

# **The University of Burdwan**



**Syllabus for 4- year Honours**

**in**

**Microbiology**

**Under Curriculum & Credit Framework for Undergraduate  
programme (CCFUP) as per National Educational Policy  
(NEP), 2020**

**w. e. f. 2023 - 2024 onward**

## Scheme of B. Sc. Microbiology 2023- 24 onwards

### Semester-I

Sr. No.	Subject Code	Course Title	Level	Course type	Scheme of teaching			Credit	Scheme of evaluation			
					L	T	P/viva		T	P/viva	IA	FM
1	MICR1011	Introduction to Microbiology and Biomolecules	100-199	Major/ DS Course (Core)	3	0	1	4	40	20	15	75
2	MICR1021	Introduction & Scope of Microbiology	100-199	Minor Course	3	0	1	4	40	20	15	75
3	MICR1031	Microbiology for Beginners		Multi/ Interdisciplinary	3	0	0	3	40	0	10*	50
4	AEC1041	Language (Eng/Hindi/Sanskrit etc) or Equivalent Course from SWAYAM/ any UGC recognized platform		Ability Enhancement Course (AEC) [L <sub>1</sub> -1 MIL]	2	0	0	2	40	0	10	50
5	MICR1051	Microbiological analysis in Health Care		Skill Enhancement Course (SEC)	3	0	0	3	40	0	10**	50
6	CVA1061	Environmental Science / Education		Common Value Added Course (VAC)	3	0	1	4	60	20	20	100
	Total							20				400

### Semester-II

Sr. No.	Subject Code	Course Title	Level	Course type	Scheme of teaching			Credit	Scheme of evaluation			
					L	T	P/viva		T	P/viva	IA	FM
1	MICR2011	Bacteriology	100-199	Major/ DS Course (Core)	3	0	1	4	40	20	15	75
2	MICR2021	Basic Bacteriology	100-199	Minor Course	3	0	1	4	40	20	15	75
3	MICR2031	Microbes and Environment		Multi/ Interdisciplinary	3	0	0	3	40	0	10*	50
4	AEC2041	Language (Eng/Hindi/Sanskrit etc) or Equivalent Course from SWAYAM		Ability Enhancement Course (AEC) [L <sub>1</sub> -1 MIL]	2	0	0	2	40	0	10	50
5	MICR2051	Biofertilizers and Biopesticides		Skill Enhancement Course (SEC)	3	0	0	3	40	0	10**	50
6	MICR2061	Understanding India/Digital & Technological Solutions/Health & Wellness, Yoga Education, Sports & Fitness		Common Value Added Course (VAC)	3/3	1/0	0/1	4	80/60	0/20	20	100
	Total							20				400

Skill based vocational course (addl. 4 Cr) during summer term for 8 weeks, who will exit the programme after securing 40 cr.

**For UG Certificate 40 cr + Additional 4 cr (work based vocational course) = 44 cr.**

**Students are allowed to re-enter within 3 years & complete the programme within the stipulated max. period of 7 years**

Note:

Theory: 1 credit is equivalent to 1 class of 1 hr duration per week. Practical: 1 credit is equivalent to 1 class of 2 hrs duration per week.

\*, Internal assessment of 10 Marks in case of Multi/ interdisciplinary course will be based on the practical portion of the course concerned.

\*\*, Internal assessment of 10 marks in case of SEC will be based on the practical portion of the course concerned.

# Semester-I

**Major/DS Course (Core Course)- I**

**Course Code: MICR1011**

**Course Title: Introduction to Microbiology and Biomolecules**

**(FM- 75; Theory-40, Practical -20, Internal- 15)**

**(100-199 level)**

**4 Credits (Theory: 03 & Practical: 01) (Lecture-03, Tutorial-0, and Practical-01)**

**Theory:**

**45 Hrs**

**Unit1: History and Development of Microbiology**

**08 Hrs**

Theory of Spontaneous generation, Germ theory of disease. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Edward Jenner, Paul Ehrlich, Martinus W. Beijerinck, and Sergei N. Winogradsky in the field of Microbiology. Major scope of Microbiology

**Unit2: Microscopy**

**07 Hrs**

Principle and application of Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Transmission Electron Microscope and Scanning Electron Microscope.

