ST. JOSEPH'S COLLEG(AUTONOMOUS)

BENGALURU-27

Re-accredited with **'A++' GRADE with 3.79/4 CGPA** by
NAAC Recognized by UGC as College of Excellence

DEPARTMENT OF MICROBIOLOGY

SYLLABUS FOR UNDERGRADUATE PROGRAMME

For Batch 2021-2024

(NATIONAL EDUCATION POLICY 2020)

Part A			
1	Title of the Academic Program	B.Sc.Microbiology (Major)	
2	Program Code	**MC, MB, MZ (Microbiology with Chemistry, Botany and Zoology)**	
3	Name of the College	St. Joseph's College (Autonomous)	
4	Objectives of the College	1. Academic Excellence 2. Character Formation 3. Social Concern	
5	Vision of the College	"Striving for a just, secular, democratic and economically sound society, which cares for the poor, the oppressed and the marginalized"	
6	Mission of the College	M1	St. Joseph's College (Autonomous) seeks to form men and women who will be agents of change, committed to the creation of a society that is just, secular and democratic.
		M2	The education offered is oriented towards enabling students to strive for both academic and human excellence.
		M3	The college pursues academic excellence by providing a learning environment that constantly challenges the students and supports the ethical pursuit of intellectual curiosity and ceaseless enquiry.
		M4	Human excellence is promoted through courses and activities that help students achieve personal integrity and conscientize them to the injustice prevalent in society.
7	Name of the Degree	Bachelor of Science (B.Sc.)	
8	Name of the Department offering the program	Microbiology	
9	Vision of the Department offering the program	• The Department intends to inculcate in the students an interest to explore the world of Microbiology and contribute to the rapidly expanding field. We wish to offer the society, a generation of humble yet aspiring young minds eagerly striving towards unraveling the mystery of science.	
10	Mission of the department offering the Program	• The Department of Microbiology aims at identifying one's potential to become a centre for augmenting and contributing continuously to the vibrant field of Microbiology. • We strive to create and provide an ambient learning atmosphere and prepare students for academia, industry and productive application of this knowledge in everyday life.	

		• It emphasizes the impact of microbes on environment and the human activities.	
11	Duration of the Program	3 years (Six semesters)	
12	Total No. of Credits	TO BE ANNOUNCED	
16	Program Specific Outcomes (PSOs)	PSO1	Students graduating from the Microbiology program will gain knowledge and understanding of concepts of microbiology and its application in pharma, food, agriculture, beverages, nutraceutical industries, etc.
		PSO2	Students will understand the distribution, morphology and physiology of microorganisms and demonstrate the skills in asepticculturingof microbes including isolation, identification and maintenance.
		PSO3	Students will belearning and practicing professional skills in handling microbes and contaminants in laboratories and production sectors, exploring the microbial world and analyzing the specific benefits and challenges.
		PSO4	Students will be able to apply the knowledge acquired to undertake studies and identify specific remedial measures for the challenges in health, agriculture, and food sectors.
		PSO5	Students will also learn and build on proficiencies in science communication, teamwork and collaboration, enabled by regular innovative assignments and activities.
		PSO6	Students will be able to demonstrate the ability to identify key questions in microbiological research, optimize research methods, and analyze outcomes by adopting scientific methods, thereby improving the employability.

SUMMARY OF CREDITS IN MICROBIOLOGY

DEPARTMENT OF MICROBIOLOGY (UG) (2021-2024)								
Semester 1	**Code Number**	**Title**	**No. of Hours of Instructions**	**Number of Hours of teaching per week**	**Number of credits**	**Continuous Internal Assessment (CIA) Marks**	**End Semester Marks**	**Total marks**
Theory	MB-121	Basic Microbiology and Microbiological Techniques	56	04	04	40	60	100
Practical	MB-1P1	Basic Microbiology and Microbiological Techniques	44	04	02	25	25	50
Theory	MBOE1	Microbial Technology for Human Welfare	42	03	03	40	60	100
	SEC	Digital Fluency			02			
Total Number of credits:			**11**					
Semester 2	**Code Number**	**Title**	**No. of Hours of Instructions**	**Number of teaching Hrs /week**	**Number of credits**	**Continuous Internal Assessment (CIA) Marks**	**End Semester Marks**	**Total marks**
Theory	MB-221	Microbial Biochemistry and Analytical Techniques	56	04	04	40	60	100
Practical	MB-2P1	Microbial Biochemistry and Analytical Techniques	44	04	02	25	25	50
Theory	MBOE2	Environmental Microbiology and Public Health	42	03	03	40	60	100
Total Number of credits:			**09**					

