॥ 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

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 पदवी तृतीय वर्षाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२६–२७ पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, दिनांक २२ एप्रिल २०२६ रोजी संपन्न झालेल्या मा.विद्यापरिषद बैठकीतील विषय क्र.०८/६४–२०२६ च्या ठरावानुसार विज्ञान व तंत्रज्ञान विद्याशाखेतील राष्ट्रीय शैक्षणिक धोरण–२०२० नुसार पदवी तृतीय वर्षाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२६–२७ पासून लागू करण्यास मा.विद्यापरिषदेने मान्यता प्रदान केली आहे. त्यानुसार विज्ञान व तंत्रज्ञान विद्याशाखेतील बी.एस्सी. तृतीय वर्षाचे खालील विषयाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२६–२७ पासून लागू करण्यात येत आहे.

01	B.Sc. III Year Botany	10	B.Sc. III Year Biochemistry
02	B.Sc. III Year Chemistry	11	B.Sc. III Year Agriculture Microbiology
03	B.Sc. III Year Mathematics	12	B.Sc. III Year Electronics
04	B.Sc. III Year Zoology	13	B.Sc. III Year Seed Technology
05	B.Sc. III Year Microbiology	14	B.Sc. III Year Horticulture
06	B.Sc. III Year Geology	15	B.Sc. III Year Analytical Chemistry
07	B.Sc. III Year Enviornment & Earth Science	16	B.Sc. III Year Agrochemical & Fertilizers
08	B.Sc. III Year Statistics	17	B.Sc. III Year Industrial Chemistry
09	B.Sc. III Year Dairy Science	18	B.Sc. III Year Industrial Microbiology

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/परिपत्रक/पदवी/बीएस्सी/२०२६–२७/60
दिनांक : १९.०६.२०२६

सहा.कुलसचिव
शैक्षणिक (१–अभ्यासमंडळे) विभाग

प्रत माहिती व पुढील कार्यवाहीस्तव :–
१) मा. कुलगुरू महोदयांचे कार्यालय, प्रस्तुत विद्यापीठ.
२) मा. प्र.कुलगुरू महोदयांचे कार्यालय, प्रस्तुत विद्यापीठ
३) मा. अधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
४) मा. संचालक, परिक्षा व मुल्यमापन मंडळ, प्रस्तुत विद्यापीठ.
५) मा. प्राचार्य, सर्व संबंधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.

SWAMI RAMANAND TEERTHMARATHWADA UNIVERSITY, NANDED - 431 606 (MS)

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

UNDERGRADUATE PROGRAMME OF

SCIENCE & TECHNOLOGY

B.Sc. Third Year

AGRICULTURAL MICROBIOLOGY

(For Affiliated Colleges)

Effective from the Academic year 2026 – 2027

(As per NEP-2020)

Framed by

Board of Studies in Microbiology

S.R.T.M. University, Nanded - 431 606

From the Desk of the Dean, Faculty of Science and Technology

Swami Ramanand Teerth Marathwada University, Nanded, enduring to its vision statement "***Enlightened Student: A Source of Immense Power***", is trying hard consistently to enrich the quality of science education in its jurisdiction by implementing several quality initiatives. Revision and updating curriculum to meet the standard of the courses at national and international level, implementing innovative methods of teaching-learning, improvisation in the examination and evaluation processes are some of the important measures that enabled the University to achieve ***the 3Es, the equity, the efficiency*** and ***the excellence*** in higher education of this region. To overcome the difficulty of comparing the performances of the graduating students and also to provide mobility to them to join other institutions the University has adopted the cumulative grade point average (CGPA) system in the year 2014-2015. Further, following the suggestions by the UGC and looking at the better employability, entrepreneurship possibilities and to enhance the latent skills of the stakeholders the University has adopted the Choice Based Credit System (CBCS) in the year 2018-2019 at graduate and post-graduate level. This provided flexibility to the students to choose courses of their own interests. To encourage the students to opt the world-class courses offered on the online platforms like, NPTEL, SWAYM, and other MOOCS platforms the University has implemented the credit transfer policy approved by its Academic Council and also has made a provision of reimbursing registration fees of the successful students completing such courses.

SRTM University has been producing a good number of high calibre graduates; however, it is necessary to ensure that our aspiring students are able to pursue the right education. Like the engineering students, the youngsters pursuing science education need to be equipped and trained as per the requirements of the R&D institutes and industries. This would become possible only when the students undergo studies with an updated and evolving curriculum to match global scenario.

Higher education is a dynamic process and in the present era the stakeholders need to be educated and trained in view of the self-employment and self-sustaining skills like start-ups. Revision of the curriculum alone is not the measure for bringing reforms in the higher education, but invite several other initiatives. Establishing industry-institute linkages and initiating internship, on job training for the graduates in reputed industries are some of the important steps that the University would like to take in the coming time. As a result, revision of the curriculum was the need of the hour and such an opportunity was provided by the New Education Policy 2020. National Education Policy 2020 (NEP 2020) aims at equipping students with knowledge, skills, values, leadership qualities and initiates them for lifelong learning. As a result the students will acquire expertise in specialized areas of interest, kindle their intellectual curiosity and scientific temper, and create imaginative individuals.

The curriculum given in this document has been developed following the guidelines of NEP-2020 and is crucial as well as challenging due to the reason that it is a transition from general science based to the discipline-specific-based curriculum. All the recommendations of the ***Sukanu Samiti*** given in the **NEP Curriculum Framework-2023** have been followed, keeping the disciplinary approach with rigor and depth, appropriate to the comprehension level of learners. All the Board of Studies (BoS) under the Faculty of Science and Technology of this university have put in their tremendous efforts in making this curriculum of international standard. They have taken care of maintaining logical sequencing of the subject matter with proper placement of concepts with their linkages for better understanding of the students. We take this opportunity to congratulate the Chairman(s) and all the members of various Boards of Studies for their immense contributions in

preparing the revised curriculum for the benefits of the stakeholders in line with the guidelines of the **Government of Maharashtra regarding NEP-2020**. We also acknowledge the suggestions and contributions of the academic and industry experts of various disciplines.

We are sure that the adoption of the revised curriculum will be advantageous for the students to enhance their skills and employability. Introduction of the mandatory ***On Job Training, Internship program*** for science background students is praise worthy and certainly help the students to imbibe firsthand work experience, team work management. These initiatives will also help the students to inculcate the workmanship spirit and explore the possibilities of setting up of their own enterprises.

Dr. M. K. Patil
Dean
Faculty of Science and Technology

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

Preamble:

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 B.Sc. programme in tertiary education, B.Sc. microbiology has its own set of different syllabi, which students must cover before they are allowed to graduate.

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 B. Sc. (Honors) 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 has 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.

In addition to these Program Educational Objectives, for each course of undergraduate 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.

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B. Sc. Agricultural Microbiology Program Objectives and Outcomes

PROGRAMME OBJECTIVES:

- To enrich students with knowledge and understanding of the different disciplines of Microbiology such as medical Microbiology, immunology, biochemistry, fermentation technology, environmental Microbiology, genetics, agricultural and food Microbiology, Waste management.
- To make students learn advanced fields of microbiology such as Nanobiotechnology and Marine microbiology.
- To introduce the concepts of application and research in Agricultural Microbiology and inculcate sense of scientific responsibilities.
- To help student's build-up a progressive and successful career in Agricultural Microbiology.
- To take a step ahead for the holistic development of students through activities like lectures from eminent personalities, Visits, and various competitions.
- It makes the students competent enough to use Agricultural Microbiology knowledge and skills to analyze problems involving microbes and undertake remedial measures.
- In addition, students are to be trained to use this knowledge in day-today applications and

get a glimpse of research.

- The students graduating in B.Sc. Agricultural Microbiology degree must have thorough understanding the fundamentals of Agricultural Microbiology as applicable to wide ranging contexts.
- They should have the appropriate skills of Agricultural Microbiology so as to perform their duties as microbiologists.
- They must be able to analyze the problems related to Agricultural Microbiology and come up with most suitable solutions.
- As Agricultural Microbiology is an interdisciplinary subject the students might have to take inputs from other areas of expertise. So, the students must develop the spirit of team work.

PROGRAM SPECIFIC OBJECTIVES [PSOB]: Programme Specific Objectives for B.Sc. Agricultural Microbiology are as follows:

- PSOB-1. The broad goal of the teaching to under graduate students in Agricultural Microbiology is to provide knowledge and skills in Microbiology to develop practical skills through the laboratory work, their presentation and articulation skills, exposure to industry and interaction with industry experts, write short research - based projects.
- PSOB-2. To learn basic concepts of amazing world of Microorganisms, Techniques in Microbiology, basics of Bacteriology, Cultivation, and growth of Micro-organisms.
- PSOB-3. To understand concepts of Medical Microbiology, Epidemiology, Immunology, Bacterial Physiology, Fermentation Technology, Bacterial Genetics, Air, Water and Soil Microbiology.
- PSOB-4. To strengthen the fundamentals of various fields of Agricultural Microbiology.
- PSOB-5.To develop scientific aptitude and motivate students to take up higher studies like B. Sc. (Hons. / Hons. with Research) microbiology and Research.
- PSOB-6. To realize and appreciate the applicability of knowledge and Interdisciplinary approach in everyday life.
- PSOB-7. The graduate students of Agricultural Microbiology should have basic skills such as culturing microbes, maintaining microbes, safety issues related to handling of microbes, Good Microbiological practices etc.

PROGRAMME SPECIFIC OUTCOMES [PSOC]: Programme specific outcomes for B.Sc. Agricultural Microbiology are as follows:

- PSOC-1. The student will be able to explain various fields of Applied Science including Medicine, Pharmacy, Cell biology, Biotechnology, Industrial Production, Biochemistry, Nanotechnology, Environmental Management, Food, Dairy, Immunology, Agriculture and Bioinformatics
- PSOC-2. The students will be able to design and execute experiments related to Basic Microbiology, Immunology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics, etc.
- PSOC-3. The students will be able to execute a short research project incorporating techniques of Basic and Advanced Microbiology under supervision.
- PSOC-4. The students will be able to acquire sound knowledge of classification, taxonomy, structure , types of microorganisms and various fields of microbiology.
- PSOC-5. The students will be able to do experiment in microbiology laboratory to

identify the microorganisms in various samples including clinical, environmental, water and food samples.

- PSOC-6. The students will be able to acquire knowledge about various diseases thereby can create awareness to the public.
- PSOC-7. The students will be able to provide knowledge on food processing, and fermented food products.
- PSOC-8. The students will be able to utilize various agricultural waste, marine sources as raw material for production of various fermented products to reduce accumulation of waste in the environment.
- PSOC-9. The students will be able to check the quality of water, dairy and food products by various learnt microbiological techniques
- PSOC-10. The students will be able to provide knowledge about history of Microbiology and contribution of various scientists. branches of Microbiology, basic structure of organism in details, microbial nutrition requirement for organism and microbial growth, microbiological techniques and control, different type of staining techniques used to distinguish between different type of bacteria and its organelles.
- PSOC-11. The students will be able to acquire knowledge about the different types of bacteria and viruses, microbial interaction, prevention of food from spoilage, preservation of food from food borne disease and food standards. also study the testing and preservation of milk and milk product in dairy industries.
- PSOC-12. The students will be able to acquire knowledge about the basic structure like Nucleic acid, carbohydrates metabolism, amino acids, enzymology in details and various vitamins. also study the fermentation at industrial level and upstream and downstream processing of fermentation
- PSOC-13. The students will be able to acquire knowledge about different types of metabolic pathways and its regulation related to carbohydrates amino acid. also study about different type of waste water treatment methods and water testing methods. this also cover air and agriculture microbiology with bioremediation and biomagnification.
- PSOC -14. The students will be able to acquire knowledge about the epidemiology and host parasites, disease transmitted and their various sources, control and prevention & spreading of infection, learn about normal flora present in body, study of pathogenic and non-pathogenic organism, morphology, cultural and biochemicals characteristic, pathogenesis, serology test and lab diagnosis, gene mutation and regulation of gene.
- PSOC-15. The students will be able to acquire knowledge about Immunity, various defense mechanism, organs of immune system, adaptive immunity, and cell mediated immune response. tools and techniques of genetic engineering. also come to know about health care, agriculture, and industrial biotechnology.
- PSOC-16 The students will be able to Explain why microorganisms are ubiquitous in nature; inhabiting a multitude of habitats and occupying a wide range of ecological habitats, their role in these ecological niches, influence of microbiome on our health, environmental cleanup, variety of industrial product development, and their significance in human wellbeing.
- PSOC-17. The students will be competent enough to use microbiology knowledge and skills to analyze problems involving microbes, learning use of microbes as a model organisms to understand facts about living systems, analyze the genetic makeup of different types understand of microbes, articulate these with peers/ team members/ other

stake holders through effective communication, and undertake remedial measures/ studies etc.

- PSOC-18. The students will take up a suitable position in academia or industry and to pursue a career in research.
- PSOC-19. The students will be able to develop their skills to start small scale business in various microbiological laboratories and in the field of research and health.

