ABOUT THE DEPARTMENT

The Department of Microbiology was established in the year 1994 with UG course. The Post Graduate Microbiology course was started in the year 2000. The Department has produced 29 UG batches and 16 PG batches. Ever since its inception, the Department has been constantly concentrating to stay updated with the latest developments. The Department has well equipped laboratory and library to cater the requirements of the syllabi. All the graduates and postgraduates of the Department have been well placed in the various fields of Microbiology. The Postgraduate Department has 6 faculty members who are eminent scholars and have wide knowledge in the field.

VISION

To be a focal point of brilliance in higher education that emphasizes pioneering education, knowledge on research and development in the field of microbiology

MISSION

To afford eminent edification in microbiology programmed to enrich the academic foundation and preparation of students for life in an intricate dynamic technological world. To generate and propagate awareness through interdisciplinary research in the field of Microbiology

SOURASHTRA COLLEGE, MADURAI – 625004

(An Autonomous Institution Re-accredited with 'A' grade by NAAC)

M.Sc. MICROBIOLOGY – SYLLABUS

(Under CBCS based on OBE)

(For the students admitted from the academic year 2025 – 2026 onwards)

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The Programme Educational Objectives of the **B.Sc. Microbiology** Programme at Sourashtra College, Madurai are given below and are numbered from PEO1 to PEO5.

PEO 1	To provide in–depth knowledge about core areas of biosciences such as biotechnology, biochemistry and microbiology.
PEO 2	To make students competent in the field of biosciences and allied areas by providing them hands on experience in basic tools and techniques
PEO 3	To instill the ability for research and entrepreneurship in the students along with strong ethics and communication skills
PEO 4	To inculcate, facilitate, motivate and promote knowledge technical skills in core areas of biological sciences including advanced tools and techniques like genomics, proteomics and transcriptomics to young aspirants and to equip and motivate the students to pursue higher education and research in reputed institutes at national and international level in the field Science
PEO 5	To develop trained human resource in the field of advanced translational research and to develop graduates with a strong professional ethics and moral duties that will positively affect their profession, community, society and Nation at large

POSTGRADUATE (PG) PROGRAMME OUTCOMES (POs)

Postgraduate (M.A., **M.Sc.,** M.Com., M. Com (CA)., M.B.A., M.C.A., etc.,) is a two year degree Programme with 4 semesters consisting the following Programme Outcomes (POs) under various criteria including critical thinking, problem solving, effective communication, societal/ citizenship/ ethical credibility, sustainable growth and employable abilities.

PO 1	**Critical Thinking**: Intellectual exploration of knowledge towards actions in clear and rational manner by understanding the logical connections between ideas and decisions.
PO 2	**Problem Solving**: Understanding the task/ problem followed by planning and narrow execution strategy that effectively provides the solution.
PO 3	**Effective Communication**: Knowledge dissemination by oral and verbal mechanisms to the various components of our society.
PO 4	**Societal/ Citizenship/ Ethical Credibility**: Realization of various value systems/ moral dimensions and demonstrate the empathetic social concern as well as equity in all the decisions, executions and actions.
PO 5	**Environmental Concern and Sustainable Growth**: Understanding the emerging environmental challenges and provide the possible contribution in sustainable development that integrates environment, economy and employment.
PO 6	**Skill Development and Employable Abilities**: Adequate training in relevant skill sector and creating employable abilities among the PG.

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PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of **M.Sc. Microbiology** Programme, the students are expected to

PSO 1	**Placement** – Prepare the students in varied disciplines like agriculture, industry–medical, pharma, dairy, hotel, food and food processing, immunological, cosmetics, vermitechnology and water treatment for effective and respectful placement.
PSO 2	**Critical Thinking** – Analyse complex problems, evaluate information, synthesize information, apply theoretical concepts to practical situations, identify assumptions and biases, make informed decisions and communicate effectively
PSO 3	**Analytical & Scientific Reasoning** – Apply scientific methods, collect and analyse data, test hypotheses, evaluate evidence, apply statistical techniques and use computational models.
PSO 4	**Entrepreneurship** – To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.
PSO 5	**Research and Development** – Design and implement HR systems that comply with good laboratory, practices, following ethical values, leading the organization towards growth and development.
PSO 6	**Contribution to Society** – To contribute to the development of society and produce microbiological products, by collaborating with stake holders, related to the betterment of environment and mankind at the national and global level.

DISTRIBUTION OF CREDITS (PG PROGRAMME)

SEMESTER	COURSES	NO. OF COURSES	HOURS	CREDITS	TOTAL CREDITS
I–IV	Core	13	5–6	4–5	56
I–IV	Elective	6	4–5	2–4	18
III	NME (Non-Major Elective)	1	5	2	2
III	Self-Study Course	1	–	1	1
III-IV	Internship/ Mini Project/ Industrial activity	1	–	2	2
I-IV	SEC (Skill Enhancement Course)	2	4	3	4
IV	Project	1	5	5	7
IV	Extension Activity	1	–	1	1
TOTAL					91

***Additional credit will be given to any Online Course taken in SWAYAM Portal**

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M.Sc. MICROBIOLOGY – SYLLABUS

(Under CBCS based on OBE)

(For the students admitted from the academic year 2025 – 2026 onwards)

M.Sc. MICROBIOLOGY

COURSE STRUCTURE – I SEMESTER

S. No.	Course Code	Course Title	Hrs./ Week	Exam (Hrs.)	CA	SE	Total	Credits
1.	25PMBC11	**Core – 1:** General Microbiology and Microbial Diversity	5	3	25	75	100	5
2.	25PMBC12	**Core – 2:** Microbial Physiology	5	3	25	75	100	5
3.	25PMBCP1	**Core – 3:** **Core Practical – I:** General Microbiology, Microbial Diversity and Microbial Physiology	4	3	40	60	100	5
4.	25PMBE11	**Elective – 1: *** Forensic Science	4	3	25	75	100	3
	25PMBE12	Micro algal Technology						
	25PMBE13	Nano Biotechnology						
5.	25PMBE14	**Elective – 2:** Entrepreneurship in Bio business	4	3	25	75	100	3
		TOTAL	**30**				**500**	**21**

***One Elective – 1 course to be chosen from THREE courses**

II – SEMESTER

S. No	Course Code	Course Title	Hrs./ Week	Exam (Hrs.)	C A	S E	Total	Credits
1.	25PMBC21	**Core – 4:** Medical Bacteriology and Mycology	5	3	25	75	100	5
2.	25PMBC22	**Core – 5:** Medical Virology and Parasitology	5	3	25	75	100	5
3.	25PMBCP2	**Core – 6:** **Core Practical – II:** Medical Microbiology	6	3	40	60	100	5
4.	25PMBE21	**Elective – 3:*** Epidemiology	5	3	25	75	100	3
	25PMBE22	Clinical Diagnostic Microbiology						
	25PMBE23	Bioremediation						
5.	25PMBE24	**Elective – 4:** Bioinformatics	5	3	25	75	100	3
6.	25PMBS21	**SEC – 1:** Vermitechnology	4	3	25	75	100	2
		TOTAL	**30**				**600**	**23**

***One Elective – 3 course to be chosen from THREE courses**

****All students will do internship after II Semester. The evaluation will be done in the beginning of III Semester and marks will be included in the III Semester Mark sheet.**

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SOURASHTRA COLLEGE, MADURAI – 625004

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M.Sc. MICROBIOLOGY – SYLLABUS

(Under CBCS based on OBE)

(For the students admitted from the academic year 2025 – 2026 onwards)

COURSE STRUCTURE – I SEMESTER

S. No.	Course Code	Course Title	Hrs./ Week	Exam (Hrs.)	CA	SE	Total	Credits
1.	25PMBC11	**Core – 1:** General Microbiology and Microbial Diversity	5	3	25	75	100	5
2.	25PMBC12	**Core – 2:** Microbial Physiology	5	3	25	75	100	5
3.	25PMBCP1	**Core – 3:** **Core Practical – I:** General Microbiology, Microbial Diversity and Microbial Physiology	4	3	40	60	100	5
4.	25PMBE11	**Elective – 1: *** Forensic Science	4	3	25	75	100	3
	25PMBE12	Micro algal Technology						
	25PMBE13	Nano Biotechnology						
5.	25PMBE14	**Elective – 2:** Entrepreneurship in Bio business	4	3	25	75	100	3
		TOTAL	**30**				**500**	**21**

***One Elective – 1 course to be chosen from THREE courses**

CA – Class Assessment (Internal)

SE – Summative Examination

SEC – Skill Enhancement Course

NME – Non – Major Elective

T – Theory

P – Practical

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M.Sc. MICROBIOLOGY – SYLLABUS

(Under CBCS based on OBE)

(For the students admitted from the academic year 2025 – 2026 onwards)

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COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
25PMBC11	GENERAL MICROBIOLOGY AND MICROBIAL DIVERSITY	CORE – 1	5	-	5

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	II	25	75	100

Curriculum Design and Development	Employability			Skill Oriented	✓	Entrepreneurship				
	National		Local	✓	Regional	✓	Global			
Curriculum Enrichment	Professional Ethics	✓	Gender		Environment and Sustainability	✓	Human Values		Other Values	

COURSE DESCRIPTION:

This course offers a comprehensive study of the field of microbiology to science majors. The course will give detailed insights into five major themes: Structure and function of microbes (cellular structures, metabolism, and growth); microbial genetics, microbial ecology, microbial diversity (prokaryotes, eukaryotes, viruses) and clinical microbiology (immunity, pathogenicity, epidemiology, control of microbes, and diseases)

COURSE OBJECTIVES:

- Acquire knowledge on the principles of different types of microscopes and their applications.
- Explain various pure culture techniques and discuss sterilization methods
- Exemplify, isolate and cultivate microalgae from diverse environmental sources.
- Compare and contrast the structure of bacteria and fungi. Illustrate nutritional requirements and growth in bacteria
- Discuss the importance and conservation of microbial diversity

COURSE OUTCOMES (COs):

After the completion of the course, the students will be able to

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	examine various microbes employing the microscopic techniques learnt. measure and compare the size of microbes.	Upto K5
CO 2	create aseptic conditions by following good laboratory practices.	Upto K5
CO 3	identify and cultivate the algae understanding their habitat. analyze the morphology, classify and propagate depending on its economic importance.	Upto K5
CO 4	differentiate and appreciate the anatomy of various microbes. plan the growth of microbes for different environmental conditions.	Upto K5
CO 5	categorize and cultivate a variety of extremophiles following standard protocols for industrial applications.	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY
K4–ANALYSE, K5–EVALUATE

Passed in the BoS Meeting held on 27/02/2025 **Signature of the Chairman**

GENERAL MICROBIOLOGY AND MICROBIAL DIVERSITY

UNIT– I:

History and Scope of Microbiology. Microscopy – Principles and applications. Types of Microscopes – Bright field, Darkfield, Phase–contrast, Fluorescence microscope, Transmission electron microscope (TEM) and Scanning electron microscope (SEM). Sample preparation for SEM & TEM. Atomic force, Confocal microscope. Micrometry – Stage, Ocular and its applications.

UNIT– II:

Microbial techniques – Safety guidelines in Microbiology Laboratories. Sterilization, Disinfection and its validation. Staining methods – Simple, Differential and Special staining. Automated Microbial identification systems – Pure cultures techniques – Cultivation of Anaerobic organisms. Maintenance and preservation of pure cultures. Culture collection centres – National and International

UNIT– III:

Algae – Distribution, morphology, classification, reproduction and economic importance. Isolation of algae from soil and water. Media and methods used for culturing algae, Strain selection and large–scale cultivation. Life cycle – Chlamydomonas, Volvox Spirogyra (Green algae), Nostoc (Cyanobacteria) Ectocarpus, Sargassum (Brown algae), Polysiphonia, Batrachospermum (Red algae).

