॥ सा विद्या या विमुक्तये ॥

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

'ज्ञानतीर्थ', विष्णुपुरी, नांदेड – ४३१ ६०६ (महाराष्ट्र राज्य) भारत

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

'Dnyanteerth', Vishnupuri, Nanded - 431 606 (Maharashtra State) INDIA

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

Established on 17th September, 1994, Recognized By the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'B++' grade

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विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत राष्ट्रीय शैक्षणिक धोरण २०२० नुसार पदव्यूत्तर द्वितीय वर्षाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२४–२५ पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, या विद्यापीठा अंतर्गत येणा–या सर्व संलग्नित महाविद्यालयामध्ये शैक्षणिक वर्ष २०२४–२५ पासून राष्ट्रीय शैक्षणिक धोरणानुसार पदव्यूत्तर द्वितीय वर्षाचे अभ्यासक्रम लागू करण्याच्या दृष्टीकोनातून विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत येणा–या अभ्यासमंडळांनी तयार केलेल्या पदव्यूत्तर द्वितीय वर्षाच्या अभ्यासक्रमांना मा. विद्यापरिषदेने दिनांक १५ मे २०२४ रोजी संपन्न झालेल्या बैठकीतील विषय क्रमांक १५/५९–२०२४ च्या ठरावाअन्वये मान्यता प्रदान केली आहे. त्यानुसार विज्ञान व तंत्रज्ञान विद्याशाखेतील खालील एम. एस्सी द्वितीय वर्षाचे अभ्यासक्रम (Syllabus) लागू करण्यात येत आहेत.

1) M. Sc. II year Biotechnology (Affiliated College)
2) M. Sc. II year Biotechnology (Campus)
3) M. Sc. II year Bioinformatics (Sub Campus Latur)
4) M. Sc. II year Bioinformatics (Affiliated College)
5) M. Sc. II year Clinical Research (Affiliated College)
6) M. Sc. II year Botany (Campus)
7) M. Sc. II year Herbal Medicine
8) M. Sc. II year Boany (Affiliated College)
9) M. Sc. II year Geology (Campus)
10) M. Sc. II year Dairy Science
11) M. Sc. II year Electronics
12) M. Sc. II year Environmental Science
13) M. Sc. II year Environmental Science (Campus)
14) M. Sc. II year Geography (Campus)
15) M. Sc. II year Applied Mathematics
16) M. Sc. II year Mathematics
17) M. Sc. II year Mathematics (Campus)
18) M. Sc. II year Microbiology
19) M. Sc. II year Microbiology (Campus)
20) M. Sc. II year Statistics
21) M. Sc. II year Statistics (Campus)

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी, ही विनंती.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.:शै–१/एनइपी/विवत्रंविपदवी/२०२४–२५/१०९
दिनांक १२.०६.२०२४

डॉ. सरिता लोसरवार
सहा.कुलसचिव
शैक्षणिक (१–अभ्यासमंडळ) विभाग

प्रत : १) मा. आधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मुंल्यमापन मंडळ, प्रस्तुत विद्यापीठ.
३) मा. प्राचार्य, सर्व संबधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
४) मा. संचालक, सर्व संकुले परिसर व उपपरिसर, प्रस्तुत विद्यापीठ
५) सिस्टीम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ. याना देवून कळविण्यात येते की, सदर परिपत्रक संकेतस्थळावर प्रसिध्द करण्यात यावे.

SWAMI RAMANAND TEERTH

MARATHWADA UNIVERSITY, NANDED - 431 606

TWO YEAR MASTERS PROGRAMME

IN SCIENCE

(As per NEP-2020)

Syllabus for

Subject

M.Sc. MICROBIOLOGY
(Semester - III & IV)

(Affiliated Colleges)

Under the Faculty of

Science and Technology

Effective from Academic year 2024-2025

From Desk of Chairman, Board of Studies of the Subject Microbiology

The emergence of microbiology many centuries ago is considered one of many of the most important scientific achievements. Since then, it has become a leading field in the biological sciences and a popular course of study in higher institutions worldwide. Like every other M.Sc. programme, M.Sc. microbiology has its own set of different syllabi, which students must cover before they are allowed to obtain postgraduate degree.

The New Education policy presents an opportunity to shift paradigm from a teacher – centric to student centric higher education system in India. It caters for skill-based education. The learning outcomes-based curriculum framework for a degree in M. Sc. Microbiology is intended to provide a comprehensive foundation to the subject and to help students develop the ability to successfully continue with further studies and research in the subject while they are equipped with required skills at various stages. Efforts have been made to integrate use of recent technology in teaching and learning. The syllabus is designed to equip students with valuable cognitive abilities and skills so that they are successful in meeting diverse needs of professional careers in a developing and knowledge-based society. The curriculum considers the need to maintain globally competitive standards of achievement in terms of knowledge and skills in Microbiology as well as develop scientific orientation, problem solving skills, human and professional values which foster rational and critical thinking in the students. This course serves a good opportunity in different fields in Microbiology.

By the end of the program, students will be able to:

- Acquire knowledge and gain understanding of concepts in microbiology and its applications in pharmaceuticals, food, agriculture, industries, and medical fields.
- Understand the distribution, morphology and physiology of microorganisms and demonstrate the skills in aseptic handling of microorganisms including isolation, identification, and maintenance.
- Competent to apply the knowledge gained for conserving the environment and resolving environment related issues.
- Learning, practicing professional skills in handling microbes and contaminants in laboratories and production sectors.
- Exploring the microbial world and analyzing the specific benefits and challenges.
- Applying the knowledge acquired to understand studies and identify specific remedial measures for the challenges in health, agriculture, and food sectors.
- Through knowledge and application of good laboratory and good manufacturing practices in microbial quality control.
- Understanding biochemical and physiological aspects of microbes and developing broader perspective to identify innovative solutions for present and future challenges posed by microbes.
- Understanding and application of microbial principles in forensic and working knowledge about clinical microbiology.
- Demonstrate the ability to identify ethical issues related to recombinant DNA technology, GMOs, intellectual property rights, Biosafety, and biohazards.
- Demonstrate the ability to identify key questions in microbiological research, optimize research methods, and analyze outcomes by adopting scientific methods, thereby improving the

employability of microbiology students.

- Enhance and develop analytical skills and apply basic computational and statistical techniques in the field of microbiology.

In addition to these Program Educational Objectives, for each course of postgraduate program, objectives and expected outcomes from learner's point of view are also included in the curriculum to support the philosophy of outcome-based education. I believe strongly that small step taken in right direction will definitely help in providing quality education to the stake holders.

Dr. Santosh M. More
Chairman, Board of Studies of the Microbiology
Swami Ramanand Teerth Marathwada University, Nanded

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Details of the Board of Studies Members in the subject Microbiology under the faculty of Science & Technology of S.R.T.M. University, Nanded

Sr No	Name of the Member	Designation	Address	Contact No.
1.	Dr. Santosh M. More	Professor & BOS, Chairman	YeshwantMahavidyalaya, Nanded	9422871533
2.	Dr. Rajendraprasad S. Awasthi	Principal	Shivaji Mahavidyalaya, Renapur	8275924462
3.	Dr. Prashant Wakte	Professor	DSM's College of Arts, Commerce and Science, Parbhani	8669062962
4.	Dr. Anupama P. Pathak	Professor	School of Life Sciences, SRTM University Nanded	9404732162
5.	Dr. Shiva C. Aithal	Professor	DSM's College of Arts, Commerce and Science, Parbhani	9421085167
6.	Dr. Deepak Vedpathak	Professor	Rajarshi Shahu Mahavidyalaya, Latur	9822757890
7.	Dr. Sanjivkumar V. Kshirsagar	Assistant Professor	SantJanabai Education Society's ACS College, Gangakhed	9421448741
8.	Dr. Hemlata J. Bhosle	Associate Professor	School of Life Sciences, SRTM University Nanded	8698809434
9.	Dr. Sunita Mukkawar	Assistant Professor	B. Raghunath ACS College, Parbhani	9422415911
10.	Dr. Ravindra R. Rakh	Assistant Professor	Shri Guru Buddhiswami Mahavidyalaya, Purna	9545335680
11.	Dr. Prashant P. Dixit	Associate Professor	Dr. B.A.M. Uni. Aurangabad, Sub-camps, Osmanabad	9421335704
12.	Dr. M. K. Ranjekar	Director	Green Vitlas Biotech, Ranje Village, Pune	9422015217
13.	Dr. Prita S. Borkar	Associate Professor	Science College, Nanded	9921121194
14.	Dr. Abhay B. Solunke	Associate Professor	Shri Govindrao Munghate Arts & Science College, Kurkheda, Gadchiroli	9403579999
15.	Dr. M. S. Dharne	Principal Scientist	National Collection of Industrial Microorganisms, CSIR- NCL, Pune	9730257991

Guidelines for Course Assessment

A. Continuous Assessment (CA) (20% of the Maximum Marks):

This will form 20% of the Maximum Marks and will be carried out throughout the semester. It may be done by conducting **Two Tests** (Test I on 40% curriculum) and **Test II** (remaining 40% syllabus). Average of the marks scored by a student in these two tests of the theory paper will make his **CA** score(col 6).