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

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**	**Yeshwant Mahavidyalaya, 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**	**7483715560**
6.	**Dr. Deepak Vedpathak**	**Professor**	**Rajarshi Shahu Mahavidyalaya, Latur**	**9822757890**
7.	**Dr. Sanjivkumar V. Kshirsagar**	**Assistant Professor**	**Sant Janabai Education Society's ACS College, Gangakhed**	**9421448741**
8.	**Dr. Hemlata J. Bhosle**	**Professor**	**School of Life Sciences, SRTM University Nanded**	**8698809434**
9.	**Dr. Sunita Mukkawar**	**Associate Professor**	**B. Raghunath ACS College, Parbhani**	**9422415911**
10.	**Dr. Ravindra R. Rakh**	**Associate Professor**	**Shri Guru Buddhiswami Mahavidyalaya, Purna**	**9545335680**
11.	**Dr. Prashant P. Dixit**	**Professor**	**Dr. B.A.M. Uni. Aurangabad, Sub-camps, Osmanabad**	**9421335704**
12.	**Dr. M. K. Ranjekar**		**Green Vitlas Biotech, Ranje Village, Pune**	**9422015217**
13.	**Dr. Prita S. Borkar**	**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**

Swami Ramanand Teerth Marathwada University, Nanded

Faculty of Science and Technology

Credit Framework for B. Sc. III Year

Multidisciplinary Degree Program with Multiple Entry and Exit

Subject: Agricultural Microbiology (Major)

Year & Level	Semester	Major *(From the same Faculty)*		Minor 1 *(From the same Faculty)*	Minor 2 *(From the same Faculty)*	Generic Elective (GE) (select from Basket 3 of *Faculties other than Science and Technology*)	Vocational & Skill Enhancement Course	Ability Enhancement Course (AEC) (Basket 4) Value Education Courses (VEC) / Indian Knowledge System (IKS) (Basket 5)	Field Project/ Case Study/ OJT/	Credits	Total Credits
1	2	3		4	5	6	7	8	9	10	11
3 (5.5)	V	SAGMCT1301 (3cr) SAGMCT1302 (3cr) SAGMIK1303 (2cr) SAGMCP1301 (2cr) SAGMCP1302 (2cr) 12 Credits	Major Elective SAGMET1301 (2cr) SAGMEP1301 (2cr) 04 Credits	--	--	--	SAGMVC1301 02 Credits	--	FP/CS SAGMFP1301 Or SAGMCS1301 04 Credits	22	132
	VI	SAGMCT1351 (3cr) SAGMCT1352 (3cr) SAGMCT1353 (2cr) SAGMCP1351 (2cr) SAGMCP1352 (2cr) 12 Credits	Major Elective SAGMET1351 (2cr) SAGMEP1351 (2cr) 04 Credits	--	--	--	SAGMVC1351 02 Credits	--	OJT SAGMOJ1351 04 Credits	22	
	Cum. Cr.	56		16	08	08	08+4=12	22	08+2=10	44	
Exit option: UG Diploma in Major Agricultural Microbiology and Minor Agricultural Microbiology on completion of 88 credits and additional 4 credits NSQF / internship in Agricultural Microbiology											

B. Sc. Third Year Semester V*(Level 5.5)*

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	SAGMCT1301	Microbial Genetics	03	--	12	03	--
	SAGMCT1302	Industrial Microbiology	03	--		03	--
	SAGMIK1303	Traditional Agriculture Practices (IKS)	02	--		02	--
	SAGMCP1301	Practical Based on SAGMCT1301	-	02		--	04
	SAGMCP1302	Practical Based on SAGMCT1302		02		--	04
Elective	SAGMET1301	Plant Tissue Culture Techniques	02	--	04	02	--
	SAGMEP1301	Practical Based on SAGMET1301	-	02		--	04
	SAGMET1302	Bioinstrumentation	02	--		02	--
	SAGMEP1302	Practical Based on SAGMET1302	-	02		--	04
Vocational Course	SAGMVC1301	Plant Biotechnology	--	02	02	--	04
Field Project Case Study	SAGMFP1301 Or SAGMCS1301	Field Project / Case Study	--	04	04	--	08
Total Credits 22			10	12	22	10	24

B. Sc. Third Year Semester V *(Level 5.5)*

Examination Scheme

[40% Continuous Assessment (***CA***) and 60% End Semester Assessment (***ESA***)]

(For illustration we have considered a paper of 02 credits, 50 marks, need to be modified depending on credits assigned to individual paper)

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)	Total of T1 & T2 (6)	Total (7)	CA (8)	ESA (9)	
Major	**SAGMCT1301**	**Microbial Genetics**	15	15	30	45	--	--	75
	SAGMCT1302	**Industrial Microbiology**	15	15	30	45	--	--	75
	SAGMIK1303	**Traditional Agriculture Practices (IKS)**	10	10	20	30	--	--	50
	SAGMCP1301	**Practical Based on SAGMCT1301**	--	--	--	--	20	30	50
	SAGMCP1302	**Practical Based on SAGMCT1302**	--	--	--	--	20	30	50
Elective	**SAGMET1301**	Plant Tissue Culture Techniques	10	10	20	30	--	--	50
	SAGMEP1301	**Practical Based on SAGMET1301**	--	--	--	--	20	30	50
	SAGMET1302	Bioinstrumentation	10	10	20	30	--	--	50
	SAGMEP1302	**Practical Based on SAGMET1302**	--	--	--	--	20	30	50
Vocational Course	**SAGMVC1301**	Plant Biotechnology	--	--	--	--	20	30	50
Field Project / Case Study	**SAGMFP1301 Or SAGMCS1301**	**Field Project / Case Study**	--	--	--	--	40	60	100

B. Sc. Third Year Semester VI *(Level 5.5)*

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	SAGMCT1351	Molecular Biology	03	--	12	03	--
	SAGMCT1352	Agricultural Biotechnology	03	--		03	--
	SAGMCT1353	Organic Farming	02	--		02	--
	SAGMCP1351	Practical Based on SAGMCT1351	-	02		--	04
	SAGMCP1352	Practical Based on SAGMCT1352		02		--	04
Elective	SAGMET1351	Management of Crop plant Diseases	02	--	04	02	--
	SAGMEP1351	Practical Based on SAGMET1351	-	02		--	04
	SAGMET1352	Environmental Microbiology	02	--		02	--
	SAGMEP1352	Practical Based on SAGMET1352	-	02		--	04
Vocational Course	SAGMVC1351	Agrobioprocessing Technology	--	02	02	--	04
OJT	SAGMOJ1351	OJT	--	04	04	--	08
Total Credits 22			**10**	**12**	**22**	**10**	**24**

B. Sc. Third Year Semester VI *(Level 5.5)*

Examination Scheme

[40% Continuous Assessment (***CA***) and 60% End Semester Assessment (***ESA***)]

(For illustration we have considered a paper of 02 credits, 50 marks, need to be modified depending on credits assigned to individual paper)

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)	Total of T1 & T2 (6)	Total (7)	CA (8)	ESA (9)	
Major	SAGMCT1351	Molecular Biology	15	15	30	45	--	--	75
	SAGMCT1352	Agricultural Biotechnology	15	15	30	45	--	--	75
	SAGMCT1353	Organic Farming	10	10	20	30	--	--	50
	SAGMCP1351	Practical Based on SAGMCT1351	--	--	--	--	20	30	50
	SAGMCP1352	Practical Based on SAGMCT1352	--	--	--	--	20	30	50
Elective	SAGMET1351	Management of Crop plant Diseases	10	10	20	30	--	--	50
	SAGMEP1351	Practical Based on SAGMET1351	--	--	--	--	20	30	50
	SAGMET1352	Environmental Microbiology	10	10	20	30	--	--	50
	SAGMEP1352	Practical Based on SAGMET1352	--	--	--	--	20	30	50
Vocational Course	SAGMVC1351	Agrobioprocessing Technology	--	--	--	--	20	30	50
OJT	SAGMOJ1351	OJT	--	--	--	--	40	60	100

Syllabus for B. Sc. Agricultural Microbiology

Third Year

Semester – V

As Per National Education Policy- 2020

To be implemented from

Academic Year 2026-2027

National Education Policy 2020

B.Sc. Agricultural Microbiology, III Year (Semester - V)

Major Core Theory Course

Course Code – SAGMCT1301

Title of the Course: Microbial Genetics

[No. of Credits: 3 Credit] **[Total: 45 Hours]**

Course pre-requisite:

1. The course is designed for students enrolled in the undergraduate second-year programme in the Faculty of Science and Technology. It is intended for those who have received foundational training in Microbiology at the first-year undergraduate level and serves as an entry-level core course for students opting for Microbiology as their major subject.
2. The students should possess basic knowledge of Microbiology, including an understanding of microbial cell structure (prokaryotic and eukaryotic), classification of microorganisms (bacteria, fungi, viruses, and algae), and their general characteristics. They should be familiar with fundamental concepts such as microbial growth, metabolism, and reproduction. In addition, a preliminary understanding of aseptic techniques, sterilization methods, and the role of microorganisms in environment, industry, and human health is desirable for better comprehension of the course.

Course objectives:

1. To understand the structure, organization, and function of genetic material in microorganisms.
2. To explain the molecular mechanisms of DNA replication, transcription, and translation in prokaryotes.
3. To study the principles and mechanisms of genetic recombination and gene transfer in bacteria.
4. To introduce the concepts of gene regulation and operon systems in microorganisms.
5. To understand the role of plasmids, transposable elements, and other mobile genetic elements.
6. To develop practical skills in basic molecular biology and microbial genetics techniques.

Course outcomes:

After successful completion of this course, students will be able to:

1. Describe the structure, organization, and properties of genetic material in microorganisms.
2. Explain the molecular mechanisms of DNA replication, transcription, and translation.
3. Illustrate different types of genetic recombination and gene transfer in bacteria (transformation, transduction, and conjugation).
4. Understand gene regulation mechanisms, including operon models in prokaryotes.
5. Explain the role of plasmids, transposable elements, and other mobile genetic elements.
6. Perform basic laboratory techniques related to microbial genetics and interpret experimental results.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**The Genetic Material**	
	1.1	**Historical Experiments Establishing DNA as Genetic Material** a. Frederick Griffith experiment b. Oswald Avery, Colin MacLeod and Maclyn McCarty experiment c. Alfred Hershey and Martha Chase experiment	**09**
	1.2	**Evidence for RNA as Genetic Material in Viruses** a. Gierer and Schramm Experiment – Tobacco Mosaic Virus	
	1.3	**DNA as Genetic Material** a. Structure and Properties of DNA	
	1.4	**Structure of Prokaryotic Chromosomes:** a. *Escherichia coli* as a Model Organism	

2.0		**Prokaryotic DNA replication**	
	2.1	**General Concepts of DNA Replication**	**12**
	2.2	**Semi-Conservative DNA Replication** Concept and experimental proof (Meselson and Stahl experiment)	
	2.3	**Replicon Model (Cairns Model)**	
	2.4	**Precursors and Enzymes of DNA Replication**	
	2.5	**Mechanism of DNA Replication:** a. Initiation, b. Elongation (Beta Clamp and Progressive Polymerases) c. Termination	
3.0		**Molecular Recombination in Bacteria**	
	3.1	**General Perspective of Genetic Recombination**	**12**
	3.2	**Homologous Recombination in** *E. coli* Initiation, Synapsis, Branch Migration, and resolution	
	3.3	**Types of Recombination** a. Site Specific Recombination (Integrative and Excessive Recombination) b. Illegitimate Recombination (Non- Homologous Recombination) c. Transposition: o Transposable elements in Prokaryotes o Insertion Sequence	
4.0		**Genetic Exchange in bacteria**	
	4.1	**Transformation:** a. Definition b. Discovery of Transformation c. Mechanism of Transformation: o Competence o DNA Binding o DNA penetration o Synapsis o Integration	**12**
	4.2	**Conjugation** a. Definition b. Discovery of Conjugation in Bacteria c. Properties of F plasmid /Sex factor d. Hfr strains and their formation e. Mechanism of Conjugation f. F′ (F prime) factor and sexduction	
	4.3	**Transduction** a. Definition b. Discovery of Transduction in Bacteria c. Types of Transduction o Generalized Transduction o Specialized Transduction d. Abortive Transduction	
		Total	**45**

Textbooks and Reference Books:

1. Essentials of Molecular Biology by David Freifelder (2002), Publisher: Narosa Publishing House.
2. Fundamental Bacterial Genetics by Nancy Trun and Jenanine Trumphy (2003),Publisher: Blackwell Publishing
3. General Microbiology (5th edn.) Stanier R. Y., Ingraham, J.L., Wheelis, M. L., Painter, P.R.(2008), Publisher: Macmillan Press Ltd, London
4. General Microbiology (Vol. I and II) Powar, C.B. and Daginawala, H. F.(2008), Publisher: Himalaya publishing house
5. Genetics a conceptual approach (3rd ed.) by Benjamin A. Pierce (2008) Publisher: W.H. Freeman and Company.
6. Genetics-A molecular approach (2nd /3rd ed.) by Peter J. Russell (2006)
7. Modern Microbial Genetics, Second Edition. Edited by Uldis N. Streips, Ronald E. Yasbin. Publisher: Wiley-Liss, Inc.
8. Principles of Genetics by R. H. Tamarin, (2004) Publisher: Tata McGraw Hill.
9. Willey, Joanne M. Prescott, Harley, and Klein's Microbiology / Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton. — 7th ed. Published by McGraw- Hill, a business unit of The McGraw-Hill Companies, Inc., 1221 Avenue of the Americas, New York, NY 10020.
10. Brock Biology of Microorganisms, Thirteenth Edition by Michael T. Madigan, John M. Martinko, David A. Stahl, David P. Clark, Benjamin Cummings, 1301 Sansome Street, San Francisco, CA 94111.
11. Molecular Genetics of Bacteria (2013) by Larry Snyder, Joseph E. Peters, Tina M. Henkin and Wendy Champness 4th Edition, ASM Press

National Education Policy 2020

B.Sc. Agricultural Microbiology, III Year (Semester - V)

Major Core Practical Course

Course Code – SAGMCP1301

Title of the Course: Practical Based on SAGMCT1301

[No. of Credits: 2 Credit] **[Total: 60 Hours]**

Course pre-requisite:

1. The course is designed for students enrolled in the undergraduate second-year programme in the Faculty of Science and Technology. It is intended for those who have received foundational training in Agricultural Microbiology at the first-year undergraduate level and serves as an entry-level core course for students opting for Agricultural Microbiology as their major subject.
2. The students should possess basic knowledge of Agricultural Microbiology, including an understanding of microbial cell structure (prokaryotic and eukaryotic), classification of microorganisms (bacteria, fungi, viruses, and algae), and their general characteristics. They should be familiar with fundamental concepts such as microbial growth, metabolism, and reproduction. In addition, a preliminary understanding of aseptic techniques, sterilization methods, and the role of microorganisms in environment, industry, and human health is desirable for better comprehension of the course.

Course objectives:

1. To develop practical skills in isolation, purification, and characterization of genomic DNA from bacterial sources such as Escherichia coli.
2. To train students in quantitative and qualitative analysis of nucleic acids using spectrophotometric and chemical methods.
3. To understand the principles and application of DNA denaturation, melting temperature (Tm), and G+C content analysis.
4. To provide hands-on experience in agarose gel electrophoresis for separation and visualization of DNA.
5. To enable students to perform extraction, purification, and characterization of RNA from eukaryotic systems such as yeast.
6. To familiarize students with colorimetric assays (Diphenylamine and Orcinol methods) for nucleic acid estimation.
7. To demonstrate fundamental mechanisms of genetic exchange in bacteria, including transformation, transduction, and conjugation.
8. To enhance laboratory skills, data interpretation, and scientific reporting in molecular microbiology experiments.

Course outcomes:

After successful completion of this course, students will be able to:

1. Isolate and purify genomic DNA from bacteria and total RNA from yeast using standard laboratory techniques.
2. Assess the purity and concentration of DNA and RNA using spectrophotometric methods.
3. Perform quantitative estimation of nucleic acids using Diphenylamine (DNA) and Orcinol (RNA) assays.
4. Determine the melting temperature (Tm) of DNA and correlate it with G+C content.
5. Carry out agarose gel electrophoresis and interpret banding patterns for nucleic acid analysis.
6. Demonstrate and explain mechanisms of bacterial genetic exchange including transformation, transduction, and conjugation.
7. Analyze experimental data, troubleshoot laboratory procedures, and maintain proper laboratory records.

