।। सा विद्या या विमुक्तये ।।

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

"ज्ञानतीर्थ" परिसर, विष्णुपूरी, नांदेड - ४३१६०६ (महाराष्ट्र)

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY NANDED

"Dnyanteerth", Vishnupuri, Nanded - 431606 Maharashtra State (INDIA)

Established on 17th September 1994 – Recognized by the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'A' Grade

ACADEMIC (1-BOARD OF STUDIES) SECTION

Phone: (02462) 229542
Fax : (02462) 229574

Website: www.srtmun.ac.in

E-mail: bos.srtmun@gmail.com

संलग्नित महाविद्यालयांतील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदवी स्तरावरील तृतीय वर्षाचे CBCS Pattern नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०२१–२२ पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, मा. विद्याशाखेने **दिनांक ३१ मे २०२१ रोजीच्या बैठकीतील केलेल्या शिफारशीप्रमाणे व दिनांक १२ जून २०२१ रोजी संपन्न झालेल्या ५१ व्या मा. विद्या परिषद बैठकीतील विषय क्र. २६/५१–२०२१**च्या ठरावानुसार प्रस्तुत विद्यापीठाच्या **संलग्नित महाविद्यालयांतील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदवी स्तरावरील तृतीय वर्षाचे** खालील विषयांचे **C.B.C.S. (Choice Based Credit System) Pattern** नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०२१–२२ पासून लागू करण्यात येत आहेत.

1. B.Sc.-III Year-Biophysics
2. B.Sc.-III Year-Bioinformatics
3. B.Sc.-III Year-Biotechnology
4. B.Sc.-III Year-Biotechnology (Vocational)
5. B.Sc.-III Year-Botany
6. B.Sc.-III Year-Horticulture
7. B.Sc.-III Year-Agro Chemical Fertilizers
8. B.Sc.-III Year-Analytical Chemistry
9. B.Sc.-III Year-Biochemistry
10. B.Sc.-III Year-Chemistry
11. B.Sc.-III Year-Dyes & Drugs Chemistry
12. B.Sc.-III Year-Industrial Chemistry
13. B.C.A. (Bachelor of Computer Application)-III Year
14. B.I.T. (Bachelor of Information Technology)-III Year
15. B.Sc.-III Year-Computer Science
16. B.Sc.-III Year-Network Technology
17. B.Sc.-III Year-Computer Application (Optional)
18. B.Sc.-III Year-Computer Science (Optional)
19. B.Sc.-III Year-Information Technology (Optional)
20. B.Sc.-III Year-Software Engineering
21. B.Sc.-III Year-Dairy Science
22. B.Sc.-III Year-Electronics
23. B.Sc.-III Year-Environmental Science
24. B.Sc.-III Year-Fishery Science
25. B.Sc.-III Year-Geology
26. B. A./B.Sc.-III Year-Mathematics
27. B.Sc.-III Year-Microbiology
28. B.Sc.-III year Agricultural Microbiology
29. B.Sc.-III Year-Physics
30. B. A./B.Sc.-III Year Statistics
31. B.Sc.-III Year-Zoology

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.: शैक्षणिक–१/परिपत्रक/पदवी–सीबीसीएस अभ्यासक्रम/२०२१–२२/७५

दिनांक : १२.०७.२०२१.

स्वाक्षरित
सहा.कुलसचिव
शैक्षणिक (१–अभ्यासमंडळ) विभाग

प्रत माहिती व पुढील कार्यवाहीस्तव :
१) मा. कुलसचिव यांचे कार्यालय, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मूल्यमापन मंडळ यांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) प्राचार्य, सर्व संबंधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
४) साहाय्यक कुलसचिव, पदव्युत्तर विभाग, प्रस्तुत विद्यापीठ.
५) उपकुलसचिव, पात्रता विभाग, प्रस्तुत विद्यापीठ.
६) सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ.
७) अधीक्षक, परिक्षा विभाग विज्ञान व तंत्रज्ञान विद्याशाखा प्रस्तुत विद्यापीठ.