B. End Semester Assessment (80% of the Maximum Marks):

(For illustration we have considered a paper of 04 credits, 100 marks and need to be modified depending upon credits of an individual paper)

1. **ESA Question paper will consists of 6 questions, each of 20 marks.**
2. **Students are required to solve a total of 4 Questions.**
3. **Question No. 1 will be compulsory and shall be based on entire syllabus.**
4. Students need to solve **ANY THREE** of the remaining Five Questions (Q.2 to Q.6) and shall be based on entire syllabus.

Note: Number of lectures required to cover syllabus of a course depends on the number of credits assigned to a particular course. One credit of theory corresponds to 15 Hours lecturing and for practical course one credit corresponds to 30 Hours. For example, for a course of two credits 30 lectures of one hour duration are assigned, while that for a three credit course 45 lectures.

****

Abbreviations:

1. **DSC:** Department/Discipline Specific Core (Major)
2. **DSE:** Department/Discipline Specific Elective (Major)
3. **DSM:** Discipline Specific Minor
4. **GE/OE:** Generic/Open Elective
5. **VSC:** Vocational Skill Course
6. **SEC:** Skill Enhancement Course
7. **AEC:** Ability Enhancement course
8. **ENG:** English Compulsory
9. **MIL:** Modern Indian languages
10. **IKS:** Indian Knowledge System
11. **VEC:** Value Education Course
12. **OJT:** On Job Training (Internship/Apprenticeship)
13. **FP:** Field Projects
14. **CEC:** Community Engagement and Service Courses
15. **CC:** Co-Curricular Courses
16. **RM:** Research Methodology
17. **RP:** Research Project/ Dissertation

Swami Ramanand Teerth Marathwada University, Nanded

Faculty of Science & Technology

Credit Framework for Two Year PG Program

Subject: Microbiology

Year & Level	Sem.	Major Subject		RM	OJT / FP	Research Project	Practicals	Credits	Total Credits
		(MIC)	(DSE)						
Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10
1	1	SMICC1401 (4 Cr) SMICC1402 (4 Cr) SMICC1403 (4 Cr)	SMICE1401 (3 Cr)	SVECR1401 *Research Methodology* (3 Cr)	--		SMICP1401 (1Cr) SMICP1402 (1Cr) SMICP1403 (1Cr) SMICEP1401 (1Cr)	22	44
	2	SMICC1451 (4 Cr) SMICC1452 (4 Cr) SMICC1453 (4 Cr)	SMICE1451 (3 Cr)	---	SMICOJ1451 (3 Cr)	--	SMICP1451 (1Cr) SMICP1452 (1Cr) SMICP1453 (1Cr) SMICEP1451(1Cr)	22	
Exit option: Exit Option with PG Diploma *(After 2024-25)*									
2	3	SMICC1501 (4Cr) SMICC1502 (4Cr) SMICC1503 (4Cr)	SMICE1501 (4Cr) (*From same Department / School)*	--		Research Project SMICR1551 (4 Cr)	SMICP1501(1Cr) SMICEP1501(1Cr)	22	44
	4	SMICC1551(4Cr) SMICC1552 (4Cr)	SMICE1551 (4 Cr) (*From same Department / School)*	SVECP1551 Publication Ethics (2 Cr)		Research Project SMICR1552 (6 Cr)	SMICP1551 (1Cr) SMICEP1551 (1Cr)	22	
Total		44	14	05	03	10	12	88	

M. Sc. Second Year Semester III

(Teaching Scheme)

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/week)	
			Theory	Practical	Total	Theory	Practical
Major	**SMICC1501**	Environmental and Agricultural Microbiology	04	--	**04**	04	--
	SMICC1502	Molecular Immunology and Human Microbiome	04	--	**04**	04	--
	SMICC1503	Molecular Biology and rDNA Technology	04	--	**04**	04	--
Elective (DSE)	**SMICE1501**	Pharmaceutical Microbiology (Besides M.Sc. Micro students this paper is Elective for all Life Science students)	04	--	**04**	03	--
Research Project	**SMICR1551**	Research Project	--	--	**04**		
MIC Practical	**SMICP1501**	Lab 1 Course (Practicals based on Course SMICC1501)	--	01	**01**	--	02
	SMICEP1501	Lab 2 Course (Practicals based on Course SMICE1501)	--	01	**01**	--	02
Total Credits			**16**	**02**	**22**	**15**	**04**

M. Sc. Second Year Semester III

(Examination Scheme)

[20% Continuous Assessment (***CA***) and 80% End Semester Assessment (***ESA***)]

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA)			ESA			
			Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)	Total (7)	CA (8)	ESA (9)	
Major	SMICC1501	Environmental and Agricultural Microbiology	20	20	20	80	--	--	100
	SMICC1502	Molecular Immunology and Human Microbiome	20	20	20	80	--	--	100
	SMICC1503	Molecular Biology and rDNA Technology	20	20	20	80	--	--	100
Elective (DSE)	SMICE1501	Pharmaceutical Microbiology (Besides M.Sc. Micro students this paper is Elective for all Life Science students)	20	20	20	80	--	--	100
Research		Research Project							
MIC Practical	SMICP1501	Lab 1 Course (Practicals based on Course SMICC1501)	--	--	--	--	05	20	25
	SMICEP1501	Lab 2 Course (Practicals based on Course SMICE1501)	--	--	--	--	05	20	25

M. Sc. Second Year Semester IV

(Teaching Scheme)

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	**SMICC1551**	Advanced Enzyme Technology	04	--	**04**	04	--
	SMICC1552	Advances in Virology	04	--	**04**	04	--
Elective (DSE)	**SMICE1551**	Medical Laboratory Technology (MLT) (Besides M.Sc. Micro students this paper is Elective for all Life Science students)	04	--	**04**	04	--
RM	**SVECP1551**	Publication Ethics	02	--	**02**	03	
Research Project	**SMICR1552**	Research Project	--	--	**06**		
MIC Practical	**SMICP1551**	Lab 1 Course (Practicals based on Course SMICC1551)	--	01	**01**	--	02
	SMICEP1551	Lab 2 Course (Practicals based on Course SMICE1551)	--	01	**01**	--	02
Total Credits			**14**	**02**	**22**	**15**	**04**

M. Sc. Second Year Semester IV

(Examination Scheme)

[20% Continuous Assessment (***CA***) and 80% End Semester Assessment (***ESA***)]

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA)			ESA			
			Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)	Total (7)	CA (8)	ESA (9)	
Major	**SMICC1551**	Advanced Enzyme Technology	20	20	20	80	--	--	100
	SMICC1552	Advances in Virology	20	20	20	80	--	--	100
Elective (DSE)	**SMICE1551**	Medical Laboratory Technology (MLT) (Besides M.Sc. Micro students this paper is Elective for all Life Science students)	20	20	20	80	--	--	100
RM	**SVECP1551**	Publication Ethics	15	15	15	60	--	--	75
Research Project	**SMICR1552**	Research Project							
MIC Practical	**SMICP1551**	Lab 1 Course (Practicals based on Course SMICC1551)	--	--	--	--	05	20	25
	SMICEP1551	Lab 2 Course (Practicals based on Course SMICE1551)	--	--	--	--	05	20	25

Course Structure for SMICC1501

Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SMICC1501	Environmental and Agricultural Microbiology	04	--	04	--	04

Assessment Scheme

Course Code (2)	Course Name (3)	Theory				Practical		Total [Col (6+7) / Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg. of (T1+T2)/2 (6)		CA (8)	ESA (9)	
SMICC1501	Environmental and Agricultural Microbiology	20	20	20	80	--	--	100

