KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

'A' Grade
NAAC Re-accredited
(4th Cycle)

Semester-wise Code structure and Syllabus for

Faculty: Science and Technology

F. Y. B. Sc. (Microbiology)
(Honors/Research) Programme

As per NEP2020 for Affiliated Colleges

w.e.f. June 2024

Preface

Skilled human resource is a prerequisite in higher education, and it is to be acquired through thorough knowledge of theoretical concepts and hands-on laboratory methods of the subject. The Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon has adopted a department-specific model as per the guidelines of UGC, NEP-2020 and the Government of Maharashtra. The Board of Studies in Microbiology of the university has prepared the syllabus for the first-year undergraduate of Microbiology. The syllabus cultivates theoretical and practical know-how of different fields of Microbiology. The contents of the syllabus have been prepared to accommodate the fundamental aspects of various disciplines of Microbiology and to build the foundation for various applied sectors of Microbiology. Besides this, in the first year, the students will be enlightened with the skill related to agricultural microbiology and microbial analysis of soil, water and air, which will enhance students' employability and sustainable development.

The overall curriculum of three / four-year covers general microbiology, biomolecules and microbial metabolism, molecular biology and microbial genetics, medical microbiology and immunology, industrial and applied microbiology, environmental microbiology, and also covers various bio techniques. Furthermore, the syllabus is structured to cater to Microbiology's present and future needs in the research field, Industrial Sector, Environmental Sector, Entrepreneurship etc., emphasizing imparting hands-on skills. Hence, the curriculum is endowed with more experiments that shall run hand-in-hand with theory. The detailed syllabus of each paper is appended with a list of suggested readings.

Program Outcomes (PO) for B.Sc. Program:

Program outcomes associated with a B.Sc. degree are as follows:

1. Graduates should have a comprehensive knowledge and understanding of the fundamental principles, theories, and concepts in their chosen field of study.
2. Graduates should possess the necessary technical skills and competencies related to their discipline, including laboratory techniques and data analysis.
3. Graduates should be able to identify, analyze, and solve complex problems using logical and critical thinking skills. They should be able to apply scientific methods and principles to investigate and find solutions.
4. Graduates should be proficient in effectively communicating scientific information, both orally and in writing.
5. Graduates should have a basic foundation in research methods and be capable of designing and conducting scientific investigations.
6. Graduates should be able to work effectively as part of a team, demonstrating the ability to collaborate with others, respect diverse perspectives, and contribute to group projects.
7. Graduates should recognize the importance of ongoing learning and professional development. They should be equipped with the skills and motivation to engage in continuous learning, adapt to new technologies and advancements in their field, and stay updated with current research.

Program Specific Outcome PSO (B.Sc. Microbiology):

After completion of this course, students are expected to learn/understand the:

1 Isolation, identification and characterization of various microbes from diverse habitats.
2 Impact of various groups of microbes on atmosphere, plant, human and animal health.
3 Principle and applications of various bio-analytical tools and techniques
4 Structure, properties, pathways and applications of biomolecules in various fields
5 Biochemical mechanisms, regulation and application of enzymes in various sectors
6 Applications of microbes in various fields such as agriculture, industry, medical etc.

Abbreviations

- **MB** : Microbiology
- **T:** Theory Course
- **P:** Practical course
- **DSC:** Discipline Specific Core Course
- **DSE:** Discipline Specific ElectiveCourse
- **MIN:** Minor subject
- **VSEC:** Vocational skill and Skillenhancement courses
- **VSC:** Vocational Skill Courses
- **SEC:** Skill Enhancement Courses
- **GE/OE:** Generic/open elective
- **CI:** Constitution of India
- **IKS:** Indian Knowledge System
- **CEP:** Community engagement and service
- **OJT**: On Job Training: Internship/ Apprenticeship
- **RP:** Research Project
- **RM:** Research methodology
- **EA:** Environment awareness
- **ENG:** English
- **MIL:** Modern Indian language
- **Indian Knowledge System (IKS):**

IK:119: Ayurvedic Medicine in Ancient India

- **Co-curricular Course (CC)**

  CC-1: CC-120: Sports / Yoga
  CC-2: CC-130: NCC/ NSS

- **Value Education Courses (VEC)**

  VEC1: EA-118: Environmental awareness
  VEC2: CI-129: Constitution of India

- **Ability Enhancement Courses (AEC)**

  AEC-1: EG: 101 – English -1
  AEC-2: EG: 102 – English -2

Cognitive learning is a change in knowledge attributable to experience. This definition has three components: (1) learning involves a change, (2) the change is in the learner's knowledge, and (3) the cause of the change is the learner's experience.

Six levels of cognitive learning according to the revised version of Bloom's Taxonomy

Cognitive level	**1**	**2**	**3**	**4**	**5**	**6**
Cognitive task	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating

Semester-wise Code structure for B. Sc. (Honors/Research) Programme as per NEP2020, for Affiliated Colleges w. e. f – June 2024.

