AC- 14/02/2022

Item No: 6.4

Rayat Shikshan Sanstha's

KARMAVEER BHAURAO PATIL COLLEGE, VASHI
NAVI MUMBAI

Sector-15- A, Vashi, Navi Mumbai - 400 703

(**AUTONOMOUS COLLEGE**)

Program: B.Sc. Microbiology

Syllabus for S.Y.B.Sc. Microbiology

(Choice Based Credit System
with effect from the academic year 2022-2023)

Rayat Shikshan Sanstha's

Karmaveer Bhaurao Patil College Vashi, Navi Mumbai

Autonomous College

[Affiliated to University of Mumbai]

Syllabus

Sr. No.	Heading	Particulars
1	**Title of Course**	S.Y.B.Sc. Microbiology (CBCS)
2	**Eligibility for Admission**	F.Y.B.Sc. (Microbiology), From a recognized university
3	**Passing Marks**	40%
4	**Ordinances/Regulations (if any)**	
5	**No. of Years/Semesters**	One year/Two semester
6	**Level**	U.G.
7	**Pattern**	Semester
8	**Status**	New
9	**To be implemented from Academic year**	2022-2023

Preamble of the Syllabus:

Bachelor of Science (B.Sc.) in Microbiology is an undergraduate program of Department of Microbiology, Karmaveer Bhaurao Patil College Vashi, Navi Mumbai [Autonomous College].

Microbiology is a branch of science that studies microorganisms such as bacteria, protozoa, algae, fungi, bacteria, viruses, etc. These studies integrate cytology, physiology, ecology, genetics and molecular biology, evolution, taxonomy and systematics with a focus on microorganisms.
The relevance and applications of microorganisms to the surrounding environment including human life and Mother Nature becomes part of this branch. Since inception of this branch of science, Microbiology has remained a field of active research and ever expanding in all possible directions; broadly categorized as pure and applied science.
Different branches of Pure Microbiology based on taxonomy are Bacteriology, Mycology, Protozoology and Parasitology, Phycology and Virology; with considerable overlap between these specific branches over each other and also with other disciplines of life sciences, like Biochemistry, Botany, Zoology, Cell Biology, Biotechnology, Nanotechnology, Bioinformatics, etc.

Areas in the applied Microbial Sciences can be identified as: Medical, Pharmaceutical, Industrial (Fermentation, Pollution Control), Air, Water, Food and Dairy, Agriculture (Plant Pathology and Soil Microbiology), Veterinary, Environmental (Ecology, Geomicrobiology); and the technological aspects of these areas.
Microbiological tools have been extensively used to study different life processes and are cutting edge technologies. There is a continual demand for microbiologists in the work force education, industry and research. Career opportunities for the graduate students are available in manufacturing industry and research institutes at technical level.
The content of a syllabus should be such that it maintains continuity with the course content of higher secondary class and post graduate course. The present curriculum is made keeping this in mind and is an effort to impart fundamental knowledge of the subject needed at this level. The curriculum is designed as per the guidelines for Choice Based Credit System and reflects the total credit, teaching hours and evaluation pattern.

Rayat Shikshan Sanstha's

KARMAVEER BHAURAO PATIL COLLEGE, VASHI, NAVI MUMBAI

(Autonomous)

Department of Microbiology

S.Y.B. Sc. Microbiology

Program Outcomes (POs)

Learners are able to:

PO-1	**Disciplinary Knowledge and Skills**	Acquire the comprehensive and in-depth knowledge of various subjects in sciences such as Physics, Chemistry, Mathematics, Microbiology, Bio- analytical Science, Computer Science, Data Science, Information Technology and disciplinary skills and ability to apply these skills in the field of science, technology and its allied branches.
PO-2	**Communication and Presentation Skills**	Develop various communication skills including presentation to express ideas evidently to achieve common goals of the organization.
PO-3	**Creativity and Critical Judgment**	Facilitate solutions to current issues based on investigations, evaluation and justification using evidence-based approach.
PO-4	**Analytical Reasoning and Problem Solving**	Build critical and analytical attitude in handling the problems and situations.
PO-5	**Sense of Inquiry**	Curiously raise relevant questions based on highly developed ideas, scientific theories and its applications including research.
PO-6	**Use of Modern Tools**	Use various digital technologies to explore information/data for business, scientific research and related purposes.
PO-7	**Research Skills**	Construct, collect, investigates, evaluate and interpret information/data relevant to science and technology to adapt, evolve and shape the future.
PO-8	**Application of Knowledge**	Develop scientific outlook to create consciousness against the social myths and blind faith.
PO-9	**Moral and Ethical Reasoning**	Imbibe ethical, moral and social values to develop virtues such as justice, generosity and charity as beneficial to individuals and society at large.
PO-10	**Leadership and Teamwork**	Work cooperatively and lead proactively to achieve the goals of the organization by implementing the plans and projects in various field-based situations related to science, technology and society at large.

PO-11	**Environment and Sustainability**	Create social awareness about environment and develop sustainability for betterment of future.
PO-12	**Lifelong Learning**	Realize that pursuit of knowledge is a lifelong activity and in combination with determined efforts, positive attitude and other qualities to lead a successful life.

Program Specific Outcomes (PSO)	
PSO1	Understand the various aspects of microbial world and history of microbiology
PSO2	Differentiate and classify different types of microorganism and its characteristics
PSO3	Distinguish between Prokaryotes and Eukaryotes with respective to their ultra-structure and functions.
PSO4	Understand & differentiate the requirement of nutrients and environmental conditions for the growth of microorganisms
PSO5	Apply the knowledge of basic instrumentation, basic techniques in microbiology and control of microorganism
PSO6	Explain and describe types and functions of different biomolecules found in living cells
PSO7	Describe the aspects of microbial ecology and industrial microbiology
PSO8	Illustrate the basic immunology and medical microbiology

S. Y. B. Sc. Microbiology Syllabus (Semester III & IV)
Choice Based Credit System

SEMESTER III

S. Y. B. Sc. Microbiology (Theory)

SEMESTER-III				
Paper No	Paper Code	Title	Credits	Lectures / Week
I	UGMB301.2	Biochemistry and Genetics	3	3
II	UGMB302.2	Introduction to Medical Microbiology and Immunology	3	3
III	UGMB303.2	Environmental Microbiology	3	3
IV	UGMBSEC 301.2A	Analysis of Air, Water & Soil	3	3
V	UGMBSEC 301.2B	Biofertilizers & Biopesticides	3	3
SEMESTER-IV				
I	UGMB401.2	Biochemistry and Basic Analytical Techniques	3	3
II	UGMB402.2	Introduction to Microbial Taxonomy And Diversity	3	3
III	UGMB403.2	Applied Microbiology	3	3
IV	UGMBSEC-401.2A	Food, Dairy & Bioprocess Technology	3	3
V	UGMBSEC-401.2B	Diagnostic Microbiology	3	3

S. Y. B. Sc. Microbiology (Laboratory Sessions)

SEMESTER-III				
Paper No	Paper Code	Title	Credits	Lectures / Week
I	UGMBP03.2	Biochemistry and Genetics Introduction to Medical Microbiology and Immunology Environmental Microbiology	3	6
II	UGMBSECP301.2A	Food, Dairy & Bioprocess Technology	1	2
III	UGMBSECP301.2B	Diagnostic Microbiology	1	2
SEMESTER-IV				
I	UGMBP04.2	Biochemistry and Basic Analytical Techniques Introduction to Microbial Taxonomy And Diversity Applied Microbiology	3	6
II	UGMBSECP401.2A	Food, Dairy & Bioprocess Technology	1	2
III	UGMBSECP401.2B	Diagnostic Microbiology	1	2