Swami Ramanand Teerth Marathwada University Nanded
Faculty of Science and Technology
M. Sc. Second Year (Semester – III)
Discipline Specific Core Course: Microbiology
Course Name: Environmental and Agricultural Microbiology
Course Code: SMICC1501
Credits: 04 (Marks: 100) **Periods: 60**

Course Pre-requisite:

The course is offered for a student who has completed **Bachelor's Degree-Honors or Bachelor's Degree-Honors with Research (Level 6.0).**

Course Objectives and Outcome:

- To know the complex interaction between agriculture system and micro-organism
- Students gain knowledge on the importance and applications of biofertilizers and beneficial microbes
- Students understand the role of microorganisms in biodegradation of Recalcitrant/Xenobiotic
- Understand the role of microorganisms as agents of environmental change
- Recognize microorganisms as indicators of alteration of an ecosystem

Module No.	Unit No.	Topic	Hrs. Required to cover contents
1.0	I	**Environmental Microbiology-I**	**15**
	1.1	Definition of Ecosystem, Biotic Environment, Abiotic Environment. Environmental Segments: Composition and Structure. Ecosystem: Characteristics, Structure and Function	
	1.2	Development of microbial ecology and emergence of field of environmental microbiology, significant applications of microbes in solving environmental pollution problems.	
	1.3	Global Environmental Problems (Brief): Role of Agricultural fertilizers, Nitrous oxide in the ozone layer, Eutrophication, Global Warming, Green house effect, Heavy Metal Toxicities to Microorganisms, Pesticides Pollution.	
	1.4	Global impacts of: Microbial Water Pollution and Sanitation, Contamination of Air, Water, Food and Soil, Destruction and Invasion of Biodiversity, Climate Change	
2.0	II	**Environmental Microbiology-II**	**15**
	2.1	Microbial diversity in extreme environments: Occurrence, diversity, adaptations and potential biotechnological applications of Oligotrophs, Thermophiles, Psychrophiles and Radiation tolerants, Metallophiles, Acidophiles, Alkaliphiles and Halophiles.	
	2.2	Bioremediation of Xenobiotics: Introduction to Recalcitrant/Xenobiotic compounds, Microbiology of degradation of Xenobiotics in the environment, Ecological considerations.	
	2.3	Concept of Biomagnification, Pollution of Oil, Surfactants and Pesticides. Genetically Modified Organisms released and its environmental impact assessment and ethical issues.	

3.0	III	**Agricultural Microbiology-I**	
	3.1	History and development of agricultural microbiology. Microbiota of soil, Interrelationship between soil microorganisms and higher plants.	**15**
	3.2	Carbon circulation on Earth and Microorganisms, Nitrogen circulation on Earth and Bacteria, Sulfur Circulation on Earth and Bacteria, Oxidation and Reduction of Iron by Bacteria,	
	3.3	Plant microbiome: Benefits, function, and biotechnological applications. Importance of microorganisms for agriculture: beneficial and pathogenic.	
	3.4	Diseases and symptoms of Plant pathogenic microorganisms: Algal, Fungal, Bacterial, Viral, Mycoplasma, Nematode (one example each). Mode of entry of pathogens and factors affecting disease incidence, Plant disease resistance and Microbiological control of plant pathogens.	
4.0	IV	**Agricultural Microbiology-II**	
	4.1	Composting: Composting, Methods of Production, Composting Process, Optimal Composting, Types of Compost: Farm Yard Manure, Town Compost, Vermicompost, Green Manure, Applications of Compost	**15**
	4.2	Biofertilizers: Types of Biofertilizers, Production and Innoculation of Bio-fertilizers, Types of Innoculants, Methods of Applications for Bio-fertilizer, Quality Control of Bio-fertilizers, Applications of Bio-fertilizers Large Scale formulation of Bio-fertilizers. Biopesticides: Types and Applications	
	4.3	Microbiology for sustainable agriculture: Techniques employed in creating Transgenic Crops, Plant Improvement Techniques. Engineering Disease Resistance in Plants, Transgenic Plants Resistant to Microbial Pathogens, Virus Assays: Detection and Diagnosis, Genetically Modified Foods.	
	4.4	Microbial inoculants: Biotechnological solutions for agriculture	
		Total	**60**

References:

1. Modern Approaches in Soil, Agriculture and environmental Microbiology, by Shiva Aithal and Kulkarni N.S., Himalaya publishing house, Nagpur. ISBN: 978-81-8488-956-7.
2. Chemolithoautotrophic Bacteria- Biochemistry and Environmental Biology by Tateo Yamanaka. Springer Publications. ISBN: 978-4-431-78540-8.
3. Himalaya's Essentials of Agricultural Microbiology by Shiva C. Aithal and Pooja R. Kakde. Himalaya Publishing House. ISBN: 978-935840-568-2.
4. A Manual of Environmental Microbiology. 2nd Edition. 2001 by Christon J. Hurst (Chief Editor), ASM Publications.
5. Advances in Waste Water Treatment Technologies. 1998. Volumes II and I by R. K. Trivedy. Global Science Publication.
6. Basic Principles of Geomicrobiology by A. D. Agate, Pune.

7. Biocatalysis and Biodegradation: Microbial transformation of organic compounds. 2000 by Lawrence P. Wacekett, C. Douglas Hershberger. ASM Publications.
8. Bioremediation by Baker K.H. And Herson D.S. 1994. MacGraw Hill Inc. N.Y.
9. Chemistry and Ecotoxicology of pollution. Edited by Des. W. Connell, G.J. Miller. WileyInterscience Publications.
10. Environmental Biotechnology by C. F. Forster and D.A., John Wase. Ellis Horwood Ltd. Publication.
11. Environmental Microbiology by Ralph Mitchell. A John Wiley and Sons. Inc.
12. Pollution: Ecology and Biotreatment by Ec Eldowney, S. Hardman D.J. and WaiteS. 1993. - Longman Scientific Technical.
13. Waste Water Engineering - Treatment, Disposal and Re-use by Metcalf and Eddy, Inc., Tata MacGraw Hill, New Delhi.
14. Waste Water Microbiology 2nd Edition by Bitton.

Course Structure for SMICP1501

(Practicals based on Course SMICC1501: Environmental and Agricultural Microbiology)

Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SMICP1501	Lab 1 Course (Practicals based on Course SMICC1501)	--	02	--	01	01

Assessment Scheme

Course Code (2)	Course Name (3)	Theory				Practical		Total [Col (6+7) / Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg. of (T1+T2)/2 (6)		CA (8)	ESA (9)	
SMICP1501	Lab 1 Course (Practicals based on Course SMICC1501)	--	--	--	--	05	20	25

Swami Ramanand Teerth Marathwada University Nanded
Faculty of Science and Technology
M. Sc. First Year (Semester-III)
Discipline Specific Core Course: Microbiology
Course Name: Lab 1 Course
(Practicals based on Course SMICC1501: Environmental and Agricultural Microbiology)
Course Code: SMICP1501

Credits: 01 **Marks: 25**

1. Isolation and enumeration of bacteria, actinomycetes and fungi from agricultural soil.
2. Microscopic observation by root colonization by VAM fungi.
3. Isolation and enumeration of Phosphate solubilizers.
4. Demonstration of different bioferlizers and biopesticides types,formulation and application methods.
   Management of common organic waste by Composting Process using microbial inoculants.
5. Isolation of Physical analysis of sewage/industrial effluent by measuring total solids, total dissolved solids and total suspended solids.
6. Determination of indices of pollution by measuring BOD/COD of different effluents.
7. Bacterial reduction of nitrate from ground waters.
8. Recovery of toxic metal ions of an industrial effluent by immobilized cells.
9. Utilization of microbial consortium for the treatment of solid waste [Municipal Solid Waste].
10. Tests for the microbial degradation products of aromatic hydrocarbons /aromatic compounds.
11. Microbial dye decolourization/adsorption.