UNIT– IV:

Bacterial Structure, properties and biosynthesis of cellular components – Cell wall. Actinomycetes and Fungi – Distribution, morphology, classification, reproduction and economic importance. Sporulation. Growth and nutrition – Nutritional requirements, Growth curve, Kinetics of growth, Batch culture, Synchronous growth, Measurement of growth and factors affecting growth.

UNIT– V:

Biodiversity – Introduction to microbial biodiversity – Thermophiles – Classification, Thermophilic Archaebacteria and its applications. Methanogens – Classification, Habitats, applications. Alkaliphiles and Acidophiles – Classification, discovery basin, its cell wall and membrane. Barophiles – Classification and its applications. Halophiles – Classification, discovery basin, cell walls and membranes – purple membrane, compatible solutes. Microbial stress response –Osmoadaptation / halotolerance – Applications of halophiles

TEXT BOOKS:

1. Kanunga R. (2017). ***Ananthanarayanan and Panicker's Text book of Microbiology***. (10th Edition). Universities Press (India) Pvt. Ltd.
2. Chan E.C.S., Pelczar M. J. Jr. and Krieg N. R. (2010). ***Microbiology. (5th Edition).*** Mc.Graw Hill. Inc, New York.
3. Prescott L. M., Harley J. P. and Klein D. A. (2004). ***Microbiology. (6th Edition).*** McGraw – Hill company, New York.
4. White D. Drummond J. and Fuqua C. (2011). ***The Physiology and Biochemistry of Prokaryotes***, Oxford University Press, Oxford, New York.
5. Dubey R.C. and Maheshwari D. K. (2009). ***Textbook of Microbiology***. S. Chand, Limited.

REFERENCE BOOKS:

1. Tortora G. J., Funke B. R. and Case C. L. (2015). ***Microbiology: An Introduction*** (12th Edition).Pearson, London, United Kingdom 14
2. Webster J. and Weber R.W.S. (2007***). Introduction to Fungi. (3rd Edition***). Cambridge University Press, Cambridge.
3. Schaechter M. and Leaderberg J. (2004). ***The Desk encyclopedia of Microbiology***. Elseiver Academic Press, California.
4. Ingraham, J.L. and Ingraham, C.A. (2000) ***Introduction to Microbiology***. (2nd Edition). Books / Cole Thomson Learning, UK.
5. Madigan M. T., Bender K.S., Buckley D. H. Sattley W. M. and Stahl (2018). ***Biology of Microorganisms.*** (15th Edition). Pearson

DIGITAL TOOLS:

http://sciencenetlinks.com/tools/microbeworld
https://www.microbes.info/
https://www.asmscience.org/VisualLibrary
https://open.umn.edu/opentextbooks/BookDetail.aspx?bookId=404
https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	2	2	3	2
CO2	2	2	2	2	2	2
CO3	1	2	2	2	2	3
CO4	2	3	2	2	2	3
CO5	2	3	3	3	3	3

3. Advanced Application 2. Intermediate Development 1. Introductory Level

SOURASHTRA COLLEGE, MADURAI – 625004

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M.Sc. MICROBIOLOGY – SYLLABUS

(Under CBCS based on OBE)

(For the students admitted from the academic year 2025 – 2026 onwards)

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COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
25PMBC12	MICROBIAL PHYSIOLOGY	CORE – 2	5	-	5

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	I	25	75	100

Curriculum Design and Development	Employability			Skill Oriented	✓	Entrepreneurship					
	National		Local	✓	Regional	✓	Global				
Curriculum Enrichment	Professional Ethics	✓	Gender		Environment and Sustainability	✓	Human Values		Other Values		

COURSE DESCRIPTION:

Microbial physiology and metabolism provide information on sources of energy and its utilization by microorganisms.

COURSE OBJECTIVES:

- Illustrate Bacterial nutrition and their utilization.
- Discuss cultivation methods and factors related to microbial growth
- Demonstrate concepts of microbial metabolism
- Impart the fundamentals and importance of biosynthetic pathways
- Discuss the methods involved in Photosynthesis.

COURSE OUTCOMES (COs):

After the completion of the course, the students will be able to

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	apply knowledge about nutritional requirement, modes of nutrient transport in microorganisms to various disciplines of microbiology.	Upto K5
CO 2	analyse microbial growth, factors influencing growth and its measurement techniques for applications in various industries.	Upto K5
CO 3	compare various metabolic pathways and discuss the properties and functions of enzymes.	Upto K5
CO 4	apply anaerobic respiration and biosynthetic pathways to enhance/control microbial growth.	Upto K5
CO 5	assimilate methods involved in microbial photosynthesis and bioluminescence	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

Passed in the BoS Meeting held on 27/02/2025 **Signature of the Chairman**

MICROBIAL PHYSIOLOGY

UNIT – I:

Nutrition – Nutritional requirements and types in bacteria – Phototrophs, Chemotrophs, Autotrophs and Heterotrophs. Nutrient transport mechanisms– Passive diffusion, Facilitated diffusion, Active transport, Group translocation
and Specific transport system.

UNIT – II:

Microbial growth – Growth curve and Measurement of Growth – Cell Number and Cell Mass and metabolic activity. Batch, Continuous, Synchronousand Asynchronous cultures, Factors affecting growth.

UNIT – III:

Enzymes – properties, functions and regulation. Basic concepts of metabolism, Oxidation – reduction reactions, Energy generation by anaerobic metabolism – Glycolysis, Pentose Phosphate pathway, ED pathway, Fermentation. Energy generation by Aerobic metabolism – TCA cycle, Glycoxylate pathway and Electron Transportchain, Mechanism of ATP synthesis – Chemiosmosis, Pasteur effect. Metabolism of lipids–β oxidation.

UNIT – IV:

Anaerobic Respiration. Nitrogen, Sulphur, Iron and Hydrogen Oxidation. Methanogenesis.
Biosynthesis – Gluconeogenesis, Peptidoglycan synthesis,Amino acids, Purines, Pyrimidines Fattyacids, Triglycerides, Phospholipids and Sterols.

UNIT – V:

Photosynthesis – process, antenna of light–harvestingpigments, Photochemical reaction centers, Photosynthetic Electron Transport Chain–Cyclicand Non–cyclic. Oxygenic and Anoxygenic Photosynthesis. Calvin–Benson cycle. Bioluminescence – Process andapplication.

TEXT BOOKS:

1. Stanier R.Y., Ingraham, J.L., Wheelis, M.L and Painter, P.R. (2010). ***General Microbiology***. 5th Edn. Macmilan education Ltd. London. 17
2. Prescott. L.M., Harley. J.P., Klein. D.A. (1993). ***Microbiology***. 2nd Edn. Wm. C. Brown publishers, Dubugue.
3. Moat, A.G. and Foster, J.W. (2003). ***Microbial Physiology***.4th Edn. John Wiley and Sons, New York.
4. Doelle, H.W. (1975) ***Bacterial Metabolism,*** 2nd Edn. Academic Press, London.
5. Caldwell, D.R (2000) ***Microbial physiology and metabolism***, 2nd Edn. Star publishing, Belmont, California.

REFERENCE BOOKS:

1. Salle. A.J. (1992). ***Fundamental Principles of Bacteriology***. 7th Edn. McGraw Hill Inc. New York.
2. Madigan, M.T., Martinko, J.M., & Parker J. (2000). Brock ***Biology of Microorganisms***. 9th Edn. Prentice Hall International, Inc.
3. ***Introduction to Microbiology***. 2nd Edn. Brook /Cole. Singapore.
4. Gottschalk, G. (1986). ***Bacterial Metabolism***. 2nd Edn. Springer–Verlag, New York.
5. Rose, A.H. (1976). ***An Introduction to Microbial Physiology***. 3rd Edn. Plenum, New York

DIGITAL TOOLS:

https://courses.lumenlearning.com/boundlessmicrobiology/chapter/microbial–nutrition/
https://www.lamission.edu/lifesciences/lecturenote/mic20/Chap06Growth.pd f
https://www.tandfonline.com/doi/abs/10.3109/07388558409082583?journalCode=ibty0
https://wew.sciencedirect.com/topics/neuroscience/microbial–respiration.
https://www.britannica.com/science/photosynthesi

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	1	1	2	2	2
CO2	2	2	2	2	2	2
CO3	2	2	2	1	2	2
CO4	3	3	2	3	1	2
CO5	1	2	3	3	2	3

3. Advanced Application 2. Intermediate Development 1. Introductory Level

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M.Sc. MICROBIOLOGY – SYLLABUS

(Under CBCS based on OBE)

(For the students admitted from the academic year 2025 – 2026 onwards)

875

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
25PMBCP1	CORE PRACTICAL – GENERAL MICROBIOLOGY, MICROBIAL DIVERSITY AND MICROBIAL PHYSIOLOGY	CORE – 3 PRACTICAL – I	-	4	5

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	I	40	60	100

Curriculum Design and Development	Employability		✓	Skill Oriented			Entrepreneurship				
	National	✓	Local	✓	Regional	✓	Global				✓
Curriculum Enrichment	Professional Ethics		Gender		Environment and Sustainability	✓	Human Values		Other Values		

COURSE DESCRIPTION:

Deals with the practical aspects of qualitative and quantitative analysis of the techniques in the laboratory.

COURSE OBJECTIVES:

- Gain knowledge on the fundamentals, handling and applications of microscopy,
- Provide fundamental skills in sterilization methods. Identify microbes by different staining methods.
- Prepare media for bacterial growth. Analyze microbial enzymes.
- Perform plating techniques and methods involved in microbial preservation.
- Measure bacterial growth, identify optimal growth parameters, cultivate bacteria, and perform antibiotic sensitivity

COURSE OUTCOMES (COs):

After the completion of the course, the students will be able to

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	apply microscopic techniques and staining methods in the identification and differentiation of microbes	Upto K5
CO 2	apply the knowledge on the sterilization of glass wares and media by different methods and measurement of cell growth	Upto K5
CO 3	prepare media for bacterial growth. analyze microbial enzymes.	Upto K5
CO 4	pertain plating techniques and methods involved in microbial preservation.	Upto K5
CO 5	analyze microbial growth, optimal growth parameters, cultivate bacteria, and perform antibiotic sensitivity.	Upto K5

K1– KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

Passed in the BoS Meeting held on 27/02/2025 **Signature of the Chairman**

CORE PRACTICAL – GENERAL MICROBIOLOGY, MICROBIAL DIVERSITY AND MICROBIAL PHYSIOLOGY

UNIT– I:

Microscopic Techniques: Light microscopy: Hay infusion broth. Wet mount to show different types of microbes, hanging drop. Micrometry. Dark field microscopy – Motility of Spirochetes. Washing and cleaning of glass wares: Sterilization methods: moist heat, dry heat, and filtration. Quality control check for each method.

UNIT– II:

Staining techniques – Simple staining, Gram's staining, Acid fast staining, Meta chromatic granule staining, Spore, Capsule, Flagella.

UNIT– III:

Media Preparation: Preparation of liquid, solid and semisolid media. Agar deeps, slants, plates. Preparation of basal, enriched, selective and enrichment media. Preparation of Biochemical test media, media to demonstrate enzymatic activities.

UNIT– IV:

Purification and maintenance of microbes. Streak plate, pour plate, and slide culture technique. Aseptic transfer. Direct counts – Total cell count, Turbidometry. Viable count – pour plate, spread plate

UNIT– V:

Bacterial growth curve. Effect of physical and chemical factors on growth. Anaerobic culture methods.