8. Apply molecular biology techniques in research areas such as microbial genetics, biotechnology, and biomedical sciences.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Molecular Characterization of DNA**	
	1.1	Cell Lysis, Extraction and Purification of Genomic DNA from Escherichia coli	**20 [5 practicals]**
	1.2	Spectrophotometric Confirmation and Purity Assessment of DNA	
	1.3	Spectrophotometric Quantification of DNA Using Diphenylamine Reagent	
	1.4	Determination of DNA Denaturation Temperature (Tm) and G+C Content	
	1.5	Separation and Visualization of DNA by Agarose Gel Electrophoresis	
2.0		**Molecular Characterization of DNA**	
	2.1	Pure culture growth and Harvesting of Yeast for RNA Extraction	**16 [4 Practicals]**
	2.2	Cell Lysis, Extraction and Purification of total RNA from Yeast	
	2.3	Spectrophotometric Confirmation and Purity Assessment of RNA	
	2.4	Spectrophotometric quantification of RNA Using Orcinol-Based Assay	
3.0		**Genetic Exchange in bacteria**	
	3.1	Demonstration of Transformation in Bacteria	**24 [6 Practicals]**
	3.2	Demonstration of Transduction in Bacteria	
	3.3	Demonstration of Conjugation in Bacteria	
		Total	**60**

Textbooks and Reference Books:

1. Gautam, A. (2022). DNA and RNA Isolation Techniques for Non-experts (pp. 79-84). Cham: Springer.
2. Willey, Joanne M. Prescott, Harley, and Klein's Microbiology / Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton. — 7th ed. Published by McGraw- Hill, a business unit of The McGraw-Hill Companies, Inc., 1221 Avenue of the Americas, New York, NY 10020.
3. Brock Biology of Microorganisms, Thirteenth Edition by Michael T. Madigan, John M. Martinko, David A. Stahl, David P. Clark, Benjamin Cummings, 1301 Sansome Street, San Francisco, CA 94111.
4. Molecular Genetics of Bacteria (2013) by Larry Snyder, Joseph E. Peters, Tina M. Henkin and Wendy Champness 4th Edition, ASM Press

National Education Policy 2020

B.Sc. Agricultural Microbiology, III Year (Semester - V)

Major Core Theory Course

Course Code – SAGMCT1302

Title of the Course: Industrial Microbiology

[No. of Credits: 3 Credit] **[Total: 45 Hours]**

Course pre-requisite:

1. The course is designed for students enrolled in the undergraduate second-year programme in the Faculty of Science and Technology. It is intended for those who have received foundational training in Agricultural Microbiology at the first-year undergraduate level and serves as an entry-level core course for students opting for Agricultural Microbiology as their major subject.
2. The students should possess basic knowledge of Agricultural Microbiology, including an understanding of microbial cell structure (prokaryotic and eukaryotic), classification of microorganisms (bacteria, fungi, viruses, and algae), and their general characteristics. They should be familiar with fundamental concepts such as microbial growth, metabolism, and reproduction. In addition, a preliminary understanding of aseptic techniques, sterilization methods, and the role of microorganisms in environment, industry, and human health is desirable for better comprehension of the course.

Course objectives:

The aim of the undergraduate degree in Agricultural Microbiology is to make students

1. Knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Agricultural Microbiology
2. Acquire knowledge and understanding of the Agricultural microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others.
3. Their understanding, knowledge and skills in Agricultural Microbiology needs to be developed through a thorough teaching learning processes in the class, practical skills through the laboratory work, their presentation and articulation skills,
4. Exposure to industry and interaction with industry experts, write short research-based projects where they are guided and mentored by the academic and other experts of the subject.
5. The student should have developed competency to demonstrate key practical skills in working with microbes for study and use in laboratory as well as outside, including the use of Microbial biofertilizers and also developed broad perspective of the discipline of Plant Tissue culture techniques and Plant genetics
6. To enable him to identify challenging society problems and plan his professional carrier to develop innovative solutions for such problems.

Course outcomes:

After successful completion of this course, students will be able to:

1. Describe a large number of substrates that are used for the industrial fermentation processes
2. Has acquired a fairly good knowledge of how microbes are used in the fermentative production of organic acids, alcohols, enzymes, antibiotics and various foods in the industry.
3. Have developed an understanding of different types of reactors or fermenters which are used for laboratory,
4. pilot and industrial scale fermentations and their processes parameters.

5. Has acquired knowledge of various physical parameters which affect production of industrial products by the microorganisms and the safety aspects of the production and use of these products.
6. Apply the knowledge of enzymes and metabolism in areas such as **biotechnology, industrial microbiology, and research**.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Introduction to Industrial Microbiology**	
	1.1	Introduction, Definition, Scope and Development of Industrial Microbiology	**15**
	1.2	Bioreactor (Definition, Ideal Design and characteristics, Working of Auxiliary equipment)	
	1.3	Types of Fermenter:laboratory fermenter, pilot plant fermenter, industrial fermenter, Horton sphere.	
	1.4	Tubular, Fed batch, Fluidised bed reactor, Tower fermenter (In brief)	
	1.5	Surface and Submerged Fermentation process	
	1.6	Batch and Continuous Fermentations,	
	1.7	Computer applications in Fermentation Technology	
2.0		**Microbes in Industrial Microbiology**	
	2.1	. Introduction, Screening Techniques (Primary and Secondary Screening)	**15**
	2.2	Strain improvement Methods and Inoculum development	
	2.3	Maintenance of microbial cultures: Stock culture and its maintenance (serial subculture, overlaying with mineral oil, lyophilization, liquid nitrogen, soil stock)	
	2.4	Fermentation media (substances used as raw materials for formulation of fermentation media) and its sterilization (batch and continuous)	
3.0		**Downstream processing**	
	3.1	Introduction to down stream Processing	**08**
	3.2	Extraction of fermentation products, solids (Insoluble) removal (Filtration, centrifugation, coagulation and flocculation, foam fractionation)	
	3.3	Primary isolation of product (Cell disruption, liquid extraction, ion exchange adsorption, precipitation)	
	3.4	Purification (Chromatography, carbon decolorization, crystallization),	
	3.5	Product Isolation (Crystalline processing, drying, packing etc).	
4.0		**Typical Fermentations**	
	4.1	Ethanol fermentation by Yeasts and Bacteria.	**07**
	4.2	Lactic acid fermentation and Citric acid fermentation	

	4.3	Antibiotics: Penicillin & Streptomycin Production	
	4.4	Biofertilizers: Rhizobium and Azotobacter	
	4.5	Bioinsecticide: Thuricide	
		Total	**45**

Textbooks and Reference Books:

1. Biochemistry byChatwal.
2. Biochemistry byGarrett.
3. Biochemistry byLubeststryer.
4. Bioenergetics 3 –Academic press. David G Nicholis& StuartJ.Ferguson.
5. Biotechnology, volume 7 A- enzymes in biotechnology 1983 Edited by H.J.Rehm and G.Reed VerlagCheime.
6. Casida L.E., Industrial Microbiology, New age Internationalpublisher.
7. Cruger and Cruger , Biotechnology : A text Book of IndustrialMicrobiology.
8. Enzymes Dixon and Webb. AcademicPress.
9. Hand Book of Enzyme Biotechnology byWiseman
10. James E .Bailey and David F Ollis, Biochemical Engineering Fundamentals, McGrawHillPublication.
11. Laboratory techniques in Biochemistry and Molecular Biology by work and work.
12. Methods in enzymology by W. A. Wood. AcademicPress
13. Methods of Enzymatic Analysis by Hans Ulrich. Bergmeyer, AcademicPress.
14. Peppler and Perlmen , Microbial Technology, Vol I and II , Academic Press.
15. Peppler H.J and Periman D., Microbial technology, Vol.I and Vol.II. Academic pressNewYork.
16. Power C.H and H.F. Daginawala. General microbiology Vol. I andII.
17. Principles of Biochemistry 2 nd Edition byHorton.
18. Shuler and FikretKargi, Bioprocess Engineering basic concepts, 2nd edition, Prentice Hall publication.
19. Stanbury P.F, Whittekar, A and Hall SJ, Principles offermentation Technology,PergamonPress.
20. Trehan K., Biotechnology, New age International publisher.
21. West and Toad, text book of Biochemistry Oxford and IBH

National Education Policy 2020

B.Sc. Agricultural Microbiology, III Year (Semester - V)

Major Core Practical Course

Course Code – SAGMCP1302

Title of the Course: Practical Based on SAGMCT1302

[No. of Credits: 2 Credit] **[Total: 60 Hours]**

Course pre-requisite:

1. The course is designed for students enrolled in the undergraduate second-year programme in the Faculty of Science and Technology. It is intended for those who have received foundational training in Agricultural Microbiology at the first-year undergraduate level and serves as an entry-level core course for students opting for Agricultural Microbiology as their major subject.
2. The students should possess basic knowledge of Agricultural Microbiology, including an understanding of microbial cell structure (prokaryotic and eukaryotic), classification of microorganisms (bacteria, fungi, viruses, and algae), and their general characteristics. They should be familiar with fundamental concepts such as microbial growth, metabolism, and reproduction. In addition, a preliminary understanding of aseptic techniques, sterilization methods, and the role of microorganisms in environment, industry, and human health is desirable for better comprehension of the course.

Course objectives:

The aim of the undergraduate degree in Agricultural Microbiology is to make students

1. Knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Agricultural Microbiology
2. Acquire knowledge and understanding of the Agricultural microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others.
3. Their understanding, knowledge and skills in Agricultural Microbiology needs to be developed through a thorough teaching learning processes in the class, practical skills through the laboratory work, their presentation and articulation skills,
4. Exposure to industry and interaction with industry experts, write short research-based projects where they are guided and mentored by the academic and other experts of the subject.
5. The student should have developed competency to demonstrate key practical skills in working with microbes for study and use in laboratory as well as outside, including the use of Microbial biofertilizers and also developed broad perspective of the discipline of Plant Tissue culture techniques and Plant genetics
6. To enable him to identify challenging society problems and plan his professional carrier to develop innovative solutions for such problems.

Course outcomes:

After successful completion of this course, students will be able to:

1. Describe a large number of substrates that are used for the industrial fermentation processes
2. Has acquired a fairly good knowledge of how microbes are used in the fermentative production of organic acids, alcohols, enzymes, antibiotics and various foods in the industry.
3. Have developed an understanding of different types of reactors or fermenters which are used for laboratory, pilot and industrial scale fermentations and their processes parameters.
4. Has acquired knowledge of various physical parameters which affect production of industrial products by the microorganisms and the safety aspects of the production and use of these products.

5. Apply the knowledge of enzymes and metabolism in areas such as **biotechnology, industrial microbiology, and research**.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Study of Industrially potent Microorganisms**	
	1.1	Primary screening of antibiotic producers from soil.	**20 [5 practicals]**
	1.2	Primary screening of organic acid producers from soil	
	1.3	Secondary screening of industrially important microorganisms	
	1.4	Extraction of amylase, protease, lipases, from bacterial and fungal sp.	
	1.5	Identification and characterization of industrially important microorganisms	
2.0		**Microbial cultures, their isolation and maintenance**	
	2.1	Stock culture and its maintenance (serial subculture, overlaying with mineral oil, Soil culture)	**16 [4 Practicals]**
	2.2	Preparation of Soil dilutions, Enrichment cultures	
	2.3	Pure culture Isolation of industrial microorganisms	
	2.4	Formulation of fermentation Media and its Sterilization	
3.0		**Fermentation Product and recovery**	
	3.1	Production of citric acid by *Aspergillus niger* sp.	**16 [4 Practicals]**
	3.2	Downstream processing and estimation of citric acid	
	3.3	Alcohol production by *Saccharomyces cerevisiae*	
	3.4	Estimation of alcohol by specific gravity method	
4.0			
	4.1	Production of Biofertilizers: *Rhizobium / Azotobacter* sp.	**8 [2 Practicals]**
	4.2	Bioassay of Penicillin/Streptomycin	
		Total	**60**

Textbooks and Reference Books:

1. Casida1. L.E., Industrial Microbiology, New age Internationalpublisher.
2. Cruger and Cruger , Biotechnology : A text Book of IndustrialMicrobiology.
3. Hand Book of Enzyme Biotechnology byWiseman
4. James E .Bailey and David F Ollis, Biochemical Engineering Fundamentals, McGrawHillPublication.
5. Laboratory techniques in Biochemistry and Molecular Biology by work and work.
6. Methods in enzymology by W. A. Wood. AcademicPress
7. Methods of Enzymatic Analysis by Hans Ulrich. Bergmeyer, AcademicPress.
8. Peppler and Perlmen , Microbial Technology, Vol I and II , Academic Press.
9. Peppler H.J and Periman D., Microbial technology, Vol.I and Vol.II. Academic press NewYork.
10. Power C.H and H.F. Daginawala. General microbiology Vol. I andII.
11. Principles of Biochemistry 2 nd Edition byHorton.
12. Shuler and Fikret Kargi, Bioprocess Engineering basic concepts, 2nd edition, Prentice Hall publication.
13. Stanbury P.F, Whittekar, A and Hall SJ, Principles of fermentation Technology,PergamonPress.
14. Trehan K., Biotechnology, New age International publisher.
15. West and Toad, text book of Biochemistry Oxford and IBH

National Education Policy 2020

B.Sc. Agricultural Microbiology, III Year (Semester - V)

Major Core Theory Course

Course Code – SAGMIK1301

Title of the Course: Traditional Agriculture Practices

[No. of Credits: 2 Credit] **[Total: 30 Hours]**

Course pre-requisite:

1. The course is designed for students enrolled in the undergraduate second-year programme in the Faculty of Science and Technology. It is intended for those who have received foundational training in Agricultural Microbiology at the first-year undergraduate level and serves as an entry-level core course for students opting for Agricultural Microbiology as their major subject.
2. The students should possess basic knowledge of Agricultural Microbiology, including an understanding of microbial cell structure (prokaryotic and eukaryotic), classification of microorganisms (bacteria, fungi, viruses, and algae), and their general characteristics. They should be familiar with fundamental concepts such as microbial growth, metabolism, and reproduction. In addition, a preliminary understanding of aseptic techniques, sterilization methods, and the role of microorganisms in environment, industry, and human health is desirable for better comprehension of the course.

Course objectives:

1. To introduce the concept, scope, and interdisciplinary nature of **Traditional Agriculture**.
2. To understand the relationship between **microbiology, anthropology, and indigenous knowledge systems in Agriculture**.
3. To explore the role of microorganisms in **Agricultural Soil across different regions of India**.
4. To study the importance of **green manuring, biofertilizers, and natural farming practices** in sustainable agriculture.
5. To provide knowledge of **traditional bio-formulations** such as Bijamrut, Jivamrut, Panchagavya, and botanical pesticides.
6. To understand the role of microorganisms in **enhancing Soil fertility**.
7. To explain the concepts and applications of **traditional practices in Agriculture**.
8. To integrate traditional knowledge with **modern techniques and biotechnological approaches in Agriculture**.