Course Structure for SMICC1502

Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SMICC1502	Molecular Immunology and Human Microbiome	04	--	04	--	04

Assessment Scheme

Course Code (2)	Course Name (3)	Theory				Practical		Total [Col (6+7) / Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg. of (T1+T2)/2 (6)		CA (8)	ESA (9)	
SMICC1502	Molecular Immunology and Human Microbiome	20	20	20	80	--	--	100

Swami Ramanand Teerth Marathwada University Nanded
Faculty of Science and Technology
M. Sc. First Year (Semester-III)
Discipline Specific Core Elective Course: Microbiology
Course Name: Molecular Immunology and Human Microbiome
Course Code: SMICE1502
Credits: 04 (Marks: 100) **Periods: 60**

Course Pre-requisite:

The course is offered for a student who has completed **Bachelor's Degree-Honors or Bachelor's Degree-Honors with Research (Level 6.0).**

Course Objectives and Outcomes:

- This course will introduce the structure and function of the families of molecules employed by the immune system to recognize and initiate a responses to antigen.
- To provide an essential grounding for the understanding of the complex cellular interactions of the immune response.
- To help students will to think strategically about developmental aspects of immunity.
- To characterize the human microbiome and analyze its role in human health and disease.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0	I	**Organs and Cells of Immune System**	**15**
	1.1	Primary lymphoid organs - thymus, bone morrow - structure and function. Lymphatic system - transporter of antigen- introduction. Secondary lymphoid organs-spleen and lymph nodes structure and functions. Mucosal associated lymphoid tissue, (MALT) - tonsils. Cutaneous associated lymphoid tissue – keratinocytes and Langerhans cells - Location and immunological functions.	
	1.2	Lymphoid cells - B-lymphocytes and T-lymphocytes- maturations, activation and differentiation. Receptor on B and T cells. Null cells. γδ T cells – Intraepithelial lymphocyte (IEL)- function, Mesangial cells, Microglial cells - Structures and secretions - interleukin I, hydrolytic enzymes, complement proteins, α-Interferon, Tumor necrosis factor α (TNF-α) (IL-6, GM-CSF, G-CSF, M-CSF).	
	1.3	Growth factors associated in haematopoiesis, Granulocytes -Neutrophile, Basophile, Eosinophile -immune response generated against parasite by granulocytes.	
	1.4	Mast cell - Structure, function in innate immunity and acquired immunity. Dendritic cell - structure and function.	
2.0	**II**	**Immunogens and Immunoglobulins**	**15**
	2.1	Immunogens: Types and General properties of antigens. Haptens, Superantigens and Adjuvants. Depot effect, Macrophage activation, Effect of lymphocyte, antitumor action. Epitopes: A.A. sequence /structure.	
	2.2	Immunoglobulins: Classes, Structure, distribution and function. Isotypic, Allotypic, Idiotypic determinants. Idiotype network. Antibody production	

		theories.	
	2.3	Genetic model for Ig structure, Germ line and somatic variation models, Dryer and Bennett two gene models, K chain genes, λ chain genes, Heavy chain genes, VH gene segments,	
	2.4	Gene rearrangement in VH region, Mechanism of variables region DNA rearrangement. Generation of antibody diversity, Regulation of Ig gene transcription	
3.0	**III**	**Histocompatibility Complexes and Clinical Immunology**	**15**
	3.1	MHC class-I, MHC class-II - Structure of molecules, gene organization. Genetic polymorphism of molecule, Peptide interaction with molecule, MHC and immune responsiveness, MHC and susceptibility to infectious diseases, Minor MHA - structure, role and genetics, HLA system, Antigen processing and presentation.	
	3.2	Hypersensitivity, Immunology of Tumors, Immunodeficiency diseases, autoimmune diseases, Immunomodulation/Immunological tolerance.	
	3.3	Transplant immunology at a glance: Organ donors, Biology of graft. Immunology of organ transplantation, Histocompatibility in transplantation. Concept of Xenotransplantation.	
4.0	**IV**	**Human Microbiome**	**15**
	4.1	The microbiota of: Human Skin, Oral Cavity, Respiratory system, Gastrointestinal tract, Genitourinary system, reproductive system.	
	4.2	Gut-brain axis, The gut microbiota in health and diseases.	
	4.3	Manipulation of microbiota using prebiotics, probiotics and fecalmicrobiota transplantation.	
		Total	**60**

References:

1. Kuby Immunology (2018) 8th ed., Punt J, Stranford S, Jones P and Owen JA, W.H Freemanand Company, ISBN: 978-1319114701.
2. Janeway'sImmunobiology (2017) 9th ed., Murphy KM and Beaver C, WW Norton and Company, ISBN: 978-0815345510.
3. Roitt's Essential Immunology (2017) 13th ed., Delvis PJ, Martin SJ, Burton DR and Roitt, IM, Wiley-Blackwell, ISBN: 978-1118415771
4. A handbook of practical immunology by G. P. Talwar, Vikas Publishing House, New Delhi.
5. Diet, Microbiome and Health (2018) 1st ed., Holban AM, Grumezescu AM. Academic Press(New York), ISBN: 9780128114407.
6. The Human Microbiota in Health and Disease-An Ecological and Community-based Approach(2018) by Mike Wilson. CRC Press. ISBN:9781351068345, 1351068342
7. Microbiota of the Human Body-Implications in Health and Disease (2016) by Andreas Schwiertz (Ed.). Springer International Publishing. ISBN:9783319312484, 3319312480.
8. The Human Microbiome Handbook (2016). Emma Allen-Vercoe, Jason Tetro (Ed.). DEStech Publications, Incorporated. ISBN:9781605951591, 1605951595
9. The Human Microbiota and Microbiome(2014). Julian Marchesi (Ed.). CABI. ISBN:9781780640495, 1780640498

Course Structure for SMICC1503

Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SMICC1503	Molecular Biology and rDNA Technology	04	--	04	--	04

Assessment Scheme

Course Code (2)	Course Name (3)	Theory				Practical		Total [Col (6+7) / Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg. of (T1+T2)/2 (6)		CA (8)	ESA (9)	
SMICC1503	Molecular Biology and rDNA Technology	20	20	20	80	--	--	100

Swami Ramanand Teerth Marathwada University Nanded
Faculty of Science and Technology
M. Sc. Second Year (Semester-III)
Discipline Specific Core Course: Microbiology
Course Name: Molecular Biology and rDNA Technology
Course Code: SMICC1503
Credits: 04 (Marks: 100) **Periods: 60**

Course Pre-requisite:

The course is offered for a student who has completed **Bachelor's Degree-Honors or Bachelor's Degree-Honors with Research (Level 6.0).**

Course Objectives and Outcomes:

- To understand the importance of recombinant DNA technology.
- To learn isolation of DNA and its separation on an agarose gel.
- To understand restriction and ligase enzymes and their application in gene cloning.
- To understand vectors and their application in gene cloning and expression.
- To understand polymerase chain termination reaction (PCR).

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0	I	**Basic tools of rDNA Technology**	**15**
	1.1	Enzymes used with their types, mode of activity and examples: Nucleases- Exonucleases (BAL 31 nuclease, Exonuclease I, III), Endonucleases- Restriction endonucleases type I, II, III, restriction modification system: nomenclature and classification of type II endonucleases (S1 nuclease). DNA polymerase (*E. coli* DNA pol. I, T7 DNA Pol., Klenow fragments, Thermostable DNA Pol., Terminal Transferase and Reverse Transcriptase). DNA ligation (Linkers and Adaptors). DNA Manipulating enzymes (Polynucleotide kinase, Phosphatase, Methylase,Topoisomerase and Ribonucleases).	
	1.2	Cloning Vectors (their structure, genealogy and derivatives): Plasmids (pBR 322 and pUC18). Bacteriophage lambda (λ), Cosmids, Phasmids and Phagemids as vectors. Artificial chromosome vectors (YACs, BACs, PACs, and MACs). Animal virus derived vectors, SV40 vaccina/bacculo and retroviral vectors. Expression vectors, Shuttle vectors, Integrative vectors.	
	1.3	Gene probes: development and labeling of DNA and RNA probes	
2.0	II	**Nucleic acid amplification, Sequencing and Hybridization Techniques**	**15**
	2.1	Polymerase Chain Reaction (PCR)- Primer design, fidelity of thermal enzymes, DNA polymerase, variations in PCR and its applications. PCR in gene recombination, deletion, addition, overlap extension and	