TEXT BOOKS:

1. Dubey R.C. and Maheshwari D. K. (2010). ***Practical Microbiology***. S. Chand.
2. Cappuccimo, J. and Sherman, N. (2002). ***Microbiology: A Laboratory Manual***, (6th Edition). Pearson Education, Publication, New Delhi.
3. Cullimore D. R. (2010). ***Practical Atlas for Bacterial Identification.*** (2nd Edition). –Taylor &Francis.
4. Moat, A.G. Foster, J.W. and Spector, M. P (2002) ***Microbial Physiology***, 4th Edn. Wiley – Liss, New York.
5. Dawes, I. W. and Sutherland, I. W (1992) ***Microbial physiology***, 2nd Edn. Black–well Scientific Publications, London.

REFERENCE BOOKS:

1. Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney ***Practical Medical Microbiology***. (14th Edition). Elsevier, New Delhi.
2. Stanier R.Y., Ingraham, J.L., Wheelis, M.L and Painter, P.R. (2010). ***General Microbiology***. 5th Edn. Macmilan education Ltd. London.
3. Prescott. L.M., Harley. J.P., Klein. D.A. (1993). ***Microbiology***. 2nd edn. Wm. C. Brown publishers, Dubugue.
4. Gottschalk, G. (1986***). Bacterial Metabolism***. 2nd Edn. Springer–Verlag, New York.
5. Rose, A.H. (1976). ***An Introduction to Microbial Physiology***. 3rd Edn. Plenum, New York

DIGITAL TOOLS:

http://textbookofbacteriology.net/
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC149666/
http://sciencenetlinks.com/tools/microbeworld
https://www.microbes.info/
https://www.asmscience.org/VisualLibrary

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	3	2	1	3
CO2	2	3	1	3	2	3
CO3	3	3	2	1	3	1
CO4	2	1	3	2	1	2
CO5	1	3	2	3	2	2

3. Advanced Application 2. Intermediate Development 1. Introductory Level

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M.Sc. MICROBIOLOGY – SYLLABUS

(Under CBCS based on OBE)

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COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
25PMBE11	FORENSIC SCIENCE	ELECTIVE – 1	4	-	3

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	I	25	75	100

Curriculum Design and Development	Employability		✓	Skill Oriented		✓	Entrepreneurship				
	National	✓	Local	✓	Regional	✓	Global				✓
Curriculum Enrichment	Professional Ethics		Gender		Environment and Sustainability		Human Values	✓	Other Values		

COURSE DESCRIPTION:

Forensic science is the use of scientific methods or expertise to investigate crimes or examine evidence that might be presented in a court of law. Forensic science comprises a diverse array of disciplines, from fingerprint and DNA analysis to anthropology and wildlife forensics.

COURSE OBJECTIVES:

- Understand the Scope, need and learn the tools and techniques in forensic science.
- Comprehend organizational setup of a forensic science laboratory.
- Identify and examine body fluids for identification.
- Extract DNA from blood samples for investigation.
- Recognize medico legal post mortem procedures and their importance.

COURSE OUTCOMES (COs):

After the completion of the course, the students will be able to

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	identify the scope and need of forensic science in the present scenario.	Upto K5
CO 2	plan for the organizational setup and functioning of forensic science laboratories	Upto K5
CO 3	analyze the biological samples found at the crime scene.	Upto K5
CO 4	perform extraction and identification of DNA obtained from body fluids	Upto K5
CO 5	discuss the concept of forensic toxicology.	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

Passed in the BoS Meeting held on 27/02/2025 **Signature of the Chairman**

FORENSIC SCIENCE

UNIT– I:

Forensic Science – Definition, history and development of forensic science. Scope and need of forensic science in present scenario. Branches of forensic science. Tools and techniques of forensic science. Duties of a forensic scientist.

UNIT– II:

Forensic science laboratories – Organizational setup of a forensic science laboratory. Central and State level laboratories in India. Mobile forensic science laboratory and its functions. Forensic microbiology – Types and identification of microbial organisms of forensic significance.

UNIT– III:

Forensic serology – Definition, identification and examination of body fluids – Blood, semen, saliva, sweat and urine. Forensic examination and identification of hair and fibre.

UNIT– IV:

DNA profiling – Introduction, history of DNA typing. Extraction of DNA from blood samples – Organic and Inorganic extraction methods. DNA fingerprinting – RFLP, PCR, STR. DNA testing in disputed paternity

UNIT– V:

Forensic toxicology – Introduction and concept of forensic toxicology. Medico legal post mortem and their examination. Poisons – Types of poisons and their mode of action.

TEXT BOOKS:

1. Nanda B. B. and Tewari R. K. (2001) ***Forensic Science in India: A Vision for the Twenty First Century.*** Select Publishers, New Delhi. ISBN– 10:8190113526 / ISBN13:9788190113526.
2. James S. H. and Nordby, J. J. (2015) ***Forensic Science: An Introduction to Scientific and Investigative Techniques.*** (5th Edition). CRC Press. ISBN–10:9781439853832 / ISBN13:978–1439853832.
3. Li R. (2015) ***Forensic Biology***. (2nd Edition). CRC Press, New York. ISBN–13:978–1–4398– 8972–5.
4. Sharma B.R (2020) ***Forensic Science in Criminal Investigation and Trials***. (6th Edition)Universal Press.
5. Richard Saferstein (2017). ***Criminalistics – An Introduction to Forensic Science***. (12th Edition).Pearson Press

REFERENCE BOOKS:

1. Nordby J. J. (2000). Dead Reckoning. ***The Art of Forensic Detection***– CRC Press, New York. ISBN:0–8493–8122–3.
2. Saferstein R. and Hall A. B. (2020). ***Forensic Science Hand book***, Vol. I, (3rd Edition). CRC Press, New York. ISBN–10:1498720196.
3. Lincoln, P.J. and Thomson, J. (1998). (2nd Edition). ***Forensic DNA Profiling Protocols***. Vol. 98. Humana Press. ISBN: 978–0–89603–443–3.
4. Val McDermid (2014***). Forensics***. (2nd Edition). ISBN 9780802125156.
5. Vincent J. DiMaio., Dominick DiMaio. (2001). ***Forensic Pathology*** (2nd Edition). CRC Press.

DIGITAL TOOLS:

http://clsjournal.ascls.org/content/25/2/114
https://www.ncbi.nlm.nih.gov/books/NBK234877/
https://www.elsevier.com/books/microbial–forensics/budowle/978–0–12–382006–8
https://www.researchgate.net/publication/289542469_Methods_in_microbial_forensics
https://cisac.fsi.stanford.edu/events/microbial

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	3	3	1	1	3
CO2	3	2	1	2	2	3
CO3	1	3	2	2	3	1
CO4	2	2	3	2	1	2
CO5	3	1	2	3	2	2

3. Advanced Application 2. Intermediate Development 1. Introductory Level

SOURASHTRA COLLEGE, MADURAI – 625004

(An Autonomous Institution Re-accredited with 'A' grade by NAAC)

M.Sc. MICROBIOLOGY – SYLLABUS

(Under CBCS based on OBE)

(For the students admitted from the academic year 2025 – 2026 onwards)

881

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
25PMBE12	MICRO ALGAL TECHNOLOGY	ELECTIVE – 1	4	-	3

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	I	25	75	100

Curriculum Design and Development	Employability		✓	Skill Oriented		✓	Entrepreneurship				
	National	✓	Local	✓	Regional	✓	Global				✓
Curriculum Enrichment	Professional Ethics		Gender		Environment and Sustainability	✓	Human Values		Other Values		

COURSE DESCRIPTION:

This course highlights the concept of algal biofuel production using open raceway ponds and a closed photo bioreactor

COURSE OBJECTIVES:

- Characterize the different groups of algae.
- Describe the cultivation and harvesting of algae.
- Identify the commercial applications of various algal products.
- Apply microalgae for environmental applications.
- Employ microalgae as alternate fuels.

COURSE OUTCOMES (COs):

After the completion of the course, the students will be able to

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	acquire knowledge in the field of micro algal technology and their characteristics.	Upto K5
CO 2	identify the methods of algal cultivation and harvesting	Upto K5
CO 3	recognize and recommend the use of microalgae as food, feed and fodder	Upto K5
CO 4	promote microalgae in phytoremediation.	Upto K5
CO 5	compare and critically evaluate recent applied research in these micro algal applications.	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

MICRO ALGAL TECHNOLOGY

UNIT– I:

Introduction to Algae – General characteristics. Classification of algae according to Fritsch. Salient features of different groups of algae. Distribution – Freshwater, brackish water and marine algae. Identification methods. An overview of applied Phycology. Economically important microalgae.

UNIT– II:

Cultivation of freshwater and marine microalgae – Growth media. Isolation and enumeration of microalgae. Laboratory cultivation and maintenance. Outdoor cultivation – Photobioreactors – construction, types and operation; raceway ponds – Heterotrophic and mixotrophic cultivation – Harvesting of microalgae biomass

UNIT– III:

Microalgae in food and nutraceutical applications – Algal single cell proteins. Cultivation of Spirulina and Dunaliella. Microalgae as aquatic, poultry and cattle feed. Microalgal biofertilizers. Value–added products from microalgae. Pigments – Production of microalgal carotenoids and their uses. Phycobiliproteins – production and commercial applications. Polyunsaturated fatty acids as active nutraceuticals. Microalgal secondary metabolites – Pharmaceutical and cosmetic applications

UNIT– IV:

Microalgae in environmental applications. Phycoremediation – Domestic and industrial waste water treatment. High–rate algal ponds and surface–immobilized systems – Treatment of gaseous wastes by microalgae. Sequestration of carbon dioxide. Scavenging of heavy metals by microalgae. Negative effects of algae. Algal blooms, algicides for algal control

UNIT– V:

Microalgae as feed stock for production of biofuels – Carbon–neutral fuels. Lipid–rich algal strains – Botryococcus braunii. Drop–in fuels from algae – hydrocarbons and biodiesel, bioethanol, biomethane, biohydrogen and syngas from microalgae biomass. Biocrude synthesis from microalgae. Integrated biorefinery concept. Life cycle analysis of algae biofuels

TEXT BOOKS:

1. Lee R.E. (2008). ***Phycology***. Cambridge University Press.
2. Sharma O.P. (2011). ***Algae***. Tata McGraw–Hill Education.
3. Shekh A., Schenk P., Sarada R. (2021). ***Microalgal Biotechnology***. Recent Advances, Market Potential and Sustainability. Royal Society of Chemistry.
4. Lele. S.S., Jyothi Kishen Kumar (2008). ***Algal Bio Process Technology***. New Age International P(Ltd)
5. Das., Mihirkumar. ***Algal Biotechnology***. Daya Publishing House, New Delhi.

REFERENCE BOOKS:

1. Andersen R.A. (2005). ***Algal Culturing Techniques***. Academic Press, Elsevier.
2. Bux F. (2013). ***Biotechnological Applications of Microalgae: Biodiesel and Value added Products.*** CRC Press.
3. Singh B., Bauddh K., Bux, F. (2015). ***Algae and Environmental Sustainability.*** Springer.
4. Das D. (2015). ***An algal biorefinery: An Integrated Approach***. Springer.
5. Bux F. and Chisti Y. (2016). ***Algae Biotechnology: Products and Processes.*** Springer.

