SHIVAJI UNIVERSITY, KOLHAPUR

Established: 1962

A^{++} Accredited by NAAC (2021) with CGPA 3.52

Structure and Syllabus in Accordance with

National Education Policy - 2020

with Multiple Entry and Multiple Exit

Syllabus For

B.Sc.Part–I

MICROBIOLOGY

(Faculty of Science and Technology)

SEMESTER I AND II

(To Be Implemented From Academic Year 2024-25)

Shivaji University, Kolhapur
NEP-2020: Credit Framework for Bachelor of Science
Microbiology-First Year

		1-Major		2-Minor	3-OE	4-SEC	5-AEC,VEC,IKS			6-OJT,FP,CEP,CC,RP			
Level	Sem	Major		Minor	IDC/MDC/ OE/GE	SEC	AEC (Language)	Value Education Courses (VEC)	IKS	CC	Summer Internship	Research Project / Dissertation	Total Credits
		DSC	DSE										
4.5	I	Microbiology-I (2) Introduction to Microbiology Microbiology -II (2) Basic techniques in Microbiology Practical-I (2)		Microbiology-I (2) Introduction to Microbiology Microbiology -II (2) Basics techniques in Microbiology Practical-I (2)	OE-I (2) Food Adulteration OE--II (2) Food Science and Food processing (2)	SEC-I(2) Industrial Sterilization Practices SEC-I-Practical (2)		-	IKS(2) Introduction to IKS			-	
	Credits	4+2=6		4+2=6	2+2=4	2+2=4			2			-	22
	II	Microbiology -III (2) Bacteriology Microbiology -IV (2) Applied Microbiology Practical-II (2)		Microbiology -III (2) Bacteriology Microbiology IV (2) Applied Microbiology I Practical-II (2)	OE -III (2) Medical Lab technology OE-IV (2) Bio fertilizer technology (2)	SEC-II(2) Bacteriological analysis of Air, Water and Milk SEC-II (2) Practicals		VEC-I(2) Democracy				-	
	Credits	4+2=6		4+2=6	2+2=4	2+2=4						-	22
		12		12	8	8		2	2				44

Learning Outcomes:

A candidate who wish to graduate in B.Sc. (Microbiology Course) needs to have acquired/developed following competencies:

1. Acquired knowledge and understanding of the microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others.
2. Demonstrate key practical skills/competencies in working with microbes for study and use in the laboratory as well as outside, including the use of good microbiological practices.
3. Competent enough to use microbiology knowledge and skills to analyze problems involving microbes, articulate these with peers/ team members/ other stake holders, and undertake remedial measures/studies etc.
4. Developed a broader perspective of the discipline of Microbiology to enable him to identify challenging societal problems and plan his professional career to develop innovative solutions for such problems.

SEMESTER- I

F. Y. B. Sc. (MICROBIOLOGY) SEMESTER I

MAJOR COURSE-DSC- I

Course Title: Introduction to Microbiology

[CREDITS - 02; LECTURES - 30 hours; LEC/WEEK - 02]

Learning Objectives:

1. To develop a good knowledge of the development of the discipline of Microbiology and the contributions made by prominent scientists in this field.
2. To develop a very good understanding of the characteristics of different types of microorganisms, methods to organize/classify these into and basic tools to study these in the laboratory.
3. To explain the useful and harmful activities of the microorganisms and scope of different branches of Microbiology.
4. To describe characteristics of bacterial cells, cell organelles and various appendages like capsules, flagella or pili.

Unit I /Credit I	**History and Scope of Microbiology**	**No. of hours: 15**
	A. History of Microbiology 1. Spontaneous generation *vs*. biogenesis. 2. Contributions of - a. Antony von Leeuwenhoek, b. Edward Jenner , c. Louis Pasteur , d. Robert Koch , e. Ivanowsky , f. Joseph Lister , g. Alexander Fleming , h. Martinus W. Beijerinck and i. Sergei N. Winogradsky. B. Introduction to types of Microorganisms : 1. General characteristics of different groups:	

	a. Acellular microorganisms-Viruses, Viroids and Prions b. Cellular microorganisms- Bacteria, Algae, Fungi and Protozoa – General Characteristics c. Ultra structure of Prokaryotic and eukaryotic cell, difference between prokaryotic and eukaryotic microorganisms. C. Bacterial Nomenclature and Classification : a. Taxonomic ranks b. Common or Vernacular name c. Scientific or International name d. Carl Woese's three domain classification systems. D. An overview of Scope of Microbiology: 1. Beneficial and harmful activities of microorganisms. Introduction to applied branches of Microbiology: a. Air, b. Water ,c. Sewage , d. Soil , e. Dairy , f. Food , g. Medical ,h. Industrial , i. Biotechnology and j. Geomicrobiology.	
Unit II /Credit II	**Bacterial Cell Structure and Functions**	**No. of hours: 15**
	A. Cell size, shape and arrangement B. Cytology of Bacteria : i) Cell wall :Composition and detailed structure of Gram-positive and Gram-negative bacterial cell walls ii) Cell Membrane: Structure, function & chemical composition of bacterial cell membranes. iii) Structure and functions of Capsule and slime layer. iv) Structure and functions of Flagella v) Structure and functions of Pilli. C. Structure and functions of Cytoplasmic Components: a. Ribosomes b. Mesosomes c. Nucleoid d. Plasmids	

	e. Endospore: Structure, stages of sporulation f. Reserve food materials - Nitrogenous and non-nitrogenous	

SEMESTER- I

F. Y. B. Sc. (MICROBIOLOGY) SEMESTER I

MAJOR COURSE-DSC- II

Course Title: Basic Techniques in Microbiology

[CREDITS - 02; LECTURES - 30 hours; LEC/WEEK - 02]

Learning Objectives :

1. To study the staining techniques for the observation of bacteria and bacterial cell components
2. To study the working principle, handling and use of microscopes for the study of microorganisms
3. To understand the principles of sterilization and disinfection of culture media, glassware and plastic ware and other objects to be used for microbiological work.

Unit I / Credit I	**Staining Techniques and Microscopy**	**No. of hours: 15**
	1. **Stains and staining procedures** A. Definition and Classification of stains - Acidic, Basic and Neutral B. Principles, Procedure, Mechanism and applications of staining procedures i) Simple staining ii) Negative staining iii) Differential staining: Gram staining and Acid fast staining C. Special staining methods i) Cell wall (Chance's method) ii) Capsule (Maneval's method) iii) Volutin granule (Albert's method) 2.**General Principles of Microscopy:** a. Types of microscopes: light and electron microscopes b. Light microscopy: Parts, Image formation, Magnification, Numerical aperture (uses of oil immersion	

	objective), Resolving power and Working distance. c. Ray diagram, special features, applications and comparative study of : i) Compound Microscope ii) Electron Microscope iii)	
Unit II / Credit II	**Control of Microorganisms**	**No. of hours: 15**
	A. Definitions of - Sterilization, Disinfection, Antiseptic, Germicide, Microbiostasis, Antisepsis and Sanitization. B. Physical agents for control of microorganisms: a. Temperature – a) Dry heat b) Moist heat b. Desiccation c. Osmotic pressure d. Radiations - U.V. Ray, Gamma rays, e. Filtration – Asbestos and Membrane filter C. Chemical Agents for control of microorganisms: Mode of action, application and advantages of - a. Phenol and Phenolic compounds b. Alcohols (Ethyl alcohol) c. Halogen compounds (chlorine and iodine) d. Heavy metals (Cu and Hg) e. Gaseous Agents – Ethylene oxide, Beta-propiolactone and formaldehyde	

MAJOR COURSE- PRACTICAL DSC Pract. -I

COURSE TITLE : PRACTICALS BASED ON Major SUBJECT 1& 2

[CREDITS - 02; PRACTICALS - 60 hours , Practicals /week - 04]

Paper I &II: Introduction to Microbiology And Basic Techniques In Microbiology Learning Objectives:

1. To understand the basic techniques in Microbiology laboratory
2. To study the working principle, handling and use of compound microscope for the study of microorganisms
3. To study the simple and special staining techniques for the observation of bacteria and bacterial cell components
4. To understand the working principles and applications various equipment's in Microbiology laboratory
5. To study the preparation, sterilization and use of various culture media.