		SOEing, site specific mutagenesis, PCR based mutagenesis, PCR in molecular diagnostics, viral and bacterial detection.	
	2.2	Methods of nucleic acid detection, sequencing methods (enzymatic DNA sequencing, chemical DNA sequencing, principles of automated DNA sequencing, RNA sequencing, thermal cycle dideoxy DNA sequencing, and pyrosequencing).	
	2.3	Methods of nucleic acid hybridization (Southern blotting, Northern blotting, in situ hybridization). DNA fingerprinting, chromosome walking and jumping.	
3.0	III	**Cloning and Screening methodologies**	
	3.1	Insertion of foreign DNA into the host cells: transformation, transfection: chemical and physical method, liposomes, microinjection, electroporation, biolistic, somatic cell fusion, gene transfer by pronuclear microinjection	
	3.2	Cloning and expression in yeast (*Saccharomyces*, and pichia), animal and plant cells. Plant transformation technology: Basic of tumor formation, hairy root, features of Ti and Ri plasmids, mechanism of DNA transfer, role of virulence gene, use of Ti and Ri as plasmids vectors. Factors affecting expression in plants and animal cells, strategies to create knockout (KO) cells and transgenic animals.	**15**
	3.3	cDNA and genomic cloning, expression cloning, jumping and hopping libraries, phage display. Construction of cDNA and genomic DNA libraries. Screening libraries with gene probes, colony hybridization, plaque hybridization, screening by gain of function, immunological screening.	
4.0	**IV**	**Applications of rDNA technology and Legal issues**	
	4.1	Molecular Markers- types and applications. Construction of molecular maps (genetic and physical maps). DNA chip Technology and Microarrays (a brief account).	
	4.2	Applications of recombinant DNA technology in medicine, agriculture, Forensic and veterinary sciences.	
	4.3	Engineering microbes for the production of antibiotics, enzymes, Insulin, growth hormones, monoclonal antibodies etc. Human genetic engineering and Gene therapy- methods of gene therapy, gene therapy in treatment of diseases, Stem cell therapy, Future of stem cell therapy, gene targeting. Gene silencing in bacteria. CRISPR-Cas systems for editing and targeting genome.	**15**
	4.4	Science and the constitution- ethical, legal and environmental issues associated with rDNA Technology.	
		Total	**60**

References:

1. DNA cloning: A practical approach by D.M. Glover and D.D. Harmes, RL press, Oxford 1995.
2. Essentials of molecular biology vol. I (A Practical Approach) by Brown T.A., IRL press Oxford. 1995.
3. From Gene to Clone by E. L. Winnacker.
4. Genetic engineering, principles and practice, by Sandhya Mitra. Macmillan India Ltd.
5. Genome mapping and sequencing by Ian Dunham. Horizon Scientific press.
6. Manipulation and expression of Recombinant DNA. Robertson.
7. Methods in enzymology gene expression technology by D.A Godgel. Academic press Inc, San Diego.

8. Methods in enzymology guide to molecular cloning techniques, vol. 152 S. L. Berger. Academic press .Inc, san Diegn, 1996.
9. Molecular biotechnology (2nd edition), by S.B. Primrose, Blackwell Scientific publishers, Oxford.
10. Molecular biotechnology: principles and application of Recombinant DNA II by Bernard R. Glick and J. Pastemak, ASM publication.
11. An introduction to genetic engineering (2nd edition) by Nicholl D.S.T., Cambridge University press, Cambridge, U.K.
12. PCR application. Protocol for functional genomics by Michael A. Innis. David H., Gelfand John J. Sninsky, Academic Press.
13. PCR technology- principles and application for DNA amplification by Henry A Erilch (Ed) Stockton Press. 1989.
14. Route maps in gene technology by M.R. Walker and R. Rapley, Blackwell science, Oxford.
15. Molecular cloning by Sambrook J, Fritsch E.F and Maniatis, cold spring harbor laboratory press, New York.
16. Principles of Gene Manipulation and Genomics, Third Edition. S.B. Primrose, S.B. and R.M. Twyman, Blackwell Publishing Company, Oxford, UK. 2006
17. Gene Cloning and DNA Analysis: An Introduction. Fifth Edition. T.A. Brown, Wiley Blackwell, UK. 2006.
18. Ethics of Emerging Technologies: Scientific Facts and Moral Challenges. John Wiley and Sons Inc. Thomas F. Budinger and Miriam D. Budinger. 2006.

Course Structure for Discipline Specific Elective Course SMICE1501

Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SMICE1501	Pharmaceutical Microbiology	04	--	04	--	04

Assessment Scheme

Course Code (2)	Course Name (3)	Theory				Practical		Total [Col (6+7)/ Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg. of (T1+T2)/2 (6)		CA (8)	ESA (9)	
SMICE1501	Pharmaceutical Microbiology	20	20	20	80	--	--	100

Swami Ramanand Teerth Marathwada University Nanded
Faculty of Science and Technology
M. Sc. Second Year (Semester-III)
Discipline Specific Core Course: Microbiology
Course Name: Pharmaceutical Microbiology
Course Code: SMICE1501
Credits: 04 (Marks: 100) **Periods: 60**

Course Pre-requisite:

The course is offered for a student who has completed **Bachelor's Degree-Honors or Bachelor's Degree-Honors with Research (Level 6.0).**

Course Objectives and Outcomes:

- To acquire the knowledge about mechanism of action of antibiotics, synthetic antimicrobial agents.
- To able to perform evaluation of microbial production and spoilage of pharmaceutical products.
- To comprehend the government regulatory practices, application of biosensor and microbial enzyme in pharmaceuticals.
- To able to recognise good manufacturing practices and good laboratory practices.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0	I	**Pharmaceutical Industry at Glance**	**15**
	1.1	Different work functions in pharmaceutical Industry: Quality assurance (QA), Manufacturing, quality control (QC) and engineering functions), Good manufacturing practices (GMP) and Good laboratory practices (GLP) in pharmaceutical industry.	
	1.2	Roles and regulations of different Regulatory guidelines (Brief) EU, MHRA, US-FDA, ISO, WHO at glance, different stages of clinical trials, Microbiological analysis of pharmaceutical water, importance sterility of products, supply chain.	
	1.3	Chemical and biochemical indicators. Design and layout of sterile product manufacturing unit. Designing of microbiology laboratory.	
2.0	II	**Microbial and Cell culture Fermentation in pharmaceutical Industry**	**15**
	2.1	Advances and use of different cell lines (CHO, Insect and Yeast) in production of different biopharmaceutical products, metabolic pathways in CHO cell line (Glycolysis and Glycosylation), types of monoclonal antibodies and its mode of action.	
	2.2	Different modes of sterilization (heat sterilization, D value, z value, survival curve, radiation, gaseous and filter sterilization).	
	2.3	Types of bioreactors in Pharma Lab, their design and work functions (Glass bioreactors, Stainless steel bioreactors), modes of fermentation in details (Fed-batch fermentation and Perfusion mode), Use of ATF (Alternate tangential flow filtration) and its importance in cell retention to increase the product, What is Scale up approach.	
	2.4	Pharmaceuticals produced by microbial fermentations: Growth factor	

		(Recombinant Insulin) and Enzymes (Urokinase and Streptokinase).	
3.0	III	**Advances and scope in pharmaceutical industry**	**15**
	3.1	Microbial production of pharmaceutical products (sterile injectable, non injectable, ophthalmic preparation and implants). Manufacturing procedure and in process control of pharmaceuticals.	
	3.2	Current developments in Single use technology in healthcare (Single Use Bioreactor, other accessories required in sterile operation (Biowelder, samping bags, media bags, sterile conncetors, etc).	
	3.3	New vaccine technology: DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines.	
	3.4	Government regulatory practices and policies, FDA perspective and legislative perspective. Rational drug design.	
4.0	**IV**	**Pharmaceutical Therapeutics**	**15**
	4.1	Importance of microbiology in pharmaceutical industry, Different sectors and different product range (sterile injectable, non injectable, ophthalmic preparation and implants) of pharmaceutical industry (dermatology, cardiology, opthalmology, vaccines and oncology).Importance of literature review in research and development (R&D) in industry.	
	4.2	Antibiotics (Penicillin) and synthetic antimicrobial agents (sulphonamides), Antifungal antibiotics, antitumour substances. Peptide antibiotics. Chemical disinfectants, antiseptics and preservatives.	
	4.3	Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis). Drug delivery system in gene therapy. Bacterial resistance to antibiotics. Mode of action of bacterial killing.	
	4.4	What are vaccines and its diverse range, Active Pharmaceutical Ingredients - API (Differnet types of Antibiotics and insulin).Current developments in Biosimilars (Monoclonal Antibodies), Development in Gene therapy and mode of action, Recombinant protein expression system in *E.Coli.*	
		Total	**60**

References:

1. A Handbook on Fundamental Concepts in Pharmaceutical Industry by Prem Swaroop
2. Good Manufacturing Practices for Pharmaceuticals, Seventh Edition by Graham P Bunn.
3. Quality Assurance Of Pharmaceuticals: A Compendium Of Guidelines And Related Materials:V. 1
4. Bioreactors: Animal Cell Culture Control For Bioprocess Engineering by Barua, Alok; Saha, Goutam; Sinha, Satyabroto. Publisher: CRC Press, Year: 2015. ISBN: 978-1-4987-3601-5,1498736017
5. Pharmaceutical Biotechnology by Adalberto Pessoa, Michele Vitolo, Paul Frederick Long
6. Biopharmaceuticals: Biochemistry and Biotechnology By Walsh G.
7. Multinational Pharmaceutical Companies: Principles And Practices By Bert Spilker
8. Handbook of Pharmaceutical Manufacturing Formulations.
9. Drugs And Pharmaceutical Industry By D. K. Mittal · 1993
10. Advances In Biochemistry And Biotechnology by Dr. A.K. Verma, Dr. Wahied khawarbalwan. Publisher By : Amiga Press
11. Single-Use Technology In Biopharmaceutical Manufacture, 2nd Edition (Wiley). Regine Eibl and Dieter Eibl (editor).
12. Disposable Bioprocessing Systems By Sarfaraz K. Niazi, Sarfaraz Niazi · 2011

Course Structure for SMICEP1501

(Practicals based on Course SMICE1501: Pharmaceutical Microbiology)

Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme(Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SMICEP1501	Lab 2 Course (Practicals based on Course SMICC1501)	--	02	--	01	01

Assessment Scheme

Course Code (2)	Course Name (3)	Theory				Practical		Total [Col (6+7)/ Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg. of (T1+T2)/2 (6)		CA (8)	ESA (9)	
SMICEP1501	Lab 2 Course (Practicals based on Course SMICE1501)	--	--	--	--	05	20	25

Swami Ramanand Teerth Marathwada University Nanded
Faculty of Science and Technology
M. Sc. Second Year (Semester-III)
Discipline Specific Core Course: Microbiology
Course Name: Lab 2 Course
(Practicals based on Course SMICE501: Pharmaceutical Microbiology)
Course Code: SMICEP1501

Credits: 01 **Marks: 25**

1. Differentiation and demonstrate the air quality in laboratory and Laminar Air Flow Unit by using simple Soybean Casein Digest Agar (SCDA) plates.
2. Preparation and filtration of any media and its storage to 2 to 4 days to validate the sterility check before using the media.
3. Demonstration of different types of antibiotic effect on *E.coli* / different culture.
4. Microbial production and Bioassay of Penicillin.
5. Bioassay of Chloramphenicol/Streptomycin by plate assay method or turbidometric assay methods.
6. Screening, Production and assay of therapeutic enzymes: Glucose Oxidase/Asperginase/beta lactamase.
7. Determination of MIC and LD50 of Ampicillin / Streptomycin.
8. Sterility testing by using *B. sterothermophilus*/*B. subtilis*.
9. Determination of Microbial contamination and Microbial loads from syrups, suspensions, creams, and other preparations.
10. Determination of D-value and Z-value for heat sterilization in pharmaceuticals.
11. Determination of antimicrobial activity of chemical compounds (like phenol, resorcinol and formaldehydes) Comparison with standard products.

SEMESTER - IV

Course Structure for SMICC1551

Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SMICC1551	Advanced Enzyme Technology	04	--	04	--	04

Assessment Scheme

Course Code (2)	Course Name (3)	Theory				Practical		Total [Col (6+7) / Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg. of (T1+T2)/2 (6)		CA (8)	ESA (9)	
SMICC1551	Advanced Enzyme Technology	20	20	20	80	--	--	100

Swami Ramanand Teerth Marathwada University Nanded
Faculty of Science and Technology
M. Sc. First Year (Semester – IV)
Discipline Specific Core Course: Microbiology
Course Name: Advanced Enzyme Technology
Course Code: SMICC1551
Credits: 04 (Marks: 100) **Periods: 60**

Course Pre-requisite:

The course is offered for a student who has completed **Bachelor's Degree-Honors or Bachelor's Degree-Honors with Research (Level 6.0).**

Course Objectives and Outcomes:

- The course will provide an overview of the key enzymes currently used in large scale industrial processes.
- Able to summarize current processes involved in industrial enzyme production, from protein production to purification and formulation,
- To describe methods for selection and optimisation of industrial enzymes using genetic and biochemical techniques.
- To understand the theories of enzyme kinetics, the mechanisms of enzyme catalysis, and the mechanisms of enzyme regulation in the cell.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0	I	**Extraction and Purification of Microbial Enzyme**	**15**
	1.1	Importance of Enzyme purification, Different sources of enzyme, Extracellular and Intracellular enzyme.	
	1.2	Physical and Chemical methods used for cell disintegration, Enzyme fractionation by precipitation (using Temperature, Salt, Solvent, pH etc.), Liquid-liquid extraction.	
	1.3	Ionic Exchange, Gel electrophoresis, Affinity chromatography and other special purification methods, Enzyme crystallization technique, Criteria of purity of enzyme.	
	1.4	Pitfalls in working with pure enzyme.	
2.0	II	**Enzyme Kinetics and Enzyme Inhibition**	**15**
	2.1	Enzyme kinetics: Steady state kinetics, Brigs Haldane equation, Michaelis Menten equation, The Monod-Wyman-Changeux (MWC) Model, the Koshland-Nemethy-Filmer(KNF) Model.	
	2.2	Irreversible, Reversible, competitive, Noncompetitive and Uncompetitive Inhibition with suitable examples and their kinetics studies.	
	2.3	Allosteric regulation, Types of allosteric regulation and their significance in metabolic regulation and their kinetics study (Hills equation).	
3.0	III	**Enzyme as a biocatalyst and Enzyme Engineering**	**15**
	3.1	Structure of active sites, Role of Ionizable group in catalysts.	
	3.2	Study on vitamins and co-enzymes: Structure and functions with suitable examples, Metallo enzymes and Metal ions as co-factors and enzyme activators.	

	3.3	Chemical modification and site directed mutagenesis to study structure-function relationship of industrially important enzyme.	
4.0	IV	**Immobilization and Applications of Microbial enzymes**	**15**
	4.1	Properties of Immobilized enzyme, Methods of immobilisation: Adsorption, Covalent bonding, Entrapment and Membrane confinement. Advanced immobilization techniques.	
	4.2	Analytical, Therapeutic and Industrial applications of Immobilized enzymes.	
	4.3	Microbial enzymes in Textiles, Leather, Wood Industries and Detergent, Enzymes in clinical diagnosis.	
	4.4	Enzyme sensors for clinical processes and environment analysis, Enzymes as therapeutic agents, Extremozymes, Solventogenic enzymes.	
		Total	**60**

References

1. Methods in enzymology. Volume22-Enzyme purification and related techniques. Edited by William B.Jakoby. Academic press, New York.
2. Allosteric enzymes − kinetic Behaviour. 1982. by B.I Kurganov. John Wiley and sond Inc., New York.
3. Biotechnology, volume 7 A- enzymes in biotechnology 1983 Edited by H.J.Rehm and G. Reed Verlag Cheime.
4. Hand Book of Enzyme Biotechnology by Wiseman.
5. Enzymes as Drugs Edited by John S. Hoilenberg and Joseph Roberts. John Wiley and Sons New York.
6. Methods of Enzymatic Analysis by Hans Ulrich. Bergmeyer, Academic Press.
7. Methods in enzymology by W. A. AWood. Academic Press.
8. Advances in enzymology by Alton Meister, Interscience Publishers.
9. Topics in enzymes and fermentation biotechnology by L.N.Weiseman, John Wiley and Sons.
10. Understanding enzymes by T. Palmer.
11. Enzymes by Dixon and Webb. Academic Press.
12. Enzyme kinetics by Segel. Academic press.