B. Sc. (Honors/Research) – First Year, SEMESTER – I, Level – 4.5											
Course	Course Type	Course Code	Course Title	Credits	Teaching Hours/ Week			Marks (Total 100)			
					T	P	Total	Internal (CA)		External (UA)	
								T	P	T	P
DSC-1	DSC	MB-111	Microbial Diversity and Taxonomy	2	2	--	2	20	--	30	--
DSC-2	DSC	MB-112	Microscopy and Basic Bacteriology	2	2	--	2	20	--	30	--
DSC-3	DSC	MB-113	Practical course in Basic Microbiology	2	--	4	4	--	20	--	30
MIN-1	MIN	MB-114	Fundamentals of Microbiology	2	2	--	2	20	--	30	--
MIN-2	MIN	MB-115	Practical course in Basic Microbiology	2	--	4	4	--	20	--	30
OE-1	OE	MB-116	Microbes and we	2	2	--	2	20	--	30	--
SEC-1	SEC	MB-117	Microbiological Analysis of Air, Water and Soil	2	2	--	2	20	--	30	--
VEC-1	VEC	EA-118	**Environmental Awareness**	2	2	--	2	20	--	30	--
IKS	IKS	IK-119	**Ayurvedic Medicine in Ancient India**	2	2	--	2	20	--	30	--
CC-1	CC	CC-120 (A/B)	**Select any one of the following A) Sports B) Yoga**	2	2	--	2	50	--	--	--
AEC-1	AEC	EG-101	**English -1**	2	2	--	2	20	--	30	--
B. Sc (Honors/Research) – First Year, SEMESTER – II, Level – 4.5											
DSC-4	DSC	MB-121	Indian knowledge system and history of Microbiology	2	2	--	2	20	--	30	--
DSC-5	DSC	MB-122	Microbiological Techniques	2	2	--	2	20	--	30	--
DSC-6	DSC	MB-123	Practical course on Microbial techniques	2	--	4	4	--	20	--	30
MIN-3	MIN	MB-124	Basic techniques in Microbiology	2	2	--	2	20	--	30	--
MIN-4	MIN	MB-125	Practical on Microbial techniques	2	--	4	4	--	20	--	30
OE-2	OE	MB-126	Health and hygiene	2	2	--	2	20	--	30	--
SEC-2	SEC	MB-127	Concepts in agricultural microbiology	2	2	--	2	20	--	30	--
SEC-3	SEC	MB-128	Practical on Environmental and Agri-microbiology	2	--	4	4	--	20	--	30
VEC-2	VEC	CI-129	**Constitution of India**	2	2	--	2	20	--	30	--
CC-2	CC	CC-130 (A/B)	**Select any one of the following A) NSS B) NCC**	2	2	--	2	50	--	--	--
AEC-2	AEC	EG-102	**English -2**	2	2	--	2	20	--	30	--
Cumulative Credits For First Year – 44											

Course Code: MB-111
Course Title: Microbial Diversity and Taxonomy

Course Code: MB-111	**Course Category: Core Course (DSC)**
Course Title: Microbial Diversity and Taxonomy	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA) Marks: 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

- To complement the students with the basic knowledge about microbial diversity

Course Outcomes: After successful completion of this course students are expected to:	Cognitive level
• Aware about scope of microbiology subject	1
• Know general microbial diversity pertinent to bacteria, fungi and algae	2
• Infer anatomy of prokaryotic cell	2
• Apply understanding of ways to classify the living system	3

Course Content:

Unit 1: Scope of Microbiology **(6 L)**

Development and scope of microbiology in the following disciplines -

- Soil microbiology, Geomicrobiology, Microbial Ecology, Food and Agricultural Microbiology, Immunology, Medical Microbiology, Pharmaceutical Microbiology, Chemotherapy and Molecular Biology, Industrial Microbiology, Nano-technology and Bioinformatics, etc.

Unit 2: Microbial Diversity **(8 L)**

- Concept of microbial diversity, ecology and its importance and ecological interactions
- General characteristics, morphological features and Significance of -
  Viruses, Virion and Prions
  Bacteria (Eubacteria, Rickettsia, Mycoplasma, Actimomycetes), Archaebacteria, Cyanobacteria
- Algae,
- Fungi and Protozoa

Unit 3: Anatomy of Prokaryotic cell **(8 L)**

- Ultra-structure of bacterial cell. Cell size, shape and arrangement
- Structure, Function and Chemical Composition of the following
- Glycocalyx/capsule, Flagella, endoflagella, Pilli, Cell wall, sphaeroplasts, protoplasts, and L-forms
- Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell
- Nucleolus, Nucleoid Mesosomes, Plasmid, phasmid, Ribosome,
- Cytoplasmic inclusions (volutin granules, PHB granule, glycogen, carbohydrates, Magnetosomes, gas vesicles, carboxysomes, chlorosome and sulphur granules) and Endospore structure and formation

Unit 4: Microbial Taxonomy **(8 L)**

- Whitakers' Five Kingdom system
- Carl Woese's three Domain system
- Binomial Nomenclature and basic rules

- Methods in microbial taxonomy: Cultural, Biochemical and molecular characteristics- Ribotyping, G=C ratio
- Numerical taxonomy and Chemotaxonomy
- Bergey's System of Bacterial Classification: structure, scheme and overview
- Introduction to classification of algae, fungi and virus

Reference Books:

- Tortora GJ, Funke BR and Case CL (2008). Microbiology: An Introduction, 9th edition, Pearson Education, New Delhi
- Talaro K and Chess B (2012) Foundations in Microbiology, 8th edition, The McGraw-Hill Companies, Inc., New York
- Tortora, Funke, and Case (2010) Microbiology, 10th edition, Brenjamin Cummings Inc., California.
- Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2016). Foundations in Microbiology, 9 th edition, Nirali Prakashan, Pune
- Frobisher M. Hinsdill, Crabtree, and Goodheart, (1974). Fundamentals of Microbiology, 9th edition, WB Saunder's Co., USA.

Course Code: MB-112
Course Title: Microscopy and Basic Bacteriology

Course Code: MB-112	**Course Category: Core Course (DSC)**
Course Title: Microscopy and Basic Bacteriology	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA) Marks: 20 Marks	**University Assessment (UA): 30 Marks**
Course Objectives: • To complement the students with the basic knowledge about microbial growth and microscopy	
Course Outcomes: After successful completion of this course students are expected to -	Cognitive level
• Demonstrate theory in microscopy and their handling techniques	1
• Learn various staining procedures	2
• Understand the concepts of bacterial growth and their reproduction	2
• Know the various Physical and Chemical growth requirements of bacteria and classification based on physical parameters.	2

Course Content:

Unit 1: Microscopy **(7 L)**

- Basics of Microscopy:
  - Magnification, Resolution, Numerical Aperture
- Compound Microscope:
  - Construction, Working Principle with Ray diagram
- Concept of Bright field and Dark filed Microscope
- Aberrations: Concept and types
- Oil immersion objective

Unit 2: Staining **(7 L)**

- Concept of stain (Acidic and Basic)

- Smear preparation, Mordant and fixative
- Methods of staining:
    - Simple (Monochrome and Negative)
    - Differential (Gram's and Acid fast)

Unit 3: Growth and Reproduction of Bacteria (8 L)

- Concept of Growth and Reproduction, Mechanism of binary fission, Fragmentation, budding
- Mathematical expression for Growth, Growth rate and Generation time (Illustration with problem).
- Typical growth curve of bacterial population and its significance
- Batch culture, Diauxic growth
- Quantitative measurement of bacterial growth Synchronous and Continuous Growth Culture with applications in microbiology

