearson Education India ISBN: 978-9332535190
7. Powar and Daginawala. General Microbiology Vol1 and Vol2, Himalaya Publishing House,**ISBN-13:** 978-9350240892

8. . Suggestive digital platforms web links-

- https:/www.classcentral.com/tag/microbiology
- https://cmp.berkeey.edu/bacteria/bacteria.html
- https://www.livescience.com/53272-what-is-a-virus.html
- https://www.slideshare.net/sardar1109/algae-notes-1
- https://www.sciencedirect.com/topics/earth-and-planetary-sciences/microscopy
- https://onlinecourses.swayam2.ac.in/cec19_bt11/preview
- https://microbenotes.com/laminar-flow-hood
- https://physics.fe.uni-lj.si/students/predavanja/MicroscopyKulkarni.pdf

Lab Virtual links-

- https://www.classcentral.com/course/basic-concepts-in-microbiology-and-clinical-pharm-32196
- https://www.labster.com/microbiology-virtual-labs/
- https://www.futurelearn.com/courses/basic-concepts-in-microbiology-and-clinicalpharmacology-of-antimicrobials

Semester-II

DISCIPLINE SPECIFIC COURSE (DSC)- Environmental and Agriculture Microbiology

No. of Hours: 75

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Environmental and Agriculture Microbiology)	4	3	0	1	Passed Class XII with Biology	Nil

UNDERGRADUATE CERTIFICATE IN MICROBIOLOGY		
Programme : ***Undergraduate Certificate in Microbiology***	**Year: I**	**Semester: I**
Subject: Microbiology		
Course: MIC DSC 2	**Course Title Environmental and Agriculture Microbiology**	

Learning objectives:

- To understand how microorganism adapt to different environment and their interaction with different habitat and also the spread of microorganism from the environment.
- To know different techniques of detection of air , soil and aquatic
- To acquire knowledge of treating sewage and industrial water through different means.
- Students will learn about positive or negative interaction of microorganisms with soil.
- To impart in-depth information on soil and agriculture.
- To know the importance of biofertilizers and biopesticides.
- To make the students to know about various techniques involved in biofertilizers and biopesticides production

Learning outcomes:

At the end of course student will be able to

- Isolate and identify pathogenic microorganism from air, soil and water habitat
- Characterize the waste water and also explain the method that can be utilized in waste water treatment
- Explain or suggest different biocontrol methodto control pests.
- Develop biofertilizer or biopesticide in lab conditions .
- Isolate *Rhizobium* from the root nodule of leguminous plants

Credits: 4	Discipline Specific Course

Max. Marks: As per Univ. rules	Min. Passing Marks: Asper Univ. rules

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UNIT - I

Microorganisms in different habitats: brief account of heterogeneous group of microorganisms, different habitats such as soil, water, air; factors affecting microbial population in nature. Water microbiology: type of water, parameters of aquatic environment (temperature, light, pressure, pH, turbidity and organic constituents); Microflora of aquatic environmental, Treatment and safety of drinking water; Methods to detect potability of water sample: Standard qualitative procedure- SPC, MPN test, Presumptive, confirmed and completed test for faecal-coliforms, Membrane filter technique, **(10 Lectures)**

UNIT – II

Microbiology of domestic and waste water: sewage/waste water (physical, chemical and microbiological analysis), BOD and COD; Waste water treatment, Solid waste management: solid waste processing (landfills, composting and anaerobic sludge digestion), Effect of solid waste on public health; Regulation for disposal of bio hazardous materials, **(10 Lectures)**

UNIT - III

Principle of Bioremediation, decomposition and degradation of common organic Matter inorganic matter, biosurfactants. **(6 Lectures)**

UNIT – IV

Microbial Interactions Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation; Microbe-Plant interaction: positive-negative interaction; Microbe-Animal interaction: positive-negative interaction; Microorganism of rhizosphere, rhizoplane and phylloplane, mycorrhiza types and its applications **(10 Lectures)**

UNIT -V

Biofertilizer Definition, Types- Bacterial, Fungal, Phosphate solubilizer, BGA & associative; Mode of application; Advantages and Disadvantages of Biofertilizer. Introduction and definition and Types of biopesticides; **(9 L)**

Course MIC DSC 2P Experiments in Environmental and Agriculture Microbiology Credit 1

1. Determination of biological oxygen demand (BOD) of water.
2. Determination of chemical oxygen demand (COD) of water.
3. Water analysis for total bacterial population by standard plate count.
4. Bacterial examination of water by multiple-tube fermentation test or multiple tube tests.
5. Isolation of microorganisms (Bacteria & Fungi) from soil sample at different temperature (28o C & 45o C)
6. Isolation of bacteria and fungi from rhizosphere and rhizoplane.
7. Isolation of bacteria & fungi from air environment by exposure plate method.
8. Isolation of Rhizobium sp. from leguminous root nodule.
9. Bacteriological examination of water by MPN test, presumptive coliform, confirmed coliform and completed coliform test.
10. Isolation and identification of fungi by using Rose Bengal agar Media from Soil and Air,
11. Isolation of root modulating bacteria from leguminous plant.
12. isolation of bacteria inhibiting phytopathogenic fungi 30 **Lectures)**

Suggested Reading

1. N.S. SubbhaRao, Soil Microbiology, Science Publisher, ISBN: 9781578080700
2. Dubey, R.C. *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
3. P.D. Sharma, Microbiology, Rastogi Publication ISBN:978-8171339358.

4. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
5. Suggestive digital platforms web links-
   • https://www.classcentral.com/tag/microbiology
   • https://www.mooc-list.com/tags/biotechnology
   • https://asm.org/articles/2020/december/virtual-resources-to-teach-microbiology-techniques
   • https://www.futuredirections.org.au/publication/living-soils-role-microorganisms-soil-health
6. Virtual Lab Links-
   • https://vlab.amrita.edu/?sub=3&brch=73
   • https://www.vlab.co.in/ba-nptel-labs-biotechnology-and-biomedical-engineering
   • https://opentextbc.ca/virtualscienceresources/chapter/environmental-science/

Semester-III

Undergraduate Diploma in Microbiology

No. of Hours- 75

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

DISCIPLINE SPECIFIC COURSE (DSC)- MICROBIAL PHYSIOLOGY AND METABOLISM

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
MICROBIAL PHYSIOLOGY AND METABOLISM	4	3	0	1	**Undergraduate certificate in Microbiology**	**Nil**

UNDERGRADUATE DIPLOMA IN MICROBIOLOGY		
Programme : *Undergraduate Diploma in Microbiology*	**Year: II**	**Semester: III**
Subject: Microbiology		
Course: MIC DSC 3	**Course Title: MICROBIAL PHYSIOLOGY AND METABOLISM**	

Learning objectives:

- To understand different phases of bacterial growth and its kinetics
- To understand how microbes do catabolism to get energy to build structure.
- To understand different metabolic pathways and enzymes involved by which energy will be generated
- To acquire knowledge of classifying enzymes and how they functions.
- To understand how the nitrogen is fixed by symbiotic and non-symbiotic nitrogen fixation and genes involved in nitrogen fixation

Learning outcomes:

At the end of course student will be able to

- Calculate generation time and number of generation.
- Explain principles and mechanism of aerobic and anaerobic respiration in microorganisms.
- Explain the concept nitrogen metabolism, assimilation of nitrates, ammonia assimilation. and fixation of nitrogen
- explain the bacterial photosynthesis and also the differentiation between oxygenic and anoxygenic photosynthesis bacteria
- Classify enzymes and demonstrate the mechanism of enzymes and their functions.

Credits: 4	**Discipline Specific Course**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

UNIT I

Bacterial Growth- Curve Synchronous growth; growth-generation time, microbial growth kinetics in batch cultures; growth measurement: by cell mass, cell count and cell turbidity; factor affecting the growth of microorganism**. (8lecture)**

Unit II Enzymes: characteristics, nomenclature, classification and application of enzymes; Factors influencing enzymatic activity;Mechanism of enzyme action; Allosteric enzymes. Enzymes kinetics : Michaelis Menton equation for simple enzymes **. (10 lecture)**

Unit III General concepts of respiration and fermentation: aerobic and anaerobic respiration, Autotrophy, Heterotrophy, chemolithotrophy, fermentation; alcoholic fermentation, lactic acid fermentation . **(10 lecture**)

Unit IV Microbial metabolism: General strategy of metabolism, anabolism, catabolism, ATP, Phosphorylation, Oxidative phosphorylation and substrate level phosphorylation, primary metabolic pathway, secondary metabolic pathway, metabolism of carbohydrates glycolysis,PPP, ED, TCA cycle and electron transport chain **(10 lecture)**

Unit V Nitrogen Fixation Nitrogen fixation in symbiotic and free-living microorganisms, root nodule formation, leghaemoglobin, nitrogenase enzyme; Physiology of nitrogen cycle Photosynthetic bacteria and their classification.(Lecture 07)

Practical/Lab Course MIC DSC 3P

Experiments in Microbial Physiology and Metabolism **Credit-1**

1. Determination of growth curve of bacteria.
2. Bacterial population count by turbidimetry method
3. Amylase production, H2S production, Urease production test, IMViC test
4. Cellulase production test.
5. Demonstration of carbohydrate fermentation, indole production, catalase test,
6. oxidase test.Demonstration of enzyme activity in given mocroorganism.
7. Detection of number of bacteria in milk by standard plate count technique.
8. Determination of quality of milk sample by MBRT (methylene blue reductase test).
9. Laboratory preparation of sauerkraut.
10. Effect of ultraviolet radiation on bacterial growth.
11. Effect of dyes on bacterial growth.
12. Separation of leaf pigments through paper chromatography on bacterial growth. **(Lecture- 60)**

Suggested Reading

1. Dubey R.C**.** and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3

Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2

2. Casida, L.E.J.R. Industrial Microbiology, New Age International Publisher,
3. A.H.Patel, Industrial Microbiology, Laxmi Publication, **ISBN-10:** 9385750267
4. Prescott and Dunns.Industrial Microbiology, CBS Publishers and Distributers, ISBN-10**:** 8123910010
5. Dubey, R.C**.** *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
6. **Suggestive digital platforms web links-**

• https://lipidnanostructuresgroup.weebly.com
•https://www.labster.com/microbiology-virtual-labs
•https://www.microbiologybook.org
•https://www.cpe.rutgers.edu/courses/current/lf0401wa.html https://www.sciencedirect.com/topics/earth-and-planetary-sciences/microscopy https://www.futurelearn.com/courses/introduction-to-microbiology

7. **Digitallinks**

•http://www.mooc.list.com/tag/molecular-biology
•http://www.mooc.list.com/course/microbiology.sayloro https://lipidnanostructuresgroup.weely.com
•http://www.mooc.list.com/microbial
• https://open.umn.edu/opentextbooks/textbooks/biochemistry-free-for-all-ahern

Semester-IV **Undergraduate Diploma in Microbiology**

No. of **Hours- 75**

DISCIPLINE SPECIFIC COURSE (DSC)- MOLECULAR BIOLOGY AND MICROBIAL GENETICS

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
MOLECULAR BIOLOGY AND MICROBIAL GENETICS	4	3	0	1	**Undergrad uate certificate in Microbiology**	

UNDERGRADUATE DIPLOMA IN MICROBIOLOGY		
Programme : ***Undergraduate Diploma in MICROBIOLOGY***	**Year: II**	**Semester: IV**
Subject: Microbiology		
Course: MIC DSC 4	**Course Title: MOLECULAR BIOLOGY AND MICROBIAL GENETICS**	

Learning objectives:

- To know the Genetic constituents of bacteria with special emphasis on inheritance and mutations
- To know the mechanism of genetic transfers in microbes
- To know the different techniques used to study the microbial genetics and utilizing the microbial phenomenon in different biotechnological applications.

Learning outcomes:

At the end of course student will be able to

- Explain why DNA is the genetic material of bacteria.
- Explain the application of genetic engineering techniques in basic and applied experimental biology.
- Use Plasmids as cloning vector and its applications.

Credits:	**Discipline Specific Course**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

UNIT - I

Experimental evidence of Nucleic acid , DNA structure, Salient features of double helix, Types of DNA, RNA Types and Structure; Replication of DNA, Mechanism of DNA replication and Enzymes and proteins involved in DNA replication **(10 Lectures)**

UNIT - II

Transcription: Definition, promoter - concept and strength of promoter. Transcriptional Machinery and Mechanism of transcription. Translation-Genetic code, Translational machinery, charging of tRNA, aminoacyl tRNAsynthetases, Mechanisms of initiation, elongation and termination of polypeptides. **(10 Lectures)**

UNIT - III

Regulation of gene Expression Principles of transcriptional regulation, Operon-operator theory with examples from *lac* and *trp*operons; Mutations-: Definition and types of Mutations; Physical and chemical mutagens; Uses of mutations, **(8Lectures)**

UNIT - IV

Mechanisms of Genetic Exchange**:** Transformation - Discovery, mechanism of natural competence Conjugation – Discovery and mechanisms, Hfr and F' strains; Transduction- Generalized transduction, specialized transduction. Plasmids and Transposable Elements: Property and functions of plasmids, Types of plasmids. **(08Lectures)**

UNIT – V

Mutations, mutagenesis and repair Types of mutations, Physical and chemical mutagens. Loss and gain of function mutants. Reversion and suppression, Uses of mutations. Ames Test, DNA repair mechanism **(09 Lectures)**

Lab Course MIC DSC P 4 -Experiments in MOLECULAR BIOLOGY AND MICROBIAL GENETICS

1. Isolation of genomic DNA from E. coli and analysis by agarose gel electrophoresis.
2. Estimation of DNA using diphenylamine reagents.
3. Resolution of proteins by polyacrylamide gel electrophoresis (SDS-PAGE) and visualization using coomassie dye.
4. Replica plating method: Preparation of master and replica plates. Isolation of Histidine auxotrophs
5. Isolation of plasmid DNA from E. coli. Study the different conformations of plasmid DNA through agarose gel electrophoresis
6. Study of the effect of chemical (nitrous acid) and physical (UV) mutagens on bacterial cells.
7. Demonstration of Ames test
8. Isolation of Bacteriophage (Lecture 30)

Suggested Reading

1. David Friefelder, Microbial Genetics, Narosa Publishing House.
2. Gardner, Principle of Genetics, Wiley
3. Dubey, R.C**.** *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
4. Lehninger, Nelson and Cox. Principles of Biochemistry, WH Freeman; 7th ed, ISBN:978-1319108243
5. **Suggestive digital platforms web links-**

• https://www.classcentral.com/tag/microbiology

• http://www.mooc.list.com/tag/molecular-biology

• http://www.mooc.list.com/course/microbiology.sayloro

• https://lipidnanostructuresgroup.weely.com

• http://www.mooc.list.com/microbial

• https://open.umn.edu/opentextbooks/textbooks/biochemistry-free-for-all-ahern

Digital links:

• https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/amestest

Semester-V

Bachelor of Science in Microbiology

No. of Hours-75

DISCIPLINE SPECIFIC COURSE (DSC)- MEDICAL MICROBIOLOGY AND IMMUNOLOGY

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Medical Microbiology and Immunology	4	3	0	0	Undergraduate diploma in Microbiology	Nil

BACHELOR OF SCIENCE IN MICROBIOLOGY		
Programme : ***Bachelor of Science in Microbiology***	**Year: III**	**Semester: V**
Subject: Microbiology		
Course: MIC DSC 5	**Course Title: MEDICAL MICROBIOLOGY AND IMMUNOLOGY**	

Learning objectives:

- Students will understand the disease caused by the bacteria, fungi, virus and protozoa.
- To know the diagnosis and treatment of bacteria, fungi and viral pathogens.