Teaching - Evaluation Scheme

Semester-III

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit Scheme			
		Lecture	Practical	Tutorial	CIE	Sem End-	Term	Practical	Oral	Total	Lecture	Practical	Tutorial	Total
UGMB301.2	Biochemistry and Genetics	03	-	-	40	60	-		-	100	03	-	-	03
UGMB302.2	Introduction to Medical Microbiology and Immunology	03	-	-	40	60	-		-	100	03	-	-	03
UGMB303.2	Environmental Microbiology	03	-	-	40	60	-		-	100	03	-	-	03
UGMBSEC 301.2A **Or** UGMBSEC 301.2B	Analysis of Air, Water & Soil **Or** Biofertilizers & Biopesticides	03	-	-	40	60	-	-	-	100	03	-	-	03
UGMBP03.2	Laboratory Sessions for UGMB301.2, UGMB302.2 & UGMB303.2	-	06	-	-	-		150	-	150	-	03	-	03
UGMBSECP 301.2A **Or** UGMBSECP 301.2B	Analysis of Air, Water & Soil **Or** Biofertilizers & Biopesticides	-	02	-			-	50	-	50	-	01	-	01
Total		**12**	**08**	**-**	**160**	**240**	**-**	**200**	**-**	**600**	**12**	**04**	**-**	**16**
Total Credit											**12**	**04**	**-**	**16**

Teaching - Evaluation Scheme

Semester-IV

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit Scheme			
		Lecture	Practical	Tutorial	CIE	Sem End-	Term	Practical	Oral	Total	Lecture	Practical	Tutorial	Total
UGMB401.2	Biochemistry and Basic Analytical Techniques	03	-	-	40	60	-		-	100	03	-	-	03
UGMB402 .2	Introduction to Microbial Taxonomy And Diversity	03	-	-	40	60	-		-	100	03	-	-	03
UGMB403.2	Applied Microbiology	03	-	-	40	60	-		-	100	03	-	-	03
UGMBSEC 401.2A Or UGMBSEC 401.2B	Food, Dairy & Bioprocess Technology Or Diagnostic Microbiology	03	-	-	40	60	-	-	-	100	03	-	-	03
UGMBP04.2	Laboratory Sessions for UGMB401.2, UGMB402.2 & UGMB403.2	-	06	-	-	-		150	-	150	-	03	-	03
UGMBSECP 401.2A **Or** UGMBSECP 401.2B	Food, Dairy & Bioprocess Technology **Or** Diagnostic Microbiology	-	02	-			-	50	-	50	-	01	-	01
Total		**12**	**08**	**-**	**160**	**240**	**-**	**200**	**-**	**600**	**12**	**04**	**-**	**16**
Total Credit											**12**	**04**		**16**

COURSE STRUCTURE FOR S.Y.B.Sc. MICROBIOLOGY

SEMESTER III

	Course	Unit	Topic	Credit	L/W
CORE COURSE	**Biochemistry and Genetics**				
	UGMB 301.2	I	Introduction to Metabolism & Bioenergetics	3	3
		II	Metabolism of Biomolecules		
		III	Basic of Genetics		
CORE COURSE	**Introduction to Medical Microbiology and Immunology**				
	UGMB 302.2	I	Epidemiology and Public Health Awareness	3	3
		II	Common Infectious Diseases		
		III	Innate Immunity & Immune System		
CORE COURSE	**Environmental Microbiology**				
	UGMB 303.2	I	Air Microbiology	3	3
		II	Water Microbiology		
		III	Soil & Geo-microbiology		
SKILL ENHANCEMENT COURSE (SEC-A)	**Analysis of Air, Water, Soil**				
	UGMBSEC 301.2A	I	Analysis of Air	3	3
		II	Analysis of Water		
		III	Analysis of Soil		
SKILL ENHANCEMENT COURSE (SEC-B)	**Biofertilizers & Biopesticides**				
	UGMBSEC 301.2B	I	Biofertilizer	3	3
		II	Biopesticides		
		III	Production & Application of biofertilizers, biopesticides		
Laboratory Session Core Courses	UGMBP03.2	I	Practicum of Core Course 1, 2 & 3	3	6
Laboratory Session SEC	UGMBSECP 301.2A	IV	Practicum of Skill Enhancement Course 1 or	1	2
	UGMBSECP 301.2A	V	Practicum of Skill Enhancement Course 2	1	2

COURSE STUCTURE FOR S.Y.B.Sc. MICROBIOLOGY

SEMESTER IV

	Course	Unit	Topic	Credit	L/W
CORE COURSE	**Biochemistry and Basic Analytical Techniques**				
	UGMB401.2	I	Microbial Biochemistry	3	3
		II	Enzyme Kinetics		
		III	Analytical Techniques		
CORE COURSE	**Introduction to Microbial Taxonomy and Diversity**				
	UGMB402.2	I	Microbial Taxonomy	3	3
		II	Prokaryotic Diversity		
		III	Eukaryotic Diversity		
CORE COURSE	**Applied Microbiology**				
	UGMB 403.2	I	Dairy Microbiology	3	3
		II	Food Microbiology		
		III	Bioprocess Technology		
SKILL ENHANCEMENT COURSE (SEC-A)	**Food, Dairy & Bioprocess Technology**				
	UGMBSEC 401.2A	I	Prebiotic & Probiotic	3	3
		II	Dairy Technology		
		III	Packaging		
SKILL ENHANCEMENT COURSE (SEC-B)	**Diagnostic Microbiology**				
	UGMBSEC 401.2B	I	Typical Diagnostic Cycle	3	3
		II	Diagnostic & Clinical Microbiology		
		III	Clinical Laboratory Management & Quality Control		
Laboratory Session	UGMBP04.2	I	Practicum of Core Course 1, 2 & 3	3	6
Laboratory Session SEC	UGMBSECP 301.2A	IV	Practicum of Skill Enhancement Course 1 or	1	2
	UGMBSECP 301.2A	V	Practicum of Skill Enhancement Course 2	1	2

Teaching Pattern for Semester I and II:

1. Three lectures per week per course. Each lecture is of 60 minutes duration and practical sessions for 06 Hrs.
2. For SEC three lectures per week per course, each lecture is of 60 minutes duration.

Objective:

1. To introduce the application-based research in Microbiology
2. To inculcate sense of scientific responsibilities and social and environment awareness
3. To enrich students' knowledge and train them in the applied microbial sciences
4. To help student's build-up a progressive and successful career

SEMESTER I
Core Course
UGMB301.2 Biochemistry and Genetics

Course Learning Outcome: By the end of the course, students will be able to –

CO1: Understand basics of carbohydrates and its metabolism [2]*
CO2: Obtain knowledge on structure and different classes of amino acids and proteins [1]*
CO3: Obtain in-depth information on protein catabolism and qualitative & quantitative analysis of proteins and lipids [4]*
CO4: Apply & evaluate the knowledge on Mendelian Genetics and chromosomal organization [5]*
CO5: Gain the knowledge and apply on Genetic code and Central dogma of life. [3]*

*Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating

ICT Tools: Videos, PPT, Smart Board,												
Students Centric Methods: Experimental, Participative, Problem Solving												
CO-PO Matrix Mapping												
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	0	0	0	2	0	0	3	0	0	0	0
CO2	1	0	0	0	2	0	0	3	0	0	0	0
CO3	0	0	1	0	0	2	0	0	0	0	0	3
CO4	0	0	3	2	0	0	0	1	0	0	0	0
CO5	1	0	0	2	0	0	0	0	0	0	0	3

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated)

Course Code	Title	Credits /Lecture
UGMB301.2	**Biochemistry and Genetics**	**03 Credits 45 Lectures**
UNIT I	**Introduction to Metabolism & Bioenergetics** 1.1 Introduction to metabolism, Metabolic pathways 1.2 Organic reaction mechanism 1.3 Experimental approaches to study metabolism 1.4 Thermodynamics of Phosphate compounds 1.5 Oxidation-reduction reactions 1.6 Thermodynamics of life	1 Credit 15 Lectures
Unit-II	**Metabolism of Biomolecules-** 2.1 Carbohydrate metabolism (With structures) Glycolysis (EMP) HMP Pathway TCA cycle 2.2 Amino Acids Structure and Classification 2.3 Protein– · Classification, · Biological role of proteins and structural organization of protein. · Catabolism of Proteins & Amino acids: Transamination, deamination, decarboxylation and urea cycle.	1 Credit 15 Lectures
Unit-III	Unit-III: **Basic of Genetics** 3.1 Mendelian genetics 3.2 Chromosomal organization in eukaryotic and prokaryotic organisms. 3.3 Genetic code and process. 3.4 Central dogma of life. 3.5 Gene function	1 Credit 15 Lectures

Reference Books:

1. Principles of Biochemistry- G. Zubay, W.W. Parson, D.E. Vance. Wm. C. Brown Publishers
2. Fundamentals of Biochemistry. D. Voet and J. Voet Publisher Wiley plus Edition 5th.
3. Lehninger- Principles of Biochemistry- David Nelson, Michael Cox. 4th edition W.H. Freeman & Company
4. Instrumental Methods of chemical analysis, V.K. Ahluwalia, Ane Books Pvt.Ltd; 2015.
5. Principles & techniques of Biochemistry &Mol biology 6th edition, Keith Wilson & John Walker, Cambridge University press, 2006
6. Laboratory manual in Biochemistry- J. Jayaraman

Core Course

UGMBP302.2: Introduction to Medical Microbiology and Immunology

Course Learning Outcome: By the end of the course, students will be able to –

CO1. Understand different epidemiological aspects and their importance. [2]*
CO2. Apply the knowledge of Public Health Measures to the Control of Disease [3]*
CO3. Identify and describe common infections of the Digestive and Nervous system [3]*
CO4. Demonstrate innate immunity and the different component associated with it [3]*
CO5. Select an appropriate methods & technique to identify microorganisms [4]*
CO6. Differentiate between different nosocomial infections. [2]*

*Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating

ICT Tools: Videos, PPT, Smart Board											
Students Centric Methods: Experimental, Participative, Problem Solving											
CO-PO Mapping Matrix											
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	1	2	3	0	0	0	2	0	0	3	3
CO2	1	0	2	3	0	0	3	2	0	2	0	1
CO3	1	0	0	3	0	3	2	0	0	0	0	1
CO4	1	0	0	1	2	0	0	2	0	0	0	1
CO5	0	0	0	3	0	3	2	2	0	0	0	1
CO6	1	0	0	0	0	0	0	0	0	0	0	1

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated)

Course Code	Title	Credits/ Lectures
UGMB 302.2	Introduction to Medical Microbiology and Immunology	**03 Credits 45 Lectures**
UNIT I	**Epidemiology and Public Health Awareness Terminology:** 1.1Epidemiology, sporadic disease, Endemic disease, Hyper endemic disease, Epidemic disease, Pandemic disease & Index case. 1.2Reservoirs of infection – Human reservoirs, Animal reservoirs, Non-living reservoirs 1.3Transmission of diseases Contact, Vehicle, Vectors Transmission 1.4Public Health Measures for the Control of Disease: (With special reference to SARS Cov-2) 1.5 Controls directed against the Reservoir & Transmission of the Pathogen Immunization, Quarantine, Surveillance, Pathogen Eradication	1 Credit 15Lecturs
Unit-II	**Common Infectious Diseases** **2.1** Infections of the Digestive system: Study of structure and functions of the digestive system Study of digestive system infections caused by Salmonella species, and E. coli **2.2** Infections of the Nervous system: Structure and functions of Nervous System, Study of disease of Nervous System: Tetanus and Rabies **2.3** Introduction to Nosocomial infections	1 Credit 15 Lectures

Unit-III	**Innate Immunity & Immune System** 3.1 Basic concepts in immunology-Revision 3.2 Principles of Innate & adaptive immunity-Primary, Secondary &Tertiary Barriers 3.3 Components of the immune system-Cells and organs of the immune system 3.4 Phagocytosis and inflammation-Mechanisms and link to immunity 3.5 Pattern recognition in the innate immune system A. PAMPs, B. PRRs, C. TLRs	1 Credit 15 Lectures

Reference Books:

1. Microbiology, an Introduction by Tortora, Funke& Case 9th and 11th edition, Pearson education.
2. Ananthnarayan & Paniker's Textbook of Microbiology, 8thEd.
3. Mackie and McCartney Practical medical microbiology 14th edition, Publication: Churchill Livingstone
4. Brock biology of microorganism by Michael T Madigan& John M Martinco, Pearson education
5. Prescott's Microbiology, 8th Edition; Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton, 2011, McGraw Hill International Edition
6. Immunology Essential and Fundamental, Third Edition, Pathak and Palan,Pareen Publishers
7. Brock biology of microorganism by Michael T Madigan& John M Martinco, Pearson education

Core Course

UGMBP303.2 Environmental Microbiology

Course Outcomes: Upon completion of the course, students will be able to,

CO1: Explain distribution of microbes in several different environments, including water, sediments, soil and air [2*]
CO2: Categorize methods of air, water & soil sampling [4*]
CO3: Compare & contrast between analysis methods [4*]
CO4: Apply analysis methods on various samples [3*]
CO5: Distinguish between biogeochemical cycles.[2*]

*Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating

ICT Tools: Videos, PPT, Smart Board											
Students Centric Methods: Experimental, Participative, Problem Solving											
CO-PO Mapping Matrix											
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	0	0	0	0	0	0	0	0	0	2	3
CO2	0	0	1	1	0	1	2	3	0	0	0	0
CO3	0	0	0	1	0	0	2	0	0	0	3	0
CO4	0	0	0	0	0	0	0	1	0	0	2	3
CO5	0	0	0	0	0	0	1	0	0	2	3	0

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated)

Course Code	Title	Credits/ Lectures
UGMB303.2	**Environmental Microbiology**	**03Credits 45 Lectures**
Unit-I	**Air Microbiology** 1.1 Aero microbiology: a. Important airborne pathogens and toxins b. Aerosols and nature of bioaerosols c. Aeromicrobiological pathway d. Microbial survival in the air e. Extramural aeromicrobiology f. Intramural aeromicrobiology 1.2 Sampling Techniques a. Sampling Devices for the Collection of Air Samples b. Detection of microorganisms on fomites 1.3 Air Sanitation 1.4 Air Quality Standards 1.5 Introduction to exobiology – a. Introduction b. Case study	1 Credit 15 Lectures
Unit-II	**Water Microbiology** **A] Fresh Water Microbiology** 2.1 Fresh water environments and micro-organisms found in Springs, rivers and streams, Lakes, marshes and bogs 2.2 Potable water: Definition, water purification, water quality standards (WHO and BIS standards) and pathogens transmitted through water 2.3 Guidelines and limits of MPCB **B]Marine Microbiology** 2.4 Zonation in Marine water body 2.5 Kinds of Microorganisms in marine environment 2.6 Role and impact of marine microorganisms **C]Sewage Microbiology** 2.7 Modern Wastewater treatment: Primary, Secondary and Tertiary Treatment 2.8 Removal of Pathogens by Sewage treatment Processes 3.4 Oxidation Ponds and Septic tanks 2.9. Sludge Processing 3.0 Disposal of treated wastewater and biosolids. 3.1 Study of wastewater index, Rules and regulations for Disposal of sludge as well as treated wastewater.	1 Credit 15 Lectures

Unit-III	**Soil and Geomicrobiology** 3.1 Terrestrial Environment Soil – Definition, Composition and function Textural triangle Types of soil microorganisms and their activities 3.2 Methods of studying soil microorganisms: Sampling and Cultural methods, Physiological methods Immunological methods Nucleic acid-based methods Radioisotope techniques 3.3 Biogeochemical Cycles: · Carbon cycle · Nitrogen cycle · Sulphur cycle · Phosphorus Cycle · Iron cycle	1 Credit 15 Lectures

References Books:

1. Environmental Microbiology, 2nd Edition; Raina M. Maier, Ian L. Pepper, Charles P. Gerba, 2010 Academic Press
2. Fundamental Principles of Bacteriology, 7th Edition; A.J. Salle, Tata McGraw Hill Publishing Company
3. Air Quality Standards- NAAQS Manual, Volume I
4. Prescott's Microbiology, 8th Edition; Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton,2011, McGraw Hill International Edition
5. Fundamentals of Microbiology, 9th Edition, Frobisher, Hinsdill, Crabtree, Goodheart, 1974, Saunders College Publishing
6. Introduction to Environmental Microbiology – Barbara Kolwzan, WaldemarAdamiak (E Book)
7. Soil Microbiology-4th Edition, N.S Subba Rao,2000, Oxford and IBH Publishing Co. Pvt. Ltd

SKILL ENHANCEMENT COURSE (SEC)

UGMBSEC301.2A: Analysis of Air, Water & Soil

Course Outcomes: Upon completion of the course, students will be able to,

CO1: To understand basics of Air, Water, Soil [2*]

CO2: To analyze different sampling methods [3*]

CO3: Compare & contrast between two analysis methods. [4*]

CO4: Apply analysis methods on various samples [3*]

CO5: Design different analysis methods for air, water & soil samples. [6*]

*Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating

ICT Tools: Videos, PPT, Smart Board												
Students Centric Methods: Experimental, Participative, Problem Solving												
CO-PO Mapping Matrix												
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	0	2	2	1	0	2	1	2	0	2	2
CO2	1	0	0	0	0	0	0	2	0	0	0	1
CO3	1	0	2	2	0	1	2	1	1	0	3	1
CO4	1	2	0	1	0	2	1	2	1	2	1	3
CO5	1	0	2	2	0	1	2	1	1	0	3	1

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated)

Course Code	Title	Credits/ Lectures
UGMBSEC 301.2A	**Analysis of Air, Water & Soil**	**03 Credits 45 Lectures**
Unit –I	**Analysis of Air** 1. Chemical composition of Air: Classification of elements, chemical speciation. 2. Particles, ions and radicals in the atmosphere 3. Sampling Devices for the Collection of Air Samples 4. Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics 5. Control Measures: Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration.	1 Credit 15 Lectures
Unit-II	**Analysis of Water** 2.1 Water Chemistry: Chemistry of water, concept of DO, BOD, COD, sedimentation, coagulation. filtration, Redox potential 2.2 Physicochemical and Bacteriological sampling and analysis of water quality 2.3 Microbial indicators of fecal pollution: Elevated temperature test 2.4 Water borne diseases (Tabular Form): Qualitative analysis: Defined substrate test, P-A (Presence Absence test)	1 Credit 15 Lectures
Unit-III	**Analysis of Soil** 3.1 Soil architecture; 3.2 Physical properties of soil; 3.3 Soil texture; 3.4 Soil water holding capacity; 3.5 Methods of studying soil microorganisms: · Direct microscopic methods, · Agar plate technique, · Enrichment culture technique, · Buried slide technique and soil respiration technique	1 Credit 15 Lectures

Reference Books:

1. Brady N.C., and R.R. Weil. 2010. Elements of the Nature and Properties of Soils, 3rd Ed. Prentice Hall.
2. Stewart B.A., Advances in soil sciences, Lewis Publisher, 2000.
3. Biswas T.D. and Mukherjee S.K., Textbook of Soil Sciences, Publisher: McGraw Hill Inc., US, 2nd edition, 1995.
4. Standard Methods for Examination of Water and Waste Water American Public Health Association (5th Ed) (1980)
5. Standard Methods for Examination of Water and Waste Water American Public Health Association (5th Ed) (1980)
6. Waste Water Engineering, Metcalf and Eddy Tata Mc Graw Hill,
7. Physico – Chemical Process for Water quality, Weber. W.J, Ann Arbor. and company, New Delhi (1974)
8. Physico – Chemical Process for Water quality, Weber. W.J, Ann Arbor.
9. Pelczar Jr, M J, Chan E C S, Krieg N R, (1986) Microbiology, 5thedn, McGraw-Hill Book Company,NY.
10. Alexander M, (1977), Soil Microbiology, 2 nd Edition Krieger Publ. Co. Melbourne, FL
11. Atlas R M, (1977), Principles of Microbiology2 nd Edition, Wm. C. Brown Publ. Iowa USA
12. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
13. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3rd edition, ASM press

SKILL ENHANCEMENT COURSE (SEC)

UGMBSEC301.2B: Biofertilizers & Biopesticides

Course Outcomes- Upon Completion of this course students will able to,

CO1: Describe types of biofertilisers & biopesticides [2*]

CO2: Understand the advantages & disadvantages of biofertilisers / biopesticides [2*]

CO3: Evaluate the method for biofertilisers / biopesticides preparation. [5*]

CO4: Apply knowledge for mass scale production [3*]

CO5: Design methods of biofertilisers / biopesticides preparation. [6*]

*Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating

ICT Tools: Videos, PPT, Smart Board												
Students Centric Methods: Experimental, Participative, Problem Solving												
CO-PO Mapping Matrix												
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	0	2	2	1	0	2	1	2	0	2	2
CO2	1	0	0	0	0	0	0	2	0	0	0	1
CO3	1	0	2	2	0	1	2	1	1	0	3	1
CO4	1	2	0	1	0	2	1	2	1	2	1	3
CO5	1	0	2	2	0	1	2	1	1	0	3	1

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated)

Course Code	Title	Credits/ Lectures
UGMBSEC 301.2B	**Biofertilisers & Biopesticides**	**04 Credits 45 lectures**
Unit -I	**Biofertilizer** 1. Introduction to Biofertilizers 2. Structure and characteristic features of microbial biofertilizers. 3. Types of Biofertilizers 4. Methods of Biofertilizer Inoculation 5. Mechanism of phosphate solubilisation and phosphate mobilization, K solubilisation. 6. Advantages of Biofertilizers 7. Disadvantages of Biofertilizers	1 Credit 15 Lectures
Unit-II	**Biopesticides** 1. History and concept of biopesticides. 2. ·Importance, scope and potential of biopesticide. · Definitions, viz. pathogen, botanical pesticides, and biorationales. 3. Virulence, pathogenicity and symptoms of a. Entomopathogenic pathogens and nematodes. 4. Types of biopesticides 5. Mass scale production-Outline	1 Credit 15 Lectures
Unit-III	**Production & Application of biofertilizers & biopesticides** 1. Mass scale production of · Azotobacter Rhizobial biofertilizer Sulphur oxidizing microorganisms Phosphate solubilizers 2. Checking the efficiency on crop growth 3. Formulation of biofertilizer & field application 4. Mass scale production of · *Bacillus thuringenesis* 5. Checking the efficacy of biopesticide on mosquito larvae 6. Formulation of biopesticide	1 Credit 15 Lectures

Reference Books:

1. Alexander M. 1977. Soil Microbiology. John Wiley.
2. Bergerson FJ. 1980. Methods for Evaluating Biological Nitrogen Fixation. John Wiley and Sons.
3. Motsara, I.M.R., Bhattacharyya, P. and Srivastava, B. 1995. Biofertilizer Technology, Marketing and Usage- A Source Book-cum-glossary. FDCO, New Delhi.
4. Subba Rao, N.S. Biofertilizers in Agriculture and Forestry. 1993. Oxford and IBH. Publ. Co., New Delhi.
5. Burges, H.D. and Hussey, N.W. (1971). Microbial Control of Insects and mites. Academic Press, New York.
6. Burges, H.D. Formulation of microbial pesticides – Kluversep, ACB, Dordrecht-ISBN. 0412 625 202.
7. Coppel H.C. and J.W. Martin. (1977). Biological control of insect pest suppression. Springail.
8. De Bach P. 1964. Biological control of Insect Pest and Weeds Chapman and Hall, New York.
9. Gautam, R.D. (2006). Biological suppression of insect pests. Kalyani Publisher, New Delhi.
10. Huffaker, C.B. and Messenger, P.S. (1976). Theory and Practice of Biological control. Academic Press, New York.
11. Ignacimuthu, S.S. and Jayaraj, S. (2003). Biological Control of Insect Pests. Phoenix Publ. New Delhi.
12. Saxena, A.B. (2003). Biological Control of Insect Pests. Anmol Publ. New Delhi.
13. Huffaker, C.B. and Messenger, P.S. (1976). Theory and Practice of Biological control. Academic Press, New York.
14. Pepper HJ and Perlman D. 1979. Microbial Technology. 2nd Ed. Academic Press.
15. A century of Nitrogen Fixation Research Present status and Future propects. 1987. F.J. Bergersen and J.R. Postgate The Royal Soc., London.
16. Biology and Biochemistry of Nitrogen fixation. 1991. M.J. Dilworth,and A.R. Glenn, Elsevier, Amsterdam. .
17. Nitrogen Fixation in plants. 1986. R.O.D. Dixon,and C.T. Wheeler, Blackie USA, Chapman and Hall, New York.
18. A treatise on dinitrogen Fixation Section IV. Agronomy and Ecology 1977. R.W.F Hardy, and A.H. Gibson John Wiley & Sons, New York..
19. Bioresearches technology for sustainable agriculture. 1999. S. Kannaiyan, Assoc. Pub. Co., New Delhi.
20. Biofertilizer Technology, Marketing and usage- A source Book -cum-glossary 1995. Motsara, I. M.R., P. Bhattacharyya and Beena Srivastava, FDCO, New Delhi.
21. Symbiotic nitrogen fixation in plants, 1976. P.S. Nutman, Cambridge Univ. Press, London.
22. Hand book for Rhizobia; Methods in legume Rhizobium Technology, 1994. P. Somasegaran and H.J. Hoben Springer-Verlag, New York.
23. Biofertilizers in Agriculture and Forestry 1993. N.S. Subba Rao Oxford and IBH Publ. Co., New Delhi.