**Unit3: Diversity of Microbial world:**

**15 Hrs**

Systems of classification: Basic idea about Hackel and Whittaker's kingdom concept and domain concept of Carl Woese

General characteristics, and economic importance of different group of Microbes: Cellular microorganisms (Archaea, Bacteria, Algae, Fungi and Protozoa); Acellular entity (Viruses, Viroids, Virusoids, Satellite viruses, Prions)

**Unit4: Introduction to Biomolecules**

**15 Hrs**

**Carbohydrates**

General properties and classification of carbohydrates, monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses and hexoses (glucose and fructose), epimer, anomer. Disaccharides: reducing and non-reducing sugars. Polysaccharides- starch and glycogen.

**Lipids**

Fatty acids: types, structures and functions; essential fatty acids. Lipid: definition, nomenclature and classification (triacyl glycerol), phospholipids, glycolipids, sphingolipids, sphingosine and ceramide.

**Amino acids & proteins:**

Amino acids: classification of amino acids, concept of zwitterion. Function of proteins, basic concept of structures of protein: primary secondary, tertiary and quaternary structures.

**Nucleic Acids**

Purine, pyrimidine bases, nucleoside, nucleotides- structure, properties. Types of DNA and RNA.

**Practical:**

**30 Hrs**

1. Microbiology Laboratory Management and Bio-safety
2. Principle and application of instruments: autoclave, incubator, hot air oven, centrifuge, light microscope, pH meter, Laminar air flow
3. Preparation of culture media: Nutrient Broth, Nutrient Agar and Potato dextrose agar
4. Sterilization of medium using Autoclave
5. Sterilization of glassware using Hot Air Oven
6. Sterilization of heat sensitive material by Filtration
7. Isolation and enumeration of bacteria from air, water and soil.
8. Study of *Rhizopus*, *Aspergillus* and *Agaricus* from permanent slides.
9. Study of *Anabaena*, *Volvox*, *Zygnema* and *Spirogyra* from permanent slides.
10. Study of *Paramecium*, *Euglena*, Amoeba and *Plasmodium* from permanent slides.
11. Qualitative estimation of Carbohydrate (glucose and starch), Amino acids (Ninhydrin test).

**Course Objectives:**

To inculcate fundamental concepts of Microbiology and create interest in the subject for the beginners. Educate students about its history and how it has progressed till date. Acquaint them with the overall content (bird eye view) of the subject: various groups and types of microorganisms.

**Course Outcome:**

Students will acquire basic fundamental concepts (both theory & Practical) of Microbiology. They will have idea on how the subject progressed from beginning, till date. They will also have grasp on different groups of microorganisms and their unique characters that distinguishes/ separates them from the rest.

They will also gain an understanding on laboratory safety rules and regulations; sterilization; how to operate autoclave and other basic equipments of microbiology laboratory, prepare culture media and isolate microorganisms from air, water and soil samples.

**Minor Course- I**

**Course Code- MICR1021**

**Course Title: Introduction & Scope of Microbiology**

**(FM- 75; Theory-40, Practical -20, Internal- 15) (100-199 level)**

**4 Credits (Theory: 03 & Practical: 01) (Lecture-03, Tutorial-0, and Practical-01)**

**Theory: 45 Hrs**

**Unit 1: History & Development of Microbiology 10 Hrs**

History and Development of microbiology. Theory of Spontaneous generation, Germ theory of disease

Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Edward Jenner in the field of Microbiology. Scope of Microbiology

**Unit 2: Diversity of Microorganisms 12 Hrs**

Systems of classification: Basic idea about Hackel and Whittaker's kingdom concept and domain concept of Carl Woese

General characteristics, and economic importance of different group of Microbes: Cellular microorganisms (Archaea, Bacteria, Algae, Fungi and Protozoa)

Acellular entity (Viruses, Viroids, Virusoids, Satellite viruses, Prions)

**Unit 3: Microscopy 08 Hrs**

Principle of Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Transmission Electron Microscope, Scanning Electron Microscope

**Unit4: Introduction to Biomolecules 15 Hrs**

**Carbohydrates**

General properties and classification of carbohydrates, monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses and hexoses (glucose and fructose), epimer, anomer. Disaccharides: reducing and non-reducing sugars. Polysaccharides- starch and glycogen.