CORE COURSES (CC)	
Course Title	Code Number
Basic Microbiology and Microbiological Techniques	MB-121
Microbial Biochemistry and Analytical Techniques	MB - 221

GENERIC ELECTIVE COURSES (GSE)/ OPEN ELECTIVES OFFERED	
Course Title	Code Number
Microbial Technology for Human Welfare	MBOE1
Environmental Microbiology and Public Health	MBOE2

VALUE ADDED COURSES (VAC)	
Course Title	Code Number
Principles of Genetic Engineering	PGE 1 MB
Food Technology	CCFT 2 MB
Ethics in Life Sciences and Health care Sector	EILSC 3 MB

Course Outcomes and Course Content

DEPARTMENT OF MICROBIOLOGY

Semester	I
Course	1
Paper Code	**MB-121**
Paper Title	**Basic Microbiology and Microbiological Techniques**
Number of teaching hours per week	04
Total number of teaching hours per semester	56
Number of credits	04

Objective of the Paper:

This paper introduces the students to the history, contribution of scientists, scope and the diversity of Microorganisms. It gives an overview of the microbial world and the techniques used to visualize and keep microbes in check. This paper acts as the first step to gain insight about the basics of the vast field of Microbiology.

UNIT - I: Historical development, origin of microorganisms, major contributions, and microscopy **13**

History and Scope of Microbiology:

Theories of origin of life
Fossil evidences of microorganisms
Scope and relevance of Microbiology as a modern science
Branches of Microbiology 4

Contribution of Scientists to the field of Microbiology:

Antony Von Leeuwenhoek, Francisco Redi, Edward Jenner, Louis Pasteur, Joseph Lister, Robert Koch and Alexander Fleming, Dr. Anand Mohan Chakravarthy, Dr. Khurana 2

Microscopic examination of Microorganisms

Light Microscopy-Bright field, Dark field, Fluorescence and Phase contrast
Electron microscopy (TEM and SEM)7

UNIT - II: Introduction to prokaryotic microorganisms **12**

Cellular organization of prokaryotes

Overview of a bacterial cell (morphology, ultra-structure and function)

Structure and function of flagella, pili and capsule, cell wall (gram positive and gram negative), cell membrane, mesosomes, ribosomes, and genetic material. Inclusion bodies and reserve food materials.

Endospore – structure, function, sporulation and germination. Reproduction in bacteria: binary fission 9

Overview of cyanobacterial cell (Ultrastructure and functions) 1

Bacteria with unusual properties:

Mycoplasma

Actinomycetes 2

UNIT - III: Introduction to eukaryotic microorganisms and infectious particles 18

Cellular organization of eukaryotes- General structure and intracellular organelles- cell membrane, cytoskeleton, Membrane bound organelles- Endoplasmic reticulum, Golgi complex, Lysosomes, Vesicles, Nucleus, Mitochondrion and Chloroplast Peroxisomes, Ribosomes. 4

Phycology

General characteristics and importance. 1

Mycology

Overview of fungal cell -ultra structure of Hyphal and yeast form.

Reproduction in fungi: asexual and sexual 3

Protozoology– General characters and type study- Paramecium (structure and reproduction). 1

Introduction to infectious particles

Virology

Structure, Reproduction, and Significance of:

Bacterial viruses - T4, Plant virus- TMV, Animal virus - HIV. 7

Infectious particles- Prions &Viroids (general characteristics and diseases.) 2

Emergent pathogen relevant at the time - case study

UNIT - IV: Microbiological techniques 13

Staining Techniques:

Simple staining (Negative staining)

Differential staining (Grams and Acid fast staining)

Structural staining (endospore, cell wall, flagella and capsular staining) and fungal staining 3

Sterilization techniques:

i) Factors affecting antimicrobial activity: -

Environment, organisms, physiological status of the organisms, inoculums concentration, intensity of concentration of the antimicrobial agent, temperature and time of action as factors affecting antimicrobial activity.

ii) Physical methods:
Moist heat (Pasteurization)
Moist heat under pressure
(Autoclave) Dry heat
(incineration, hot air over)
Filtration- membrane filter,
HEPA filter
Radiation (UV- rays, X- rays, ultrasonic rays)

iii) Chemicals (alcohols, formaldehyde, phenol, halogens and heavy metals, gaseous agents) Desired characteristics of antimicrobial chemical agents
Evaluation of antimicrobial chemical agents- agar plate techniques, Phenol co-efficient methods. 10

NOTE: 4 hours of self-study will be assigned from the following topics.
(Contribution of scientists to the field of microbiology, overview of fungal ultrastructure)

