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

Semester wise and Course wise Distribution of Credit & Marks under CCFUP as per NEP, 2020

SEM ESTER	Course Type	Code	Name of the Course	Credit	L – T - P	Marks	Marks Dist. Th. – Pr. - IA
I	Major (DS)/Core Course	MICR1011	Introduction to Microbiology and Biomolecules	4	3-0-1	75	40 – 20– 15
	Minor Course	MICR1021	Introduction & Scope of Microbiology	4	3-0-1	75	40 – 20– 15
	Multi/ Interdisciplinary	MICR1031	Microbiology for Beginners	3	3-0-0	50	40-0-10
	Ability Enhancement Course (AEC) [L_1-1 MIL]	….. 1041	Language (Eng/Hindi/Sanskrit etc) or Equivalent Course from SWAYAM/ any UGC recognized platform	2	2-0-0	50	40-0-10
	Skill Enhancement Course (SEC)	MICR 1051	Microbiological analysis in Health Care	3	3-0-0	50	40-0-10
	Common Value Added Course (VAC)	CVA 1061	Environmental Science / Education	4	3-0-1	100	60-20-20
	Total			**20**		**400**	
II	Major (DS)/Core Course	MICR 2011	Bacteriology	4	3-0-1	75	40 – 20 – 15
	Minor Course	MICR 2021	Basic Bacteriology	4	3-0-1	75	40 – 20 – 15
	Multi/ Interdisciplinary	MICR 2031	Microbes and Environment	3	3-0-0	50	40 – 0 – 10

	Ability Enhancement Course (AEC) [L_1-1 English]	ENGL 2041	Functional English or Equivalent Course from SWAYAM /any UGC recognized platform	2	2-0-0	50	40 – 0 – 10
	Skill Enhancement Course (SEC)	MICR 2051	Biofertilizers and Biopesticides	3	3-1-0	50	40 – 0 – 10
	Common Value Added Course (VAC)	MICR 2061	Understanding India/Digital & Technological Solutions/Health & Wellness, Yoga Education, Sports & Fitness	4	3-1-0 3-0-1	100	60-20-20
	Total			**20**		**400**	

SEM ESTER	**Course Type**	**Code**	**Name of the Course**	**Credit**	**L – T - P**	**Marks**	**Marks Dist. Th. – Pr. - IA**
III	Major/ (DS)Core Course	MICR 3011	Chemistry of Biomolecules	5	4-0-1	75	40 – 20– 15
	Major/(DS)Core Course	MICR 3012	Biophysical Chemistry	5	4-0-1	75	40 – 20– 15
	Minor course (Voc. Edn & Trng.)	MSR 3021 Or HRM 3021 Or RSA 3021	Medical Sales Representative OR Human Resource Management OR Retail Sales Associate	4	3-1-0	75	60 – 0– 15
	Multi/ Interdisciplinary	MICR 3031	Mushroom Cultivation	3	3-0-0	50	40 – 0 – 10

	Ability Enhancement Course (AEC) [L_1-2 MIL]	…… 3041	Language (Arabic/Bengali/Hindi/Sanskrit/ Santhali/Urdu) or Equivalent Course from SWAYAM/ any UGC recognized platform	2	2-0-0	50	40 – 0 – 10
	Skill Enhancement Course (SEC)	MICR 3051	Food Fermentation Techniques	3	3-0-0	50	40 – 0 – 10
	Total			**22**		**375**	
IV	Major/ (DS) Core Course	MICR 4011	Eukaryotic Microbiology & Plant Pathology	5	4-0-1	75	40 – 20 – 15
	Major/ (DS) Core Course	MICR 4012	Cell Biology	5	4-0-1	75	40 – 20 – 15
	Major/ (DS) Core Course	MICR 4013	Virology	5	4-0-1	75	40 – 20 – 15
	Minor course	MICR 4021	Introduction to Virology	4	3-0-1	75	40 – 20 – 15
	Minor Course (other than Microbiology)	…. 4021		4		75	…. – … – 15
	Ability Enhancement Course (AEC) [L_2-2 English]	ENGL 4041	Language and creativity or Equivalent Course from SWAYAM/ any UGC recognized platform	2	2-0-0	50	40-0-10
	Total			**25**		**425**	

SEM ESTER	**Course Type**	**Code**	**Name of the Course**	**Credit**	**L – T - P**	**Marks**	**Marks Dist. Th. – Pr. - IA**

V	Major/Core Course	MICR5011	Microbial Physiology	5	3-0-2	75	40 – 20– 15
	Major/Core Course	MICR5012	Microbial Metabolism	5	3-0-2	75	40 – 20– 15
	Major/Core Course	MICR5013	Microbial Genetics	5	3-0-2	75	40 – 20– 15
	Minor Course (Vocational Education &Training)	MSR 5021 Or HRM 5021 Or RSA 5021	Medical Sales Representative OR Human Resource Management OR Retail Sales Associate	4	3-1-0	75	60 – 0 – 15
	Internship	INT 5081	Internship	2	0-0-2	50	00– 50 – 00 (Project/ Field Diary: 30 + Viva-voce: 20)
	Total			**21**		**350**	
VI	Major/Core Course	MICR6011	Immunology	4	3-0-1	75	40 – 20 – 15
	Major/Core Course	MICR6012	Molecular Biology	4	3-0-1	75	40 – 20 – 15
	Major/Core Course	MICR6013	Food & Dairy Microbiology	4	3-0-1	75	40 – 20 – 15
	Major/Core Course	MICR6014	Environmental Microbiology	4	3-0-1	75	40 – 20 – 15

	Minor Course (Vocational Education &Training)	MSR 6021 Or HRM 6021 Or RSA 6021	Medical Sales Representative OR Human Resource Management OR Retail Sales Associate	4	3-1-0	75	60 – 0 – 15
	Total			**20**		**375**	
	Grand total (Sem. I -VI)			**128**		**2325**	

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 maximum period of 7 years.

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.