## **Lipids**

Fatty acids: types, structures and functions; essential fatty acids. Lipid: definition, nomenclature and classification (triacyl glycerol), phospholipids, glycolipids, sphingolipids, sphingosine and ceramide.

## **Amino acids & proteins**

Amino acids: classification of amino acids, concept of zwitterion. Function of proteins, basic concept of structures of protein: primary secondary, tertiary and quaternary structures.

## **Nucleic Acids**

Purine, pyrimidine bases, nucleoside, nucleotides- structure, properties. Types of DNA and RNA.

## **Practical:**

**30 Hrs**

1. Microbiology Laboratory Management and Bio-safety
2. Principle and application of instruments: autoclave, incubator, hot air oven, centrifuge, light microscope, pH meter, Laminar air flow
3. Preparation of culture media: Nutrient Broth, Nutrient Agar and Potato dextrose agar
4. Sterilization of medium using Autoclave
5. Sterilization of glassware using Hot Air Oven
6. Sterilization of heat sensitive material by Filtration
7. Isolation and enumeration of bacteria from air, water and soil
8. Study of *Rhizopus*, *Aspergillus* and *Agaricus* from permanent slides
9. Study of *Anabaena*, *Volvox*, *Zygnema* and *Spirogyra* from permanent slides
10. Study of *Paramecium*, *Euglena*, Amoeba and *Plasmodium* from permanent slides
11. Qualitative estimation of Carbohydrate (glucose and starch), Amino acids (Ninhydrin test)

## **Course Objectives:**

To introduce fundamental concepts of Microbiology, inculcate importance of the subject and create interest for students. Educate students about its history and how it has progressed till date. Acquaint them with various groups and types of microorganisms.

## **Course Outcome:**

Students will acquire basic fundamental concepts of Microbiology. They will know the importance of the

subject and learn some applications of the subject. They will also gain an understanding on laboratory safety rules and regulations; sterilization; working principle and operation of basic equipments of microbiology laboratory, prepare culture media and isolate microorganisms from soil sample.

**Multi-Disciplinary/ Interdisciplinary Course Paper- I** **Course Code- MICR1031**

**Course Title: Microbiology for the beginners**

**(FM-50: Theory- 40, Internal-10)**

**3 Credits (Theory: 03)**

**(Lecture-03)**

**Theory: 30 Hrs**

**Unit 1: History & Development of Microbiology 10 Hrs**

History and Development of microbiology. Theory of Spontaneous generation, Germ theory of disease Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Edward Jenner in the field of Microbiology. Scope of Microbiology

**Unit 2: Diversity of Microorganisms 10 Hrs**

Basic idea of cellular microorganisms (Archaea, Bacteria, Algae, Fungi and Protozoa)

Basic idea of acellular microorganisms (Viruses, Viroids, Prions)

**Unit 3: Microscopy 06 Hrs**

Principle, components and applications of Bright Field Microscope and Phase Contrast Microscope.

**Unit 4: Sterilization 04 Hrs**

Moist Heat, Dry Heat and Filtration

**\*, Internal assessment of 10 Marks in case of Multi/ interdisciplinary course will be based on the practical portion of the course concerned.**

**\*Practicals: 15 Hrs**

1. Microbiology Laboratory Management and Bio-safety
2. Principle and applications of important instruments (Laminar air flow, Autoclave, Incubator, Hot air oven, Light microscope) used in the microbiology laboratory
3. Preparation of culture media (Nutrient Broth and Nutrient Agar) for bacterial cultivation

4. Sterilization of medium using Autoclave and assessment for sterility
5. Isolation and enumeration of bacteria from soil.
6. Study of *Rhizopus*, *Aspergillus* and *Agaricus* from permanent slides.
7. Study of *Anabaena*, *Volvox*, *Zygnema* and *Spirogyra* from permanent slides.
8. Study of *Paramecium*, *Euglene*, *Amoeba* and *Plasmodium* from permanent slides.