Course outcomes:

After successful completion of this course, students will be able to:

1. Define and explain the **scope and significance of Traditional Agriculture Practices**.
2. Analyze the contribution of **indigenous knowledge systems** to **farming**.
3. Explain the role of microorganisms in **Agricultural Soil across India**.
4. Understand the principles and applications of **green manuring and biofertilizers** in sustainable agriculture.
5. Describe preparation and applications of **traditional bio-formulations and natural pest control methods**.
6. Explain the role of microorganisms in in **enhancing Soil fertility**.
7. Differentiate between **traditional and Modern practices in Agriculture**.
8. Apply traditional knowledge with **modern techniques and biotechnological approaches in Agriculture**.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Introduction to Traditional Agriculture**	

	1.1	Definition, scope, and importance of Traditional Agriculture	**07**
	1.2	Historical Evolution: Overview of ancient Indian farming systems and the philosophy of Vrikshayurveda	
	1.3	Seed Conservation: Traditional methods of seed selection, storage, and preservation of indigenous varieties.	
	1.4	Role of indigenous knowledge in Ancient Farming	
2.0		**Traditional Agriculture Practices in India**	
	2.1	Traditional Tools & Techniques: Use of animal power, wooden implements, and manual labor in land preparation.	**07**
	2.2	Resource Management: Indigenous irrigation systems, mixed cropping, and crop rotation for biodiversity	
	2.3	Soil Conservation: Techniques for preventing erosion and improving water-holding capacity through mulching	
3.0		**Green Manure and Bio-fertilizers**	
	3.1	Concept of green manure and the role of nitrogen-fixing bacteria in Biofertilizers	**08**
	3.2	Characteristics and cultivation of Sunnhemp (Crotalaria juncea), Dhaincha (Sesbania), and leguminous pulses	
	3.3	In-situ vs. Ex-situ: Benefits of burying green crops directly into the soil versus bringing in green leaf mulch.	
	3.4	Ecological Impact: Effect on soil texture, weed suppression, and long-term sustainability.	
4.0		**Bio-formulations and Natural Pest Control**	
	4.1	Bio-formulations and Natural Pest Control Seed Treatment: Preparation and application of Bijamrut for protecting young seedlings	**08**
	4.2	Nutrient Boosters: Standard procedures for making Jivamrut (liquid fertilizer) and Panchagavya (growth promoter)	
	4.3	Natural Pesticides: Formulation of Dashparni Ark and other botanical extracts for pest management	
	4.4	Application Schedules: Dosages, spray timings, and safety measures for organic liquid formulations.	
		Total	**30**

Textbooks and Reference Books:

1. Akanksha Dhananjay Dambare, Harsha Prasanna Gatne (2025) Indian Knowledge System-Ethno-Microbiology, by International Journal of Microbial Science.

National Education Policy 2020

B.Sc. Agricultural Microbiology, III Year (Semester - V)

Elective Theory Course

Course Code – SAGMET1301

Title of the Course: Plant Tissue Culture Techniques

[No. of Credits: 2 Credit] **[Total: 30 Hours]**

Course pre-requisite:

1. The course is designed for students enrolled in the undergraduate second-year programme in the Faculty of Science and Technology. It is intended for those who have received foundational training in Microbiology at the first-year undergraduate level and serves as an entry-level core course for students opting for Microbiology as their major subject.
2. The students should possess basic knowledge of Microbiology, including an understanding of microbial cell structure (prokaryotic and eukaryotic), classification of microorganisms (bacteria, fungi, viruses, and algae), and their general characteristics. They should be familiar with fundamental concepts such as microbial growth, metabolism, and reproduction. In addition, a preliminary understanding of aseptic techniques, sterilization methods, and the role of microorganisms in environment, industry, and human health is desirable for better comprehension of the course.

Course objectives:

1. To provide in-depth knowledge of **Plant Tissue Culture Techniques (PTC).**
2. To understand the explant **cultures used in** Plant Tissue Culture Techniques.
3. To explain the steps involved in Micro-propagation.
4. To develop the callus cultures, regeneration of new plants and artificial seed.
5. To understand acclimatization, hardening of PTC plants.
6. To provide PTC sugarcane and Banana plantlets to the Farmers
7. To develop entrepreneurs in PTC.

Course outcomes:

After successful completion of this course, students will be able to:

1. Identify and describe **Plant Tissue Culture Techniques (PTC)** and its importance.
2. Explain the lab. Infrastructure for **Plant Tissue Culture Techniques (PTC).**.
3. Describe the various **Nutrient Media (MS and others) used in PTC.**
4. Explain the steps involved in **micropropagation**.
5. Understand the role of acclimatization, hardening of PTC plants
6. Explain PTC sugarcane and Banana plantlets developed in labs. to the Farmers.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Introduction to Plant Tissue Culture**	
	1.1	Introduction and Principles of plant tissue culture, Brief History of Plant Tissue Culture Technique	**07**
	1.2	A Tissue Culture Laboratory Setup and Equipment	
	1.3	Sterilization Techniques, Cleanliness and Care	
	1.4	Nutrition and Physiology: Media components and preparation of PTC Media, Stock Solutions.	

	1.5	Totipotency, De- Differentiation, Re-differentiation	
2.0		**Types of cultures of Plant materials**	
	2.1	Explant culture, Callus culture, Cell suspension culture, Embryo culture, Organ culture, Anther and Pollen Culture, Organogenesis	**07**
	2.2	Protoplast culture:Isolation of protoplast, Protoplast culture and Regeneration	
	2.3	Protoplast fusion and Somatic Hybridization	
	2.4	Steps involved in Micro propagation	
3.0		**Production of Haploid plants**	
	3.1	Genetics and its role in plant tissue culture Somaclonal & Gametoclonal Variation: applications and limitations.	**08**
	3.2	Screening procedures. Haploid production (Anther, Ovule, Pollen cultures).	
	3.3	Cryopreservation and ex-situ conservation of germplasm. In vitro pollination and fertilization, embryo rescue, embryo culture, endosperm culture and production of seedless plants.	
	3.4	Somatic hybridization (Symmetric, Asymmetric, and Cybrids)	
4.0		**Applications in Agriculture**	
	4.1	Improvement of Hybrids	**08**
	4.2	Encapsulated Seeds and their production	
	4.3	Production of Disease Resistant Plants	
	4.4	Production of Stress Resistant Plants	
	4.5	Commercial crops like banana, sugarcane using PTC techniques	
		Total	**30**

Textbooks and references:

1. Poehlmann M. (1959) Breeding of field crops, Henry Holt and Co., New York.
2. Strickberger M.W. (1985) Genetics, Pearson Education Inc. , and Dorling Kindersley Publ., Inc.
3. Reinert J.R. and Bajaj Y.P.S.(1997) Applied and fundamental aspects of plant cell, tissue and organ culture. Springer and Verlag, Berlin.
4. Allard R. D. (1999) Princ'iples of Plant Breeding, John Wiley and Sons, Inc.
5. Purohit S.S. (1999) Agricultural Biotechnology. Agro Botanica. India
6. Levin B. (2000) Genes VII, Oxford Uni. press.
7. Sharma K.V.S. (2002) Plant Tissue Culture Techniques

National Education Policy 2020

B.Sc. Agricultural Microbiology, III Year (Semester - V)

Elective Practical Course

Course Code – SAGMEP1301

Title of the Course: Practical Based on SAGMET1301

[No. of Credits: 2 Credit] [Total: 60 Hours]

Course pre-requisite:

1. The course is designed for students enrolled in the undergraduate second-year programme in the Faculty of Science and Technology. It is intended for those who have received foundational training in Agricultural Microbiology at the first-year undergraduate level and serves as an entry-level core course for students opting for Agricultural Microbiology as their major subject.
2. The students should possess basic knowledge of Agricultural Microbiology, including an understanding of microbial cell structure (prokaryotic and eukaryotic), classification of microorganisms (bacteria, fungi, viruses, and algae), and their general characteristics. They should be familiar with fundamental concepts such as microbial growth, metabolism, and reproduction. In addition, a preliminary understanding of aseptic techniques, sterilization methods, and the role of microorganisms in environment, industry, and human health is desirable for better comprehension of the course.

Course objectives:

1. To provide in-depth knowledge of **Plant Tissue Culture Techniques (PTC).**
2. To understand the explant **cultures used in** Plant Tissue Culture Techniques.
3. To explain the steps involved in Micro-propagation.
4. To develop the callus cultures, regeneration of new plants and artificial seed.
5. To understand acclimatization, hardening of PTC plants.
6. To provide PTC sugarcane and Banana plantlets to the Farmers
7. To develop entrepreneurs in PTC.

Course outcomes:

After successful completion of this course, students will be able to:

1. Identify and describe **Plant Tissue Culture Techniques (PTC)** and its importance.
2. Explain the lab. Infrastructure for **Plant Tissue Culture Techniques (PTC).**.
3. Describe the various **Nutrient Media (MS and others) used in PTC.**
4. Explain the steps involved in **micropropagation**.
5. Understand the role of acclimatization, hardening of PTC plants
6. Explain PTC Sugarcane and Banana plantlets developed in labs. to the Farmers.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Preparation of PTC media and Sterilization**	
	1.1	Demonstration of Tissue culture Laboratory	**20 [5 practicals]**
	1.2	Nutrient media composition of PTC (Murashige & Skoog), Preparation of stock solution	
	1.3	Sterilization of MS media and Glasswares	
	1.4	Sterilization of Explants (surface sterilization)	
	1.5	Transfer of sterile explants on solidified nurient medium	
2.0		**Types of cultures**	
	2.1	Selection of explants, surface sterilization, establishment and maintenance of different types of plant cultures for callus induction and regeneration	**20 [5 Practicals]**
	2.2	Callus Formation and its culture	

	2.3	Organogenesis, root culture, shoot culture and micropropagation	
	2.4	Initiation and establishment of suspension cultures Micro propagation via adventitious shoot proliferation	
	2.5	Micro propagation of dicot and monocot plants via axillary shoot Proliferation	
3.0		**Preparation of Protoplasts and Artificial seeds**	
	3.1	Preparation of Protoplast from plant tissue	**16 [4 Practicals]**
	3.2	Demonstration of Protoplast fusion	
	3.3	Preparation of somatic embryo	
	3.4	Preparation of artificial seeds	
4.0			
	4.1	Production of Sugarcane and Banana plantlets by PTC technique	**4 [1 Practicals]**
		Total	**60**

Textbooks and references:

8. Poehlmann M. (1959) Breeding of field crops, Henry Holt and Co., New York.

9. Strickberger M.W. (1985) Genetics, Pearson Education Inc. , and Dorling Kindersley Publ., Inc.
10. Reinert J.R. and Bajaj Y.P.S.(1997) Applied and fundamental aspects of plant cell, tissue and organ culture. Springer and Verlag, Berlin.
11. Allard R. D. (1999) Princ'iples of Plant Breeding, John Wiley and Sons, Inc.
12. Purohit S.S. (1999) Agricultural Biotechnology. Agro Botanica. India
13. Levin B. (2000) Genes VII, Oxford Uni. press.
14. Sharma K.V.S. (2002) Plant Tissue Culture Techniques

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B.Sc. Agricultural Microbiology, III Year (Semester - V)

Elective Theory Course

Course Code – SAGMET1302

Title of the Course: Bioinstrumentation

[No. of Credits: 2 Credit] **[Total: 30 Hours]**

Course pre-requisite:

1. The course is designed for students enrolled in the undergraduate second-year programme in the Faculty of Science and Technology. It is intended for those who have received foundational training in Microbiology at the first-year undergraduate level and serves as an entry-level core course for students opting for Microbiology as their major subject.
2. The students should possess basic knowledge of Microbiology, including an understanding of microbial cell structure (prokaryotic and eukaryotic), classification of microorganisms (bacteria, fungi, viruses, and algae), and their general characteristics. They should be familiar with fundamental concepts such as microbial growth, metabolism, and reproduction. In addition, a preliminary understanding of aseptic techniques, sterilization methods, and the role of microorganisms in environment, industry, and human health is desirable for better comprehension of the course.

Course objectives:

The course is designed to:

1. Provide fundamental understanding of **bioinstrumentation principles**, including measurement systems, units, and performance characteristics such as accuracy, precision, sensitivity, and resolution.
2. Familiarize students with **calibration, standardization**, and the role of detectors and transducers in biological measurements.
3. Develop knowledge of **centrifugation techniques** and their application in separation of biological materials.
4. Introduce the principles and applications of **chromatographic and electrophoretic techniques** used in microbiological and biochemical analysis.
5. Explain the working principles and applications of **spectroscopic methods**, including UV-Visible spectrophotometry, fluorimetry, and IR spectroscopy.
6. Provide insight into **advanced instruments** such as PCR, gel documentation systems, ELISA readers, and biosensors.
7. Promote awareness of **laboratory safety and Good Laboratory Practices (GLP)** in handling sophisticated instruments.

Course outcomes:

After successful completion of this course, students will be able to:

1. Explain the **basic principles of bioinstrumentation**, measurement systems, and performance parameters.
2. Perform and understand **calibration and standardization** procedures in laboratory instruments.
3. Describe and apply **centrifugation techniques** for separation of biological components.
4. Demonstrate knowledge of **chromatographic and electrophoretic methods** for analysis of biomolecules.
5. Apply **spectroscopic techniques** and interpret results based on the Beer-Lambert law.
6. Understand the working and applications of **modern analytical instruments** such as PCR, ELISA, and biosensors.
7. Analyze experimental data generated using **bioanalytical instruments** in microbiology and biotechnology.

8. Follow **Good Laboratory Practices (GLP)** and ensure safety while handling laboratory instruments.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Fundamentals of Bioinstrumentation**	
	1.1	Measurement systems and units; Accuracy, precision, sensitivity and resolution	**07**
	1.2	Calibration and standardization	
	1.3	Detectors and transducers	
	1.4	Laboratory safety and Good Laboratory Practices (GLP)	
2.0		**Centrifugation and Separation by Sedimentation**	
	2.1	Principles of centrifugation (RCF and sedimentation)	**07**
	2.2	Types: differential centrifugation	
	2.3	Density gradient centrifugation	
	2.4	Ultracentrifugation (basic idea)	
3.0		**Chromatography and Electrophoresis**	
	3.1	Principles of chromatography	**08**
	3.2	Types: Paper, TLC, Column chromatography	
	3.3	Basic idea of HPLC	
	3.4	Gel electrophoresis (agarose and PAGE)	
	3.5	Applications in microbial analysis	
4.0		**Spectroscopy and Advanced Instruments**	
	4.1	Principles of spectroscopy; UV-Visible spectrophotometer and colorimetry Fluorimetry and basics of IR spectroscopy	**08**
	4.2	Beer-Lambert Law and applications PCR (Thermocycler)	
	4.3	Gel documentation system ELISA reader and washer	
	4.4	Biosensors (basic concept) Introduction to automated instruments (RT-PCR, microbial analyzers)	
		Total	**30**

Textbooks and Reference Books:

1. Veerakumari, L. (2019). *Bioinstrumentation*. MJP Publisher.
2. Boyer, R. (2000). Modern Experimental Biochemistry. (3rd ed.). Addison Wesley Longman, New Delhi.
3. Chatwal, G.R., and Anand, S.K., (2003). Instrumental Methods of Chemical Analysis. (5th ed.). Himalaya Publishing House, Mumbai
4. Friedfelder, D. (2001). Physical Biochemistry: Applications to biochemistry and molecular biology. Oxford Publishers, New York.
5. Sharma, B.K. (2007). Instrumental Methods of Chemical Analysis, Krishna Prakashan Media (P) Ltd, India.
6. Wilson, K., and Walker, J., (2010). Principles and Techniques of Biochemistry and Molecular Biology, (7th Low Price ed.). Cambridge University Press, India.