LABORATORY SESSIONS

UGMBP03.2: Microbiology Practicum of Core Course 1, 2 & 3

Course Outcome: At the end of the course, learners will be able to:

CO1: Obtain in-depth information on protein catabolism and qualitative & quantitative analysis of proteins and lipids [2]*
CO2: Apply & evaluate the knowledge on Mendelian Genetics, chromosomal organization, Genetic code and Central dogma of life [4]*
CO3. Understand different epidemiological aspects and their importance and apply the knowledge of Public Health Measures to the Control of Disease [4]*
CO4. Demonstrate immunity and the different component associated with it [3]*
CO5: Explain distribution of microbes in several different environments, including water, sediments, soil and air and analyse air, water& soil samples [5*]

*Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating

ICT Tools: Videos, PPT, Smart Board											
Students Centric Methods: Experimental, Participative, Problem Solving											
CO-PO Mapping Matrix											
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	-	2	2	1	-	2	1	2	-	2	2
CO2	1	-	2	2	-	1	2	2	1	-	3	1
CO3	1	1	2	3	-	-	3	2	-	2	3	3
CO4	1	-	-	1	2	-	-	2	-	-	-	1
CO5	1	-	1	1	-	1	2	3	-	1	2	3

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated)

Course Code	Title	Credits/ Lectures
UGMBP301.2	**Practicum of Core Course 1, 2 & 3**	**3 Credits**
Practicum of Core Course 1	1. Study of biochemical pathway and study of end product and its characterization. a) Lysine Decarboxylase b) Oxidative and fermentative utilization of glucose by microbes c) Detection of homo and heterofermentative lactic acid fermentation 2. Estimation of Amino acids by Ninhydrin method 3. Estimation of total sugar by Anthrone(Demonstration) 4. Estimation of reducing sugar by DNSA method 5. Estimation of glycine by Sorrenson's Formal Titration. 6. Estimation of protein by Biuret method. 7. Extraction of lipid by Soxhlet method (Demonstration) 8. Problems on laws of Mendelian genetics 9. Problems on Genetic code	2 Hr/Week
Practicum of Core Course 2	1. Assignment on Epidemiology, Public Health Measures for the Control of Disease 2. Study the morphological, cultural, and biochemical characteristics of *E. coli* and *Salmonella species* (w.r.t. Digestive system infections) 3. Demonstration of phagocytosis 4. Study of Immunodiffusion by Mancini method (Antigen Antibody Reaction) 5. Simulation studies of strains from fomites 6. Case study on Covid 19	2 Hr/Week
Practicum of Core Course 3	1. Routine analysis of water: a. Detection of Coliforms in water: Presumptive Test, Confirmed Test and Completed Test b. Rapid Detection of E. coli by MUG Technique (Demonstration) 2. Enumeration of microorganisms in air and study of its load after fumigation 3. Study of air microflora and determination of sedimentation rate 4. Waste water analysis: a. Study of microbial flora in raw and treated sewage b. Determination of total solids in waste water c. Determination of BOD of waste water d. Determination of COD of waste water 5. Presentation on "Water Recycling" (By students)	2 Hr/Week

	6. Study of microorganisms in sea water 7. Isolation of bacteria, Actinomycetes and fungi from soil 8. Winogradskys column (Demo) 9. Visit to a sewage treatment plant or water purification plant 10. Analysis of sewage water collected from different regions (Pollution Index) 11. Total viable count of soil microflora	

Laboratory Sessions
Skill Enhancement Course
UGMBSECP301.2A: Analysis of Air, Water & Soil

Course Outcomes: Upon completion of this course students will be able,

CO1: To understand basics of Air, Water, Soil [2*]
CO2: To analyse different sampling methods [3*]
CO3: Apply analysis methods on various samples [3*]

*Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating

ICT Tools: Videos, PPT, Smart Board											
Students Centric Methods: Experimental, Participative, Problem Solving											
CO-PO Mapping Matrix											
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	-	2	2	1	-	2	1	2	-	2	2
CO2	1	-	-	-	-	-	-	2	-	-	-	1
CO3	1	2	-	1	-	2	1	2	1	2	1	3

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated)

Course Code	Title	Credits/ Lectures
UGMBSECP 301.2 A	**Practicum UGMBSECP301A course**	**1 credit**
Practicum SEC301A course	1. Enumeration of air microflora at different places. 2. Demonstration of Air Sampler. 3. Qualitative analysis of drinking water. 4. COD of effluent water. 5. BOD of effluent water. 6. Isolation of antibiotic producing microorganism from soil. 7. Visit to Sewage Treatment Plant	2 Hr/Week

Laboratory Sessions
Skill Enhancement Course
UGMBSECP301.2B: Biofertilisers and Biopesticides

Course Outcomes [Theory]: Upon completion of this course students will able to,

CO1: Evaluate the method for biofertilisers / biopesticides preparation. [5*]

CO2: Apply knowledge for mass scale production [3*]

CO3: Design methods of biofertilisers / biopesticides preparation. [6*]

*Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating

ICT Tools: Videos, PPT, Smart Board												
Students Centric Methods: Experimental, Participative, Problem Solving												
CO-PO Mapping Matrix												
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	-	2	2	-	1	2	1	1	-	3	1
CO2	1	2	-	1	-	2	1	2	1	2	1	3
CO3	1	-	2	2	-	1	2	1	1	-	3	1

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated)

Course Code	Title	Credits/ Lectures
UGMBSECP 301.2 B	**Practicum UGMBSECP301B course**	**1 credit**
Practicum SEC301B course	**1.** Isolation of Rhizobium from root nodules. Isolation of *Azotobacter ,Azospirillium*. I. By dilution pour plate technique and II. By enrichment culture technique **2.** Isolation and purification of P-solubilizers and *cyanobacteria.* I. By dilution pour plate technique II. By enrichment culture technique **3.** Production of Rhizobium commercial biofertilizers of Azotobacter , Azospirillum. **4.** Methods of application of biofertilizers, Biopesticides **5.** Quality control of biopesticides. **6.** Visits to Commercial biofertiliser & biopesticide units.	2 Hr/Week

SEMESTER IV

CORE COURSE

UGMB401.2-Biochemistry and Basic Analytical Techniques

After successful completion of each course in Microbiology a learner should be able to:
Course Learning Outcome: By the end of the course, a student will be able to:

CO1: Understand the basic principle of microbial biochemistry [2*]
CO2: Construct experiments to carry out enzyme activity [5*]
CO3: Show separation of amino acids by chromatography [3*]

*Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating

ICT Tools: Videos, PPT, Smart Board												
Students Centric Methods: Experimental, Participative, Problem Solving												
CO-PO Mapping Matrix												
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	2	-	1	1	1	-	1	1	-	-	-	3
CO2	1	-	3	2	1	-	2	2	-	-	-	1
CO3	1	-	1	3	1	2	1	-	-	1	1	1

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Course Code	Title	Credits/ Lectures
UGMB 401.2	**Microbial Biochemistry & Analytical Techniques**	**03 Credits 45 lectures**
Unit-I	**Microbial Biochemistry** 1.1Microbial growth Definition, Measurement of growth, Diauxic growth Measurements of cell constituents, Turbidity measurements, Synchronous growth, Continuous growth (Chemostast and turbidostat). 1.2 Solute Transport (With mechanism) · Passive transport · Active transport · Facilitated diffusion · Group translocation 1.3 Bioluminescence · Brief survey of bioluminescent systems · Biochemistry of light emission · Schematic diagram · Significance / Application	1 Credit 15 Lectures
Unit-II	**Enzyme Kinetics** **2.1** Introduction of Enzymes: · General properties of enzymes · Enzyme as a biocatalyst · Michaelis-Menten equation and Lineweaver Burk plot · Classification of enzymes **2.2** Overview of Coenzyme: · Coenzymes: Different types and reactions catalyzed by coenzymes (in tabular form) · Nicotinic acid: structure, occurrence & biochemical Function 2.3. Enzyme Kinetics: · Saturation kinetics · Effect of temperature and pH · Effect of Inhibitors- Reversible, irreversible, competitive, non-competitive and uncompetitive Inhibitors · Multisubstrate reactions Ordered, Random and Ping-Pong reactions Allosteric effects in enzyme catalyzed reactions- Koshland Nemethy and Filmer model & Monod, Wyman and Changeux model	1 Credit 15 Lectures