Learning outcomes:

At the end of course students will be able to

- Understand the development and contribution of different scientist in the field of medical microbiology.
- Describe etiology, pathogenicity, epidemiology and laboratory diagnosis of disease caused by microorganism.
- To isolate and detect the pathogens from the clinical samples.
- Suggest different antimicrobial agent for the treatment of bacterial infections.

Credits: 1	**Discipline Specific Course**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

UNIT–I

Historical background of medical microbiology, Classification of medically important microorganisms, Normal microflora of the human body and it**s** importance, normal microflora of skin, throat, gastrointestinal tract, and respiratory tract; Disease cycle, transmission of pathogen and its routes. Infection and its type. Host parasite relationship, pathogenicity and virulence in relation with bacteria, Virus fungi **(8 Lectures)**

UNIT -II

Bacterial diseases: symptoms, mode of transmission, prophylaxis, treatment and control of: Respiratory Diseases: *Streptococcus pyogenes*, *Mycobacterium tuberculosis;* Gastrointestinal Diseases: *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, *Staphylococcus aureus* **Viral diseases:** Symptoms, mode of transmission, prophylaxis and control of Polio, Herpes, Hepatitis-B, Rabies, Dengue and AIDS **(10 Lectures)**

UNIT –III

Fungal diseases: transmission, symptoms and prevention of cutaneous mycoses: Tineapedis (Athlete's foot); Systemic mycoses: Histoplasmosis; opportunistic mycoses: candidiasis.

Prevention of Microbial Diseases: General preventive measures, Importance of personal hygiene, environmental sanitation and methods to prevent the spread of infectious agents, antibiotic substances, Major antimicrobial agents, Mode of action of chemotherapeutic and antibiotic substances. Mechanism of antibiotic resistance. **(10 Lectures)**

UNIT–IV

Immunology- Historical background: Humoral and Cellular components of the immune system Concept of Innate and Adaptive immunity; **Antigens and antibodies;** Characteristics of an antigen Haptens; Epitopes Adjuvants; T-cell and B-cell, Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies, Monoclonal and Chimeric antibodies, **(10 Lectures)**

UNIT–V

Antigen- Antibody reactions(Precipitation, Agglutination, RIA and ELISA, Vaccines: Importance, types of vaccines, Major Histocompatibility Complex**;** Structure and Functions of MHC I & II molecules; Antigen processing and presentation, Complement System-Components of the Complement system, Biological consequences of complement Activation. **(7 Lectures)**

Practical/Lab Course MIC DSC 5P: Experiments in Medical Microbiology and Immunology

1. Blood group determination by slide agglutination method.
2. Preparation of chocolate agar, and other media required for medically important microorganisms
3. Isolation and characterization of skin normal microflora
4. Isolation of bacteria from teeth crevices
5. Demonstration of α and β haemolysis on blood agar medium.
6. Demonstration of serological tests: blood groups, Rh factor determination, pregnancy test, Widal, VDRL, ELISA

7. Demonstration of pathogenic fungi in mycoses lesion
8. Antibiotic sensitivity test and MIC determination
9. Demonstration of antibiotic resistance transfer from resistant to sensitive microorganism
10. Demonstration of bacterial plasmid isolation.
11. Determination of nitrate production in nitrite broth soil cultures.
12. Isolation of antibiotic resistant bacteria by gradient plate technique.
13. Water Testing,
14. Fumigation
15. Predict the microorganism on the basis of reaction on TSI slant
16. Perform citrate utilisation test.
17. Determination of titre by slide agglutination method.

Suggested Reading

1. Dubey R.C**.** and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. Mackie and McCartney. Practical Medical Microbiology, Elsevier
3. CKJ Paniker. Test Book of Microbiology, Orient Longman
4. D.R.Arora. Medical Mycology, CBS Publisher and Distributors
5. Janis Kubey, Immunology, W.H.Freeman
6. Peter J Delves, S.J. Martins, D.R. Burtons, Roitts Essential Immunology, Wiley Blackwell
7. C.V.Rao , An Introduction to Immunology, Alpha Science International Ltd , **ISBN** 978-1842650356
8. **Digital Links**

• https://www.mcgill.ca/microimm/undergraduate-programs/courses

• https://oline.creighton.edu/program/medical-microbiology-and-immunology-ms

• http://www.vlab.co.in

• http://www.vlab.iitb.ac.in

• http://www.onlinelabs.in

• http://www.vlab.amrita.edu

• http://asm.org/articles/2020/december/virtual-resources-to-teach-microiology-techniques

https://www.futurelearn.com/courses/basic-concepts-in-microbiology-and-clinical-pharmacology-ofantimicrobials
https://vlab.amrita.edu/?sub=3&rch=73
https://www.mooc-list.co/tags/pathology
https://online.creighton.ed/program/medical-microbioogy-and-immunology-ms

B.Sc III Year **Semester-VI**

Bachelor of Science in Microbiology

No. of hours-75

DISCIPLINE SPECIFIC COURSE (DSC)- Industrial Microbiology

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Industrial Microbiology	4	3	0	1	**Undergraduate diploma in Microbiology**	**Nil**

BACHELOR OF SCIENCE IN Microbiology		
Programme : *Bachelor of Science in Microbiology*	**Year: III**	**Semester: VI**
Subject: Microbiology		
Course: MIC DSC 6	**)- Industrial Microbiology**	

Course Outcomes:

After the completion of the course the students will be able to:

- Acquaint with complex interrelationship between organisms and environment;
- Understand methods for studying vegetation, community patterns and processes,ecosystem functions, and principles of phytogeography.
- Understand the strategies for sustainable natural resource management and biodiversity conservation.
- Develop practical knowledge of the different statistical tools and techniques.

Credits: 4	**Discipline Specific Course**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

UNIT – I

Isolation of industrially important microbial strains, strain improvement, preservation and maintenance of industrial microbes, scale-up. Metabolite: Primary and secondary screening, strain development strategies, principal of exploitation of microorganism and their products, **(8 Lectures)**

UNIT – II

Fermentation: Media, Raw material, Antifoaming agents, Buffers. Equipments, Fermenter design. Types of fermentation – Single, Batch, Continuous. Down-stream processing steps: Detection and assay of the product, Recovery and Purification **(10 Lectures)**

UNIT – III

Industrial production of antibiotics : Fermentation and recovery process of penicillin, streptomycin, β – lactam and rifamcyin and tetracycline. **(8 Lectures)**

UNIT - IV

Industrial production of Enzymes and Amino acids: Microbial production and applications of amylases, lipase, protease; pectinase, and cellulases Amino acids: production of L-glutamic acid and L-lysine.

(11 Lectures)

UNIT - V

Microbial production of Vitamin B-12; Vitamin B2 (riboflavin), Vitamin C; Organic acids: Lactic acid and citric acid (fermentation and recovery). **(08Lectures)**

Suggested Reading

1. Dubey, R.C. *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
2. Casida, L.E.J.R. Industrial Microbiology, New Age International Publisher,
3. A.H.Patel, Industrial Microbiology, Laxmi Publication, ISBN-10: 9385750267
4. Prescott and Dunns.Industrial Microbiology, CBS Publishers and Distributers, ISBN-10**:** 8123910010

Suggestive digital platforms web links

• http://foodhaccp.com/foodsafetymicro/onlineindex.html

• http://www.cpe.rutgers.ed/courses/current/If0401wa.html

Practical/Lab Course MIC DSC 6P **Experiments in Industrial and Food and Dairy Microbiology.** **Credit 1**

1. Isolation of antibiotic producing microorganisms from soil.
2. Laboratory production of alcohol from Grape Juice/Sugarcane Juice.
3. Demonstration of vinegar production in laboratory.
4. Bioassay of vitamin $B_{12.}$
5. Fat hydrolysis (lipase activity) by a given bacterial culture.
6. Demonstration of fermentation by yeast.
7. Isolation of *Azotobacter* from garden soil.
8. Isolation of VAM (Vascular ArbuscularMycorrihizal spore from soil.
9. Isolation of phosphate solubilising microorganisms from soil.
10. Antibiotic sensitivity of UTI causing bacteria.
11. Slide agglutination reaction of unknown bacterial culture.
12. Demonstration of antigen-antibody reaction.
13. Study of Bioreactor & its essential parts
14. Necessity & procedure of writing SOPs for instruments used in large scale production
15. Isolation and characterization of microorganism used in Dairy industry
16. Isolation and characterization of Yeast used in Bakery/distillery/winery
17. Bacteriological analysis of food products

Suggested Reading

1. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2

BSC 4th Year (Honours) **Semester VII**

DISCIPLINE SPECIFIC COURSE (DSC) – Microbial Diversity- Prokaryotes and Viruses

No. of Hours-75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Microbial Diversity- Prokaryotes and Viruses	**4**	**3**	**0**	**1**	**Bachelor of Science in Microbiology**	**Nil**

BACHELOR IN MICROBIOLOGY WITH HONOURS		
Programme : ***Bachelor in Microbiology With Honours***	**Year: IV**	**Semester: VII**
Subject: Microbiology		
Course: MIC DSC7	**Course Title: Microbial Diversity- Prokaryotes and Viruses**	

Learning objectives:

- To understand the microbes diversity and their role .

To understand the basic concept of prokaryotes, their taxonomy,their differentiation from eukaryotes and biosafety regulatory framework for prokaryotes.

Learning outcomes:

At the end of course students will be able to explain the role of prokaryotes and their role in Microbiology development and what is the scope of the various branches of the subject and other beneficial roles.

- Cultivate viruses , Cyanobacteria in laboratory by different methods

Credits: 4	**Discipline Specific Course**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit I:

Discovery of microbial world; Introduction to microbial biodiversity distribution, abundance, ecological niche of bacteria and archaea.

Unit II:

Microbial evolution; classification of microorganisms: Haeckel's three kingdoms, Whittaker's five kingdoms, three domains of Carl Woese, ribosomal RNA in microbial taxonomy, concept of microbial species; classification and salient features of bacteria on the basis of *Bergey's Manual of systemic Bacteriology*. General features of important groups of bacteria Protobacteria, Firmicutes , Actinobacteria, Spirochaetes, Rickettisia and Archaebacteria and cyanobacteria .

Unit III:

Extreme environments and extremophiles; Microbial diversity in different ecosystems thermophiles, halophiles, mesophiles, hyper thermophiles, acidophiles, alkalophiles, barophiles and other extremophiles) and their biotechnological applications

Unit IV:

General characters, nomenclature, classification, morphology and ultra-structure of viruses; Capsid and their arrangement; Cultivation of viruses using embryonated eggs, experimental animals and cell cultures , viroids– host range, genome and origin of viroids;); prions- spread of prions and diseases.

Unit V

: Bacteriophages- Structural organization, multiplication cycle; one step growth curve lytic and lysogenic cycle, bacteriophage typing, M13, Mu, T4, Φx174, phage λ; application of bacteriophages in health-bacteriophage therapy. cyanophages- morphology, growth cycle, mycoviruses- replication and types of mycoviruses

Suggested Readings (Latest Editions):

1. Bergey's manual systematic Bacteriology(2011) 2nd edition
2. Prakash S. Bisen (2012). Microbes-concepts and applications, Wiley-Blackwell.
3. J.D.S.Panwar (2012)-Fundamentals of Microbilogy-S.R.S Pub
4. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hil
5. Bisen, P.S. (2014). Microbes in Practices, I K international publication house pvt Ltd.
6. Sharma P.D. (2015-16). Microbilogy, 3rd edn, Rastogi publications
7. J.G.Black(2015) –Microbiology, 9th edition, Wiley publication

Practical/Lab Course MIC DSC 7P :Experiments in Microbial Diversity- Prokaryotes and Viruses

1. Preparation of various models based on History of Microbiology.
2. Determination of growth of bacteria by spectrophotometrically.
3. Demonstration of pour plate, spread plate and streak plate methods.
4. Preparation of bacterial growth curve.
5. Isolation and characterization of thermophiles.
6. Isolation and characterization of psychrophiles.
7. Isolation and characterization of osmophiles.
8. Isolation and characterization of acidophiles.
9. Isolation and characterization of alkalophiles.
10. Isolation and characterization of halophiles.