Unit 4: Cultivation of Bacteria (8 L)

- Physical parameters: Effect of pH, temperature, water activity, Oxygen on growth and cultivation
- Types of bacteria, mode of their adaptations w.r.t.
- Temperature requirement (psychrophiles, mesophiles, thermophiles, thermodurics, psychrotrophs),
- pH requirement (acidophiles, alkaliphiles),
- Salt/solute and water activity (halophiles, xerophiles, osmophilic),
- Oxygen requirement (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), Pressure (barophile).
- Media ingredients
- Types of media and Enrichment culture technique
- Classification of bacteria based on nutrition: Phototroph and chemotroph

Reference Books:

- Wiley, JM, Sherwood, LM and Woolverton, CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International, New York
- Frobisher M. Hinsdill, Crabtree and Goodheart Fundamentals of Microbiology, 9th edition, WB Saunder's Co. USA.
- Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company, New York
- Tortora, Funke and Case (2010). Microbiology, 10 edition, Brenjamin Cummings Inc, California.
- Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2016). Foundations in Microbiology 9th edition, Nirali Prakashan, Pune

Course Code: MB-113
Course Title: Practical in Basic Microbiology

Course Code: MB-113	**Course Category: Core Course (DSC)**
Course Title: Practical in Basic Microbiology	**Type: Practical**
Total Contact Hours: 60 (4/week)	**Course Credits: 02**
College Assessment (CA) Marks: 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:	
• To introduce various microorganisms present in the ecosystem and acquaint with common equipment used in routine microbiology laboratory	
Course Outcomes: After successful completion of this course students are expected to: Inculcate the ability to apply the process of science	Cognitive level
• Demonstrate theory and practical skills in microscopy and their handling techniques and staining procedures	1
• Understand the basic microbial practices and study the comparative characteristics of prokaryotes and eukaryotes	2
• Aware and train in aseptic handling of microbial specimens.	1
• Practice safe microbiology, using appropriate protective and emergency procedures.	1

List of Experiment:

1. Microbiology Good Laboratory practices and Biosafety
2. To study the principle, working and application of instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, pH meter, colorimeter) used in the microbiology laboratory
3. Acquainting basic microbiology tools: Cleaning and washing of Glassware, Wrapping the items prior to sterilization, Cotton Plugging, Aseptic handling (LAF/Bunsen burner), Inoculation of bacterial culture and inoculating needle, Microbial culture and biological waste Disposal
4. Use and Care of Compound Microscope with functions of each par
5. Study of fungi using temporary mounts and permanent slides (e.g. Rhizopus/ Penicillium /Aspergillus/ Fusarium)
6. Study of Algae/BGA temporary mounts and permanent slides (e,g. Spirogyra /Anabaena / Nostoc/ Cyanobacteria)
7. Study of the protozoans using temporary and permanent mounts (e.g. Amoeba/Entamoeba/ Paramecium / Plasmodium)
8. Preparation of culture media for bacterial cultivation.(Nutrient broth and nutrient agar/ MacConky's broth and MacConky's agar
9. Study of colony characteristics of different bacteria (e.g. Escherichia coli, Staphylococcus aurous, Actinomycetes)
10. Study of bacterial morphology using Monochrome staining
11. Study of morphological features of bacteria using Negative Staining
12. Study of Gram characteristics of bacteria using Gram's staining
13. Study of acid fast characteristics of bacteria using Acid fast staining (Nocardia spp./ Atypical mycobacteria)
14. Effect of pH and temperature on growth of bacteria
15. Demonstration of bacterial growth by spectrophotometer

Reference Books:

- Burns, R.G. and Slater, J.H. (1982) Experimental Microbial Ecology, Blackwell Scientific Publ., Oxford
- Benson, H. (2001) Microbiological Applications Lab Manual, 8th edition, The McGraw-Hill Companies, New York.

- Dubey, R.C. and Maheshwari D.K (2004) Practical Microbiology, S. Chand and Co. New Delhi.
- Harley, J.P. and Prescott, L.M (1996) Laboratory Exercise in Microbiology, 3rd edition, WCB/McGraw Hill, London

Course Code: MB-114
Course Title: Fundamentals of Microbiology

Course Code: MB-114	**Course Category: Minor Course (MIN)**
Course Title: Fundamentals of Microbiology	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA) Marks: 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

- To complement the students with the basic knowledge about microbial world

Course Outcomes: After successful completion of this course students are expected to:	Cognitive level
• Know general microbial diversity pertinent to bacteria, fungi and algae	1
• Know the various concepts related to bacterial growth	1
• Explain physical parameters associated with growth and associated types	2
• Understand basics of microscopy and staining	2

Course Content:

Unit 1: Microbial Diversity **(8 L)**

- Concept of microbial diversity, ecology and its importance and ecological interactions
- General characteristics, MorMBological features and Significance of -
  Viruses, Virion and Prions
  Bacteria (Eubacteria, Rickettsia, Mycoplasma, Actimomycetes), Archaebacteria, Cyanobacteria
- Algae,
- Fungi and Protozoa

Unit 2: Growth and Reproduction of Bacteria **(8 L)**

- Concept of Growth and Reproduction, Mechanism of binary fission, Fragmentation, budding
- Mathematical expression for Growth, Growth rate and Generation time (Illustration with problem).
- Typical growth curve of bacterial population and its significance
- Batch culture, Diauxic growth
- Quantitative measurement of bacterial growth Synchronous and Continuous Growth Culture with applications in microbiology

Unit 3: Cultivation of Bacteria **(7 L)**

- Physical parameters: Effect of pH, temperature, water activity, Oxygen on growth and cultivation
- Types of bacteria, mode of their adaptations w.r.t.
  - Temperature requirement
  - pH requirement
  - Salt/solute and water activity
  - Oxygen requirement
  - ,Pressure

- Media ingredients (water, peptone, malt extract, meat extract, yeast extract, trace elements, growth factor)
- Types of media: complex, synthetic, selective, differential, enriched media
- Enrichment culture technique
- Classification of bacteria based on nutrition: Phototroph (Phto-autotroph, Photo-heterotroph) and chemotroph (Chemo-autotroph, Chemo- heterotroph)