Unit III	**Analytical Techniques** **3.1** Chromatography Introduction to chromatography, types of Chromatography Paper chromatography: Principle, circular, ascending and descending Paper Chromatography, Separation of amino acids and monosaccharides by Paper Chromatography. Thin layer chromatography: principle, technique & application Column chromatography: Introduction & principle Exclusion chromatography, gel chromatography 3.2 Centrifugation Introduction: basic principles of sedimentation · Types, Preparative centrifugation & its applications. Analytical centrifugation and its application 3.3 Electrophoresis General principles, support media Agarose gels, polyacrylamide gels	1 Credit 15 Lectures

Reference Books:

1. Principles of Biochemistry- G. Zubay, W.W. Parson, D.E. Vance. Wm. C. Brown Publishers
2. Fundamentals of Biochemistry. D. Voet and J. Voet Publisher Wiley plus Edition 5th. 3. Lehninger- Principles of Biochemistry- David Nelson, Michael Cox. 4th edition W.H. Freeman & Company
4. Instrumental Methods of chemical analysis, V.K. Ahluwalia, Ane Books Pvt. Ltd; 2015.
5. Principles & techniques of Biochemistry &Mol biology 6th edition, Keith Wilson & John Walker, Cambridge University press, 2006
6. Laboratory manual in Biochemistry- J. Jayaraman

CORE COURSE

UGMB402.2 Introduction to Microbial Taxonomy and Diversity

Course Learning Outcome: By the end of the course, a student should develop the ability to,

CO1. Select an appropriate technique to identify a microbial genus, species, strain
CO2. Predict the basic biological as well as public health implications of microbial taxonomic identifications.
CO3. Paraphrase the rationale underpinning the construction of phylogenetic trees.
CO4. Classify microorganisms
CO5. Summarize characteristics of microorganisms.

*Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating

ICT Tools: Videos, PPT, Smart Board											
Students Centric Methods: Experimental, Participative, Problem Solving											
CO-PO Mapping Matrix											
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	-	-	3	-	3	-	2	-	1	-	1
CO2	1	-	1	-	-	2	-	-	-	-	2	1
CO3	1	-	-	2	-	3	-	-	-	-	-	1
CO4	1	-	-	-	-	3	-	-	-	-	-	1
CO5	1	-	-	-	-	-	-	-	-	-	-	-

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated)

Course Code	Title	Credits/ Lectures
UGMB402.2	**Introduction to Microbial Taxonomy And Diversity**	**03 Credits 45 lectures**
Unit I	**Microbial Taxonomy** 1.1 Introduction to microbial Taxonomy Terminologies: Taxonomy, Nomenclature, Systematics, Natural classification, Species, Genus, strain, polyphasic taxonomy 1.2 Taxonomic ranks 1.3 Tools for taxonomy a) Phenetic classification b) Phylogenetic classification c) Genotypic classification, d) Numerical taxonomy e) Classical characteristics Morphological, Physiological and metabolic, biochemical characteristics, ecological characteristics, Genetic analysis f) Molecular Characteristics Nucleic acid base composition, nucleic acid hybridisation, nucleic acid sequencing 1.4 Phylogenetic Trees (a) Types, (b) Construction (an overview), 1.5 Organization of Bergey's manual of systematic bacteriology	1 Credit 15 Lectures

Unit II	**Prokaryotic Diversity** 2.1 Introduction to microbial diversity and phylogeny, a) A survey of prokaryotic phylogeny and diversity(Table only) 2.2 Diversity of bacteria Proteobacteria a)Alphaproteobacteria- Rhizobiales b)Betaproteobacteria- Nitrosomonades c)Gammaproteobacteria- Enterobacterials(mix acid fermenters) d)Deltaproteobacteria- Desulfovibrionales e)Epsilonproteobactria- Helicobacter, f) Firmicutes- lactobacillus, g) Actinomycetales-actinomycetes,Nocardia,Streptomyces 2.3Diversity of archea I)a)Euryarchaeota- Extremlyhalophlicarchaea, b)Methanogenicarchaea c)Thermoplasmatales-Thermococcus,Mrthanopyrus II)Thaumarchaeota-Nanoarchaeota and korarchaeota III)Crenarchaeota-Sulfolobales from terrestrial volcanic habitats) Pyrodictum(from submarine volcanic habitats	1 Credit 15 Lectures
Unit III	**Eukaryotic Diversity** 3.1Phylogenetic lineages of Eucarya 3.2 Protists: Introduction to a)Diplomonads & Parabasalids, Euglenozoans,Alveolates b)Stramenopiles c)Amoebozoa 3.3 Fungi- Fungal physiology,structure and symbiosis 3.4 Algae a)Chytridiomycetes b)Zygomycetes and Glomeromycetes c)Acomycetes d)Mushrooms and other Basidiomycetes e)Red and green algae,Endolithic phototrophs	1 Credit 15 Lectures

Reference Books:

1. Microbiology, an Introduction by Tortora, Funke& Case 9th and 11th edition, Pearson education.
2. Brock biology of microorganism by Michael T Madigan& John M Martinco,Pearson education,14th edition
3. Prescott's Microbiology, 8th Edition; Joanne M. Willey, Linda M. Sherwood,Christopher J. Woolverton, 2011, McGraw Hill International Edition

CORE COURSE
UGMB403.2 Applied Microbiology

Course Outcomes: Upon Completion of this course students will able,

CO1: To understand basics of Dairy, Food & bioprocess technology [2*]
CO2: To analyse different spoilage methods of Food [3*]
CO3: Apply analysis methods on various samples of dairy & food industry [3*]
CO4: Design different methods of fermentation product preparation. [6*]

*Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating

ICT Tools: Videos, PPT, Smart Board											
Students Centric Methods: Experimental, Participative, Problem Solving											
CO-PO Mapping Matrix											
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	1	-	2	2	3	2	-	1	1	2	-
CO2	1	-	3	2	2	2	2	2	1	2	2	1
CO3	1	1	2	3	2	2	1	1	-	1	-	1
CO4	1	-	2	1	3	2	1	2	-	2	-	3

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated)

Course Code	Title	Credits/ Lectures
UGMB403.2	**Applied Microbiology**	**03 Credits 45 lectures**
Unit –I	**Dairy Microbiology** A] Raw and Market Milk 1.1 Constituents and properties of milk 1.2 Microflora of raw milk Effect of microbial contamination in Milk 1.3 Control of microorganisms in milk Microbial analysis of raw milk 1.4 Processing of market milk B] Milk Products 1.5 Butter Production 1.6 Cheese production: Cheddar, Cottage and Swiss Cheese 1.7 Dahi (Curd) 1.8 Milk power and dry Whey 1.9 Evaporated milk and Condensed milk 1.10 Other fermented milk of India	1 Credit 15 Lectures
Unit-II	**Food Microbiology** 2.1 Introduction: Food microbiology and food Food as a substrate for microorganism a. pH, aw, O-R potential b. Nutrient Content c. Accessory food substances d. Inhibitory substances & biological structure e. Combined effects of factors affecting growth 2.2 Food-borne Illness associated Microorganisms: a) Classification of Food-borne diseases (Schematic). b) Food -borne intoxication overview/tabulation. I. *Staphylococcus* food intoxication ii. Salmonellosis 2.3 General Principles of spoilage : a) Fruits and vegetables b) Meat (under aerobic & anaerobic conditions) c) Seafood, Shellfish d) Canned foods	1 Credit 15 Lectures

	2.4 A] General Principles of Preservation: B] Methods of Preservation: a) High temperature (including TDT, D, F, Z values, 12D concept), principle of canning b) Low temperature c) Drying d) Food preservatives (organic acids & their salts, Sugar & salt) e) Ionizing radiations f) Hurdle Technology	
Unit-III	**Bioprocess Technology** Upstream processes 3.1 Fermentation media: Characteristics of ideal production medium, Types of production media, Raw materials used for and sterilization of production media 3.2 Industrial strains: Characteristics of ideal Industrial strains, Screening of Industrial strains, screening antibiotic producers, organic acid producers and amino acid producers 3.3 Culture collection centers 3.4 Preservation of industrial cultures 3.5 Preparation of inocula 3.6 Fermenter: Characteristics of ideal fermenter STR: Design and its applications 3.7 Ethanol production 3.8 Beer fermentation 3.9 Citric acid fermentation	1 Credit 15 Lectures