11. Isolation and characterization of cyanobacteria.
12. Demonstration of bacteriophage typing.
13. Preparation of various models based on structure of viruses.
14. Study of virus infected plant material
15 Starch hydroloysis
16. Protein degradation-casein degradation
17. Carbohydrate fermentation (different sugars)
18. IMViC Tests: Indole, Methyl red, Vogus Prausker, Citrate utilization test.

BSC 4th Year (Honours) **Semester VIII**

DISCIPLINE SPECIFIC COURSE (DSC) – Microbial Biochemistry

No. of Hours-75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Microbial Biochemistry	**4**	**3**	**0**	**1**	**Bachelor of Science in Microbiology**	**Nil**

BACHELOR IN MICROBIOLOGY WITH HONOURS		
Programme : *Bachelor in Microbiology With Honours*	**Year: IV**	**Semester: VIII**
Subject: Microbiology		

Course: MIC DSC8	Course Title: Microbial Biochemistry

Learning objectives:

- To understand the statics role in biochemistry in microbiology
- To understand the basic concept of macromolecules .

Learning outcomes:

At the end of course students will be able to explain the role of macromolecules in Microbiology development and what is the scope of the various fields of the subject and other beneficial roles.

Credits: 4	Discipline Specific Course
Max. Marks: As per Univ. rules	Min. Passing Marks: Asper Univ. rules

Unit I

Carbohydrates : Structure and Properties and uses of monosaccharides, oligosaccharides and polysaccharides, glycoproteins, glycolipids, proteoglycans, mutarotation, annomerisation, epimerization, stability of polysaccharides

Unit II

Structure and properties of amino acids, Structure of protein (Primary, Secondary, Tertiary and Quaternary), essential and non-essential amino acids, general reactions of amino acid metabolism, urea cycle, synthesis of various molecules via amino acid metabolism intermediates, non-standard Amino Acids

Unit III

Structure and properties of fatty acids, storage and membrane lipids, phospholipids and cholesterol, Composition and synthesis of lipoproteins and their transport in the body, oxidation of fatty acids (beta & alpha), oxidation of long chain fatty acids, Synthesis of lipids, elongation of fatty acids, desaturation of fatty acids, regulation of fatty acid synthesis, cholesterol metabolism, regulation of cholesterol metabolism.

Unit IV:

Structure, composition and properties of nucleic acids, De-Novo synthesis of purine and pyrimidine nucleotides and its regulation. Synthesis of nucleoside di- and triphosphates, deoxynucleotides and TMP and degradation of purine and pyrimidine nucleotides, salvage pathways of nucleotides synthesis...

Unit V:

Structure,and properties of vitamins, co-enzymes, biochemical action of vitamins and Fat and water soluble vitamins, Biosynthesis of vitamins, role of vitamins in the metabolism.

Suggested Readings (Latest Editions):

1. Nelson D and Cox MM. (2010). Lehninger's Principles of Biochemistry. W.H. Freeman and Company, New York.

2. Voet D and Voet JG. (2013). Principle's of Biochemistry. John Wiley and sons New York.
3. Moat AG and Foster J W (Latest Edition). Microbial Physiology. John Wiley and Sons, New York.
4. Stryer. L (2003). Biochemistry. W. H. Freeman and Co.
5. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hil
6. J.L. Jain(2015).Fundamentals of Biochemistry, S. Chand and Co.
7. U. Satyanarayan(2015). Biochemistry, Elsevier

Practical/Lab Course MIC DSC 7P Experiments in Microbial Biochemistry

1. To carry out qualitative analysis of Carbohydrates
2. To carry out qualitative analysis of Lipids
3. To carry out qualitative analysis of amino acids
4. To carry out qualitative analysis of Proteins
5. To perform biochemical test of starch hydrolysis.
6. To perform biochemical test of casein hydrolysis.
7. To carry out estimation of DNA by Diphenylamine method
8. To carry out estimation of RNA by Orcinol method
9. To carry out estimation of protein by Biuret method.
10. To carry out separation of amino acid by Paper Chromatography and determination of Rf value TLC of fatty acids/lipids
11. To detect presence of reducing sugar using Benedict's test.
12. Determination of absorption maxima of given sample using spectrophotometer.
13. To demonstrate carbohydrate metabolism (oxidation and fermentation of Glucose) in microorganisms
14. To demonstrate Fat hydrolysis (lipase activity) by bacteria
15. To study ability of microorganisms to hydrolyze gelatin
16. To demonstrate degradation of sulphur containing amino acids by bacteri

Master Of Science In Microbiology (5th Year) **Semester IX**

DISCIPLINE SPECIFIC COURSE (DSC9) – Medical Microbiology

No. of Hours-75 **CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE**

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		

Medical Microbiology	**4**	**3**	**0**	**1**	**Honours Degree in Microbiology**	**Nil**

MASTER IN SCIENCE IN MICROBIOLOGY		
Programme : ***Master in Science in Microbiology***	**Year: V**	**Semester: IX**
Subject: Microbiology		
Course: MIC DSC 9	**Course Title: Medical Microbiology**	

Learning objectives:

- Students will understand the disease caused by the bacteria, fungi, virus and protozoa.
- To know the diagnosis and treatment of bacteria, fungi and viral pathogens.

Learning outcomes:

At the end of course students will be able to

- Understand the development and contribution of different scientist in the field of medical microbiology.
- Describe etiology, pathogenicity, epidemiology and laboratory diagnosis of disease caused by microorganism.
- To isolate and detect the pathogens from the clinical samples.
- Suggest different antimicrobial agent for the treatment of bacterial infections.

Credits: 4	**Discipline Specific Course**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

UNIT – I

Basics of medical microbiology- Early discovery of pathogenic microorganisms, development of bacteriology as scientific discipline, contribution of early microbiologists; classification of medically important microorganisms; normal microflora of human body, role of resident flora on human health; infection- types of infection, virulence, pathogenicity; characteristics of infectious diseases - disease cycle (sources of disease, reservoirs, carriers); transmission of pathogens.

UNIT – II

Bacterial Diseases: Characteristics of a successful pathogen, virulence factors- entry, adherence, invasiveness, iron sequestering, antiphagocytic factors, bacterial toxins (exotoxins and endotoxins and their mechanism of action), host-mediated pathogenesis, antigenic variation, immune suppression; bacterial diseases- characteristic features of causal organisms, symptoms, epidemiology,

prophylaxis and treatment of diseases caused by *Salmonella*, *Vibrio, Mycobacterium*, *Neisseria, Corynebacterium, Staphylococcus.*

UNIT – III

Viral diseases- Classification, epidemiology, symptoms, pathogenesis, diagnosis and treatment of diseases caused by adenovirus, poxvirus, herpesvirus, hepatitis B virus, influenza virus, paramyxovirus (mumps, measles and rubella viruses), rabdoviruses, retrovirus (HIV) and ebola virus.

UNIT – IV

Fungal diseases- Significance of fungi in human health, mycoses and mycotoxicoses, superficial mycoses (tinea nigra), subcutaneous mycoses (chromoblastomycosis, basidiobolomycosis), dermatophytoses (tinea capitis, tinea barbae, tinea corporis, tinea cruris, tinea unguium, tinea pedis), systemic mycoses (**histoplasmosis, candidiasis, aspergillosis**).

UNIT – V

Diagnosis and antimicrobial therapy- Methods of specimen collection, transportation and storage; laboratory diagnosis- identification of pathogens through microscopy, culture, serology and molecular biology; antimicrobial chemotherapy - development of chemotherapy, antimicrobial drugs and their mode of actions, drug resistance; drug sensitivity tests- significance in patient care, various methods of drug susceptibility testing, MICs, MBCs, antibiotic assay in body fluids; vaccines- vaccination schedules, schedules; nosocomial infections-factors affecting, sources and transmission, common types of hospital infections, prevention and control;

Practical/Lab Course MIC DSC 9P: Experiments in Medical Microbiology

1. To prepare various basic, selective, enrichment and enriched media used for isolation of medically important bacteria from clinical samples.
2. To perform various biochemical tests (IMVIC, oxidase, catalase, urea utilization test, sugar utilization and H2S production on TSI agar slant) used for identification of medically important bacteria.
3. To perform sugar fermentation tests for identification of medically important bacteria.
4. Demonstration normal microbial flora of skin, mouth and throat.
5. Isolation and identification of Staphylococcal species using suitable media, staining techniques and biochemical tests.
6. Isolation and identification of Streptococcal species using suitable media, staining techniques and biochemical tests.
7. Isolation and identification of enteric fever causing bacteria (Salmonella typhi) using suitable media and biochemical tests.
8. Microbiological analysis of urine specimens.
9. Microbiological analysis of stool specimens.
10. Microbiological analysis of blood specimens.
11. Microbiological analysis of sput um specimens
12. To determine antibiotic sensitivity for Gram negative and Gram positive bacteria by disc diffusion method
13. To determine Minimal Inhibitory Concentration (MIC) and Minimal Bactericidal concentration of an antibiotic for test bacteria.
14. To evaluate antimicrobial chemical agents by log reduction method.

Semester-I

Undergraduate Certificate in Microbiology

GENERIC ELECTIVE (GE)- Microorganisms for Human Welfare

No. of Hours- 60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Microorganisms for Human Welfare	4	4	0	0	Passed Class XII	Nil

UNDERGRADUATE CERTIFICATE IN BOTANY		
Programme : ***Undergraduate Certificate inMicrobiology***	**Year: I**	**Semester: I**
Subject: Microbiology		
Course: MIC GE 1	**Microorganisms for Human Welfare**	

Learning Outcomes:

After the completion of the course the students will be able to:

1. Understand the microorganism used in daily life .
2. Understand the various microbial products and the diseases coursing microorganism

Credits: 4	**Generic Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit – 1: Food and Fermentation Fermented Foods – Types, nutritional values and health benefits. Probiotics, prebiotics, synbiotics and nutraceuticals. Fermented Products – Alcoholic and non-alcoholic beverages, dairy

products Microorganisms as food (SCP) fermented food products) and probiotics. Microorganisms in food spoilage and food borne infections

Unit – 2: Agriculture Bio-fertilizers and bio-pesticides - types and applications, beneficial microorganisms in agriculture, AM fungi, Mushroom cultivation, Biogas production.

Unit – 3: Pharmaceutical Industry Drugs – types, development and applications. Antibiotics – types, functions and antibiotic therapy. Vaccines – types, properties, functions and schedules.

Unit 4 Microbes in Human Health: List of important human diseases and their causative agents of various human systems. Definitions of immunity (active/passive), primary and secondary immune response, antigen, antibody and their types.

Unit 5 Industrial Microbiology Definition of fermentation, primary and secondary metabolites, types of fermentations and fermenters and microbes producing important industrial products through fermentation.

Suggesting Reading

1. Ananthnarayanan, R and Jeyaram Panicker, C. K. 2010.Textbooks of Microbiology, Orient Longman.
2. Dubey, R.C. and Maheshwari, D.K. 2013. A Textbook of Microbiology –2nd edition (S chand & Co. N. Delhi).
3. Michael, J. Pelczar, Jr. E.C.S., Chan, Noel R. 1998. Krieg Microbiology Tata McGraw- Hill Publisher.
4. Pelczar, M.J., Chan E.C.S. and Kreig, N.R. 1993. Microbiology 5th edition (Tata McGraw-Hill, New Delhi)
5. Prescott, L.M., Harley, J.P. and Klein, D.A., 2007. Microbiology –7th edition (Wm. C. Brown Publishers, USA)

Elementary Microbiology – Modi, HA (vol. I), 1st edition (Ekta Pakashan, Nadiad).

Semester-II

Undergraduate Certificate in Microbiology

GENERIC ELECTIVE (GE)- MICROBIAL DIAGNOSIS IN HEALTH CLINICS

No. of Hours- 60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
MICROBIAL DIAGNOSIS IN HEALTH CLINICS	4	4	0	0	Passed Class	Nil

UNDERGRADUATE CERTIFICATE IN BOTANY		
Programme : ***Undergraduate Certificate in Microbiology***	**Year: I**	**Semester: II**

Subject: Microbiology	
Course: MICGE 2	**MICROBIAL DIAGNOSIS IN HEALTH CLINICS**

Course Outcomes:

After the completion of the course the students will be able to:

1. Understand the different types of microbial diseases
2. Understand the structure and shape of different pathogens
3 Understand the diagnosis of different diseases.
3. Understand rapid test of different clinical sample.

Credits: 4	Generic Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: Asper Univ. rules

Unit 1 Importance of Diagnosis of Diseases and Collection of Clinical Samples Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis. Collection of Clinical Samples: How to collect clinical samples (oral cavity, throat, skin, Blood, CSF, urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.

Unit 2 Direct Microscopic Examination Examination of sample by staining - Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsa-stained thin blood film for malaria.

Unit 3 Culturing Pathogens Preparation and use of culture media - Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar, Distinct colony properties of various bacterial pathogens.

Unit 3 Serology, Molecular Methods and Kits for Rapid Detection of Pathogens

Serological Methods - Agglutination, ELISA, , Nucleic acid based methods - PCR, Nucleic acid probes. Kits for Rapid Detection of Pathogens: Typhoid, Dengue and HIV, Swine flu.

Unit 4 Testing for Antibiotic Sensitivity in Bacteria Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method, Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method

Suggested Readings

1. Ananthanarayan R and Paniker CKJ (2009)Textbook of Microbiology, 8th edition, Universities Press Private Ltd.

2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication

3. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2nd edition, Elsevier India Pvt Ltd

4. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby

5. Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and Mccartney Practical Medical Microbiology, 14th edition, Elsevier.

Semester-III

Undergraduate Diploma in Microbiology

No. of Hours- 60

Generic Elective: MANAGEMENT OF HUMAN MICROBIAL DISEASES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
MANAGEMENT OF HUMAN MICROBIAL DISEASES	4	4	0	0	Passed Class	Nil

UNDERGRADUATE DIPLOMA IN MICROBIOLOGY		
Programme : ***Undergraduate Diploma in Microbiology***	**Year: II**	**Semester: III**
Subject: Microbiology		
Course: MIC GE 3	**MANAGEMENT OF HUMAN MICROBIAL DISEASES**	

Course Outcomes:

After the completion of the course the students will be able to

1. Understand the basic microbial diseases.
2. Understand prevention and treatment of microbial diseases.
3. Understand the concept of Antibiotics and antiviral drugs .