Unit I / Credit I	**Basic Techniques**	**No. of hours: 15**
	1. Biosafety- a. Aseptic techniques b. Table disinfection c. Hand wash d. Use of aprons e. Proper disposal of used material f. Cleaning and sterilization of glassware 2. Study of parts of light compound microscope, its use and care. 3. Staining Techniques - a. Monochrome staining b. Negative staining c. Gram's staining d. Cell wall staining (Chance's method), e. Capsule staining (Maneval's method), f. Volutine granule staining (Albert's method) 4. Motility by Hanging drop method.	

	5. Study of the principle and applications of instruments a. Biological safety cabinets – Laminar Air Flow Device b. Autoclave c. Incubator d. Hot air oven e. Colorimeter, f. Colony counter	
Unit II / Credit II	**Preparation of Culture Media**	**No. of hours: 15**
	1. Preparation of culture media and their sterilization - agar plates, buts and slants 2. Simple media: a. Peptone water – 1% & 2 % b. Nutrient broth c. Nutrient agar 3. Biochemical test media : a. Glucose phosphate broth b. Koser's citrate broth c. Milk agar d. Starch agar 4. Selective media - Sabouraud's agar, Potato Dextrose Agar 5. Selective & Differential Media -MacConkey's agar.	

SEMESTER- I

F. Y. B. Sc. (MICROBIOLOGY) SEMESTER I

MINOR COURSE- I

Course Title: Introduction to Microbiology

[CREDITS - 02; LECTURES - 30 hours; LEC/WEEK - 02]

Learning Objectives:

1. To develop a good knowledge of the development of the discipline of Microbiology and the contributions made by prominent scientists in this field.
2. To develop a very good understanding of the characteristics of different types of microorganisms, methods to organize/classify these into and basic tools to study these in the laboratory.
3. To explain the useful and harmful activities of the microorganisms and scope of different branches of Microbiology.
4. To describe characteristics of bacterial cells, cell organelles and various appendages like capsules, flagella or pili.

Unit I /Credit I	**History and Scope of Microbiology**	**No. of hours: 15**
	A. History of Microbiology 1. Spontaneous generation *vs*. biogenesis. 2. Contributions of - a. Antony von Leeuwenhoek, b. Edward Jenner , c. Louis Pasteur , d. Robert Koch , e. Ivanowsky , f. Joseph Lister , g. Alexander Fleming , h. Martinus W. Beijerinck and i. Sergei N. Winogradsky. B. Introduction to types of Microorganisms : 1. General characteristics of different groups: a. Acellular microorganisms-Viruses, Viroids and Prions	

	b. Cellular microorganisms- Bacteria, Algae, Fungi and Protozoa – General Characteristics c. Ultra structure of Prokaryotic and eukaryotic cell, difference between prokaryotic and eukaryotic microorganisms. C. Bacterial Nomenclature and Classification : a. Taxonomic ranks b. Common or Vernacular name c. Scientific or International name d. Carl Woese's three domain classification systems. D. An overview of Scope of Microbiology: 1. Beneficial and harmful activities of microorganisms. Introduction to applied branches of Microbiology: a. Air, b. Water ,c. Sewage , d. Soil , e. Dairy , f. Food , g. Medical ,h. Industrial , i. Biotechnology and j. Geomicrobiology.	
Unit II /Credit II	**Bacterial Cell Structure and Functions**	**No. of hours: 15**
	A. Cell size, shape and arrangement B. Cytology of Bacteria : i) Cell wall :Composition and detailed structure of Gram-positive and Gram-negative bacterial cell walls ii) Cell Membrane: Structure, function & chemical composition of bacterial cell membranes. iii) Structure and functions of Capsule and slime layer. iv) Structure and functions of Flagella v) Structure and functions of Pilli. C. Structure and functions of Cytoplasmic Components: a. Ribosomes b. Mesosomes c. Nucleoid d. Plasmids e. Endospore: Structure, stages of sporulation f. Reserve food materials - Nitrogenous and non-nitrogenous	

SEMESTER- I

F. Y. B. Sc. (MICROBIOLOGY) SEMESTER I

MINOR COURSE - II

Course Title: Basic Techniques in Microbiology

[CREDITS - 02; LECTURES - 30 hours; LEC/WEEK - 02]

Learning Objectives :

1. To study the staining techniques for the observation of bacteria and bacterial cell components
2. To study the working principle, handling and use of microscopes for the study of microorganisms
3. To understand the principles of sterilization and disinfection of culture media, glassware and plastic ware and other objects to be used for microbiological work.

Unit I / Credit I	**Staining Techniques and Microscopy**	**No. of hours: 15**
	1. **Stains and staining procedures** A. Definition and Classification of stains - Acidic, Basic and Neutral B. Principles, Procedure, Mechanism and applications of staining procedures i) Simple staining ii) Negative staining iii) Differential staining: Gram staining and Acid fast staining C. Special staining methods i) Cell wall (Chance's method) ii) Capsule (Maneval's method) iii) Volutin granule (Albert's method) 2.**General Principles of Microscopy:** a. Types of microscopes: light and electron microscopes b. Light microscopy: Parts, Image formation, Magnification, Numerical aperture (uses of oil immersion objective), Resolving power and Working distance. c. Ray diagram, special features, applications and comparative study of : i) Compound Microscope	

	ii) Electron Microscope iii)	
Unit II / Credit II	**Control of Microorganisms**	**No. of hours: 15**
	A. Definitions of - Sterilization, Disinfection, Antiseptic, Germicide, Microbiostasis, Antisepsis and Sanitization. B. Physical agents for control of microorganisms: a. Temperature – a) Dry heat b) Moist heat b. Desiccation c. Osmotic pressure d. Radiations - U.V. Ray, Gamma rays, e. Filtration – Asbestos and Membrane filter C. Chemical Agents for control of microorganisms: Mode of action, application and advantages of - a. Phenol and Phenolic compounds b. Alcohols (Ethyl alcohol) c. Halogen compounds (chlorine and iodine) d. Heavy metals (Cu and Hg) e. Gaseous Agents – Ethylene oxide, Beta-propiolactone and formaldehyde	

MINOR COURSE- PRACTICAL Pract. -I

COURSE TITLE : PRACTICALS BASED ON Minor SUBJECT 1& 2

[CREDITS - 02; PRACTICALS - 60 hours , Practicals /week - 04]

Paper I &II: Introduction to Microbiology And Basic Techniques In Microbiology Learning Objectives:

1. To understand the basic techniques in Microbiology laboratory
2. To study the working principle, handling and use of compound microscope for the study of microorganisms
3. To study the simple and special staining techniques for the observation of bacteria and bacterial cell components
4. To understand the working principles and applications various equipment's in Microbiology laboratory
5. To study the preparation, sterilization and use of various culture media.