Syllabus
UG Microbiology (NEP)
Semester wise and Course wise Distribution of Credit & Marks under CCFUP as per NEP, 2020

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**

Unit 1: 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

Unit 2: Microscopy **07 Hrs**

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

Unit 3: 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)

Unit 4: 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 **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 **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 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

***, 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 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*, *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 **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. 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) **Course Code- MICR2011**

Course Title: Bacteriology

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

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 course **Course Code- MICR2021**

Course Title: Basic Bacteriology

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

4 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 **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: nematophagus 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 fecalcoliforms; 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 **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_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 **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 Micro-organisms. 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 WaterA Laboratory Manual, CRCPress.
6. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing,USA
7. Maier RM, Pepper IL and GerbaCP. (2009). Environmental Microbiology.2nd edition, Academic Press.
8. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3rd edition, ASMpress.
9. Kannaiyan, S. (2003). Bioetchnology 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. 9th edition. McGraw Hill Higher Education.
23. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited.

Semester III

Major/DS Course (Core Course) **Course Code: MICR3011**

Course Title: Chemistry of Biomolecules

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

5 Credits (Theory: 04 & Practical: 01) **(Lecture-04, Tutorial-0, and Practical-02)**

Theory: 40 **60Hrs**

Unit1: Carbohydrate chemistry **15Hrs**

Stereochemistry of monosaccharides, General concepts of symmetry elements (plane of symmetry, centre and axis of symmetry), Chirality, concept of Conformation & Configuration, Optical isomerism, D/L & R/S nomenclature, Projection formula (Fischer & Howarth), Determination of ring structure of hexose sugar (glucose), Mutarotation and its mechanism, chair conformation of glucose, concept of axial & equatorial bonds.

Chemical reactions of monosaccharides (glucose & fructose) with HNO_2, Br_2-H_2O, phenylhydrazine, periodiate oxidation, Ascending sugar (Kiliany reaction). Concept of glycosides, sugar acids, deoxysugars, aminosugars.

Concept of *O*- & *N*-glycosidic bonds. Hydrolysis of disaccharides (lactose, maltose, sucrose). Structure of polysaccharides (starch, glycogen, cellulose, proteoglycans, glysocaminoglycans).

Unit2: Protein chemistry **15Hrs**

Structure, classification and stereochemistry of amino acids, Physico-chemical properties of amino acids: amphoteric molecule, zwitterions, ionization, biuret reaction, pk values, isoelectric point, formol titration of glycine, Reaction with ninhydrin, FDNB, Dansyl & Dabsyl chloride, Fluorescamine, van-Slykes reaction, reaction of carboxyl and amino groups of amino acids. Titration curve of amino acids.

Characters of Peptide bond, Ramachandran plot, torsion angles (φ and ψ), secondary structural elements (repetitive and non-repetitive).

Forces that stabilize protein tertiary structure: H-bonds, hydrophobic interaction, electrostatic force, van der Waal's interaction, dipole-dipole interaction, disulfide bond.

Domain, motif, subunit structure of proteins, protein denaturation, molten globule structure.

Unit 3: Nucleic acid chemistry **8Hrs**

Purines, Pyrimidines- structure and chemical properties, Forces that stabilize double helical structure of DNA, types of DNA (A-, B-, Z- DNA), Hydrolysis (acid, alkali, enzymatic) of DNA, viscocity, buoyant density, hyperchromicity, DNA denaturation-renaturation kinetics, Tm, Cot curve. General properties of RNA: tRNA, mRNA, rRNA.

Unit 4: Lipid chemistry **7Hrs**

Nomenclature, classification (only structure based) and properties of different types of lipids. Lipid hydrolysis, saponification, saponification number, I2 number, acetyl number, cis-trans isomerism, rancidity.

General classification of fatty acids; chemical reactions of saturated and unsaturated

fatty acids (esterification, hydrogenation, halogenations).

Lipid micelles, lipoproteins, liposomes, bilayer formation.

Unit 5: Enzymes **15Hrs**

Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD, metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, specificity, enzyme kinetics, Michaelis-Menten equation and their transformations, Km and allosteric mechanism, Lock and key hypothesis, and Induced Fit hypothesis. Definitions – enzyme unit, specific activity and turnover number, Multienzyme complex: pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature, substrate concentration, enzyme concentration, time on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts, uncompetitive.

Practical Chemistry of Biomolecules
30Hrs

1. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non-reducing sugars (DNS method)

2. Qualitative/Quantitative tests for proteins (Lowry method), amino acids (Ninhydrine), DNA(DPA) and RNA(Orcinol).

3. Qualitative/Quantitative assay of amylase.

4. Study the effect of temperature and pH on enzyme activity (amylase).

5. *Estimation of Ascorbic acid.*

Course Objectives: To inculcate general concept and understanding on the biomolecules or molecules of life, their types, characteristics, structure and function and or fundamental roles; their implication in context to biological processes. Finally to inculcate role and understanding of enzymes, their classification, various theories on their mechanism of action, different structural types of enzymes, effect of various factors on enzyme activities and finally inhibition of enzymes. To inculcate practical skills required for quantitative estimation of carbohydrates, amino acids, organic acid as well as nucleic acids. On common enzyme, namely, amylase, has been included for study, this includes: assay of enzyme and study of different factors on the activity of enzyme.

Course outcome:
Students will learn basic fundamental concepts (both theory & Practical) of biochemistry, in relation to biomolecules and about enzyme functions how do they work, their types,

classification, mechanism of action and inhibition types. Through practical they will learn quantitative estimation of carbohydrates, amino acids, organic acid as well as nucleic acids. They will also study how to assay an enzyme and will study effect of different factors on the activity of enzyme (through amylase as case study).

Reference Books:

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning.

2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone.

3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W. H. Freeman

4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company.

5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.

6. Willey MJ, Sherwood, LM & Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill.

7. Voet, D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons.

Major/DS Course (Core Course) **Course Code: MICR3012**

Course Title: Biophysical Chemistry

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

5 Credits (Theory: 04 & Practical: 01) **(Lecture-03, Tutorial-0, and Practical-02)**

Theory: 40 **60Hrs**

Unit1: Physicochemical Properties of water **10Hrs**

Structure of water molecule, physical properties, ionic product of water, pH & pK – their definition, relation to acids, bases & buffers in biological system, Henderson-Hasselbaltch equation.

Unit2: Bioenergetics **15Hrs**

Laws of thermodynamics- application in biological system, concept of free energy, entropy & enthalpy, relation among them, standard free energy change & equilibrium constant, high energy bond. Biophysical Principles of Osmosis, osmotic pressure, Donan equilibrium, diffusion potential, diffusion coefficient, endocytosis & exocytosis, gradient of chemical potential as driving force in transport, membrane potential & ionophores.

