

## Detailed B.Sc. Microbiology Syllabus

S. Y. B.Sc. Syllabus with effect from the Academic year 2022-2023

### Syllabus - S. Y. B.Sc. Microbiology

Course No.	Course Title	Course Code	Credits	Hr	Periods (50 min)	Module	Lectures per module (50 minutes)	Examination		
								Internal Marks	External Marks	Total Marks
<b>SEMESTER III</b>										
<b>Core courses THEORY</b>										
I	Medical Microbiology	22US3MBCC1MDM	2	30	36	3	12	40	60	100
II	Genetics, Virology & Taxonomy	22US3MBCC2GVT	2	30	36	3	12	40	60	100
III	Environmental Microbiology	22US3MBCC3EVM	2	30	36	3	12	40	60	100
IV	Soil Microbiology	22US3MBCC4SOM	2	30	36	3	12	40	60	100
<b>Core courses PRACTICAL</b>										
		1.22US3MBCC1P 2.22US3MBCC2P 3.22US3MBCC3P OR 22US3MBCC4P	3	90	108	-	-	40	60	100

**SEMESTER IV**

Core courses THEORY

I	Immunology	22US4MBCCI- IMM	2	3 0	36	3	12	40	60	100
II	Concepts in Biochemis- try	22US4MBCC2CBC	2	3 0	36	3	12	40	60	100
III	Industrial & Food Microbiolog- y	22US4MBCC3IFM	2	3 0	36	3	12	40	60	100
IV	Dairy Microbiolog- y	22US4MBCC4DAM	2	3 0	36	3	12	40	60	100

Core courses PRACTICAL

		1. 22US4MBCCIP 2. 22US4MBCC2P 3. 22US4MBCC3P OR 22US4MBCC4P	3	90	108	-	-	40	60	100
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S.Y. B. Sc. (MICROBIOLOGY) SEMESTER III

Core course - I

COURSE TITLE: Medical Microbiology

COURSE CODE: 22US3MBCCIMDM [CREDITS - 02]

**Course Learning Outcomes**

After the successful completion of the three courses, the learner should be able to:

1. Explain and analyse the concept of host microorganism interaction.
2. Describe the pathogenicity of microorganisms.
3. Demonstrate a basic understanding of epidemiologic methods and study design.

<b>Module 1</b>	<b>Host-Microorganism Interaction</b>	<b>[12L]</b>
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**Learning Objectives:**

This module is intended to :

1. Explore the host-microorganism interactions.
2. Describe the entry, invasion and dissemination of microorganisms in the human host.
3. Acquire the knowledge of genetics of virulence.

**Learning Outcomes:**

After the successful completion of the module, the learner will be able to

1. Explain the significance of host microbes interaction.
2. Discuss the factors contributing to specific and nonspecific host defense systems.
3. Describe the colonization process by microorganisms.

1.1	The encounter between host and microorganism : 1.1.1) The human host's Perspective-	02
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	<ul style="list-style-type: none"> <li>a) Microbial reservoirs and transmission</li> <li>b) Human as Microbial Reservoirs</li> <li>c) Animals as Microbial Reservoirs</li> <li>d) Birds as Microbial Reservoirs</li> <li>e) Insect as vectors</li> <li>f) The environment as Microbial Reservoir</li> </ul> <p>1.1.2) The Microorganism's perspective</p>	
1.2	<p>Microorganism colonization of host surfaces:</p> <p>1.2.1) The host's Perspective-</p> <ul style="list-style-type: none"> <li>a) Skin and Skin structures</li> <li>b) Mucous membranes- general and specific protective characteristics</li> </ul> <p>1.2.2) The Microorganism's perspective</p> <ul style="list-style-type: none"> <li>a) Microbial colonization</li> </ul>	03
1.3	<p>Microorganism entry, invasion and dissemination:</p> <p>1.3.1) The host's Perspective-</p> <ul style="list-style-type: none"> <li>a) Disruption of surface barriers</li> <li>b) Response to microbial invasion of deeper tissues</li> <li>c) Nonspecific responses- phagocytes and inflammation</li> <li>d) Specific responses- The immune system</li> <li>e) Components of Immune system</li> <li>f) Two arms of the immune system : Antibody mediated immunity and cell mediated immunity</li> </ul> <p>1.3.2) The Microorganism's perspective :</p> <ul style="list-style-type: none"> <li>a) Colonization and infection</li> </ul>	05

	b) Pathogen and virulence c) Microbial Virulence factors	
1.4	Genetics of virulence : Pathogenicity islands	OI
1.5	Outcome and prevention of infectious diseases : a) acute infection b) chronic infection c) Immunization	OI

**References:**

- Bailey & Scott's Diagnostic Microbiology, 12th Edition, Elsevier International edition.
- Prescott, Harley and Klein. (2008). Microbiology. 7th edition McGraw Hill international edition.
- Sherris Medical Microbiology-An introduction to infectious diseases- Kenneth.J.Ryan/ C.George Ray-4th edition
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6521974/>

**Module 2**

**Pathogenicity of microorganism**

**[12L]**

**Learning Objectives:**

This module is intended to

1. Explain the outcome of the host parasite relationship.
2. Identify the type of infectious process.
3. Perceive the overview of bacterial pathogenicity and virulence.

**Learning Outcome:**

After the successful completion of the module, the learner will be able to

1. Explain various factors associated with host parasite relationship.
2. Comprehend the mechanism of infections.

3. Differentiate between exotoxins and endotoxins.		
2.1	<b>Host parasite relationship :</b> a) Introduction to virulence b) Outcome of host parasite relationship c) Mathematical expression of infection d) Various types of infection e) Concept of LD50 and ID50 f) Determination of LD50 and ID50	03
2.2	Overview of bacterial pathogenesis	02
2.3	Bacterial adherence factors – Fimbriae, glycocalyx, pili, S-layer, slime layer, teichoic and lipoteichoic acid	02
2.4	Virulence factors: Enzymes: hyaluronidase, collagenase, streptokinase, coagulase, hemolysin, siderophores	02
2.5	Toxicogenicity : Chief characteristics of a. Exotoxins and Endotoxin b. Neurotoxin, Enterotoxin, Cytotoxin	03
<b>References:</b> <ul style="list-style-type: none"> <li>• Prescott, Harley and Klein. (2008). Microbiology. 7th edition McGraw Hill international edition.</li> <li>• Bailey &amp; Scott's Diagnostic Microbiology, 12th Edition, Elsevier International edition.</li> <li>• Khan Fahim Halim, The elements of Immunology, 1st edition ,Published by Pearson Education (2009)</li> </ul>		
<b>Module 3</b>	<b>Epidemiology</b>	<b>[12L]</b>
<b>Learning Objectives:</b> The module is intended to: 1) Measure the frequency of a disease. 2) Evaluate the course of an infectious disease.		

**Learning Outcome:**

By the end of this course students will be able to:

- 1) Classify the disease based on its frequency.
- 2) Calculate morbidity and mortality rate of an infection.
- 3) Suggest measures to control the spread of a disease.