Unit I / Credit I	**Basic Techniques**	**No. of hours: 15**
	1. Biosafety- a. Aseptic techniques b. Table disinfection c. Hand wash d. Use of aprons e. Proper disposal of used material f. Cleaning and sterilization of glassware 2. Study of parts of light compound microscope, its use and care. 3. Staining Techniques - a. Monochrome staining b. Negative staining c. Gram's staining d. Cell wall staining (Chance's method), e. Capsule staining (Maneval's method), f. Volutine granule staining (Albert's method) 4. Motility by Hanging drop method. 5. Study of the principle and applications of instruments a. Biological safety cabinets – Laminar Air Flow Device b. Autoclave c. Incubator d. Hot air oven e. Colorimeter, f. Colony counter	
Unit II / Credit II	**Preparation of Culture Media**	**No. of hours: 15**
	1. Preparation of culture media and their sterilization - agar plates, buts and slants 2. Simple media: a. Peptone water – 1% & 2 % b. Nutrient broth c. Nutrient agar 3. Biochemical test media :	

	a. Glucose phosphate broth b. Koser's citrate broth c. Milk agar d. Starch agar 4. Selective media - Sabouraud's agar, Potato Dextrose Agar 5. Selective & Differential Media -MacConkey's agar.	

OPEN ELECTIVE COURSE-1(OE-I)

COURSE TITLE: FODD ADULTERATION

[CREDITS - 02; LECTURES - 30 hours;]

Course Learning objectives
The objective of this course is to; *1.* Demonstrate the role played by microbes in food production and food spoilage *2.* Make student aware about different food additives. *3.* Give an overview of food Adulteration *4.* Make students understand the concepts of Adulteration to Improve food quality
Course leraning outcomes
After completion of this course learner will be able to; *1.* Understand the interaction between microbes and food *2.* Know and explore more about food additives *3.* Student become aware about Concept of adulterants *4.* To understand Adulteration to Improve Physical and Sensory Properties

Credit I	**Introduction to Food Processing**	**No. of hours: 15**
	a) Basic Concept of Food Microbiology, Genetically Modified food- Basic Concept, Examples – GM Tomato, Golden Rice, Bt Maize, Bt Cotton and Edible Vaccines, b) Role of Microorganisms in food fermentation with examples – Bread and Bun, Cucumber Pickle, Dahi and Butter, Idli, Dhokala. c) Food safety – Basic concept, Physical, Chemical and Biological hazards in Food. d) Contaminants – Basic concept, Types – Antibiotic residue, Pesticide Residue, Metallic contaminants and Microbial Contaminants. e) Food Packaging – Concept, Significance, Function. Labellling food – Mandatory labeling requirement, Nutrional labelling and Bar codings	

Credit II	Methods of Food Adulteration	No. of hours: 15
	a) Concept of food, Definition of food adulteration, Common adulterated foods, Criteria to decide adulteration, Causes of food adulteration, Methods of food adulteration. b) Concept of adulterants, Typical Supply chain for food to understand food adulteration, Adulterants found in most consumable foods with emphasis on reason explaining their addition - Milk (Water, Sugar, Starch and Urea), Edible oils (Cheaper oil - castor oil, mineral oil, argernone oil, palmolein, cottonseed oil and rapeseed oil), Ghee (Vanaspati or Hydrogenated oil, Lard) and Spices (Starch from wheat, jawar, rice, corn and arrowroot, exhausted spices). c) Adulteration to Improve Physical and Sensory Properties - Purpose, Use, Representative examples and their possible health effects i. Artificial Ripening (Ethylene, ethanol, methanol, propylene, methyl jasmonate, ethylene glycol, ethephon, and calcium carbide) ii. Growth Hormones (Gibberellic acid, alpha naphthyl acetic acid, and oxytocin used in gourds, bitter gourds, pumpkins and cucumbers) iii. Artificial Sweetening Agents (Saccharine, external sugar in fruit juice) iv. Artificial Coloring Agents (Rhodamine B, Malachite Green, Orange II, Metanil Yellow, Lead chromate, Tartrazine) v. Substances to improve Food Consistency (detergents with oil and fat in milk, adulterants added to improve SNF of milk) Preservatives (Formaldehyde and Hydrogen peroxide in milk, wax for fruits)	

Reference Books and Websites:

1. DART Book – FSSAI - https://www.fssai.gov.in/book-details.php?bkid=201
2. Momtaz, M.; Bubli, S.Y.; Khan, M.S. Mechanisms and Health Aspects of Food Adulteration: A Comprehensive Review. Foods **2023**, 12, 199. https://doi.org/10.3390/foods12010199
3. Manual for Food Safety officers - https://fssai.gov.in/upload/knowledge_hub/16230060e42ededcc7dFSO_Manual_05_07_2021_.pdf

OPEN ELECTIVE COURSE-OE-II

COURSE TITLE: FODD SCIENCE AND FOOD PROCESSING

[CREDITS - 02; LECTURES - 30 hours; LEC/WEEK - 02]

Course Learning objectives
The objective of this course is to; 1. Demonstrate the role played by microbes in food production and food spoilage 2. Make student familiar with the traditional and modern fermented foods 3. Give an overview of food borne illnesses 4. Make students understand the concepts of food preservation and food safety
Course leraning outcomes
After completion of this course learner will be able to; 1. Understand the interaction between microbes and food 2. Know and explore more about Indian fermented foods 3. Appreciate the science behind food preservation techniques 4. Practice food hygiene and sanitization to overcome food borne illnesses

OE-II	**(CREDITS:02; TOTAL HOURS : 30)**	**No. of Hours per Credit 15**
Credit-1	**. Food Science and Nutrition** **1.1** Chemical Nature, Sources and Functions of Nutrients. Examples Proteins, Carbohydrates, Fats, Minerals, Vitamins, Water, Fibre, Antioxidants and phytochemicals. **1.2** Food Additives – Intentional / Unintentional, general. Examples : Antioxidants, chelating agents, colouring agents, emulsions, flavours and flavour enhancers, flavour improvers, humectants and anticaking agents, leavening agents, nutrient supplements, non nutritive sweeteners, pH controlling agents **1.3** Energy Value of Foods. Methods of measurement of energy, **1.4** Nutritional Disorders due to deficiency and excess of Nutrients. Vitamin deficiency- pernicious anemia, scurvy, night blindness, rickets. Protein deficiency : Kwashiorkar, Mineral deficiency due to iron, iodine and calcium.	

Credit II	**Pri ciples of Food Processiog** **A) Cereal based foods** Pasta. Macaroni. Semolina Processed Soy bean products- Fermented Soyabean Products – miso, tofu, soy sauce **B)** Nutraceuticals C) Probiotic foods-Production and quality control D) Convenience foods E) Processing of fruits and Vegetables-Jam, Jelly, squash. ketchup **F)** Foods of Microbial Origin-SCP- and Mushrooms **Production of SCP** Introduction Production – Algae(Spirulina) Product quality and safety	**15**

SKILL ENHANCEMENT COURSE-(SEC-I)

COURSE TITLE: Industrial Sterilization Practices

COURSE CODE: XXX

[CREDITS - 02; LECTURES - 30 hours; LEC/WEEK - 02]

Course Learning objectives
The objective of this course is to; **1)** Understand the skills for sterilization. **2)** Learn the disinfection processes **3)** To learn the air sanitation, disinfection of air, water **4)** To learn laboratory, hospital and food industry disinfection processes.
Course leraning outcomes
After completion of this course learner will be able to; 1) Capable of sterilization of large surfaces 2) Aquanted with different sterilization and disinfection processes 3) Acqure knowledge water purification and air sanitation processes.