Reference Book

1. Fundamental Food Microbiology by Bibek Ray, ArunBhunia (2007), 4th edition CRC Press
2. Food Microbiology – An Introduction by Montville and Mathews, (2008), ASM Press 3. Industrial Microbiology by Waites and Morgan, Blackwell Science
4. Modern Industrial Microbiology and Biotechnology by NdukaOkafor, (2007), Science Publishers.
5. Food Science by Sumati R. Mudambi, ShaliniRao, M.V. Rajagopal, revised 2nd edition, (2006), New Age international publications.
6. Prescott's Microbiology by J.M. Willey, L.M. Sherwood, C.J. Woolverton, (2011) 8th edition, McGraw-Hill International edition
7. Prescott, Harley and Klein's Microbiology by Willey, Sherwood, Woolverton, (2008) 7th edition, McGraw-Hill International edition
8. Brock Biology of Microorganisms by Madigan, Martinko, Dunlap and Clark (2009) 12th edition, Pearson Education.

9. Microbiology an Introduction: 9th Edition; Gerard J. Tortora, Berdell R. Funke, Christine L. Case, Pearson Education Course
10. Food Microbiology by Frazier 5th edition
11. Modern Food Microbiology by James Jay 6th edition
12. Applied Dairy Microbiology by Martha & Steele
13. BIS standards, FSSAI
14. Food Microbiology by Frazier

SKILL ENHANCEMENT COURSE (SEC)
UGMBSEC401.2A: Food, Dairy & Bioprocess Technology

Course Outcomes: Upon Completion of this course students will able,

CO1: To understand food as a substrate [2*]
CO2: To understand health benefits of fermented dairy products [2*]
CO3: To analyse functional fermented dairy products [3*]
CO4: Compare & contrast between Prebiotics & Probiotics [4*]
CO5: Analyse different packaging methods [3*]

*Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating

ICT Tools: Videos, PPT, Smart Board											
Students Centric Methods: Experimental, Participative, Problem Solving											
CO-PO Mapping Matrix											
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	1	-	2	2	3	2	-	1	1	2	-
CO2	1	1	-	2	2	3	2	-	1	1	-	-
CO3	1	1	2	3	-	2	1	1	-	1	-	2
CO4	1	1	2	3	-	-	1	1	-	1	1	2
CO5	1	1	2	2	-	2	1	3	2	-	1	1

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated)

Course Code	Title	Credits/ Lectures
UGMB SEC401.2A	**Food, Dairy & Bioprocess Technology**	**03 Credits 45 Lectures**
Unit –I	**Prebiotics & Probiotics** · Food as a substrate for microorganisms – microorganisms important in food microbiology: molds, yeasts and bacteria – factors affecting the growth of microorganisms in food, feed and fodder. · Introduction and history of Probiotics, safety of probiotic microorganisms, legal status of probiotics Characteristics of Probiotics for selection. · Tolerance to additives, stability during storage, stability during passage to intestinal sites, Role of probiotics in health and disease, minimum effective dose, maintenance of probiotic microorganisms · Prebiotics: concept, definition, criteria, types and sources of prebiotics, prebiotics and gut microflora, Prebiotics and health benefits: prebiotics in foods.	1 Credit 15 Lectures
Unit-II	**Dairy Technology** Functional Dairy Products: Definition, fermented milk products, functional dairy products, and therapeutic applications. · Processing of market milk · Health benefits of functional fermented dairy products: such as dahi, lassi, yoghurt, cheese, kefir, koumiss, Yakult, fermented whey drinks, and dairy based cereal foods, soy based yoghurt containing probiotics.	1 Credit 15 Lectures

Unit-III	**Packaging** · Objectives of packaging, flexible packaging, properties of the following packaging materials-low density polyethylene, high density polyethylene, polypropylene, polyvinyl chloride, polyvinylidene chloride, ethylene vinyl alcohol, polystyrene, polyethylene terephthalate, nylon, ethylene vinyl acetate, ethylene acrylic acid, ethylene methacrylic acid, ionomers. · Antimicrobial packaging; concepts and development, · Modified atmosphere packaging(MAP) · Intermediate moisture foods (IMF) · Hurdle technology in processed foods. · Aseptic and vacuum packaging.	1 Credit 15 Lectures

Reference Book:

1. Doyle M.P. and Buchanan R.L. (Ed.) (2013) Food Microbiology: Fundamentals and Frontiers, 4th Edn. ASM press.
2. Jay J.M., Loessner M.J. and Golden D.A. (2005) Modern Food Microbiology, 7thEdn. Springer Publishers.
3. Robinson R.K. (2002) Dairy Microbiology: Milk and Milk Products, 3rd Edn. Wiley Publishers.
4. Food Microbiology. 2nd Edition, Adams MR and Moss MO. (1995).
5. Basic Food Microbiology by Banwart George J.
6. Advances in Applied Microbiology by D. Pearlman, Academic Press.
7. Coles R, McDowell D and Kirwan MJ, Food Packaging Technology, CRC Press, 2003
8.Jenkins WA and Harrington JP, Packaging Foods with Plastics, Technomic Publishing Company Inc., USA, 1991

SKILL ENHANCEMENT COURSE (SEC)
UGMBSEC401.2B: Diagnostic Microbiology

Course Learning Outcome: By the end of the course, the learner will able to

CO1. Describe post-examination procedures applicable to diagnostic microbiology [2]*
CO2. Explain the principles behind different media utilized for the growth, isolation, or identification of microbes.[2]*
CO3. Recognize and diagnose common infectious diseases from the clinical presentation and associated microbiology. [4]*
CO4. Evaluate methods used to identify infectious agents in the clinical micro lab. [5]*
CO5. Prioritized and choose appropriate molecular and serological methods for the detection & Identification microbes**.** [4] [5]*
CO6. Describe quality assessment practices for diagnostic microbiology. [2]*

*Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating

ICT Tools: Videos, PPT, Smart Board												
Students Centric Methods: Experimental, Participative, Problem Solving												
CO-PO Mapping Matrix												
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	2	1	1	1	3	2	1	2	1	-	1
CO2	2	2	2	2	1	3	2	3	3	-	-	1
CO3	2	-	2	3	1	3	2	3	3	-	-	1
CO4	1	1	3	3	1	3	2	3	3	3	-	1
CO5	2	1	2	1	1	3	2	3	3	0	-	1
CO6	1	2	1	1	1	3	2	1	2	3	-	1

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated)

Course Code	Title	Credits/ Lectures
UGMBSEC 401.2B	**Diagnostic Microbiology**	**03 Credits 45Lectures**
Unit I	**Typical diagnostic cycle** 1. Overview of the Clinical Microbiology Laboratory 2. Specimen collection a. Direct and Indirect sample collection b. Samples from normal flora sites c. Specimen for viral diagnosis d. Patient preparation, e. Special instruction, f. Transportation to the lab g. Storage before processing, **3.** Primary plating media, Direct examination (microscopy), Comments **4.** Cultures: a. Isolation and Identification of bacteria b. Bacteriological media c. Identification of bacteria **5.** Isolation and identification of Viruses: a. Cell and organ culture b. Detection of Viral Growth c. Viral identification **6.** Rapid Methods of Identification	1 Credit 15 Lectures
Unit II	**Diagnostic and Clinical Microbiology** 1. Isolation of Pathogens from clinical specimens: a. Types of specimens and their culture: - Blood, Urine, Feces, sputum, Cerebrospinal fluid, pus, genital and culture of anaerobes. 2.Identification of microorganisms from specimens: a. Identification criteria & characteristics for Microbial Classification (phenotypic and genotypic criteria) b. Microscopy a. Growth-Dependent Identification Methods b. Growth media and culture c. Common Biochemical tests (Metabolic fingerprinting)	1 Credit 15 Lectures

