

**RAYAT SHIKSHAN SANSTHA'S  
KARMAVEER BHAURAO PATIL COLLEGE, VASHI  
NAVI MUMBAI  
[AUTONOMOUS COLLEGE]**

**DEPARTMENT OF MICROBIOLOGY**

**Program: B. Sc. Microbiology**

**Course: S.Y.B.Sc.**

**Choice Based Credit and Grading System**

**2019-20**

A/C- 16/02/2019

Item No:2.36



**Rayat Shikshan Sanstha's**

**KARMAVEER BHURAO PATIL COLLEGE VASHI**

**(AUTONOMOUS COLLEGE)**

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

**Syllabus for S.Y.B.Sc. Microbiology**

**Program: B.Sc. Microbiology**

**Course: S.Y.B.Sc. Microbiology**

**(Choice Based Credit, Grading and Semester System  
with effect from the academic year 2019-2020)**

## **Preamble**

Bachelor of Science (B.Sc.) in Microbiology is an under-graduation programme 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 become part of this branch. Since the 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 workforce in education, industry and research. Career opportunities for graduate students are available in the manufacturing industry and research institutes at a technical level.

The content of a syllabus should be such that it maintains continuity with the course content of higher secondary classes and postgraduate courses. 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.

## Objectives of the Course:

1. To enrich students' knowledge and train them in the pure microbial sciences
2. To introduce the concepts of application and research in Microbiology
3. To inculcate a sense of scientific responsibilities and social and environmental awareness
4. To help students' build up a progressive and successful career

## Program Outcome [PO]

POs	<b>PO-1</b>	<b>Disciplinary Knowledge:</b> (i) Acquire the knowledge with facts and figures related to various subjects in pure sciences such as Physics, Chemistry, Mathematics, Microbiology and Computer Science; and Biotechnology, Information Technology and its other fields related to the program. (ii) Understand the basic concepts, fundamental principles, theoretical formulations and experimental findings and the scientific theories related to various scientific phenomena and their relevance in the day-to-day life.
	<b>PO-2</b>	<b>Communication Skills:</b> Develop various communication skills such as reading, listening and speaking skills etc., which we will help in expressing ideas and views clearly and effectively.
	<b>PO-3</b>	<b>Critical Thinking:</b> Think creatively to propose novel ideas in explaining the scientific data, facts and figures related to science and technology.
	<b>PO-4</b>	<b>Analytical Reasoning and Problem Solving:</b> Identify, describe, formulate, interpret, analyze the data systematically and solve theoretical and numerical problems in the diverse areas of science and technology and provide alternate solutions to the problems.
	<b>PO-5</b>	<b>Sense of Inquiry:</b> Curious for asking relevant questions like why and how for better understanding of the basic concepts, fundamental principles, scientific theories and applications related to the study.
	<b>PO-6</b>	<b>Use of Modern Tools:</b> Use of modern tools, equipment, instrumentation and laboratory techniques to design and perform the experiments and write the programs in different languages (software).
	<b>PO-7</b>	<b>Research Skills:</b> Ability to search for, find, collect, analyze, interpret and evaluate information/data that is relevant to the subjects related to science and technology being studied.
	<b>PO-8</b>	<b>Application of Knowledge:</b> Develop scientific outlook with respect to the subjects related to science and technology and also participate in various social and cultural activities.
	<b>PO-9</b>	<b>Ethical Awareness:</b> Imbibe ethical and social values in personal and social life leading to cultured and civilized personality.
	<b>PO-10</b>	<b>Teamwork:</b> Work effectively within the groups and individuals, participate and take initiative for various field-based situations related to science,

		technology and society at large.
	<b>PO-11</b>	<b>Environment and Sustainability:</b> Understand how developments in science and technology and interdisciplinary subjects are taking place for protecting our environment and sustainable developments.
	<b>PO-12</b>	<b>Lifelong Learning:</b> Ability of self-driven to explore, learn and gain knowledge and new skills to improve the quality of life and sense of self-worth by paying attention to the ideas and goals throughout the life.

### **Program Specific Outcomes [PSO's]**

**PSO\_1:** Understand the various aspects of the microbial world and the history of microbiology

**PSO\_2:** Differentiate and classify different types of microorganisms and its characteristics

**PSO\_3:** Distinguish between Prokaryotes and Eukaryotes with respective to their ultra-structure and functions

**PSO\_4:** Understand & differentiate the requirement of nutrients and environmental conditions for the growth of microorganisms

**PSO\_5:** Apply the knowledge of basic instrumentation, basic techniques in microbiology and control of microorganism

**PSO\_6:** Explain and describe types and functions of different biomolecules found in living cells

**PSO\_7:** Describe the aspects of microbial ecology and industrial microbiology

**PSO\_8:** Illustrate the basic immunology and medical microbiology

## Scheme of examination for Each Semester:

**Continuous Internal Evaluation: 40 Marks** (Common Test-20 Marks & 20 Marks for- Assignment, Projects, Group discussion, Open book test, online test, Societal awareness activity etc based on Unit III of each paper.