Unit 4: Microscopy and Staining **(7 L)**

- Basics of Microscopy: Magnification, Resolution, Numerical Aperture
- Compound Microscope: Construction, Working Principle with Ray diagram
- Oil immersion objective
- Concept of stain (Acidic and Basic)
- Smear preparation, Mordant and fixative
    - Methods of staining: Simple (Monochrome and Negative)
    - Differential (Gram's and Acid fast)

Reference Books:

- Tortora GJ, Funke BR and Case CL (2008). Microbiology: An Introduction, 9th edition, Pearson Education, New Delhi
- Talaro K and Chess B (2012) Foundations in Microbiology, 8th edition, The McGraw-Hill Companies, Inc., New York
- Tortora, Funke, and Case (2010) Microbiology, 10th edition, Brenjamin Cummings Inc., California.
- Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2016). Foundations in Microbiology, 9 th edition, Nirali Prakashan, Pune
- Frobisher M. Hinsdill, Crabtree, and Goodheart, (1974). Fundamentals of Microbiology, 9th edition, WB Saunder's Co., USA.
- Wiley, JM , Sherwood , LM and Woolverton, CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International, New York
- Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw
- Hill Book Company, New York
- Tortora, Funke and Case (2010). Microbiology, 10 edition, Brenjamin Cummings Inc, California.

Course Code: MB-115
Course Title: Practical in Basic Microbiology

Course Code: MB-115	**Course Category: Minor Course (MIN)**
Course Title: Practical in Basic Microbiology	**Type: Practical**
Total Contact Hours: 60 (4/week)	**Course Credits: 02**
College Assessment (CA) Marks: 20 Marks	**University Assessment (UA): 30 Marks**
Course Objectives: • To introduce various microorganisms present in the ecosystem and acquaint with common equipment used in routine microbiology laboratory	

Course Outcomes: After successful completion of this course students are expected to: Inculcate the ability to apply the process of science	Cognitive level
• Demonstrate theory and practical skills in microscopy and their handling techniques and staining procedures	1
• Understand the basic microbial practices and study the comparative characteristics of prokaryotes and eukaryotes	2
• Aware and train in aseptic handling of microbial specimens.	1
• Practice safe microbiology, using appropriate protective and emergency procedures.	1

List of Experiment:

1. Microbiology Good Laboratory practices and Biosafety
2. To study the principle, working and application of instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, pH meter, colorimeter) used in the microbiology laboratory
3. Acquainting basic microbiology tools: Cleaning and washing of Glassware, Wrapping the items prior to sterilization, Cotton Plugging, Aseptic handling (LAF/Bunsen burner), Inoculation of bacterial culture and inoculating needle, Microbial culture and biological waste Disposal
4. Use and Care of Compound Microscope with functions of each par
5. Study of fungi using temporary mounts and permanent slides (e.g. Rhizopus/ Penicillium /Aspergillus/ Fusarium)
6. Study of Algae/BGA temporary mounts and permanent slides (e,g. Spirogyra /Anabaena / Nostoc/ Cyanobacteria)
7. Study of the protozoans using temporary and permanent mounts (e.g. Amoeba/Entamoeba/ Paramecium / Plasmodium)
8. Preparation of culture media for bacterial cultivation.(Nutrient broth and nutrient agar/ MacConky's broth and MacConky's agar
9. Study of colony characteristics of different bacteria (e.g. Escherichia coli, Staphylococcus aurous, Actinomycetes)
10. Study of bacterial morphology using Monochrome staining
11. Study of morphological features of bacteria using Negative Staining
12. Study of Gram characteristics of bacteria using Gram's staining
13. Study of acid fast characteristics of bacteria using Acid fast staining (Nocardia spp./ Atypical mycobacteria)
14. Effect of pH and temperature on growth of bacteria
15. Demonstration of bacterial growth by spectrophotometer

Reference Books:

- Burns, R.G. and Slater, J.H. (1982) Experimental Microbial Ecology, Blackwell Scientific Publ., Oxford
- Benson, H. (2001) Microbiological Applications Lab Manual, 8th edition, The McGraw-Hill Companies, New York.
- Dubey, R.C. and Maheshwari D.K (2004) Practical Microbiology, S. Chand and Co. New Delhi.
- Harley, J.P. and Prescott, L.M (1996) Laboratory Exercise in Microbiology, 3rd edition, WCB/McGraw Hill, London

Course Code: MB-116
Course Title: Microbes and we

Course Code: MB-116	**Course Category: Open Elective Course (OE)** **(To be chosen compulsorily from faculty other than that of the Major)**
Course Title: Microbes and we	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA) Marks: 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

- To complement the students with the basic knowledge about microbial world

Course Outcomes: After successful completion of this course students are expected to:	Cognitive level
• Know general microbial diversity	1
• Aware about significance of subject microbiology	2
• Learn applied aspects of microbial world	2
• Association of microbes and human welfare	1

Course Content:

Unit 1: Introduction to microbial world **(8 L)**

- Concept of prokaryotes and eukaryotes
- Ultrastructure and general characteristics of:
  - Bacteria
  - Fungi
  - Algae
  - Protozoa
  - Virus

Unit 2: Significance of microorganisms **(8 L)**

- Beneficial microorganisms: common flora, microorganisms and agriculture, microorganisms in food, dairy, pharmaceutical industry
- Harmful microorganisms: microorganisms as plant, animal and human pathogens
- Important microbial products: antibiotics, vitamins, insecticides, enzymes etc.

