The University of Burdwan

Syllabus for 3- year Degree/ 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 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	2	0	1	3	30	10	10	50
4	AEC1041	Language (Eng/Hindi/Sanskrit etc) or Equivalent Course from SWAYAM/ any UGC recognized platform	Ability Enhancement Course (AEC) [L_1-1 MIL]		2	0	0	2	40	0	10	50
5	MICR1051	Microbiological analysis in Health Care	Skill Enhancement Course (SEC)		2	0	1	3	30	10	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	2	0	1	3	30	10	10	50
4	AEC2041	Language (Eng/Hindi/Sanskrit etc) or Equivalent Course from SWAYAM	Ability Enhancement Course (AEC) [L_1-1 MIL]		2	0	0	2	40	0	10	50
5	MICR2051	Biofertilizers and Biopesticides	Skill Enhancement Course (SEC)		2	0	1	3	30	10	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.

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 anddomain 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 anddomain 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- 30, Practical 10, Internal-10)

3 Credits (Theory: 02 & Practical: 01) (Lecture-02, Tutorial-0 and Practical-01)

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 andProtozoa)

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

Practicals: **30 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 an 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*, *Euglena*, 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- 30, Practical- 10, Internal- 10)

Credit-3 (Theory: 02 & Practical: 01) **(Lecture-02, Tutorial-0, and Practical-01)**

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 **06 Hrs**

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

Unit 4: Testing for Antibiotic Sensitivity of Bacteria **06 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

Practical: **30 Hrs**

1. Simple 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).
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. 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.
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, 13th edition,Mosby

Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007). Mackie and Mccartney. Practical Medical Microbiology, 14th 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.2nd edition, Academic Press.
13. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3rd 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 thefollowing 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- 30, Practical 10, Internal -10)

3 Credits (Theory: 02 and Practicals: 01) **(Lecture-02, Tutorial-0, and Practical-01)**

Theory: **30 Hrs**

Unit 1: Microorganisms and their habitats **08 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: nematophagus fungi and symbiotic luminescent bacteria (Definition and examples)

Unit 3: Role of microbes in Bio-geochemical Cycles **06 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

Practicals: **30 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- 30, Practical- 10, Internal- 10)

Credit-3 (Theory: 02 credit and Practical: 01 credit) (Lecture-02, Practical-01)

Theory: 30 Hrs

Unit 1: Biofertilizers 08 Hrs

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

Symbiotic N_2 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 05 Hrs

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

Unit3: Phosphate Solubilizers 05 Hrs

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

Unit4: Mycorrhizal Bio-fertilizers 05 Hrs

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

Unit5: Bio-Pesticides 07 Hrs

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

Practical: **30 Hrs**

1. Isolation of *Rhizobium* from root nodules of leguminous plants and identification by phenotypic characteristics
2. Preparation of rhizobial inoculum for use as biofertilizer
3. Isolation of free living nitrogen fixing bacteria and study of their diagnostic characters
4. Isolation of phosphate solubilizing bacteria and determination of phosphate solubilizing potential
5. Isolation of phyllosphere microorganism

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 Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.

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6. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing,USA

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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.

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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

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Publishers, Dordrecht

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McMillan.
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