Unit3: Spectrophotometry **15Hrs**

Concept of electromagnetic radiation, Orbital theory, concept of chromophore, auxochrome, blue shift, red shift, Beer-Lambert's Law, derivation & deviation. Molar Extinction co-efficient, absorptivity & working principle of Colorimeter & Spectrophotometer. Application of UV-VIS Spectrophotometer. Principles of Light scattering, Fluorescence, IR, NMR and Mass spectroscopy.

Unit4: Radioactivity **8Hrs**

Fundamental of Radioactivity: Radioactive & non-radioactive isotopes, Laws of Radioactivity, Decay constant, Half-life & Average life, types of radiation (α, β, γ radiations), measurement of radioactivity (liquid scintillation counter), application of radioactive isotopes in biology.

Unit5: Chromatography **7Hrs**

Chromatographic Techniques: Principle & application of Paper, Thin Layer (TLC), Column, Gas- Liquid, High Performance Liquid (HPLC), Ion-exchange, Absorption & Affinity Chromatography.

Unit6: Electrophoresis **5Hrs**

Principle & application of Agarose Gel Electrophoresis, SDS-PAGE, Iso-electric Focusing & Immuno-electrophoresis.

Practical ***Biophysical Chemistry*** ***30Hrs***

1. Concept of pH and buffers, preparation of buffers – phosphate and acetate buffer.
2. Separation of mixtures of amino acids and sugars by paper chromatography
3. Separation of mixtures of amino acids and sugars by thin layer chromatography
4. Separation of protein mixtures by gel filtration chromatography.
5. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE)
6. Determination of λmax for an unknown sample and calculation of extinction coefficient
7. Separation of components of a given mixture using a laboratory scale centrifuge

8. Demonstration of density gradient centrifugation with the help of pictures

Course Objectives:

To inculcate concepts of biophysical chemistry, which starts with understanding the properties of water and its structure –function correlation; Concepts of buffers and ways they regulate concentration of hydrogen as well as hydroxyl ions. Concepts of bioenergetics and the way they govern or regulate biochemical processes, pathways etc. Basic concepts of spectrophotometry, radioactivity, chromatography and electrophoresis will be inculcated. Practical skills for separation of mixture of amino acids (by TLS), proteins (by PAGE & chromatography techniques) and other analytes by centrifugation will be inculcated. Moreover, basic concept of pH, buffers etc. will be inculcated through hands on preparatory experiments.

Corse outcome:

Students will learn the basic concepts of biophysical chemistry, which starts with understanding the properties of water and its structure –function correlation; Concepts of buffers and ways they regulate concentration of hydrogen as well as hydroxyl ions. concepts of bioenergetics and the way they govern or regulate biochemical processes, pathways etc. Basic concepts of spectrophotometry, radioactivity, chromatography and electrophoresis will be inculcated. Practical skills for separation of mixture of amino acids (by TLS), proteins (by PAGE & chromatography techniques) and other analytes by centrifugation will be inculcated. Moreover, basic concept of pH, buffers etc. will be inculcated through hands on preparatory experiments

Reference Books:

1. Biophysics and Biophysical Chemistry. Debajyoti Das. Academic Publishers, 2009. ISBN: 8189781391, 9788189781392
2. Biophysical Chemistry (Principles & techniques). Upadhyay, A. Upadhyay, K. and Nath, N. Himalaya Publishing house. ISBN: 978-81-83188-65-4
3. Physical Biochemistry: applications to Biochemistry and Molecular Biology. ISBN:0716714442. Publisher:W. H. Freeman
4. Principles of Biochemistry. Nelson DL and Cox MM (2008). 5th Edition., W.H. Freeman and Company.
5. Voet, D. and Voet J.G. (2004). Biochemistry 3rd edition, John Wiley and Sons.

Inter/ Multi-Disciplinary Course **Course Code: MICR3031**

Course Title: Mushroom cultivation

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

3 Credits (Theory: 03) (Lecture-03, Practical-0) **45Hrs**

Unit 1: **Introduction to mushrooms:** Mushrooms -Taxonomical rank -History and Scope of mushroom cultivation. Edible and Poisonous Mushrooms. Vegetative & reproductive structures (Ascomycetes and Basidiomycetes fungi). Economic importance of mushrooms **5Hrs**

Unit 2: Common edible mushrooms: Button mushroom (*Agaricus bisporus*), Oyster mushroom (*Pleurotus sajorcaju*) and paddy straw mushroom (*Volvariella volvcea*). **5Hrs**

Unit 3: Principles of mushroom cultivation. Structure and construction of mushroom house. Sterilization of substrates. Spawn production - culture media preparation- production of pure culture, mother spawn, and multiplication of spawn. Composting technology, mushroom bed preparation. Spawning, spawn running, harvesting. Cultivation of oyster and paddy straw mushroom. Problems in cultivation - diseases, pests and nematodes, weed moulds and their management strategies. Demonstration on mushroom cultivation through audio-visual aids

25Hrs

Unit 4: Nutritional and medicinal values of mushrooms. Therapeutic aspects- antitumor effect

4Hrs

Unit 5: Post harvest technology: Preservation of mushrooms - freezing, dry freezing, drying, canning, quality assurance and entrepreneurship. Value added products of mushrooms.

6Hrs

Course Objective:

To inculcate knowledge of mushroom, different types and difference between edible and poisonous mushrooms; emphasis will be given on Button mushroom (*Agaricus bisporus*), Oyster mushroom (*Pleurotus sajorcaju*) and paddy straw mushroom (*Volvariella volvcea*); to inculcate Principles of mushroom cultivation; Nutritional and medicinal values of mushrooms, therapeutic aspects- antitumor effect and preservation of mushrooms - freezing, dry freezing, drying, canning, quality assurance and entrepreneurship well value added products of mushrooms.

Course Outcome

Students will learn about mushrooms, their types, nutritional and medicinal values of mushrooms, therapeutic aspects; cultivation principles and post harvesting technology that includes preservation of mushrooms - freezing, dry freezing, drying, canning, quality assurance and entrepreneurship well value added products of mushrooms.

Reference Books:

1. Marimuthu, T. et al. (1991). Oster Mushroom. Department of Plant Pathology. Tamil Nadu Agricultural University, Coimbatore.