Unit 3: Role of microbes **(7 L)**

- Agriculture: PGPR, biopesticides
- Industry: wine and bakery
- Pharmaceuticals: antibiotics and vaccines
- Medicine: insulin and growth hormones
- Environment: bioremediation and waste water management

Unit 4: Microbes and human welfare **(7 L)**

- Recycling vital element
- Sewage treatment- using microbes
- Bioremediation using microbes
- Insect pest control by microbes

Reference Books:

- Frobisher M. Hinsdill, Crabtree, and Goodheart, (1974). Fundamentals of Microbiology, 9th edition, WB

Saunder's Co., USA.
- Tortora GJ, Funke BR and Case CL (2008). Microbiology: An Introduction, 9th edition, Pearson Education, New Delhi
- Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2016). Foundations in Microbiology, 9 th edition, Nirali Prakashan, Pune
- Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company, New York
- Wiley, JM , Sherwood , LM and Woolverton, CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International, New York

Course Code: MB-117
Course Title: Microbiological Analysis of Air, Water and Soil

Course Code: MB-117	**Course Category: Skill Enhancement Course**
Course Title: Microbiological Analysis of Air, Water and Soil	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA) Marks: 20 Marks	**University Assessment (UA): 30 Marks**
Course Objectives: • To learn Microbiological Analysis of Air, Water and Soil	
Course Outcomes: After successful completion of this course, the students are expected to:	Cognitive level
• Understand the basic aspects of air microbiology	2
• Understand the basic aspects of soil microbiology	2
• Understand the basic aspects of water microbiology	2
• Explain various aspects of environmental microbiology	1

Course Content:

Unit 1: Aero-microbiology **(8 L)**

- Bio-aerosols, droplet nuclei, Air borne microbes, impact on human health and environmental, Significance in food, pharma industries, allergens, surgical operation theatres
- Techniques for microbial sampling of air from various sources, Aerosol sampling, fate of aerosols, inactivation by UV light and HEPA filter
- Assessment of air quality by solid, liquid impingement, Enumeration of microflora by different techniques,
- Air borne transmission of microbes, their diseases and preventive control measures

Unit 2: Soil microbiology **(8 L)**

- Biogeochemical cycles: C, P, N, S
- Soil horizons, classification of soils
- Microflora of various soil types and salt affected soils
- Rhizosphere microflora
- Preparation of Winogradsky's column to study soil microflora Enumeration of soil microflora by different techniques,

Unit 3: Water microbiology (7 L)

- Water ecosystem: Fresh water (Ponds, Lakes, Stream); Marine water (Estuaries, mangroves, deep sea, hydrothermal vents, saltpans, Coral reef)
- Microflora of water
- Bacterial assessment of water and potability of water
- Indicator bacteria: *E. coli, Staphylococcus aureus, Clostridium perfringens*, MPN (Black, White), MPN index, IMViC test
- Physiochemical characteristics of water: TSS, TDS, DO, BOD and COD
- Brief account of water borne diseases and their control measures

Unit 4: Environment microbiology (7 L)

- Waste as resource
    - Organic compost
    - Biogas
    - Waste water treatment
- Concept of Biodegradation

Reference Books:

- Clesceri L S., Greenberg, A. E, and Eaton A. D. (1998) Standard Methods for Examination of Water and Wastewater, 18th Edition, American Public Health Association, Washington.
- Maier R.M., pepper, I.L. and Gerba, C.P. (2009) Environmental Microbiology, 2nd edn., Academic Press, NY
- Salle, S.J. (1974) Fundamental Principals of Bacteriology, 2nd edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- SubbaRao, N.S. (1999) Soil Microbiology, 4th edn., Oxford and IBH Publ. Co., New Delhi
- Coyne, M.S. (2001) Soil Microbiology: An Exploratory Approach, Delmar Thomson Learning
- Alexander, M. (1977) Introduction to Soil Microbiology, John Wiley and sons Inc. New York
- Atlas, R.M. and Bartha, R. (2000) Microbial Ecology, 4th edn., Benjamin/Cumming Science Publ., USA

Course Code: MB-121
Course Title: Indian knowledge system and history of Microbiology

Course Code: MB-121	**Course Category: Major Specific IKS (DSC)**
Course Title: Indian knowledge system and history of Microbiology	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA) Marks: 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

- To complement the students with the basic knowledge about microbial history and IKS

Course Outcomes: After successful completion of this course students are expected to:	Cognitive level
• know the Indian Knowledge system in Microbiology	1
• learn about traditional Indian fermented food	1
• aware about contribution of various researcher of Indian origin	1
• aware about historical developments, pioneers of microbiology	1

Course Content

Unit 1:Indian Knowledge System in Microbiology (8 L)

- Microbiology in Vedas
  - Contribution of Atherva Veda and Sege Kannva
  - Contribution of Sage Baadarayani and Sage Chatana
  - Sage Kannva and Agni Hotra
- Vedic scientific terms for microorganisms
  - Knowledge of Medical Microbiology
  - Microbial transfer and Madhav Nidan
  - Knowledge of communicable diseases
  - Herbal remedies for microbial infection
- Ancient Indian bacteriology

Unit 2:Traditional Indian fermented food (8 L)

- Milk-based fermented foods
- Cereal and legume-based fermented foods
- Milk and cereal/legume-based fermented foods
- Vegetable-based fermented foods

Unit 3: Contributions of researchers from Indian origin (6 L)

- Ananda Mohan Chakraborty,
- Subba Rao,
- Natteri Veeraraghavan,
- Khem Shahani,
- R. Ananthanarayan etc.

Unit 4: Historical developments (8 L)

- Spontaneous generation (abiogenesis) – Concept and experimental evidences to prove it
- Concept of Prokaryotic (Microorganisms) and Eukaryotic cells
- Discovery of Microscope

- Germ theory of Fermentation
- Germ theory of Disease: Koch's and Revere's postulate
- Development of pure culture methods and preparation of Decimal Dilution, solidifying agent (potato, gelatin, agar agar)
- Contribution(s) of the following scientists in the development of microbiology
- Antonie von Leeuwenhoek, Louis Pasteur, Robert Koch, JoseMB Lister, Alexander Fleming, Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman, Paul Ehrlich, Elie Metchnikoff, Edward Jenner

Reference Books:

- Frobisher, M. Hinsdill, Crabtree, and Goodheart, (1974). Fundamentals of Microbiology, 9th edition, WB Saunder's Co., USA.
- Dubey, R. C., & Maheshwari, D. K. (2005). Text Book of Microbiology, S Chand and Co, New Delhi
- Kuhad, U., Goel, G., Maurya, P. K., & Kuhad, R. C. (2021). Sukshmjeevanu in Vedas: The Forgotten Past of Microbiology in Indian Vedic Knowledge. Indian Journal of Microbiology, 61, 108-110.
- Sircar, N. N. (1991). Ancient Indian Bacteriology. Ancient Science of Life, 10(3), 180.
- Frend, C. (2006). Microbiology in the Veda. Vedic sciences, 8(4), 27-34.