Swami Ramanand Teerth Marathwada University Nanded
Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Science and Technology
Subject: Agricultural Microbiology
B. Sc. Third year (Semester- V& VI)
Semester Pattern effective from June -2021

Semester/ Annual	Course No.	Name of the Course	Instruction Hrs./ Week	Total Periods	Internal Evaluation (CA)	End Semester Examination (ESE)	Total Marks	Credits
V Semester	DSEAMBI (SectionA)	Molecular Biology (P – XII)	03	45	10	40	50	**2**
	DSEAMB I [Section B I] **OR** DSEAMB I [Section B II]	Industrial Microbiology (P – XIII A) **OR** Microbial Enzymes and Crop Production (P – XIII B)	03	45	10	40	50	**2**
VI Semester	DSEAMBII (SectionA)	Genetic Engineering (P-XIV)	03	45	10	40	50	**2**
	DSEAMBII [Section BI] **OR** DSEAMB II [Section B II]	Agricultural Biotechnology (P – XVA) **OR** Environmental Biotechnology (P – XVB)	03	45	10	40	50	**2**
Annual Practicals / Skill	DSEAMBP I [DSEAMB I & II Section A]	Practicals Based on P – XII & P -XIV (P -XVI)	04	10 Practical	10	40	50	**2**
	SECAMB III (A**OR** B)	Genetic Molecular Techniques (A) **OR** Tissue Culture Technique (B)	03	45	25	25	50	**(02)** *
Annual Practicals / Skill	DSEAMBP II [DSEAMB I & II (Section B I & II)	Practicals based on P -XIII A & B & P – XV A & B (P - XVII)	04	10 Practical	10	40	50	**2**
	SECAMB IV (A **OR** B)	Mushroom Cultivation Techniques (A) **OR** Biofertilizer Technology (B)	03	45	25	25	50	(**02**) *
						Total Credits Semester V & VI		12 (04*)

DSEAMB – Discipline Specific Elective Agricultural Microbiology
DSEMBP – Discipline Specific Elective Agricultural Microbiology Practical
SECAMB – Skill Enhancement Course Agricultural Microbiology
ESE – End Semester Examination
CA – Continuous Assessment

Outline and Salient Feature:

B. Sc. Third year Agricultural Microbiology syllabus is crafted to serve the need of choice-based credit system course structure to orient and practically train students in the field ofAgriculturalMicrobiology.Thecourseisspecificallybringingdisciplineelectiveandskilled enhancedcoursestogetherdealingadditionaldomainofknowledgeinthisfieldofstudywhere in DSE course based on Molecular Biology and Recombinant DNA Technology introduction of gene of interest and its expression, their manipulation and techniques of suchmanipulation.

Another DSE course (with choice) provide an option to learn diverse fermentations processandroleofmicrobialenzymesintheimprovementofagriculture and industries.Thiscourseisgiving emphasis on enzymology, industrial processes and also offer agriculturalbiotechnologyorplantmicrobialinteractionsasDSEcoursesisanareawhichdeals with production of various useful end products on large scale by using agricultural bio-waste and various beneficial as well as harmful role played by microorganisms withenvironment.

Skill enhanced courses on genetic molecular techniques, tissue culture technique, mushroom cultivation techniques and bio fertilizer Technology is well suited to understand application of scientific and engineering skills to the processing of materials by microorganisms.

Utility:

ThesyllabusofB.Sc.Thirdyearagriculturalmicrobiologycoursewillorientandtrain the students in view of microbial genetics and molecular biology, occurrence of metabolic events and its relation to environment and agriculture, Industrial and Agricultural biotechnology to understand and apply this knowledge for carrierorientation.

SECoursewillprovideadditionalopportunityforastudenttodevelopskillsofinterest in this field ofstudy.

Learning Objectives:

The learning or training objectives of SEC has been mentioned below the skill of the course.

Prerequisite:

The course is offered for a student registered for undergraduate programme in the faculty of Science and technology who had primary training in the field of microbial sciences and also likes to gain additional advanced knowledge in this field of science.

Swami Ramanand Teerth Marathwada University Nanded
Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Science and Technology
Subject: Agricultural Microbiology
Semester: V
Paper Name: Molecular Biology DSEAMB I (Section A)]
Paper Number: XII

Credits: 02 (Marks: 50) **Periods: 45**

Specific Program Outcome:

The aim of the undergraduate degree in Agricultural Microbiology is to make students knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Agricultural Microbiology and acquire knowledge and understanding of the Agricultural microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others. 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, 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. 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 to enable him to identify challenging society problems and plan his professional carrier to develop innovative solutions for such problems.

Specific Course Outcome:

Molecular Biology course makes students to understand

- the prokaryoticgenetic material, concept of gene.
- Split genes, Over-lapping genes, Jumping genes
- DNA mutation, DNA Damage and Repair mechanisms,
- Gene expression and its regulation in Prokaryotes.

