

CBCS SYLLABUS
FOR
THREE YEARS UNDER-GRADUATE COURSE
IN
MICROBIOLOGY (PROGRAMME)
(w.e.f. 2017)



BANKURA UNIVERSITY
BANKURA
WEST BENGAL
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1. INTRODUCTION

The syllabus for Microbiology at undergraduate level using the Choice Based Credit system has been framed in compliance with model syllabus given by UGC.

The main objective of framing this new syllabus is to give the students a holistic understanding of the subject giving substantial weightage to both the core content and techniques used in Microbiology.

The ultimate goal of the syllabus is that the students at the end are able to secure a job. Keeping in mind and in tune with the changing nature of the subject, adequate emphasis has been given on new techniques of mapping and understanding of the subject.

The syllabus has also been framed in such a way that the basic skills of subject are taught to the students, and everyone might not need to go for higher studies and the scope of securing a job after graduation will increase.

It is essential that Microbiology students select their general electives courses Chemistry as compulsory and any one from the branch of Life Sciences disciplines.

While the syllabus is in compliance with UGC model curriculum, it is necessary that Microbiology students should learn “Bioinformatics, Microbes in Sustainable Agriculture and Development & Instrumentation and Biotechniques” as one of the core courses rather than as elective while. Course on “Concept of Genetics” has been moved to electives.

Also, it is recommended that the Project Work and Industrial Tour is compulsory for all the students as per their respective semester curriculum.



2. Scheme for CBCS Curriculum

2.1 Credit Distribution across Courses

			Credits
Course Type	Total Papers	Theory + Practical	Theory*
Core Courses			
Discipline Specific Electives			
Generic Electives			
Ability Enhancement Language Courses			
Skill Enhancement Courses			
Totals			

*Tutorials of 1 Credit will be conducted in case there is no practical component

Note:

- Microbiology students will be encouraged to take at least one Chemistry course as General Elective along with others from any branch of Life Science
- The DSE, SE courses may be made compulsory



2.2 Scheme for CBCS Curriculum

SEMESTER	COURSE	COURSE DETAIL	CREDITS
I	Ability Enhancement Compulsory Course – I	English communication / Environmental Science	2
	Core course – 1A	Introduction and scope of Microbiology	4
	Core course – 1A Practical	Introduction and scope of Microbiology	2
	Core course – 2A	Discipline 2	4
	Core course – 2A Practical	Discipline 2	2
	Core course – 3A	Discipline 3	4
	Core course – 3A Practical	Discipline 3	2
II	Ability Enhancement Compulsory Course – II	English communication / Environmental Science	2
	Core course – 1B	Bacteriology and Virology	4
	Core course – 1B Practical	Bacteriology and Virology	2
	Core course – 2B	Discipline 2	4
	Core course – 2B Practical	Discipline 2	2
	Core course – 3B	Discipline 3	4
	Core course – 3B Practical	Discipline 3	2
III	Core course – 1C	MicrobialMetabolism	4
	Core course – 1C Practical	MicrobialMetabolism	2
	Core course – 2C	Discipline 2	4
	Core course – 2C Practical	Discipline 2	2
	Core course – 3C	Discipline 3	4
	Core course –3C Practical	Discipline 3	2
	Skill Enhancement Course – 1	MicrobiologicalAnalysisofAirandWater	2
IV	Core course – 1D	Medical Microbiology and Immunology	4
	Core course – 1D Practical	Medical Microbiology and Immunology	2
	Core course – 2D	Discipline 2	4
	Core course – 2D Practical	Discipline 2	2
	Core course – 3D	Discipline 3	4
	Core course – 3D Practical	Discipline 3	2
	Skill Enhancement Course-2	MicrobialDiagnosisinHealthClinics	2