3.1	Epidemiology of infectious disease : include a case study in practical	O1
3.2	Epidemiology terminology.	O1
3.3	Measuring frequency- The epidemiologist's tools: Mortality rate and Morbidity rate	O2
3.4	Infectious disease cycle	O2
3.5	Recognition of a infectious disease in a population in an epidemic	O1
3.6	Virulence and mode of transmission	O1
3.7	Emerging and re-emerging infectious diseases and pathogens	O1
3.8	Control of epidemics	O1
3.9	Nosocomial infections	O1
3.10	Global travel and health considerations	O1

**References:**

- Prescott, Harley and Klein. (2008). Microbiology. 7th edition McGraw Hill international edition.
- Bailey & Scott's Diagnostic Microbiology, 12th Edition, Elsevier International edition.
- Frobisher, M. (1974) Fundamentals of Microbiology.9th Edition. W.B. Saunders Company



S.Y.B.S.c (Microbiology)  
Semester III - Practicals  
Course I  
Course Code: **22US3MBCCIP**  
Credits: 01

Sr.No	Experiments	No of Hours
	1) Study of virulence factor (enzymes): Coagulase, Haemolysin, Lecithinase.	10
	2) Study of Normal flora from human skin, Throat and stool sample	10
	3) Study of Phagocytosis demonstration	05
	Assignments: Epidemiology case studies	05

**Question Paper Template**

S.Y. B. Sc. (Microbiology) SEMESTER III

Core Course- I

COURSE TITLE: Medical Microbiology

COURSE CODE: 22US3MBCCIMDM [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	15	10	05	-	-	-	30
II	10	10	05	05	-	-	30
III	10	10	05	05	-	-	30
Total marks per objective	35	30	15	10			90
% Weightage	39%	33%	17%	11%	-	-	100





S.Y. B. Sc. (Microbiology) SEMESTER III

Core course - II

COURSE TITLE: Genetics, Virology & Taxonomy

COURSE CODE: 22US3MBCC2GVT- [CREDITS - 02]

**Course Learning Outcomes**

After the successful completion of the Course, the learner will be able to:

1. Describe the organization of DNA and features of genetic code in prokaryotic organisms.
2. Describe the structure, classification and replication of different viruses and their major features.
3. Evaluate the different methods employed in bacterial taxonomy.

<b>Module I</b>	<b>Informational Macromolecules</b>	<b>[12L]</b>
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**Learning Objectives:**

This module is intended to familiarize the learner with :

1. Central dogma of the cell
2. Structural aspects of ds DNA and prokaryotic chromosomes.
3. Historical aspects and significance of the Genetic code.

**Learning Outcomes:**

By the end of this course learners will be able to:

1. List the contributions of prominent scientists in elucidating the structure of the double helix.
2. Explain the structural features of double stranded DNA.
3. Describe the organization of DNA in a prokaryotic chromosome.
4. Differentiate between A, B and Z forms of DNA.
5. Describe features of Genetic code and variations of the code.

6. Analyse reasons for degeneracy of the genetic code.		
1.1	<p>Central dogma of the cell</p> <p>a) Informational macromolecules</p> <p>b) Basics of exons and introns</p>	O2
1.2	<p>Organization of DNA in prokaryotic chromosomes</p> <p>Structure of double helix DNA:</p> <p>a) Features</p> <p>b) Discovery</p> <p>c) A, B and Z forms of DNA</p> <p>d) Important features of DNA structure-Palindrome structures</p> <p>e) Circularity, Supercoiling of prokaryotic chromosome and role of Topoisomerases</p> <p>f) Introduction to special types of RNA- snRNA, siRNA, snoRNA, miRNA, stRNA (Only definitions)</p>	O5
1.3	<p>Genetic Code</p> <p>a) Historical perspective</p> <p>b) Features of the genetic code</p> <p>c) Wobble hypothesis</p> <p>d) Variations to the genetic code</p>	O5
<p><b>References:</b></p> <ul style="list-style-type: none"> <li>● Russel, I P. J. (2006), —iGenetics-A molecular approach, 3rd edition. New York: Pearson Education International.</li> <li>● Madigan, M., Martinko, J., Parkar, J., (2009), Brock Biology of</li> </ul>		

microorganisms, 12th edition. Pearson Education International.

- Nelson, D. and Cox, M. (2008). Lehninger Principles of Biochemistry. 5th edition. New York: W H Freeman and Company.
- Nelson, D. and Cox, M. (2017). Lehninger Principles of Biochemistry. 7th edition. New York: W H Freeman and Company.

**Module 2**

**Basics of Virology**

**[12L]**

**Learning Objectives:**

This module is intended to familiarize the learner with:

1. Basic concepts of viral architecture
2. Basis of viral classification
3. Replication of different types of viruses

**Learning Outcomes:**

After the successful completion of the module, the learner will be able to:

1. Describe the structure of different types of viruses with one example each.
2. List the criteria for viral classification.
3. Describe the replication of different viruses and compare major features.

2.1	Viral architecture- Virus structure and morphology of plant (TMV) and animal viruses (Influenza virus, HIV).	O4
2.2	Viral classification: Baltimore, ICTV	O2
2.3	The viral replication cycle- attachment, penetration, uncoating, types of viral genome and their replication, assembly, maturation and release. Life cycle of TMV, Influenza Virus in detail.	O5
2.4	Viroids.	O1

**References:**

- Shors T. (2009). Understanding Viruses. Massachusetts: Jones and Bartlett Publisher
- Carter J.(2007). Virology-Principles and Applications: John wiley & Sons, Ltd.

<b>Module 3</b>	<b>Taxonomy</b>	<b>[12L]</b>
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**Learning Objectives:**

The module is intended to:

1. Explain the basic concepts under Taxonomy
2. Discuss the phylogenetic and classical approaches employed in bacterial taxonomy.

**Learning Outcomes:**

After the successful completion of the module, the learner will be able to:

1. Explain the rules of binomial nomenclature
2. Apply the concepts of phylogenetic and classical approaches of taxonomy for classification and identification of the isolate.
3. Evaluate the newer methods of bacterial taxonomy

3.1	Taxonomic ranks, Binomial Nomenclature	O1
3.2	Phylogenetic approach and Classical approach to taxonomy	O1
3.3	Numerical taxonomy	O3
3.4	Newer methods to Bacterial Taxonomy: a) DNA base composition and $T_m$ b) Nucleic acid Hybridisation. c) DNA Sequencing d) RNA Fingerprinting and Sequencing. e) Ribotyping. f) Fatty acid analysis	O6



	g) Automated analysis: VITEK, API	
3.5	Bergey's Manual Volume description, List of Bacterial groups	OI
<b>References:</b> <ul style="list-style-type: none"><li>● Prescott, Harley and Klein. (2008). Microbiology. 7th edition. McGraw Hill international edition.</li><li>● Stanier. R.Y., Ingraham, J.L., Wheelis, M.L., Painter, R.R, (1987). General Microbiology, 5th edition. The Macmillan press Ltd.</li><li>● Frobisher, M. (1974) Fundamentals of Microbiology.9th Edition. W.B. Saunders Company.</li><li>● Prakash S. Bisen, Mousumi Debnath, Godavarthi B. K. S. Prasad (2012), Microbes:Concepts and Applications, Wiley-Blackwell publications</li><li>● Eugene Rosenberg (Editor-in-Chief) Edward F. DeLong, Stephen Lory, Erko Stackebrandt and Fabiano Thompson (Eds.), (2014) The Prokaryotes Other Major Lineages of Bacteria and the Archaea. 4th Edition. Springer Publication</li></ul>		