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome	Number of Lectures
Unit – I The prokaryotic Gene	1. Definition and concept of gene 2. location of genes, genome and plasmon, recon, muton, cistron 3. Prokaryotic genome 4. Split genes (Hexon gene, ovalbumin gene, β-globin gene) 5. Overlapping genes 6. Jumping genes (Insertion sequences, Transposable elements (Tn series)	Able to understand the concept of DNA & organization of prokaryotic genome as well as it gives better understanding of Split genes, overlapping genes Jumping genes and how the genes translocate to other location.	**11**
Unit – II Gene Mutation	1. Concept of Mutation 2. Types of Mutations: Silent, Missense, base pair substitutions or switches and frameshift mutations, induced and spontaneous mutation 3. Mechanism of Spontaneous Mutation: Mispairing of Bases due to Tautomerism, Deamination, Depurination and Damage due to Oxidative Metabolism	Have developed an incredibly good understanding about the concept of mutation, types of mutation and had acquired knowledge about Evidences for occurrence of mutation	**12**

	4. Mechanism of Induced Mutation: Physical and Chemical Mutagenic agents 5. Evidence for occurrence of mutation in bacteria - Replica platemethod, Fluctuation test 6. Ames Test- Carcinogenic test	in bacteria	
Unit – III DNA Damage and Repair	1. Biological indications of Damage to DNA: UV radiation 2. Repair of DNA by: i. Photo-reactivation ii. Nucleotide Excision Repair (NER) iii. Base Excision Repair (BER) iv. Mismatch Excision Repair (MER) v. Recombinational Repair and vi. SOS Repair	Developed a good knowledge about hoe the DNA is Damaged and what different types of DNA Repair systems operate in Prokaryotes.	**10**
Unit – IV Regulation of Gene expression in Prokaryotes	1. Gene regulation at Transcription level: Repressors, Activators, Sigma factor and Attenuation 2. Gene regulation at Translation level 3. The lac Operon of *E. coli* 4. The trp Operon of *E. coli* 5. The Arabinose Operon 6. Autoregulation and Feedback inhibition	Has acquired the knowledge of gene regulation at transcription and translation. Capable of explaining the Lac Operon and Trp Operon of *E. coli* and Arabinose Operon.	**12**

References:

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. Bacterial and Bacteriophage Genetics 4th Edition byBrige.
6. DNA Repair and Mutagenesis by Errol Friedberg.1995.
7. Gene VIII by Benjamin Lewin.2007.
8. Methods of General and Molecular Bacteriology by Philip.1993.
9. Microbial Genetics by Frefielder- 4thEdition.
10. Microbial Genetics by Maloy.1994.
11. Modern Microbial Genetics by Streips and Yasbin.1991.
12. Molecular Biology of Gene- 4th Edition by Watson.1987.
13. Molecular Genetics of Bacteria by Dale.1994
14. Organization of Prokaryotic Genome by Robert Charlebois.1999.
15. General microbiology Vol. I and II by Power C.H and H.F.Daginawala.
16. Microbiology by Pelczar andCrick.
17. General Microbiology byStainer.
18. Fundamental principles of bacteriology by A.J.Salle

Swami Ramanand Teerth Marathwada University Nanded
Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Science and Technology
Subject: Agricultural Microbiology
Semester: V
Paper Name: Industrial Microbiology DSEAMB II (Section B I)
Paper Number: XIII A

Credits: 02 (Marks: 50) **Periods: 45**

Specific Program Outcome:

The aim of the undergraduate degree in Agricultural Microbiology is to make students knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Agricultural Microbiology and acquire knowledge and understanding of the Agricultural microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others. 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, 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. 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 to enable him to identify challenging society problems and plan his professional carrier to develop innovative solutions for such problems.

Specific Course Outcome:

By Industrial Microbiology course the students

- Are capable of describing a large number of substrates that are used for the industrial fermentation processes
- 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.
- 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
- 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.

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome	Number of Lectures
Unit – I Definition and Scope of Industrial Microbiology	1. Introduction, Definition, Scope and Development of Industrial Microbiology 2. Bioreactor (Definition, Ideal Design and characteristics, Working of Auxiliary equipment) 3. Types of Fermenter: laboratory fermenter, pilot plant fermenter, industrial fermenter, Horton sphere. Batch, continuous, Tubular, fed batch, fluidised bed reactor, tower fermenter (In brief) 4. Computer application in fermentation technology	The students have acquired knowledge of scope and development in IndustrialMicrobiology, bioreactor, types of fermenter and its design and operation	**10**
UNIT II –	1. Introduction, Screening	Student capable of	**09**