Credit I	**Sterilization and Disinfection of different environments**	**No. of hours: 15**
	I. Difference between Cleaning, Disinfecting, Sanitizing, Antiseptics, Pasteurization, Sterilization a. Types of biological contaminants b. Industrial sectors where sterilization and disinfection are important c. Overview of typical sterilization and disinfection processes d. Establishment of an ideal decontamination process II. Air sanitation a. Importance of sanitation of air b. Methods to sanitize air - Chemical(use of sprays and vapors), Mechanical, UV, electrostatic precipitation , heating. III. Water purification a. Safely managed drinking water b. Methods to purify- Boiling, Chlorination, Flocculation, Solar and slow sand filters IV. Disinfection of Surfaces Common disinfectants: Phenolics, Bleach (0.05% and 5% sodium hypochlorite), Alcohol, 3% hydrogen peroxide, Lysol, Bacillocid (QUATs), Peracetic acid, Accelerated hydrogen peroxide	

Credit-II	**Sterilization and Disinfection practices in the industry**	**No. of hours: 15**
	I. Laboratories: Common methods of lab sterilization II. Hospitals: Disinfection in hospital environments, Concept of WASH in Healthcare facility III. Food Industry: Food and beverage disinfection Pharma Industry: Control of microorganisms in Pharmaceuticals production environment	

References

1. Prescott, Hurley, Klein-Microbiology, 10th edition, International edition, McGraw Hill.
2. Microbiology, An Introduction by Tortora, Funke & Case 9th and 11th edition, Pearson education.
3. Laboratory Manual and Workbook in Microbiology: Applications to Patient Care, 7th Edition, Josephine A. Morello, Paul A. Granato and Helen Eckel Mizer
4. Sanitization During and After COVID-19 Pandemic: A Short Review Majid Hassan Khan and Harekrishna Yadav, Transactions of the Indian National Academy of Engineering (2020) 5:617–627. https://doi.org/10.1007/s41403-020-00177-9
5. **1**.https://www.cdc.gov/infectioncontrol/guidelines/disinfection /sterilization/index.html
6. https://onlinelibrary.wiley.com/doi/full/10.1002/pssa.2020007 32
7. **2**.Air-sanitation - Air sanitation - Sanitation of Air (Control of Microorganisms in Air) Air - Studocu

3.Household Water Treatment | Global Water, Sanitation and Hygiene | Healthy Water | CDC)

SKILL ENHANCEMENT COURSE-(SEC-I PRACTICAL)

COURSE TITLE: Industrial Sterilization Practices

COURSE CODE: XXX

[CREDITS - 02; LECTURES - 30 hours; LEC/WEEK - 02]

Course Learning objectives
The objective of this course is to; 1.To learn MIC determination processes. 2.To learn determination of chlorine dose of water 3. To learn effect of lab disinfectant on surfaces.
Course leraning outcomes
After completion of this course learner will be able to; 1. Capable of determining MIC of disinfectant. 2. Aquanted with sterilization and disinfection processes. 3. Capable of monitoring the bacteriological quality of air, water, hospital surfaces.

Credit I	**Sterilization and Disinfection of different environments**	**No. of hours: 15**
	1.MIC of disinfectant 2. Estimation of Chlorine dose of water 3. Determination of residual chlorine in the water 4. Determination of lethal dose of UV against E.coli 5. Detection of microbial load in Air 6.Effect of lab disinfectant on surfaces 7.Effect of alcohol sterilization of glassware	
Credit-II	**Sterilization and Disinfection practices in the industry**	**No. of hours: 15**
	1. SPC of pharmaceutical products (syrups) 2. Determination of MIC of Streptomycin by Broth dilution method 3. Determination of sterilization efficiency of Oven. 4. Sterilization of laboratory by gaseous sterilization	

	5. Detection of efficiency of gaseous sterilization 6. Determination of efficiency of pasteurization- Qualitative test.	

References

8. Prescott, Hurley, Klein-Microbiology, 10th edition, International edition, McGraw Hill.
9. Microbiology, An Introduction by Tortora, Funke & Case 9th and 11th edition, Pearson education.
10. Laboratory Manual and Workbook in Microbiology: Applications to Patient Care, 7th Edition, Josephine A. Morello, Paul A. Granato and Helen Eckel Mizer
11. Sanitization During and After COVID-19 Pandemic: A Short Review Majid Hassan Khan and Harekrishna Yadav, Transactions of the Indian National Academy of Engineering (2020) 5:617–627. https://doi.org/10.1007/s41403-020-00177-9
12. **1**.https://www.cdc.gov/infectioncontrol/guidelines/disinfection /sterilization/index.html
13. https://onlinelibrary.wiley.com/doi/full/10.1002/pssa.2020007 32
14. **2**.Air-sanitation - Air sanitation - Sanitation of Air (Control of Microorganisms in Air) Air - Studocu

3.Household Water Treatment | Global Water, Sanitation and Hygiene | Healthy Water | CDC)

INDIAN KNOWLEDGE SYSTEM (Generic-IKS)

COURSE TITLE: AYURVEDA AND MICROBIOLOGY

COURSE CODE: [CREDITS - 02; LECTURES - 30 hours; LECTURES/WEEK - 02]

Course learning objectives:

The objective of this course is to:

1. Introduce students to the overall organization of Indian Knowledge System(IKS)
2. Develop an appreciation among the students of the role and importance of Veda, Vedāṅgas, Upa Vedas and Purāṇas in food and medicine

3.Motivate students to take up a detailed study of some of these topics and explore their application potential

Course Learning Outcomes:

After completion of this course learner will be able to:

1. Inculcate Ayurvedic practices in food
2. Apply traditional knowledge for sustainability
3. Follow dincharya or daily regime and appropriate food for the maintenance of good health

Understand the importance of Ayurvedic pharmacopoeia

Credit I	**Introduction to IKS, Ayurveda and Food**	**No. of hours: 15**
	Introduction to Vedic microbiology, Nature, Philosophy and Characteristics of IKS brief overview of Ayurveda and Microbiology in ancient Indian context **Ayurvedic Concept of Food and Nutrition** Ayurvedic nutrition, taste, ayurvedic diet, role of spices in ayurvedic diet, Influence of food over mind and emotions, food source, incompatible food and diet, hunger and nutrition, thirst and water intake. Indian view about health foods, grain-based traditional health food, Fruit and vegetable-based traditional health food, Milk-based health food, Ayurvedic health foods, Miscellaneous health foods, Ayurvedic diet in diseases, Weaning foods in Indian tradition.	

Credit II	**Ayurveda: a knowledge system** **Vedas and medical science** Introduction to the different vedas. Ayurveda as the ancient Indian system of medicine. Other vedas (Atharvaveda) for description of medicine. Use of different ayurvedic preparations as mentioned in the vedas that are oldest examples of nanotechnology **Ancient Indian Bacteriology** Krimi and krimiroga in the Vedas (germs and the diseases caused by them). Description of krimis in water, milk, in and on the body and the methods of counting them. Knowledge of various diseases with their prophylaxis and treatment using herbs. **Ancient Indian practices and Microbiology** Agnihotra and its effects on environment and agriculture. Influence of other rituals on microbes. Use of ayurvedic combinations for eco-friendly management of plant diseases.	No. of hours: 15

References:

1. Kapil Kapoor (2005). Indian Knowledge Systems. D.K. Print World Ltd
2. Guha, Amala, "Ayurvedic Concept of Food and Nutrition" (2006). SoM Articles. 25.
3. Preetam Sarkar et.al, “Traditional and ayurvedic foods of Indian origin”. J Ethn Foods 2015; 2: 97-109
4. Payyappallimana U and Venkatasubramanian P (2016) Exploring Ayurvedic Knowledge on Food and Health for Providing Innovative Solutions to Contemporary Healthcare. Front. Public Health 4:57. doi: 10.3389/fpubh.2016.00057
5. Sanjeev Rastogi (2014). Ayurvedic Science of Food and Nutrition. Springer New York Heidelberg Dordrecht London.