2. Nita Bhal. (2000). Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi

3. Pandey R.K, S. K Ghosh, 1996. A Hand Book on Mushroom Cultivation. Emkey Publications.

4. Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.

5. Tewari Pankaj Kapoor, S. C. (1988). Mushroom Cultivation. Mittal Publication, New Delhi.

6. Tripathi, D.P. (2005) Mushroom Cultivation, Oxford & IBH Publishing Co. PVT.LTD, New Delhi.

7. V.N. Pathak, Nagendra Yadav and Maneesha Gaur, Mushroom Production and Processing Technology/ Vedams Ebooks Pvt Ltd., New Delhi (2000)

SEC (Skill Enhancement Course) **Course Code: MICR3051**

Course Title: Food Fermentation Techniques

(FM- 50 Theory-40, Practical- 00, Internal- 10)

3 Credits (Theory: 03, Practical-0) (Lecture-03, Practical-0) **45Hrs**

Unit 1 Fermented Foods **10Hrs**

Definition, types, advantages, and health benefits

Unit 2 Milk Based Fermented Foods **10Hrs**

Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process.

Unit 3 Grain Based Fermented Foods **10Hrs**

Soy sauce, Bread, Idli and Dosa: Microorganisms and production process

Unit 4 Vegetable Based Fermented Foods **05Hrs**

Pickles, Saeurkraut: Microorganisms and production process

Unit 5 Fermented Meat and Fish **05Hrs**

Types, microorganisms involved, fermentation process

Unit 6 Probiotic Foods **05Hrs**

Definition, types, microorganisms and health benefits

Course objectives:

To inculcate knowledge on different types of fermented foods, their advantages and health benefits; production process for milk based fermented foods (Dahi, Yogurt, Butter milk and cheese), grain based fermented foods (Soy sauce, Bread, Idli and Dosa), vegetable based fermented foods (pickles and sauerkraut), fermented meat and fish; probiotic foods, their types, health benefits and microorganisms involved. Also to inculcate practical skill to perform experiments to determine oxidative/fermentative reaction of microorganisms, isolation of microbes from Dahi, study of microbes in fermented rice, preparation of fermented milk products and wine.

Course outcome:

Students will learn different types of fermented foods, their advantages and health benefits; production process for milk based, grain based, and vegetable based fermented foods (pickles and sauerkraut); fermented meat and fish; probiotic foods. They will also learn practical skills to perform experiments to determine oxidative/fermentative reaction of microorganisms, isolation of microbes from Dahi, study of microbes in fermented rice, preparation of fermented milk products and wine.

Reference Books:

1.Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press

2.Holzapfel W (2014) Advances in Fermented Foods and Beverages, Wood head Publishing.

3.Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan

4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer.

Semester IV

Major/DS Course (Core Course) **Course Code: MICR4011**

Course Title: Eukaryotic Microbiology & Plant Pathology

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

5 Credits (Theory: 04 & Practical: 01) **(Lecture-03, Tutorial-0, and Practical-02)**

Theory: 40 **60Hrs**

Unit 1: Phycology **10Hrs**

General characteristics of algae including occurrence (habitat), thallus organization, cell ultra structure, pigments, flagella, eyespot, food reserves (reserve foods) and reproduction in Chlorophyta and Xanthophyta. Economic Importance of algae.

Unit 2: Mycology **15Hrs**

General characteristics of fungi including habit, habitat, nutritional requirements, thallus organization and aggregation, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Classification of Ainsworth, Characteristics and reproduction of Phycomycota, Ascomycota, Basidiomycota and Deuteromycota. Economic importance of fungi

Unit 3: Protozoa **10Hrs**

Classification of Levine (up to subkingdom). General characteristics, reproduction. Life Cycle of *Amoeba, Paramecium, Plasmodium*. Economic importance of Protozoa.

Unit 4: Introduction and history of Plant Pathology **10Hrs**

Concept of plant diseases, disease cycle, disease tringle, disease pyramid, concept of monocyclic and polycyclic and polyetic disease, classification of plant diseases, concept of disease symptoms, Concept of parasitism, saprophytism and Koch postulate. Contribution of some eminent plant pathologist.

Unit 5: Disease development **10Hrs**

Stages in development of diseases: infection, invasion, colonization, pathogenesis, and perennation Host pathogen interactions, virulence factors of pathogen (enzymes, toxin, growth regulator, virulence factors in virus (coat protein, replicase, silencing suppressors) in disease development Effect of pathogen on host physiology (photosynthesis, respiration translocation of solute) Concept of resistance gene and avirulant gene. A brief idea about defense mechanism of plants: cork layer, abscission layer, tyloses, gum.

Unit 6: Important plant diseases **5Hrs**

Causal agent, transmission, pathogenesis, control - Late Blight of Potato, Brown spot of rice, Black stem rust of wheat, citrus cancer, Mosaic disease of tobacco.

Practical: Eukaryotic Microbiology & Plant Pathology ***30Hrs***

1. Study of *Rhizopus*, *Penicillium* and *Aspergillus* from permanent slides.

2. Study of *Chlamydomonas, Oedogonium, Spirogyra, and Zygnema* from permanent slides.

3. Study of *Entamoeba* sp., *Euglena* sp. *Paramecium* and *Plasmodium* from permanent slides.

4. Demonstration of Koch's postulates in bacterial plant pathogens.

5. Study of important diseases of crop plants by cutting sections of infected plant material-*Puccinia, Colletotrichum.*

6. Study of plant pathogens using permanent slides (Late blight of potato, Red rot of sugarcane, Citrus canker, Brown spot of rice, Red rust of tea or *Magnolia*.)

Course objectives:

To inculcate knowledge on eukaryotic microorganisms and plant pathology. This includes study of general characteristics and diversity of Algae, fungi and protozoa: their classifications, diversity in morphological forms and reproductive processes. It also aims to inculcate a thorough understanding of plant pathology, which includes basic concepts related to host –pathogen interactions, development and progression of disease in host and different factors affecting host-pathogen interactions. Also case study of disease of some economically important plants (from this geographical region) is included to understand and correlate the overall concept. The course also aims to inculcate practical skills related to identification of algae, fungi and protozoa. Understanding Koch's postulates and study of plant pathogens, as well as plant disease samples through microscopic examination and permanent slides.