Microbes in Industrial Microbiology	Techniques (Primary and Secondary) 2. Strain improvement 3. Stock culture and its maintenance (serial subculture, overlaying with mineral oil, lyophilization, liquid nitrogen, soil stock) 4. Inoculum development, Fermentation media (substances used as raw materials for formulation of fermentation media) and its sterilization (batch and continuous)	understanding Screening techniques Strain improvement Inoculum development and maintenance of cultures.	
Unit – III Downstream processing	1. Introduction, Extraction of fermentation products, solids (Insoluble) removal (Filtration, centrifugation, coagulation and flocculation, foam fractionation) 2. Primary isolation of product (Cell disruption, liquid extraction, ion exchange adsorption, precipitation) 3. Purification (Chromatography, carbon decolorization, crystallization), Product Isolation (Crystalline processing, drying, packing etc).	Has acquired the knowledge and skill of extraction and purification of fermentation products.	**14**
Unit – IV Typical Fermentative production	1. Production strain, Fermentation media, Fermentation conditions, Metabolic pathway involved in synthesis of the product, Product recovery operations, and uses of following: i. Beverages: Beer ii. Organic acid: Citric acid iii. Antibiotics: Streptomycin iv. Biofertilizers: Legume inoculants v. Bioinsecticide: Thuricide	Has acquired a fairly good knowledge and skill for production of fermentation products.	**12**

	vi. Amino acids: Glutamic acid vii. Enzymes: Fungal Amylase		

References:

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 , AcademicPress.
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, PrenticeHallpublication.
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21. West and Toad, text book of Biochemistry Oxford andIBH

Swami Ramanand Teerth Marathwada University Nanded
Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Science and Technology
Subject: Agricultural Microbiology
Semester: V
Paper Name: Microbial Enzymes and Crop Production DSEAMBI (Section B II)
Paper Number: XIII B

Credits: 02 (Marks: 50) **Periods: 45**

Specific Program Outcome:

The aim of the undergraduate degree in Agricultural Microbiology is to make students knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Agricultural Microbiology and acquire knowledge and understanding of the Agricultural microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others. 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, 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. 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 to enable him to identify challenging society problems and plan his professional carrier to develop innovative solutions for such problems.

Specific Course Outcome:

Microbial enzymes and Crop Production makes students understand

- the role of nitrogen fixers in environmental nitrogen cycle,
- microbiology and biochemistry of oxidation of ammonia. Nitrite and denitrification.
- Immobilization of Nitrogen and Phosphorous Transformation
- Role of Soil Enzymes in maintaining Soilfertility

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome	Number of Lectures
Unit – I Nitrogenase and Molecular Nitrogen Fixation	1. Nitrogenase Producing Microorganisms and theirhabitat. 2. Enzymatic mechanism of NitrogenFixation 3. Structure and properties ofNitrogenase 4. Regulation of Nitrogenase and cropproductivity	Have learned the process of nitrogen fixation by microorganisms	**10**
Unit – II Mineralization and Immobilization of Nitrogen	1. Nitrogen Mineralizing Microbial Enzymes and its influence onagriculture. 2. Nitrogen Immobilization and protein decomposingEnzymes 3. Nitrifying Enzymes and its influence on cropproduction: 4. Nitrifying bacteria, Oxidation of Ammonia and Hydroxylamine 5. Oxidation of Nitrite and Nitratepollution	Student capable of explaining the microbiology and biochemistry of oxidation of ammonia, nitrite, and denitrification and nitrite reduction.	**14**

	6. Soil PerfusionTechnique 7. Denitrification: loss of nitrogen in soil, mechanism of volatilization, Biochemistry and Microbiology of nitritereduction		
Unit – III Microbial TransformationofPhosphorous	1. Chemistry of Agricultural SoilPhosphorous 2. Solubilization of Inorganic Phosphorous and cropproductivity 3. Enzymes of Mineralization of OrganicPhosphorous 4. Phosphate solubilizing Enzymes: Phytase Phosphatases, and its activity in crop production 5. VAM and Mechanism of Phosphorous Transport in Mycorrhizalcrops	Acquired knowledge about mineralization of Phosphorous and its transformation.	**12**
Unit – IV Enzymes andSoilFertility	1. Definition of SoilFertility 2. Role of Soil Enzymes in maintaining Soilfertility 3. Soil Enzymes as indicators ofAgriculture 4. Significance and potential uses of soil enzymes 5. Soil enzymes in changing environment for sustainable crop production	Gained knowledge about role of soil enzymes and its significance in maintain sol fertility.	**09**

References:

1. D. L. Nelson and M. M. Cox. 'Lehninger Principles of Biochemistry', Macmillan Int.
2. J. M. Berg, J. L. Tymoczko and L. Stryer. 'Biochemistry' 6th edition, W. H Freeman andCompany.
3. S. C. Rastogi. 'Biochemistry'. Tata McGraw Hill Publishing Company, NewDelhi.
4. Gottschalk G. 'Bacterial Metabolism'. Springer, NewYork.
5. Doelle H. W. 'Bacterial Metabolism'. Elsevier, NewDelhi.
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Swami Ramanand Teerth Marathwada University Nanded
Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Science and Technology
Subject: Agricultural Microbiology
Semester: VI
Paper Name: Genetic Engineering(DSEAMBII (Section A)
Paper Number: XIV

Credits: 02 (Marks: 50) **Periods: 45**

The aim of the undergraduate degree in Agricultural Microbiology is to make students knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Agricultural Microbiology and acquire knowledge and understanding of the Agricultural microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others. 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, 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. 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 to enable him to identify challenging society problems and plan his professional carrier to develop innovative solutions for such problems.