6. R.C. Dubey (2021) Vedic Microbiology: A Scientific Approach Motilal Banarsidass (Publisher), India
7. Panda, C. K.Natural Medicines prescribed in the vedas (2021) IJCRT; Vol 9 (3) ISSN: 2320-2882
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SEMESTER- II

MAJOR COURSE-DSC- III

COURSE TITLE: : Bacteriology

[CREDITS - 02; LECTURES - 30 hours; LEC/WEEK - 02]

Learning Objectives:

1. To describe the nutritional requirements of bacteria and other microbes which grow under extreme environments.
2. To understand the basic laboratory experiments to isolate, cultivate and differentiate bacteria
3. To study the preservation of bacteria in the laboratory

Learning Outcomes:

1. Capable of design the nutritional media of bacteria and other microbes which grow under extreme environments.
2. Able to isolate, cultivate and differentiate bacteria
3. Able to preserve of bacteria in the laboratory

Unit I / Credit I	Microbial Nutrition and Culture Media	No. of hours: 15
	A. Nutritional requirements of microorganisms: a. Water b. Micronutriments c. Macronutrients d. Carbon e. Energy source f. Oxygen g. Hydrogen h. Nitrogen i. Sulphur j. Phosphorous k. growth factors – auxotroph, prototroph and fastidious organisms. B. Nutritional types of microorganism based on carbon and energy sources: a. Autotrophs b. Heterotrophs c. Phototrophs d. Chemotrophs e. Photoautotrophs f. Chemoautorphos g. Photoheterotrophs h. Chemoheterotrophs C. Types of Culture Media: a. Components of media b. Natural and Synthetic media c. Chemically defined media d. Complex media, Selective e. Differential f. Enriched g. Enrichment media. D. Cultivation of microorganisms: a. Use of culture media for cultivation b. Conditions required for growth of the microorganisms.	

Unit II / Credit II	**Isolation, Cultivation and Preservation of Microorganisms.**	**No. of hours: 15**
	A. Isolation of Microorganisms from natural habitats : a. Pure culture techniques – Streak plate, Spread plate, Pour Plate and micromanipulator b. Isolation and cultivation of anaerobic organisms by using media components and by exclusion of air/O2 B. Preservation of microbial cultures : a. Subculturing b. overlaying of cultures with mineral oils c. storage at low temperature d. lyophilization C. Systematic study of pure cultures: a. Morphological characteristics. b. Cultural characteristics : i. Colony characteristics on solid media ii. growth in liquid media iii. growth on agar slants D. Biochemical Characteristics – a. Sugar fermentation b. Production of metabolites - H_2S gas c. Production of enzymes - Amylase, Caseinase and Catalase.	

MAJOR COURSE- DSC-IV

COURSE TITLE: Applied Microbiology

[CREDITS - 02; LECTURES - 30 hours; LEC/WEEK - 02]

Learning Objectives:

1. To develop a very good understanding of applied branches of Microbiology.
2. To develop the knowledge of how the microorganisms play role in Water microbiology
3. To make well conversant about food preservation techniques
4. To develop knowledge of milk processing and milk testing.

Unit I / Credit I	**Air and Water Microbiology**	**No. of hours: 15**
	1.Air Microbiology: **A.** Sources of microorganisms in air. **B.** Definitions of - Infectious dust, Droplets & Droplet nuclei **C.** Sampling methods for microbial examination of air 1. Solid impaction - Sieve device **D.** Liquid Impingement – Bead-bubbler device 2. Water Microbiology: a. Sources of microorganisms in water. b. Fecal pollution of water, Indictors of fecal pollution of water – *E. coli* c. Routine Bacteriological analysis of water. ii. SPC iii. Tests for coliforms - 1. Qualitative-Detection of coliforms - Presumptive test, Confirmed Test, Completed test. Differentiation between coliforms - IMViC test, Eijkman test. 2. Quantitative – MPN, Membrane filter technique d. Municipal water purification process and its significance.	

Unit II / Credit II	**Food and Dairy Microbiology**	**No. of hours: 15**
	1. Food Microbiology _ a. Introduction b. Microbial spoilage of food c. Food Preservation : General Principle and methods and Application Asepsis, Removal of Microorganisms, Dehydration, Use of Heat, Irradiation, Anaerobiosis, Chemicals 2. Milk Microbiology: D. Sources of microorganisms in milk E. General composition of Milk. F. Microbiological examination of Milk – DMC, SPC and dyereduction test- MBRT test G. Pasteurization - Definition, Methods – LTH , HTST ,UHT, Efficiency of Pasteurization– Phosphatase test (Qualitative)	

MAJOR - PRACTICAL COURSE DSC Pract. -II

COURSE TITLE : PRACTICALS BASED ON MAJOR SUBJECT III & IV

Bacteriology and Applied Microbiology

: [CREDITS - 02; PRACTICALS - 60 hours , Practicals /week - 04]

Learning Objectives:

1. To understand the basic laboratory experiments to isolate and cultivate
2. To study various biochemical tests used to differentiate bacteria

Unit I / Credit I	**Study of Bacteria**	**No. of hours: 15**
	1. Demonstration of presence of micro flora in / on – 1. Air by solid impaction technique on nutrient agar plates 2. Water by direct cultivation method 3. Hand, nails, teeth and skin (swabbing) by direct cultivation methods. 2. Isolation of pure cultures of bacteria by four quadrant streaking method and study of Colony characteristics, Gram staining and motility of – 1. *Escherichia coli* 2. *Bacillus species* 3. *Staphylococcus aureus* 3. Enumeration of bacteria from water and milk by SPC method.	
Unit II / Credit II	Biochemical Tests	No. of hours: 15
	1. IMViC Test 2. MBRT Test 3. H_2S production test 4. Sugar fermentation - glucose and lactose 5. Enzyme production - Amylase Catalase Caseinase	

Books recommended for Theory

1. Microbiology by Pelczar, M.J.Jr., Chan E.C.S., Krieq, N.R. 5th edition, 1986 (McGraw Hills Publication).
2. Fundamental Principles of bacteriology by A. J. Salle, Tata McGraw Hill.
3. Fundamentals of Microbiology by Frobisher, Hindsdill, Crabtree, Good Heart, W.B. Saunders

Company, 7th edition.

4. Medical Microbiology Vol. I and II by Cruick Shank R., Duguid J.P., Marmion B.P., Swain R.H.A., XIIth edition, Churchill Livingston, New York.
5. A textbook of Microbiology by Ananthnarayan – Orient Longman, Bombay
6. General Microbiology by Stanier R. Y. Vth edition, McMilan, London.
7. General Microbiology Vol I and II by Powar and Daginawala, Himalaya Publications.
8. Medical Bacteriology by Dey and Dey – Allied Agency, Calcutta.
9. Food Microbiology by W. C. Frazier.
10. Basic Experimental Microbiology by Ronal M. Atlas, Alfred E. Brown, Kenneth W. Dobra, Wonas Miller (1986) Pren-tice Hall.
11. General Microbiology by Robert F. Boyd (1984), Times, Mirror/Mosby College.
12. A Biologics guide to principles, techniques of Practical Biochemistry by K. Wilson and K. H. Goulding, Edward Arnold Publication.
13. Introduction to Practical Biochemistry by D. Plummer, J. Willey and Sons.
14. Microbiology by Prescott, Herley and Klein, IInd edition.
15. Bacteriological Techniques by F. K. Baker
16. Introduction to Microbial Techniques by Gunasekaran.
17. Biochemical methods by Sadasivam& Manickam
18. Elementary Microbiology Vol. I by Dr. H.A. Modi, Akta Prakashan, Nadiad, Gujrat.
19. Principles of Biochemistry by Nelson and Cox (Lehninger) – Fifth edition.