Credits: 4	**Generic Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit 1 Introduction to Human Microbial Diseases Definition and concept of health, disease, Infection and Pathogen. Types of human microbial diseases and their transmission, causative agents and symptoms of human microbial diseases: Respiratory microbial diseases, gastrointestinal microbial diseases, , skin diseases, eye diseases, urinary tract diseases, sexually transmitted diseases, Microbial mediated cancers and Nosocomial infections.

Unit 2 Diagnosis of Human Microbial diseases Various serological and molecular methods for diagnosis of microbial diseases. Detection by diagnostic kits based on ELISA, Immunofluorescence, Agglutination tests,

Unit 3 Therapeutics of Microbial diseases Treatment using antibiotics: Mechanism of action of antibiotics belonging to different classes: beta lactam antibiotics (penicillin, cephalosporins), quinolones, polypeptides and aminoglycosides**.** Judicious use of antibiotics, importance of completing antibiotic regimen, Concept of DOTS, emergence of antibiotic resistance, current issues of MDR/XDR microbial strains.

Unit 4 Microbial Viral Diseses SARS/ Swine flu/Ebola causes, spread and control.

Treatment using antiviral agents: Mechanism of action of Amantadine, Acyclovir,.

Unit 4 Prevention of Microbial Diseases

General preventive measures, Importance of personal hygiene, environmental sanitation and methods to prevent the spread of infectious agents transmitted by direct contact, food, water and insect vectors. Vaccines: Importance, types, vaccines available against microbial diseases, vaccination schedule (compulsory and preventive) in the Indian context.

Suggested Readings

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier.
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education.
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.

Semester-IV

Undergraduate Diploma in Microbiology

Generic Elective: MICROBIAL BIOTECHNOLOGY

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility	Pre-
		Lecture	Tutorial	Practical/Practice	criteria	requisite of the course(if any)
MICROBIAL BIOTECHNOLOGY	4	4	0	0	Passed class	Nil

UNDERGRADUATE DIPLOMA IN MICROBIOLOGY		
Programme : ***Undergraduate Diploma in Microbiology***	**Year: II**	**Semester: IV**
Subject: Microbiology		
Course: MIC GE 4	**MICROBIAL BIOTECHNOLOGY**	

Course Outcomes:

After the completion of the course the students will be able to

1. Understand the concepts and biotechnological tools .
2. Understand the genetic modified organisms
3. Learn how different microbial products

Credits: 4	**Generic Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit 1 Microbial Biotechnology and its Applications Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology Use of prokaryotic and eukaryotic microorganisms in biotechnological applications Genetically engineered microbes for industrial application: Bacteria and yeast

Unit 2 Therapeutic and Industrial Biotechnology Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine) Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics Microbial biosensors

Unit 3 Applications of Microbes in Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute

Unit 4 Microbial Products and their Recovery Microbial product purification: filtration, Immobilization methods and their application: Whole cell immobilization

Unit 5 Microbes for Bio-energy and Environment Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture.

SUGGESTED READING

1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.
2. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology,2nd Edition, ASM Press.
3. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins.Current Opinion in Biotechnology, 12, 195–201.
4. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, McGraw Hill Publishers.
5. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications,6. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press
7. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
8. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition., Elsevier Science
9. Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc.

Semester-V

Bachelor of Science in Microbiology

Generic Elective: INTRODUCTION AND SCOPE OF MICROBIOLOGY

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
INTRODUCTION AND SCOPE OF MICROBIOLOGY	4	4	0	0	Passed Class	Nil

BACHELOR OF SCIENCE IN MICROBIOLOGY

Programme : *Bachelor of Science in Microbiology*	Year: III	Semester: V
Subject: Microbiology		
Course: MIC GE 5	**INTRODUCTION AND SCOPE OF MICROBIOLOGY**	

Course Outcomes:

After the completion of the course the students will be able to:

1. Understand the scope of microbiology
2. Understand .the different technique used in control of microorganisms
3. Understand the economic importance of microbes

Credits: 4	Generic Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: Asper Univ. rules

Unit 1

Development of Microbiology Development of microbiology as a discipline and Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner.

Unit 2

Diversity of Microorganisms Systems of classification : Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility General characteristics of different groups: Acellular microorganisms and Cellular microorganisms giving definitions and citing examples.

Unit 3

Microscopy Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope,Transmission Electron Microscope, Scanning Electron Microscope. **Sterilization** Moist Heat, Autoclave, Dry Heat, Hot Air Oven, , Filteration. ,

Unit 4 Industrial Microbiology Definition of fermentation, primary and secondary metabolites, types of fermentations and fermenters and microbes producing important industrial products through fermentation.

Unit 5

Food and Dairy Microbiology Microorganisms as food (SCP), microorganisms in food fermentations (dairy and non dairy based fermented food products) and probiotics. Microorganisms in food spoilage and food borne infections.

SUGGESTED READING

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited.
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.

Semester-VI

Bachelor of Science in Microbiology

GENERIC ELECTIVE (GE): INDUSTRIAL AND FOOD MICROBIOLOGY

No. OF Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Industrial And Food Microbiology	4	4	0	0	Passed Class	Nil

BACHELOR OF SCIENCE IN MICROBIOLOGY		
Programme : ***Bachelor of Science in Microbiology***	**Year: III**	**Semester: VI**
Subject: Microbiology		
Course: MIC GE 6	**INDUSTRIAL AND FOOD MICROBIOLOGY**	

Course Outcomes:

After the completion of the course the students will be able to:

1. Understand the industrially important microorganism and products .
2. Learn about the microorganisms used in food products and .

Credits: 4	**Generic Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit 1

Introduction to Industrial microbiology Brief history and developments in industrial microbiology. Types of fermentation processes - solid state, liquid state, batch, fed-batch and continuous. Types of fermenters – laboratory, pilot-scale and production fermenters. Components of a typical continuously stirred tank bioreactor.

Unit 2

Isolation of industrial strains and fermentation medium Primary and secondary screening. Preservation and maintenance of industrial strains. Ingredients used in fermentation medium - molasses, corn steep liquor, whey &yeast extract.

Unit 3

Microbial fermentation processes Downstream processing - filtration, centrifugation, cell disruption, solvent extraction. Microbial production of industrial products - Industrial production and uses of the enzymes

Unit 4

Food as a substrate for microbial growth Intrinsic and extrinsic parameters that affect microbial growth in food. Microbial spoilage of food - milk, egg, bread and canned foods . **Principles and methods of food preservation and food sanitation** Physical methods - high temperature, low temperature, irradiation, aseptic packaging. Chemical methods - salt, sugar, benzoates, citric acid, ethylene oxide, nitrate and nitrite. Food sanitation and control – HACCP.

Unit 5

Dairy products, probiotics and Food-borne Diseases Fermented dairy products - yogurt, acidophilus milk, kefir, dahi and cheese.n Probiotics definition, examples and benefits. Food intoxication by *Clostridium botulinum* and *Staphylococcus aureus*. Food infection by *Salmonella* and *E.coli*.

Suggested Readings

1. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd Edition. Panima Publishing Company, New Delhi.

2. Patel AH. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India.

Semester VII

GENERIC ELECTIVE (GE)- Biostatistics, Computer Applications and Bioinformatics

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Biostatistics, Computer Applications and Bioinformatics	**4**	**4**	**0**	**0**	**Bachelor of Science in Microbiology**	**Nil**

BACHELOR IN MICROBIOLOGY WITH HONOURS		
Programme : ***Master of Science in Microbiology***	**Year: IV**	**Semester: VII**
Subject: Microbiology		
Course: MIC GE7	**Course Title: Biostatistics, Computer Applications and Bioinformatics**	

Course outcomes:

Learning objectives:

- To understand the statics role in biological and Research industry
- To understand the basic concept biostatics and computer.
- At the end of course students will be able to explain the role of computer and statics in Microbiology development and what is the scope of the various field of the subject and other beneficial roles.

Credits: 4	**Generic Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit I:

Presentation of data; Frequency distributions; Graphical representation of data by histogram, polygon, frequency curves and pie diagram. Measures of central tendency: Mean, median and mode; Measures of dispersion: Mean deviation, standard deviation, coefficient of variation;

Unit II:

Correlation : properties, nature, coefficient of correlation, , significance of correlation Probability: Basic concepts related to probability theory, classical probability. Probability Distributions

Unit III:

Testing of significance: Students t-test for the significance of population mean, Chi square test for population variance, F-test for the equality of two population variance; Analysis of variance- One-way

Unit IV:

Introduction to Computers: Definition, Components of computer, Basics for operating systems Introduction to MS Office (MS-Word, MS-Excel, MS-Power Point); Introduction to Networking Computer application in Microbiological ,fermentation and Pharmaceutical Industry

Unit V:

Introduction to Bioinformatics: Definition and scope; Search engines: tools for web search; Introduction to biological databases (NCBI, EBI, DDBJ, Gen Bank,),Introduction to BLAST and FASTA

studies.

Suggested Readings (Latest Editions):

1. Bailey, NT J (2000). Statistical Methods in Biology. English Univ. Press.
2. Campbell R.C (Latest Edition). Statistics for Biologist. Cambridge University Press, UK.
3. Sinha PK (Latest Edition). Fundamentals of computers. BPB Publication, New Delhi
4. Jonathan, P. 2008. Bioinformatics & Functional Genomics.
5. B.D.Singh(2015). Biotechnology, Kalyani Publication.
6. Sharma and Munjal(2015). A test book of Bioinformatics, Rastogi publication

Semester VII

GENERIC ELECTIVE (GE)- BACTERIOLOGY AND VIROLOGY

No. of Hours- 60

CREDITDISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
BACTERIOLOGY AND VIROLOGY	**4**	4	0	0	**Bachelor of Science in Microbiology**	**Nil**

BACHELOR IN MICROBIOLOGY WITH HONOURS		
Programme : ***Bachelor in Microbiology With Honours***	**Year: IV**	**Semester: VII**
Subject: Microbiology		
Course: MIC GE 8	**Course BACTERIOLOGY AND VIROLOGY**	

Course Outcomes:

After the completion of the course the students will be able to:

1. Understand the structure, classification and functions of Bacteria .
2. Understand the structure of virus
3. Understand the role of bacteria and virus in human health .

Credits: 4	**Generic Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit 1

Cell organization Cell size, shape and arrangements, capsule, flagella and pili, Composition and detailed structure of gram- positive and gram- negative cell wall and archaeal cell wall, Structure, chemical composition and functions of bacterial and archaeal cell membranes, Ribosomes, inclusions, nucleoid, plasmids, structure, formation and stages of sporulation.

Unit 2

Bacterial growth and control Culture media: Components of media, Synthetic or defined media, Complex media, enriched media, selective media, differential media, enrichment culture media. Pure culture isolation: Streaking, serial dilution and plating methods, cultivation, maintenance and stocking of pure cultures, cultivation of anaerobic bacteria. Growth: Binary fission, phases of growth.

Unit 3

Bacterial Systematics and Taxonomy Taxonomy, nomenclature, systematics, types of classifications. Morphology, ecological significance and economic importance of the following groups: Archaea: methanogens, thermophiles and halophiles. Eubacteria: Gram negative and Gram positive. Gram negative: Non-proteobacteria– *Deinococcus, Chlamydia,* Spirochetes. Alpha proteobacteria- *Rickettsia, Rhizobium, Agrobacterium*. Gamma proteobacteria –*Escherichia,Shigella,Pseudomonas*. Gram positive: Low G+C: *Mycoplasma*, *Bacillus, Clostridium, Staphylococcus* High G+C: *Streptomyces, Frankia*.

Unit 4

Introduction to Viruses Properties of viruses; general nature and important features. Subviral particles; viroids, prions and their importance. Isolation and cultivation of viruses. Viruses as pathogens: Role of viruses in causing diseases. Prevention and control of viruses:

Unit 5

Structure, and multiplication of viruses Morphological characters: Capsid symmetry and different shapes of viruses with examples. Viral multiplication in the Cell: Lytic and lysogenic cycle. Description of important viruses: salient features of the viruses infecting different hosts - Bacteriophages (T4 & Lambda); Plant (TMV & Cauliflower Mosaic Virus), Human (HIV & Hepatitis viruses).

SUGGESTED READING

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP (2014). Brock Biology of Micro-organisms. 14th edition. Pearson Education, Inc.
3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
4. Carter J and Saunders V(2007). Virology; principles and Applications. John Wiley and Sons.

5. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR Skalka, AM (2004) Principles of Virology, Molecular Biology, Pathogenesis and Control. 2nd edition.ASM Press.
6. Shors Teri (2013) Understanding Viruses 2nd edition Jones and Bartlett Learning Burlington USA.
7. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.

BSc 4th Year (Honors) **Semester VIII**

GENERIC ELECTIVE (GE) – FOOD BORNE DISEASES AND FOOD PRESERVATION

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
FOOD BORNE DISEASES AND FOOD PRESERVATION	4	4	0	0	Bachelor of Science in Botany	Nil

BACHELOR IN MICROBIOLOGY WITH HONOURS		
Programme : ***Bachelor in Microbiology with Honours***	**Year: IV**	**Semester: VIII**
Subject: Microbiology		
Course: MIC GE 9	**Course Title: FOOD BORNE DISEASES AND FOOD PRESERVATION**	

Learning objectives:

- To understand the prevalence of bacteria in food commodities.
- To understand the occurrence of food-borne diseases.
- To know the different test for the detection of food-borne infection.

Learning outcomes:

At the end of course student will be able to

- Explain the role of microorganism in food commodities.
- Explain the factor responsible for the growth of bacteria.
1. Perform the different microbiological test to determine the quality of food.