DIGITAL TOOLS:

https://www.classcentral.com/course/algae–10442
https://onlinecourses.nptel.ac.in/noc19_bt16/preview
https://freevideolectures.com/course/4678/nptel–industrial–biotechnology/4632
https://nptel.ac.in/courses/103103207
https://www.sciencedirect.com/topics/earth–and–planetary–sciences/microalgae

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	2	3	2	1	3
CO2	2	3	1	3	2	1
CO3	3	3	2	1	3	2
CO4	1	1	3	2	1	3
CO5	2	3	2	3	2	2

3. Advanced Application 2. Intermediate Development 1. Introductory Level

SOURASHTRA COLLEGE, MADURAI – 625004

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M.Sc. MICROBIOLOGY – SYLLABUS

(Under CBCS based on OBE)

(For the students admitted from the academic year 2025 – 2026 onwards)

884

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
25PMBE13	NANO BIOTECHNOLOGY	ELECTIVE – 1	4	-	3

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	I	25	75	100

Curriculum Design and Development	Employability		✓	Skill Oriented			Entrepreneurship				
	National	✓	Local	✓	Regional	✓	Global				✓
Curriculum Enrichment	Professional Ethics		Gender		Environment and Sustainability		Human Values	✓	Other Values		

COURSE DESCRIPTION:

Nanobiotechnology takes most of its fundamentals from nanotechnology and applies them to biological systems to produce nanoscale materials and devices designed to perform tasks impossible for macroscopic products.

COURSE OBJECTIVES:

- Analyze nanomaterials based on the understanding of nanobiotechnology.
- Discuss the methods of fabrication of nanomaterials.
- Gain Knowledge on characterization of nanomaterials.
- Discover nanomaterials for targeted drug delivery.
- Explain nanomaterials in nanomedicine and environmental pollution.

COURSE OUTCOMES (COs):

After the completion of the course, the students will be able to

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	employ knowledge in the field of nano biotechnology for development.	Upto K5
CO 2	identify various applications of nanomaterial in the field of medicine and environment.	Upto K5
CO 3	examine the prospects and significance of nano biotechnology.	Upto K5
CO 4	identify recent advances in this area and create a career or pursue research in the field.	Upto K5
CO 5	design non–toxic nanoparticles for targeted drug delivery.	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

Passed in the BoS Meeting held on 27/02/2025 **Signature of the Chairman**

NANO BIOTECHNOLOGY

UNIT– I:

Introduction to nanobiotechnology, Nano size–changing phenomena at nano scale, Classification of nanomaterials based on their dimensions (0D, 1D, 2D and 3D materials) and based on realization of their applications (The First, second, third and fourth generation materials),Class of nanomaterials and their applications. Need for nanomaterials and the risks associated with the materials.

UNIT– II:

Fabrication of Nanomaterials–Top–down and Bottom–up approaches, Solid phase synthesis–milling, Liquid phase synthesis–Sol–gel synthesis, colloidal synthesis, micro emulsion method, hydrothermal synthesis and solvo thermal synthesis, Vapour/Gas phase synthesis–Inert gas condensation, flame pyrolysis, Laser ablation and plasma synthesis techniques. Microbial synthesis of nanoparticles

UNIT– III:

Characterization of nanoparticles – Based on particle size/morphology– Dynamic light scattering (DLS),Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Atomic force microscopy(AFM), Based on surface charge–zeta potential, Based on structure –X–ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), Energy dispersive X–ray analysis (EDX),Based on optical properties– UV – Spectrophotometer, Based on magnetic properties–Vibrating sample magnetometer(VSM).

UNIT– IV:

Nanomaterial based Drug delivery and therapeutics–surface modified nano particles, MEMS/NEMS based devices, peptide/DNA coupled nanoparticles, lipid and inorganic nano particles for drug delivery, Metal/metaloxide nano particles as antibacterial, antifungal and antiviral agents. Toxicity of nanoparticles and Toxicity Evaluation.

UNIT– V:

Nanomaterials in diagnosis–Imaging, nanosensors in detection of pathogens. Treatment of surface water, ground water and waste water contaminated by toxic metal ions, organic and inorganic solutes and microorganisms

TEXT BOOKS:

1. Brydson R. M., Hammond, C. (2005). ***Generic Methodologies for Nanotechnology: Characterization.*** In Nanoscale Science and Technology. John Wiley & Sons, Ltd.
2. Leggett G. J., Jones R. A. L. (2005). ***Bionanotechnology. In Nanoscale Science and Technology.*** John Wiley & Sons, Ltd.
3. Mohan Kumar G. (2016). ***Nanotechnology: Nanomaterials and Nanodevices.*** Narosa Publishing House.
4. Goodsell D. S. (2004). ***Bionanotechnology.*** John Wiley & Sons, Inc.
5. Pradeep T. (2007). ***Nano: The Essentials–Understanding Nanoscience and Nanotechnology.*** Tata McGraw–Hil

REFERENCE BOOKS:

1. Nouailhat A. (2008). ***An Introduction to Nanoscience and Nanotechnology***, Wiley.
2. Sharon M. and Maheshwar (2012). ***Bio–Nanotechnology: Concepts and Applications***. New Delhi. Ane books Pvt Ltd.
3. Niemeyer C.M. and Mirkin C.A. (2005). ***Nanobiotechnology.*** Wiley Interscience. 28
4. Rehm, B. (2006). ***Microbial Bionanotechnology: Biological Self–Assembly Systems and Biopolymer–Based Nanostructures.*** Horizon Scientific Press.
5. Reisner, D.E. (2009). ***Bionanotechnology***: Global Prospects. CRC Pres.

DIGITAL TOOLS:

https://www.gale.com/nanotechnology
https://www.understandingnano.com/resources.html
http://dbtnanobiotech.com/index2.php
http://www.istl.org/11–winter/internet1.html.
https://www.cdc.gov/niosh/topics/nanotech/default.htm

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	3	2	1	3
CO2	2	3	1	3	2	3
CO3	3	3	2	1	3	1
CO4	2	1	3	2	1	2
CO5	1	3	2	3	2	2

3. Advanced Application 2. Intermediate Development 1. Introductory Level

SOURASHTRA COLLEGE, MADURAI – 625004

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M.Sc. MICROBIOLOGY – SYLLABUS

(Under CBCS based on OBE)

(For the students admitted from the academic year 2025 – 2026 onwards)

887

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
25PMBE14	ENTREPRENEURSHIP IN BIO BUSINESS	ELECTIVE – 2	4	-	3

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	I	25	75	100

Curriculum Design and Development	Employability	✓	Skill Oriented	✓		Entrepreneurship	✓				
	National	✓	Local	✓	Regional	✓	Global				
Curriculum Enrichment	Professional Ethics		Gender		Environment and Sustainability		Human Values		Other Values		

COURSE DESCRIPTION:

The course is a great opportunity for those looking to start a biotechnology–based business or invest in the industry. The course provides an in–depth introduction to the sector, including market trends, funding opportunities, and the latest research and development

COURSE OBJECTIVES:

- Understanding basic concepts in the area of entrepreneurship, the role and importance of entrepreneurship for economic development.
- Developing personal creativity and entrepreneurial initiative, adopting of the key steps in the elaboration of business idea.
- Understanding the stages of the entrepreneurial process and the resources needed for the successful development of entrepreneurial ventures.
- Acquire knowledge about proposal preparation, funding and face challenges in bio business.

COURSE OUTCOMES (COs):

After the completion of the course, the students will be able to

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	describe and apply several entrepreneurial ideas and business theories in practical framework.	Upto K5
CO 2	analyse the business environment in order to identify business opportunities, identify the elements of success of entrepreneurial ventures, evaluate the effectiveness of different entrepreneurial strategies and interpret their own business plan.	Upto K5
CO 3	express the mass production of microbial inoculants used as Bio fertilizers and Bio insecticides in response with field application and crop response.	Upto K5
CO 4	analyze the application and commercial production of Monoclonal antibodies, Cytokines. TPH and teaching kits.	Upto K5
CO 5	integrate and apply knowledge of the regulation of biotechnology industries, utilize effective team work skills within an effective management team with a common objective, and gain effective team work skills	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

Passed in the BoS Meeting held on 27/02/2025 **Signature of the Chairman**

ENTREPRENEURSHIP IN BIOBUSINESS

UNIT– I: Bio Entrepreneurship – Introduction to bio–business, SWOT analysis of bio–business. Ownership. Development of Entrepreneurship. Stages in entrepreneurial process. Government schemes and funding. Small scale industries – Definition, characteristics, need and rationale.

UNIT– II:

Entrepreneurship opportunity in agricultural Microbiology – Business opportunity, Essential requirement, marketing, strategies, schemes, challenges and scope. Case study on Plant cell and tissue culture technique, polyhouse culture. Herbal bulk drug production, nutraceuticals, value added herbal products. Bioethanol production using agricultural waste, algal source. Integration of system biology for agricultural applications. Biosensor development in agri management

UNIT– III:

Entrepreneurship opportunity in industrial biotechnology – Business opportunity, Essential requirement, marketing 6 CO3 44 strategies, schemes, challenges, and scope. Pollution monitoring and Bioremediation for Industrial pollutants. Integrated compost production – microbe enriched compost. Bio pesticide/ insecticide production. Biofertilizers. Single cell protein.

UNIT– IV:

Therapeutic and Fermented products – Stem cell production, stem cell bank, production of monoclonal/polyclonal antibodies, secondary metabolite production – antibiotics, probiotic and prebiotics.

UNIT– V:

Project Management, Technology Management and Startup Schemes – Building Biotech business challenges in Indian context – biotech partners (BIRAC, DBT, Incubation centers. etc.,), operational biotech parks in India. Indian Company act for Biobusiness – schemes and subsidies. Project proposal preparation, Successful start–ups–case study.

TEXT BOOKS:

1. Shimasaki C. (2014). ***Biotechnology Entrepreneurship***: Starting, Managing, and Leading Biotech Companies– Academic Press. ISBN: 978–0–12–404730–3
2. Acton A. Q. (2021). ***Biological Pigments*** – Advances in Research and Application– (Scholarly Editions). Atlanta, Georgia. ISBN: 978–1–481–68574–0 45
3. Stanbury P. F. and Whitekar. A. ***Principles of Fermentation Technology***, (3rd Edition). Butterworth–Heinemann. ISBN 10: 0080999530
4. Anil Kumar (2020). ***Small Business and Entrepreneurship***, Willey Distributions, Dream Tech Press.
5. Angi Redy (2015). ***An Unfinished Agenda***. ISBN 139780670087808.