Books recommended for Practical

1) Medical Microbiology by Cruickshank Vol. II.

2) Stains and Staining procedures by Desai and Desai.

3) Introduction to Practical Biochemistry by D. Plummer, J Wiley and Sons.

4) Bacteriological techniques by F. J. Baker.

5) Introduction to Microbial techniques by Gunasekaran.

6) Biochemical methods by Sadasivam and D. Manickam.

7) Laboratory methods in Biochemistry by J. Jayaraman.

8) Experimental Microbiology by Patel & Patel

SEMESTER- II

MINOR COURSE- III

COURSE TITLE: : Bacteriology

[CREDITS - 02; LECTURES - 30 hours; LEC/WEEK - 02]

Learning Objectives:

1. To describe the nutritional requirements of bacteria and other microbes which grow under extreme environments.
2. To understand the basic laboratory experiments to isolate, cultivate and differentiate bacteria
3. To study the preservation of bacteria in the laboratory

Learning Outcomes:

1. Capable of design the nutritional media of bacteria and other microbes which grow under extreme environments.

2. Able to isolate, cultivate and differentiate bacteria

3. Able to preserve of bacteria in the laboratory

Unit I / Credit I	Microbial Nutrition and Culture Media	No. of hours: 15
	A. Nutritional requirements of microorganisms: a. Water b. Micronutriments c. Macronutrients d. Carbon e. Energy source f. Oxygen g. Hydrogen h. Nitrogen i. Sulphur j. Phosphorous k. growth factors – auxotroph, prototroph and fastidious organisms. B. Nutritional types of microorganism based on carbon and energy sources: a. Autotrophs b. Heterotrophs c. Phototrophs d. Chemotrophs e. Photoautotrophs f. Chemoautotrophs g. Photoheterotrophs h. Chemoheterotrophs C. Types of Culture Media: a. Components of media b. Natural and Synthetic media c. Chemically defined media d. Complex media, Selective e. Differential f. Enriched g. Enrichment media. D. Cultivation of microorganisms: a. Use of culture media for cultivation b. Conditions required for growth of the microorganisms.	

Unit II / Credit II	**Isolation, Cultivation and Preservation of Microorganisms.**	**No. of hours: 15**
	E. Isolation of Microorganisms from natural habitats : a. Pure culture techniques – Streak plate, Spread plate, Pour Plate and micromanipulator b. Isolation and cultivation of anaerobic organisms by using media components and by exclusion of air/O2 F. Preservation of microbial cultures : a. Subculturing b. overlaying of cultures with mineral oils c. storage at low temperature d. lyophilization G. Systematic study of pure cultures: a. Morphological characteristics. b. Cultural characteristics : i. Colony characteristics on solid media ii. growth in liquid media iii. growth on agar slants H. Biochemical Characteristics – a. Sugar fermentation b. Production of metabolites - H_2S gas c. Production of enzymes - Amylase, Caseinase and Catalase.	

MINOR COURSE -IV

COURSE TITLE: Applied Microbiology

[CREDITS - 02; LECTURES - 30 hours; LEC/WEEK - 02]

Learning Objectives:

5. To develop a very good understanding of applied branches of Microbiology.
6. To develop the knowledge of how the microorganisms play role in Water microbiology
7. To make well conversant about food preservation techniques
8. To develop knowledge of milk processing and milk testing.

Unit I / Credit I	**Air and Water Microbiology**	**No. of hours: 15**
	1.Air Microbiology: **A.** Sources of microorganisms in air. **B.** Definitions of - Infectious dust, Droplets & Droplet nuclei **C.** Sampling methods for microbial examination of air 1. Solid impaction - Sieve device **D.** Liquid Impingement – Bead-bubbler device 2. Water Microbiology: a. Sources of microorganisms in water. b. Fecal pollution of water, Indictors of fecal pollution of water – *E. coli* c. Routine Bacteriological analysis of water. ii. SPC iii. Tests for coliforms - 1. Qualitative-Detection of coliforms - Presumptive test, Confirmed Test, Completed test. Differentiation between coliforms - IMViC test, Eijkman test. 2. Quantitative – MPN, Membrane filter technique d. Municipal water purification process and its significance.	

Unit II / Credit II	**Food and Dairy Microbiology**	**No. of hours: 15**
	1. Food Microbiology _ d. Introduction e. Microbial spoilage of food f. Food Preservation : General Principle and methods and Application Asepsis, Removal of Microorganisms, Dehydration, Use of Heat, Irradiation, Anaerobiosis, Chemicals 2. Milk Microbiology: H. Sources of microorganisms in milk I. General composition of Milk. J. Microbiological examination of Milk – DMC, SPC and dyereduction test- MBRT test K. Pasteurization - Definition, Methods – LTH , HTST ,UHT, Efficiency of Pasteurization– Phosphatase test (Qualitative)	

MINOR - PRACTICAL COURSE Pract. -II

COURSE TITLE : PRACTICALS BASED ON MINOR SUBJECT III & IV

Bacteriology and Applied Microbiology

: [CREDITS - 02; PRACTICALS - 60 hours , Practicals /week - 04]

Learning Objectives:

3. To understand the basic laboratory experiments to isolate and cultivate
4. To study various biochemical tests used to differentiate bacteria

Unit I / Credit I	**Study of Bacteria**	**No. of hours: 15**
	4. Demonstration of presence of micro flora in / on – 1. Air by solid impaction technique on nutrient agar plates 2. Water by direct cultivation method 3. Hand, nails, teeth and skin (swabbing) by direct cultivation methods. 5. Isolation of pure cultures of bacteria by four quadrant streaking method and study of Colony characteristics, Gram staining and motility of – *1. Escherichia coli* *2. Bacillus species* *3. Staphylococcus aureus* 6. Enumeration of bacteria from water and milk by SPC method.	
Unit II / Credit II	Biochemical Tests	No. of hours: 15
	1. IMViC Test 2. MBRT Test 3. H_2S production test 4. Sugar fermentation - glucose and lactose 5. Enzyme production - Amylase Catalase Caseinase	

Books recommended for Theory

4. Microbiology by Pelczar, M.J.Jr., Chan E.C.S., Krieq, N.R. 5th edition, 1986 (McGraw Hills Publication).
5. Fundamental Principles of bacteriology by A. J. Salle, Tata McGraw Hill.
6. Fundamentals of Microbiology by Frobisher, Hindsdill, Crabtree, Good Heart, W.B. Saunders

Company, 7th edition.

7. Medical Microbiology Vol. I and II by Cruick Shank R., Duguid J.P., Marmion B.P., Swain R.H.A., XIIth edition, Churchill Livingston, New York.
8. A textbook of Microbiology by Ananthnarayan – Orient Longman, Bombay
9. General Microbiology by Stanier R. Y. Vth edition, McMilan, London.
10. General Microbiology Vol I and II by Powar and Daginawala, Himalaya Publications.
11. Medical Bacteriology by Dey and Dey – Allied Agency, Calcutta.
12. Food Microbiology by W. C. Frazier.
13. Basic Experimental Microbiology by Ronal M. Atlas, Alfred E. Brown, Kenneth W. Dobra, Wonas Miller (1986) Pren-tice Hall.
14. General Microbiology by Robert F. Boyd (1984), Times, Mirror/Mosby College.
15. A Biologics guide to principles, techniques of Practical Biochemistry by K. Wilson and K. H. Goulding, Edward Arnold Publication.
16. Introduction to Practical Biochemistry by D. Plummer, J. Willey and Sons.
17. Microbiology by Prescott, Herley and Klein, IInd edition.
18. Bacteriological Techniques by F. K. Baker
19. Introduction to Microbial Techniques by Gunasekaran.
20. Biochemical methods by Sadasivam& Manickam
21. Elementary Microbiology Vol. I by Dr. H.A. Modi, Akta Prakashan, Nadiad, Gujrat.
22. Principles of Biochemistry by Nelson and Cox (Lehninger) – Fifth edition.