S.Y.B.S.c (Microbiology)  
Semester III - Practicals  
Course II  
Course Code:22US3MBCC2P  
Credits: 01

Sr.No	Experiments	No of Hours
1.	Enrichment and enumeration of phages by phage assay method. (Demonstration)	06
2.	Identification of a bacterial isolate using Bergey's manual	10
3	Extraction of DNA from onion and E.coli.	05
4	Estimation of DNA by UV spectroscopy	05
5	Determination of purity of DNA by spectroscopy	04

**Question Paper Template**

**S.Y. B. Sc. (MICROBIOLOGY) SEMESTER III**

**Core Course- II**

**COURSE TITLE: Genetics, Virology & Taxonomy**

**COURSE CODE: 22US3MBCC2 GVT [CREDITS - 02]**

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	10	10	--	05	05	--	30
II	05	15	--	10	--	--	30
III	---	5	10	10	5	---	30
Total marks per objective	15	30	10	25	10	--	90
% Weightage	17	33	11	28	11	--	100



S.Y. B. Sc. (Microbiology) SEMESTER III

Course - III

COURSE TITLE: Environmental Microbiology

COURSE CODE: 22US3MBCC3EVM

[CREDITS - 02]

**Course Learning Outcomes**

After the successful completion of the Course, the learner will be able to:

1. Analyse the significance of synchronous and regulated networks of different biogeochemical cycles functional in the ecosystem.
2. Summarize the data on different types of microbial products.
3. Implement the different methods of waste management.
4. Evaluate the potential of microbes in bioremediation.

Module I	Biogeochemical Cycles	[12L]
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**Learning Objectives:**

1. To describe different biogeochemical cycles operating in ecosystems.
2. To correlate the sulphur cycle to different reduced habitats.
3. To distinguish between different nitrogen sources.

**Learning Outcomes:** After the successful completion of the module, the learner will be able to:

1. Schematically illustrate the flow of nutrients in the ecosystem.
2. Appreciate the dynamic exchange of major elements between biotic and abiotic components.
3. Recognize the role of phosphate solubilizers.
4. Distinguish between nitrification and denitrification.
5. Describe the degradation of carbon-based polymers.

I.1	Concept of Biogeochemical cycle and its significance.	01
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1.2	Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin.	03
1.3	Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction	03
1.4	Phosphorus cycle: Phosphate immobilization and solubilisation	02
1.5	Sulphur cycle: Microbes involved in sulphur cycle	03
<ul style="list-style-type: none"> <li>Barton LL &amp; Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA</li> <li>Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.</li> <li>Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals &amp; Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.</li> </ul>		
<b>Module 2</b>	<b>Microbial derived value-added products</b>	<b>[12L]</b>
<p><b>Learning Objective:</b></p> <p>This module is intended to</p> <ol style="list-style-type: none"> <li>Describe the features, production and uses of Biofuels.</li> </ol>		
<p><b>Learning Outcomes:</b></p> <p>After the successful completion of the module, the learner will be able to</p> <ol style="list-style-type: none"> <li>Discuss the significance of Biofuels.</li> <li>Describe the production of biofuels.</li> <li>Apply the use of biotechnology for improvement of biofuel production methods.</li> </ol>		
2.1	<p><b>Biofuels:</b></p> <p>2.1.1 Conventional fuels and their impact on the environment</p> <p>Oil, Coal, Natural gas</p>	02



	2.1.2 Advantages and disadvantages of Biofuels. 2.1.3 Conversion of Wood, Sugar and starch crops into biofuel, 2.1.4 Hydrocarbon producing crops	
2.2	<b>Biogas:</b> 2.2.1 Benefits, Stages of Anaerobic digestion, types of digesters. factors affecting.	O3
2.3	<b>Bioethanol, Biobutanol:</b> 2.3.1 Advantages of Bioethanol over Petrol 2.3.2 Production and Recovery of Bioethanol 2.3.3 Future directions for Research and Development	O2
2.4	<b>Biodiesel:</b> 2.4.1 Lipids as a source of Biodiesel 2.4.2 Biodiesel from hydrocarbons	O1
2.5	<b>Biohydrogen:</b> 2.5.1 Methods of production: (List of names of the methods) 2.5.2 Routes of production of Biohydrogen, 2.5.3 Anaerobic fermentation , 2.5.4 Photosynthetic algae 2.5.5 In-vitro photosynthetic hydrogenase system	O2
2.6	<b>Microbial Fuel Cells</b> 2.6.1 Features and applications. 2.6.2 Comparison among different types of Biosensors	O2
<ul style="list-style-type: none"> <li>• B. D. Singh, (2010). Biotechnology- Expanding Horizon, 3rd Revised Edition, Kalyani Publishers.</li> <li>• R.C. Dubey, A TextBook of Biotechnology.4th edition, S.Chand &amp; Co Ltd, New Delhi</li> </ul>		

Module 3	Microbial Bioremediation	[12L]
<p><b>Learning Objectives:</b></p> <p>The module is intended to:</p> <ol style="list-style-type: none"> <li>1. Define the concept of bioremediation and allied terms.</li> <li>2. Describe different types of bioremediation.</li> <li>3. Explain the types and applications of Biosensors.</li> </ol>		
<p><b>Learning Outcomes:</b></p> <p>After the successful completion of the module, the learner will be able to:</p> <ol style="list-style-type: none"> <li>1. Describe different methods of bioremediation.</li> <li>2. Appreciate the difference between in-situ and ex-situ bioremediation methods.</li> <li>3. Recognize the role of biosurfactants in bioremediation.</li> <li>4. Represent the structural components of Biosensors.</li> <li>5. Explain the applications of Biosensors.</li> <li>6. Cite the characteristic features of biosensors</li> </ol>		
3.1	Concept of Bioremediation and its significance: 3.1.1 Types- in-situ and ex-situ bioremediation.	O2
3.2	Methods: Bioremediation of hydrocarbons, dyes, paper and pulp industry, heavy metals, xenobiotics, common pesticides, oil spills.	O5
3.3	3.3.1 Biofilters, Bioaugmentation and Bioventing 3.3.2 Role of Biosurfactants in bioremediation	O1



3.	Isolation and characterization of chitinase producing microorganisms.	04
4.	Enrichment, isolation and characterization of dye degrading microorganisms.	06
5.	Study of Microbial fuel cell- Demonstration/ visit to an institute producing Biofuels.	06
5.	Enrichment, isolation and characterization of phenol degrading microorganisms.	06

### Question Paper Template

S.Y. B. Sc. (MICROBIOLOGY) SEMESTER III

Core Course- III

COURSE TITLE: Environmental Microbiology

COURSE CODE: 22US3MBCC3EVM

[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	—	5	5	10	10	-	30
II	—	5	5	10	10	-	30
III	—	5	10	05	10	-	30
Total marks per objective	—	15	20	25	30	-	90
% Weightage	—	17	22	28	33	—	100



S.Y. B. Sc. (MICROBIOLOGY) SEMESTER III

Core course - IV

COURSE TITLE: Soil Microbiology

COURSE CODE: 22US3MBCC4SOM [CREDITS - 02]

**Course Learning Outcomes**

After the successful completion of the Course, the learner will be able to:

1. Characterize soil as a living environment.
2. Apply techniques to cultivate and enumerate soil microorganisms.
3. Describe the need, preparation, merits and demerits of biofertilizers.
4. Describe the need, preparation, merits and demerits of biopesticides

**Module 1**

**Soil as a living environment**

**[12L]**

**Learning Objectives:**

This module is intended to enable the learner to:

1. Give an account of physico-chemical characteristics of the Earth environment
2. Introduce the diversity of microorganisms in soil.
3. Elaborate the distribution of microorganisms in different soil environments.