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B.Sc. Agricultural Microbiology, III Year (Semester - V)

Elective Practical Course

Course Code – SAGMEP1302

Title of the Course: Practical Based on SAGMET1302

[No. of Credits: 2 Credit] **[Total: 60 Hours]**

Course pre-requisite:

1. The course is designed for students enrolled in the undergraduate second-year programme in the Faculty of Science and Technology. It is intended for those who have received foundational training in Microbiology at the first-year undergraduate level and serves as an entry-level core course for students opting for Microbiology as their major subject.
2. The students should possess basic knowledge of Microbiology, including an understanding of microbial cell structure (prokaryotic and eukaryotic), classification of microorganisms (bacteria, fungi, viruses, and algae), and their general characteristics. They should be familiar with fundamental concepts such as microbial growth, metabolism, and reproduction. In addition, a preliminary understanding of aseptic techniques, sterilization methods, and the role of microorganisms in environment, industry, and human health is desirable for better comprehension of the course.

Course objectives:

The course is designed to:

1. Provide hands-on training in the **use and operation of basic laboratory instruments** such as pipettes, volumetric flasks, weighing balances, and spectrophotometers.
2. Develop understanding of **measurement accuracy, precision, and calibration techniques** using standard laboratory equipment.
3. Familiarize students with the **principles and practical applications of centrifugation**, including calculation of RPM and relative centrifugal force (RCF).
4. Train students in **separation techniques** such as paper chromatography, thin layer chromatography (TLC), and agarose gel electrophoresis.
5. Introduce the practical aspects of **spectrophotometry and colorimetry**, including verification of Beer–Lambert law.
6. Enable estimation and analysis of **biomolecules (DNA, RNA, proteins)** using spectrophotometric methods.
7. Provide exposure to **modern analytical tools**, including biosensors such as glucose meters.
8. Develop skills in **experimental observation, data recording, and interpretation** of analytical results.

Course outcomes:

After successful completion of this course, students will be able to:

1. Operate and handle **basic laboratory instruments** with accuracy and follow standard procedures.
2. Perform **calibration and measurement exercises** and evaluate accuracy and precision of experimental data.
3. Calculate and apply **RPM and relative centrifugal force (RCF)** and perform centrifugation-based separation techniques.
4. Conduct and interpret **chromatographic techniques** (paper chromatography and TLC) for separation of biomolecules.
5. Perform **agarose gel electrophoresis** and understand its applications in biomolecular analysis.
6. Apply **spectrophotometric methods** for verification of Beer–Lambert law and estimation of biomolecules.

7. Analyze **UV absorption spectra** of nucleic acids and proteins for qualitative and quantitative assessment.
8. Understand the working principle and application of **biosensors**, such as glucose biosensors.
9. Record, analyze, and interpret experimental results and present findings in a **systematic scientific manner**.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Fundamentals of Bioinstrumentation**	
	1.1	Study of basic laboratory instruments available in your lab and their uses	**12 [3 practicals]**
	1.2	Demonstration of calibration concepts using simple measuring devices like Measuring cylinder, pipettes (graduated and volumetric), micropipettes, standard volumetric flask, thermometer in water bath.	
	1.3	Exercise on accuracy and precision (weighing repeated	
2.0		**Centrifugation and Separation by Sedimentation**	
	2.1	Study of laboratory centrifuge and its components	**20 [5 Practicals]**
	2.2	Calculation of RPM and relative centrifugal force (numerical exercise)	
	2.3	Demonstration of differential centrifugation	
	2.4	Separation of particles using centrifugation (simple suspension)	
	2.5	Observation and interpretation of sedimentation results	
3.0		**Chromatography and Electrophoresis**	
	3.1	Paper chromatography (separation of amino acids or pigments)	**12[3 Practicals]**
	3.2	Thin Layer Chromatography (TLC)	
	3.3	Interpretation of chromatogram	
	3.4	Agarose gel electrophoresis (practical/demonstration as per availability)	
4.0		**Spectroscopy and Advanced Instruments**	
	4.1	Demonstration of colorimeter / spectrophotometer and verification of Beer-Lambert Law	**16 [4 Practicals]**
	4.2	Estimation of biomolecules using vis spectrophotometric method	
	4.3	UV absorption spectra of nucleic acids /proteins using UV spectrophotometer.	
	4.4	Demonstration and explanation of Biosensors using Glucose biosensors (blood glucometer).	
		Total	**60**

Textbooks and Reference Books:

1. Laboratory Exercises in Microbiology, Fifth Edition Harley−Prescott
2. Cappuccino, J., Cappuccino, J. G., & Welsh, C. T. (2017). *Microbiology: A laboratory manual*. BoD–Books on Demand.
3. Microbiological Applications Lab Manual, Eighth Edition by Benson
4. Hiper Teaching Kit published by Himedia Laboratories Pvt. Ltd.
5. Dubey, R. C., & Maheshwari, D. K. (2002). *Practical Microbiology, 4/e*. S. Chand Publishing.

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B.Sc. Agricultural Microbiology, III Year (Semester - V)

Elective Practical Course

Course Code – SAGMVC1302

Title of the Course: Plant Biotechnology

[No. of Credits: 2 Credit] **[Total: 60 Hours]**

Course pre-requisite:

1. The course is designed for students enrolled in the undergraduate second-year programme in the Faculty of Science and Technology. It is intended for those who have received foundational training in Agricultural Microbiology at the first-year undergraduate level and serves as an entry-level core course for students opting for Agricultural Microbiology as their major subject.
2. The students should possess basic knowledge of Agricultural Microbiology, including an understanding of microbial cell structure (prokaryotic and eukaryotic), classification of microorganisms (bacteria, fungi, viruses, and algae), and their general characteristics. They should be familiar with fundamental concepts such as microbial growth, metabolism, and reproduction. In addition, a preliminary understanding of aseptic techniques, sterilization methods, and the role of microorganisms in environment, industry, and human health is desirable for better comprehension of the course.

Course objectives:

1. To provide in-depth knowledge of **Plant Biotechnology.**
2. To explain the steps involved in **Isolation and Characterization of Nitrogen fixing microorganisms.**
3. To produce the **Microbial biofertilizers.**
4. To understand the preparation of **Farm yard manure and Green manure.**
5. To prepare **bioformulations** as plant growth promoters
6. To understand the use of technology in production of **Biofuels and Bioenergy.**
7. To develop entrepreneurs.

Course outcomes:

After successful completion of this course, students will be able to:

1. Identify and describe **Plant Biotechnology** and its importance.
2. Explain the methods of **Isolation and Characterization of Nitrogen fixing microorganisms.**
3. Describe the various **Microbial biofertilizers.**
4. Explain the steps involved in the preparation of **Farm yard manure and Green manure.**
5. Understand the role of prepared **bioformulations.**
6. Explain the use of technology in production of **Biofuels and Bioenergy.**

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Biofertilizers**	
	1.1	Isolation of *Azotobacter* and production of *Azotobacter* Biofertilizer	**24 [6 practicals]**
	1.2	Isolation of *Rhizobium* from Root Nodules and production of *Rhizobium* Biofertilizer	
	1.3	Isolation of *Azospirillum* from Root Nodules and production of *Azospirillum* Biofertilizer	
	1.4	Isolation of Blue Green Algae and Azolla and production of Biofertilizer	
	1.5	Production of Mycorrhizal Biofertilizer	
	1.6	Isolation and characterization of Phosphate Solubilizing Microorganisms	

2.0		**Green Manures and Bio-Composts**	
	2.1	Preparation of Farm yard manure	**12 [3 Practicals]**
	2.2	Preparation of green manure	
	2.3	Bio-composting of Agro-wastes	
3.0		**Bioformulations**	
	3.1	Preparation and application of Bijamrut for protecting young seedlings	**16[4 Practicals]**
	3.2	Preparation of Jivamrut (liquid fertilizer) and its use	
	3.3	Preparation of Panchagavya (growth promoter) and its use	
	3.4	Formulation of Dashparni Ark and other botanical extracts for pest management.	
4.0		**Bio-fuels and Bio-energy**	
	4.1	Bio-ethanol Production using sugarcane molasses	**08 [2 Practicals]**
	4.2	Biogas Production from Agro-wastes	
		Total	**60**

Textbooks and Reference Books:

1. Laboratory Exercises in Microbiology, Fifth Edition Harley−Prescott
2. Cappuccino, J., Cappuccino, J. G., & Welsh, C. T. (2017). *Microbiology: A laboratory manual*. BoD–Books on Demand.
3. Microbiological Applications Lab Manual, Eighth Edition by Benson
4. Hiper Teaching Kit published by Himedia Laboratories Pvt. Ltd.
5. Dubey, R. C., & Maheshwari, D. K. (2002). *Practical Microbiology, 4/e*. S. Chand Publishing.
6. http://shodhganga.inflibnet.ac.in/bitstream/10603/2219/12/12_chapter%201.pdf

Syllabus for B. Sc. Agricultural Microbiology

Third Year

Semester – VI

As Per National Education Policy- 2020

To be implemented from

Academic Year 2026-2027

National Education Policy 2020

B.Sc. Agricultural Microbiology, III Year (Semester - VI)

Major Core Theory Course

Course Code – SAGMCT1351

Title of the Course: Molecular Biology

[No. of Credits: 3 Credit] **[Total: 45 Hours]**

Course pre-requisite:

1. The course is designed for students enrolled in the undergraduate second-year programme in the Faculty of Science and Technology. It is intended for those who have received foundational training in Agricultural Microbiology at the first-year undergraduate level and serves as an entry-level core course for students opting for Agricultural Microbiology as their major subject.
2. The students should possess basic knowledge of Agricultural Microbiology, including an understanding of microbial cell structure (prokaryotic and eukaryotic), classification of microorganisms (bacteria, fungi, viruses, and algae), and their general characteristics. They should be familiar with fundamental concepts such as microbial growth, metabolism, and reproduction. In addition, a preliminary understanding of aseptic techniques, sterilization methods, and the role of microorganisms in environment, industry, and human health is desirable for better comprehension of the course.

Course objectives:

After completion of this module, students will be able to:

1. **Understand the fundamental principles of gene expression**, including the genetic code, transcription, and translation in prokaryotic systems.
2. **Explain the structure and function of key molecular machinery**, such as RNA polymerase and ribosomes involved in protein synthesis.
3. **Analyze different types of mutations and their molecular mechanisms**, including spontaneous and induced mutagenesis.
4. **Describe various DNA repair mechanisms** and their role in maintaining genomic stability.
5. **Interpret regulatory mechanisms of gene expression in prokaryotes**, including operon models such as lac and trp operons.
6. **Understand tools and techniques used in molecular cloning and gene transfer**, along with their applications in biotechnology.
7. **Develop conceptual knowledge of recombinant DNA technology**, including screening strategies and expression of foreign genes.

Course outcomes:

Upon successful completion of this module, students will be able to:

1. **Describe the genetic code and mechanisms of transcription and translation**, including bacterial transcriptional and translational cycles.
2. **Explain the structure and role of RNA polymerase and ribosomes** in gene expression.
3. **Classify different types of mutations** and explain mechanisms of spontaneous and induced mutagenesis.
4. **Illustrate various DNA repair pathways** such as photoreactivation, NER, BER, and mismatch repair.
5. **Analyze gene regulation mechanisms in prokaryotes**, including the role of repressors, activators, sigma factors, and attenuation.
6. **Explain the working of operons**, particularly lac and trp operons in *E. coli*.
7. **Describe molecular cloning tools and vectors**, including restriction enzymes, ligases, plasmids, bacteriophages, and cosmids.
8. **Demonstrate understanding of gene transfer methods** such as transformation, electroporation, transduction, and liposome fusion.

9. **Explain screening methods used in recombinant DNA technology** such as insertional inactivation and colony hybridization.
10. **Apply knowledge of molecular techniques in biotechnology**, exemplified by the expression of the human insulin gene in *E. coli*.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Gene Expression**	
	1.1	Genetic code: Characteristics of Genetic code: Triplet code, comma free, non-overlapping, degenerate, start and stop signals and wobble hypothesis	**09**
	1.2	Structure of RNA Polymerase (RNAP)	
	1.3	Process of transcription	
	1.4	Structure of Ribosome: Process of Translation	
	1.5	Bacterial Transcriptional and Translational Cycle	
2.0		**Mutagenesis and DNA Repair**	
	2.1	Concept of Mutation Types of Mutations: Silent, Missense, base pair substitutions or switches and frameshift mutations, induced and spontaneous mutation	**12**
	2.2	Mechanism of Spontaneous Mutation: Mispairing of Bases due to Tautomerism, Deamination, Depurination and Damage due to Oxidative Metabolism	
	2.3	Mechanism of Induced Mutation: Physical and Chemical Mutagenic agents	
	2.4	Repair of DNA by a. Photo-reactivation b. Nucleotide Excision Repair (NER) c. Base Excision Repair (BER) d. iv. Mismatch Excision Repair (MER)	
3.0		**Regulation of Gene expression in Prokaryotes**	
	3.1	Gene regulation at Transcription level: Repressors, Activators, Sigma factor and Attenuation	**12**
	3.2	Gene regulation at Translation level	
	3.3	The lac Operon of *E. coli* The trp Operon of *E. coli*	
4.0		**Molecular Techniques and Applications**	
	4.1	Introduction, Definition and purpose of Cloning	**12**
	4.2	Tools for molecular cloning: a. Enzymes: Restriction endonucleases, DNA ligases, alkaline phosphatase, DNA Modifying enzymes b. Vectors: PlasmidspBR322, Bacteriophage- Phage λ, Cosmids	
	4.3	Methods of Gene Transfer a. Transformation b. Electroporation c. Liposome Fusion d. Transduction	
	4.4	Screening Strategies (In short) a. Insertional Inactivation b. Immunochemical Methods c. Colony hybridization	

	4.5	Application: Expression of Human insulin gene in *E. coli*	
		Total	**45**

Textbooks and Reference Books:

1. Genetics-A molecular approach (2nd /3rd ed.) by Peter J. Russell (2006)
2. Genetics a conceptual approach (3rd ed.) by Benjamin A. Pierce (2008) Publisher: W.H. Freeman and Company.
3. Principles of Genetics by R. H. Tamarin, (2004) Publisher: Tata McGraw Hill.
4. Essentials of Molecular Biology by David Freifelder (2002), Publisher: Narosa Publishing House.
5. General Microbiology (5th edn.) Stanier R. Y., Ingraham, J.L., Wheelis, M. L., Painter, P.R.(2008), Publisher: Macmillan Press Ltd, London
6. General Microbiology (Vol. I and II)Powar, C.B. and Daginawala,H.F.(2008), Publisher: Himalaya publishing house
7. Biotechnology by Satyanarayana U. (2007), Publisher: Books and Allied Pvt. Ltd.Kolkata.
8. Molecular Biology and Genetic Engineering by Narayanan, Moni, Selvaraj, Singh, Arumugam (2004) Publisher: Saras Publication, Nagercoil, Kanyakumari.
9. Modern Microbial Genetics, Second Edition. Edited by Uldis N. Streips, Ronald E.Yasbin. Publisher: Wiley-Liss, Inc.
10. Fundamental Bacterial Genetics by Nancy Trun and Jenanine Trumphy (2003),Publisher: Blackwell Publishing: Tata McGraw Hill.
11. Willey, Joanne M. Prescott, Harley, and Klein's Microbiology / Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton. — 7th ed. Published by McGraw- Hill, a business unit of The McGraw-Hill Companies, Inc., 1221 Avenue of the Americas, New York, NY 10020.
12. Brock Biology of Microorganisms, Thirteenth Edition by Michael T. Madigan, John M. Martinko, David A. Stahl, David P. Clark, Benjamin Cummings, 1301 Sansome Street,San Francisco, CA 94111.
13. Molecular Genetics of Bacteria (2013) by Larry Snyder, Joseph E. Peters, Tina M. Henkin and Wendy Champness 4th Edition, ASM Press

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B.Sc. Agricultural Microbiology, III Year (Semester - VI)

Major Core Practical Course

Course Code – SAGMCP1351

Title of the Course: Practical Based on SAGMCT1351

[No. of Credits: 2 Credit] **[Total: 60 Hours]**

Course pre-requisite:

1. The course is designed for students enrolled in the undergraduate second-year programme in the Faculty of Science and Technology. It is intended for those who have received foundational training in Microbiology at the first-year undergraduate level and serves as an entry-level core course for students opting for Microbiology as their major subject.
2. The students should possess basic knowledge of Microbiology, including an understanding of microbial cell structure (prokaryotic and eukaryotic), classification of microorganisms (bacteria, fungi, viruses, and algae), and their general characteristics. They should be familiar with fundamental concepts such as microbial growth, metabolism, and reproduction. In addition, a preliminary understanding of aseptic techniques, sterilization methods, and the role of microorganisms in environment, industry, and human health is desirable for better comprehension of the course.