**Semester End Examination: 60 Marks** will be as follows -

<b>I.</b>	<b>Theory:</b> The Semester End Examination for theory course work will be conducted as per the following scheme.	
	Each theory paper shall be of two hours duration.	
	All questions are compulsory and will have internal options.	
	Q – I	Subject questions from Unit – I (having internal options.) 20 M
	Q – II	Subjective questions from Unit – II (having internal options.)20 M
	Q – III	Objective type questions based on both the Units with equal weightage. 20 M
<b>II.</b>	<b>Practical</b>	The Semester End Examination for practical course work will be Conducted as per the following scheme.

<b>Sr. No.</b>	<b>Particulars of Semester End Practical Examination</b>	<b>Marks%</b>
1	Laboratory Work	80
2	Journal	10
3	Viva	10
	<b>TOTAL</b>	<b>100</b>



**S.Y.B.Sc. Microbiology Syllabus (Semester III and IV)**  
**Revised for Choice Based Credit and Grading System**  
**Academic year 2019-2020**  
**SEMESTER III**

**Theory:**

Course Code	UNIT	TOPIC HEADINGS	Credits	NH/ Week
UGMB301 Biochemistry and Genetics	I	Introduction to Metabolism & Bioenergetics	03	03
	II	Estimation of Biomolecules		
	III	Basic of Genetics		

Course Code	UNIT	TOPIC HEADINGS	Credits	NH/ Week
UGMB302 Introduction to Medical Microbiology and Microbial Taxonomy	I	Common Infectious Diseases, Epidemiology and Public Health	03	03
	II	Diagnostic and Clinical Microbiology		
	III	Microbial Taxonomy		

Course Code	UNIT	TOPIC HEADINGS	Credits	NH / Week
UGMB303 Environmental Microbiology	I	Air Microbiology	03	03
	II	Water Microbiology		
	III	Soil and Geomicrobiology		

**Practical:**

Course Code	UNIT	TOPIC HEADINGS	Credits	NH / Week
UGMBP301, 302 and 303	I	Metabolism and Genetics	03	09
	II	Introduction to Medical Microbiology and Microbial Taxonomy		
	III	Environmental Microbiology		

## SEMESTER IV

### Theory:

Course Code	UNIT	TOPIC HEADINGS	Credits	NH/ Week
UGMB401 Biochemistry & Basic Analytical Techniques	I	Microbial growth & Microbial Biochemistry	03	03
	II	Enzyme Kinetics		
	III	Analytical Techniques		

Course Code	UNIT	TOPIC HEADINGS	Credits	NH/ Week
UGMB402 Medical microbiology and Biodiversity	I	Medical Microbiology	03	03
	II	Innate Immunity & Immune System		
	III	Biodiversity in Extreme Environments		

Course Code	UNIT	TOPIC HEADINGS	Credits	NH/ Week
UGMB403 Applied Microbiology	I	Dairy Microbiology	03	03
	II	Food Microbiology		
	III	Bioprocess Technology		

### Practical:

#### Practical

Course Code	UNIT	TOPIC HEADINGS	Credits	NH / Week
UGMBP 401, 402 and 403	I	Microbial growth, Biochemistry & Basic Analytical Techniques	03	09
	II	Medical microbiology and Biodiversity		
	III	Applied Microbiology		

- Note:** 1) **Green Color:** Topics related to Local/National/Regional & global development needs  
 2) **Blue Color:** Topics related to Employability/Entrepreneurship/Skill Development  
 3) **Yellow Color:** Topics related to professional ethics, gender, human values, Environment & Sustainability

## UGMB301: Biochemistry and Genetics

### Course Outcome:

By the end of the course, the learner will be able to-

**CO1:** Schematically represent Metabolic Pathways [4] \* & Organic reaction mechanism[4] \*

**CO2:** Describe and diagrammatically represent carbohydrate metabolic reactions as Glycolysis, HMP & TCA cycle.[5]\*

**CO3:** Illustrate the skills on estimation Biomolecules & Analytical Techniques[4] \*

**CO4:** Explain Mendelian genetics [3] \*

**CO5:** Schematically/diagrammatically represent the organization of chromosomes in Prokaryotes and Eukaryotes [4] \*

**CO6:** Explain the characteristics of Genetic code[3] \*

**\*Note:** [1]: Remembering, [2]: Understanding, [3]: Applying, [4] : Analyzing, [5] : Evaluating, [6]: Creating

<b>SEMESTER III Paper I</b>		
<b>Course Code</b>	<b>Title</b>	<b>Credits</b>
<b>UGMB-301</b>	<b>Biochemistry and Genetics</b>	<b>03 Credits (45 lectures)</b>
<b>UNIT I</b>	<b>1.Introduction to Metabolism &amp; Bioenergetics</b> 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 1.8 Carbohydrate metabolism (With structures) Glycolysis (EMP) HMP Pathway TCA cycle	15 Lectures
<b>Unit-II</b>	<b>2. Estimation of Biomolecules</b> 2.1 Macromolecular composition of a Microbial cell. 2.2 Methods of elemental analysis: Carbon, Nitrogen and Phosphorus 2.3 Estimation of Proteins and amino acids	15 Lectures