Course Code: MB-122
Course Title: Microbiological Techniques

Course Code: MB-122	**Course Category: Core Course (DSC)**
Course Title: Microbiological Techniques	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA) Marks: 20 Marks	**University Assessment (UA): 30 Marks**
Course Objectives: • To complement the students with cultivation and control of microbe with physical and chemical approach	
Course Outcomes: After successful completion of this course students are expected to:	Cognitive level
• Know microbial techniques for isolation of pure cultures of bacteria, fungi, algae and virus	1
• Explain theory associated with aseptic handling microbial culture and disinfection	1
• Understand various physical and chemical means of sterilization	2
• Summarize methods to control the microbes	2

Course Content:

Unit 1: Isolation and Cultivation of Microbes (8 L)

- Pure culture technique for bacteria - Streak, Pour plate, Spread plate
- Cultivation of anaerobes: Roll tube method, anaerobic jar and anaerobic cabinet/chamber
- Cultivation of fungi, Blue green algae, algae

- Cultivation of animal and plant viruses (living animals, embryonated eggs and cell line cultures), Cultivation of bacteriophage

Unit 2: Aseptic conditions and Disinfection (8 L)

- Aseptic condition - necessity and application
- Concept of - Antiseptic, Sanitizer, Germicide, Antibiotics, Microbiocide, Microbiostasis
- Concept of disinfectant and hharacters of an ideal disinfectant
- Mode of action and applications of following
    - Phenol and Phenolic compounds, Alcohols, Halogens, Heavy metals and their compounds, Dyes, Detergents, Quaternary ammonium compounds, H_2O_2.

Unit 3: Sterilization (8 L)

- Concept of sterilization
- Physical methods: Dry heat (Hot air oven, Incineration), Moist heat (Autoclave, Tyndallisation) and Radiation- (X- rays, Gamma rays and UV rays)
- Sterilization by Filtration: Membrane filter, LAF (HEPA), Nucleopore filters
- Chemical methods - Ethylene oxide and Formaldehyde
- Chemical and Biological Indicators of Sterilization
- Validation of sterility in autoclave and LAF

Unit 4: Control of microbes (6 L)

- Concept of TDT and TDP
- Pasteurization - Concept and Methods - LTH, HTST, and UHT
- Control of microbes by Low Temperature,
- Desiccation, Osmotic pressure, Surface tension etc.

Reference Books:

- Pawar, CB, & Daginawala HF. (1998) General Microbiology, Vol. I & II, Himalaya Publ., House, Mumbai.
- Black, JG. (2008) Microbiology: Principles and Explorations, 7th edition, Prentice Hall, New Jersey.
- Madigan, MT and Martinko, JM. (2014) Brock Biology of Micro-organisms, 14th edition, Parker J. Prentice Hall International, Inc., New Jersey.
- Frobisher, M. Hinsdill, R., Crabtree, KT., and Goodheart, CR. (1974) Fundamentals of Microbiology, 9th edition, WB Saunder's Co., Many, USA.
- Pelczar MJ, Chan, ECS and Krieg, NR. (1993) Microbiology. 5th edition. McGraw Hill Book Company, Penguin, USA
- Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2016) Foundations in Microbiology, 9th edition, Nirali Prakashan, Pune.
- Modi, H. A. (2014) Elementary Microbiology, Vol. 1 and 2, Akshar Prakashan, Ahmedabad

Course Code: MB-123
Course Title: Practical on Microbial techniques

Course Code: MB-123	**Course Category: Core Course (DSC)**
Course Title: Practical on Microbial techniques	**Type: Practical**
Total Contact Hours: 60 (4/week)	**Course Credits: 02**
College Assessment (CA) Marks: 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

- To instill practical skills about methods of isolation, characterization, control of microbes.

Course Outcomes: After successful completion of this course students are expected to:	Cognitive level
• Analyze and interpret results from a variety of staining techniques	2
• Introduce microbiology Laboratory Skills to cultivate microbes	1
• Become conversant in basic biochemical methods in microbiology	2
• Preparation of standard solutions	3

List of Experiment:

1. Demonstration of motility by hanging drop and swarming growth
2. Capsule staining
3. Endospore staining
4. Isolation of bacteria by Streak Plate technique
5. Isolation of bacteria by spread plate technique from water sample
6. Determination of Colony Forming Unit (cfu) by pour plate method from soil/water sample
7. Slide culture technique for fungi
8. Effect of heavy metal(s) on growth of bacteria and demonstration of oligodynamic action
9. Sterilization of heat sensitive material by membrane filtration
10. Evaluation of skin disinfectant (alcohol/soap/Dettol)for disinfection
11. Study micro-flora of the air and water on nutrient agar plates
12. Qualitative tests for carbohydrate and lipids
13. Qualitative tests for amino acids and proteins
14. Qualitative tests for nucleic acid
15. Preparation of standard solutions (Normal/ Molar/ Percentage)

Reference Books:

1. Aneja, K.R. (1996) Experiments in Microbiology, 3rd edition, Wishwa Prakashan, New Delhi.
2. Benson, H. (2001) Microbiological Applications Lab Manual, 8th edition, The McGraw-Hill Companies, New York.
3. Dubey, R.C. and Maheshwari D.K. (2004) Practical Microbiology, S. Chand and Co., New Delhi.
4. Jayaraman, I (1981) Laboratory Manual in Biochemistry, Wiley Eastern Ltd., New Delhi.
5. Norris, J.R. (1969) Methods in Microbiology Vol. I, 1st edition, Academic Press Inc., London.
6. Parija, S.C. (2007) Textbook of Practical Microbiology, Ahuja Publishing House, New Delhi.
7. Plummer, D.T. (1992) an Introduction to Practical Biochemistry, Tata McGraw Hill Publisher, New Delhi.
8. Sharma, K. (2007) Manual of Microbiology Tools and Techniques, Ane's Book India, New Delhi.