V	Discipline Specific Elective (5)-1A	Industrial and Food Microbiology	4
	Discipline Specific Elective (5) – 1A Practical	Industrial and Food Microbiology	2
	Discipline Specific Elective – 2A	Discipline 2	4
	Discipline Specific Elective – 2A Practical	Discipline 2	2
	Discipline Specific Elective – 3A	Discipline 3	4
	Discipline Specific Elective – 3A Practical	Discipline 3	2
	Skill Enhancement Course-3	Food Fermentation Techniques	2
VI	Discipline Specific Elective (6)-1B	Microbes in Environment	4
	Discipline Specific Elective (6)-1B Practical	Microbes in Environment	2
	Discipline Specific Elective (6)-2B	Discipline 2	4
	Discipline Specific Elective (6)-2B	Discipline 2	2
	Discipline Specific Elective (6)-3B	Discipline 3	4
	Discipline Specific Elective (6)-3B	Discipline 3	2
	Skill Enhancement Course-4	Biofertilizers and Biopesticides	2

2.3 Choices for Discipline Specific Electives

DSE(5)-1A	Industrial and Food Microbiology
DSE(6)-1B	Microbes in Environment

2.4 Choices for Skill Enhancement Courses

SEC-1	Microbiological Analysis of Air and Water
SEC-2	Microbial Diagnosis in Health Clinics
SEC-3	Food Fermentation Techniques
SEC-4	Biofertilizers and Biopesticides

**3. Core T-1A/GE-1: INTRODUCTION AND SCOPE OF MICROBIOLOGY**

INTRODUCTION AND SCOPE OF MICROBIOLOGY
4 CREDITS
Unit 1 History and Development of Microbiology
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.
Unit 2 Principle and Application of Important Instruments
Biological Safety Cabinet, Autoclave, Incubator, Hot Air Oven, Light Microscope.
Unit 3 Media Type
A brief idea regarding Media type (Natural, Synthetic, Semi-synthetic, Selective and Differential) and Preservation of Microorganisms.
Unit 4 An Overview of the Scope of Microbiology

Core P-1A/GE-1: INTRODUCTION AND SCOPE OF MICROBIOLOGY

INTRODUCTION AND SCOPE OF MICROBIOLOGY
2 CREDITS
List of Practical
<ol style="list-style-type: none"> 1. Microbiology Laboratory Management and Biosafety 2. To study the principle and applications of important instruments (autoclave, incubator, hot air oven, centrifuger, light microscope, pH meter) used in the microbiology laboratory 3. Preparation of Natural media for bacterial cultivation 4. Preparation of Culture media (Nutrient Broth and Nutrient Agar) for bacterial cultivation 5. Preparation of Semi-synthetic media (PDF). 6. Sterilization of medium using Autoclave and assessment for sterility 7. Sterilization of glassware using Hot Air Oven

**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. McGrawHill 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.

3. Core T-1B/GE-2: BACTERIOLOGY AND VIROLOGY**BACTERIOLOGY AND VIROLOGY****4 CREDITS****Unit 1 Cell Organization**

Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Gram staining mechanisms. Effect of antibiotics and enzymes on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial cell membranes. Cytoplasm: Ribosomes, mesosomes, nucleoid and plasmids Endospore: Structure, formation, stages of sporulation.

Unit 2 Bacteriological Techniques

Pure culture isolation: Serial dilution, Streaking, Spreading and pour plating methods; Preservation of pure cultures by Slant and Stab methods.

Unit 3 Microscopy

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

Unit 4 Control of Microorganism

Physical methods of microbial control: heat, filtration, radiation Chemical methods of microbial



control: disinfectants, types and mode of action of ethanol, phenolics, ethylene oxide, formaldehyde and halogens.

Unit 5 Nature, Properties and Classification of Viruses

Discovery of Viruses, Nature and Definition of Viruses, General properties, Structural organization and chemistry of Viruses. Classification of Virus according to ICTV, Viral assay.

Unit 6 Bacteriophage

Lytic cycle of Bacteriophages with reference to *E.coli* and T4; Lysogenic conversion and significance.