REFERENCE BOOKS:

1. Crueger, W, and Crueger. A. (2017). ***Biotechnology: A Text Book of Industrial Microbiology.*** (2nd Edition). Medtech. ISBN–10 : 9385998633
2. Teng P. S. (2008**).** ***Bioscience Entrepreneurship in Asia***. World Scientific Publishing Company. 2008.
3. Agarwal S., Kumari S. and Khan S. (2021). ***Bioentrepreneurship and Transferring Technology into Product Development***. Business Science Reference. ISBN–10 : 1799874125
4. Krishnamurthy A.G. ***Dirubai Ambani Against All Odds***. McGraw Hills.
5. Peter F. Drucker. ***Innovation and Entrepreneurship*** (1985)

DIGITAL TOOLS:

https://www.profitableventure.com/biotech–business–ideas/
https://www.bio–rad.com/webroot/web/pdf/lse/literature/Biobusiness.pdf
https://www.nature.com/articles/s41587–021–01110–3
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3003900/
https://springhouse.in/government–schemes–every–entrepreneur/

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	3	2	1	3
CO2	2	3	1	3	2	3
CO3	3	3	2	1	3	1
CO4	2	1	3	2	1	2
CO5	1	3	2	3	2	2

3. Advanced Application 2. Intermediate Development 1. Introductory Level

SOURASHTRA COLLEGE, MADURAI – 625004

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M.Sc. MICROBIOLOGY – SYLLABUS

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(For the students admitted from the academic year 2025 – 2026 onwards)

COURSE STRUCTURE – II SEMESTER

S. No	Course Code	Course Title	Hrs./ Week	Exam (Hrs.)	CA	SE	Total	Credits
1.	25PMBC21	**Core – 4:** Medical Bacteriology and Mycology	5	3	25	75	100	5
2.	25PMBC22	**Core – 5:** Medical Virology and Parasitology	5	3	25	75	100	5
3.	25PMBCP2	**Core – 6:** **Core Practical – II:** Medical Microbiology	6	3	40	60	100	5
4.	25PMBE21	**Elective – 3:*** Epidemiology	5	3	25	75	100	3
	25PMBE22	Clinical Diagnostic Microbiology						
	25PMBE23	Bioremediation						
5.	25PMBE24	**Elective – 4:** Bioinformatics	5	3	25	75	100	3
6.	25PMBS21	**SEC – 1:** Vermitechnology	4	3	25	75	100	2
		TOTAL	**30**				**600**	**23**

***One Elective – 3 course to be chosen from THREE courses**

*****All students will do internship after II Semester. The evaluation will be done in the beginning of III Semester and marks will be included in the III Semester Mark sheet.**

CA – Class Assessment (Internal)

SE – Summative Examination

SEC – Skill Enhancement Course

NME – Non –Major Elective

T – Theory

P – Practical

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COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
25PMBC21	MEDICAL BACTERIOLOGY AND MYCOLOGY	CORE – 4	5	-	5

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	II	25	75	100

Curriculum Design and Development	Employability			Skill Oriented	✓		Entrepreneurship					
	National		Local	✓	Regional	✓	Global					
Curriculum Enrichment	Professional Ethics		Gender		Environment and Sustainability	✓	Human Values	✓	Other Values			

COURSE DESCRIPTION:

Medical bacteriology and mycology are fields of medical microbiology that study the biology of bacteria and fungi, and how they relate to human health.

COURSE OBJECTIVES:

- Acquire Knowledge on collection, transportation and processing of various kinds of clinical specimens.
- Explain morphology, characteristics and pathogenesis of bacteria.
- Discuss various factors leading to pathogenesis of bacteria
- Acquire knowledge on antifungal agents and their importance.
- Describe various diagnostic methods available for fungal disease diagnosis.

COURSE OUTCOMES (COs):

After the completion of the course, the students will be able to

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	collect, transport and process of various kinds of clinical specimens.	Upto K5
CO 2	analyze various bacteria based on morphology and pathogenesis.	Upto K5
CO 3	discuss various treatment methods for bacterial disease.	Upto K5
CO 4	employ various methods detect fungi in clinical samples and apply knowledge on antifungal agents	Upto K5
CO 5	apply various immunodiagnostic method to detect fungal infections.	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

Passed in the BoS Meeting held on 27/02/2025 **Signature of the Chairman**

MEDICAL BACTERIOLOGY AND MYCOLOGY

UNIT– I:

Classification of medically important bacteria, Normal flora of human body, Collection, transport, storage and processing of clinical specimens, Microbiological examination of clinical specimens, antimicrobial susceptibility testing. Handling and maintenance of laboratory animals – Rabbits, guinea pigs and mice.

UNIT– II:

Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by species of Staphylococci, Streptococci, Pneumococci, Neisseriae., Bacillus, Corynebacteria, Mycobacteria and Clostridium.

UNIT– III:

Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by Enterobacteriaceae members, Yersinia, Pseudomonas, Vibrio, Mycoplasma, Helicobacter, Rickettsiae, Chlamydiae, Bordetella, Francisella., SpirochaetesLeptospira, Treponema and Borrelia. Nosocomial, 20 CO3 56 zoonotic and opportunistic infections –prevention and control.

UNIT– IV:

Morphology, taxonomy and classification of fungi. Detection and recovery of fungi from clinical specimens. Dermatophytes and agents of superficial mycoses. Trichophyton, Epidermophyton & Microsporum. Yeasts of medical importance – Candida, Cryptococcus. Mycotoxins. Antifungal agents, testing methods and quality control.

UNIT– V:

Dimorphic fungi causing Systemic mycoses, Histoplasma, Coccidioides, Sporothrix, Blastomyces. Fungi causing Eumycotic Mycetoma, Opportunistic fungi– Fungi causing secondary infections in immunocompromised patients. Immunodiagnostic methods in mycology– Recent advancements in diagnosis. Antifungal agents.

TEXT BOOKS:

1. Kanunga R. (2017). ***Ananthanarayanan and Panicker's Text book of Microbiology.*** (2017).Orient Longman, Hyderabad.
2. Greenwood, D., Slack, R. B. and Peutherer, J. F. (2012) ***Medical Microbiology***, (18th Edition). Churchill Livingstone, London.
3. Finegold, S. M. (2000) ***Diagnostic Microbiology***, (10th Edition). C.V. Mosby Company, St. Louis.
4. Alexopoulos C. J., Mims C. W. and Blackwell M. (2007). ***Introductory Mycology***, (4th Edition). Wiley Publishers.
5. Chander J. (2018). ***Textbook of Medical Mycology***. (4th Edition). Jaypee brothers Medical Publishers.

REFERENCE BOOKS:

1. Salle A. J. (2007). ***Fundamental Principles of Bacteriology***. (4th Edition). Tata McGraw–Hill Publications.
2. Collee J.C. Duguid J.P. Foraser, A.C, Marimon B.P, (1996). ***Mackie & McCartney 57 Practical Medical Microbiology***. 14th edn, Churchill Livingston.
3. Cheesbrough M. (2006). ***District Laboratory Practice in Tropical countries*** – Part 22nd edn.Cambridge University Press. .
4. Topley and Wilson's. (1998). ***Principles of Bacteriology***. 9th edn. Edward Arnold, London.
5. Murray P.R., Rosenthal K.S. and Michael A. (2013). ***Medical Microbiology***. Pfaller. 7th edn. Elsevier, Mosby Saunders.

DIGITAL TOOLS:

https://microbiologysociety.org/members–outreach–resources/links.html
https://www.pathelective.com/micro–resources
https://www.adelaide.edu.au/mycology/

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
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CO2	3	3	1	2	2	3
CO3	1	3	2	3	3	1
CO4	2	1	3	2	1	2
CO5	2	3	2	1	2	2

3. Advanced Application 2. Intermediate Development 1. Introductory Level

SOURASHTRA COLLEGE, MADURAI – 625004

(An Autonomous Institution Re-accredited with 'A' grade by NAAC)

M.Sc. MICROBIOLOGY – SYLLABUS

(Under CBCS based on OBE)

(For the students admitted from the academic year 2025 – 2026 onwards)

894

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
25PMBC22	MEDICAL VIROLOGY AND PARASITOLOGY	CORE – 5	5	-	5

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	II	25	75	100

Curriculum Design and Development	Employability			Skill Oriented		✓	Entrepreneurship				
	National	✓	Local	✓	Regional	✓	Global				✓
Curriculum Enrichment	Professional Ethics		Gender		Environment and Sustainability		Human Values	✓	Other Values		

COURSE DESCRIPTION:

Medical parasitology is a subfield of microbiology which studies the relationships between human hosts and parasites which live in or on them. Medical virology is the study of submicroscopic organisms called viruses.

COURSE OBJECTIVES:

- Describe the replication strategy and cultivation methods of viruses.
- Acquire knowledge about oncogenic virus and human viral infections.
- Develop diagnostic skills, in the identification of virus infections.
- Impart knowledge about parasitic infections.
- Develop diagnostic skills, in the identification of parasitic infections.

COURSE OUTCOMES (COs):

After the completion of the course, the students will be able to

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	cultivate viruses by different methods and aid in diagnosis. perform purification and viral assay.	Upto K5
CO 2	investigate the symptoms of viral infections and presumptively identify the viral disease.	Upto K5
CO 3	diagnose various viral diseases by different methods.(serological, conventional and molecular)	Upto K5
CO 4	educate public about the spread, control and prevention of parasitic diseases.	Upto K5
CO 5	identify the protozoans and helminthes present in stool and blood specimens. perform serological and molecular diagnosis of parasitic infections.	Upto K5

K1– KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

Passed in the BoS Meeting held on 27/02/2025 **Signature of the Chairman**

MEDICAL VIROLOGY AND PARASITOLOGY

UNIT– I:

General properties of viruses – Structure and Classification – viroids, prions, satellite RNAs and virusoids. Cultivation of viruses – embryonated eggs, experimental animals and cell cultures. Purification and Assay of viruses – Physical and Chemical methods (Electron Microscopy, Protein and Nucleic acids studies.) Infectivity Assays (Plaque and endpoint).

UNIT– II:

Virus Entry, Host Defenses Against Viral Infections, Epidemiology, pathogenic mechanisms, Pathogenesis, laboratory diagnosis, treatment for the following viruses: DNA Viruses– Pox, Herpes, Adeno, Papova and Hepadna , RNA Viruses– Picorna, Orthomyxo, Paramyxo, Rhabdo, 20 CO2 59 Rota, HIV and other Hepatitis viruses, Arbo – Dengue virus, Ebola virus, Emerging and reemerging viral infections

UNIT– III:

Bacterial viruses – ΦX 174, M13, MU, T4, lambda, Pi; Structural organization, life cycle and phage production. Lysogenic cycle–typing and application in bacterial genetics. Diagnosis of viral infections –conventional serological and molecular methods. Antiviral agents and viral vaccines

UNIT– IV:

Introduction to Medical Parasitology – Classification, hostparasite relationships. Epidemiology, life cycle, pathogenic mechanisms, laboratory diagnosis, treatment for the following: Protozoa causing human infections – Entamoeba, Aerobic and Anaerobic amoebae, Giardia, Trichomonas, Balantidium. Toxoplasma, Cryptosporidium, Leishmania, and Trypanasoma.

UNIT– V:

Classification, life cycle, pathogenicity, laboratory diagnosis and treatment for parasites – Helminthes – Cestodes – Taenia Solium, T. Saginata, T. Echinococcus. Trematodes – Fasciola Hepatica, Fasciolopsis Buski, Paragonimus, Schistosomes. Nematodes – Ascaris, Ankylostoma, Trichuris, Trichinella, Enterobius, Strongyloides and Wuchereria. Other parasites causing infections in immune compromised hosts and AIDS. Cultivation of parasites. Diagnosis of parasitic infections – Serological and molecular diagnosis. Anti–protozoan drugs.

TEXT BOOKS:

1. Kanunga R. (2017). Ananthanarayanan and Panicker's ***Text book of Microbiology.*** (10th Edition). Universities Press (India) Pvt. Ltd.
2. Dubey, R.C. and Maheshwari D.K. (2010). ***A Text Book of Microbiology***. S. 60 Chand & Co.
3. Rajan S. (2007). ***Medical Microbiology***. MJP publisher.
4. Paniker J. (2006). ***Text Book of Parasitology***. Jay Pee Brothers, New Delhi.
5. Arora, D. R. and Arora B. B. (2020). ***Medical Parasitology***. (5th Edition). CBS Publishers & Distributors Pvt. Ltd. New Delhi.