### **Course Objectives:**

Educate students about its history and how it has progressed till date. Acquaint them with major groups and types of microorganisms. Inculcate basics of microscopy and sterilization to the beginners.

### **Course Outcome:**

Students will acquire basic idea on how the subject progressed from beginning, till date. They will also have grasp on different groups of microorganisms and their unique characters that distinguishes/ separates them from the rest. They will also gain an understanding on working principles of different types of microscopes as well as basic understanding on different types of sterilization: their selection, process and principle.

**Skill Enhancement Course-I,**

**Course Code- MICR1051**

**Course Title: Microbiological analysis in health care**

**(FM-50, Theory- 40, Internal- 10)**

**Credit-3 (Theory: 03)**

**(Lecture-03)**

**Theory** **30 Hrs**

**Unit 1: Collection of Clinical Samples** **06 Hrs**

Collection of 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 and Culture** **06 Hrs**

Examination of sample by staining - Gram stain, Acid fast staining for tuberculosis, Geimsa – stained thin blood film for malaria. Preparation and use of culture media- Blood agar, Chocolate agar, and MacConkey agar. Colony characteristics of bacterial pathogens.



**Unit 3: Serological and Molecular Methods** **04 Hrs**

Serological Methods- Agglutination and precipitation. ELISA. Nucleic acid based methods- PCR.

**Unit 4: Testing for Antibiotic Sensitivity of Bacteria** **08 Hrs**

Antibiotic resistance/ sensitivity of bacteria (disc diffusion & agar cup methods) and its importance; Minimal inhibitory concentration (MIC) of antibiotic by serial dilution method

**Unit 5: Microbiological Analysis of Water** **06 Hrs**

Sample Collection; Methods to determine potability of water samples:

Standard qualitative procedure: presumptive/ MPN tests, confirmed and completed tests for faecal coliforms. Membrane filter technique

**\*\* , Internal assessment of 10 marks in case of SEC will be based on the practical portion of the course concerned.**

**\*\*Practicals:**

**15 Hrs**

1. Gram staining
2. Preparation of culture media: blood agar, Chocolate agar, MacConkey Agar and their use in differentiation microorganisms.
3. Antibiotic sensitivity assay (agar cup diffusion method, disc diffusion method).
4. Determination of MIC of streptomycin for *E. coli*.
5. MPN test: Presumptive, Confirmed and Completed tests. Membranes filter technique.

**Course Objectives:**

To inculcate fundamental concepts of Microbiological methods involved in human health care. This includes collection of clinical samples and their microscopic examination through staining followed by cultivation of microorganisms and study of their diagnostic characteristics, finally serological and molecular methods towards their detection & identification.

**Course Outcome:**

Students will acquire basic fundamental theoretical concepts regarding microbiological analytical methods, tools and techniques for detection of pathogenic microorganisms from clinical samples using

microscopic staining based techniques, based on culture dependent biochemical reactions and finally serological and molecular methods. The course also aims to teach students how to control microorganisms using antibiotics. Students will also learn basic standard techniques for microbiological examination of water and infer its quality.

### Reference Books

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9<sup>th</sup> 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.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM. T. Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Ananthanarayan R and Paniker CKJ (2009). Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
8. 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.
9. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2nd edition, Elsevier India Pvt Ltd.
10. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13<sup>th</sup> edition, Mosby  
Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007). Mackie and McCartney. Practical Medical Microbiology, 14<sup>th</sup> edition, Elsevier.
11. Da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012) Microbiological Examination Methods of Food and Water: A Laboratory Manual, CRC Press.
12. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2<sup>nd</sup>

edition, Academic Press.

13. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3<sup>rd</sup> edition, ASM press.