Credits: 4	**Generic Elective**
Max. Marks:	**Min. Passing Marks: Asper Univ. rules**

UNIT – I

Food spoilage: Microbes in food, factors affecting microbial growth in foods: Extrinsic and intrinsic, microbial spoilage of foods, microbial spoilage of food – milk and milk products, fruits and vegetables, meat products, canned foods.

UNIT – II

Food preservation methods: Aseptic handling, temperature treatment, dehydration, lyophilization, osmotic pressure, radiations canning, chemical preservatives (salt and sugars, organic acids, propylene oxide, wood smoke and antibiotics), mechanism of chemical preservatives.

UNIT - III

Food-borne diseases (Bacteria and Virus): Food poisoning (food intoxication and food infections);Bacterial food poisoning (*Clostridium, Bacillus cereus* and *Staphylococcus);* Viral infections:Rotavirus, Hepatitis A & C

UNIT – IV

Food-borne diseases (Fungus and protozoans): Fungal food poisoning (*Aspergillus* and *Penicillium*), health hazards of mycotoxins; Protozonal infections; *Entamoebahistolytica, Teniasolium, Fasciola hepatica*

UNIT - V

Methods for microbiological examination of food and quality control: Indicator organisms for assuring the suitability of food products, methods of microbiological examination, direct culture technique, enumeration methods (plate count and MPN), alternative methods (dye reduction tests), electrical methods, quality criteria, sampling schemes.

B.Sc 4th Year (Honors) **Semester VIII**

GENERIC ELECTIVE (GE) – GENETIC ENGINEERING AND BIOTECHNOLOGY

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
GENETIC ENGINEERING AND BIOTECHNOLOGY	4	4	0	0	Bachelor of Science in Microbiology	Nil

BACHELOR IN MICROBIOLOGY WITH HONOURS		
Programme : ***Bachelor in Microbiology with Honours***	**Year: IV**	**Semester: VIII**
Subject: Microbiology		
Course: MIC GE 10	**Course Title: GENETIC ENGINEERING AND BIOTECHNOLOGY**	

Course outcomes: After the completion of the course the students will be able to:

1. Understand the concept, scope and importance of traditional knowledge.
2. Study the Genetic Engineering and its role in Biotechnology .
3. Interpret the concepts of Intellectual property right .

Credits: 4	**Generic Elective**
Max. Marks:	**Min. Passing Marks: Asper Univ. rules**

Unit 1

Introduction to genetic engineering Milestones in genetic engineering and biotechnology. Restriction modification

systems: Mode of action, applications of Type II restriction enzymes in genetic engineering. DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase kinases and phosphatases, and DNA ligases. Cloning: Use of linkers and adaptors. Transformation of DNA: Chemical method, Methods of DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques

Unit 2

Vectors Cloning Vectors: Definition and Properties. Plasmid vectors: pBR and pUC series. Bacteriophage lambda and M13 based vectors. Cosmids, BACs, YACs. Expression vectors: *E.coli* lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors.

Unit 3

DNA Amplification and DNA sequencing PCR: Basics of PCR, RT-PCR, Real-Time PCR. Genomic and cDNA libraries: Preparation and uses, Genome sequencing. Sanger's method of DNA Sequencing: traditional and automated sequencing.

Unit 4

Application of Genetic Engineering and Biotechnology Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral-mediated delivery, *Agrobacterium* - mediated delivery. Products of recombinant DNA technology: Products of human therapeutic interest – insulin . Bt transgenic - cotton, Gene therapy, recombinant vaccine.

Unit 5 Intellectual Property Rights Patents, Copyrights, Trademarks.

Master Of Science In Microbiology (5th year) **Semester IX**

GENERIC ELECTIVE (GE) – APPLIED MICROBIOLOGY

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisiteof the course(if any)
		Lecture	Tutorial	Practical/Practice		
APPLIED MICROBIOLOGY	4	4	0	0	Honours Degree in Microbiology	Nil

MASTER OF SCIENCE IN MICROBIOLOGY		
Programme : ***Master of Science in Microbiology***	**Year: V**	**Semester: IX**

Subject: Microbiology	
Course: MIC GE 11	**Course Title: Applied Microbiology**

Learning objectives:

- Students will learn about the components of the Microbial products as well as their functions and response..
- To develop understanding of Process of their development
- To understand different Application of microbial Products .

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Learning outcomes:

At the end of course student will be able to

- Explain the different components of Microbes involved in different product processing .
- Describe how these microbial products beneficial for welfare.

1.

Credits: 4	Generic Elective
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit 1:

Applications and Function microbial Production of Nutraceuticals- Probiotics, Prebiotics, Synbiotics, SCP,.

Unit 2:

Biosensors: Definition, Components, Basic Characteristics, Principles, Applications. Bioplastics Definition, Properties, types and composition Environmental impact.

Unit 3:

Applications of Microbes in Biotransformation Definition, types of microbial transformations/bioconversions, biocatalysts,

Unit 4

Immobilisation methods and Applications Introduction, preparation of immobilised enzymes, RNAi Definition, RNA silencing and applications

Unit 5.

Nanotechnology Definition of nanoparticles, types, characterization and properties. Applications - drug delivery systems, antifouling, degradation of xenobiotics .

Suggested Readings

1. Harrigan WF (1998)Laboratory Methods in Food Microbiology, 3rd ed. Academic Press.
2. Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.

3. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer.
4. Baird RM, Hodges NA and Denyer SP (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.

Master Of Science (5th Year) **Semester IX**

GENERIC ELECTIVE (GE) – MICROBIAL QUALITY CONTROL IN FOOD AND PHARMACEUTICAL INDUSTRIES

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Microbial Quality Control In Food And Pharmaceutical Industries	4	4	0	0	Honours Degree in Microbiology	Nil

MASTER OF SCIENCE IN MICROBIOLOGY		
Programme : ***Master of Science in Microbiology***	**Year: V**	**Semester: IX**
Subject: Microbiology		
Course: MIC GE 12	**Course Title: Microbial Quality Control In Food And Pharmaceutical Industries**	

Course outcomes: After the completion of the course the students will be able to

1. Understand the processing and importance of Herbarium.
2. Learn about the preparation of Flora.
3. Learn the basic techniques of classification.
4. Understand the collection and identification of plants.

Credits: 4	**Generic Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit 1

Microbiological Laboratory and Safe Practices No. of Hours: 8

Good laboratory practices, Good microbiological practices. Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL-1, BSL-2, BSL-3.Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration.

Unit 2

Determining Microbes in Food / Pharmaceutical Samples No. of Hours: 10

Culture and microscopic methods - Standard plate count, Most probable numbers,Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, geldiffusion, sterility testing for pharmaceutical products. Molecular methods - Nucleic acid probes, PCR based detection, biosensors.

Unit 3

Pathogenic Microorganisms of importance in Food & Water No. of Hours: 8

Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Manitol salt agar, EMB agar, McConkey Agar, Saboraud Agar.

Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centres (COB, 10 min Resazurin assay).

Unit 4

HACCP for Food Safety and Microbial Standards No. of Hours: 4

Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations

Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water.

SUGGESTED READING

1. Harrigan WF (1998)Laboratory Methods in Food Microbiology, 3rd ed. Academic Press.
2. Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.
3. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer.
4. Baird RM, Hodges NA and Denyer SP (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.

Semester X

GENERIC ELECTIVE (GE): LICHENOLOGY

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
Lichenology	4	4	0	0	Botany in Honours Degree	Nil

MASTER OF SCIENCE IN BOTANY		
Programme : ***Master of Science in Botany***	**Year: V**	**Semester: X**
Subject: Botany		
Course: BOT GE 13	**Course Title: Lichenology**	

Course Outcomes:

After the completion of the course the students will be able to:

1. Understand the general characters, structure, types, reproduction and various habitats of lichens.
2. Develop conceptual skill about identifying fungi and lichens.
3. Understand the physiology and biochemistry of lichens.
4. Study the ecological and economic importance of lichens.
5. Gain knowledge about the major lichen families and their representative genera.

Credits: 4	**Generic Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit	Topic	No. of Hours (60)
1	Introduction, General characteristics of lichens, history of Lichenology, collection and preservation of lichens, habitat and growth form of lichens. Classification of lichens. Morphology and anatomy of lichens, Reproduction in lichens.	**20**
2	Physiology and chemistry of lichens, ecological and economic importance of lichens, Overview of some common lichens of Uttarakhand Himalaya.	**15**
3	Salient features of Parmeliaceae, Lecanoraceae, Teloschistaceae, Ramalinaceae, Physciaceae, Collemataceace, Candelariaceae, Peltigeraceae and Usneaceae.	**15**
4	Methods to identify different lichens. Demonstration of different lichen specimens	**10**

Suggested readings

- Arya, V., Kumar, B. and Arya, P. (2019). Lichen Wealth of Uttarakhand Himalaya. Lap Lambert Academic Publishing.
- Awasthi, D.D. (2000). Hand book of lichens, Bishen Singh Mahendrapal Singh: Dehradun India.
- Awasthi, D.D. (2007). A compendium of the macrolichens of India, Nepal and Srilanka. Dehradun Bishen Singh Mahendra pal Singh: Dehradun India.
- Sati, S.C. and Pant, P. (2023). A test Book on Lichens: The Endolichenic Fungi. Elite Publishing House, New Delhi.
- Webster, J. (1985). Introduction to Fungi. Cambridge University Press. New York.

Skill Enhancement Course: Microbiology

No. of Hours- 45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Tools and Techniques	**2**	**1**	**0**	**1**	**Passed class XII**	**Nil**

Skill Enhancement Courses in Microbiology		
Programme : Skill Enhancement Courses in Microbiology	**Year: I**	**Semester: I**
Subject: Microbiology		
Course: MIC SEC 1	**Tools and Techniques**	

Learning objectives:

- To get the knowledge of sophisticated and common instruments used in the microbiology laboratory
- To know aseptic techniques to keep the instrument and media sterile.

Learning outcomes:

At the end of course students will be able to

- Maintain the sterility of glassware, utensils and medium by different physical and chemical procedure.

1. Operate the different sophisticated instruments available in the laboratory..

Credits: 2	**Skill Enhancement Course**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

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UNIT–I Industrial microbiology- Definition and scope, history of industrial microbiology, industrial microbiology in present scenario, development of industrial microbiology in India.

UNIT-II Basic knowledge of different instruments and their applications in microbiology such as microscope , micrometry, hot air oven, autoclave, laminar air flow and BOD incubator.

UNIT–III Isolation of industrially important microorganisms, Primary screening (crowded plate technique,

Auxanography technique, enrichment culture technique, differential culture technique), Importance of screening.

UNIT–IV Aseptic technique: contamination, sterilization (heating, steam sterilization, tyndallization, dry heat, chemicals, radiation sterilization, filter sterilization), sterilization of air.

UNIT–V Disinfection Chemical and Physical Disinfectant , UV IR Gama Radiation . Ionization and Non Ionizing

Practical/Lab Course MIC SEC-MC-1P 1. To determine the effect of temperature on microbial growth.
2. To determine the effect of pH on microbial growth.
3. To determine the effect of oxygen on microbial growth
4. Fumigation
5 Efficagy of Disinfectant
6. Effect of uv in Microbial Growth
7. Isolation of Yeast
8. Sterilization Technique

Suggested Reading

1. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. Prescott's Microbiology, 10th Edition, McGraw Hill Publication
3. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2
4. Dubey, R.C. *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.

Skill Enhancement Course: Food Fermentation Technology

No. of Hours- 45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Food Fermentation Technology	**2**	**1**	**0**	**1**		**Nil**

Skill Enhancement Courses in Microbiology		
Programme : Skill Enhancement Courses in Microbiology	**Year: I**	**Semester: II**
Subject: Microbiology		
Course: MIC SEC 2	Food Fermentation Technology	

Learning Objective:
The course aims to provide an advanced understanding of the core principles and topics of Food fermentation techniques.

Learning Outcome:
- Understand the role of different microorganisms in Food undustry
- Learn different fermentation processes used in the food industry
- Understand role of Probiotics in food

Credits: 2	**Skill Enhancement Course**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit 1 Fermented Foods Definition, types, advantages and health benefits

Unit 2 Milk Based Fermented Foods Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process

Unit 3 Grain Based Fermented Foods Soy sauce, Bread, Idli and Dosa: Microorganisms and production process

Unit 4 Vegetable and Non Vegetarian Based Fermented Foods Pickels, Saeurkraut: Microorganisms and production process, **Fermented Meat and Fish** Types, microorganisms involved, fermentation process

Unit 5 Probiotic and Prebiotics Foods Definition, types, microorganisms and health benefits advantage for currant scenario .

Practical/Lab Course MIC SEC 2P

1. **Preparation fermented foods**
2. **Isolation of curd bacteria**
3. **Isolation of Prebiotics**
4. **Preparation of Microbial products , Idli, bread, buttermilk dahi,**

Skill Enhancement Course: Microbiological Analysis Of Air And Water

No. of Hours- 45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility	Pre-
		Lecture	Tutorial	Practical/Practice	criteria	requisite of the Course (if any)
Microbiological Analysis Of Air And Water	2	1	0	1		Nil

Skill Enhancement Courses in Microbiology		
Programme : Skill Enhancement Courses in Microbiology	**Year: II**	**Semester: III**
Subject: Microbiology		
CourseMIC SEC 3	Microbiological Analysis Of Air And Water	

Learning objectives:

- To understand how microorganisms adapt to different environments and their interaction with different habitat and also the spread of microorganism from the environment.
- To know different techniques of detection of microorganism from air,soil, and aquatic environment.
- To acquire knowledge of treating polluted water.

Learning outcomes:

At the end of course student will be able to

- Perform and demonstrate different methods used to determine the quality of water and air.

Purify the household water through physical, chemical and biological method

Credits: 2	**Skill Enhancement Course**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

UNIT – I Aeromicrobiology: Bioaerosols, Air borne microorganisms (bacteria, viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens.

UNIT – II Air Sample Collection and Analysis: Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics.

UNIT – III Control Measures: Fat of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration.