Course objectives:

1. **Develop practical skills in isolation and characterization of plasmid DNA**, including extraction, purification, and analytical techniques.
2. **Understand and apply spectrophotometric methods** for DNA quantification, purity assessment, and thermal denaturation studies.
3. **Gain experimental knowledge of mutation and DNA repair mechanisms** using model organisms such as *Escherichia coli* and yeast.
4. **Perform mutagenesis experiments using physical and chemical agents** and analyze their effects on microbial survival.
5. **Isolate and characterize different types of mutants**, including antibiotic-resistant and morphological mutants.
6. **Understand gene expression experimentally**, with reference to operon systems (lac operon in *E. coli*).
7. **Apply basic molecular biology techniques**, such as restriction digestion, agarose gel electrophoresis, and replica plating.
8. **Develop analytical, observational, and data interpretation skills** in molecular microbiology experiments.

Course outcomes:

After successful completion of this course, students will be able to:

1. **Isolate and purify plasmid DNA from *Escherichia coli*** and assess its quality using standard laboratory techniques.
2. **Quantify and evaluate purity of DNA** using spectrophotometric methods and chemical assays (Diphenylamine method).
3. **Determine DNA melting temperature (Tm) and estimate G+C content**, interpreting nucleic acid stability.
4. **Perform agarose gel electrophoresis** for separation and visualization of plasmid DNA.
5. **Analyze UV survival curves in yeast and *E. coli*** and interpret mutation frequency.
6. **Demonstrate DNA repair mechanisms**, including dark repair and photoreactivation in microbial systems.
7. **Induce mutations using physical and chemical mutagens** and evaluate their effects on microbial populations.

8. **Isolate and characterize antibiotic-resistant and morphological mutants** using appropriate screening techniques.
9. **Demonstrate gene expression studies in *E. coli***, particularly lac operon regulation.
10. **Perform restriction digestion and analyze DNA fragments**, interpreting banding patterns.
11. **Apply replica plating technique** to identify mutants and study mutation patterns.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Molecular Characterization of Plasmid DNA**	
	1.1	Cell Lysis, Extraction and Purification of Plasmid DNA from *Escherichia coli*	**20 [5 practicals]**
	1.2	Spectrophotometric Confirmation and Purity Assessment of plasmid DNA	
	1.3	Spectrophotometric Quantification of Plasmid DNA Using Diphenylamine Reagent	
	1.4	Determination of Plasmid DNA Denaturation Temperature (Tm) and G+C Content	
	1.5	Separation and Visualization of Plasmid DNA by Agarose Gel Electrophoresis	
2.0		**Mutation and Mutational Repair study**	
	2.1	To Study the UV survival pattern of Yeast	**16 [4 Practicals]**
	2.2	Repair mechanisms in Yeast (Dark and Photo reactivation)	
	2.3	To study the U.V survival pattern of *E.coli*	
	2.4	Repair mechanisms in *E.coli* (Dark and Photo reactivation)	
3.0		**Applications of Mutations**	
	3.1	Isolation of antibiotics resistant Bacterial Mutants by Chemical Mutagenic Agents	**16 [4 Practicals]**
	3.2	Isolation of antibiotics resistant Bacterial Mutants by Physical Mutagenic agents	
	3.3	Isolation of Morphological mutants by Physical Mutagenic agents	
	3.4	Studies on gene expression in *E. coli* with reference to Lac operon	
4.0		**Molecular Techniques**	
	4.1	Restriction digestion and Agarose gel electrophoresis of DNA	**08 [2 Practicals]**
	4.2	Replica Plating Techniques	
		Total	**60**

Textbooks and Reference Books:

1. Gautam, A. (2022). DNA and RNA Isolation Techniques for Non-experts (pp. 79-84). Cham: Springer.
2. Laboratory Exercises in Microbiology, Fifth Edition Harley−Prescott
3. Microbiology – A laboratory Manual 10th edition by James Cappuccino and Natalie Sherman
4. Microbiological Applications Lab Manual, Eighth Edition by Benson
5. Hiper Teaching Kit published by Himedia Laboratories Pvt. Ltd. Molecular Genetics of Bacteria (2013) by Larry Snyder, Joseph E. Peters, Tina M. Henkin and Wendy Champness 4th Edition, ASM Press

National Education Policy 2020

B.Sc. Agricultural Microbiology, III Year (Semester - VI)

Major Core Theory Course

Course Code – SAGMCT1352

Title of the Course: Agricultural Biotechnology

[No. of Credits: 3 Credit] **[Total: 45 Hours]**

Course pre-requisite:

1. The course is designed for students enrolled in the undergraduate second-year programme in the Faculty of Science and Technology. It is intended for those who have received foundational training in Agricultural Microbiology at the first-year undergraduate level and serves as an entry-level core course for students opting for Agricultural Microbiology as their major subject.
2. The students should possess basic knowledge of Agricultural Microbiology, including an understanding of microbial cell structure (prokaryotic and eukaryotic), classification of microorganisms (bacteria, fungi, viruses, and algae), and their general characteristics. They should be familiar with fundamental concepts such as microbial growth, metabolism, and reproduction. In addition, a preliminary understanding of aseptic techniques, sterilization methods, and the role of microorganisms in environment, industry, and human health is desirable for better comprehension of the course.

Course objectives:

After completion of this module, students will be able to:

1. **Understand the scope and significance of Agricultural Biotechnology** and its role in modern biotechnology industries.
2. **Develop knowledge of microbial production of Biofertilizers**
3. **Understand the production of** Biogas and Biodiesel production
4. **Gain insight into** Plant Tissue culture techniques
5. **Understand the industrial production of important metabolites** such as organic acids, antibiotics, and bio-products.
6. **Familiarize with** computer applications and automation in fermentation technology.
7. **Develop an integrated understanding of** industrial fermentation processes.
8. **Application of** Tissue culture techniques in Agriculture.

Course outcomes:

Upon successful completion of this module, students will be able to:

1. **Define and explain the scope of Agricultural Biotechnology** and the role of microbiologists in Agrobased industries.
2. **Describe the** microbial production of Biofertilizers
3. **Different types of** explants used in Plant Tissue culture techniques
4. **Explain production of** Biogas and Biodiesel production
5. **Demonstrate knowledge of** Tissue culture techniques in Agriculture

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Biofertilizers**	
	1.1	Isolation, Characterization, Identification, mass production and field Applications of Biofertilizers: *Rhizobium*	**10**

	1.2	Isolation, Characterization, Identification, mass production and field Isolation, Characterization, Identification, mass production and field Applications of Biofertilizers: *Azotobacter*	
	1.3	Isolation, Characterization, Identification, mass production and field Applications of Biofertilizers: Blue green algae	
	1.4	Isolation, Characterization, Identification, mass production and field Applications of Biofertilizers: Mycorrhizae	
	1.5	Isolation, Characterization, Identification, mass production and field Applications of Biofertilizers: *Azospirillum*	
2.0		**Bioenergy and Biofuels**	
	2.1	Ethanol: Industrial Production of Ethanol and its application	**09**
	2.2	Biogas: Production of Biogas, Stages of methanogenesis, Biochemistry of methane formation, Application of Biogas	
	2.3	Hydrogen Production and conversion of light energy, its application.	
	2.4	Biodiesel production: Biodiesel producing plants, industrial production its application.	
3.0		**Plant Cell Cultures**	
	3.1	Basic Requirements for Tissue culture laboratory, Formulation of tissue culture Medium, Sterilization of Media	**12**
	3.2	Collection of explant materials, Surface sterilization of explant materials.	
	3.3	Callus culture, suspension culture, embryo culture, meristem culture, antherculture, Callus formation and its culture, Organogenesis and micropropagation	
	3.4	Application of Plant tissue culture technique	
4.0		**Secondary metabolites and Transgenic Plants**	
	4.1	Secondary metabolites from Cell Cultures	**14**
	4.2	Secondary metabolites from Immobilized plant cells	
	4.3	Bio-transformation: Defination, advantages and disadvantages; Microbial transformations with example	
	4.4	Biochemical Production: Biochemicals from cultured plant cells, improving Biochemcal production by optimization of medium, culture conditions; development of high producing clones and elicitors.	
	4.5	Commercial production of Shikonin	

	4.6	Transgenic Plants: Transgenic Plants for crop improvement, Herbicide resistant, Stress resistant, drought resistant	
	4.7	Transgenic Plants as bioreactors: Golden Rice; Vit A, Improved nutritional quality, Modification of oil quality, Plant edible vaccine.	
		Total	**45**

Textbooks and Reference Books:

1. Industrial Microbiology by A.H. Patel.
2. Industrial Microbiology by Prescott & Dunn.
3. Industrial Microbiology by Casida
4. Biotechnology: A textbook of Industrial Microbiology by Cruger and Cruger
5. Modern Industrial Microbiology and Biotechnology by Nduka Okafor
6. Industrial Microbiology: An Introduction by Wastes, Morgan, Rockey and Higten
7. Practical Microbiology by Maheshwari and Dubey
8. Principles of Fermentation Technology by Peter F. Stanbury Allan Whitaker Stephen J. Hall publisher: Elsevier.

National Education Policy 2020

B.Sc. Agricultural Microbiology, III Year (Semester - VI)

Major Core Practical Course

Course Code – SAGMCP1352

Title of the Course: Practical Based on SAGMCT1352

[No. of Credits: 2 Credit] **[Total: 60 Hours]**

Course pre-requisite:

1. The course is designed for students enrolled in the undergraduate second-year programme in the Faculty of Science and Technology. It is intended for those who have received foundational training in Microbiology at the first-year undergraduate level and serves as an entry-level core course for students opting for Microbiology as their major subject.
2. The students should possess basic knowledge of Microbiology, including an understanding of microbial cell structure (prokaryotic and eukaryotic), classification of microorganisms (bacteria, fungi, viruses, and algae), and their general characteristics. They should be familiar with fundamental concepts such as microbial growth, metabolism, and reproduction. In addition, a preliminary understanding of aseptic techniques, sterilization methods, and the role of microorganisms in environment, industry, and human health is desirable for better comprehension of the course.

Course objectives:

After completion of this module, students will be able to:

1. **Understand the scope and significance of Agricultural Biotechnology** and its role in modern Agrobased industries.
2. **Develop knowledge of microbial production of Biofertilizers**
3. **Gain insight into** Plant Tissue culture techniques
4. **Application of** Tissue culture techniques in Agriculture
5. **Understand the industrial production of Bioethanol and Biodiesel**
6. **Familiarize with** methanogenesis and Biogas production.
7. **Develop an integrated understanding of** industrial fermentation processes.

Course outcomes:

Upon successful completion of this module, students will be able to:

1. **Define and explain the scope of Agricultural Biotechnology** and the role of microbiologists in Agrobased industries.
2. **Describe the** microbial production of Biofertilizers
3. **Different types of** explants used in Plant Tissue culture techniques
4. **Explain production of** Biogas and Biodiesel production
5. **Demonstrate knowledge of** Tissue culture techniques in Agriculture

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Biofertilizer production**	
	1.1	Mass Production of Biofertilizer (*Rhizobium*)	**16[4 practicals]**
	1.2	Mass Production of Biofertilizer (*Azotobacter*)	
	1.3	Mass Production of Biofertilizer (*Blue green algae*)	
	1.4	Mass Production of Biofertilizer (*Azospirillum*)	
2.0		**Biofuels production**	
	2.1	Production of Wine & and its estimation by Titrable acidity	**12 [3 Practicals]**
	2.2	Production of Alcohol and its Estimation by Specific Gravity method	

	2.3	Production of Biogas	
3.0		**Plant Tissue culture**	
	3.1	Preparation of tissue culture Medium, Sterilization of Media (MS)	**16 [4 Practicals]**
	3.2	Selection of explant materials, Surface sterilization of explant materials	
	3.3	Development of callus culture using *Daucus carota* root cambium	
	3.4	Preparation of artificial seeds using somatic embryo	
4.0		**Secondary metabolites and Transgenic plants**	
	4.1	Production of Antibiotics, Shikonin	**16 [4 Practicals]**
	4.2	Study of Bt cotton, Bt Bringal	
	4.3	Study of Golden Rice, improved oil seeds	
	4.4	Study of Herbicide resistant transgenic plants	
		Total	**60**

Textbooks and Reference Books:

1. Principles and Applications of Fermentation Technology by Arindam Kuila and Vinay Sharma, Scrivener Publisher.
2. Laboratory Exercises in Microbiology, Fifth Edition Harley−Prescott
3. Microbiology – A laboratory Manual 10th edition by James Cappuccino and Natalie Sherman
4. Microbiological Applications Lab Manual, Eighth Edition by Benson
5. Laboratory Manual in Microbiology by Balkrishna M, Sandikar and Shaileshkumar V. Mamdapure, Kripa Drishti Publications, Pune, 2021
6. Microbiology: A Laboratory Manual, by James G. Cappuccino, Natalie Sherman,Publisher :Pearson Benjamin Cummings; 10th edition

National Education Policy 2020

B.Sc. Agricultural Microbiology, III Year (Semester - VI)

Major Core Theory Course

Course Code – SAGMCT1353

Title of the Course: Organic Farming

[No. of Credits: 2 Credit] **[Total: 30 Hours]**

Course pre-requisite:

1. The course is designed for students enrolled in the undergraduate second-year programme in the Faculty of Science and Technology. It is intended for those who have received foundational training in Agricultural Microbiology at the first-year undergraduate level and serves as an entry-level core course for students opting for Agricultural Microbiology as their major subject.
2. The students should possess basic knowledge of Agricultural Microbiology, including an understanding of microbial cell structure (prokaryotic and eukaryotic), classification of microorganisms (bacteria, fungi, viruses, and algae), and their general characteristics. They should be familiar with fundamental concepts such as microbial growth, metabolism, and reproduction. In addition, a preliminary understanding of aseptic techniques, sterilization methods, and the role of microorganisms in environment, industry, and human health is desirable for better comprehension of the course.