Core P-1B/GE-2: BACTERIOLOGY AND VIROLOGY

BACTERIOLOGY AND VIROLOGY	
	2 CREDITS
List of Practical	
<ol style="list-style-type: none"> 1. Simple staining 2. Gram's staining 3. Endospore staining. 4. Isolation of pure cultures of bacteria by streaking method. 5. Preservation of bacterial cultures (slant / stab). 6. Estimation of CFU count by spread plate method/pour plate method. 10. Demonstration of Plaque assay 	
Reference Books	
<ol style="list-style-type: none"> 1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.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. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht 6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan. 7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education. 8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education. 9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited 	

**3. Core T-1C/GE-3: MICROBIAL METABOLISM**

MICROBIAL METABOLISM	
	4 CREDITS
Unit 1 Microbial Growth	
Definitions of growth, measurement of microbial growth, Generation time, Kinetics of Growth, Batch culture, Phases of Growth, Continuous culture, Chemostat, Turbidostat. Synchronous growth, Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermotolerants, psychrotrophs), pH (acidophiles, alkaliphiles), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe).	
Unit 2 Microbial Nutrition	
Define Nutrition, Nutritional types (Definition with example only) – Autotroph/Phototroph, heterotroph, Photoautotrophs, Photoorganotrophs, Chemolithotrophs (Ammonia, Nitrate, Sulphur, Hydrogen, Iron oxidizing bacteria), Chemoorganotrophs.	
Unit 3 Aerobic Respiration	
Concept of aerobic respiration. Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway. TCA cycle. Brief concept of Electron transport chain: components of respiratory chain.	
Unit 4 Anaerobic Respiration	
Brief description regarding Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction. Fermentation - Alcohol fermentation; Lactate fermentation (homofermentative and heterofermentative pathways).	

Core P-1C/GE-3: MICROBIAL METABOLISM

MICROBIAL METABOLISM	
	2 CREDITS

**List of Practical**

1. Study and plot the growth curve of *E. coli* by turbidometric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E. coli*
4. Effect of pH on growth of *E. coli*
5. Effect of salt on growth of *E. coli*

Reference Books

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
6. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
7. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

3. Core T-1D/GE-4: MEDICAL MICROBIOLOGY AND IMMUNOLOGY**MEDICAL MICROBIOLOGY AND IMMUNOLOGY****4 CREDITS****Unit 1 Normal microflora of the human body and host pathogen interaction**

Normal microflora of skin, respiratory tract, gastrointestinal tract, urogenital tract
 Host pathogen interaction: Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers, reservoir, Opportunistic infections, Nosocomial infections, Epidemic, Endemic, Pandemic

Unit 2 Microbial diseases

Transmission, pathogenicity, prevention and treatment of following diseases:

Bacterial: Typhoid

Viral: AIDS

Fungal: Candidiasis

Unit 3 Immune Cells and Organs

Structure, Functions and Properties of:

Immune Cells – B cell, T cell, NK cell, Macrophage, Dendritic cell, Stem cell



Immune Organs – BoneMarrow, Thymus, Lymph Node, Spleen
Unit 4 Antigens and Antibodies
Characteristics of an antigen, Conceptof Epitopes, Adjuvants, Haptens, CarrierTypes , Structureand Functions of antibodies.
Unit 5 Generation of Immune Response
Generation of Humoral and Cell Mediated Immune Response Antibody dependent cellular cytotoxicity (ADCC)
Unit 6 Immunological Techniques
Principles of Precipitation, Agglutination, Immunoelctrophoresis, ELISA, ELISPOT

CoreP-1D/GE-4: MEDICAL MICROBIOLOGY AND IMMUNOLOGY

MEDICAL MICROBIOLOGY AND IMMUNOLOGY	2 CREDITS
List of Practical	
1. Identify bacteria on the basis of cultural, morphological and biochemical characteristics: IMViC,nitrate reduction, acid & gas production and catalase tests	
2. Study of composition and use of important differential media for identification of bacteria: EMB Agar/McConkey agar, Mannitol salt agar.	
3. Study of bacterial flora of skin by swab method	
4. Perform antibacterial sensitivity by Kirby-Bauer method	
5. Identification of human blood groups	
6. To separate serum from the blood sample (demonstration).	

Reference Books
1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, 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, New York.