Course Code: MB-124
Course Title: Basic techniques in Microbiology

Course Code: MB-124	**Course Category: Minor Course (MIN)**
Course Title: Basic techniques in Microbiology	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA) Marks: 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

- To complement the students with cultivation and control of microbe with physical and chemical approach

Course Outcomes: After successful completion of this course students are expected to:	Cognitive level
• Know microbial techniques for isolation of pure cultures of bacteria, fungi, algae and virus	1
• Explain theory associated with aseptic handling microbial culture and disinfection	1
• Understand various physical and chemical means of sterilization	2
• Summarize methods to control the microbes	2

Course Content:

Unit 1: Isolation and Cultivation of Microbes (8 L)

- Pure culture technique for bacteria - Streak, Pour plate, Spread plate
- Cultivation of anaerobes: Roll tube method, anaerobic jar and anaerobic cabinet/chamber
- Cultivation of fungi, Blue green algae, algae
- Cultivation of animal and plant viruses (living animals, embryonated eggs and cell line cultures), Cultivation of bacteriophage

Unit 2: Aseptic conditions and Disinfection (8 L)

- Aseptic condition - necessity and application
- Concept of - Antiseptic, Sanitizer, Germicide, Antibiotics, Microbiocide, Microbiostasis
- Concept of disinfectant and hharacters of an ideal disinfectant
- Mode of action and applications of following
    - Phenol and Phenolic compounds, Alcohols, Halogens, Heavy metals and their compounds, Dyes, Detergents, Quaternary ammonium compounds, H_2O_2.

Unit 3: sterilization (8 L)

- Concept of sterilization
- Physical methods: Dry heat (Hot air oven, Incineration), Moist heat (Autoclave, Tyndallisation) and Radiation- (X- rays, Gamma rays and UV rays)
- Sterilization by Filtration: Membrane filter, LAF (HEPA), Nucleopore filters
- Chemical methods - Ethylene oxide and Formaldehyde
- Chemical and Biological Indicators of Sterilization
- Validation of sterility in autoclave and LAF

Unit 4: Control of microbes (6 L)

- Concept of TDT and TDP
- Pasteurization - Concept and Methods - LTH, HTST, and UHT
- Control of microbes by Low Temperature,
- Desiccation, Osmotic pressure, Surface tension etc.

Reference Books:

- Pawar, CB, & Daginawala HF. (1998) General Microbiology, Vol. I & II, Himalaya Publ., House, Mumbai.
- Black, JG. (2008) Microbiology: Principles and Explorations, 7th edition, Prentice Hall, New Jersey.
- Madigan, MT and Martinko, JM. (2014) Brock Biology of Micro-organisms, 14th edition, Parker J. Prentice Hall International, Inc., New Jersey.
- Frobisher, M. Hinsdill, R., Crabtree, KT., and Goodheart, CR. (1974) Fundamentals of Microbiology, 9th edition, WB Saunder's Co., Many, USA.
- Pelczar MJ, Chan, ECS and Krieg, NR. (1993) Microbiology. 5th edition. McGraw Hill Book Company, Penguin, USA
- Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2016) Foundations in Microbiology, 9th edition, Nirali Prakashan, Pune.
- Modi, H. A. (2014) Elementary Microbiology, Vol. 1 and 2, Akshar Prakashan, Ahmedabad

Course Code: MB-125
Course Title: Practical on Microbial techniques

Course Code: MB-125	**Course Category: Minor Course (MIN)**
Course Title: Practical on Microbial techniques	**Type: Practical**
Total Contact Hours: 60 (4/week)	**Course Credits: 02**
College Assessment (CA) Marks: 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

- To instill practical skills about methods of isolation, characterization, control of microbes.

Course Outcomes: After successful completion of this course students are expected to:	Cognitive level
• Analyze and interpret results from a variety of staining techniques	2
• Introduce microbiology Laboratory Skills to cultivate microbes	1
• Become conversant in basic biochemical methods in microbiology	2
• Preparation of standard solutions	3

List of Experiment:

1. Demonstration of motility by hanging drop and swarming growth
2. Capsule staining
3. Endospore staining
4. Isolation of bacteria by Streak Plate technique
5. Isolation of bacteria by spread plate technique from water sample
6. Determination of Colony Forming Unit (cfu) by pour plate method from soil/water sample
7. Effect of heavy metal(s) on growth of bacteria and demonstration of oligodynamic action
8. Sterilization of heat sensitive material by membrane filtration
9. Evaluation of skin disinfectant (alcohol/soap/Dettol)for disinfection
10. Study micro-flora of the air and water on nutrient agar plates
11. Qualitative tests for carbohydrate and lipids
12. Qualitative tests for amino acids and proteins

13. Qualitative tests for nucleic acid
14. Slide culture technique for fungi
15. Preparation of standard solutions (Normal/ Molar/ Percentage)

Reference Books:

- Aneja, K.R. (1996) Experiments in Microbiology, 3rd edition, Wishwa Prakashan, New Delhi.
- Benson, H. (2001) Microbiological Applications Lab Manual, 8th edition, The McGraw-Hill Companies, New York.
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- Harley, J.P. and Prescott, L.M. (1996) Laboratory Exercise in Microbiology, 3rd edn., WCB/McGraw Hill Publ. Co., London
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- Plummer, D.T. (1992) an Introduction to Practical Biochemistry, Tata McGraw Hill Publisher, New Delhi.
- Sharma, K. (2007) Manual of Microbiology Tools and Techniques, Ane's Book India, New Delhi.

Course Code: MB-126
Course Title: Health and hygiene

Course Code: MB-126	**Course Category: Open Elective Course (OE)**
Course Title: Health and hygiene	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA) Marks: 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

- This course is intended to provide an introduction to Health and hygiene with respect to microbes

Course Outcomes: This course will enable the students to understand	Cognitive level
• Microorganism and their association to human health	1
• Aware about control of microbes through various techniques	1
• Know common microbial diseases	1
• Understand various interaction between microbes and host	2

Course Content:

Unit 1: Human health and microorganisms **(8 L)**

- Significance of microorganisms in human body
- Normal flora of:
  - Skin
  - Intestine
  - Genitals
  - Mouth

Unit 2: Control of microorganisms **(8 L)**

- Concept and significance of sterilization
- Disinfection
- Sanitization

- Antisepsis
- Importance of hand washing, personal and community hygiene
- Concept of antibiotic resistance
- Concept and significance of vaccines