**Learning Outcomes:**

After the successful completion of the module, the learner will be able to:

1. Describe physico-chemical characteristics of the Earth environment.
2. Explain abiotic and biotic stresses.
3. Summarize characteristics of different microorganisms in surface soils.
4. Compare and contrast microorganisms in shallow and deep subsurface environments.

1.1	Earth's living skin	01
1.2	<b>Physico-chemical characteristics of the Earth environment:</b> 1.2.1 Earth environments 1.2.2 The solid phase 1.2.3 The liquid phase 1.2.4 Soil atmosphere	04
1.3	<b>Soil as a microbial environment:</b> 1.3.1 Biotic stresses 1.3.2 Abiotic stresses	01
1.4	<b>Microorganisms in surface soils:</b> 1.4.1 Bacteria 1.4.2 Actinomycetes 1.4.3 Archaea 1.4.4 Fungi 1.4.5 Algae 1.4.6 Protozoa	03
1.5	<b>Distribution of microorganisms in soil</b>	01
1.6	<b>Microorganisms in subsurface environments:</b> 1.6.1 Microorganisms in shallow subsurface environments 1.6.2 Microorganisms in deep subsurface environments	02

**References:**

- Environmental Microbiology.(2014) 3rd edition, Ian L. Pepper. Elsevier Academic Press.
- Soil Microbiology and Biochemistry. (2007) 3rd edition. Elsevier Academic Press.

Module 2		Techniques for studying soil environment	[12L]
<p><b>Learning Objectives:</b></p> <p>This module is intended to:</p> <ol style="list-style-type: none"> <li>1. Familiarize the learners with the techniques to cultivate and enumerate microorganisms from soil.</li> <li>2. Enable the learners to undertake field studies related to microorganisms in soil.</li> <li>3. Acquaint the learners with new approaches to explore unculturable bacteria.</li> </ol>			
<p><b>Learning Outcomes:</b></p> <p>After the successful completion of the module, the learner will be able to:</p> <ol style="list-style-type: none"> <li>1. Apply methods to study unculturable bacteria.</li> <li>2. Cultivate fungi, algae and other organisms of environmental significance.</li> <li>3. Examine natural environments under controlled conditions.</li> </ol>			
2.1	Extraction of cells from soil		O1
2.2	<p><b>Plating methods:</b></p> <p>2.2..a Unculturable bacteria</p> <p>2.2.b New approaches</p>		O2
2.3	<p><b>Culturing microbial population from soil:</b></p> <p>Heterotrophic Plate Count</p> <p>Cultivation of special populations- fluorescent pseudomonads, nitrifying bacteria, organisms degrading xenobiotics/ synthetic compounds.</p>		O5
2.4	Cultivation of fungi and algae		O2
2.5	Microcosms and field studies.		O2
<p><b>References:</b></p> <ul style="list-style-type: none"> <li>• Environmental Microbiology. (2014) 3rd edition, Ian L. Pepper. Elsevier</li> </ul>			

Academic Press.

- Environmental Microbiology, A Laboratory Manual. (2004) 2nd edition. Elsevier Academic Press.

**Module 3**

**Biofertilizer and Biopesticide**

**[12L]**

**Learning Objectives:**

The module is intended to:

1. Provide an overview of the relevance of use of biofertilizers and biopesticides.
2. Familiarize with the microbes used as biofertilizers and biopesticides
3. Elaborate the advantages and disadvantages of biofertilizers and biopesticides.

**Learning Outcomes:**

After the successful completion of the module, the learner will be able to:

1. Outline the relevance of use of biofertilizers and biopesticides.
2. Review the use of bacteria and fungi as biofertilizers and biopesticides
3. Evaluate the merits and demerits of biofertilizers and biopesticides.

3.1	Bio fertilizers: a) Different microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers. b) Symbiotic and non-symbiotic nitrogen fixers.	O1
3.2	Azolla & BGA Bio fertilizers: a) Characteristics Production c) Methods of application	O2
3.3	PSB Bio fertilizer (Phosphate solubilising bacteria) a) Mechanism of phosphate solubilisation b) Production c)Methods of application on field	O2
3.4	VAM Biofertilizer a) Characteristics & types of association b) Production	O1



3.5	Methods of applications of biopesticide a) Seed inoculation b) Vegetative part inoculation c) Soil inoculation d) Use of Mycorrhizal fungi	O2
3.6	Bt crops: a) <i>Bacillus thuringiensis</i> as a source of insecticidal protein b) Examples of Bt crops	O1
3.7	Biocontrol of Insect pest a) Bacterial pesticide b) Viral pesticide c) Mycopesticide	O1
3.8	Biological control of weeds a) Mycoherbicides b) Insect as biocontrol agents	O1
3.9	Mass production of biopesticide a) Solid substrate fermentation: Fungal Biopesticide	O1

**References:**

- Bagyaraj, D. J. and Rangaswami, G. (1993). Agricultural Microbiology. India: Prentice-Hall. ,ISBN, 0876926685, 9780876926680.
- Sharma, A. K.. (2002). Biofertilizers for Sustainable Agriculture. India Agro-Bios. ISBN-10: 9788177541182 .
- Integration of Insect-Resistant Genetically Modified Crops within IPM Programs: edited by Jörg Romeis, Anthony M. Shelton, George Kennedy.(2008)
- Dubey, R.C. A TextBook of Biotechnology. 5th revised edition (2014 ) New Delhi: S.Chand & Co Ltd
- Fulekar, M.H. Environmental Biotechnology. (2010) Taylor and Francis group, CRC Press



S.Y.B.S.c (Microbiology)

Semester III - Practicals

Course IV

Course Code: 22US3MBCC4P

Credits: 01

Sr.No	Experiments	No of Hours
1	Determination of soil moisture content	02
2	Contact slide method	04
3	Enumeration of bacteria -heterotrophic plate count	03
4	Slide culture of fungi	05
5	Enrichment and isolation of pesticide degraders.	08
6	Isolation of <i>Azotobacter</i> and <i>Rhizobium</i>	02
7	Preparation of Biofertilizer and its efficacy testing	06

**Question Paper Template**

S.Y. B. Sc. (Microbiology) SEMESTER III

Core Course- IV

COURSE TITLE: Soil Microbiology

COURSE CODE:22US3MBCC4SOM [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	05	10	05	05	05	--	30
II	---	10	05	10	05	---	30
III	05	10	05	05	05	--	30
Total marks per objective	10	30	15	20	15	--	90
% Weightage	11	33	17	22	17	—	100



S.Y. B. Sc. (Microbiology) SEMESTER IV

Core course - I

COURSE TITLE: Immunology

COURSE CODE: 22US4MBCCI-IMM [CREDITS - 02]