REFERENCES:

1. Willey, J. M., Sherwood, L., Woolverton, C. J., Prescott, L. M., & Willey, J. M. (2011). Prescott's microbiology. New York: McGraw-Hill.
2. Black, J. G., & Black, L. J. (2008). Microbiology: Principles and explorations. Hoboken, NJ: John Wiley & Sons, Inc.
3. O.P. Sharma. (1992), Textbook of algae, New Delhi : Tata McGraw-Hill.
4. Douglas B Murphy;(2012), Fundamentals of light microscopy and electronic imaging; John Wiley and Sons.
5. Constantine John Alexopoulos; Charles W Mims; Meredith Blackwel, (1996), Introductory mycology, New York : Wiley.

Practical I

MB $1P_1$ – Basic Microbiology and Microbiological Techniques
(4 hours/11 sessions)

1. Microbiological laboratory standards and safety protocols.
2. Standard aseptic conditions of Microbiological laboratory.
3. Study of compound microscope.
4. Study of instruments - Autoclave, hot air oven, LAF, incubator, membrane filter, colony counter. Applications of basic microbiological tools (Pipettes, Micropipette, Bunsen burner, Inoculation loop, Spreader).
5. Preparation of media – NB, NA.
6. Isolation and identification of bacteria.
7. Pure culture techniques – pour plate, spread plate and streak plate (Simple, Continuous, Quadrant) methods.
8. Aseptic transfer techniques.
9. Simple staining, Negative staining
10. Differential staining- Gram's staining, Acid-fast staining
11. Structural staining- Flagella, Cell wall, Endospore and Capsule Staining.
12. Bacterial motility- hanging drop, swarming/ swimming agar
13. Staining and identification of fungi.
14. Demonstration and observations of microorganisms from natural sources under light microscope (Algae, Yeast and Protozoa).

Course outcomes (MB121): **At the end of the Course, the Student will be able to**

CO1	Appreciate contributions of Pioneers in the field of microbial research.
CO2	Get acquainted with different types of microbial life forms and their basic structure and functions.
CO3	Understand the basics of structural organization of a prokaryotic and eukaryotic cell.
CO4	Build a strong foundation in theoretical and practical understanding of growth and control of microorganisms
CO5	Apply the knowledge gained to identify and use various laboratory aids to culture, visualize and control microorganisms.
CO6	Compare and contrast the similarities and differences between different groups of microorganisms.
CO7	Assess the importance of microbes in all realms of life.
CO8	Apply the basic disinfection and sterilization techniques to maintain health and hygiene.

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Semester	I
Course	**2**
Paper Code	**MBOE1**
Paper Title	**Microbial Technology for Human Welfare**
Number of teaching hours per week	03
Total number of teaching hours per semester	42
Number of credits	03

Objective of the Paper:
This paper gives a bird's-eye view on the diversified microbes and their role in the field of food, agriculture and pharmaceutical industries. This paper also creates an awareness of the use and abuse of antibiotics and the development of antibiotic resistance.

UNIT- 1:Microbial Diversity 4

Introduction to microbial biodiversity: distribution, abundance, nutrition and types.Gut microbiota and its importance.

UNIT - 2: Food and Fermentation Technology 12

Fermented Foods – Types, Nutritional Values, Advantages and Health Benefits
3
Prebiotics, Probiotics, Synbiotics and Nutraceutical Foods
3
Fermented Products – Alcoholic (wine) and non-alcoholic beverages (coffee), fermented food and dairy products (Idli, Bread,Yoghurt and Acidophilus milk), Fruit fermented drinks (Kombucha and Tepache) 6

UNIT - 3: Microbial Technology in Agriculture13

Microbial Fertilizers – Definition and scope, applications, advantages and disadvantages.
Vermicompost and Composting 4

Microbial Pesticides: Definition and scope, Importance of Bio-fungicide, Bio-herbicide, Bio-insecticide 4

Mushroom Cultivation: Examples, Nutritive values, Applications, Cultivation of paddy straw mushroom 3

Biogas Production and its applications 2

UNIT - 4: Pharmaceutical Microbiology 13

Microbial Drugs – Types (Natural, Synthetic and Semi synthetic), Development of Drug Resistance 5

Antibiotics – Types, Functions, Use and abuse of Antibiotic Therapy 4

Vaccines – Types, Properties, Functions and Schedules4

REFERENCES:

1. Black, J.G. (2008).*Microbiology principles and explorations*. New Jersey:John Wiley and Sons Inc.,
2. Cruger, W. and Crueger, A. (2000). *Biotechnology: A Text Book of Industrial Microbiology*,New Delhi: Panima Publishing Corporation.
3. Dubey, R. C and D. K. Maheshwari, (1999). *A Textbook of Microbiology*. New Delhi: S. Chand & Company Ltd.,.
4. Frazier, W. C., Westhoff, D. C. (1988). *Food Microbiology*, New York: McGraw-Hill.
5. Maier, Pepper and Gerba, (2000). *Environmental Microbiology*, London: Academic Press.
6. Michael J Pelczar, Chan and Noel R. Krieg; *Microbiology*, Uttar Pradesh: TATA McGraw-Hill publication.Prescott, Harley, Klein. (2008).*Microbiology*, New York: McGraw Hill.
7. Rangaswami, G and Bagyaraj, D.J. (2010), *Agricultural Microbiology*, New Delhi: PHI Learning Pvt.Ltd.,.
8. Stanier, Ingraham. (1987), *General Microbiology*.Noida: Macmillan education limited.
9. Talaro, K. P. (2009).*Foundations in Microbiology*, New York: McGraw Hill.
10. Tortora,G.J, Funke, B.R and C. L. Case. (2016).*Microbiology – An Introduction*, London: Pearson Education.

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Semester	II
Course	**1**
Paper Code	**MB-221**
Paper Title	**Microbial Biochemistry and Analytical Techniques**
Number of teaching Hrs per week	04
Total number of teaching Hrs per semester	56
Number of credits	04

Objective of the Paper:
This paper enables students to learn about the structure, classification and importance of Bio molecules present in microbial cellsand the techniques used in their analysis.

UNIT - 1: Biochemical concepts **16**

Basic Biochemical Concepts: Major elements of life and their primary characteristics, atomic bonds and molecules – bonding properties of carbon, chemical bonds- covalent and non-covalent, Hydrogen bonds and Vander Waal Forces 3

Biological Solvents: Structure and properties of water molecule, Water as a universal solvent, polarity, hydrophilic and hydrophobic interactions, properties of water 3

Acids, bases, electrolytes, hydrogen ion concentration, pH, buffers and physiological buffer system, Henderson – Hasselbach equation. 4

Bioenergetics: Law of thermodynamics, Free energy, Enthalpy, Entropy, Classification of high energy compounds, Oxidation reduction reactions, equilibrium constant. 6

UNIT - 2:Macromolecules – Types, Structure and Properties22

Carbohydrates: Definition, classification, structure and properties4

Amino acids and proteins: Definition, structure, classification and properties of amino acids, Structure and classification of proteins. 6

Nucleic acids: Structure, function, forms/types - DNAandRNA 5

Lipids and Fats: Definition, classification, structure, properties and importance of lipids. 3

Porphyrins and Vitamins: Definition, structure, properties and importance of chlorophyll, cytochrome and hemoglobin. 4

UNIT- 3: Analytical techniques **18**

Principles, Methods and Applications:

a. Chromatography (Thin Layer Chromatography, Ion exchange, Size exclusion, Affinity, and High Performance Liquid Chromatography) 6

b. Centrifugation (Preparative and Analytical) 5

c. Electrophoresis (Agarose Gel Electrophoresis and SDS-PAGE) 4

d. Spectrophotometry (UV-Visible) 3

NOTE:4hours of self-study will be assigned from the following topics.

1. Deficiencies of Vitamins
2. Applications of Chromatography

REFERENCES:

1. David L Nelson, Michael M Cox (7th edition). *LehningerPrinciples of Biochemistry*, Worth Publishers, Inc.
2. Jeremy M. Berg, LubertStryer, John Tymoczko and Gregory Gatto (9th edition).*Biochemistry*, Freeman and Company, New York.
3. Donald Voet, JudithVoet& Charlotte W. Pratt (4th edition). *Voet's Principles of Biochemistry*, John Wiley and Sons.
4. Reginald H. Garrett and Charles M. Grisham (6th edition). *Biochemistry*. Cengage Learning Inc.
5. Rodney F. Boyer (3rd edition). *Concepts in Biochemistry*. John Wiley and Sons.
6. J. L. Jain, Sunjay Jain and Nitin Jain (2007). *Fundamentals of Biochemistry*. S. Chand & CompanyLtd.
7. Mary K. Campbell and Shawn O. Farrell (8th edition). *Biochemistry*, Cengage Learning.
8. Keith Wilson and John Walker (7th edition). *Principles and Techniques of Biochemistry and Molecular Biology*. Cambridge University Press.
9. Avinash Upadhyay, Kakoli Upadhyayand Nirmalendu Nath(2009),*Biophysical Chemistry (Principles and Techniques)*, Himalayan Publishing House.