	3.Immunological System in Diagnosis: a. Methods for Detecting an Antigen-Antibody Reaction. Precipitation Agglutination Neutralization Complement Fixation b. Serologic Classification c. Antibody Detection (Serology) d. Antigen Detection **4.** Introduction to Molecular Biological Techniques in diagnostics	
Unit III	**Clinical Laboratory Management & Quality Control** 1. Space requirement & organization of workflow a. Lab design with respect to safety b. Design of mechanical system c. Wall floors, ceiling & furniture d. Instrumentation 2. Selection of diagnostic test 3. Analysis of test 4. Organization of microbiology laboratory 5. Quality in Clinical microbiology laboratory a. QC program b. Specimen collection & transport c. Standard operating procedure d. Personnel e. Reference laboratory f. Proficiency testing g. Performance check h. AST i. Maintenance of QC Record and QC stock j. QA Program	1 Credit 15 Lectures

Reference Books :

1. Bailey and Scott's Diagnostic microbiology, 12th edition
2. Jawetz, Melnick and Adelberg's Medical Microbiology, 26th Edition, Lange publication
3. Sherries, John C, Ed, Medical Microbiology: an Introduction to infectious diseases.
4. Medical microbiology, Elsevier Publication IInd edition. BS Nagoba, Asha Pichare

Laboratory Sessions

UGMBP04.2-Microbiology Practicum of Core Course 1, 2 & 3

Course Outcomes: Upon Completion of this course students will able,

CO1: Construct experiments to carry out enzyme activity [5*]
CO2: Distinguish between different methods for analysis [4*]
CO3: Select an appropriate technique to identify a microbial genus, species, strain
CO4: Paraphrase the rationale underpinning the construction of phylogenetic trees, classify and characterize microorganisms
CO5: Analyse Dairy and Food samples with respect to spoilage, preservation and fermentation [4*]

*Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating

ICT Tools: Videos, PPT, Smart Board												
Students Centric Methods: Experimental, Participative, Problem Solving												
CO-PO Mapping Matrix												
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	0	3	2	1	0	2	2	0	0	0	1
CO2	2	2	3	3	1	2	1	1	0	1	1	1
CO3	1	0	0	3	0	3	0	2	0	1	0	1
CO4	1	0	0	2	0	3	0	0	0	0	0	1
CO5	1	1	2	3	3	2	1	2	0	1	1	3

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated)

Course Code	Title	Credits
UGMBP04.2	**Microbiology Practicum of Core Course 1, 2 & 3**	3 credits
Practicum of Course 1	1. Qualitative detection of Amylase, Lipase, Protease and Cellulase enzyme production 2. Extracellular production of Invertase enzyme by *Saccharomyces cerevisiae* 3. Determination of pH optima of Invertase enzyme activity 4. Determination of Temperature optima of Invertase enzyme activity 5. Determination of Enzyme concentration on Invertase enzyme activity 6. Determination of Km and Vmax value of Invertase enzyme (Michaelis Menten & Lineweaver Burk Plot) 7. Separation of Amino acids by Paper Chromatography 8. Separation of Amino acids by Thin Layer Chromatography (Demonstration) 9. Sizing of bacterial and yeast cells by Density Gradient Centrifugation 10. Separation and visualization of Plasmid DNA by Agarose Gel Electrophoresis (Demo) 11. Isolation and study of Bioluminescent bacteria from Raja-Rani fish 12. Study of growth curve of *E. coli* in minimal and complete medium	2 Hr/Week
Practicum of Course 2	1. Identification of Bacteria from soil and water source (Using 2. Bergey's Manual of Determinative Bacteriology) 3. Isolation of salt tolerating bacteria (Halophiles) from Marine environment 4. Study of DNA of bacteria by using gel electrophoresis 5. Enrichment of thermophilic bacteria (Thermophiles') from hot water springs 6. Enrichment of Acidophiles and Alkaliphiles from environment 7. Study of Nocardia spp. using slide culture 8. Isolation, characterization and screening of an antibiotic producing actinomycetes from soil 10. Study of fungi using wet mount technique	2 Hr /Week
Practicum of Course 3	**1.** Isolation of antibiotic producers from soil. **2.** Auxanography **3.** Isolation of organisms from spoiled fruits & vegetables **4.** Determination of TDT and TDP **5.** Determination of Salt and sugar tolerance **6.** Determination of MIC of preservatives **7.** Rapid platform tests of raw and pasteurized milk.	2 Hr / Week

	8. Microbiological analysis of raw and pasteurized Milk. **9.** Microbiological analysis of Butter and Cheese (group project) **10.** Study natural fermentation of raw milk (24 hours) **11.** Nutritional labelling, BIS, FSSAI **12.** Visit to Food/Dairy industry	

Laboratory Sessions
Skill Enhancement Course
UGMBSECP401.2A: Food, Dairy & Bioprocess Technology

Course Outcomes: Upon Completion of this course students will able,

CO1: To understand food as a substrate [2*]
CO2: To understand health benefits of fermented dairy products [2*]
CO3: To analyse functional fermented dairy products [3*]
CO4: Compare & contrast between Prebiotics & Probiotics [4*]
CO5: Analyse different packaging methods [3*]

*Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating

ICT Tools: Videos, PPT, Smart Board											
Students Centric Methods: Experimental, Participative, Problem Solving											
CO-PO Mapping Matrix											
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	1	0	2	2	3	2	0	1	1	2	0
CO2	1	0	3	2	2	2	2	2	1	2	2	1
CO3	1	1	2	3	0	0	1	1	0	1	1	1
CO4	1	1	2	3	2	2	1	1	0	1	0	1
CO5	1	0	2	1	3	2	1	2	0	2	0	3

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated)

Course Code	Title	Credits/ Lectures
UGMBSECP 401.2A	**Practicum UGMBSECP401.2A course**	**1 credit**
Practicum UGMBSECP 401.2A course	1.Detection of formalin in milk 2.Detection of hydrogen peroxide in milk using Potassium Iodide and Starch reagent 3. Isolation of probiotic microorganism & its antibacterial activity 4. Microbial analysis of Idli Batter. 5. Detection of food spoilage causing organisms from Paneer and Cheese products 6. Visit to Dairy Industry.	2 Hr/Week

Laboratory Sessions
Skill Enhancement Course
UGMBSECP401.2B-Diagnostic Microbiology

Course Outcomes: Upon Completion of this course students will able to,

CO1. Describe post-examination procedures applicable to diagnostic microbiology [2]*
CO2. Explain the principles behind different media utilized for the growth, isolation, or identification of microbes.[2]*
CO3. Recognize and diagnose common infectious diseases from the clinical presentation and associated microbiology. [4]*
CO4. Evaluate methods used to identify infectious agents in the clinical microbiology lab. [5]*
CO5. Prioritized and choose appropriate molecular and serological methods for the detection & Identification microbes**.** [4] [5]*
CO6. Describe quality assessment practices for diagnostic microbiology. [2]*

*Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating

ICT Tools: Videos, PPT, Smart Board

Students Centric Methods: Experimental, Participative, Problem Solving

CO-PO Mapping Matrix

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	1	2	1	1	1	3	2	1	2	1	0	1
CO2	2	2	2	2	1	3	2	3	3	0	0	1
CO3	2	0	2	3	1	3	2	3	3	0	0	1
CO4	1	1	3	3	1	3	2	3	3	3	0	1
CO5	2	1	2	1	1	3	2	3	3	0	0	1
CO6	1	2	1	1	1	3	2	1	2	3	0	1

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated)

Course Code	Title	Credits/ Lectures
UGMBSECP 401.2B	**Practicum UGMBSECP401.2B course**	**1 credit**
Practicum UGMBSECP 401.2B course	1. Isolation and identification of microorganisms from clinical specimens - Swab, pus, sputum, stool, and urine using different medical microbiology techniques. 2. Study of different biochemical tests w.r.t. Catalase, Oxidase, Motility, Indole Production test, Methyl Red Test, V.P Test, Citrate utilization Test, Nitrate Reduction Test, Carbohydrate Utilization Test, TSI Test, Bile solubility Test 3. Serological identification of microorganism – Rapid malarial antigen test, Typhoid fever diagnosis, Antistreptolysis O test (ASLO), VDRL 4. Rapid identification techniques [Demonstration of Vitek 2] 5. Quality control in the laboratory 6. Visit to clinical microbiology laboratory and Report writing .	2 Hr/Week