Course Learning Outcome		
<p>After the successful completion of the Course, the learner will be able to:</p> <ol style="list-style-type: none"> <li>Describe the basic information regarding Innate Immunity and Virulence factors.</li> <li>Explain defence mechanisms against invading pathogens.</li> <li>Recognize the molecular nature of antigens and antibodies along with the role of different cells and their surface molecules in acquired immunity.</li> </ol>		
<b>Module 1</b>	<b>Immune system</b>	<b>[12L]</b>
<p><b>Learning Objectives:</b></p> <p>This module is intended to enable the learner to:</p> <ol style="list-style-type: none"> <li>List various types of human blood cells and its function.</li> <li>Explain the concept of Antigen presentation.</li> <li>Recognise the differences between primary and secondary lymphoid organs and tissues.</li> </ol>		
<p><b>Learning Outcome:</b></p> <p>After the successful completion of the module, the learner will be able to</p> <ol style="list-style-type: none"> <li>Classify various blood cells and relate its functions.</li> <li>Differentiate between granulocytes and agranulocytes.</li> <li>Infer the anatomy and significance of primary and secondary lymphoid organs and tissues</li> </ol>		
1.1	Overview of host resistance: a) Introduction of host resistance b) Immunity : types of immunity c) Major	02

	components of the mammalian immune system	
1.2	Cells of immune system: a) Pluripotent stem cells in the bone marrow b) Normal adult blood count c) Monocyte and macrophages system d) Polymorphonuclear leukocytes: basophils, eosinophils, neutrophils e) Mast cells f) Dendritic cells g) Lymphocytes : T and B lymphocytes, Natural killer cells	07
1.3	Organs and tissues of the immune system. a) Primary lymphoid organ and tissue b) Secondary lymphoid organ and tissue.	03

**References:**

- Prescott, Harley and Klein. (2008). Microbiology. 7th edition McGraw Hill international edition.
- Thomas J. Kindt, Richard A. G, Barbara A. Osburne (2007) Kuby Immunology: New York: W. H. Freeman and Company
- Pathak, S., Palan U. () Immunology Essential and Fundamental. Bombay: Preen publications.
- Khan F.H. The elements of immunology.1 st edition. Pearson Education.
- kuby.

**Module 2**

**Concept of antigen and antibody**

**[12L]**

**Learning Objectives:**

This module is intended to enable learner to:

1. Describe the concepts of antigen and immunogen
2. Explain different types of antigens
3. Explain different types of immunoglobulin structure and their functions.

**Learning Outcome:**

After the successful completion of the module, the learner will be able to

1. Explain different types of antigen.
2. List the various properties of antibodies.
3. Differentiate amongst different types of immunoglobulins.

2.1	Introduction a) Terms of antigen, immunogen, hapten, epitope, difference between these terms b) Properties of immunogen that contribute to immunogenicity	O1
2.2	Immunogenicity of some natural substances	O1
2.3	Types of antigen : a) Heterophiles antigen b) Isophile antigen c) Sequestered antigens d) Bacterial antigen	O1
2.4	Factor influencing the immune response of host	O1
2.5	Adjuvants : a) Types : Freund's complete and incomplete adjuvant and other examples b) Mechanism	O1
2.6	Basic structure of antibodies : a) Main features of immunoglobulin b) Immunoglobulin structure c) Chemical and enzymatic methods revealing basic antibody structure	O2
2.7	Structure function relationship of antibodies and structure of immunoglobulin in relation to basic antigen binding. Concepts of affinity and avidity	O1
2.8	Types of antibodies : a) Isotype b) Allotype c) Idiotypes	O2
2.9	Isotypes of immunoglobulin properties, structure, and function: IgG, IgM, IgD, IgE, and IgA.	O1
2.10	Immunoglobulin receptors	O1

**References:**

- Pathak, S., Palan U. () Immunology Essential and Fundamental. Bombay: Pareen publications.
- Khan F.H. The elements of immunology.1 st edition. Pearson Education.
- Thomas J. Kindt, Richard A. G, Barbara A. Osburne (2007) Kuby Immunology: New York: W. H. Freeman and Company

**Module 3**

**Concept of antigen and antibody reaction**

**[[12L]**

**Learning Objectives:**

The module is intended to

1. Explain the mechanism of antigen antibody reaction.
2. Categorise various reactions between antigen-antibodies.
3. Demonstrate the applications of antigen-antibody reactions .

**Learning Outcome:**

After the successful completion of the module, the learner will be able to

1. Differentiate between types of in vitro reactions between antigen and its homologous antibody.
2. Illustrate various applications of antigen antibody reaction in disease diagnosis
3. Evaluate different types of antigen antibody reaction.

3.1	Introduction of terms used in serological reactions : a) Agglutination b) Precipitation c) flocculation d) Agglutinin e) Agglutigen f) Precipitin g) Precipitinogen	O2
3.2	a) Comparative efficiency of various immunoglobulins in different serological reactions b) Important parameters in serological test	O1
3.3	Zone phenomenon	O1
3.4	Agglutination test : a) Mechanism b) Applications –	O2

	Slide agglutination Tube test (Widal test)	
3.5	Precipitation reaction : a) Mechanism of precipitation: lattice hypothesis b) Types of precipitation c) Flocculation	O2
3.6	Immuno-diffusion	O1
3.7	Complement fixation	O1
3.8	Immunofluorescence test	O1
3.9	ELISA	O1

**References:**

- Pathak, S., Palan U. () Immunology Essential and Fundamental. Bombay: Preen publications.
- Thomas J. Kindt, Richard A. G, Barbara A. Osburne (2007) Kuby Immunology: New York: W. H. Freeman and Company
- Ananthanarayan and Paniker. (2009). Textbook of Microbiology. 8 th Edition. Universal Press
- Khan F.H. The elements of immunology.1st edition. Pearson Education.

S.Y.B.S.c (Microbiology)

Semester IV - Practicals

Course I

Course Code: **22US4MBCCIP**

Immunology

Credits: O1

Sr.No	Experiments	No. of Hours
1	Blood staining	O5
2	Blood grouping	O2
3	Single radial immunodiffusion and Double immunodiffusion	O5



4	Widal qualitative and quantitative – Demonstration	O6
5	Preparation of O and H antigens	O8
6	ELISA test( demonstration)	O4
7	Internship at a diagnostic laboratory (4 weeks)	-

### Question Paper Template

S.Y. B. Sc. (Microbiology) SEMESTER IV

Core Course- I

COURSE TITLE:

COURSE CODE: 22US4MBCCI-IMM [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	10	10	05	05			30
II	10	10	-	10			30
III	10	5	10	5			30
Total marks per objective	30	25	15	20			90
% Weightage	33%	28%	17%	22%			100





S.Y. B. Sc. (Microbiology) SEMESTER IV

Core course - II

COURSE TITLE: Concepts in Biochemistry

COURSE CODE: 22US4MBCC2CBC [CREDITS - 02]