UNIT – IV Microbiological Analysis of Water: Sample Collection, Treatment and safety of drinking

(potable) water, methods to detect portability of water samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.

UNIT – V Control Measures: Precipitation, chemical disinfection, filtration, high temperature, UV light.

Practical/Lab Course MIC SEC 3P

1. **Isolation of water micro flora by SPC**
2. **Check the water quality by Membrane filtration**
3. **Test of MPN**
4. **Isolation micro flora from fatty products**
5. **Complete test of fecal coli forms**

Skill Enhancement Course: MICROBIAL QUALITY CONTROL IN FOOD AND

No. of Hours- 45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Food Testing And Quality Control	2	1	0	1		Nil

Skill Enhancement Courses in Microbiology		
Programme : Skill Enhancement Courses in Microbiology	**Year: II**	**Semester: IV**
Subject: Microbiology		
Course: MIC SEC- 4	**MICROBIAL QUALITY CONTROL IN FOOD AND PHARMACEUTICAL INDUSTRIES**	
Learning outcome : Understand the safety of microbiological lab **Understand the technique of isolation** **Know about industrial lab and its standards**		

Credits: 2	**Skill Enhancement Course**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit 1 Microbiological Laboratory and Safe Practices

Good laboratory practices - Good laboratory practices, Good microbiological practices; Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL1, BSL-2, BSL-3. Discarding biohazardous waste – Methodology of Disinfection Autoclaving & Incineration

Unit 2 Determining Microbes in Food / Pharmaceutical Samples

Culture and microscopic methods - Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical and, sterility testing for pharmaceutical products;.

Unit 3 Pathogenic Microorganisms of Importance in Food & Water

Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Manitol salt agar, EMB agar, McConkey Agar, Saboraud Agar.

Unit 4 Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centres (COB, 10 min Resazurin assay)

Unit 5 HACCP for Food Safety and Microbial Standards

Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations. Microbial Standards for Different Foods and Water

Practical/Lab Course MIC SEC 4P

1. **Determine the pharmaceutical products micro flora**
2. **MLT**
3. **Sterility Testing**
4. **MBRT**
5. **Identified the selective microorganism**

Skill Enhancement Course: Food Processing, Preservation and Packaging

No. of Hours- 45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Food Processing, Preservation and Packaging	**2**	**1**	**0**	**1**		**Nil**

Skill Enhancement Courses in Microbiology		
Programme : Skill Enhancement Courses in Microbiology	**Year: III**	**Semester: V**
Subject: Microbiology		
Course: MIC SEC 5	**Food Processing, Preservation and Packaging**	

Course Outcomes:

The student at the completion will be able to –

• Adjust to protocols and guidelines relevant to the assistant role in Food Processing, Preservation and Packaging /Techniques

• Recognize the boundary of the Food Processing, Preservation and Packaging responsibility.

• Exhibit managing potential to the quality and safety.

• Be aware of relevant legislation, standard, policies and procedures followed in the lab Practical and internship on all units with skill partners

Credits: 2	**Skill Enhancement Course**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit 1 Introduction to food processing, food container manufacturing, food canning, food science and high processing techniques • Shelf life of processed food . Food processing of cereals Legumes, oil seeds, fruits and vegetables Dairy products, dairy processing biotechnology, membrane technology in dairy products processing.

Unit 2 Introduction to preservation, types of preservation Natural and artificial preservative agent, class I, II and III preservative agents Methods of preservation, thermal process, Vacuum drying and dehydration, cooking and freezing Food preservation by chemicals, minimal processing of fresh foods.

Unit 3 Emerging techniques in food processing, Modified atmosphere packaging, genetic engineering

Unit 4 Emerging technologies for minimally processed fresh fruit juices, Pulse electric field, high hydrostatic pressure.

Unit 5 Environmental aspects of food processing technology , Food packaging wastes and its environmental aspects environmental impact on packaging, Food processing industry, safety in food processing

Practical/Lab Course MIC SEC 5P

1. **Preservative efficacy test**
2. **Determination of shelf life**
3. **Process of canning**
4. **Role of environment in food process**
5. **Thermal Preservation technique**
6. **Pasteurization**

Skill Enhancement Course: Biofertilizers And Biopesticides

No. of Hours- 45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Biofertilizers And Biopesticides	2	1	0	1		Nil

Skill Enhancement Courses in Microbiology		
Programme : Skill Enhancement Courses in Microbiology	**Year: III**	**Semester: VI**
Subject: Microbiology		
Course: MIC SEC 6	**Biofertilizers And Biopesticides**	
Learning Out come : **Understand the Biofertilizer and Biopesticides** **Understand the impact of biofertilizer and biopesticides in nature**		

Credits: 2	Skill Enhancement Course

Unit 1Biofertilizers General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers. Symbiotic N2 fixers:*Rhizobium* - Isolation, characteristics,types, inoculum production and field application, legume/pulses plants. Cyanobacteria, *Azolla* - Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application.

Unit 2 Non - Symbiotic N2 fixers Free living *Azospirillum, Azotobacter* - free isolation, characteristics, mass inoculum production and field application.

Unit 3 Phosphate and silicate solubilizers Phosphate and silicate solubilizing microbes - Isolation, characterization, mass inoculum production, field application.

Unit 4 Mycorrhizal biofertilizers Importance of mycorrizal inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM.

Unit 5 Bioinsecticides General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, *Bacillus thuringiensis*, production, Field applications, Viruses – cultivation and field applications. Introduction to mycoinsecticides.

Practical/Lab Course MIC SEC 6P

1. Isolation of Nitrogen fixing bacteria
2. Preparation of inoculam for large scale
3. Isolation of cynobacteria in rice field
4. Isolation of biocides

Semester-III

Bachelor of Science in Microbiology

No. of hours-60

DISCIPLINE SPECIFIC ELECTIVE (DSE 1)- MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT	4	3	0	0	**Undergraduate certificate in Microbiology**	**Nil**

BACHELOR OF SCIENCE IN MICROBIOLOGY		
Programme : ***Bachelor of Science in Microbiology***	**Year: II**	**Semester: III**
Subject: Microbiology		
Course: MIC DSE 1	**MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT**	
Course Outcomes: After the completion of the course the students will be able to: 1. Students learn about microbes used in agriculture 2. Understand the useful microorganisms		

Credits: 4	**Discipline Specific Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit 1 Soil Microbiology
Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil (8L)
Unit 2 : Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium (6L)
Unit 3 Microbial Activity in Soil , Green House Gases and Soil Borne Plant Pathogens Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control. Microbial Control of Soil Borne Plant Pathogens: Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds (10L)
Unit 4 Biofertilization, Phytostimulation, Bioinsecticides Plant growth promoting bateria, biofertilizers – symbiotic (*Bradyrhizobium, Rhizobium, Frankia*), Non Symbiotic (*Azospirillum, Azotobacter*, Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs (10L)
Unit 5 Secondary Agriculture Biotechnology and GM crops Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters; **GM crops:** Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals. (11 L)

Semester-IV

Bachelor of Science in Microbiology

No. of hours-60

DISCIPLINE SPECIFIC ELECTIVE (DSE 2)- PLANT PATHOLOGY

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
PLANT PATHOLOGY	4	3	0	0	**Undergraduate certificate in Microbiology**	**Nil**

BACHELOR OF SCIENCE IN MICROBIOLOGY

Programme : *Bachelor of Science in Microbiology*	Year: II	Semester: IV
Subject: Microbiology		
Course: MIC DSE 2	**PLANT PATHOLOGY**	

Course Outcomes:

After the completion of the course the students will be able to:

1. Students learn plants pathogens
2. Students known about prevention of diseases

Credits: 4	Discipline Specific Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: Asper Univ. rules

Unit 1 Introduction, History of plant pathology, Stages in development of a disease its epidemiology
Concept of plant disease- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. Significant landmarks in the field of plant pathology- Contributions of Anton DeBary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Van Der Plank, Koch's postulates. Contributions of eminent Indian plant pathologists (8L).

Unit 2 Stages in development of a disease: Infection, invasion, colonization, dissemination of pathogens and perennation. Plant disease epidemiology: Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context. (8L)
Unit 3 Host Pathogen Interaction *Microbial Pathogenicity*: Virulence factors of pathogens: enzymes, toxins (host specific and non specific) growth regulators, virulence factors in viruses in disease development. Effects of pathogens on host physiological processes . *Defense Mechanisms in Plants:* Concepts of constitutive defense mechanisms in plants, inducible structural defenses, inducible biochemical defenses. (10L)

Unit 4 Control of Plant Diseases
Principles & practices involved in the management of plant diseases by different methods, *viz.* regulatory - quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material; cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulches; chemical - protectants and systemic fungicides, antibiotics, resistance of pathogens to chemicals. biological - suppressive soils, antagonistic microbes-bacteria and fungi.(10L)
Unit 5 Specific Plant diseases Study of some important plant diseases giving emphasis on its etiological agent, symptoms, epidemiology and control . Important diseases caused by fungi: White rust of crucifers - *Albugo candida;* Downy mildew of onion - *Peronospora destructor;* Late blight of potato - *Phytophthora infestans;* Ergot of rye - *Claviceps purpurea;* Wilt of tomato - *Fusarium oxysporum* f.sp. Red rot of sugarcane - *Colletotrichum falcatum;* Early blight of potato - *Alternaria solani*
B. Important diseases caused by phytopathogenic bacteria: Angular leaf spot of cotton, bacterial cankers of citrus

C. Important diseases caused by viruses: Papaya ring spot, tomato yellow , **Potato spindle tuber,**

BSc III Year **Semester-V**

Bachelor of Science in Microbiology

No. of hours-60

DISCIPLINE SPECIFIC ELECTIVE (DSE 3)- PHARMACEUTICAL MICROBIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
PHARMACEUTICAL MICROBIOLOGY	4	3	0	0	**Undergraduate Diploma in Microbiology**	**Nil**

BACHELOR OF SCIENCE IN MICROBIOLOGY		
Programme : ***Bachelor of Science in Microbiology***	**Year: III**	**Semester: V**
Subject: Microbiology		
Course: MIC DSE 3	**PHARMACEUTICAL MICROBIOLOGY**	

Learning objectives:

- Students will learn about the basics of pharmaceutical microbiology and important microorganism playing role in pharmaceutics.
- To understand different products of microbial origin playing key role in pharmaceutical applications.
- To understand role of secondary metabolites in pharmaceutical industry.
- To understand good practices and regulation involved in utilizing microbial product for pharmaceutical applications

Learning outcomes:

At the end of course students will be able to

- Describe how antibiotic work and resistance develop in microorganisms.
- Suggest good practices and regulation involved in utilizing microbial product for pharmaceutical applications.
- Design microbiology laboratory and explain the safety measures used in microbiology laboratory.
- Determine antibiotic sensitivity, MIC, MBC and other quality parameter of microbiology laboratory.

Credits: 4	**Discipline Specific Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

UNIT - I

Pharmaceutical industries types Sterile and non sterile, Pharmaceutical premises: selection of area for a pharmaceutical premise, different components of a premise, Govt. norms for a premise. Inspectional Guidance **of microbiology lab** Good manufacturing practices (GMP) and its organization, good laboratory practice (GLP), cGMP; Operation of quality control (QC) and quality assurance (QA) of company. **(10 Lectures)**

UNIT - II

Introduction Principal , Calibration, Validation and Function of different instrument in Microbiology Lab, sterilization of glassware, preparation, validatin and sterilization of media, Discarding Methods, Documents Preparation SOP, COA , Specification, log book. **(12 Lectures)**

UNIT - III

Sterile area and its maintenance, environmental monitoring, types of environmental monitoring, methods of sterilization in pharma, disinfectants and antiseptics, evaluation of disinfectants Fumigation process and its schedule .Water used in pharma, properties, types, specification, microbial limits , Techniques of water testing used in pharmaceutical company . **(16 Lectures)**

UNIT - IV

Microbial limit test (MLT), pyrogen tests, pathogens test for confirmation Bacterial Endotoxin Testing, Antibiotic assay , vitamin B12 Assay , preservative efficacy test. Sterility testing, Antimicrobial Effectiveness Testing, Microbial Examination of sterile and Non-Sterile Products. (16 Lectures)

UNIT - V

Safety and working in microbial laboratory: Biosafety cabinets ; Occurrence of laboratory infections, Microbiology Laboratory Biosafety Guidelines, section in microbiology lab , Disposal of contaminated waste

(10 Lectures)

Suggested Reading

1. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. SS Purohit and AK Saluja. Pharmaceutical Microbiology, Agrobios (India), ISBN-13-9788177541939
3. CKJ Paniker. Test Book of Microbiology, Orient Longman

4. Indian Pharmacopeia , USP, BP

1. **Digital Links**
   - https://www.mcgill.ca/microimm/undergraduate-programs/courses
   - https://oline.creighton.edu/program/medical-microbiology-and-immunology-ms
   - http://www.vlab.co.in
   - http://www.vlab.iitb.ac.in
   - http://www.onlinelabs.in
   - http://www.vlab.amrita.edu
   - http://asm.org/articles/2020/december/virtual-resources-to-teach-microiology-techniques

BSc III Year **Semester-VI**

Bachelor of Science in Microbiology

No. of hours-60

DISCIPLINE SPECIFIC ELECTIVE (DSE 4)- FOOD AND DAIRY MICROBIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
FOOD AND DAIRY MICROBIOLOGY	4	3	0	0	**Undergraduate Diploma in Microbiology**	**Nil**

BACHELOR OF SCIENCE IN MICROBIOLOGY		
Programme : ***Bachelor of Science in Microbiology***	**Year: III**	**Semester: VI**
Subject: Microbiology		
Course: MIC DSE 4	**FOOD AND DAIRY MICROBIOLOGY**	

Learning objectives:

- To know the different types of fermented foods available in markets.
- To know about the vegetable and grain based fermented products.

Learning outcomes:

At the end of course student will be able to

- Prepare the fermented foods from milk, grain and vegetables.
- Prevent and control the bacterial infection through various techniques.