Books recommended for Practical

a. Medical Microbiology by Cruickshank Vol. II.
b. Stains and Staining procedures by Desai and Desai.
c. Introduction to Practical Biochemistry by D. Plummer, J Wiley and Sons.
d. Bacteriological techniques by F. J. Baker.
e. Introduction to Microbial techniques by Gunasekaran.
f. Biochemical methods by Sadasivam and D. Manickam.
g. Laboratory methods in Biochemistry by J. Jayaraman.
h. Experimental Microbiology by Patel & Patel

OPEN ELECTIVE COURSE-OE-III

COURSE TITLE: Medical Lab technology

[CREDITS - 02; LECTURES - 30 hours; LEC/WEEK - 02]

Course Learning objectives
The objective of this course is to; **1)** Understand the skills for diagnosis of pathogens ¬ **2)** Widen their knowledge in Collection of samples, transport of clinical samples. **3)** Become skilful in lab diagnosis
Course leraning outcomes
After completion of this course learner will be able to; 1. Capable of collection of clinical samples. 2. Capable of diagnosis of diseases 3. Acquire knowledge about different media, isolation of pathogens and diagnosis.

Credit I	**Importance of diagnosis**	**No. of hours: 15**
	1. Importance of Diagnosis of Diseases Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Types of disease associated clinical samples for diagnosis 2. Collection of Clinical Samples : Containers used for collection of clinical samples, Collection of clinical samples (Sputum, Skin, Blood, Urine and Stool)with proper precautions Transport media and Methods of transport of clinical samples to the laboratory and storage 3. Direct Microscopic Examination and Culture : Examination of sample by staining - Gram staining, Ziehl-Nelson staining, Giemsas staining, Blood smears for Malaria 4. Preparation and use of culture media-Blood agar, Chocolate	

	agar, Lowenstein-Jensen medium, MacConkey agar, Mannitol salt agar, Wilson and Blair agar, Bared Parker media, XLD media.	
Credit II	Methods of diagnosis	**No. of hours: 15**
	1. Serological and Molecular Methods Serological Methods -Agglutination, ELISA, Immunofluorescence, Nucleic acid based methods -PCR, Nucleic acid probes 2. Kits for Rapid Detection of Pathogens, Dengue, Malaria, Typhoid, and HIV 3. Testing for Antibiotic Sensitivity in Bacteria 1.Determination of resistance/sensitivity of bacteria against antibiotic (Penicillin/Streptomycin) using disc diffusion method. 2.Determination of minimal inhibitory concentration (MIC) of an antibiotic using agar well and broth dilution method. 3.Estimation of sugar by Benedicts method 4.Determination of SGPT/SGOT levels 4. Diagnosis of TB Genexpert test and Line probe assay for diagnosis of TB	

Reference Books

1. Ananthanarayan R and Paniker C K J (2009) Textbook of Microbiology, 8th edition, Universities Press Private Ltd. 2. BrooksG.F.,CarrollK.C.,ButelJ.S.,MorseS.A.andMietzner,T.A.(2013)Jawetz,MelnickandAdelberg'sMedicalMicrobiology.26th edition. McGraw Hill Publication 3. Collee JG, Duguid JP, Fraser AG, Marmion BP(1989) Practical Medical Microbiology, 13th edition, Churchill Livingstone 4. Randhawa,VS,MehtaGandSharmaKB(2009)PracticalsandVivainMedicalMicrobiology 2nd edition, Elsevier India Pvt Ltd

OPEN ELECTIVE COURSE-OE-IV

COURSE TITLE: BIOFERTILIZER TECHNOLOGY

[CREDITS - 02; LECTURES - 30 hours;]

Learning objectives: 1. To learn about types of biofertilizers 2. To learn production technology for biofertilizers
Learning Outcomes: 1. Able to explain all kinds of biofertilizers 2. Cable of producing biofertilizers and became skilful self employer. 3. Acquire knowledge about mass scale cultivation

Credit-I	**Types of Biofertilizers**	**15 Hours**
1	Different Agriculturally important beneficial Microorganisms. Introduction and scope of Biofertilizers.	
2	Types and classification of Biofertilizers. Total Biofertilizer production in India.	
3	Different Nitrogen Biofertilizers. Symbiotic & Non Symbiotic Nitrogen fixation.	
4	Nodule formation, Competitiveness, Quantification of Nitrogen fixed.	
5	Associative and Free living Nitrogen fixation. Cynobacterial Biofertilizers.	
6	Phosphate solubulising Bacteria and Fungi. Mechanism and solubulization of Phosphorus	
7	Phosphate mobilizing microorganisms. VAM in detail.	
8	Potassium and Zinc Biofertilizers.	
9	Plant Growth Promoting Biofertilizers (PGPR)	

Credit-II	**Production Technology**	**15 Hours**
1	Isolation techniques of Nitrogen fixing organisms *Rhizobium*, *Azotobacter and* Phosphate solubilizing mobilizing microbes from soil sample	
2	Development & production techniques of efficient Microbes. Preservation and pure cultures development.	
3	Study of Nitrogen fixing mechanism and detection of nitrogen fixing Activity by ARA method.	

4	Indole Acetic Acid and Production technique of Indole Acetic Acid (IAA).	
5	Siderophores, activity, significance and Production of Siderophores.	
6	Production technique for different Carrier based Biofertilizers. Bacterial and Fungal.	
7	Quality parameters of Biofertilizers	
8	Biofertilizers Production technology; Strain selection, Sterilization, Growth and Fermentation.	
9	Mass scale production of different carrier and liquid based biofertilizers.	
10	FCO specifications and quality control of biofertilizers.	

REFERENCES

1. Biofertilisers in Agriculture by N. S. Subba Rao.
2. Recent Trends in Biofertilisers by Pati Bikasir and Mandal Santi, M.
3. The complete technology book on Biofertiliser and Organic Farming (2nd revised edition) by Niir Board. 2012 published.
4. Hand book of Microbial Biofertilisers by Mahendra Rai. Published in 2006 by CRC Press.
5. Biofertiliser in Sustainable Agriculture by A. C. Guar. Published by ICAR.
6. Biofertilisers Technology by S. Kannaiyan, K. Kumar and Govindarajan published by Scientific Publishers (India) 2004.

SKILL ENHANCEMENT COURSE-(SEC-II)

Course Title: Industrial Skills-I (Bacteriological analysis of Air, Water and Milk)

[CREDITS - 02; LECTURES - 30 hours; LEC/WEEK - 02]

Learning objectives

1. To learn about the bacteriology of Air, water and Milk.
2. Students will learn about bacteriological analysis of Air, Water and Milk

Learning Outcomes

1. Students will be capable of explain bacteriology and presence of pathogens in Air, Water and Milk.
2. Capable of bacteriological analysis of Air, Water and Milk.