Course Learning Outcomes		
<p>After the successful completion of the course, the learner will be able to:</p> <ol style="list-style-type: none"> <li>1. Explain the principles of thermodynamics with respect to a living cell.</li> <li>2. Evaluate the role of different metabolic pathways in cellular metabolism.</li> <li>3. Analyze the basic structural and functional aspects of enzymes in the functioning of a living cell.</li> </ol>		
Module 1	Thermodynamics	[12L]
<p><b>Learning Objectives:</b></p> <p>This module is intended to:</p> <ol style="list-style-type: none"> <li>1. Familiarize the student with basic concepts of thermodynamics from a biological perspective.</li> <li>2. Introduce various common ATP yielding mechanisms in a cell</li> </ol>		
<p><b>Learning Outcomes:</b></p> <p>After the successful completion of the module, the learner will be able to</p> <ol style="list-style-type: none"> <li>1. Define terms related to Thermodynamics.</li> <li>2. Differentiate between <math>\Delta G</math> and <math>\Delta G^\circ</math></li> <li>3. Explain the relation of <math>K'_{eq}</math> and <math>\Delta G</math>.</li> <li>4. Describe structure and significance of ATP.</li> <li>5. Explain role of high energy compounds</li> <li>6. Identify and compare energy yielding mechanisms.</li> </ol>		
1.1	<p>a) Scope of thermodynamics: First and second laws of thermodynamics system, universe, enthalpy, entropy.</p>	04

	b) Concepts: Gibbs free energy, free energy change, exergonic and endergonic reactions, relation between $K_{eq}$ and $\Delta G$ , $\Delta G$ and $\Delta G^\circ$ , $K_{eq}$ and $K'_{eq}$ .	
1.2	a) Structure and properties of ATP b) Free energy change for hydrolysis of ATP and other high-energy compounds viz. 1,3-diphosphoglyceric acid and phosphoenolpyruvate.	04
1.3	a) Types of ATP generating reactions: Substrate level phosphorylation, oxidative phosphorylation and photophosphorylation. b) Energy yielding metabolic mechanisms: 1. Fermentation: alcoholic and lactic acid 2. Respiration; aerobic and anaerobic 3. Photosynthesis: Cyclic and non-cyclic	04

**References:**

- Nelson, D. and Cox, M. (2005). Lehninger Principles of Biochemistry. 5 th edition. New York: W H Freeman and Company.
- Tortora Funke and Case. (1998). Microbiology An Introduction. 6 th edition Addison Weseley Longman Inc.
- Conn P., Stumpf, G., Bruening and Doi R. (1995). Outlines in Biochemistry. 5 th edition. New York: John Wiley and Sons .

**Module 2**

**Introduction to Metabolism**

**[12L]**

**Learning Objectives:**

This module is intended to:

1. Familiarize the learner with basic terminologies of metabolism.
2. Introduce the learner to the role of redox reactions.
3. Enable the learner to understand types of metabolic pathways with details of two central metabolic pathways

**Learning Outcomes:**

After the successful completion of the module, the learner will be able to

1. Compare features and significance of anabolism and catabolism.
2. Explain link between anabolism and catabolism.
3. Discuss the role of pyridine nucleotides.
4. Explain different types of biochemical pathways with examples.
5. Schematically represent EMP and TCA pathway.

2.1	Metabolism- catabolism, anabolism, link between catabolism and anabolism viz. ATP, reducing power, precursors (list of 12 precursors), amphibolic pathways.	O2
2.2	Biological oxidation reduction reactions, role of pyridine nucleotides in metabolism	O2
2.3	a) Types of biochemical pathways- linear, branched and cyclic with one example each. b) Constitutive and Inducible pathways with one example each	O4
2.4	EMP and TCA with structures	O4

**References:**

- Nelson, D. and Cox, M. (2005). Lehninger Principles of Biochemistry. 4 th edition. New York: W H Freeman and Company.
- Palmer, T.. (2004).Enzymes, Biochemistry, Biotechnology and Clinical Chemistry. New Delhi: .East West Press Ltd.
- Conn P., Stumpf, G., Bruening and Doi R. (1995). Outlines in Biochemistry. 5 th edition. New York: John Wiley and Sons .

**Module 3**

**Enzymology**

**[12L]**

**Learning Objectives:**

The module is intended to:

1. Explain the basic concepts and mechanisms in Enzymology.
2. Describe the purification and separation of enzymes.
3. Evaluate the effect of different parameters on enzyme activity.

<p>4. Introduce concepts in enzyme kinetics.</p> <p>5. Describe allosteric enzymes and their role in metabolism.</p>		
<p><b>Learning Outcomes:</b></p> <p>After the successful completion of the module, the learner will be able to:</p> <ol style="list-style-type: none"> <li>Describe the mechanism of enzyme action.</li> <li>Compare and contrast between methods of enzyme purification.</li> <li>Analyze the basic structural and functional aspects of enzymes in the functioning of a living cell.</li> </ol>		
3.1.	<p><b>3.1.a Basic concepts:</b> Apoenzyme, Holoenzyme, Co-factors, Coenzymes, Prosthetic groups.. Mechanism of enzyme action.</p> <p><b>3.1.b Coenzymes:</b> Table showing coenzyme, chemical group transferred, and dietary precursor</p>	O1
3.2	<p><b>3.2.a Concepts of enzyme purification:</b></p> <p>Objectives and strategy in enzyme purification</p> <p>Methods of homogenization and extraction</p> <p>Methods of separation on the basis of:</p> <p><b>Size or mass:</b> Centrifugation, Dialysis</p> <p><b>Solubility:</b> Salting-in, salting-out, Solvent extraction</p> <p><b>3.2.b Definitions of Enzyme Unit:</b> Specific activity, Katal, International Unit</p>	O3
3.3	<p><b>Classification of enzymes:</b></p> <ol style="list-style-type: none"> <li>Six classes of enzymes and their mode of action</li> <li>Enzyme Nomenclature as per IUBMB</li> </ol>	O1
3.4	<p><b>Enzyme kinetics</b></p> <ol style="list-style-type: none"> <li>Michaelis- Menten equation and plot</li> </ol>	O3

	b) Line-weaver Burk equation and plot c) $K_m$ and $V_{max}$ Multisubstrate enzyme reactions	
3.5	<b>Effect of following parameters on enzyme activity:</b> Enzyme concentration, substrate concentration, pH and temperature	O1
3.6	<b>Enzyme Inhibition:</b> Description and plots: Reversible and irreversible (Competitive, Uncompetitive and Non-competitive)	O1
3.7	<b>Allosteric enzymes</b> a) Structure, kinetics (sigmoidal curve) b) Activation : concerted and sequential models	O2
<b>References:</b> <ul style="list-style-type: none"> <li>• Nelson, D. and Cox, M. (2005). Lehninger Principles of Biochemistry. 4 th edition. New York: W H Freeman and Company.</li> <li>• Conn P., Stumpf, G., Bruening and Doi R. (1995). Outlines in Biochemistry. 5 th edition. New York: John Wiley and Sons .</li> </ul>		



S.Y.B.S.c (Microbiology)  
Semester IV - Practicals  
Course I  
Course Code: 22US4MBCC2P  
Credits: 01

Sr.No	Experiments	No. of Hours
1	Production of Invertase from yeast Crude enzyme preparation by ammonium sulphate precipitation Purification by dialysis	05
2	Effect of parameters like enzyme concentration, substrate concentration, pH and temperature on activity of yeast Invertase. Michaelis-Menten and Line-weaver Burk plot Determination of Km and Vmax	20
3	Problems on Bioenergetics	05

**Question Paper Template**

S.Y. B. Sc. (Microbiology) SEMESTER IV

Core Course- II

COURSE TITLE: Biochemistry

COURSE CODE: 22US4MBCC2CBC [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	10	05	10	05	—	30
II	5	10		10	05	—	30
III	05	10	05	05	05	--	30
Total marks per objective	10	30	10	25	15	—	90
% Weightage	11	33	11	28	17	—	100