	Proteins by Biuret method (Direct and indirect) Amino acids by Ninhydrin method 2.4 Estimation of Carbohydrates Total carbohydrates by Anthrone method Reducing Sugars (maltose) by DNSA method Reducing sugar Fehling's method 2.5 Extraction of Lipids by Soxhlet method 2.6 Estimation of Nucleic acids General principles and extraction of Nucleic acids DNA by DPA method RNA by Orcinol method	
Unit-III	<b>3. Basic of Genetics</b> 3.1 Mendelian genetics 3.2 Chromosomal organization in both eukaryotic and prokaryotic organisms. 3.3 Genetic code and process. 3.4 Central dogma of life. 3.5 Transcription Prokaryotic transcription apparatus 3.6 Translation, Translation apparatus and process	15 Lectures

- Note:** 1) **Green Color:** Topics related to Local/National/Regional & global development needs  
 2) **Blue Color:** Topics related to Employability/Entrepreneurship/Skill Development  
 3) **Yellow Color:** Topics related to professional ethics, gender, human values, Environment & Sustainability

### REFERENCES: UGMB301

1. Methods in Microbiology, Vol.5B, Edition. Norris & Ribbon, Academic Press
2. Lehninger: Principles of Biochemistry, 4th Ed., D. Nelson & M. Cox, W. H. Freeman & Co., New York 2005
3. Outlines of Biochemistry, 5/E, Conn P. Stumpf, G. Bruening & R. Doi, John Wiley & Sons, New York, 1995
4. Enzymes: Biochemistry, Biotechnology & Clinical Chemistry, T. Palmer, East West Press Ltd., New Delhi 2004
5. An Introduction to Practical Biochemistry, David Plummer, 3rd Edition (2003), Tata McGraw-Hill Publishing Co. Ltd.
6. Biochemical Methods, S. Sadasivam & A. Manickam, 2nd Edition (1996), New Age International (P) Ltd.
7. Laboratory Manual in Biochemistry, J. Jayaraman
8. iGenetics by Peter Russell, 3<sup>rd</sup> edition
9. Brock biology of microorganism by Michael T Madigan & John M Martinco, Pearson education

<b>UGMBP301</b>	<b>(Practical Based on Unit-I, II &amp; III of UGMB301)</b>	<b>Credits</b>
<b>UNIT I</b>	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	1 Credit
<b>UNIT II</b>	2. Estimation of total sugar by Anthrone (Demonstration) 3. Estimation of reducing sugar by DNSA method 4. Estimation of reducing method by Fehling's Method 5. Estimation of protein Biuret method (indirect and direct). 6. Extraction of lipid by Soxhlet method (Demonstration)	
<b>UNIT III</b>	7. Problems on laws of Mendelian genetics 8. Problems on Genetic code	

## **UGMB302: Introduction to Medical Microbiology and Microbial Taxonomy**

**Course Outcome:** By the end of the course, the learner will be able to-

**CO1:** Distinguish between vectors and vehicles and comprehend methods of control of diseases. [4]\*

**CO2:** Examine infections caused by Staphylococci, Streptococci, Salmonella and Escherichia coli and elaborate on different prevention, control and treatment methods for skin and gut infections. [4]\*

**CO3:** Apply Biochemical tests, understand its purpose and select it for microbial identification and characterization. [3]\*