Course Outcome

The students will acquire knowledge on eukaryotic microorganisms and plant pathology. This includes study of general characteristics and diversity of Algae, fungi and protozoa: their classifications, diversity in morphological forms and reproductive processes. They will learn basic concepts related to host –pathogen interactions, development and progression of disease in host and different factors affecting host-pathogen interactions. Case study of disease of economically important plants (from this geographical region). Students will also acquire practical skills related to identification of algae, fungi and protozoa. Understanding Koch's postulates and study of plant pathogens, as well as plant disease samples through microscopic examination and permanent slides.

Reference Books:

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
2. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
3. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition

4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco

5. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.

6. Agarios,GN 1988:Plant Pathology Academic Press Inc, New York 6. TK Prasad. Hand book of Entemology. New Vishal Publications, New Delhi

7. Fundamentals of Plant logy by Mehrotra, R. S. McGraw Hill Education (India), 2013. ISBN: 1259029557

8. Hand book of plant diseases by Saha. 2nd Edition, 2008. L. R. Kalyani Publisher. ISBN: 978-8127240684.

Major/DS Course (Core Course) **Course Code: MICR4012**

Course Title: Cell Biology

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

5 Credits (Theory: 04 & Practical: 01) (Lecture-03, Tutorial-0, and Practical-02)

Theory: 40 **60Hrs**

Unit 1: Structure and organization of Cell **15Hrs**

Cell Organization – Comparative account of Eukaryotic (Plant and animal cells) and prokaryotic Cell. Cell organelles, Cytoskeleton: Structure and organization of actin filaments, cell surface protrusions (Flagella, fimbriae, pilli), intermediate filaments, and microtubules. Structure and composition of cell membrane, lipid bilayer, fluid mosaic model, Transport across cell membrane.

Unit 2: Nucleus **5Hrs**

Nuclear envelope and nuclear pore complex, Chromatin – Molecular organization, Nucleolus

Unit 3: Protein Sorting and Transport **10Hrs**

Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, export of proteins, Golgi apparatus – Organization, protein glycosylation and export from Golgi apparatus, Lysosomes

Unit 4: Cell Signaling **15Hrs**

Signaling molecules and their receptors, Function of cell surface receptors. Pathways of intra-cellular receptors – Cyclic AMP pathway and MAP kinase pathway

Unit 5: Cell cycle, Apoptosis and cancer **15Hrs**

Eukaryotic cell cycle and its regulation, Mitosis and Meiosis, General & fundamental concept of

Apoptosis; Development of cancer, causes of cancer

Practical Paper ***Cell Biology*** ***30Hrs***

1. Study of a representative plant (epidermal cell of Rheo sp.) and animal cell (squamous epithelial cell) by microscopy

2. Study of the structure of cell organelles through electron micrographs (Mitochondria, Endoplasmic Reticulum, Ribosome, Chloroplast)

3. Cytochemical staining of DNA– Feulgen

4. Study of polyploidy in Onion root tip by colchicine treatment.

5. Identification and study of cancer cells by photomicrographs.

6. Study of different stages of Mitosis from permanent slide.

7. Study of different stages of Meiosis from permanent slide

Course objectives:

Comparative account of prokaryotic and eukaryotic cells, cell organelles, cytoskeleton, their structure function; ultrastructure details of nucleus, chromatin structure, nucleolus; concept of protein sorting and transport, its components, mechanistic details and role of different organelles; concept of cell signaling, signaling molecules, receptors, path ways of intracellular receptors; concept, general understanding of cell cycle, cell divisions, apoptosis and cancer. To learn practical skills necessary for study of plant and animal cells, their organelles; staining of cells and their visualization; study of cells division types by using permanent slides; study of polyploidy and cancer cells.

Course Outcome:

Students will learn to compare prokaryotic and eukaryotic cells and know structure-function of cell organelles, cytoskeleton, different types of filaments; will learn and understand ultrastructure of nucleus, chromatin, nucleolus; protein sorting and transport and cell signaling processes, their components, etc.; cell cycle, cell divisions, apoptosis and cancer. They will learn practical skills of staining cells, DNA and study different cell organelles, different stages of cell division (i.e. mitosis & meiosis).

Reference Books:

1.Hardin J, Bertoni G and K leinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.

2.Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons.Inc.

3.De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.

4.Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach.5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Major/DS Course (Core Course) **Course Code: MICR4013**

Course Title: Virology

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

5 Credits (Theory: 04 & Practical: 01) (Lecture-03, Tutorial-0, and Practical-02)

Theory: 40 **60Hrs**

Unit 1: Nature & Properties of Viruses **12Hrs**

Introduction: Discovery of viruses, nature and general properties. Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses Isolation, purification and cultivation of viruses Viral taxonomy: Baltimore Classification

Unit 2: Bacteriophages **8Hrs**

Diversity, classification, lytic and lysogenic cycle of lambda phage

Unit 3: Viral Transmissions and Replication **12Hrs**

Salient features of Viral Nucleic acids & Reproduction, Mode of viral transmission. Structure, Nucleic acid, Replication and Symptoms of: Adenovirus, Retrovirus, Hepatitis B virus, Influenza virus, Assembly, budding and maturation of HIV

Unit 4: Viruses & Cancer **10Hrs**

Introduction to oncogenic viruses, Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes

Unit 5: Prevention & Control of Viral Diseases **10Hrs**

Antiviral compounds and their mode of action Interferon and their mode of action. General principles of viral vaccination

Unit 6: Applications of Virology **8Hrs**

Use of viral vectors in cloning and expression and Gene therapy.

Practical Paper ***Virology*** ***30Hrs***

1. Study of TMV infection on Tomato plant induced by TMV infected tobacco extract.
2. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique
4. Demonstration of Bacteriophage DNA and study of its HindIII digestion pattern.
5. Report writing: Educational tour to Institute/Industry.

Course objectives:

To inculcate knowledge on nature and properties of viruses, their discovery, classification, structural diversity, isolation, purification and cultivation strategies; Study of bacteriophages and their life cycle types; transmission of viruses, their reproduction, assembly and maturation; concept of viruses and cancer, concept of oncogenic and proto-oncogenic viruses and their role in cancer; general principles and understanding on the prevention and control of viral diseases, finally application of virology. To learn practical skills for isolation of bacteriophage, isolation of phage DNA and its digestion using a restriction endonuclease enzyme. Study of TMV infection on tomato plant, induced by TMV infected tobacco extract.