S.Y. B. Sc. (MICROBIOLOGY) SEMESTER IV

Elective course - III

COURSE TITLE: Industrial & Food Microbiology

COURSE CODE: 22US4MBCC3IFM

[CREDITS - 02]

Course Learning Outcome		
<p>After the successful completion of the Course, the learner will be able to:</p> <ol style="list-style-type: none"> <li>1. Articulate inoculum development plan for a fermentation process</li> <li>2. Formulate a fermentation media</li> <li>3. Evaluate the different modes of fermentation</li> <li>4. Appreciate the application of Microbes in Food industries.</li> <li>5. Investigate foodborne illnesses</li> <li>6. Appraise the different food preservation methods.</li> </ol>		
<b>Module I</b>	<b>Fermentation Technology</b>	<b>[12L]</b>
<p><b>Learning Objectives:</b> This module is intended to</p> <ol style="list-style-type: none"> <li>1. Familiarize with the different types of fermentation media components.</li> <li>2. Apply the principles underlying Inoculum development.</li> <li>3. Analyze the choice of appropriate mode of fermentation.</li> </ol>		
<p><b>Learning Outcome:</b></p> <p>After the successful completion of the module, the learner will be able to</p> <ol style="list-style-type: none"> <li>1. Plan an inoculum development for a given production.</li> <li>2. Distinguish the different modes of fermentation.</li> <li>3. Formulate the media for a given industrial production.</li> </ol>		
1.1	<p>Fermentation Media:</p> <p>a) Concept of defined and undefined media</p>	05

	<p>b) Medium formulation</p> <ul style="list-style-type: none"> <li>-Water</li> <li>- Cellular yield coefficient</li> <li>-Energy and carbon sources, nitrogen sources, minerals, chelators, growth factors, buffers, precursors, inhibitors, inducers, steering agents, antifoam agents</li> </ul> <p>c)Animal Cell Culture Media (Serum, serum-free media supplements, protein free media, trace elements, osmolality, pH, non nutritional media supplements)</p>	
1.2	<p>Inoculum development:</p> <p>a) Definition</p> <p>b) Principles and various aspects of inoculum development:</p> <ul style="list-style-type: none"> <li>- Inoculum size</li> <li>-Inoculum media and incubation conditions</li> <li>-Transfer of microbial growth</li> <li>-Contamination</li> <li>-Back mutation</li> </ul> <p>c)Example: Inoculum development in the production of Sagamicin by Micromonospora spp.</p>	O2
1.3	<p>Types of Fermentation:</p> <p>a) Principle, Concept, advantages and limitations of -</p> <ul style="list-style-type: none"> <li>-Batch, Continuous, fed-batch</li> <li>-Aerobic, Anaerobic, Surface, Submerged, Solid Substrate</li> </ul>	O5
<p><b>References:</b></p> <ul style="list-style-type: none"> <li>● Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation</li> </ul>		



Technology. 2nd edition, Elsevier Science Ltd.

- Fermentation Technology (Vol: I and II Set) H A Modi, Published by Pointer, Jaipur, 2009
- Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
- Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.

**Module 2**

**Spoilage causing agents and their detection in food.**

**[12L]**

**Learning Objectives:**

This module is intended to

1. Summarize the spoilage causing agents in food and food products
2. Apply methods for enumeration of food pathogens
3. Investigate foodborne outbreaks

**Learning Outcome:**

After the successful completion of the module, the learner will be able to

1. Elaborate the importance of food microbiology and food safety
2. Appreciate the need for microbiological quality control
3. Evaluate the foodborne illnesses investigation procedures for ensuring food safety & hygiene.

2.1

**Spoilage:**

- a) Introduction to Food Spoilage, Spoilage of Fruits, Vegetables, and their Products.
- b) Spoilage of Canned Food, Spoilage of Bakery and Egg Products.
- c) Spoilage of Meat, Fish and SeaFood.
- d) Current Food Safety Issues.

05

2.2	<p><b>Detection of food pathogens:</b></p> <p>a) Advances in Isolation and Enumeration of Microorganisms in Food: Molecular methods and Immunological methods.</p>	03
2.3	<p><b>Foodborne Outbreaks:</b></p> <p>a) Bacterial Agents for Foodborne Illnesses. b) Fungal and Algal Agents for Foodborne Illnesses. c) Foodborne Animal Parasites. d) Investigation of Foodborne Illnesses outbreaks.</p>	04

**References:**

- Adams MR and Moss MO. (1995). Food Microbiology. 4th edition. New Age International (P) Limited Publishers, New Delhi, India.
- Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
- Tanner FW, and Tanner LP (1953). Food-Borne Infections and Intoxications. 2nd edition. Champaign, IL:Garrard Press.
- Mariateresa Ferone, Aoife Gowen, Séamus Fanning, Amalia G. M. Scannell (2000). Microbial detection and identification methods: Bench top assays to omics approaches. <https://doi.org/10.1111/1541-4337.12618>

**Module 3**

**Control of food borne pathogens**

**[12L]**

**Learning Objectives:**

The module is intended to

1. Familiarize yourself with factors affecting microbial growth in food products.

2. Evaluate the different food preservation methods.

**Learning Outcome:**

After the successful completion of the module, the learner will be able to

1. Elaborate the role of various factors impacting survival of microorganisms in food.
2. Apply the various techniques for enumeration of microbes in food samples.
3. Evaluate the methods of food preservation.

3.1	a) Introduction to Food Microbiology and Food Safety b) Microflora of Food c) Intrinsic Factors and Extrinsic Factors Affecting Microbial Growth and Survival in Food.	O3
3.2	a) Food Preservation: i) Principles of Food Preservation and Significance  ii) Preservation of Food by Physical Methods – Low and High Temperatures, Radiations	O4
3.3	a) Preservation of Food by Chemical Methods b) Biopreservation of Food	O2
3.4	a) Modified Environment for Storage of Food b) Fermentative Microorganisms as Food and Value-Added Product c) Lactic Fermentation in Food.	O3

**References:**

- Adams MR and Moss MO. (1995). Food Microbiology. 4th edition. New

Age International (P) Limited Publishers, New Delhi, India.

- Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
- Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.

**S.Y. B. Sc. (MICROBIOLOGY) SEMESTER IV**

**Core course - III**

**PRACTICAL**

**COURSE TITLE: Industrial & Food Microbiology**

**COURSE CODE: 22US4MBCC3P**

**[CREDITS - 02]**

Sr.No	Experiments	No. of Hours
1	Comparative study of solid state and submerged fermentation.	04
2	Food preservative –Sugar and Salt (MIC)	04
3	Molecular methods for detection of food borne pathogens: Demo	02
4	Selective isolation of food spoilage organism : a. Detection and Determination of Coliforms, fecal coliforms in food and beverages. b. DMC for Sauces, Tomato puree and Pastes. c. Detection Determination and Confirmation of	15



	Staphylococcus in food.	
5	TDP and TDT	05
6	Visit to Industry	

**Question Paper Template**

**S.Y. B. Sc. (MICROBIOLOGY) SEMESTER IV**

**Core Course- III**

**COURSE TITLE: Industrial and Food Microbiology**

**COURSE CODE: 22US4MBCC3IFM**

**[CREDITS - 02]**

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	5	10	10	5	-	30
II	-	10	5	10	5	-	30
III	-	10	10	5	5	-	30
Total marks per objective	-	25	25	25	15	-	90
% Weightage	-	28%	28%	28%	16%	-	100