# Semester-II

Major/DSC (Core Course)- II,

Course Code- MICR2011

Course Title: Bacteriology

(FM- 75; Theory-40, Practical -20, Internal- 15)

(100-199 level)

4 Credits (Theory: 03, Practical: 01)

(Lecture-3, Tutorial-0, and Practical-01)

**Theory: 45 Hrs**

## **Unit 1: Cell Organization**

**10 Hrs**

Cell size, shape and arrangement; glycocalyx; capsule, flagella, endo-flagella, fimbriae and pili. Cell wall: Composition and detailed structure of Gram-positive and Gram-negative bacteria cell wall. Archaeal cell wall, Gram staining and acid fast staining mechanisms.

Spheroplast, protoplast, and L-form. Effect of penicillin and lysozyme on the cell wall.

Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membrane.

Cytoplasm: Ribosome, inclusion bodies, nucleoid, chromosome and plasmids.

Endospore: Structure, formation, germination.

## **Unit 2: Culture Techniques**

**04 Hrs**

Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation of pure culture, cultivation of anaerobic bacteria, and accessing non- culturable bacteria

## **Unit 3: Nutrition**

**05 Hrs**

Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, selective, differential, enriched media.

## **Unit 4: Control of Microorganisms**

**06 Hrs**

Physical methods: Mode of action and application (heat, low temperature, filtration, desiccation, osmotic pressure, radiation); Chemical methods: Mode of

action and application (formaldehyde, alcohol, ethylene oxide).

**Unit 5: Growth & Reproduction in Bacteria**

**05 Hrs**

Methods of reproduction, logarithmic representation of bacterial populations, phases of growth, determination of generation time and specific growth rate

**Unit 6: Bacterial systematics**

**07 Hrs**

Systems of classification: Basic idea about Haeckel and Whittaker's kingdom concept and domain concept of Carl Woese, basic idea of Bergey's manual, taxonomy, concept of species, taxa, strain; Characters used in bacterial systematic.

**Unit 7: Important Archaeal & Bacterial Groups**

**08 Hrs**

**Archaea:** Different physiological groups, suitable example and economic importance. **Bacteria:** General characteristics & economic importance with suitable example of the following groups:

**Gram Negative:** Proteobacteria and Cyanobacteria

**Gram Positive:** Low G+C (Firmicutes), High G+C (Actinobacteria).

**Practical:**

**30 Hrs**

1. Preparation of different media: synthetic media, Complex media, Differential and Selective media.
2. Simple staining
3. Negative staining
4. Gram staining.
5. Endospore staining.
6. Isolation of pure cultures of bacteria by streaking method
7. Preservation of bacterial cultures (slant /stab)
8. Determination of CFU by spread plate method/pour plate method

**Course Objectives:**

To inculcate fundamental concepts of Bacteriology and create interest in the subject for the beginners. Educate students about its cell ultrastructure, cultivation methods, nutritional types, growth &

reproduction, control and finally systematics as well as general characteristics and function of important groups of organisms under bacteria & Archaea.

**Course Outcome:**

Students will acquire basic fundamental concepts (both theory & Practical) of Bacteriology. They will also have grasp on the detail cell ultrastructure, cultivation methods, nutritional types, growth & reproduction, control and finally systematics as well as general characteristics and importance of groups of bacteria & Archaea. They will also learn how to isolate, cultivate (in pure form) and preserve bacteria in laboratory; determine viable count of bacteria and study staining properties (Simple, Negative, Gram's) as well as endospore staining.

**Minor Paper-II,**

**Course Code- MICR2021**

**Course Title: Basic Bacteriology**

**(FM- 75; Theory-40, Practical -20, Internal- 15)**

**(100-199 level4 Credits**

**(Theory: 03, and Practical: 01)**

**(Lecture-03, Tutorial-0, and Practical-01)**

**Theory: 45 Hrs**

**Unit 1: Cell organization 10 Hrs**

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 membrane, Ribosome, cell inclusions, nucleoid, plasmid, structure, formation and stages of sporulation

**Unit 2: Bacteriological culture techniques 04 Hrs**

Isolation of pure culture: Streaking, serial dilution and plating methods; cultivation, maintenance and

preservation of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria.