**CO4:** Compare the traditional methods with rapid methods and understand their advantages and drawbacks. [5]

**CO5:** Paraphrase microbial taxonomy and importance in research and elaborate on Numerical Taxonomy.[2]\*

**CO6:** Evaluate the origins of Bergey's Manual of Systematic Bacteriology and its relevance in taxonomy. [5]\*

**\*Note: [1]: Remembering, [2]: Understanding, [3]: Applying, [4] : Analyzing, [5] : Evaluating, [6]: Creating**

SEMESTER III Paper II		
Course Code	Title	Credits
UGMB-302	<b>Common Infectious Diseases, Epidemiology and Public Health Awareness</b>	<b>03 Credits (45 lectures)</b>
<b>UNIT I</b>	<p><b>A] The Epidemiology of Infectious Disease:</b></p> <p>1.1 Epidemiological Terminology: Epidemiology, sporadic disease, endemic disease, hyper endemic disease, epidemic disease, index case, pandemic disease, outbreak</p> <p>1.2 The spread of infection: (Revision)</p> <p>a) Reservoirs of infection –human reservoirs, animal reservoirs, non-living reservoirs</p> <p>b) Transmission of disease- Contact transmission, Vehicle transmission, Vectors</p> <p>1.3 Public Health Measures for the Control of Disease: Controls directed against the Reservoir, Controls Directed against Transmission of the Pathogen, Immunization, Quarantine, Surveillance, Pathogen Eradication</p> <p><b>B. Common Infectious Diseases:</b></p> <p>1.4 Skin infections: Study of structure and functions of Skin: Study of skin infections caused by <i>Streptococcus</i> and <i>Staphylococcus</i>.</p> <p>1.5 Infections of Digestive system: Study of structure and functions of Digestive system Study of digestive system infections caused by <i>Salmonella</i> species, <i>E.coli</i></p>	15 Lectures
<b>Unit-II</b>	<p><b>2. Diagnostic and Clinical Microbiology</b></p> <p><b>2.1 Overview of the Clinical Microbiology Laboratory</b></p> <p><b>2.2 Isolation of Pathogens from clinical specimens:</b></p> <p>a) Growth media and Culture</p> <p>b) Collection of specimens, handling and transport</p> <p>c) Types of specimens and their culture: - Blood, Urine, Feces, sputum, Cerebrospinal fluid, pus, genital and culture of Anaerobes.</p> <p><b>2.3 Identification of microorganisms from specimens:</b></p> <p>a) Microscopy</p> <p>b) Growth-Dependent Identification Methods</p> <p><b>2.4 Common Biochemical tests (Metabolic finger printing)</b></p> <p><b>2.5 Rapid Methods of Identification</b></p> <p><b>2.6 Bacteriophage Typing</b></p>	15 Lectures

Unit-III	<p><b>Microbial Taxonomy</b></p> <p>3.1 Introduction to microbial Taxonomy</p> <p>3.2 Taxonomic ranks</p> <p>3.3 Techniques for determining Microbial Taxonomy and Phylogeny:</p> <p>(a) Microscopic &amp; macroscopic morphology and biochemical characteristics,</p> <p>(b) Chemical Analysis,</p> <p>(c) Serological analysis,</p> <p>(d) Genetic &amp; molecular analysis: -</p> <p>(i) RNA sequencing and finger printing,</p> <p>(ii) G+C content,</p> <p>(iii) DNA sequencing,</p> <p>(iv) DNA-DNA hybridization</p> <p>3.4 Phylogenetic Trees</p> <p>(a) Types,</p> <p>(b) Construction (an overview)</p> <p>3.5 Numerical Taxonomy</p> <p>(a) Grouping by numerical methods of taxonomic units,</p> <p>(b) Phylogenetic inferences</p> <p>3.6 Bergey's Manual of Systematic Bacteriology</p>	15 Lectures
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- Note:** 1) **Green Color:** Topics related to Local/National/Regional & global development needs  
2) **Blue Color:** Topics related to Employability/Entrepreneurship/Skill Development  
3) **Yellow Color:** Topics related to professional ethics, gender, human values, Environment & Sustainability

#### **REFERENCES: USMB 302**

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



**Practical Paper: Introduction to Medical Microbiology and Microbial Taxonomy**

UGMBP302	Practical Based on Unit-I, II & III	Credit
<p><b>Unit-I, II &amp; III</b></p>	<ol style="list-style-type: none"> <li>1. Assignment on Epidemiology, Public Health Measures for the Control of Disease</li> <li>2. Study the morphological, cultural and biochemical characteristics of <i>Staphylococcus</i> and <i>Streptococcus</i> species (w.r.t.Skin infections)</li> <li>3. Study the morphological, cultural and biochemical characteristics of <i>E. coli</i> and <i>Salmonella species</i> (w.r.t.Digestive system infections)</li> <li>4. Study of different biochemical tests w.r.t. Catalase, Oxidase, Motility, Indole Production test, Methyl Red Test, Vogues Proskauer Test, Citrate utilization Test, Nitrate Reduction Test, Carbohydrate Utilization Test, TSI Test, Bile solubility Test</li> <li>5. Identification of Bacteria from soil and water source (Using Bergey’s Manual of Determinative Bacteriology)</li> </ol>	<p><b>1 Credit</b></p>