Unit 3: Common microbial diseases **(8 L)**

- Common cold
- Diarrhea
- Malaria
- Typhoid
- Flu (Covid 19, bird flu)
- General hygienic practices for preventing microbial diseases

Unit 4: Interaction between microbes and host **(6 L)**

- Principles of disease and epidemiology
- Microbial mechanism of pathogenicity
- Defense of the host
- Actions of microbial drugs

Reference Books:

- Ananthnarayan, P., Paniker, C. K. J., (2009), Textbook of Microbiology 8th Edn, Universities Press, Hyderabad
- Atlas, R. M. (1995), Microorganisms in our world, Mosby Yearbook Inc
- Chakraborty P (2013), A textbook of Microbiology, New Central Book Agency, Delhi
- Davis, B. D., Dulbecco, R, Eisen, H. N., Ginsberg, R. S., (1990), Microbiology, 4th Ed., Harper and Row Publishers, Singapore
- Dey, N. C. and Dey, T. K., (1999) Medical Bacteriology and Microbiology, 16th Edn, Allied Agency, Calcutta
- Prescott, L. M., Hartley, J. P. and Klein, D. A., (1993), Microbiology, 2nd Ed., W. M. C. Brown Publ, England

Course Code: MB-127
Course Title: Concepts in agricultural microbiology

Course Code: MB-127	**Course Category: Skill Enhancement Course**
Course Title: Concepts in agricultural microbiology	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA) Marks: 20 Marks	**University Assessment (UA): 30 Marks**
Course Objectives: • To familiarize students with the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers.	
Course Outcomes: After successful completion of this course students are expected to: • To sustainably minimize damage from pests or increase agricultural productivity.	Cognitive level
• Give an overview of relevant use of microbial biofertilizers	2

• Give an overview of relevant use of microbial biofertilizers and its application	3
• Understand the aspects related to use of microbial biopesticides	2
• Become familiar with the biomass and bioenergy	2

Course Content:

Unit 1: Biofertilizers I **(8 L)**

- Microbes as biofertilizers and their advantages over chemical fertilizers
- Screening of symbiotic and non-symbiotic nitrogen fixing bacteria for production of biofertilizer
- Rhizobium: Isolation, characteristics, types, inoculum production and field application, legume/pulses plants
- Cyanobacteria, Azolla: Isolation, characterization and role in crop cultivation
- Non-symbiotic nitrogen fixing bacteria: Azospirillum, Azotobacter: isolation, characteristics, mass inoculum production and field application

Unit 2: Biofertilizers II **(7 L)**

- Frankia: Isolation, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis PGPR, phosphate solubilizing bacteria and Mycorrhizal biofertilizers: isolation, characteristics, mass inoculum production and field application
- Application of biofertilizers: Liquid, and preparation of carrier-based formulation, Seed bacterization, soil broadcasting
- Bio-efficacy and quality parameters

Unit 3: Biopesticides **(8 L)**

- General account of microbes used as biopesticides / bioinsecticides and their advantages over synthetic pesticides
- Screening and isolation of bioagents
- Bacillus thuringiensis, Pseudomonas fluorescence, Trichoderma viridae: Mode of action, mass production, formulation, Field applications
- NPV and Beauveria bassiana: Action, Cultivation and field applications
- Advantages and disadvantages of biopesticides
- Bio-efficacy and quality parameters assessment

Unit 4: Biomass and bioenergy **(7 L)**

- Energy sources :Traditional and biomass as energy source
- Composition of biomass
- Aquatic biomass
- Waste as renewable energy source
- Biomass conversion : Non biological and biological
- Bioenergy: Bio ethanol, biogas, bio hydrogen

Reference Books:

- Kannaiyan, S. (2003) Biotechnology of Biofertilizers, CHIPS, Texas.
- Rai M. K. (2005) Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
- Reddy, S.M. et. al. (2002) Bioinoculants for sustainable Agriculture and Forestry, Scientific Publishers, New Delhi
- Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH Publishing co. Pvt. Ltd., New Delhi.

- Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG
- Aggarwal SK (2005) Advanced Environmental Biotechnology, APH Publication, New Delhi
- Dubey R. C. (2006) A text book of Biotechnology, S. Chand New Delhi

Course Code: MB-128
Course Title: Practical on Environmental and Agri-microbiology

Course Code: MB-128	**Course Category: Skill Enhancement Course**
Course Title: Practicals on Environmental and Agri-microbiology	**Type: Laboratory**
Total Contact Hours: 60 (4/week)	**Course Credits: 02**
College Assessment (CA) Marks: 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

- To inculcate skills in environmental and Agri-microbiology

Course Outcomes: After successful completion of this course students are expected to:	Cognitive level
• Get the skills related to microscopic observation of microbes	1
• Know skills in to isolate agriculturally important microbes	2
• Learn enumeration of microbes from air and environment	1
• Understand on field aspects of microbiology	2

List of Experiment:

1. Temporary wet mount technique for microscopic observation of living microbe from pond
2. Microscopic examination of free living protozoa of pond
3. Identification of symbiotic bacteroids of rhizobia
4. Isolation of Rhizobium from legume root nodule.
5. Enumeration of rhizosphere to non rhizosphere population of bacteria.
6. Microscopic observations of root colonization by VAM fungi.
7. Isolation of P solubilizing microorganisms.
8. Demonstration on different biofertilizers types, formulation and application methods.
9. Seed inoculation with rhizobia
10. Screening of antibiotic producer from soil
11. Isolation of fungal pathogen from soil / diseased plant part
12. Enumeration of soil microflora
13. Isolation of seed microflora
14. Enumeration of environment / air microflora
15. Field visit to farmland / forest / polluting sites

Reference Books:

- Amaresan N., Patel P. and Amin D. (Eds.) (2022) Springer Protocols: Practical Handbook on Agricultural Microbiology. Springer.
- Sharma Kanika (2007) Manual of microbiology tools and techniques, Ane Book India, New Delhi
- Aneja, K.R. (1996) Experiments in Microbiology, 3rd edition, Wishwa Prakashan, New Delhi.
- Benson, H. (2001) Microbiological Applications Lab Manual, 8th edition, The McGraw-Hill Companies, New York.
- Dubey, R.C. and Maheshwari D.K. (2004) Practical Microbiology, S. Chand and Co., New Delhi.