Course outcome:

Students will learn properties of viruses, their discovery, classification, structural diversity, isolation, purification and cultivation strategies; bacteriophages, their life cycle types; transmission of viruses, their reproduction, assembly and maturation; concept of viruses and cancer, concept of oncogenic and proto-oncogenic viruses and their role in cancer; control of viral diseases and application of virology. They will also learn practical skills for isolation of bacteriophage, isolation of phage DNA and its digestion using a restriction endonuclease enzyme and will carry out study of TMV infection on tomato plant, induced by TMV infected tobacco extract.

Reference Books:

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.

2. Murray PR, Rosenthal KS, Kobayashi GS, Pfaller MA. Medical Microbiology. 3rd edition, Mosby, Inc

3. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.

4. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004).

5. Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.

6. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.

7. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India

Minor Course **Course Code: MICR4021**

Course Title: Introduction to Virology

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

4 Credits (Theory: 03, Practical- 1) (Lecture-03, Practical- 02)

Theory: 40 **45Hrs**

Unit 1: History & Development of virology **15Hrs**

Introduction: Discovery of viruses. Nature and general properties. Structure of Viruses: enveloped and non-enveloped viruses. Isolation, purification, and cultivation of viruses. Baltimore Classification. Economic importance of viruses

Unit 2: Life cycle of Viruses (Bacteriophages) 4Hrs

Lytic and lysogenic cycle of lambda phage

Unit 3: Viral Nucleic acid, Transmissions and Replication 10Hrs

Salient features of Viral Nucleic acids & Reproduction, Mode of viral transmission. Structure, Nucleic acid, Replication and Symptoms of: Adenovirus and Retrovirus (HIV)

Unit 4: Concepts of oncovirus 8Hrs

Introduction to oncogenic viruses, Concepts of oncogenes and proto-oncogenes

Unit 5: Control of Viral Diseases 8Hrs

Antiviral compounds and their mode of action. Concept of Viral vaccines.

Practical Paper Introduction to Virology 30Hrs

1. Study of structures of different viruses by using electron micrograph images.
2. Demonstration on isolation of bacteriophages (PFU) from water/sewage sample.
3. Education tour/ Visit to industry/ institute/ university of excellent repute.

Course objectives:

To inculcate knowledge and basic concept on the properties of viruses, their discovery, classification, structural diversity, isolation, purification and cultivation strategies; Study of their life cycle types with special emphasis to bacteriophages; transmission of viruses and their reproduction; concept of oncogenic and proto-oncogenic viruses and their role in cancer; general principles and understanding on the prevention and control of viral diseases, finally application of virology. To understand practical skills for isolation of bacteriophage from environmental sample and study of structural variation using electron micrographs.

Course outcome:

Students will learn properties of viruses, their discovery, classification, structural diversity, isolation, purification and cultivation strategies; their life cycle types; transmission of viruses and their reproduction; concept of oncogenic and proto-oncogenic viruses; control of viral diseases and application of virology. They will also learn structural diversity of viruses using electron micrographs and will also understand practical skills for isolation of bacteriophage.

Reference Books:

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
4. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
5. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.

Semester-V

Major/DSC Course **Course Code- MICR5011**

Course Title: Microbial Physiology

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

5 Credits (Theory: 04 & Practical: 01) **(Lecture-03, Tutorial-0, and Practical-02)**

Theory **45 Hrs**

Unit 1: Microbial Nutrition: 6 Hrs

Nutritional types (Definitions and examples) - Photoautotrophs, Photoorganotrophs, Chemo-lithotrophs (ammonia, nitrate sulphur, hydrogen, iron oxidizing bacteria), Chemo-organotrophs; effects of oxygen on growth, Classification on the basis of oxygen requirement and tolerance.

Unit 2: Media type and Preservation: 8 Hrs

Components, criteria and role of macro and micro-nutrients. Natural, Synthetic, Complex, Selective media & Differential Media, Enriched and Reduced media. Preservation of Microorganisms: short-term preservation types, long-term preservation- cryopreservation, lyophilyzation.

Unit 3: Bacterial Growth: 8 Hrs

Growth phases, Generation Time, Kinetics of Growth, Batch Culture, Continuous culture, Synchronous culture, Chemostat, Turbidostat, Diauxic Growth, Enrichment Culture. Physical factors influencing growth: Temperature, pH, Atmospheric Pressure. Chemical factors: heavy metal (copper and iron), surfectants (Triton X-100 and SDS) and salt Concentration.

Unit 4: Control of Microorganisms: 8 Hrs

Physical methods- heat (dry and moist heat) , filtration, radiation, chemical methods: Ethanol, phenolics, ethylene oxides, formaldehyde, halogens.

Unit 5: Chemotheraupetic agents: 7 Hrs

Chemotherapy: definition, criteria, therapeutic index; classification: Sulphonamides, Antibiotics-Mechanisms of action (basic concept). Drug resistance (MDR, PDR, XDR).

Unit 6: Bacterial Photosynthesis: 8 Hrs

Photosynthetic microorganisms; Bacterial photosynthetic apparatus; Pigments; Bacterial photosynthesis mechanism and differences from Eukaryotic photosynthesis.

Practicals:

1. Enrichment culture technique – enrichment of spore former.
2. Study of bacterial growth by optical density.
3. Study of bacterial growth by cell number counting (Breed Method) & determination of generation time (Haemocytometer).
4. Study of different factors affecting growth (Temperature, pH, Osmotic pressure using salt/sugar).
5. Control of microbial growth – moist heat, dry heat and UV irradiation.

REFERENCE BOOKS:

1.Madigan MT and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall InternationalInc.
2.Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley

&Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific PublishersIndia
4.Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. SpringerVerlag
6.Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillanPress.
7.Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill HigherEducation.