## **UGMB303: Environmental Microbiology**

**Course Outcome:** By the end of the course, the learner will be able to-

**CO1:** Choose a device for sampling and a method for detecting microorganisms from the air.

[5]\*

**CO2:** Discuss air sanitation methods [2]\*

**CO3:** Schematically explain the water purification system and wastewater treatment. [4]\*

**CO4:** Justify the impact of marine microorganisms. [5]\*

**CO5:** Summarize soil sampling and cultural methods to study soil flora. [2]\*

**CO6:** Compare and contrast between physiological methods & immunological methods to study soil flora [4]\*

**\*Note: [1]: Remembering, [2]: Understanding, [3]: Applying, [4] : Analyzing, [5] : Evaluating, [6]: Creating**

<b>SEMESTER III Paper III</b>		
<b>Course Code</b>	<b>Title</b>	<b>Credits</b>
<b>UGMB-303</b>	<b>Environmental Microbiology</b>	<b>03 Credits (45 lectures)</b>
<b>UNIT I</b>	<p><b>1.Air Microbiology</b></p> <p>1.1 Aero microbiology:</p> <ul style="list-style-type: none"> <li>a. Important airborne pathogens and toxins</li> <li>b. Aerosols and nature of bioaerosols</li> <li>c. Aeromicrobiological pathway</li> <li>d. Microbial survival in the air</li> <li>e. Extramural aeromicrobiology</li> <li>f. Intramural aeromicrobiology</li> </ul> <p>1.2 a. Sampling Devices for the Collection of Air Samples b. Detection of microorganisms on fomites</p> <p>1.3 Air Sanitation</p> <p>1.4 Air Quality Standards</p> <p>1.5 Introduction to exobiology –</p> <ul style="list-style-type: none"> <li>a. Introduction</li> <li>b. Case study</li> </ul>	15 Lectures
<b>Unit-II</b>	<p><b>2.Water Microbiology</b></p> <p>2.1 Fresh water environments and micro-organisms found in Springs, rivers and streams, Lakes, marshes and bogs</p> <p>2.2 Potable water: Definition, water purification, water quality standards (WHO and BIS standards) and pathogens transmitted through water</p> <p>2.3 Microbiological analysis of water: Indicator organisms and their detection in water, Total Coliforms, Fecal Coliforms and E. coli, Fecal Streptococci, Clostridium perfringens</p> <p>B] Sewage Microbiology</p> <p>2.4 Modern Wastewater treatment: Primary, Secondary and Tertiary Treatment</p> <p>2.5 Nature of wastewater and Monitoring of wastewater treatment process (BOD and COD)</p> <p>2.6 Removal of Pathogens by Sewage treatment Processes</p> <p>2.7 Oxidation Ponds and Septic tanks</p> <p>2.8. Sludge Processing</p> <p>2.9. Disposal of treated wastewater and biosolids.</p> <p>2.10 Study of wastewater index, Rules and regulations for disposal of sludge as well as treated wastewater.</p>	15 Lectures

	<p>C] Marine Microbiology</p> <p>2.10 Zonation in Marine water body</p> <p>2.11. Kinds of Microorganisms in marine environment</p> <p>2.12 Role and impact of marine microorganisms</p>	
<b>Unit-III</b>	<p><b>3. Soil and Geomicrobiology</b></p> <p>3.1 Terrestrial Environment Soil –  Definition, Composition and function  Textural triangle  Types of soil microorganisms and their activities</p> <p>3.2 Methods of studying soil microorganisms:  Sampling and Cultural methods,  Physiological methods  Immunological methods  Nucleic acid-based methods  Radioisotope techniques</p> <p>3.3 Biogeochemical Cycles:  Carbon cycle  Nitrogen cycle  Sulphur cycle  Phosphorus Cycle  Iron cycle</p>	15 Lectures

- Note:** 1) **Green Color:** Topics related to Local/National/Regional & global development needs  
2) **Blue Color:** Topics related to Employability/Entrepreneurship/Skill Development  
3) **Yellow Color:** Topics related to professional ethics, gender, human values, Environment & Sustainability

#### **REFERENCES: UGMB303**

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, Waldemar Adamiak (E Book)
7. Soil Microbiology-4th Edition, N.S Subba Rao, 2000, Oxford and IBH Publishing Co. Pvt. Ltd

## Practical Paper: Environmental Microbiology

<b>UGMBP303</b>	<b>Practical Based on Unit-I, II &amp; III</b>	<b>Credit</b>
<b>Unit I</b>	1. Enumeration of microorganisms in air and study of its load after fumigation 2. Study of air microflora and determination of sedimentation rate	<b>1 Credit</b>
<b>Unit II</b>	3. Routine analysis of water: a. Detection of Coliforms in water: Presumptive Test, Confirmed Test and Completed Test b. Rapid Detection of <i>E. coli</i> by MUG Technique (Demonstration) 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 and COD of waste water 5. Presentation on “Water Recycling” (By students) 6. Guidelines and limits of MPCB 7. Study of microorganisms in sea water	
<b>Unit III</b>	6. Total viable count of soil microflora 7. Isolation of bacteria, Actinomycetes and fungi from soil 9. Winogradskys column (Demo) 10. Visit to a sewage treatment plant or water purification plant 11. Analysis of sewage water collected from different regions (Pollution Index)	