Course Structure for SMICP1551

(Practicals based on Course SMICC1551: Advanced Enzyme Technology)

Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme(Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SMICP1551	Lab 1 Course (Practicals based on Course SMICC1551)	--	02	--	01	01

Assessment Scheme

Course Code (2)	Course Name (3)	Theory				Practical		Total [Col (6+7) / Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg. of (T1+T2)/2 (6)		CA (8)	ESA (9)	
SMICP1551	Lab 1 Course (Practicals based on Course SMICC1551)	--	--	--	--	05	20	25

Swami Ramanand Teerth Marathwada University Nanded
Faculty of Science and Technology
M. Sc. Second Year (Semester–IV)
Discipline Specific Core Course: Microbiology
Course Name: Lab 1 Course
(Practicals base on Course SMICC1551)
Course Code: SMICP1551

Credits: 01 **Marks: 25**

1. Microbial production, Extraction, Purification and confirmation of alpha amylase /Lipase.
2. Determination of efficiency of enzyme purification by measuring specific activity at various stages viz. Salt precipitation, dialysis, electrophoresis etc.
3. Effect of pH and Temperature on enzyme activity (Amylase/ Lipase)
4. Studies on enzyme activation and inhibition of extracted Alpha amylase / Lipase and Effect of heavy metal ions, chelating agents as activators and inhibitors.
5. Immobilization of cells and enzyme using sodium alginate and egg albumin and measurement of enzyme activity (Amylase / Lipase).
6. Studies on impact of immobilization of enzyme activity in terms of temperature tolerance and determination of Vmax and Km using various forms of Alpha amylase/ Lipase.
7. Determination of molecular weight of enzyme using PAGE technique.
8. Preparation of biosensors of urease and determination of its activity.

Course Structure for SMICC1552

Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SMICC1552	Advances in Virology	04	--	04	--	04

Assessment Scheme

Course Code (2)	Course Name (3)	Theory				Practical		Total [Col (6+7) / Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg. of (T1+T2)/2 (6)		CA (8)	ESA (9)	
SMICC1552	Advances in Virology	20	20	20	80	--	--	100

Swami Ramanand Teerth Marathwada University Nanded
Faculty of Science and Technology
M. Sc. Second Year (Semester-IV)
Discipline Specific Elective Course: Microbiology
Course Name: Advances in Virology
Course Code: SMICC1552
Credits: 04 (Marks: 100) **Periods: 60**

Course Pre-requisite:

The course is offered for a student who has completed **Bachelor's Degree-Honors or Bachelor's Degree-Honors with Research (Level 6.0).**

Course Objectives and Outcomes:

- Able to gain in depth knowledge on the overall virus world and their characteristics.
- To acquire knowledge of virus morphology, replication strategies, viral pathogenesis, disease, and viral epidemiology.
- To discuss general strategies for virus disease control, including the mode of action of antiviral drugs and the development of vaccine.
- To acquire knowledge about bacteriophages, plant and insect viruses, subviral agents, importance of viruses in human welfare.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0	I	**Classification, Cultivation and Detection of Viruses**	**15**
	1.1	Morphology and Ultra structure of Viruses, Definitive properties of viruses, Cataloguing of Viruses-International Committee on Taxonomy of viruses (ICTV), Structure based classification, Baltimore classification, LHT system of classification and Homes classification.	
	1.2	Methods for cultivation of Viruses into Embryonated eggs, Laboratory animals and tissue culture. Methods for isolation and purification of Viruses: Centrifugation chromatographic and electrophoretic techniques.	
	1.3	Detection of viral growth in the host: Measurement of infectious units, Measurement of virus particles and their components, One step growth cycle. Assay of viruses: Physical (Electron microscopy) and Chemical methods (Protein and Nucleic acid studies). Infectivity assays: Plaque assay, Focus forming assay, End-point dilution assay and serological assay methods.	
2.0	II	**Viral attachment, Entry and Multiplication of Viruses in Host**	**15**
	2.1	Architecture of cell surfaces, Interaction of viruses with cell receptors, Uptake of macromolecules by cells, Mechanism of virus entry into cells, Transport of viral genome into the cell nucleus.	
	2.2	Genomic replication of Viruses (DNA/RNA), mRNA production by animal viruses. Mechanism of RNA synthesis, Transcription mechanism and Post transcriptional processing,	

	2.3	Translation of viral protein, Assembly, Exit and Maturation of progeny virions.	
	2.4	Multiplication of bacteriophages.	
3.0	III	**Viral Pathogenesis**	
	3.1	Host and virus factors involved in pathogenesis, Patterns of infection, Pathogenesis of animal viruses (Adenovirus, HIV, Herpes virus, Hepatitis virus, Picorna virus, Poxivirus, Corona viruses and Orthomyxovirus),	**18**
	3.2	Pathogenesis of plant viruses (TMV) and Insect viruses (NPV).	
	3.3	Host cell transformation by viruses and oncogenesis of DNA and RNA viruses.	
4.0	IV	**Prevention and Control of Viruses**	
	4.1	Viral vaccines, Preparation of viral vaccines, New vaccine technology, Antiviral drugs, Antiviral proteins and photodynamic inactivation of viruses.	**12**
	4.2	Virus evolution and Emergence of new viruses.	
		Total	**60**

References

1. A textbook on comprehensive virology (2022) by Nikhilesh Kulkarni, Shiva Aithal and Renuka Joshi, Himalaya Publishing House. ISBN 978-93-5433-045-2
2. *An Introduction to Viruses* by S. B. Biswas &Amita Biswas (2009), Vikas PublishingHouse PVT LTD.
3. *Compendium of Immunology and Virology by* A.B. Solunke, S.C. Aithal, V.S. Hamde, R.S. Awasthi (2018) Published by Notion Press, India, ISBN 978-1-64249-611-0 Pages 360.
4. *Applied Virology Research: New Diagnostic Procedures* by Edouard Kurstak, R. G.Marusyk, F. A. Murphy (1984), Academic press Inc.
5. *Brocks Biology of Microorganisms* (Eleventh Edition) by Michael T. Madigan, John M.Martinko (2006), Pearson Prentice Hall.
6. *Clinical Virology Manual* by Steven C. Specter, Richard L. Hodinka, Danny L.Wiedbrauk, Stephen A. Young (2009), ASM Press.
7. *Introduction to Modern Virology 4th Edition* by N. J. Dimmock & S. B. Primrose (1994),Blackwell Scientific publications, Oxford.
8. *Notes on Medical Virology, 10th Edition* by Morag C. Timbury (1994).
9. *Principles of Virology: Molecular Biology, Pathogenesis and Control* by S. J. Flint, L.W. Enquist, V. R. Racaniello, A. M. Skalkaj (2009), ASM Press, Washington.
10. *Principles* of *Molecular Virology* (4thedn.), Edward Arnold & A. J. Cann (2005).Academic Press, London.
11. *Text Book on principles of bacteriology, Virology and Immunology* (1995) by Topley and Wilsons.
12. *Virology 3rd Edition* by H. F. Conrat, P.C. Kimball and J.A. Levy (1994). Prentice Hall, Englewood Cliff, New Jersey.

Course Structure for
Discipline Specific Elective Course SMICE1551

Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SMICE551	Medical Laboratory Technology (MLT)	04	--	04	--	04

Assessment Scheme

Course Code (2)	Course Name (3)	Theory				Practical		Total [Col (6+7) / Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg. of (T1+T2)/2 (6)		CA (8)	ESA (9)	
SMICE1551	Medical Laboratory Technology (MLT)	20	20	20	80	--	--	100

Swami Ramanand Teerth Marathwada University Nanded
Faculty of Science and Technology
M. Sc. First Year (Semester-IV)
Discipline Specific Core Course: Microbiology
Course Name: Medical Laboratory Technology (MLT)
Course Code: SMICE1551

Credits: 04 (Marks: 100) **Periods: 60**

Course Pre-requisite:

The course is offered for a student who has completed **Bachelor's Degree-Honors or Bachelor's Degree-Honors with Research (Level 6.0).**

Course Objectives and Outcomes:

- To enable the students to acquire knowledge of Pathological laboratory and operation of ground based growing Health Industry needs.
- To provide analytical skills in different areas of clinical laboratory, clinical research and quality standards.
- To deliver the knowledge in the field of Hematology, Clinical Pathology, Microbiology, Biochemistry, Serology and Immunology, Histopathology, Cytopathology and Transfusion Medicine.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0	I	**Clinical Biochemistry**	**16**
	1.1	Carbohydrates: Definition, Digestion & absorption of Carbohydrates. Regulation of blood glucose & its importance, Hyperglycemia, Hypoglycemia. Diabetes & Glycosylated Hb. Blood Glucose estimation & Glucose Tolerance Test.	
	1.2	Plasma Proteins: Definition, Classification, Functions of Plasma Proteins. Plasma Proteins estimations. Clinical significance plasma protein; Bence-Jones' Proteins and Cryoglobulins	
	1.3	Lipids and Lipoproteins: Definition, Essential Fatty Acids. Important Lipid Profile Tests- cholesterol, triglyceride, Lipoproteins, phospholipids and its significance in various disorders.	
	1.4	Clinical Enzymology: Therapeutic, diagnostic and analytical uses of enzymes. Diagnostic Importance of Enzymes and Isoenzymes: Phosphatases; Transaminases; Lactate Dehydrogenases; Creatine Kinase; Amylase; Lipase; Gama GlutamylTransferase	
	1.5	Hormones: Determination of T3, T4, TSH. Vitamins: Determination of Vitamin B12 and D3.	
2.0	II	**Clinical laboratories and Haematology**	**14**
	2.1	Introduction to clinical laboratories, Laboratory safety and first aid.	
	2.2	Miscellaneous investigation in hematology. Haemostasis and Fibrinolysis	
	2.3	Blood group serology. Blood banking, Blood Transfusion and	