**Unit 3: Nutrition 05 Hrs**

Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, selective, differential, enriched media, acid-base indicator.

**Unit 4: Growth & Reproduction in Bacteria 06 Hrs**

Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate

**Unit 5: Chemical Control of Microorganisms** **05 Hrs**

Chemical methods of microbial control: Types and mode of action.

**Unit 6: Bacterial Systematics** **07 Hrs**

Aim and principles of classification, taxonomy, concept of species, taxa, strain; Characters used in bacterial systematics

**Unit 7: Important Archaeal & Bacterial Groups** **08 Hrs**

**Archaea:** Different physiological groups, suitable example and economic importance. **Bacteria:** General characteristics & economic importance with suitable example of the following groups:

**Gram Negative:** Proteobacteria and Cyanobacteria

**Gram Positive:** Low G+ C (Firmicutes), High G+C (Actinobacteria).

**Practical:** **30 Hrs**

1. Preparation of different media: synthetic media, Complex media, Differential and Selective media.
2. Simple staining
3. Negative staining
4. Gram staining.
5. Endospore staining.
6. Isolation of pure cultures of bacteria by streaking method
7. Preservation of bacterial cultures (slant /stab)
8. Determination of CFU by spread plate method/pour plate method

**Course Objectives:**

To inculcate fundamental concepts of Bacteriology and create interest in the subject for the beginners. Educate students about its cell ultrastructure, cultivation methods, nutritional types, growth & reproduction, control and finally systematics as well as general characteristics and function of important groups of organisms under bacteria & Archaea.

**Course Outcome:**

Students will acquire basic fundamental concepts (both theory & Practical) of Bacteriology. They will also have grasp on the detail cell ultrastructure, cultivation methods, nutritional types, growth & reproduction, control and finally systematics as well as general characteristics and importance of groups of bacteria & Archaea. They will also learn how to isolate, cultivate (in pure form) and preserve bacteria in laboratory; determine viable count of bacteria and study staining properties (Simple & Gram's).

**Multi-Disciplinary/ Interdisciplinary Paper- II****Course Code- MICR2031****Course Title: Microbes and Environment****(FM-50, Theory- 40, Internal -10)****3 Credits (Theory: 03)****(Lecture-03)****Theory: 30 Hrs****Unit 1: Microorganisms and their habitats 06 Hrs**

Soil microflora, aeromicroflora, aquatic microflora; Microbes in human body (an overview);  
Dispersal of microbes

**Unit 2: Microbial Interactions 10 Hrs**

Microbe-Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation (Definition and examples).

Microbe-Plant interaction: Symbiotic and non-symbiotic interactions (Definition and examples).

Microbe-animal interaction: nematophagous fungi and symbiotic luminescent bacteria (Definition and examples)

**Unit 3: Role of microbes in Bio-geochemical Cycles 08 Hrs**

Carbon cycle, Nitrogen cycle, Phosphorus cycle, Sulphur cycle

**Unit 4: Water Potability 06 Hrs**

Treatment and safety of drinking (potable) water, methods to detect potability of water samples: Standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for fecal coliforms; Membrane filtration



**\*, Internal assessment of 10 Marks in case of Multi/ interdisciplinary course will be based on the practical portion of the course concerned.**

**\*Practicals:**

**15 Hrs**

1. Isolation of bacteria from Air
2. Assessment of microbiological quality of water by filter disc method
3. Isolation of starch degrading bacteria from soil
4. Isolation of *Rhizobium* from root nodules
5. Enumeration of bacteria in soil by dilution plate method

**Course Objectives:**

To inculcate fundamental concepts on environmental microbiology. This includes soil, water, air and human body inhabiting microbes. Interactions among microbes as well as with plants and animals; role of microbes in biogeochemical cycles and finally quality control of water. They will be taught how to isolate bacteria from air and from soil; assess microbiological quality of water; isolation of starch degrading bacteria and *Rhizobium* from root nodules.