## SEMESTER IV

### UGMB401: Microbial growth, Biochemistry & Basic Analytical Techniques

**Course Outcome:** By the end of the course, the learner will be able to-

**CO1:** Describe the microbial growth & its measurement.[2]\*

**CO2:** Describe and distinguish between various types of Transport mechanisms of various essential nutrients involved in the metabolism of a cell.[4]\*

**CO3:** Illustrate/derive Michaelis-Menten equation & Lineweaver Burk plot.[3]\*

**CO4:** Describe and diagrammatically represent Allosteric effects in enzyme catalyzed reactions.[4]\*

**CO5:** Understand the general principle & diverse types of analytical techniques viz. Chromatography, Centrifugation, Electrophoresis.[4]\*

**CO6:** Describe & schematically/diagrammatically represent the analysis of Biomolecules with respect to analytical techniques viz. Chromatography, Centrifugation, Electrophoresis.[4]\*

**\*Note:** [1]: Remembering, [2]: Understanding, [3]: Applying, [4] : Analyzing, [5] : Evaluating, [6]: Creating

<b>SEMESTER IV Paper I</b>		
<b>Course Code</b>	<b>Title</b>	<b>Credits</b>
<b>UGMB-401</b>	<b>Microbial growth, Biochemistry &amp; Basic Analytical Techniques</b>	<b>03 Credits (45 lectures)</b>
<b>UNIT I</b>	<b>1. Microbial Biochemistry</b> 1.1 Microbial 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	15 Lectures
Unit-II	<b>2. Enzyme Kinetics</b> 2.1 Introduction of Enzymes: General properties of enzymes How do enzymes accelerate reaction? Rate law for a simple catalyzed reaction, Michaelis-Menten equation and it's derivation 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 and 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	15 Lectures

Unit-III	<b>3. Analytical techniques</b> <b>3.1 Chromatography</b> 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, preparation of TLC plates, procedure for TLC, preparative TLC, 2D TLC [one paragraph], HPTLC- [1 page], Separation of amino acids and sugars by TLC. Column chromatography: Introduction & principle Exclusion chromatography, gel chromatography <b>3.2 Centrifugation</b> Introduction: basic principles of sedimentation Types, care and safety aspects of centrifuges, types of rotors, care and maintenance, safety & centrifugation Preparative centrifugation & its applications, Analytical centrifugation and its application <b>3.3 Electrophoresis</b> General principles, support media Agarose gels, polyacrylamide gels	15 Lectures
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- Note:** 1) **Green Color:** Topics related to Local/National/Regional & global development needs  
2) **Blue Color:** Topics related to Employability/Entrepreneurship/Skill Development  
3) **Yellow Color:** Topics related to professional ethics, gender, human values, Environment & Sustainability

#### **REFERENCES: UGMB 401**

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



**Practical paper: Metabolism & Basic Analytical Techniques**

UGMBP401	Practical Based on Unit-I, II & III	Credit
Unit-I, II & III	<ol style="list-style-type: none"> <li>1. Qualitative detection of Amylase, Lipase, Protease and Cellulase enzyme production</li> <li>2. Extracellular production of Invertase enzyme by <i>Saccharomyces cerevisiae</i></li> <li>3. Determination of pH optima of Invertase enzyme activity</li> <li>4. Determination of Temperature optima of Invertase enzyme activity</li> <li>5. Determination of Enzyme concentration on Invertase enzyme activity</li> <li>6. Determination of Km and Vmax value of Invertase enzyme (Michaelis Menton &amp; Lineweaver Burk Plot)</li> <li>7. Separation of Amino acids by Paper Chromatography</li> <li>8. Separation of Amino acids by Thin Layer Chromatography (Demonstration)</li> <li>9. Sizing of bacterial and yeast cells by Density Gradient Centrifugation</li> <li>10. Separation and visualization of Plasmid DNA by Agarose Gel Electrophoresis (Demo)</li> <li>11. Isolation and study of Bioluminescent bacteria from Raja-Rani fish</li> <li>12. Study of growth curve of <i>E. coli</i> in minimal and complete medium</li> </ol>	1 Credit

- Note:**
- 1) **Green Color:** Topics related to Local/National/Regional & global development needs
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## UGMB402: Medical Microbiology and Biodiversity

**Course Outcome:** By the end of the course, the learner will be able to-

**CO1:** Illustrate different conditions of the respiratory tract and nervous system and their relation to systemic infections. [3]\*