REFERENCE BOOKS:

1. Carter J. (2001). ***Virology: Principles and Applications*** (1st Edition). Wiley Publications.
2. Willey J., Sandman K. and Wood D. ***Prescott's Microbiology.*** (11th Edition). McGraw Hill Book.
3. Jawetz E., Melnick J. L. and Adelberg E. A. (2000). ***Review of Medical Microbiology***. (19th Edition). Lange Medical Publications, U.S.A.
4. Finegold S.M. (2000). ***Diagnostic Microbiology.*** (10th Edition). C.V. Mosby Company, St. Louis.
5. Willey J., Sandman K. and Wood D. ***Prescott's Microbiology.*** (11th Edition). McGraw Hill Book.

DIGITAL TOOLS:

https://en.wikipedia.org/wiki/Virology
https://academic.oup.com/femsre/article/30/3/321/546048
https://www.sciencedirect.com/science/article/pii/S0042682215000859
https://nptel.ac.in/courses/102/103/102103039/
https://www.healthline.com/health/viral–diseases#contagiousness

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	3	2	1	3
CO2	2	3	1	3	2	3
CO3	3	3	2	1	3	1
CO4	2	1	3	2	1	2
CO5	1	3	2	3	2	2

3. Advanced Application 2. Intermediate Development 1. Introductory Level

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897

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
25PMBCP2	CORE PRACTICAL – MEDICAL MICROBIOLOGY	CORE–6 PRACTICAL – II	-	6	5

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	II	40	60	100

Curriculum Design and Development	Employability		✓	Skill Oriented		✓	Entrepreneurship				
	National		Local	✓	Regional	✓	Global				✓
Curriculum Enrichment	Professional Ethics		Gender		Environment and Sustainability	✓	Human Values	✓	Other Values		

COURSE DESCRIPTION:

Methods for identifying microorganisms in a laboratory, such as using genetic probes, growth characteristics, and enzymatic activity

COURSE OBJECTIVES:

- Develop skills in the diagnosis of bacterial infections and antimicrobial sensitivity.
- Impart knowledge on fungal infections and its diagnosis.
- Cultivation, identification and assay of viruses for diagnostics and vaccine production
- Diagnose parasitic infections.
- Identification of medically important vectors.

COURSE OUTCOMES (COs):

After the completion of the course, the students will be able to

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	collection of different clinical samples, transport, culture and examination.	Upto K5
CO 2	identify medically important fungus from the clinical samples.	Upto K5
CO 3	perform and interpret serological tests for viral diseases.	Upto K5
CO 4	exam and identify ova and cyst in samples.	Upto K5
CO 5	collection and identification of arthropod vectors.	Upto K5

K1– KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

Passed in the BoS Meeting held on 27/02/2025 **Signature of the Chairman**

CORE PRACTICAL – MEDICAL MICROBIOLOGY

UNIT– I:

Staining of clinical specimens – Wet mount, Differential and Special staining methods. Isolation and identification of bacterial pathogens from clinical specimens – cultivation in basal, differential, enriched, selective and special media – Biochemical identification tests. Enumeration of bacteria in urine to detect significant bacteriuria. Antimicrobial sensitivity testing – Kirby Bauer method and Stokes method. Minimum inhibitory concentration (MIC) test. Minimum bactericidal concentration (MBC) test.

UNIT– II:

Identification and Classification of common fungi. Examination of different fungi by Lactophenol cotton blue staining. Examination of different fungi by KOH staining. Cultivation of fungi and their identification – Mucor, Rhizopus, Aspergillus, Penicillium. Microscopic observation of different asexual fungal spores. Microscopic observation of fungal fruiting bodies. Identification of Dermatophytes.

UNIT– III:

Isolation and characterization of bacteriophage from natural sources by phage titration. Cultivation of viruses –Egg Inoculation methods. Diagnosis of Viral Infections –ELISA – HIA. Spotters of viral inclusions and CPE–stained smears.

UNIT– IV:

Examination of parasites in clinical specimens – Ova/cysts in faeces. Concentration: methods – Floatation methodssimple Saturated salt solution method – Zinc sulphate methods – Sedimentation methods– Formal ether method. Blood smear examination for malarial parasites. Thin smear by Leishman's stain – Thick smear by J.B. stain.

UNIT– V:

Identification of common arthropods of medical importance – spotters of Anopheles, Glossina, Phlebotomus, Aedes, Ticks and mites.

TEXT BOOKS:

1. Cullimore D. R. (2010). ***Practical Atlas for Bacterial Identification***, 2nd Edn. Publisher–Taylor and Francis.
2. Abbott A.C. (2010). ***The Principles of Bacteriology***. Nabu Press.
3. Parija S. C. (2012). ***Textbook of Practical Microbiology***. Ahuja Publishing House.
4. Cappuccimo, J. and Sherman, N. (2002) ***Microbiology: A Laboratory Manual,*** (6th Edition). Pearson Education, Publication, New Delhi.
5. Morag C. and Timbury M.C. (1994). ***Medical Virology.*** 4th Edn. Blackwell Scientific Publishers.

REFERENCE BOOKS:

1. Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). ***Mackie & McCartney Practical Medical Microbiology.*** (14th Edition). Elsevier, New Delhi.
2. Chart H. (2018). ***Practical Laboratory Bacteriology***. CRC Press.
3. Moore V. A. (2017). ***Laboratory Directions for Beginners in Bacteriology***. Triste Publishing Ltd.
4. .Cheesbrough M. (2006). ***District Laboratory Practice in Tropical countries.***– Part 22nd Edition.Cambridge University Press.
5. Murray P.R., Rosenthal K.S. and Michael A. (2013). ***Medical Microbiology. Pfaller***. 7th Edition. Elsevier, Mosby Saunders

DIGITAL TOOLS:

http://textbookofbacteriology.net/
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7173454/
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3768729/
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC149666/
https://www.intechopen.com/books/current–issues–in–molecular–virologyviral–genetics

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	1	2	2	1	3
CO2	3	3	1	3	2	3
CO3	2	3	2	1	3	1
CO4	1	1	3	2	1	2
CO5	2	3	2	3	2	2

3. Advanced Application 2. Intermediate Development 1. Introductory Level

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900

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
25PMBE21	EPIDEMIOLOGY	ELECTIVE – 3	5	-	3

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	II	25	75	100

Curriculum Design and Development	Employability			Skill Oriented	✓	Entrepreneurship					
	National	✓	Local	✓	Regional	✓	Global				✓
Curriculum Enrichment	Professional Ethics		Gender		Environment and Sustainability		Human Values		Other Values		

COURSE DESCRIPTION:

Epidemiology is the study and analysis of the distribution patterns and determinants of health and disease conditions in a defined population. It is a cornerstone of public health, and shapes policy decisions.

COURSE OBJECTIVES:

- Describe the role of epidemiology in public health.
- Explain about epidemiology tools and disease surveillance methods.
- Analyze various communicable and non–communicable diseases in India.
- Discuss on mechanism of antimicrobial resistance.
- Outline on National health programmes that have been designed to address the issues.

COURSE OUTCOMES (COs):

After the completion of the course, the students will be able to

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	apply the knowledge acquired on concepts of epidemiology to clinical and public health environment	**Upto K5**
CO 2	plan various strategies to trace the epidemiology.	**Upto K5**
CO 3	plan the control of communicable and non–communicable diseases.	**Upto K5**
CO 4	analyze the implications of drug resistance in the society and design the control of antimicrobial resistance and its management.	**Upto K5**
CO 5	employ national control programs related to communicable and non–communicable diseases with the public.	**Upto K5**

K1– KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

Passed in the BoS Meeting held on 27/02/2025 **Signature of the Chairman**

EPIDEMIOLOGY

UNIT– I:

Fundamentals of epidemiology – Definitions of epidemiology – Epidemiology of infectious diseases in Public Health. Natural history of disease – Historical aspects of epidemiology. Common risk factors – Epidemiologic Triad – Agent factors, host factors and environmental factors. Transmission basics – Chain of infection, portal of entry. Modes of transmission – Direct and indirect. Stages of infectious diseases. Agents and vectors of communicable diseases of public health importance and dynamics of disease transmission. Epidemiology of Zoonosis – Factors, routes of transmission of bacterial, viral, parasitic and fungal zoonotic agents. Control of zoonosis

UNIT– II:

Tools of Epidemiology – Measures of Disease – Prevalence, incidence. Index case. Risk rates. Descriptive Epidemiology – Cohort studies, measuring infectivity, survey methodology including census procedures. Surveillance strategies – Disease surveillance, geographical indication system, outbreak investigation in public health and contact investigation.

UNIT– III:

Epidemiological aspects of diseases of national importance – Background to communicable and non–communicable diseases. Vector borne diseases in India. Diarrhoeal diseases. Zoonoses. Viral haemorrhagic fevers. Mycobacterial infections. Sexually transmitted diseases. Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS). Emerging disease threats – Severe Acute Respiratory Syndrome (SARS), Covid–19, Ebola, MDR–TB, Malaria, Mucor mycosis, Avian flu. Dengue, Swine Flu, Chikungunya. Epidemiology, prevention, and control of non–communicable diseases – Asthma, Coronary heart disease, Malignancy, diabetes mellitus, respiratory diseases, eye diseases, Dental disorders. Emerging and Re–emerging Diseases.

UNIT– IV:

Mechanisms of Antimicrobial resistance – Multidrug Efflux pumps, Extended Spectrum β–lactamases (ESBL). Hospital acquired infections – Factors, infection sites, mechanisms, Role of Multidrug resistant pathogens. Role of Pseudomonas, 12 CO4 66 Acinetobacter, Clostridium difficile, HBV, HCV, Rotavirus, Cryptosporidium and Aspergillus in Nosocomial infections. Prevention and management of nosocomial infections.

UNIT– V:

National Programmes related to Communicable and NonCommunicable diseases – National Malaria Eradication Programme, Revised National Tuberculosis Control Programme, Vector Borne Disease Control Programme, National AIDS Control Programme, National Cancer Control Programme and National Diabetes Control Programme. Biochemical and immunological tools in epidemiology – Biotyping, Serotyping, Phage typing, FAME (Fatty acid methyl ester analysis), Curie Point PyMS (Pyrolysis Mass spectrometry), Protein profiling, Molecular typing methods.

TEXT BOOKS:

1. Dicker R., Coronado F., Koo. D. and Parrish. R. G. (2012). ***Principles of Epidemiology in Public Health Practice***. (3rd Edition). CDC.
2. Gerstman B. (2013). Epidemiology Kept Simple: ***An Introduction to Classic and Modern Epidemiology.*** (3rd Edition). Wiley Blackwell.
3. Greenwood, D., Slack, R. B. and Peutherer, J. F. (2012) ***Medical Microbiology,*** (18th Edition). Churchill Livingstone, London.
4. Jawetz E., Melnick J. L. and Adelberg E. A. (2000). ***Review of Medical Microbiology.*** (19th Edition). Lange Medical Publications, U.S.A.
5. Dimmok N. J. and Primrose S. B. (1994). ***Introduction to Modern Virology.*** 5th edn. Blackwell Scientific Publishers.

REFERENCE BOOKS:

1. Bhopal R. S. (2016).***Concepts of Epidemiology – An Integrated Introduction to the Ideas, Theories, Principles and Methods of Epidemiology.*** (3rd Edition). Oxford University Press, New York. 67
2. Celentano D. D. and Szklo M. (2018). ***Gordis Epidemiology***. (6th Edition). Elseiver, USA.
3. Cheesbrough, M. (2004). ***District Laboratory Practice in Tropical Countries*** – Part 2, (2nd Edition). Cambridge University Press.
4. Ryan K. J. and Ray C. G. (2004). ***Sherris Medical Microbiology***. (4th Edition), McGraw Hill, New York.
5. Topley W.W. C., Wilson, G. S., Parker M. T. and Collier L. H. (1998***). Principles of Bacteriology***. (9th Edition). Edward Arnold, London.