S.Y. B. Sc. (MICROBIOLOGY) SEMESTER IV

Elective Course - IV

COURSE TITLE: Dairy Microbiology

COURSE CODE: 22US4MBCC4DAM

[CREDITS - 02]

Course Learning Outcome		
After the successful completion of the Course, the learner will be able to:		
<ol style="list-style-type: none"> <li>Describe the microbiology of milk</li> <li>Apply different methods of processing raw milk</li> <li>Elaborate the dairy processing technologies</li> </ol>		
<b>Module 1</b>	<b>Introduction to Dairy Microbiology</b>	<b>[12L]</b>
<b>Learning Objectives:</b>		
This module is intended to		
<ol style="list-style-type: none"> <li>Familiarize with the dairy history of India</li> <li>Introduce the physical and chemical properties of milk constituents.</li> <li>Apprehend the normal and abnormal microflora of milk.</li> </ol>		
<b>Learning Outcome:</b>		
After the successful completion of the module, the learner will be able to		
<ol style="list-style-type: none"> <li>Appreciate the progress of dairy development in India</li> <li>Describe the composition of milk and the physicochemical characteristics of the main constituents.</li> <li>Enlist the microflora of milk.</li> </ol>		
1.1	<b>Dairy Development in India:</b>	03
	a) Role of National Dairy Development Board	

	<p>(NDDB)</p> <p>b) National Dairy Research Institute (NDRI)</p> <p>c) Military dairy farm, Indian Dairy Corporation (IDC)</p> <p>d) Dairy Co-operatives, Milk Grid, Operation Flood.</p>	
1.2	<p><b>Milk Chemistry and Constituents:</b></p> <p>a) Definition and Composition of milk</p> <p>b) Types of Milk (skimmed, toned and homogenized).</p> <p>c) Concept of clean milk</p> <p>d) Factors affecting quality and quantity of milk.</p> <p>e) Nutritive value of milk</p> <p>f) Physico-Chemical properties of milk.</p>	O4
1.3	<p><b>Microbiology of Milk:</b></p> <p>a) Microbial flora of milk</p> <p>b) Normal and abnormal flora, their sources and changes induced by them.</p> <p>c) Sources of microorganisms in milk.</p> <p>d) Biochemical types of bacteria in milk</p> <p>e) Temperature characteristics of bacteria in milk</p> <p>f) Pathogenic types of bacteria in milk (milk-borne disease)</p>	O5
<p><b>References:</b></p> <ul style="list-style-type: none"> <li>Richard K. Robinson, Dairy microbiology handbook third edition, 2002 by John Wiley and Sons, inc., New York.</li> <li>Eckles, C., Combs W. and Macy, H. Milk and milk products .4th edition. New Delhi: TMH.</li> </ul>		

- Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
- Microbiology by Pelczar McGraw-Hill Education, 199 ISBN 0074623206.

<b>Module 2</b>	<b>Milk- Processing and testing</b>	<b>[12L]</b>
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**Learning Objectives:**

This module is intended to

- 1) Evaluate milk samples using different rapid platform tests
- 2) Apply culture-based methods to determine milk quality.
- 3) Elaborate the packaging and storage requirements for milk and milk products

**Learning Outcome:**

After the successful completion of the module, the learner will be able to

- 1) Detect the microbiological quality of milk.
- 2) Grade the quality of milk.
- 3) Recommend packaging and storage criteria.

2.1	Processing of Milk a) Pasteurization (HTLT, LTST, UHT) b) Phosphatase test	02
2.2	Analysis of milk: Platform tests: a) Determination of acidity b) Determination of pH c) Dye reduction tests (MBRT, Resazurin)	02
2.3	a) Sedimentation test, Alcohol test, Alizarin-Alcohol test, Clot on boiling. b) Direct test for enumerating microbes in milk: DMC, SPC, LPC, Thermoduric count, psychrophilic count.	03
2.4	Grading of milk: Raw and Pasteurized milk of milk	03



2.5	Shelf life, Packaging, Storage and distribution	O2
<p><b>References:</b></p> <ul style="list-style-type: none"> <li>Eckles, C., Combs W. and Macy, H. Milk and milk products .4th edition. New Delhi: TMH.</li> <li>Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.</li> </ul>		
<b>Module 3</b>	<b>Fermented milk products</b>	<b>[12L]</b>
<p><b>Learning Objectives:</b></p> <p>The module is intended to enable the learner to</p> <ol style="list-style-type: none"> <li>Explain the importance of beneficial dairy starters.</li> <li>Describe the production of fermented milk and dairy products</li> <li>Elaborate the manufacturing details of important fermented milk products.</li> </ol>		
<p><b>Learning Outcome:</b></p> <p>After the successful completion of the module, the learner will be able to</p> <ol style="list-style-type: none"> <li>Characterize different types of beneficial microorganisms that can be incorporated in the development of fermented dairy foods.</li> <li>Prepare different types of fermented milk products possessing nutritional benefits.</li> </ol>		
3.1	Dairy starter cultures	O1
3.2	Fermented dairy products: Characterization, Production and Spoilage of:	O6



	<p>a) Cheese: i) Fresh ii) Gouda iii) Swiss iv) Cheese with special flora.</p> <p>b) Butter</p>	
3.3	<p>Fermented dairy products: Characterization and Production of:</p> <p>a) Yoghurt</p> <p>b) Ice Cream</p> <p>c) Whipping Cream</p> <p>d) Evaporated Milk</p> <p>e) Sweetened Condensed Milk</p>	05
<p><b>References:</b></p> <ul style="list-style-type: none"> <li>• P. Walstra T. J. Geurts A. Noomen A. Jellema M. A. J. S. van Boekel DAIRY TECHNOLOGY: Principles of Milk Properties and Processes. Marcel Dekker, INC. ISBN: 9780824702281 1999.</li> <li>• Richard K. Robinson, Dairy microbiology handbook third edition, 2002 by John Wiley and Sons, inc., New York.</li> </ul>		

S.Y. B. Sc. (MICROBIOLOGY) SEMESTER IV

Core course - IV PRACTICALS

COURSE TITLE: Dairy Microbiology

COURSE CODE: 22US4MBCC4P

[CREDITS - 02]

Sr.No	Experiments	No. of Hours
1	Detection and Quantification of Starch in Milk	03
2	Determination of Total Solids (Gravimetric method)	03



3	Microbial analysis of milk: a. MBRT: Methylene Blue Reduction Test b. RRT: Resazurin Reduction Test c. DMC: Direct Microscopic Count d. SPC: Standard Plate Count e. LPC: Laboratory Pasteurization Count f. Coliform count g. Presumptive test	20
4	Determination of Milk Fat (by Acid Digestion Method) in Cheese	04
5	Visit to Dairy Industry	

**Question Paper Template**

**S.Y. B. Sc. (MICROBIOLOGY) SEMESTER IV**

**Core Course- IV**

**COURSE TITLE: 22US4MBCC4DAM**

**COURSE CODE: [CREDITS - 02]**

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	5	10	10	5		30
II	5	5	5	5	10		30
III	-	5	10	10	5		30
Total marks per objective	5	15	25	25	20		90
% Weightage	6%	16%	28%	28%	22%		100