Course objectives:

After completion of this module, students will be able to:

1. **Understand the scope and importance of Organic farming** in sustainable agriculture and soil health.
2. **Gain knowledge of soil microbial diversity** and their ecological roles in different soil environments.
3. **Understand the** principles of Organic Farming, Soil health in Organic Agriculture.
4. **Understand** Certification of Organic farming in India**.**
5. **Gain knowledge of** Composting, Cover Cropping, Crop rotation and Pest management
6. **Familiarize with** weed management strategies without synthetic Herbicides
7. **Familiarize with** Market trends and consumer demand for organic products.
8. **Gain knowledge of** Financial incentives and support programs for organic farmers.

Course outcomes:

Upon successful completion of this module, students will be able to:

1. **Describe scope and importance of Organic farming** in sustainable agriculture.
2. **Identify soil microorganisms** and their ecological roles in different soil environments.
3. **Explain** principles of Organic Farming, Soil health in Organic Agriculture
4. **Apply for** Certification to Organic farming in India**.**
5. **Explain** Composting, Cover Cropping, Crop rotation
6. **Evaluate the principles and benefits of** organic farming practices.
7. **Describe** Weed and Pest management strategies without synthetic Herbicides
8. **Attain knowledge of** Financial incentives and support programs for organic farmers.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Introduction to Organic Farming**	
	1.1	Definition, Historical background, Scope, and Importance	**07**
	1.2	Principles of Organic Farming	
	1.3	Advantages and Benefits of Organic Farming	

	1.4	Organic farming: Soil health, Biodiversity and ecological balance.	
2.0		**Comparison with conventional farming**	
	2.1	Conventional Farming: Pros and Cons of Conventional Farming:	**07**
	2.2	Challenges of Chemical Use in conventional Farming	
	2.3	Increased productivity and yield	
	2.4	Technological advancements and efficiency	
3.0		**Certification of Organic Products**	
	3.1	Purpose of organic certification:	**08**
	3.2	Certification process:	
	3.3	Regulatory framework National programme for organic production (NPOP):	
	3.4	Certification bodies	
	3.5	Steps in organic certification	
4.0		**Soil health in Organic Agriculture**	
	4.1	Importance of soil health for organic farming, Types of soil for Organic Agriculture, Important factors for improving organic soil	**08**
	4.2	Practices for enhancing soil fertility a. Integrated Nutrient Management (INM) b. Crop Rotation and Diversification c. Cover Cropping d. Use of Biofertilizers	
	4.3	Weed Management: Mechanical methods, Biological methods and Bioherbicides	
	4.4	Pest and Disease control:Integrated Pest Management and Biological Control	
		Total	**30**

Textbooks and Reference Books:

1. Alexander M. 1977. Soil Microbiology. John Wiley.
2. Bergerson FJ. 1980. Methods for Evaluating Biological Nitrogen Fixation. John Wiley and Sons.
3. Motsara, I.M.R., Bhattacharyya, P. and Srivastava, B. 1995. Biofertilizer Technology, Marketing and Usage- A Source Book-cum-glossary. FDCO, New Delhi.
4. SubbaRao, N.S. Biofertilizers in Agriculture and Forestry. 1993. Oxford and IBH. Publ. Co., New Delhi.
5. Burges, H.D. and Hussey, N.W. (1971). Microbial Control of Insects and mites. Academic Press, New York.
6. Burges, H.D. Formulation of microbial pesticides – Kluversep, ACB, Dordrecht-ISBN. 0412 625 202.
7. Coppel H.C. and J.W. Martin. (1977). Biological control of insect pest suppression. Springail.
8. De Bach P. 1964. Biological control of Insect Pest and Weeds Chapman and Hall, New York.
9. Gautam, R.D. (2006). Biological suppression of insect pests. Kalyani Publisher, New Delhi.

10. Huffaker, C.B. and Messenger, P.S. (1976). Theory and Practice of Biological control. Academic Press, New York.
11. Ignacimuthu, S.S. and Jayaraj, S. (2003). Biological Control of Insect Pests. Phoenix Publ. New Delhi.
12. Saxena, A.B. (2003). Biological Control of Insect Pests. Anmol Publ. New Delhi.
13. Huffaker, C.B. and Messenger, P.S. (1976). Theory and Practice of Biological control. Academic Press, New York.
14. Pepper HJ and Perlman D. 1979. Microbial Technology. 2nd Ed. Academic Press.
15. A century of Nitrogen Fixation Research Present status and Future propects. 1987. F.J. Bergersen and J.R. Postgate The Royal Soc., London.
16. Biology and Biochemistry of Nitrogen fixation. 1991. M.J. Dilworth,and A.R. Glenn, Elsevier, Amsterdam. .
17. Nitrogen Fixation in plants. 1986. R.O.D. Dixon,and C.T. Wheeler, Blackie USA, Chapman and Hall, New York.
18. A treatise on dinitrogen Fixation Section IV. Agronomy and Ecology 1977. R.W.F Hardy, and A.H. Gibson John Wiley & Sons, New York..
19. Bioresearches technology for sustainable agriculture. 1999. S. Kannaiyan, Assoc. Pub. Co., New Delhi.
20. Biofertilizer Technology, Marketing and usage- A source Book -cum-glossary 1995. Motsara, I. M.R., P. Bhattacharyya and BeenaSrivastava, FDCO, New Delhi.
21. Symbiotic nitrogen fixation in plants, 1976. P.S. Nutman, Cambridge Univ. Press, London.
22. Hand book for Rhizobia; Methods in legume Rhizobium Technology, 1994. P. Somasegaran and H.J. Hoben Springer-Verlag, New York.
23. Biofertilizers in Agriculture and Forestry 1993. N.S. Subba Rao Oxford and IBH Publ. Co., New Delhi.

National Education Policy 2020

B.Sc. Agricultural Microbiology, III Year (Semester - VI)

Elective Theory Course

Course Code – SAGMET1351

Title of the Course: Management of Crop Plant Diseases

[No. of Credits: 2 Credit] **[Total: 30 Hours]**

Course pre-requisite:

1. The course is designed for students enrolled in the undergraduate second-year programme in the Faculty of Science and Technology. It is intended for those who have received foundational training in Agricultural Microbiology at the first-year undergraduate level and serves as an entry-level core course for students opting for Agricultural Microbiology as their major subject.
2. The students should possess basic knowledge of Agricultural Microbiology, including an understanding of microbial cell structure (prokaryotic and eukaryotic), classification of microorganisms (bacteria, fungi, viruses, and algae), and their general characteristics. They should be familiar with fundamental concepts such as microbial growth, metabolism, and reproduction. In addition, a preliminary understanding of aseptic techniques, sterilization methods, and the role of microorganisms in environment, industry, and human health is desirable for better comprehension of the course.

Course objectives:

After completion of this module, students will be able to:

1. **Understand the** management of crop plant Diseases
2. **Gain knowledge** of Prophylaxis
3. **Understand** Plant disease control by Chemicals.
4. **Learn concepts of** Biological control of plant diseases
5. **Develop understanding** about biocides in Crop Protection

Course outcomes:

Upon successful completion of this module, students will be able to:

1. **Explain** Crop plant diseases and their management
2. **Describe** of Prophylaxis
3. **Explain** Plant disease control by Chemicals.
4. **Use of** Biological agents to control plant diseases
5. **Determine the effect of** biocides in Crop Protection

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Prophylaxis**	
	1.1	Quarantine, Exclusion of Inoculum, Inspection and Certification	**07**
	1.2	Eradication of Pathogens, Crop rotation, Sanitation, Soil treatment	
	1.3	Improved Cultural Practices	
2.0		**Control of Plant Diseases by Chemicals**	
	2.1	Copper fungicides: Bordaux mixture, Burgundy mixture, Chestnut compound	**07**
	2.2	Sulphur fungicides: inorganic, sulphur compounds, lime, sulphur and element, sulphur	
	2.3	Mercury Fungicides	
	2.4	Systemic Fungicides	

3.0		**Biological Control**	
	3.1	Definition, and aim of biological control, the mechanism of biological control	**08**
	3.2	Antagonism, Competition, Predation, Mycoparasitism	
	3.3	Nematophagy, Mycophagy	
	3.4	Application of Biological control	
4.0		**Biocides in Crop Protection**	
	4.1	Definition of biocides, Kinds of Biocides, Microbial biocides	**08**
	4.2	Bioinsecticides: Bacterial Insecticides and Viral Insecticides	
	4.3	Fungal Insecticides and Bioherbicides	
	4.4	Use of Botanicals in Plant Disease Control	
		Total	**30**

Textbooks and Reference Books:

1. Plant Pathology by G.N. Agrios (6th ed.) for a comprehensive overview,
2. Plant Pathology: Concepts and Laboratory Exercises for practical knowledge, and specialized texts like Plant Bacteriology by K.K. Mondal.
3. Fones, H. N., Bebber, D. P., Chaloner, T. M., Kay, W. T., Steinberg, G. and Gurr, S. J. 2020. Threats to global food security from emerging fungal and oomycete crop pathogens. *Nat. Food* 1:332-342.
4. Kim, B., Kim, Y. S., Han, J. W., Yu, J. S., Kim, T. H., Shin, T. S., Choi, G. J. and Kim, H. 2024. Biocontrol potential of *Bevibacillus brevis* HK544 for fungal plant diseases. *Biol. Control* 198:105629.
5. Sheoran, A. R., Lakra, N., Saharan, B. S., Luhach, A., Kumar, R., Seth, C. S. and Duhan, J. S. 2025. Enhancing plant disease resistance: insights from biocontrol agent strategies. *J. Plant Growth Regul.* 44:436-459.
6. Villavicencio-Vásquez, M., Espinoza-Lozano, F., Espinoza-Lozano, L. and Coronel-León, J. 2025. Biological control agents: mechanisms of action, selection, formulation and challenges in agriculture. *Front. Agron.* 7:1578915.

National Education Policy 2020

B.Sc. Agricultural Microbiology, III Year (Semester - VI)

Elective Practical Course

Course Code – SAGMEP1351

Title of the Course: Practical Based on SAGMET1351

[No. of Credits: 2 Credit] **[Total: 60 Hours]**

Course pre-requisite:

1. The course is designed for students enrolled in the undergraduate second-year programme in the Faculty of Science and Technology. It is intended for those who have received foundational training in Microbiology at the first-year undergraduate level and serves as an entry-level core course for students opting for Microbiology as their major subject.
2. The students should possess basic knowledge of Microbiology, including an understanding of microbial cell structure (prokaryotic and eukaryotic), classification of microorganisms (bacteria, fungi, viruses, and algae), and their general characteristics. They should be familiar with fundamental concepts such as microbial growth, metabolism, and reproduction. In addition, a preliminary understanding of aseptic techniques, sterilization methods, and the role of microorganisms in environment, industry, and human health is desirable for better comprehension of the course.

Course objectives:

After completion of this module, students will be able to:

1. **Understand the** management of crop plant Diseases
2. **Gain knowledge** of Prophylaxis
3. **Understand** Plant disease control by Chemicals.
4. **Learn concepts of** Biological control of plant diseases
5. **Develop understanding** about biocides in Crop Protection

Course outcomes:

Upon successful completion of this module, students will be able to:

1. **Explain** Crop plant diseases and their management
2. **Describe** of Prophylaxis
3. **Explain** Plant disease control by Chemicals.
4. **Use of** Biological agents to control plant diseases
5. **Determine the effect of** biocides in Crop Protection

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Isolation of Plant Pathogens**	
	1.1	Isolation of Bacterial pathogens from Diseased plant parts	**08 [2 practicals]**
	1.2	Isolation of Fungal pathogens from Diseased plant parts	
2.0		**Study of Symptoms of Plant Diseases**	
	2.1	Citrus cankar and Black arm of Cotton	**24 [6 Practicals]**
	2.2	Yellow vein mosaic of Bhendi and Leaf curl of Tomato	
	2.3	Leaf spot of Tomato and Stem rust of Wheat	
	2.4	Green ear of Bajra and Grain smut of Jowar	
	2.5	Little leaf of Brinjal	
	2.6	Sesamum phylloidy	
3.0		**Effect of Fungicides**	

	3.1	Effect of bactericides on plant pathogenic bacteria	**20 [5Practicals]**
	3.2	Effect of Plant extracts on growth of fungal pathogens	
	3.3	Effect of fungicides on spore germination of fungal pathogens	
	3.4	Effect of fungicides on growth of fungal pathogens	
	3.5	Study of Antagonism	
4.0		**Biocides**	
	4.1	Study of Biocides available in Market	**08 [2 Practicals]**
	4.2	Effect of Biocides on Plant pathogens	
		Total	**60**

Textbooks and Reference Books:

1. Plant Pathology by G.N. Agrios (6th ed.) for a comprehensive overview,
2. Plant Pathology: Concepts and Laboratory Exercises for practical knowledge, and specialized texts like Plant Bacteriology by K.K. Mondal.
3. Fones, H. N., Bebber, D. P., Chaloner, T. M., Kay, W. T., Steinberg, G. and Gurr, S. J. 2020. Threats to global food security from emerging fungal and oomycete crop pathogens. *Nat. Food* 1:332-342.
4. Kim, B., Kim, Y. S., Han, J. W., Yu, J. S., Kim, T. H., Shin, T. S., Choi, G. J. and Kim, H. 2024. Biocontrol potential of *Bevibacillus brevis* HK544 for fungal plant diseases. *Biol. Control* 198:105629.
5. Sheoran, A. R., Lakra, N., Saharan, B. S., Luhach, A., Kumar, R., Seth, C. S. and Duhan, J. S. 2025. Enhancing plant disease resistance: insights from biocontrol agent strategies. *J. Plant Growth Regul.* 44:436-459.
6. Villavicencio-Vásquez, M., Espinoza-Lozano, F., Espinoza-Lozano, L. and Coronel-León, J. 2025. Biological control agents: mechanisms of action, selection, formulation and challenges in agriculture. *Front. Agron.* 7:1578915.