Major/DSC Course **Course Code- MICR5012**

Course Title: Microbial Metabolism

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

5 Credits (Theory: 04 & Practical: 01) **(Lecture-03, Tutorial-0, and Practical-02)**

Theory **45 Hrs**

Unit 1: Carbohydrate Metabolism: **20 Hrs**
Concept of aerobic respiration, anaerobic respiration and fermentation, Sugar degradation pathways: Glycolysis, TCA cycle, Pentose Phosphate Pathway, Entner Doudroff Pathway, Gluconeogenesis, Glycogen Synthesis and glycogenolysis, Glyoxalate Cycle. Substrate level Phosphorylation & Oxidative Phosphorylation, Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, uncouplers and inhibitors, Anaerobic respiration (dissimilatory Nitrate reduction), Fermentation (alcohol fermentation & Pasteur effect, Homolactic and Heterolactic Fermentation)

Unit 2: Amino acid and Protein Metabolism: **8 Hrs**
Concept of endo- and exo-peptidase, Transamination, Deamination, Transmethylation and decarboxylation. Catabolic pathways of amino acids, Glucogenic and ketogenic amino acids, Catabolism of carbon skeleton of amino acids, urea cycle, general concept of biosynthesis of amino acids (overview of different routes).

Unit 3: Biological Nitrogen Fixation: **5 Hrs**
Symbiotic and Non-symbiotic nitrogen fixation; Mechanisms of nitrogen fixation; Component of nitrogenase system.

Unit 4: Lipid Metabolism: **6 Hrs**
Transport of fatty acids to mitochondria, detailed account of beta-oxydation of even and odd number, saturated and unsaturated fatty acids, biosynthesis of fatty acids.

Unit 5: Nucleic acid metabolism: **6 Hrs**
Digestion of nucleic acids, Catabolism of purine and pyrimidine nucleotides, de novo synthesis of purine and pyrimidine nucleotides, salvage pathways, Biosynthesis of deoxyribonucleotides.

Practicals:

1. Utilisation of sugars (glucose, lactose, sucrose) by *E. coli*
2. Effect of combination of sugar (glucose + lactose i.e. di-auxic growth) on growth of *E. coli*
3. Biochemical Tests- Catalase, Protease, Amylase, nitrate reductase.
4. Utilization of TSI medium.

Reference Books:

1. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman andCompany.
2. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman andCompany.
3. Willey MJ, Sherwood, LM & Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed.,McGrawHill.
4. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley andSons.

5. Madigan MT and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall InternationalInc.

Major/DSC Course **Course Code- MICR5013**

Course Title: Microbial Genetics

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

5 Credits (Theory: 04 & Practical: 01) **(Lecture-03, Tutorial-0, and Practical-02)**

Theory **45 Hrs**

Unit 1: Nucleic acid as Genetic Material: **6 Hrs**
Experimental evidence for DNA and RNA as genetic material: experiments of Griffith, Avery MacLeod and McCarthy, Hershey and Chase, Fraenkel and Conrat.

Unit 2: Mechanisms of Genetic Exchange: **10 Hrs**
Transformation - Discovery, mechanism of natural competence, mapping by co-transformation of markers. Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating

technique and time of entry mapping Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers.

Unit 3: Mutations, Repair and Recombination: 10 Hrs

Mutations and mutagenesis: Definition and types of mutation (tautomeric shift, base analog, alkylating agent, UV radiation and thymine dimers, replicational error). Mutagenic agents: Physical and chemical mutagens, Molecular basis of mutations, Functional mutants (loss and gain of function mutants), Uses of mutants. Reversion and suppression: True revertant; Intra- and inter-genic suppression; Ames test.

Repair of DNA: Mismatch and nucleotide excision repair, photoreactivation, SOS repair, error prone repair

Recombination: Homologous recombination (Holiday structure-RecBCD system).

Unit 4: Plasmids: 5 Hrs

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids. Yeast plasmids- 2 µ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, Regulation of plasmid copy number, curing of plasmids.

Unit 5: Phage Genetics: 10 Hrs

Features of lambda phage lytic cycle: antitermination, early, delayed early and late genes, Lysogenic cycle: lambda repressor, lysogenic induction. Genetic basis of lytic *versus* lysogenic switch of phage lambda.

Unit 6: Transposable elements: 4 Hrs

Basic idea of Prokaryotic and Eukaryotic transposable elements. IS an element, composite and non- composite, replicative and non-replicative transposition. Application of transposon

Practical:

1. Study of the effect of physical mutagens (UV) on antibiotic sensitivity.
2. Isolation of mutant by replica plating technique.
3. Isolation of Plasmid DNA from *E. coli* (alkali lysis method) and study of different conformations of plasmid DNA through Agarose gel electrophoresis using DNA ladder.
4. Demonstration-Ames test
5. Demonstration-Transformation

REFERENCE BOOKS

1.Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., BenjaminCummings.

2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and BartlettLearning

3.Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher EducationLearning

4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of theGene,

6th Ed., Benjamin Cummings
5.Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
6.Russell PJ. (2009). *i* Genetics- A Molecular Approach. 3rd Ed,Benjamin Cummings

Semester- VI

Major/DSC Course **Course Code: MICR 6011**

Course Title: Immunology

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

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

Theory: **45 Hrs**

Unit 1: Basic Concept: **6 Hrs**
Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of the field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff and Susumu Tonegawa.

Unit 2: Immune Cells and Organs: **6 Hrs**
Structure, Functions and Properties of Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT.

Unit 3: Antigens: **5 Hrs**
Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants.

Unit 4: Antibodies: **6 Hrs**
Structure, Types, Functions and Properties of antibodies; Antigenic Determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal, polyclonal and Chimeric antibodies.

Unit 5: Major Histocompatibility Complex: **4 Hrs**
Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways)

Unit 6: Complement System: **3 Hrs**
Components of the Complement system; Activation pathways (Classical, Alternative, and Lectin pathways); Biological consequences of complement Activation.

Unit 7: Generation of Immune Response: **10 Hrs**
Primary and Secondary Immune Response; B and T cell maturation, Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction
to tolerance.

Unit 8: Immunological Techniques: **5 Hrs**

Principle of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluorescence.

Practical:

1. Identification of human blood groups (ABO system)
2. Total & differential Leukocyte Count of the given blood sample
3. Immunodiffusion by Ouchterlony method
4. DOT ELISA
5. Immunoelectrophoresis
6. Demonstration-Western blotting

REFERENCE BOOKS:

1.Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition SaundersPublication, Philadelphia.

2.Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition Wiley-Blackwell Scientific Publication,Oxford.

3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, NewYork.

4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, NewYork.