		Compatibility testing.	
3.0	III	**Diagnostic Microbiology**	**15**
	3.1	Basic rules for working in Diagnostic Microbiology Lab. Laboratory procedures in Microbiology. Quality control in Microbiology and Stock culture preservation.	
	3.2	Specimen collection and processing with examples: Serum, Sputum, fecal, urine, wound exudates, cerebrospinal fluid and Miscellaneous body fluids.	
	3.3	Identification of common pathogenic microbes. Lab diagnosis of: Infectious agents. Tuberculosis, Leprosy, Anaerobic infections.	
	3.4	Antimicrobial Susceptibility Tests. Minimum Inhibitory Concentration (MIC), Broth Dilution and Disc Diffusion	
4.0	IV	**Basic Immunology and Serodiagnosis**	**15**
	4.1	Introduction. Antigen Antibody and Complement.	
	4.2	Specific Immune Response, Antigen-Antibody Reaction *in Vitro*. Immunoassay for Influenza and Immunologic test for Pregnancy.	
	4.3	Clinical Significance of serodiagnosis. Common Serodiagnostic Tests.	
	4.4	Laboratory procedures in Serology: Febrile Agglutination Tests and C-reactive Protein (CRP) Test, Rheumatoid Arthritis (RA) Test. Serodiagnosis of: Streptococcal infection, AIDS, Viral Hepatitis, Malaria.	
		Total	**60**

References:

1. Chatterjee M. N. and Shinde R. 2007. Textbook of Medical Biochemistry, 8th ed., Jaypee Brothers Publishers.(ISBN: 9789350254844)
2. Godkar P. B. (2014). Textbook of Medical Laboratory Technology, 3rd ed., Bhalani Publishing house. (ISBN: 9789381496190)
3. Ochei J. &Kolhatkar A. (2000), Medical Laboratory Science: Theory & Practice, Tata McGraw Hill Pub. (ISBN: 9780074632239)
4. Satyanarayan, U. Chakrapani, Biochemistry, 3rd edition, Books¬ & Allied Pvt Ltd Kolkatta (ISBN: 9788187134800)
5. Harold Varley, (1990), Practical Clinical Biochemistry, Indian Edition, Anold Heinemann. (ISBN: 9780433338062)
6. Vasudevan D. &Sreekumari S. (2005). Textbook of Biochemistry; 4th ed, Jaypee Publishers.(ISBN: 9789389034981)
7. Wilson K. & Walker J., Practical Biochemistry: Principles & Technique, 5 ed., Cambridge University Press. (ISBN: 9780521799652)
8. Denise Harmening, Modern Blood banking and Transfusion Practices, 6th Edition 2012. (ISBN: 9780803626829)

Course Structure for SMICEP1551

(Practicals based on Course SMICE1551: Medical Laboratory Technology)

Teaching Scheme

Course Code	Course Name (Paper Title)	Teaching Scheme(Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SMICEP1551	Lab 2 Course (Practicals based on Course SMICE1551)	--	02	--	01	01

Assessment Scheme

Course Code (2)	Course Name (3)	Theory				Practical		Total [Col (6+7)/ Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg. of (T1+T2)/2 (6)		CA (8)	ESA (9)	
SMICEP1551	Lab 2 Course (Practicals based on Course SMICE1551)	--	--	--	--	05	20	25

Swami Ramanand Teerth Marathwada University Nanded
Faculty of Science and Technology
M. Sc. Second Year (Semester-IV)
Discipline Specific Core Course: Microbiology
Course Name: Lab 2 Course
(Practicals based on Course SMICE1551: Medical Laboratory Technology)
Course Code: SMICEP1551

Credits: 01 **Marks: 25**

1. Preparation of solutions, calculation of Molecular Weights and Equivalent Weights
2. Preparation of Normal solutions, Molar solutions, percent solution and reagents, dilution techniques

Hematology, Immunology and Serology:
1. ABO & Rh blood grouping/Coomb's test
2. Hemoglobin estimation
3. Total RBC, WBC and Platelet count
4. Staining of blood film & interpretation of PBF
5. Differential leukocytes count
6. Erythrocyte sedimentation rate (ESR)
7. VDRL Tests
8. WIDAL
9. ELISA
10. Pregnancy Test

Clinical Biochemistry and Microbiology:
1. Identification of substances of Physiological importance (Carbohydrates, Proteins, Lipids E.g. Glucose, Cholesterol etc.) using semi & fully automated analyzers.
2. Urine analysis- Normal & Pathological.
3. Colorimetric estimation-– Glucose, Urea, Creatinine etc.
4. Collection of specimens for Microbiological investigations such as Blood, Urine, Throat swab, Nasal swab, Stool, Pus (swabs), OT and other specimens
5. Storage and transport of the clinical specimens: Preparation of smears from clinical material, Microscopic Examination.

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY

NANDED-431606, MAHARASHTRA.

Faculty of Science and Technology

PG-Question Paper Pattern-Theory, Credits : 4 (NEP 2020)

Exam: Winter 20…./ Summer 20….

Subject: M Sc Biotechnology/ Bioinformatics/ Clinical Research/ Microbiology/ Botany

Time: 3 Hours Marks: 80

Notes:

1. Question No 1 is compulsory
2. Of the remaining, attempt any Three Questions
3. Draw neat and Labelled Diagram wherever required

Q 1 Write brief notes on the following:(Covering All Modules) 20 Marks

a)
b)
c)
d)

Q 2 a) 10 Marks
b) 10 Marks

Q 3 a) 10 Marks
b) 10 Marks

Q 4 a) 10 Marks
b) 10 Marks

Q 5 a) 10 Marks
b) 10 Marks

Q 6 Write brief notes on the following: (Covering All Modules) 20 Marks

a)
b)
c)
d)

(There must be equal weightage for all Four Modules)

BOS In Biotechnology / Clinical Research / Bioinformatics / Botany / Microbiology

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY

NANDED-431606, MAHARASHTRA.

Faculty of Science and Technology

PG-Internal Practical Exam Question Paper Pattern, Credit: 1 (NEP 2020)

Exam: Winter 20..../ Summer 20....

Subject: M Sc Biotechnology/ Bioinformatics/ Clinical Research/ Microbiology/ Botany

Time: 4 Hours Marks: 05

Q 1 Experiment 03 Marks

Q 2 Viva Voce 02 Marks

BOS In Biotechnology / Clinical Research / Bioinformatics/ Botany / Microbiology

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY
NANDED-431606, MAHARASHTRA.
Faculty of Science and Technology
PG-External Practical Exam Question Paper Pattern, Credit: 01 (NEP 2020)
Exam: SEMESTER-III

Subject: M Sc Microbiology **Lab Course: 1 and 2**
Time: 4 Hours (9 AM to 1 PM) **Marks: 20**
(For two Consecutive days for each batch)

Q1 Major (SMICP1501/SMICEP1501)	10 Marks
Q2 Minor (SMICP1501/SMICEP1501)	05 Marks
Q3 Viva Voce	03 Marks
Q4 Record Book Submission	02 Marks

SWAMI SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY
NANDED-431606, MAHARASHTRA.
Faculty of Science and Technology
PG-External Practical Exam Question Paper Pattern, Credit: I (NEP 2020)
Exam: SEMESTER-IV

Subject: M Sc Microbiology **Lab Course: 1 and 2**
Time: 4 Hours (9 AM to 1 PM) **Marks: 20**
(For two Consecutive days for each batch)

Q1 Major (SMICP1551/ SMICEP1551)	10 Marks
Q2 Minor (SMICP1551/ SMICEP1551)	05 Marks
Q3 Viva Voce	03 Marks
Q4 Record Book Submission	02 Marks