Credits: 4	**Discipline Specific Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

UNIT-I

Microorganisms important in food microbiology- Molds,Yeasts and Bacteria- general characteristics, classification and importance. Principles, physical methods of food preservation: temperature (low, high, canning and drying), irradiation, chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins. Fermented Foods: Definition, types, advantages and health benefits of fermented foods. **(10 Lectures)**

UNIT- II

Microflora of raw milk ; Sources of contamination of milk; Nutritional and therapeutic benefits of fermented milk products; Dahi/Yogurt, Buttermilk (Chhach), Shrikhand and Cheese: Preparation of inoculum and production process. Probiotic foods; Spoilage of fermented dairy products; Quality control in dairy industry.

(16 Lectures)

UNIT-III

Food fermentations; bread, vinegar, fermented vegetables; prevention and spoilage of cereals, vegetables, fruits, meat and meat products fish and sea products. Industrial enzymes and their uses in food industry – amylases, proteases, cellulases; Oriental foods – Mycoprotein, Tempeh, soya sauce; Traditional foods

(16 Lectures)

UNIT–IV

Microbial cells as food single cell proteins, Mushroom cultivation, Probiotic Foods: History, definition, types, microorganisms and health benefits in supply of vitamins, Immunomodulation, control of pathogenic bacteria

(08 Lectures)

UNIT–V

Food borne infections and intoxifications; Bacterial diseases with examples of infective and toxic types – Brucella, Bacillus clostridium, Escherichia, Pseudomonas , Salmonella, Shigella, Staphylococcus, Vibrio, fungi Aflatoxins - structures and functions; Food borne out breaks – laboratory testing procedures; Preventive measures – Sanitation in manufacture; Food control agencies and its regulations, HACCP, ISO standards and FSSAI .

(10 Lectures)

Suggested Reading

1. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2
3. Doyle et al., Food Microbiology: Fundamentals and Frontier, American Society of Microbiology
4. William C Frazier, Food Microbiology, MacGraw Hills Education.
5. Adam and Moss, Food Microbiology, Royal Society of Chemistry
6. Dubey, R.C. *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.

BSc 4th Year **Semester-VII**

Bachelor of Science in Microbiology (Honours)

No. of hours-60

DISCIPLINE SPECIFIC ELECTIVE (DSE 5)- Microbiological Tools and Technique

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Microbiological Tools and Technique	4	3	0	0	**Bachelor of Science in Microbiology**	**Nil**

BACHELOR OF SCIENCE IN MICROBIOLOGY		
Programme : *Bachelor of Science in Microbiology*	**Year: IV**	**Semester: VII**
Subject: Microbiology		
Course: MIC DSE 5	**Microbiological Tools and Technique**	

Learning objectives:

- To get the knowledge of sophisticated and common instruments used in the microbiology laboratory
- To know aseptic techniques to keep the instrument and media sterile.

Learning outcomes:

At the end of course students will be able to

- Maintain the sterility of glassware, utensils and medium by different physical and chemical procedure.
- Operate the different sophisticated instruments available in the laboratory.
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Credits: 4	**Discipline Specific Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit I:

Principle , Calibration and Application of different instruments of microbiology Lab such as microscopes, hot air oven, autoclave, laminar air flow and BOD incubator , pH Meter, Analytical Balance. Staining Technique Specimen preparation and principles of Simple, Gram's stain, Capsule, Endospore, Flagella, Acid fast and Geimsa's staining.

Unit II:

Aseptic technique: contamination, sterilization (steam sterilization, tyndallization, dry heat, chemicals, radiation sterilization, filter sterilization), sterilization of air. Evaluation of antimicrobial agent effectiveness, evaluation of efficacy of disinfectants, determination of phenol coefficient)

Unit III:

Isolation of industrially important microorganisms, Primary screening (crowded plate technique, enrichment culture technique, streak plate, Serial dilution plate and spread plate), Importance of screening. maintenance of pure cultures; methods of preservation. Maintenance and Cultivation of anaerobic bacteria.

Unit IV:

Principles and applications of Chromatography techniques: paper chromatography, thin layer chromatography, adsorption column chromatography, gas liquid chromatography, HPTLC Principle and Function of UV-Vis spectrophotometry,

Unit V

Principles and applications of Electrophoresis for protein, RNA and DNA; Centrifugation; Ultracentifugation; Lyophilization and Fumigation

Suggested Readings

1. Nelson D and Cox MM. (2010). Lehninger's Principles of Biochemistry. W.H. Freeman and Company, New York.
2. Wilson K. and Walker J. (2013). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.
3. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hill.
4. Upadhyaya and Nath (2015) Biophysical chemistry, Himalaya pub. House.
5. T.A.Brown (2016). Gene cloning and DNA analysis, an introduction,Wiley Blackwell pub.
6. B.D.Singh (2015). Biotechnology, Kalyani publication.
7. Dubey R.C**.** and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New

Delhi, p. 1034. ISBN 81-219-2620-3
8. Prescott's Microbiology, 10th Edition, McGraw Hill Publication
9. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2

Bachelor of Science in Microbiology (Honours)

No. of hours-60

DISCIPLINE SPECIFIC ELECTIVE (DSE 6)- ALGAL AND FUNGAL BIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Algal and Fungal Biology	4	3	0	0	**Bachelor of Science in Microbiology**	**Nil**

BACHELOR OF SCIENCE IN MICROBIOLOGY		
Programme : ***Bachelor of Science in Microbiology***	**Year: IV**	**Semester: VII**
Subject: Microbiology		
Course: MIC DSE 6	**Algal and Fungal Biology**	

Learning objectives:

- To understand the microbes diversity and their role of Fungi and Algae in Ecosystem
- To understand the basic concept of prokaryotes, their taxonomy their differentiation from Prokaryotes and bio safety regulatory framework for Eukaryotes .

Learning outcomes:

At the end of course students will be able to explain the role of Fungi and Algae and their role in Microbiology development and what is the scope of the various field of the subject and other beneficial roles.

- Cultivate Fungi and Algae in laboratory by different methods

Credits: 4	**Discipline Specific Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit 1

Algae: General account of habitat, cell structure, pigments, flagellum, reserve food. . taxonomic position of cyanobacteria. Algal growth and reproduction. Cultivation of algae in laboratory. Nittrogen fixation. Biological and economic aspects of algae, algal biotechnology. Algal blooms and eutropication.

Unit II

Mycology: Thallus morphology and modifications in fungi. Nutrition and physiology of fungi. Reproduction (asexual, sexual and parasexual) characteristics of fungi. Major taxonomic group of fungi with focus on structure, reproduction, life cycle and significance of the following: representatives: i) Gymnomycota (Cellular slime moulds), ii) Mastigomycota (*Phytophthora*), iii) Amastigomycota: a) Zygomyocotina (*Mucor/Rhizopus*), b) Ascomycotina (*Saccharomyces*), c) Basidiomycotina (*Agaricus*), d) Deutromycotina (*Fusarium*). Characteristics and importance of Deuteromycetes. Yeasts: General characteristic, structure, classification, life cycles (important forms), sexual and asexual reproduction of yeast (Saccharomyces cerevisiae)

Unit III

Nutrition and reproduction in fungi, Mycorrhiza, Lichens, Heterothallism, sex hormones in fungi. Evolutionary tendencies in lower fungi. Economic importance. Fungi in ecosystem: contribution of fungi to ecosystems, breakdown of hemicellulose, cellulose, pectins, chitin, starch and glycogen, lignin degradation; flow of nutrients-transport and translocation, secretion of colonizers on a substrate.

UNIT – IV

Fungal pathogens: occurrence, classification, morphology, characteristics features and life cycle of, *Fusarium oxysporum, Alternaria solani*, . Mycoses- superficial , cutaneous, subcutaneous opportunistic and systemic diseases

UNIT – V

Fungal metabolites of industrial importance– industrial alcoholic beverages and organic acids;

Fungi as bioinoculant agents, mycotoxins- Aflatoxin ,Rubratoxin, Ochratoxin; fungal enzymes of commercial importance-amylases and cellulases, mycoprotein .

Suggested Readings (Latest Editions):

1. Chatterjee K.D. (2015). Parasitology, Calcutta publication.
2. David Greenwood (2015). Medical Microbiology, 18th edition.
3. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hill.
4. J.G. Black(2015) –Microbiology, 9th edition, Wiley publication
5. Lee. R. E. (Latest Edition). Phycology, Cambridge University Press, Cambridge.
6. Talaro K.P. & Talaro A. (Latest Edition). Foundations in Microbiology (6th Ed.), McGraw-Hill College Dimensi.
7. Sharma, P.D. (2016). Mycology and Phyotopathology, Rastogi Publications, Meerut

Bachelor of Science in Microbiology (Honours)

No. of hours-60

DISCIPLINE SPECIFIC ELECTIVE (DSE 7)- HISTORY AND SCOPE OF MICROBIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
HISTORY AND SCOPE OF MICROBIOLOGY	4	3	0	0	**Bachelor of Science in Microbiology**	**Nil**

BACHELOR OF SCIENCE IN MICROBIOLOGY		
Programme : ***Bachelor of Science in Microbiology***	**Year: IV**	**Semester: VII**
Subject: Microbiology		

Course: MIC DSE 7	HISTORY AND SCOPE OF MICROBIOLOGY

Learning objectives:

- To understand the statics role in biological and Research industry
- To understand the basic concept and role of microorganisms as beneficial and harmful .

Learning outcomes:

At the end of course students will be able to explain the role of Microbiology development in different field and what is the scope of the various fields of the subject and other beneficial roles.

Credits: 4	Discipline Specific Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: Asper Univ. rules

Unit 1-

History and Development of microbiology , spontaneous generation vs biogenesis, golden age of microbiology branches of microbiology; germ theory of disease, Scope and relevance of Microbiology; Development of microbiology 20^{th} and 21^{st} century Golden era of Microbiology, , Development of various microbiological techniques, Establishment of fields of medical microbiology and immunology.

Unit 2-

Microbes in Human Health & Environment, Medical microbiology and immunology: List of important human diseases and their causative agents. Environmental microbiology: Definitions and examples of important microbial interactions,

Unit 3

Application of microorganisms: bio-pesticides, bio-fertilizers, biodegradation, bio-deterioration and bioremediation,

Unit 4

Role of microorganisms in fermentation, microbes producing important industrial products through fermentation. Biofuels, Microorganisms in food spoilage and food borne infections.

Unit 5

Concept of ecosystem: Types. Structure and function of ecosystems. Trophic levels: Primary and secondary production. Energy flow: ecological pyramids, food chains and food webs.

Suggested Readings

1. Chatterjee K.D. (2015). Parasitology, Calcutta publication.
2. David Greenwood (2015). Medical Microbiology, 18th edition.
3. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hill.
4. J.G. Black(2015) –Microbiology, 9th edition, Wiley publication
5. Lee. R. E. (Latest Edition). Phycology, Cambridge University Press, Cambridge.

6. Talaro K.P. & Talaro A. (Latest Edition). Foundations in Microbiology (6th Ed.), McGraw-Hill College Dimensi

Bachelor of Science in Microbiology (Honours)
Semester VIII

No. of hours-60

DISCIPLINE SPECIFIC ELECTIVE (DSE 8)- Techniques of Microbial Genetics and Molecular

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Techniques of Microbial Genetics and Molecular Biology	4	3	0	0	**Bachelor of Science in Microbiology**	**Nil**

BACHELOR OF SCIENCE IN MICROBIOLOGY		
Programme : ***Bachelor of Science in Microbiology***	**Year: IV**	**Semester: VIII**
Subject: Microbiology		
Course: MIC DSE 8	**Techniques of Microbial Genetics and Molecular Biology**	

Learning objectives:

- To understand the Microbial technology and Molecular biology.
- To understand the basic concept genetic material;.

Learning outcomes:

At the end of course students will be able to explain the role of gene and genetic material and microbial technology and what is the scope of the various fields of the subject and other beneficial roles

Credits: 4	**Discipline Specific Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

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Unit I-

Nucleic acids as genetic information carriers, DNA structure, types of DNA. DNA replication in prokaryotes and eukaryotes. Structural features of RNA (mRNA, tRNA, rRNA). Transcription in prokaryotes and eukaryotes.

Unit II-

Regulation of gene expression. Basic features of the genetic code. Protein synthesis in prokaryotes and eukaryotes. Recombination: general principles. Plasmids (types of plasmids- F plasmids, R plasmids, Col plasmids and Ti plasmid). Gene transfer mechanisms: transformation, transduction, and conjugation.

Unit III-

Mutations: spontaneous mutation, Induced mutagenesis- mutagens (physical mutagens: non ionizing and ionizing radiations; chemical mutagens: Base analogues, alkylating agents, deaminating agents, intercalating agents and others), molecular mechanism of mutagenesis. DNA repair mechanism: repair by direct reversal, excision repair, recombinational repair and SOS repair.

Unit IV-

Basic steps of r-DNA technology. Restriction endonucleases. Cloning vectors: general properties, plasmids, bacteriophages, cosmids, shuttle vectors, bacterial artificial chromosomes. Eukaryotic cloning vectors for yeast, and animal cells.

Unit V-

Molecular Techniques; Principles, methods and their applications in medical diagnosis - such as PCR, Southern Blotting, Northern Blotting, Western Blotting, DNA finger printing and DNA sequencing. DNA vaccines design and advantages. Recombinant vaccines.

Suggested Readings (Latest Editions):

1. David P Clark (2010). Cell and Molecular Biolgy
2. Robert J. Brooker (2011). Genetics, Analysis and principles, Mc Graw Hill.
3. J.E. Krebs (2011). Lewin's Genes X, Jones Pub.
4. T.A.Brown (2010). Gene cloning of DNA Analysis. Wiley Blackwell.
5. J D Watson (2008), Molecular biology
6. Jeff Hardin, Gregory Bertoni, Lewis J. Kleinsmith (2012). Becker's Word of the cell.
7. William. D Stans Field (2012). Molecular and cell Biolgy, Mc Graw Hill pub.
8. Gerald Karp (2014). Cell Biology, Wiley Blackwell, Pub.