DIGITAL TOOLS:

https://www.scielo.br/j/rbca/a/mjDFGTtfWtBm786ZmR9TG9d/?lang=en
https://hal.archives–ouvertes.fr/hal–00902711/document
https://www.who.int/csr/resources/publications/whocdscsreph200212.pdf
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7187955/
https://www.who.int/diseasecontrol_emergencies/publications/idhe_2009_london_out

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	3	2	1	3
CO2	2	3	1	3	2	3
CO3	3	3	2	1	3	1
CO4	2	1	3	2	1	2
CO5	1	3	2	3	2	2

3. Advanced Application 2. Intermediate Development 1. Introductory Level

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903

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
25PMBE22	CLINICAL AND DIAGNOSTIC MICROBIOLOGY	ELECTIVE–3	5	-	3

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	II	25	75	100

Curriculum Design and Development	Employability		✓	Skill Oriented		✓	Entrepreneurship			
	National		Local	✓	Regional	✓	Global			
Curriculum Enrichment	Professional Ethics	✓	Gender		Environment and Sustainability	✓	Human Values		Other Values	

COURSE DESCRIPTION:

Clinical microbiology is a discipline that encompasses a broad range of testing methodologies, and it is complex in terms of organisms and methods used to isolate and identify them.

COURSE OBJECTIVES:

- Describe appropriate safety protocol and laboratory techniques for handling specimens and biomedical waste management.
- Develop working knowledge of techniques used to identify infectious agents in lab.
- Elucidate various diagnostic procedures in microbiology.
- Acquire knowledge on different methods employed to check antibiotic sensitivity.
- Gain knowledge on hospital acquired infections and their control measures.

COURSE OUTCOMES (COs):

After the completion of the course, the students will be able to

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	apply laboratory safety procedures and hospital waste disposal strategies.	Upto K5
CO 2	collect various clinical specimens, handle, preserve and process safely.	Upto K5
CO 3	identify the causative agents of diseases by conventional and molecular methods following standard protocols.	Upto K5
CO 4	assess the antimicrobial susceptibility pattern of pathogens.	Upto K5
CO 5	trace the sources of nosocomial infection and recommend control measures.	Upto K5

K1– KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

Passed in the BoS Meeting held on 27/02/2025 **Signature of the Chairman**

CLINICAL AND DIAGNOSTIC MICROBIOLOGY

UNIT– I:

Microbiology Laboratory Safety Practices –General Safety Guidelines, Handling of Biological Hazards, Infectious health care waste disposal – Biomedical waste management, Emerging and Re–emerging infections.

UNIT– II:

Diagnostic procedures – General concept of Clinical specimen collection, transport, storage and general processing in Microbiology laboratory – Specimen acceptance and rejection criteria.

UNIT– III:

Diagnosis of microbial diseases – Clinical, differential, Microbiological, immunological and molecular diagnosis of microbial diseases. Modern and novel microbial diagnostic methods. Automation in Microbial diagnosis.

UNIT– IV:

Antibiotic sensitivity tests – Disc diffusion – Stokes and Kirby Bauer methods, E test – Dilution – Agar dilution & broth dilution – MBC/MIC – Quality control for antibiotics and standard strains.

UNIT– V:

Nosocomial infections – common types, sources, reservoir and mode of transmission, pathogenesis and control measures. Hospital Infection Control Committee (HICC) – Functions.

TEXT BOOKS:

1. Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). ***Mackie & McCartney Practical Medical Microbiology.*** (14th Edition). Elsevier, New Delhi. ISBN–10:0443047219 / ISBN–13–978–0443047213.
2. Tille P. M. (2021). ***Bailey and Scott's Diagnostic Microbiology.*** (15th Edition). Elsevier. ISBN: 9780323681056.
3. Jawetz E., Melnick J. L. and Adelberg E. A. (2000). ***Review of Medical Microbiology.*** (19th Edition). Lange Medical Publications, U.S.A.
4. Mukherjee K.L. (2000). ***Medical Laboratory Technology***. Vol. 1–3. (2nd Edition). Tata McGraw–Hill Education. ISBN–10:0074632604.
5. Sood R. (2009). ***Medical Laboratory Technology – Methods and Interpretations.*** (6th Edition). Jaypee Brothers Medical Publishers (P) Ltd. New Delhi. ISBN: 9788184484496.

REFERENCE BOOKS:

1. Murray P. R., Baron E. J., Jorgenson J. H., Pfaller M. A. and Yolken R.H. (2003). ***Manual of Clinical Microbiology.*** (8th Edition). American Society for Microbiology, Washington, DC. ISBN: 1–555810255–4.
2. Bennett J. E., Dolin R. and Blaser M. J. (2019). ***Principles and Practice of Infectious Diseases.*** (9th Edition). Elsevier. EBook ISBN: 9780323550277. Hardcover ISBN: 9780323482554.
3. Ridgway G. L., Stokes E. J. and Wren M. W. D. (1987). ***Clinical Microbiology*** 7th Edition. Hodder Arnold Publication. ISBN–10:0340554231/ ISBN13:9780340554234.
4. Koneman E.W., Allen S. D., Schreckenberg P. C. and Winn W. C. (2020). ***Koneman's Color Atlas and Textbook of Diagnostic Microbiology.*** (7th Edition). Jones & Bartlett Learning. ISBN: 1284322378 9781284322378.
5. Cheesbrough, M. (2004). ***District Laboratory Practice in Tropical Countries – Part 2***, (2nd Edition). Cambridge University Press. ISBN–13:978–0–521–67631–1 / ISBN–10:0– 521–67631–2.

DIGITAL TOOLS:

https://www.ncbi.nlm.nih.gov/books/NBK20370/
https://www.msdmanuals.com/en–in/home/infections/diagnosisofinfectious3disease/diagnosis–of–infectious–disease
https://journals.asm.org/doi/10.1128/JCM.02592–20
https://www.sciencedirect.com/science/article/pii/S2221169116309509
http://www.textbookofbacteriology.net/normalflora_3.html

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	1	3	1	1	3
CO2	1	3	2	3	2	3
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906

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
25PMBE23	BIOREMEDIATION	ELECTIVE– 3	5	-	3

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	II	25	75	100

Curriculum Design and Development	Employability			Skill Oriented	✓	Entrepreneurship	✓				
	National		Local	✓	Regional	✓	Global				
Curriculum Enrichment	Professional Ethics	✓	Gender		Environment and Sustainability	✓	Human Values		Other Values		

COURSE DESCRIPTION:

Bioremediation is a biotechnical process, which abates or cleans up contamination. It is a type of waste management technique which involves the use of organisms to remove or utilize the pollutants from a polluted area.

COURSE OBJECTIVES:

- Describe the nature and importance of bioremediation and use in real world applications.
- Describe the typical composition of waste water and application of efficient technologies for water treatment.
- Explain the fundamentals of treatment technologies and the considerations for its design
- Explain the potential of microbes in ore extraction and acquaint students with methods of reducing health risks caused by xenobiotics.
- Familiarize the role of plants and their associated microbes in remediation and management of environmental pollution

COURSE OUTCOMES (COs):

After the completion of the course, the students will be able to

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	differentiate ex–situ bioremediation and in–situ bioremediation. assess the roles of organisms in bioremediation	Upto K5
CO 2	distinguish microbial processes necessary for the design and optimization of biological processing unit operations.	Upto K5
CO 3	identify, formulate and design engineered solutions to environmental problems.	Upto K5
CO 4	explore microbes in degradation of toxic wastes and playing role on biological mechanisms.	Upto K5
CO 5	establish the mechanisms of arbuscular mycorrhizal fungi	Upto K5

K1– KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

Passed in the BoS Meeting held on 27/02/2025 **Signature of the Chairman**

BIOREMEDIATION

UNIT– I:

Bioremediation – process and organisms involved. Bioaugmentation – Ex–situ and in–situ processes; Intrinsic and engineered bioremediation. Major pollutants and associated risks; organic pollutant degradation. Microbial aspects and metabolic aspects. Factors affecting the process. 12 CO1 72 Recent developments and significance.

UNIT– II:

Microbes involved in aerobic and anaerobic processes in nature. Water treatment – BOD, COD, dissolved gases, removal of heavy metals, total organic carbon removal. Secondary waste water treatments – use of membrane bioreactor. Aquaculture effluent treatment. Aerobic sludge and landfill leachate process. Aerobic digestion.

UNIT– III:

Composting of solid wastes, anaerobic digestion – methane production and important factors involved, Pros and cons of anaerobic process, sulphur, iron and nitrate reduction, hydrocarbon degradation, degradation of nitroaromatic compounds. Bioremediation of dyes, bioremediation in paper and pulp industries. Aerobic and anaerobic digesters – design. Various types of digester for bioremediation of industrial effluents.

UNIT– IV:

Microbial leaching of ores – process, microorganisms involved and metal recovery with special reference to copper and iron. Biotransformation of heavy metals and xenobiotics. Petroleum biodegradation – reductive and oxidative. Dechlorination. Biodegradable of plastics and super bug.

UNIT– V:

Phytoremediation of heavy metals in soil – Basic principles of phytoremediation – Uptake and transport, Accumulation and sequestration. Phytoextraction. Phytodegradation. Phytovolatilization. Rhizodegradation. Phytostabilization – Organic and synthetic amendments in multi metal contaminated mine sites. Role of Arbuscular mycorrhizal fungi and plant growth promoting rhizobacteria in phytoremediation.

TEXT BOOKS:

1. Bhatia H.S. (2018). ***A Text book on Environmental Pollution and Control.*** (2nd Edition). Galgotia Publications.
2. Chatterjee A. K. (2011). ***Introduction to Environmental Biotechnology.*** (3rd Edition). Printice–Hall, India.
3. Pichtel, J. (2014). ***Waste Management Practices: Municipal, Hazardous, and Industrial,*** 2nd edition, CRC Press.
4. Liu, D.H.F and Liptak, B.G (2005). ***Hazardous Wastes and Solid Wastes***, Lewis Publishers. .
5. Rajendran, P. & Gunasekaran, P. (2006). ***Microbial Bioremediation.*** 1st edition. MJP Publishers

REFERENCE BOOKS:

1. Sangeetha J., Thangadurai D., David M. and Abdullah M.A. (2016). ***Environmental Biotechnology: Biodegradation, Bioremediation, and Bioconversion of Xenobiotics for Sustainable Development.*** (1st Edition). Apple Academic Press.
2. Singh A. and Ward O. P. (2004). ***Biodegradation and Bioremediation. Soil Biology.*** Springer.
3. Singh A., Kuhad R. C., and Ward O. P. (2009). ***Advances in Applied Bioremediation*** (1st Edition). Springer–Verlag Berlin Heidelberg, Germany.
4. Atlas, R.M & Bartha, R. (2000). ***Microbial Ecology.*** Addison Wesley Longman Inc.
5. Rathoure, A.K. (Ed.). (2017). ***Bioremediation: Current Research and Applications.*** 1st Edition. I.K. International Publishing House Pvt. Ltd.