5.Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers,Edinberg.

6.Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

Major/DSC Course **Course Code: MICR 6012**

Course Title: Molecular Biology

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

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

Theory: **45 Hrs**

Unit 1: Genetic Material and its Features: **5 Hrs**

Types of Genetic material: DNA and RNA; Types of RNA (mRNA, tRNA, rRNA, miRNA, siRNA, snRNA etc.). Organization of DNA in prokaryotes and eukaryotes; Organelle DNA - mitochondrial and chloroplast DNA. The Central Dogma.

Unit 2: Replication: 10 Hrs

DNA replication - Meselson-Stahl experiment as evidence of semi-conservative replication, Bidirectional and unidirectional replication, Semi-discontinuous replication. Mechanism of DNA replication: Enzymes and proteins involved in DNA replication, differences with eukaryotic replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends. Various models of DNA replication including Θ (theta), rolling circle mode of replication and other accessory proteins, fidelity of DNA replication.

Unit 3: Transcription: 10 Hrs

Transcription: Definition, difference from replication, promoter - concept and strength of Promoter, RNA Polymerase and the transcription unit. Mechanism of transcription (initiation, elongation and termination). Transcription in Eukaryotes: major difference with prokaryotic system, important modifications of eukaryotic RNA: concept of introns and exons, RNA splicing, concept of alternative splicing, Polyadenylation and capping, Processing of rRNA and tRNA.

Unit 4: Translation: 10 Hrs

Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, genetic code and its features, mechanism of initiation, elongation and termination of translation in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryote and eukaryote.

Unit 5: Regulation of gene Expression in Prokaryotes and Eukaryotes: 10 Hrs

Principle of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons, changes in chromatin structure: DNA methylation and Histone acetylation mechanisms.

Practical:

1. Isolation of genomic DNA from *E.coli*.
2. Estimation of DNA and its purity check using UV spectrophotometer
3. Demonstration-Blue-White screening
4. Demonstration-Expression of recombinant proteins in bacteria

REFERENCE BOOKS

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab.Press, Pearson Publication
2. Becker WM, K leinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, SanFrancisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th

edition. Lippincott Williams and Wilkins,Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6thedition, John Wiley & Sons.Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual.4th Edition, Cold Spring Harbour Laboratory press.
6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and BartlettLearning
7. GardnerEJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

Major/DSC Course **Course Code- MICR 6013**

Course Title: Food & Dairy Microbiology

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

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

Theory: **45 Hrs**

Unit 1: Foods as a substrate for microorganisms: **4 Hrs**
Intrinsic and extrinsic factors that affect growth and survival of microbes in food, natural flora of food

Unit 2: Microbial spoilage of foods: **4 Hrs**
Principles, Spoilage of vegetables, fruits, meat, eggs, milk, butter, bread and canned Foods

Unit 3: Food preservation: **6 Hrs**
Principles, physical methods of food preservation: temperature (low, high, canning and drying), irradiation, chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins.

Unit 4: Fermented foods: **10 Hrs**
Starter cultures, fermented dairy products: yogurt, acidophilus milk, kefir, dahi and cheese, other fermented foods: dosa, soy based fermented food, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market, concept of prebiotics

Unit 5: Food borne diseases (causative agents, foods involved, symptoms and preventive measures): **10 Hrs**
Food intoxications: Diseases caused by the intoxications from *Staphylococcus aureus*, *Clostridium botulinum* and *Aspergillus flavus*
Food infection: *Escherichia coli*, *Salmonella*, *Shigella*, and *Campylobacter jejuni*

Unit 6: Food sanitation: **6 Hrs**
Indices of food sanitary quality and sanitizers (Some terminology FSMS, GMP, GHP, GAP and their importance; HACCP in food safety)

Unit 7: Rapid detection methods of food borne pathogens in foods: **5 Hrs**
Basic concept of the rapid detection methods of food borne pathogens with examples. Comparison with conventional method

Practical:

1. MBRT of milk samples.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Preparation of Dahi & study of microorganisms.
4. Isolation of spoilage microorganisms from spoiled milk, banana.
5. Preparation of probiotic drink- Kanji.

REFERENCE BOOKS

1.Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi,India.
2.Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi,India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, NewYork.
4. Dillion VM and BoardRG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford,Oxon.
5.Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi,India.
6.GouldGW.(1995).NewMethodsofFoodPreservation.BlackieAcademicand

Major/DSC Course **Course Code- MICR 6014**

Course Title: Environmental Microbiology

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

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

Theory: **45 Hrs**

Unit 1: Microorganisms and their Habitats: **6 Hrs**
Structure and function of ecosystems, Terrestrial Environment: Soil profile and soil microflora, Aquatic Environment: Micro- flora of fresh water and marine habitats. Atmosphere: Aero-

micro-flora: basic idea. Extreme Habitats: Microbes thriving at high & low temperature, pH, high hydrostatic & osmotic pressure, salinity & low nutrient Level

Unit 2: Microbial Interactions: 10 Hrs

Microbe-Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation. Microbe-Plant interaction: Symbiotic and non-symbiotic interactions. Microbe-Animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria

Unit 3: Biogeochemical Cycling: 4 Hrs

Role of microbes in Carbon cycle, N itrogen cycle.

Unit 4: Waste Management: 10 Hrs

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill). Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment.

Unit 5: Microbial Bioremediation: 5 Hrs

Principles and degradation of common organic material (hydrocarbons, oil spills)

Unit 6: Water Potability: 10 Hrs

Treatment and safety of drinking water, methods to detect potability of water samples: (a) standard qualitative procedure: MPN test(presumptive test,confirmatory and completed test) for fecal coliforms (b) Membrane filter technique.

Practical:

1. Analysis of soil - pH, moisture content, water holding capacity
2. Isolation of microbes (bacteria &fungi) from Rhizosphere.
3. Assessment of microbiological quality of water by MPN test.
4. Bacterial interaction in soil- antagonism.
5. Isolation of *Rhizobium* from root nodules.

REFERENCE BOOKS:

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing,USA
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ BenjaminCummings
3.Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, AcademicPress
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, NewYork
5. Singh A, Kuhad, RC &Ward OP (2009). Advances in Applied Bioremediation.

Volume 17, Springer-Verlag, BerlinHedeilberg
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition,Wiley

Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
7.Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.