**B.Sc. (HONOURS) MICROBIOLOGY (CBCS
STRUCTURE)
DISCIPLINE SPECIFIC ELECTIVES**

**DSE (5)-T-1A: INDUSTRIAL AND FOOD MICROBIOLOGY**

INDUSTRIAL AND FOOD MICROBIOLOGY
4 CREDITS
Unit 1 Introduction to Industrial Microbiology
Brief history and developments in industrial microbiology Types of fermentation processes - solid state, liquid state, batch, fed-batch and continuous Types of fermenters – laboratory, pilot-scale and production fermenters Components of a typical continuously stirred tank bioreactor
Unit 2 Isolation of Industrial Strains and Fermentation Medium
Primary and secondary screening Preservation and maintenance of industrial strains Ingredients used in fermentation medium - molasses, corn steep liquor, whey & Yeast extract
Unit 3 Microbial Fermentation Processes
Downstream processing - filtration, centrifugation, solvent extraction. Microbial production of industrial products - ethanol Industrial production and uses of the enzymes – amylases
Unit 4 Food as a Substrate for Microbial Growth
Intrinsic and extrinsic parameters that affect microbial growth in food Microbial spoilage of food - milk, egg.
Unit 5 Principles and Methods of Food Preservation and Food Sanitation
Physical methods - high temperature, low temperature, irradiation, aseptic packaging Chemical methods - salt, sugar, benzoates, citric acid, ethylene oxide, nitrate and nitrite Food sanitation and control – HACCP
Unit 6 Food Born Diseases
Food intoxication by <i>Clostridium botulinum</i> and <i>Staphylococcus aureus</i> Food infection by <i>Salmonella</i> and <i>E.coli</i>

**DSE(5)-P-1A:INDISTRIAL AND FOOD MICROBIOLOGY****INDUSTRIAL AND FOOD MICROBIOLOGY****2 CREDITS****List of Practical**

1. Microbial fermentation for the production and estimation of amylase
2. Microbial fermentation for the production and estimation of ethanol (DEMONSTRATION)
3. Determination of the microbiological quality of milk sample by MBRT
4. Isolation of fungi from spoilt bread/fruits/vegetables
5. Preparation of Yogurt/Dahi

Reference Books

1. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd Edition. Panima Publishing Company, New Delhi
2. Patel AH. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An introduction.9th Edition. Pearson Education
4. Willey JM, Sherwood LM AND Woolverton CJ (2013), Prescott, Harley and Klein's Microbiology.9th Edition. McGraw Hill Higher education
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
7. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
8. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
9. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
10. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.

**DSC (6)-T-1B: MICROBES IN ENVIRONMENT**

MICROBES IN ENVIRONMENT
4 CREDITS
Unit 1 Microorganisms and their Habitats
<p>Structure and function of ecosystems</p> <p>Terrestrial Environment: Soil profile and soil microflora</p> <p>Aquatic Environment: Microflora of fresh water and marine habitats</p> <p>Atmosphere: Aeromicroflora and dispersal of microbes</p> <p>Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body.</p> <p>Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, salinity.</p>
Unit 2 Microbial Interactions
<p>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.</p>
Unit 3 Biogeochemical Cycling
<p>Carbon cycle: Microbial degradation of cellulose, hemicelluloses.</p> <p>Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction</p> <p>Phosphorus cycle: Phosphate immobilization and solubilisation</p>
Unit 4 Waste Management
<p>Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill)</p> <p>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.</p>
Unit 5 Water Potability
<p>Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique.</p>

**DSC (6)-P-1B:MICROBES IN ENVIRONMENT****MICROBES IN ENVIRONMENT****2 CREDITS****List of Practical**

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28°C & 45°C).
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4. Assessment of microbiological quality of water.
5. Determination of BOD of waste water sample.
6. 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/ Benjamin Cummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
8. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
9. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
11. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition.