**CO2:** Evaluate and compare different methods of diagnosis of pathogens. [5]\*

**CO3:** Distinguish different barriers of the immune system and their significance. [4]\*

**CO4:** Illustrate various cells of the immune system and enlist different functions

**CO5:** Distinguish between various Extremophiles growing in different extreme environments.[4]\*

**CO6:** Account for the molecular adaption in Extremophiles [2]\*

**\*Note:** [1]: Remembering, [2]: Understanding, [3]: Applying, [4] : Analyzing, [5] : Evaluating, [6]: Creating

<b>SEMESTER IV Paper II</b>		
<b>Course Code</b>	<b>Title</b>	<b>Credits</b>
<b>UGMB-402</b>	<b>MEDICAL MICROBIOLOGY AND BIODIVERSITY</b>	<b>03 Credits (45 lectures)</b>
<b>UNIT I</b>	<p><b>1. Medical Microbiology</b></p> <p>1.1 Infections of Respiratory Tract: Streptococcal and Pneumococcal infections: Morphology, cultural characteristics of a pathogen, factors involved in pathogenesis and pathogenicity, laboratory diagnosis</p> <p>1.2 Infections of Nervous system: Study of structure and functions of Nervous System, Study of Tetanus and Rabies</p> <p>1.3 Introduction to Nosocomial infections</p>	15 Lectures

Unit-II	<b>2. Innate Immunity &amp; Immune System</b> 2.1 Basic concepts in Immunology-Revision 2.2 Principles of Innate & adaptive immunity-Primary, Secondary & Tertiary Barriers 2.3 Components of the immune system-Cells and organs of the immune system 2.4 Phagocytosis and inflammation-Mechanisms and link to immunity 2.5 Pattern recognition in innate immune system-PAMPs, PRRs, TLRs	15 Lectures
<b>Unit-III</b>	<b>3. Biodiversity in Extreme Environments</b> 3.1 Extreme Environments and their types with respect to the physical conditions which lead to microbial stress. a) Temperature based environments- Low and high temperature environments b) pH-based environments- Acidic and alkaline environments, Acid mine drainage. c) Environments with high salt concentration. 3.2 Microbial Physiology of the extremophiles a) Examples of extremophiles in each environment with their morphology and cultural characteristics. b) Physiology of the extremophiles in each environment. c) Molecular adaptations of the extremophiles 3.3 Applications of extremophiles a) Applications of Acidophiles and Alkalophiles b) Applications of halophiles- in biotechnology and medicine c) Applications of psychrophiles in pharmaceuticals and environment. d) Applications of thermophiles and hyperthermophiles in industries	15 Lectures

### References:

1. Biology of Microorganisms by BROCK Twelfth Edition, Martinco Dunlap Clark 16 Pearson International Edition
2. Text book of Microbiology by Ananthnarayan and Panikar
3. Microbiology: An Introduction by Tortora, Funke, Case (International Edition, Eighth Edition)
4. Immunology Essential and Fundamental, Third Edition, Pathak and Palan, Parea Publishers.
5. Prescott's Microbiology: 8th Edition; Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton, McGraw Hill International Edition
6. Microbiology an Introduction: 9th Edition; Gerard J. Tortora, Berdell R. Funke, Christine L. Case, Pearson Education Course

**Practical Paper: MEDICAL MICROBIOLOGY AND BIODIVERSITY**

UGMBP402	Practical Based on Unit-I, II & III	Credit
Unit-I, II & III	<ol style="list-style-type: none"> <li>1. Study morphological, cultural and biochemical characteristic of <i>Streptococcal</i> species from respiratory system</li> <li>2. Study morphological, cultural and biochemical characteristic of <i>Pseudomonas</i> species from respiratory system.</li> <li>3. Simulation studies of strains from fomites</li> <li>4. Collection of Blood sample (Demonstration)</li> <li>5. Differential staining of Blood smear by Field's Method</li> <li>6. Separation of Plasma and serum from Blood</li> <li>7. Demonstration of phagocytosis</li> <li>8. Study of Immunodiffusion (Antigen-Antibody Reaction)</li> <li>9. Isolation of salt tolerating bacteria (Halophiles) from Marine environment</li> <li>10. Enrichment of thermophilic bacteria (Thermophiles) from hot water springs</li> <li>11. Enrichment of Acidophiles and Alkalophiles from environment</li> <li>12. Visit to pathology laboratory and Report writing</li> </ol>	1 Credit

- Note:** 1) **Green Color:** Topics related to Local/National/Regional & global development needs  
 2) **Blue Color:** Topics related to Employability/Entrepreneurship/Skill Development  
 3) **Yellow Color:** Topics related to professional ethics, gender, human values, Environment & Sustainability

## UGMB403 - Applied Microbiology

**Course Outcome:** By the end of the course, the learner will be able to-

**CO1:** Justify various ill effects of microbial contamination in Milk. [5]\*

**CO2:** Categorize different types of dairy products & diagrammatically/ schematically represent dairy products [4]\*

**CO3:** Justify food as a substrate for Microorganism[5]\*

**CO4:** Describe methods of preservation of Industrial cultures. [2]\*

**CO5:** Describe characteristics of ideal production medium, types of production media, raw materials used for and sterilization of production media. [2]\*