Bachelor of Science in Microbiology (Honours)
Semester VIII

No. of hours-60

DISCIPLINE SPECIFIC ELECTIVE (DSE 9)- Microbial Environmental Technologies Biology

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Microbial Environmental Technologies	4	3	0	0	**Bachelor of Science in Microbiology**	**Nil**

BACHELOR OF SCIENCE IN MICROBIOLOGY		
Programme : ***Bachelor of Science in Microbiology***	**Year: IV**	**Semester: VIII**
Subject: Microbiology		
Course: MIC DSE 9	**Microbial Environmental Technologies**	

Learning objectives:

- To understand the Microbial technology and Environmental Microbiology
- To understand the basic concept Disposal of and Treatment of Waste .

Learning outcomes:

At the end of course students will be able to explain the role of microbes to treatment of water and microbial technology to water testing and what is the scope of the various fields of the subject and other beneficial roles.

Credits: 4	**Discipline Specific Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

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Unit –1

Definitions, biotic and abiotic environment. Environmental segments. Composition and structure of environment. Concept of biosphere, communities and ecosystems. Ecosystem characteristics, structure and function. Food chains, food webs and trophic structures. Ecological pyramids.

Unit – 2

Water pollution and its control: Need for water management. Sources of water pollution. Measurement of water pollution, Eutrophication: Definition, causes of eutrophication, and microbial changes in eutrophic bodies of water induced by various inorganic pollutants. Effects of eutrophication on the quality of water environment,

factors influencing eutrophication. Qualitative characteristics and properties of eutrophic lakes. Measurement of degree of eutrophication. Algae in eutrophication, algal blooms, their effects and toxicity, coloured waters, red tides, and cultural eutrophication. Physico-chemical and biological measures to control eutrophication

Unit –3

Microbiology of wastewater and solid waste treatment: - Waste-types-solid and liquid waste characterization, physical, chemical, biological, aerobic, anaerobic, primary, secondary and tertiary treatments. Anaerobic processes: Anaerobic digestion, anaerobic filters, and upflow anaerobic sludge. Treatment schemes for effluents of dairy, distillery, tannery, sugar and antibiotic industries Bioconversion of Solid Waste and utilization as fertilizer. Bioaccumulation of heavy metal ions from industrial effluents .

Unit – 4

Microbiology of degradation of xenobiotics in the environment, ecological considerations, decay behaviour, biomagnification and degredative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants and pesticides. Genetically Modified Organisms released and its
environmental impact assessment and ethical issues.

Unit – 5

Microbes and water potability. Purification of potable water; Sanitary analysis of water Standards (tolerable levels) of water quality of fecal contamination., Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.

Bachelor of Science in Microbiology (Honours)
Semester VIII

No. of hours-60

DISCIPLINE SPECIFIC ELECTIVE (DSE 10)- RECOMBINANT DNA TECHNOLOGY

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
RECOMBINANT DNA TECHNOLOGY	4	3	0	0	**Bachelor of Science in Microbiology**	**Nil**

BACHELOR OF SCIENCE IN MICROBIOLOGY		
Programme : ***Bachelor of Science in Microbiology***	**Year: IV**	**Semester: VIII**
Subject: Microbiology		
Course: MIC DSE 10	**RECOMBINANT DNA TECHNOLOGY**	

Learning objectives:

- To make students understand about the structure and function of biologically important molecules.
- To know the historical background of DNA structure and its role as genetic material.
- Become familiar with different tools and techniques used in genetic engineering and recombinant DNA technology.
- To understand the applications of DNA modifying enzymes, cloning strategies, vector types, and screening of recombinants
- Students will know how gene expresses and regulates in prokaryotic cells.

Learning outcomes:

At the end of course students will be able to

- Explain why DNA is the genetic material of bacteria.
- Explain the application of genetic engineering techniques in basic and applied experimental biology.
- Amplify the DNA using PCR for the diagnosis and DNA fingerprinting.
- Describe how protein synthesis occur in procaryotic cell and enzyme involved in it.

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Credits: 4	**Discipline Specific Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

UNIT- I

Introduction to Genetic Engineering: Milestones in genetic engineering and biotechnology; Molecular Cloning-Tools and Strategies-Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyltransferase, kinases and phosphatases, and DNA ligases Cloning Vectors: Definition and Properties Plasmid vectors: pBR, Cosmids, Expression vectors.

UNIT- II

Methods in Molecular Cloning:Transformation of DNA: chemical method, electroporation, Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viralmediated delivery, *Agrobacterium* - mediated delivery DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern – blotting techniques, DNA Western blotting.

UNIT- III

DNA Amplification and DNA sequencing PCR: Basics of PCR, Real-Time PCR, Sanger's method of DNA Sequencing: traditional and automated sequencing.

UNIT- IV

Construction and Screening of Genomic and cDNA libraries: Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR.

UNIT - V

Applications of Recombinant DNA Technology: Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines, protein engineering and site directed mutagenesis.

Suggested Reading

1. Bruce Alberts. Molecular Biology of the Cells, W.W. Norton and Company, ISBN: 9780815344643
2. Dubey, R.C**.** *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
3. Harvey, Lodish. Molecular Cell Biology, W.H.Freeman
4. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2

Master of Science in Microbiology (5th year)
Semester IX

No. of hours-60

DISCIPLINE SPECIFIC ELECTIVE (DSE 11)- FERMENTATION TECHNOLOGY AND MICROBIAL PRODUCTS

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Fermentation Technology And Microbial Products	4	3	0	0	**Bachelor of Science (Honors) in Microbiology**	**Nil**

MASTER OF SCIENCE IN MICROBIOLOGY		
Programme : ***Master of Science in Microbiology***	**Year: V**	**Semester:IX**
Subject: Microbiology		
Course: MIC DSE 11	**Fermentation Technology And Microbial Products**	

Learning objectives:

- To understand the scope and applications of industrial microbiology.
- To understand fermentation technologies used for the production of industrially important products.
- To understand how different fermentation product are produced, purified and recovered.

Learning outcomes:

At the end of course student will be able to

- Screen and isolate industrially important microorganisms.
- Make use of fermentor to produce alcoholic beverages and other fermentation products.
- Explain the different method of disinfection used in industry and also how to maintain quality of product.

Credits: 4	**Discipline Specific Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit I

Fermentation: an overview, isolation, screening and selection of industrially important microorganisms, Crude and synthetic media; molasses, cornsteep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates. Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch and continuous fermentations.

Unit II

Bioreactors, design and components of basic fermentor, specialized fermentors for specific Purposes. Bioprocessing – Downstream processing of industrial fermentation processes, product purification and recovery, Physico-chemical basis of bio-separation processes, techniques for purification of end products – chromatography, distillation, crystallization,filtration.

Unit III

Antibiotic fermentations – production of β lactams (penicillins amino-glycosides (streptomycin),.Recombinant and synthetic Vitamins (B_{12}, riboflavin A) Alcoholic beverages Whisky, Beer Wine and Cidar Vinegar microbes as food - single cell protein, mushrooms, probiotics.

Unit IV

Biofertilizers, sources of nitrogen and Phosphate solubilizing microorganisms, Biofertilizer production technology-strain selection, sterilization, growth, standards and quality control, Biopesticides –production of

biopesticides from bacteria, fungi and viruses and their applications against different types of pathogens. Bacillus thuringiensis (Bt) as a major biopesticide, role of Bt in pest control,

Unit V

Production of organic solvent acetone- butanol fermentation, glycerol Microbial polysaccharides (xanthan, dextran, alginate, gellan, cellulose, curdlan, microbial Enzymes – production and applications of enzymes such as invertase, pectinase, cellulase oxidase, catalase,

Master of Science in Microbiology (5th year)
Semester IX

No. of hours-60

DISCIPLINE SPECIFIC ELECTIVE (DSE 12)- PHARMACEUTICAL AND FOOD MICROBIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Pharmaceutical and Food Microbiology	4	3	0	0	**Bachelor of Science (Honors) in Microbiology**	**Nil**

MASTER OF SCIENCE IN MICROBIOLOGY		
Programme : ***Master of Science in Microbiology***	**Year: V**	**Semester:IX**
Subject: Microbiology		
Course: MIC DSE 12	**Course Title : Pharmaceutical and Food Microbiology**	

Learning objectives:

- Students will learn about the basics of pharmaceutical microbiology and important microorganism playing role in pharmaceutics.
- To understand different products of microbial origin playing key role in pharmaceutical applications.
- To understand role of secondary metabolites in pharmaceutical industry.
- To understand good practices and regulation involved in utilizing microbial product for pharmaceutical applications

Learning outcomes:

At the end of course students will be able to

- Describe how antibiotic work and resistance develop in microorganisms.
- Suggest good practices and regulation involved in utilizing microbial product for pharmaceutical applications.
- Design microbiology laboratory and explain the safety measures used in microbiology laboratory.

Determine antibiotic sensitivity, MIC, MBC and other quality parameter of microbiology laboratory.

Credits: 4	**Discipline Specific Elective**

Max. Marks: As per Univ. rules	Min. Passing Marks: Asper Univ. rules

UNIT – I

Control Measures: Non-medicinal antimicrobial agents:- Bacteriostatic and bactericidal agents, factors affecting antimicrobial activity; sanitizers, disinfectants, antiseptics, , filtration, high temperature antimicrobial action of phenols and phenolic compounds, alcohols, halogens, UV Light detergents,

Unit – 2

Quality Assurance and Validation- Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry. Regulatory aspects of quality control. Quality assurance and quality management in pharmaceuticals. SOP , Specification and Calibration of Microbiological Instruments

Unit – 3

Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization) Chemical and biological indicators. Design and layout of sterile product manufacturing unit. (Designing of Microbiology laboratory) Safety in microbiology laboratory

The drug resistance – The phenomenon, clinical basis of drug resistance, microbiological assays: assays for growth promoting substances vitamin assay (B12), Assay for growth inhibiting substances – Antibiotics, drug sensitivity testing methods and their importance; determination of MIC, Preservative Efficacy Test

Unit 4 Methods for microbiological examination of food and quality control and Standard **:** Indicator organisms for assuring the suitability of food products, methods of microbiological examination methods (plate count and MPN), quality criteria Food Hygiene – Food-borne Infections and Intoxications, Microbial Toxins, Indicator Organisms, Food preservation methods Radiations - UV, Gamma and microwave Temperature Chemical and naturally occurring antimicrobials

UNIT - V

Concept of food safety and standard Authority of India (FSSAI) Quality Control & Assurance –GMP, , GLP, , HACCP; Indian and International Quality Systems and Standards (BIS, ISO, Codex Alimentarius, Codex India, etc.); CEDAC; Food Adulteration

Applications of microbial enzymes in dairy industry [Protease, Lipases]. Utilization and disposal of dairy by-product - whey.

Master of Science in Microbiology (5th year)
Semester IX

No. of hours-60

DISCIPLINE SPECIFIC ELECTIVE (DSE 13)- MOLECULAR IMMUNOLOGY

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if
		Lecture	Tutorial	Practical/Practice		

						any)
Molecular Immunology	4	3	0	0	**Bachelor of Science (Honors) in Microbiology**	**Nil**

MASTER OF SCIENCE IN MICROBIOLOGY		
Programme : ***Master of Science in Microbiology***	**Year: V**	**Semester:IX**
Subject: Microbiology		
Course: MIC DSE 13	**Course Title : Molecular Immunology**	

Learning objectives:

- Students will learn about the components of the immune system as well as their functions and response..
- To develop understanding of innate and adaptive immunity
- To understand different serological reaction for the diagnosis of diseases.
- To integrate immunology with medical sciences and enrich the knowledge for autoimmune disorders, hypersensitivity reactions.

Learning outcomes:

At the end of course student will be able to

- Explain the different components of immune system and how they provide defense against infections.
- Describe how our immune system protects against foreign pathogens.
- Diagnose the viral and bacterial infection through different serological tests.
- Gain knowledge of different diseased conditions generated due abnormalities in immune system.
- Explain antigen antibody reactions.

Credits: 4	**Discipline Specific Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

UNIT – I

Immune system and Immunity: History of immunology, structure, composition and function of cells and organs involved in immune system; Host-parasite relationships; microbial infection; immune response – naturally acquired immunity; artificially acquired immunity;

UNIT – II

Antigens and Antibodies- Antigens- structure and properties (types, haptens, adjuvants); antigen specificity; Immunoglobulins: Structure and properties of immunoglobulin classes. Theories of antibody formation, hybridoma technology for monoclonal antibodies and designer monoclonal antibodies. Multiple mylomas and structural basis of antibody diversity. Freund's adjuvants and its significance.

UNIT - III

Antigen-Antibody reaction by precipitation, agglutination and complement fixation. Non-specific immune mechanism: - Surface defenses, tissue defenses, opsonization, inflammatory reaction, and hormone balance. Tissue metabolites with bactericidal properties (lysozyme, nuclein, histone, protamine, basic peptides of tissues – leukins, phagocytins, lecterins, haemocompounds) . Immuno-assays: Widal test, haemagglutination, precipitation, complement fixation, ELISA, , RIA, Immunofluroscens and their application. Immune deficiencies and autoimmunity.

UNIT – IV

Regulation of immune response: antigen processing and presentation, generation of humoral and cell mediated immune response, activation of B and T lymphocytes, cytokines and their role in immune regulation, T cell regulation, MHC restriction, immunological tolerance. Cell mediated cytotoxicity: Mechanism of T cells and NK mediated lysis, antibody dependent cell mediated cytotoxicity, and macrophage mediated cytotoxicity. Complement system Transplantation immunology: MHC, types of grafts, , GVH reactions, mechanism Of graft rejection, and prevention of graft rejection.

UNIT – V

Hypersensitivity reactions- Antibody-mediated Type I; anaphylaxis: Type II; antibody dependent cell toxicity, Type III; immune complex mediated reactions; Type IV; cell mediated hypersensitivity reactions and the respective disease, immunological methods of their diagnosis; lymphokines and cytokines- its assay methods.