Credit-I	Bacteriology of Air, Water	**15 Hours**
1	Aero microbiology :Definition, 1. Bioaerosols; Air borne microorganisms and their significance. Bioaerosol sampling; Air samplers; Methods of sampling and analysis; Culture media for bacteria and fungi; Identification characteristics. 2. Bioaerosols Inactivation mechanisms (U.V. light, H.E.P.A filters, desiccation and incineration);	
2	Water Microbiology: Fecal pollution of water, Indictors of fecal pollution of water 1. Water-borne pathogens; Water-borne diseases. 2. Purification and Treatment of water: Precipitation and Flocculation, Chemical disinfection, Filtration, High temperature and U.V. light treatment. **3. Microbiological Analysis of Water** Safety of drinking (potable) water, Water purification, Methods to detect potability of water samples: Sample collection, 1 . Standard qualitative procedures- Presumptive, Confirm, Completed test, Rapid detection of E.coli by MUG test. 2. Quantitative tests: (a)(MPNtest) (b) Membrane filter technique and	

Credit-II	**Milk Microbiology**	**15 Hours**
1.	**Microorganisms in milk.** Starter culture and its types-(single, mixed) Sources of contamination of milk. Microbiological analysis of milk- a) Qualitative tests: 1. Dye reduction tests: 2. MBRT test, 3. Resazurin test 4. Rapid platform tests(organoleptic, alcohol, COB, Alcohol test, 5. Phosphatase test, b) Quantitative tests: SPC, DMC. c) Preservation of milk- Pasteurization. Dehydration, sterilization. . Packing of milk and dairy products.	

SKILL ENHANCEMENT COURSE-(SEC-II)Practicals

Course Title: (Bacteriological analysis of Air, Water and Milk)

[CREDITS - 02; LECTURES - 60 hours; LEC/WEEK - 04]

Learning objectives
1. To get hands on training in Air, Water and Milk analysis
Learning Outcomes
1. Students will be capable of Capable of performing analysis of Air, Water and Milk independently. 2. Will work in analytical laboratory as skilled person

Credit-I	**Air and Water**	**30 Hours**
1	Enumeration of microorganisms in Air before and after fumigation by 1.solid impaction method 2.Liquid impingement method Using culture media for bacteria and fungi	
2	Study of Effect of U.V. light on Bioaerosols Inactivation	
3	Bacteriological analysis of water: 1 . Standard qualitative procedures- a.Presumptive test b. Confirmatory test using BGLBB and Endo agar. c.Rapid detection of E.coli by MUG test 2. Quantitative tests: MPNtest	
Credit-II	**Nutritional and Bacteriological Analysis of Milk**	**30 Hours**
	1. Nutritional analysis: a.Estimation of protein from milk by formal titration b.Estimation of carbohydrate from milk by DNSA method 2. Bacteriological analysis of Milk a) Qualitative tests: 1. Dye reduction tests: a.MBRT test, b.Resazurine test 2. Rapid platform tests(organoleptic, COB, Alcohol test, Specific gravity. 3. Phosphatase test, b) Quantitative tests: SPC, DMC.	

References:

1. Da Silva, N., Taniwaki, M.H., Junqueira, V.C., Silveira, N., Nascimento, M.S., Gomes, R.A.R. Microbiological examination methods of food and water: A laboratorymanual.CRC Press, Boca Raton.
2. Atlas, R.M. and Bartha, R. Microbial ecology: Fundamentals and applications.Benjamin/Cummings Science Publishing, USA.
3. Madigan, M.T., Martinko, J.M. and Parker, J. Brock biology of icroorganisms. PrenticeHall, New Jersey.
4. Mitchell, R. and Gu, J.D. Environmental microbiology. Wiley-Blackwell, New Jersey.
5. Maier, R., Pepper, I. and Gerba, C. Environmental microbiology. Academic Press,SanDiego.
6. Adams, M.R., and Moss, M.O. Food microbiology. Royal Society of Chemistry Publication, Cambridge.
7. Frazier, W.C. and Westhoff, D.C. Food microbiology. Tata McGraw Hill, New Delhi.
8. Stanbuty, P.F. and Hall, S.J. Principles of fermentation technology. PergamonPress,Oxford.
9. Robinson, R.K. Dairy microbiology. Elsevier Applied Sciences, London.
10. James M.J. Modern food microbiology. CBS Publishers and Distributors, New Delhi.

List of Minimum Equipment's

1. Hot air oven – 1
2. Incubator - 1
3. Autoclave - 1
4. Refrigerator – 1
5. Medical microscopes - 10 nos. for one batch
6. Digital balance - 2
7. pH meter - 1
8. Seitz filter –1
9. Centrifuge -1
10. Colorimeter - 1
11. Distilled Water Plant – 1
12. Laminar air flow cabinet - 1
13. Arrangements for gas supply and fitting of two burners per table.
14. One working table of 6' x 2½' for two students.
15. One separate sterilization room attach to the laboratory (10' x 15')
16. At least one wash basin for a group of five students
17. Colony counter
18. Water bath
19. One separate instrument room attached to lab (10' x 15')
20. One laboratory for one batch including working tables (6' x 2½') per two students for one batch
21. Store room (10' x 15')
22. Lactometer

Practical Examination

(A) The practical examination will be conducted on two consecutive days for three hours per day per batch of the practical examination.

(B) Each candidate must produce a certificate from the Head of the Department in her/his college, stating that he/she has completed in a satisfactory manner the practical course on lines laid down from time to time by Academic Council on the recommendations of Board of Studies and that the journal has been properly maintained. Every candidate must have recorded his/her observations in the laboratory journal and have written a report on each exercise performed. Every journal is to be checked and signed periodically by a member of teaching staff and certified by the Head of the Department at the end of the year. Candidates must produce their journals at the time of practical examinations.

(C) Nature of question paper and distribution of marks for Practical Examination

Q.1	Special Staining	10
Q.2	Isolation and study of colony characters, gram nature and motility of bacteria / Enumeration of bacteria from water / milk by SPC	15
Q.3	Biochemical tests /Detection of enzyme activity	10
Q.4	Spotting	10
Q.5	Journal	05
	Total Marks	50

Modality of Assessment

Students appearing for the NEP BSc l Microbiology will be evaluated as per the 80:20 scheme wherein the term end exam will be of 80 marks while 20 marks will be through internal evaluation.

I. Theory -

A. Internal assessment 20%

Sr No	Evaluation type	Marks
1.	Evaluation modalities: 1. Assignments that can include a. Essay Writing b. Solving Subjective Questions c. Problem Solving d. Report on lab/industry visit e. Any other subject/content specific assignments 2. Project based learning activities a. Group Discussion b. Research/Case studies c. Seminar Presentations d. Skits e. Poster Presentation f. Debate 3. Self-study/Class test	15
2	**a.** Active participation in routine class instructional deliveries **b.** Overall conduct as a responsible student, w.r.t manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular activities, etc.	05

B. External examination - 80%

Semester End Theory Assessment 40 marks

- The duration of this exam will be of 2 Hrs (120 minutes)
- For each unit there will be at least one question
- All questions shall be compulsory with internal choice within the questions

II. Practical Examination pattern

Semester 1

Practical Course	Major Techni que - I	Minor Techni que - I	Minor Techni que - II	Quiz/Spotti ng	Jour nal	Total
DSC Pract-I	15	10	10	10	05	50 Marks
SEC-Pract-I	15	10	10	10	05	50 Marks

Semester 2

Practical Course	Major Techni que - I	Minor Techni que - I	Minor Techni que - II	Quiz /Spot ting	Journa l	Total
DSC Pract-II	15	10	10	10	05	50 Marks
SEC-Pract-II	15	10	10	10	05	50 Marks

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