**B.Sc. (HONOURS) MICROBIOLOGY (CBCS
STRUCTURE)
SKILL ENHANCEMENT COURSES**

**SEC-1: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER**

MICROBIOLOGICAL ANALYSIS OF AIR AND WATER	
	4 CREDITS
Unit 1 Aeromicrobiology	
Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi, each from every category) and their impact on human health, and environment, significance in food and pharma industries and operation theatres, allergens.	
Unit 2 Air Sample Collection and Analysis	
Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics	
Unit 3 Control Measures	
Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration	
Unit 4 Water Microbiology	
Water borne pathogens, water borne diseases (any one)	
Unit 5 Microbiological Analysis of Water	
Sample Collection, Methods to detect potability of water samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique. Control measures by precipitation, chemical disinfection, filtration.	
Reference Books	
<ol style="list-style-type: none"> 1. 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 2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA 3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press 4. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3rd edition, ASM press 	

**SEC-2: MICROBIAL DIAGNOSIS IN HEALTH CLINICS**

MICROBIAL DIAGNOSIS IN HEALTH CLINICS
2 CREDITS
Unit 1 Importance of Diagnosis of Diseases
Bacterial, Viral Diseases of various human body systems, Disease associated clinical samples for diagnosis
Unit 2 Collection of Clinical Samples
Collection of clinical samples (Sputum, Blood and Urine) with proper precautions Method of transport of clinical samples to the laboratory and storage
Unit 3 Direct Microscopic Examination and Culture
Examination of sample by staining - Gram staining, Ziehl-Neelson staining. Preparation and use of culture media - Blood agar, MacConkey agar.
Unit 4: Kits for Rapid Detection of Pathogens
ELISA, Widal test.
Unit 5: Testing for Antibiotic Sensitivity in Bacteria
Determination of resistance/sensitivity of bacteria against antibiotic (Penicillin/Streptomycin) using disc diffusion method. Determination of minimal inhibitory concentration (MIC) of an antibiotic (Penicillin/Streptomycin)
Reference Books
1. Ananthanarayan R and Paniker CKJ (2009) Textbook of Microbiology, 8th edition, Universities Press Private Ltd. 2. 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 3. Collee JG, Duguid JP, Fraser AG, Marmion BP(1989) Practical Medical Microbiology, 13 th edition, Churchill Livingstone 4. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2 nd edition, Elsevier India Pvt Ltd

**SEC-3: FOOD FERMENTATION TECHNIQUES**

FOOD FERMENTATION TECHNIQUES	
	4 CREDITS
Unit 1 Fermented Foods	
Definition, types, advantages and health benefits.	
Unit 2 Milk Based Fermented Food	
Yogurt and Cheese: Preparation of inoculums, types of microorganisms and production process.	
Unit 3 Grain Based Fermented Foods	
Bread, Idli: Microorganism and production process.	
Unit 4 Vegetables Based Fermented Foods	
Saeurkraut: Microorganism and production process.	
Unit 5 Fermented Meat and Fish	
Types, Microorganism involved, Fermentation process.	
Unit 6 Probiotic Foods	
Definition, Types, Microorganism and Health Benefits.	
Reference Books	
<ol style="list-style-type: none">1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer	

**SEC-4: BIOFERTILIZER AND BIOPESTICIDES**

BIOFERTILIZER AND BIOPESTICIDES
4 CREDITS
Unit 1 Biofertilizers
General account of the microbes used as biofertilizers (any one) for various crop plants and their advantages over chemical fertilizers. Symbiotic N ₂ fixers: <i>Rhizobium</i> - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants
Unit 2 Non-Symbiotic Nitrogen Fixers
Free living <i>Azotobacter</i> - free isolation, characteristics, mass inoculums, production and field application.
Unit 3 Phosphate Solubilizers
Phosphate solubilizing microbes (any one) - Isolation, characterization, mass inoculum production, field Application
Unit 4 Mycorrhizal Biofertilizers
Importance of mycorrhizal inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM.
Unit 5 Bioinsecticides
General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, <i>Bacillus thuringiensis</i> , production, Field applications.
Reference Books
<ol style="list-style-type: none"> 1. Kannaiyan, S. (2003). Bioetchnology of Biofertilizers, CHIPS, Texas. 2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York. 3. Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers. 4. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. NewDelhi. 5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG 6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.