DIGITAL TOOLS:

https://agris.fao.org
https://www.sciencedirect.com/topics/earth–and–planetary–sciences/bioremediation
https://www.intechopen.com/chapters/70661
https://microbiologysociety.org/blog/bioremediation–the–pollution–solution.html

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	1	1	2	2	3
CO2	2	3	2	3	2	3
CO3	2	3	2	1	3	1
CO4	2	1	3	2	1	2
CO5	1	3	2	3	2	2

3. Advanced Application 2. Intermediate Development 1. Introductory Level

SOURASHTRA COLLEGE, MADURAI – 625004

(An Autonomous Institution Re-accredited with 'A' grade by NAAC)

M.Sc. MICROBIOLOGY – SYLLABUS

(Under CBCS based on OBE)

(For the students admitted from the academic year 2025 – 2026 onwards)

909

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
25PMBE24	BIOINFORMATICS	ELECTIVE – 3	5	-	3

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	II	25	75	100

Curriculum Design and Development	Employability	✓	Skill Oriented	✓	Entrepreneurship						
	National	✓	Local	✓	Regional	✓	Global				
Curriculum Enrichment	Professional Ethics	✓	Gender		Environment and Sustainability		Human Values		Other Values		

COURSE DESCRIPTION:

Bioinformatics, as related to genetics and genomics, is a scientific subdiscipline that involves using computer technology to collect, store, analyze and disseminate biological data and information, such as DNA and amino acid sequences or annotations about those sequences.

COURSE OBJECTIVES:

- Discuss about various biological data mining concepts, tools.
- Elucidate the principles and applications of sequence alignment methods and tools.
- Demonstrate different phylogenetic tree construction methods and its uses in phylogenetic analysis.
- Acquaint with various approaches in predicting 3D and 2D structure of proteins.
- Describe various tools and techniques used in molecular docking, immune informatics and subtractive genomics.

COURSE OUTCOMES (COs):

After the completion of the course, the students will be able to

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	access to databases that provides information on nucleic acids and proteins.	Upto K5
CO 2	invent algorithms for sequence alignment.	Upto K5
CO 3	construct phylogenetic tree.	Upto K5
CO 4	predict the structure of proteins.	Upto K5
CO 5	design drugs by predicting drug ligand interactions and molecular docking.	Upto K5

K1– KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

Passed in the BoS Meeting held on 27/02/2025 **Signature of the Chairman**

BIOINFORMATICS

UNIT– I:

Biological Data Mining – Exploration of Data Mining Tools. Cluster Analysis Methods. Data Visualization. Biological Data Management. Biological Algorithms – Biological Primary and Derived Databases. Concept of Alignment, Pairwise Sequence Alignment (PSA), Multiple Sequence Alignment (MSA), BLAST, CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

UNIT– II:

Phylogenetic Tree Construction – Concept of Dendrograms. Evolutionary Trees – Distance Based Tree Reconstruction – Ultrametric trees and Ultrametric distances – Reconstructing Trees from Additive Matrices – Evolutionary Trees and Hierarchical Clustering – Character Based Tree Reconstruction – Maximum Parsimony Method, Maximum likelihood method – Reliability of Trees – Substitution matrices – Evolutionary models.

UNIT– III:

Computational Protein Structure prediction – Secondary structure – Homology modelling– Fold recognition and ab initio 3D structure prediction – Structure comparison and alignment – Prediction of function from structure. Geometrical parameters – Potential energy surfaces – Hardware and Software requirements–Molecular graphics – Molecular file formatsMolecular visualization tools.

UNIT– IV:

Prediction of Properties of Ligand Compounds – 3D Autocorrelation –3D Morse Code– Conformation Dependent and Independent Chirality Codes –Comparative Molecular Field Analysis – 4 D QSAR –HYBOT Descriptors – Structure Descriptors – Applications – Linear Free Energy Relationships – Quantity Structure – Property Relationships – Prediction of the Toxicity of Compounds

UNIT– V:

Molecular Docking– Flexible – Rigid docking– Target– Ligand preparation– Solvent accessibility– Surface volume calculation, Active site prediction– Docking algorithms– Genetic, Lamarckian – Docking analyses– Molecular interactions, bonded and nonbonded – Molecular Docking Software and Working Methods. Genome to drug discovery – Subtractive Genomics – Principles of Immunoinformatics and Vaccine Development.

TEXT BOOKS:

1. Lesk A. M. (2002). ***Introduction to Bioinformatics.*** (4^{th} Edition). Oxford University Press.
2. Lengauer T. (2008). ***Bioinformatics– from Genomes to Therapies*** (Vol–1).Wiley–VCH.
3. Rastogi S. C., Mendiratta N. and Rastogi P. (2014). ***Bioinformatics – Methods and Applications (Genomics, Proteomics and Drug Discovery)*** (4^{th} Edition). Prentice–Hall of India Pvt. Ltd.
4. Attwood, T.K. and Parry–Smith, D.J. (1999). ***Introduction to Bioinformatics.*** Addision Wesley Longman Limited, England.
5. Mount D.W., (2013). ***Bioinformatics Sequence and Genome Analysis,*** 2^{nd} edn. CBS Publishers, New Delhi.

REFERENCE BOOKS:

1. Baxevanis A. D. and Ouellette F. (2004). ***Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins.*** (2nd Edition). John Wiley and Sons.
2. Bosu O. and Kaur S. (2007). ***Bioinformatics – Database, Tools, and Algorithms***. Oxford University Press.
3. David W. M. (2001). ***Bioinformatics Sequence and Genome Analysis*** (2nd Edition). CBS Publishers and Distributors (Pvt.) Ltd.
4. Xiong J, (2011). ***Essential Bioinformatics,*** First south Indian Edition, Cambridge University Press.
5. Harshawardhan P.Bal, (2006). ***Bioinformatics Principles and Applications***, Tata McGraw–Hill Publishing Company Limited.

DIGITAL TOOLS:

https://www.hsls.pitt.edu/obrc/
https://www.hsls.pitt.edu/obrc/index.php?page=dna
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1669712/
https://www.ebi.ac.uk/
https://www.kegg.jp/kegg/kegg2.html

Mapping of CO with PSO

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CO1	1	2	1	3	1	3
CO2	3	3	1	3	2	3
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(Under CBCS based on OBE)

(For the students admitted from the academic year 2025 – 2026 onwards)

912

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
25PMBS21	VERMITECHNOLOGY	SEC – 1	4	-	2

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	II	25	75	100

Curriculum Design and Development	Employability			Skill Oriented	✓	Entrepreneurship	✓				
	National		Local	✓	Regional	✓	Global				
Curriculum Enrichment	Professional Ethics	✓	Gender		Environment and Sustainability	✓	Human Values		Other Values		

COURSE DESCRIPTION:

Vermitechnology includes the study and commercial application of technologies that utilise earthworms for degrading waste organic materials for sanitation and agricultural re–use.

COURSE OBJECTIVES:

- Introduce the concepts of vermicomposting.
- Explain the physiology, anatomy and biology of earthworms.
- Acquire the knowledge of the vermicomposting process.
- Explain the trouble shooting, harvesting and packaging of vermin composts.
- Gain knowledge on applications of vermin composts and their value added products.

COURSE OUTCOMES (COs):

After the completion of the course, the students will be able to

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	compare and contrast the uses of vermicompost to the soil.	Upto K5
CO 2	recommend different species of earthworms after acquiring knowledge on its biology	Upto K5
CO 3	design the vermicomposting process.	Upto K5
CO 4	assess the best practices of vermicomposting	Upto K5
CO 5	recommend the applications of vermicompost to different soils and for different crops.	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

Passed in the BoS Meeting held on 27/02/2025 **Signature of the Chairman**

VERMITECHNOLOGY

UNIT– I:

Introduction to Vermiculture – Definition, classification, history, economic importance– In sustainable agriculture, organic farming, earthworm activities, soil fertility & texture, soil aeration, water impercolation, decomposition & moisture, bait & food and their value in maintenance of soil structure. Its role in the bio transformation of the residues generated by human activity and production of organic fertilizers. Choosing the right worm. Useful species of earthworms. Local species of earthworms. Exotic species of earthworms. Factors affecting distribution of earthworms in soil.

UNIT– II:

Earthworm Biology and Rearing – Key to identify the species of earthworms. Biology of Eisenia fetida. a) Taxonomy Anatomy, physiology and reproduction of Lumbricidae. b) Vital cycle of Eisenia fetida: alimentation, fecundity, annual reproducer potential and limiting factors (gases, diet, humidity, temperature, PH, light, and climatic factors). Biology of Eudrilus eugeniae. c) Taxonomy Anatomy, physiology and reproduction of Eudrilidae. d) Vital cycle of Eudrilus eugeniae: alimentation, fecundity, annual reproducer potential and limit factors (gases, diet, humidity, temperature, PH, light, and climatic factors).

UNIT– III:

Vermicomposting Process – Feeds for Vermitech systemsAnimal manures– Kitchen Waste and Urban waste– Paper pulp and card board solids– Compost and waste products– Industrial Wastes. Vermicomposting Basic process– Initial precomposting phase– Mesophilic phase– Maturing and stabilization phase– Mechanism of Earthworm action. Methods of vermicomposting– a) windrows system; b) wedge system; c) container system–pits, tanks & cement rings; commercial model; beds or bins–top fed type, stacked type, d) Continuous flow system.

UNIT– IV:

Vermicomposting – Trouble Shooting–Temperature–AerationAcidity– Pests and Diseases– Ants, rodents, Birds, Centipedes, sour crop, Mite pests. Odour problems. Separation techniquesLight Separation–Sideways Separation–Vertical SeparationGradual transfer. Harvesting Earthworms– manual methodmigration method. Packing & Nutritional analysis of vermicompost.

UNIT– V:

Applications of Vermiculture – Vermiculture Bio–technology, use of vermi castings in organic farming/horticulture, as feed/bait for capture/culture fisheries; forest regeneration. Application quantity of vermicompost in Agricultural fieldscrops, fruits, vegetables & flowers. By–products and valueadded products– Verm wash– vermicompost tea–vermi mealenriched vermicompost–pelleted vermicompost.

TEXT BOOKS:

1. Ismail S. A. (2005). ***The Earthworm Book***, Second Revised Edition. Other India Press, 87 Goa, India.
2. Rathoure A. K., Bharati P. K. and Ray J. (2020). ***Vermitechnology, Farm and Fertilizer***. Vermitechnology, Farm and Fertilizer Discovery Publishing House Pvt Ltd.
3. Christy M. V. 2008. ***Vermitechnology,*** (1st Edition), MJP Publishers.
4. ***The Complete Technology Book on Vermiculture and Vermicompost with Manufacturing Process, Machinery Equipment Details and Plant Layout***. AB Press.
5. Keshav Singh (2014). ***A Textbook of Vermicompost: Vermiwash and Biopesticide***.

REFERENCE BOOKS:

1. Roy D. (2018). ***Handbook of Vermitechnology***. Lambert Academic Publishing.
2. Kumar A. (2005). ***Verms and Vermitechnology***, A.P.H. Publishing Corporation, New Delhi.
3. Lekshmy M. S., Santhi R. (2012). ***Vermitechnology***, Sara Publications, New Delhi, India.
4. Edwards CA, Arancon NQ Sherman RL. (2011) ***Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Managemen*t** 1st edn.CRC Press.
5. Ismail, S.A. (1997). ***Vermicology–The Biology of Earthworm.***1st edn. Orient longman.

DIGITAL TOOLS:

https://en.wikipedia.org/wiki/Vermicompost
http://stjosephs.edu.in/upload/papers/9567411a78c63d4ccfbbe85e6aa22840.pdf
https://www.kngac.ac.in/elearningportal/ec/admin/contents/4_18K4ZEL02_20211280320 4629.pdf
https://composting.ces.ncsu.edu/vermicomposting–2/
https://rodaleinstitute.org/science/articles/vermicomposting–for–beginners/

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3. Advanced Application 2. Intermediate Development 1. Introductory Level