**Course Outcome:**

Students will acquire basic fundamental concepts on environmental microbiology. This includes soil, water, air and human body inhabiting microbes. Interactions among microbes as well as with plants and animals; role of microbes in biogeochemical cycles and finally quality control of water. They will learn how to isolate bacteria from air and from soil; assess microbiological quality of water; isolation of starch degrading bacteria and *Rhizobium* from root nodules.

**Skill Enhancement Course- 2,**

**Course Code- MICR2051**

**Course Title: Biofertilizers and Biopesticides**

**(FM-50, Theory- 40, Internal- 10)**

**Credit-3 (Theory: 3 credit)**

**(Lecture-03)**

**Theory:**

**30 Hrs**

**Unit 1: Biofertilizers**

**14 Hrs**

General account of the microbes used as bio-fertilizers for various crop plants and their advantages over chemical fertilizers.

Symbiotic N<sub>2</sub> fixers: *Rhizobium*- Isolation, characteristics, types, inoculum production and field application on legume/pulses plants

*Azolla*- Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application.

**Unit2: Non-Symbiotic Nitrogen Fixers**

**04 Hrs**

Free living *Azospirillum*, *Azotobacter*- Isolation, characterization, mass production and field application

**Unit3: Phosphate Solubilizers**

**03 Hrs**

Phosphate solubilizing microbes-Isolation, characterization, mass production and field application

**Unit4: Mycorrhizal Bio-fertilizers**

**04 Hrs**

Importance of mycorrhizal inoculum, types of mycorrhizae and associated plants, Mass production of VAM and Ectomycorrhizae; and Field applications

**Unit5: Bio-Pesticides**

**05 Hrs**

General account of microbes used as bio-pesticides, their advantages over synthetic pesticides, *Bacillus thuringiensis*- production, Field applications, Viruses cultivation and applications

**\*\* , Internal assessment of 10 marks in case of SEC will be based on the practical portion of the course concerned.**

**\*\*Practicals:**

**15 Hrs**

1. Isolation of *Rhizobium* from root nodules of leguminous plants and identification by phenotypic characteristics.
2. Isolation of free living nitrogen fixing bacteria especially *Azotobacter* and *Azospirillum* study of their diagnostic characters.
3. Isolation of phosphate solubilizing bacteria and determination of phosphate solubilizing potential.
4. Study of Mycorrhizal fungi from plant samples.
5. Isolation of *Bacillus thuringiensis*.
6. Cultivation of virus.

### **Course Objectives:**

To inculcate fundamental concepts on microorganism based bio-fertilizers and bio-pesticides. This includes knowledge on symbiotic and non-symbiotic Nitrogen fixing, phosphate solubilizing microorganisms and mycorrhizal based bio-fertilizers, their utility and field applications.

### **Course outcome:**

Students will acquire basic fundamental concepts on microorganism based bio-fertilizers and bio-pesticides. This includes knowledge on symbiotic and non-symbiotic Nitrogen fixing, phosphate solubilizing microorganisms and mycorrhizal based bio-fertilizers, their utility and field applications.

### **Reference Books:**

1. Atlas RM. Principles of Microbiology. 2nd edition. WM.T. Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Microorganisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. Da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012) Microbiological Examination Methods of Food and Water A Laboratory Manual, CRC Press.
6. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4<sup>th</sup> edition. Benjamin/Cummings Science Publishing, USA
7. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2<sup>nd</sup> edition, Academic Press.
8. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3<sup>rd</sup> edition, ASM press.
9. Kannaiyan, S. (2003). Bioethnology of Biofertilizers, CHIPS, Texas.

10. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. NewYork.
11. Reddy, S.M. et. al.(2002). Bioinoculants for sustainable agriculture andforestry, Scientific Publishers.
12. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd.NewDelhi.
13. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, LapLambert Academic Publishing GmbHKG
14. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.
15. Hui YH, Meunier-Goddik L, Josephsen J, N ip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRCPress
16. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.
17. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan
18. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer
19. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
20. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition  
McMillan.
21. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition  
Pearson  
Education.
22. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9<sup>th</sup> edition. McGraw  
Hill Higher Education.
23. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9<sup>th</sup> edition.  
Pearson  
Education Limited.