**CO6:** Schematically represent the production process of Ethanol, Citric acid and Beer. [4]\*

**\*Note:** [1]: Remembering, [2]: Understanding, [3]: Applying, [4] : Analyzing, [5] : Evaluating, [6]: Creating

<b>SEMESTER IV Paper III</b>		
<b>Course Code</b>	<b>Title</b>	<b>Credits</b>
<b>UGMB-403</b>	<b>APPLIED MICROBIOLOGY</b>	<b>03 Credits (45 lectures)</b>
<b>UNIT I</b>	<b>1. Dairy Microbiology</b>  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>B] Milk Products</b> 1.5 Butter Production 1.6 Cheese production: Cheddar, Cottage and Swiss Cheese 1.7 Dahi (Curd) 1.8 Milk powder and dry whey 1.9 Evaporated milk and Condensed milk 1.10 Other fermented milk of India	15 Lectures

Unit-II	<p><b>2.Food Microbiology</b></p> <p>2.1 Introduction: Food microbiology and food  Food as a substrate for microorganism</p> <ol style="list-style-type: none"> <li>pH, aw, O-R potential</li> <li>Nutrient Content</li> <li>Accessory food substances</li> <li>Inhibitory substances &amp; biological structure</li> <li>Combined effects of factors affecting growth</li> </ol> <p>2.2 Important Microorganisms in Food Microbiology:</p> <p>A] Spoilage –causing microorganisms</p> <ol style="list-style-type: none"> <li>Yeast &amp; Molds: <i>Saccharomyces</i>, <i>Aspergillus</i> &amp; <i>Penicillium</i></li> <li>Bacteria: <i>Bacillus</i>, <i>Clostridium</i>, <i>Flavobacterium</i>, <i>Pseudomonas</i></li> </ol> <p>B] Food-borne Illness associated Microorganisms:  Classification of Food-borne diseases (Schematic).  Bacteria responsible for food -borne intoxication and  infections-overview/tabulation.  Examples of nonbacterial food-borne pathogens  Details of:</p> <ol style="list-style-type: none"> <li>Staphylococcus food  intoxication (organism,  enterotoxin, incidence, foods  involved, prevention of outbreaks)</li> <li>Salmonellosis (organism, source,  incidence, foods involved,  outbreak conditions &amp; prevention)</li> <li>Starter Cultures: Significance and  examples</li> </ol> <p>2.3 Food Spoilage, General Principles of spoilage of:</p> <ol style="list-style-type: none"> <li>Fruits and vegetables</li> <li>Meat (including spoilage under aerobic &amp; anaerobic  conditions- exclude spoilage of different kinds of  meats) <i>Listeria monocytogens</i></li> <li>Seafood, Shellfish by <i>E.coli</i></li> <li>Canned foods</li> </ol> <p>2.4 General Principles of Food Preservation:</p> <ol style="list-style-type: none"> <li>Preservation using High temperature (including TDT,  D, F, Z values, 12D concept), principle of canning</li> <li>Low temperature</li> <li>Drying</li> <li>Food preservatives (organic acids &amp; their salts, Sugar  &amp; salt)</li> <li>Ionizing radiations</li> <li>Hurdle Technology</li> </ol>	15 Lectures
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Unit-III	<b>3.Bioprocess Technology</b> 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 stain: Characteristics of ideal Industrial stain. Screening of Industrial stain Example of 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 inoculums 3.6 Fermenter: Characteristics of ideal fermenter STR: Design of STR and its applications 3.7 Ethanol production 3.8 Citric acid fermentation 3.9 Beer fermentation	15 Lectures
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**REFERENCES: USMB 403**

1. Fundamental Food Microbiology by Bibek Ray, Arun Bhunia (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 Nduka Okafor, (2007), Science Publishers.
5. Food Science by Sumati R. Mudambi, Shalini Rao, 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) 8<sup>th</sup> edition, McGraw-Hill International edition
7. Prescott, Harley and Klein's Microbiology by Willey, Sherwood, Woolverton, (2008) 7<sup>th</sup> edition, McGraw-Hill International edition
8. Brock Biology of Microorganisms by Madigan, Martinko, Dunlap and Clark (2009) 12<sup>th</sup> 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

### Practical Paper: Applied Microbiology

UGMBP403	Practical Based on Unit-I, II & III	Credit
Unit I, II and III	<ol style="list-style-type: none"><li>1. Isolation of antibiotic producers from soil.</li><li>2. Auxanography</li><li>3. Isolation of food spoilage agent</li><li>4. Determination of TDT and TDP</li><li>5. Determination of Salt and sugar tolerance</li><li>6. Determination of MIC of preservatives</li><li>7. Visit to Food/Dairy industry</li><li>8. Rapid platform tests of raw and pasteurized milk.</li><li>9. Microbiological analysis of raw and pasteurized Milk.</li><li>10. Microbiological analysis of Butter and Cheese (group project)</li><li>11. Study natural fermentation of raw milk (24 hours)</li><li>12. Nutritional labeling, BIS, FSSAI</li></ol>	1 Credit