Practical II

MB2P$_1$: Microbial Biochemistry and Analytical Techniques

(4 hours/11 sessions)

1. Preparation of Solution: Normal and Molar solutions
2. Calibration of pH meter and determination of pH of natural samples
3. Preparation of Buffer Solutions (Phosphate and Citrate buffers)
4. Qualitative determination and identification of Carbohydrates
5. Qualitative determination and identification of Proteins
6. Qualitative determination and identification of Amino Acids
7. Qualitative determination and identification of Fatty Acids
8. Quantitative estimation of Reducing Sugar by DNS method
9. Quantitative estimation of Proteins by Biuret and Lowry's /UVmethod
10. Quantitative estimation of DNA by Diphenyl amine / UV method
11. Quantitative estimation of RNA by Orcinol method
12. Determination of lipid saponification values of fats and iodine number of fatty acids
13. Thin Layer Chromatography of Amino Acids
14. Demonstration – HPLC, Agarose gel electrophoresis, SDS-PAGE

Course outcomes (MB221): At the end of the Course, the Student will be able to

CO1	Gain insights into major elements and their chemical interactions required for functioning of living cells.
CO2	Gain knowledge about the structure, classification and functions of biomolecules.
CO3	Understand the principles and the processes of various analytical techniques used to study biomolecules.
CO4	Estimate biomolecules from different samples
CO5	Analyse the data obtained from the experiments.
CO6	Appreciate the importance of biomolecules in living systems

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Semester	II
Course	**2**
Paper Code	**MBOE2**
Paper Title	**Environmental Microbiology and Public Health**
Number of teaching Hrs per week	03
Total number of teaching Hrs per semester	42
Number of credits	03

Objective of the Paper:
This paper gives a broader understanding on the microbes present in soil, air and water. The student will also get a better idea about the diseases spread through various sources and the hygienic practices to be followed.

UNIT – 1:Microbial Diversity

Introduction to microbial biodiversity: distribution, abundance, nutrition and types.Gut microbiota and its importance.

4

UNIT - 2: Soil and Air Microbiology 15

Soil and Air as a major component of environment 2

Types, properties and uses of soil and air 2

Distribution of microorganisms in soil and air 2

Air sampling methods: Personal samplers, advantages and disadvantages, differences between impingers and impactors (Impingers: Lemon sampler; Impactors: Andersons' sampler). Indicators of air pollution. 3

Air sanitation methods (Personal HEPA filter, UV germicidal lights, Ozone oxidation, chemical sanitizers and activated carbon technology). 3

Overview of Air and Soil fumigation and its importance. 1

Epidemiology of Airborne microbial infections 2

UNIT – 3: Water Microbiology 15

Water as a major component of environment
2

Types, general properties and uses of water
3

Microorganisms of different water bodies (potable and recreational) 2

Standard qualities of drinking water, Drinking water purification methods and its importance: (Sediment Filtration, Membrane Filtration, Carbon Filtration, UV treatment, Reverse Osmosis)
4

Water pollution and microbial indicators 2
Epidemiology of Waterborne microbial infections 2

UNIT – 4: Public Health 8

Public health and hygiene, regulatory bodies and guidelines (Overview of guidelines imposed by National Centre for Disease Control and WHO) 2

Communicable diseases 2

Survey and surveillance of microbial infections
2

Epidemiology of Food borne microbial infections
2

REFERENCES:

1. Black, J.G. (2008), *Microbiology principles and explorations.* New Jersey:John Wiley and Sons Inc.,
2. Dubey, R. C and D. K. Maheshwari, (1999).*A Textbook of Microbiology*. New Delhi: S. Chand & Company Ltd.,.
3. M.T.Madigan, M.T., Martinko, J.M., Dunlap, P.V. and D. P. Clark. (2009).*Brock Biology of Microorganisms*. San Francisco: Pearson Benjamin Cummings.
4. Pelczar, J.R.,Chan and Krieg (1993).*Microbiology- Concepts and Applications*.New York: McGraw Hill.

5. Pommerville, J.C.(2011).*Alcamo's Fundamentals of Microbiology.*Sudburry: Jones and Bartlett.
6. Prescott, Harley and Klein (2008).*Microbiology*. New York: McGraw Hill.
7. Talaro, K.P. (2009).*Foundations in Microbiology*. New York: McGraw Hill,.
8. Tortora, G. J., FunkeB. R., and C. L. Case (2016). *Microbiology – An Introduction*.London: Pearson Education.