National Education Policy 2020

B.Sc. Agricultural Microbiology, III Year (Semester - V)

Elective Theory Course

Course Code – SAGMET1352

Title of the Course: Environmental Microbiology

[No. of Credits: 2 Credit] [Total: 30 Hours]

Course pre-requisite:

1. The course is designed for students enrolled in the undergraduate second-year programme in the Faculty of Science and Technology. It is intended for those who have received foundational training in Microbiology at the first-year undergraduate level and serves as an entry-level core course for students opting for Microbiology as their major subject.
2. The students should possess basic knowledge of Microbiology, including an understanding of microbial cell structure (prokaryotic and eukaryotic), classification of microorganisms (bacteria, fungi, viruses, and algae), and their general characteristics. They should be familiar with fundamental concepts such as microbial growth, metabolism, and reproduction. In addition, a preliminary understanding of aseptic techniques, sterilization methods, and the role of microorganisms in environment, industry, and human health is desirable for better comprehension of the course.

Course objectives:

After completion of this module, students will be able to:

1. **Understand the fundamental concepts of environment and ecosystems**, including physical, chemical, and biological components.
2. **Gain knowledge of microbial diversity and distribution** in natural habitats and their ecological roles as producers and decomposers.
3. **Differentiate between culture-dependent and culture-independent methods** for studying microbial diversity.
4. **Understand physiological adaptations of microorganisms** to environmental conditions and stress factors.
5. **Learn ecological principles governing microbial growth**, including Liebig's law of minimum and Shelford's law of tolerance.
6. **Understand microbial community dynamics**, including succession and biofilm formation.
7. **Develop knowledge of quantitative ecology**, including diversity indices and sampling strategies.
8. **Understand extremophiles and their adaptations**, including physiological and molecular mechanisms.

Course outcomes:

Upon successful completion of this module, students will be able to:

1. **Describe environmental components and microbial roles in ecosystems**, including nutrient cycling and decomposition.
2. **Explain microbial habitats and ecological functions** in various environmental niches.
3. **Compare culture-dependent and culture-independent approaches** for studying microbial diversity, including limitations and advantages.
4. **Explain the concept of viable but non-culturable (VBNC) microorganisms**.
5. **Analyze microbial adaptations to environmental conditions**, including stress responses and survival strategies.
6. **Apply ecological laws such as Liebig's law of minimum and Shelford's law of tolerance** to microbial growth.
7. **Describe microbial community interactions**, succession patterns, and biofilm formation.
8. **Calculate and interpret microbial diversity indices**, including Shannon and Simpson

indices.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Environment and Ecosystem**	
	1.1	Physical, chemical and biological aspects of environment	**07**
	1.2	Natural habitats of microorganisms; microorganisms in ecosystem as producers and decomposers	
	1.3	Culture- dependent and independent approaches for microbial diversity in environment	
	1.4	Culture- dependent approaches and their limitations, and culture-independent molecular approaches for understanding microbial diversity in the environment; Viable but non-culturable bacteria	
2.0		**Physiological Ecology of microorganisms**	
	2.1	Adaptation to environmental condition	**07**
	2.2	Abiotic growth limiting factors-Leibig's law of minimum	
	2.3	Shelford law of tolerance	
	2.4	Microbial community succession-biofilm communities	
3.0		**Quantitative Ecology**	
	3.1	Microbial diversity, Operational Taxonomic Units (OTUs)	**08**
	3.2	Diversity indices (Shannon, Shimpson)	
	3.3	Alpha and beta diversity, Richness and evenness	
	3.4	Samples and samplings, Concept of culturability	
	3.5	Determination of total and viable microbial number; Molecular analysis of function and diversity of microbial community, Metagenomics and microbiomics	
4.0		**Extremophiles**	
	4.1	Thermophiles, Psychrophiles, Osmophiles (halophiles, saccharophiles)	**08**
	4.2	Acidophiles, Alkalophiles, Barophiles, xerophiles	
	4.3	Physiology and metabolism of Archaea	
	4.4	Concept of stress and stress tolerance, signaling molecules and signal transducing machinery in microbial system. Transmitter and receiver proteins. Concept of free radicals	
		Total	**30**

Textbooks and Reference Books:

1. Environmental Microbiology and Biotechnology by Singh and Dwivedi. New Age Int. Sci. Publication. Environmental Microbiology by Riana.
2. Environmental Microbiology: Principles and Applications. Patrick K. Jjemba
3. Microbial Ecology by Alexander. Willey Publication.
4. Microbial Diversity: Form and Function of Prokaryotes. Wiley Blackwell Publication.
5. Biodiversity and Environmental Biotechnology by Dwivedi and M C Kalita. Scientific Publication.
6. Extremophiles, Springer Verlag
7. Statistics for Biologists by Campbell R C. Cambridge University Press.
8. Statistics in Biology by Bliss C I K. MGH Publication.
9. Environmental Microbiology By. P D Sharma

National Education Policy 2020

B.Sc. Agricultural Microbiology, III Year (Semester - VI)

Elective Practical Course

Course Code – SAGMEP1352

Title of the Course: Practical Based on SAGMET1352

[No. of Credits: 2 Credit] [Total: 60 Hours]

Course pre-requisite:

1. The course is designed for students enrolled in the undergraduate second-year programme in the Faculty of Science and Technology. It is intended for those who have received foundational training in Agricultural Microbiology at the first-year undergraduate level and serves as an entry-level core course for students opting for Microbiology as their major subject.
2. The students should possess basic knowledge of Agricultural Microbiology, including an understanding of microbial cell structure (prokaryotic and eukaryotic), classification of microorganisms (bacteria, fungi, viruses, and algae), and their general characteristics. They should be familiar with fundamental concepts such as microbial growth, metabolism, and reproduction. In addition, a preliminary understanding of aseptic techniques, sterilization methods, and the role of microorganisms in environment, industry, and human health is desirable for better comprehension of the course.

Course objectives:

The course is designed to:

1. **Develop practical skills** for isolation, enumeration, and morphological characterization of cyanobacteria from environmental samples.
2. **Train students in microbial diversity analysis**, including qualitative and quantitative assessment using ecological indices (Shannon and Simpson).
3. **Provide hands-on experience in isolation and study of extremophiles** such as thermophiles, psychrophiles, halophiles, acidophiles, alkalophiles, and osmophiles.
4. **Enhance understanding of environmental factors** (temperature, pH, salinity, freezing stress) affecting microbial growth and survival.
5. **Introduce stress physiology of microorganisms**, including stress enzymes and adaptive mechanisms.
6. **Familiarize students with applied environmental microbiology techniques**, including studies on organisms from unique ecosystems (e.g., Lonar lake) and metal-oxidizing bacteria.

Course outcomes:

After successful completion of this course, students will be able to:

1. **Isolate, enumerate, and identify cyanobacteria** from environmental samples using standard microbiological techniques.
2. **Assess microbial diversity quantitatively** using ecological indices such as Shannon and Simpson indices.
3. **Isolate and characterize different groups of extremophiles** based on their physiological and environmental adaptations.
4. **Evaluate the effect of environmental stress factors** (temperature, pH, salinity, freezing) on microbial growth and survival.
5. **Demonstrate knowledge of microbial stress responses**, including production of stress enzymes and proteins.
6. **Perform specialized experiments** such as iron oxidation by *Thiobacillus ferrooxidans* and studies on alkalophiles from unique habitats.
7. **Analyze and interpret experimental data scientifically**, and present findings effectively in laboratory records and reports.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Cyanobacteria**	
	1.1	Isolation, Enumeration and Morphological Study of Cyanobacteria	**12 [3 practicals]**
	1.2	Study of Cyanobacterial Diversity in Environmental Samples	
	1.3	Quantitative Analysis of Cyanobacterial Diversity (Shannon & Simpson Indices)	
2.0		**Extremophiles - I**	
	2.1	Isolation of Thermophilic Bacteria	**20 [5 Practicals]**
	2.2	Isolation of Spore-Forming Thermophiles	
	2.3	Effect of pH on Thermophilic Growth	
	2.4	Isolation of Psychrophilic Microorganisms	
	2.5	Effect of Freezing and Thawing on Psychrophiles	
3.0		**Extremophiles - II**	
	3.1	Isolation of Halophiles	**16 [4Practicals]**
	3.2	Isolation of Acidophiles and Alkalophiles	
	3.3	Study of Osmophiles (Saccharophiles)	
	3.4	Effect of Environmental Stress on Microbial Growth	
4.0		**Stress Responses**	
	4.1	Demonstration of stress enzymes/ proteins from extremophiles	**12[3 Practicals]**
	4.2	Studies on Alkalophiles isolated from lonar water	
	4.3	Demonstration of iron oxidation rate of *Thiobacillus ferrooxidans*	
		Total	**60**

Textbooks and Reference Books:

1. Laboratory Exercises in Microbiology, Fifth Edition Harley−Prescott
2. Cappuccino, J., Cappuccino, J. G., & Welsh, C. T. (2017). *Microbiology: A laboratory manual*. BoD–Books on Demand.
3. Microbiological Applications Lab Manual, Eighth Edition by Benson
4. Hiper Teaching Kit published by Himedia Laboratories Pvt. Ltd.
5. Dubey, R. C., & Maheshwari, D. K. (2002). *Practical Microbiology, 4/e*. S. Chand Publishing.

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B.Sc. Agricultural Microbiology, III Year (Semester - VI)

Elective Practical Course

Course Code – SAGMVC1351

Title of the Course: Agrobioprocessing

[No. of Credits: 2 Credit] **[Total: 60 Hours]**

Course pre-requisite:

1. The course is designed for students enrolled in the undergraduate second-year programme in the Faculty of Science and Technology. It is intended for those who have received foundational training in Agricultural Microbiology at the first-year undergraduate level and serves as an entry-level core course for students opting for Microbiology as their major subject.
2. The students should possess basic knowledge of Agricultural Microbiology, including an understanding of microbial cell structure (prokaryotic and eukaryotic), classification of microorganisms (bacteria, fungi, viruses, and algae), and their general characteristics. They should be familiar with fundamental concepts such as microbial growth, metabolism, and reproduction. In addition, a preliminary understanding of aseptic techniques, sterilization methods, and the role of microorganisms in environment, industry, and human health is desirable for better comprehension of the course.

Course objectives:

The course is designed to:

1. **Develop fundamental laboratory skills** including safety practices, GLP, aseptic handling, and sterilization techniques for agro-based samples.
2. **Train students in preparation and pretreatment of agro-waste substrates** for their effective utilization in bioprocessing.
3. **Provide hands-on experience in fermentation technologies**, including inoculum preparation, solid-state fermentation (SSF), and submerged fermentation (SmF).
4. **Familiarize students with production of bio-based products** such as bioethanol, organic acids, and microbial metabolites using agricultural resources.
5. **Introduce value-added product development** including single cell protein (SCP), biofertilizers, biopesticides, and composting techniques.
6. **Enhance knowledge of enzyme-based agrobioprocessing**, including enzyme production, extraction, and activity assays.
7. **Develop skills in downstream processing and product analysis**, including estimation of alcohol and organic acids.
8. **Promote sustainable and eco-friendly approaches** for agro-waste utilization and resource recycling.

Course outcomes:

After successful completion of this course, students will be able to:

1. **Apply laboratory safety, aseptic techniques, and GLP guidelines** in agrobioprocessing experiments.
2. **Prepare and process agro-waste substrates** for use in microbial fermentation and product development.
3. **Perform fermentation processes** (SSF and SmF) for the production of bioethanol, organic acids, and enzymes.
4. **Develop and evaluate value-added products** such as SCP, biofertilizers, biopesticides, and compost.
5. **Extract and assay enzymes** and analyze their activity using standard biochemical methods.

6. **Estimate fermentation products quantitatively** using techniques like titrable acidity and specific gravity.
7. **Interpret experimental data and optimize process parameters** for improved yield and efficiency.
8. **Apply agrobioprocessing knowledge in sustainable agriculture, waste management, and entrepreneurship.**
9. Analyze **UV absorption spectra** of nucleic acids and proteins for qualitative and quantitative assessment.
10. Understand the working principle and application of **biosensors**, such as glucose biosensors.
11. Record, analyze, and interpret experimental results and present findings in a **systematic scientific manner**.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Basic Techniques in Agrobioprocessing**	
	1.1	Laboratory Safety, GLP and Aseptic Techniques a. Handling agro-based samples b. Sterilization and contamination control	**08 [2 practicals]**
	1.2	Preparation of Agro-Waste Substrates a. Processing of substrates (molasses, fruit waste, cereal waste) b. Pretreatment (physical/chemical)	
2.0		**Fermentation-Based Agrobioprocessing**	
	2.1	Preparation of Inoculum for Fermentation: a. Development of starter cultures (yeast/bacteria)	**20 [5 Practicals]**
	2.2	Solid State Fermentation (SSF) a. Production of enzymes using agro-waste (bran, husk)	
	2.3	Submerged Fermentation (SmF) a. Production of microbial metabolites using liquid media	
	2.4	Production of Bioethanol from Agricultural Waste a. Fermentation of molasses/fruit waste b. Distillation (demonstration)	
	2.5	Production of Organic Acids (Citric/Lactic Acid) a. Fermentation using agro-substrates b. Estimation by titration	
3.0		**Value-Added Products from Agro-Resources**	
	3.1	Production of Single Cell Protein (SCP) a. Using yeast on molasses or waste substrate	**16[4 Practicals]**
	3.2	Production of Biofertilizers a. Mass multiplication of Azotobacter / Rhizobium	
	3.3	Production of Biopesticides a. Demonstration of Trichoderma / Bacillus formulation	
	3.4	Composting and Vermicomposting a. Preparation and monitoring of compost b. Microbial role in decomposition	
4.0		**Enzyme-Based Agrobioprocessing**	
	4.1	Production of Industrial Enzymes (Amylase/Cellulase) a. Using agro-waste substrates b. activity from absorbance	**16 [4 Practicals]**
	4.2	Enzyme Extraction and Activity Assay a. Crude enzyme extraction b. Activity measurement (DNS method, etc.)	
	4.3	Clarification of Fruit Juice using Enzymes a. Use of pectinase b. Measurement of clarity	

	4.4	Estimation of Fermentation Products a. Alcohol (specific gravity method) b. Organic acids (Titrable acidity)	
		Total	**60**

Textbooks and Reference Books:

1. Laboratory Exercises in Microbiology, Fifth Edition Harley−Prescott
2. Cappuccino, J., Cappuccino, J. G., & Welsh, C. T. (2017). *Microbiology: A laboratory manual*. BoD–Books on Demand.
3. Microbiological Applications Lab Manual, Eighth Edition by Benson
4. Hiper Teaching Kit published by Himedia Laboratories Pvt. Ltd.
5. Dubey, R. C., & Maheshwari, D. K. (2002). *Practical Microbiology, 4/e*. S. Chand Publishing.
6. Chaplin, M. F., & Bucke, C. (1990). *Enzyme technology*. CUP Archive.
7. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2013). *Principles of fermentation technology*. Elsevier.