Specific Course Outcome:

Genetic Engineering course makes students understand

- The role of microorganisms in Genetic Engineering
- Enzymes and Vectors used in Genetic Engineering
- Screening of recombinant molecules
- Transformation methods for genetic engineering
- Application of Genetic Engineering

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome	Number of Lectures
Unit – I Introduction to Genetic Engineering	1. Recombinant DNA Technology 2. Microorganisms as a tool in genetic engineering. 3. Isolation and characterization of particularDNA Fragments 4. Enzymes involved in Genetic Engineering 5. Vectors- Plasmids, pBR322, pUC19, Bacteriophages (Lambda Phage),Single stranded DNAPhage- M13.	The students have acquired knowledge of tools and methods in genetic engineering	**10**
Unit – II Joining and introduction of rDNA molecules	1. Insertion of foreign DNA into suitable vector (Sticky end ligation) 2. Joining of DNA fragments by addition of Homopolymer tail 3. Blunt end ligation by using linkers and adapters 4. Introduction of rDNA molecules into host cell: **In Prokaryotes:** Heat shock	Student capable of understanding the Joining of DNA fragments and Introduction of rDNA molecules into host cell.	**10**

	treatment, Transformation, Transduction, Cell transformation with plasmids, Transfection with phage vectors **In Eukaryotes:** Electroporation, Protoplast fusion, Liposome mediated, microcell fusion technique		
Unit – III **Detection of recombinant molecules**	**1. Direct Screening:** i. Insertional inactivation of marker gene ii. Visual Screening method: Blue White colonies screening iii. Plaque phenotype **2. Indirect Screening:** i. Complementation ii. Colony hybridization Techniques iii. Immunological Techniques **3. Plant Genetic Engineering** i. Methods of gene transfer in Plants: ii. Protoplast fusion iii. Organelle engineering iv. Non integrative DNA transfer by plant RNA viruses v. Integrative DNA transfer by Ti and Ri Plasmid 4. **Expression of Foreign gene in Plants**	Has acquired the knowledge of Detection of recombinant molecules by various methods and expression of gene in Plants	**13**
Unit – IV **Genetic engineering anditsapplication**	1. Applications of genetic engineering: in research, in medicine, gene therapy, in commercial and industrial possibilities, in productionand application of eukaryoticproteins. 2. Applications of genetic engineering: in Agriculture Resistance to herbicides, pathogen resistance, stress resistance, secondary metabolite production, post-harvest preservation. 3. Applications of genetic engineering: in Environment 4. Ethical issues of genetic engineering.	Has acquired a fairly good knowledge of the applications of genetic engineering.	**12**

References:

1. Bacterial and Bacteriophage Genetics 4th Edition byBrige.
2. DNA Repair and Mutagenesis by Errol Friedberg.1995.
3. Gene VIII by Benjamin Lewin.2007.
4. Methods of General and Molecular Bacteriology by Philip.1993.
5. Microbial Genetics by Frefielder- 4thEdition.
6. Microbial Genetics by Maloy.1994.
7. Modern Microbial Genetics by Streips and Yasbin.1991.
8. Molecular Biology of Gene- 4th Edition by Watson.1987.
9. Molecular Genetics of Bacteria by Dale.1994
10. Organization of Prokaryotic Genome by Robert Charlebois.1999.
11. General microbiology Vol. I and II by Power C.H and H.F.Daginawala.
12. Microbiology by Pelczar andCrick.
13. General Microbiology byStainer.
14. Fundamental principles of bacteriology by A.J.Salle
15. 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.
16. 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, CA94111.

Swami Ramanand Teerth Marathwada University Nanded
Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Science and Technology
Subject: Agricultural Microbiology
Semester: VI
Paper Name: Agricultural Biotechnology (DSEAMBII (Section B I)
Paper Number: XVA

Credits: 02 (Marks: 50) **Periods: 45**

Specific Program Outcome:

The aim of the undergraduate degree in Agricultural Microbiology is to make students knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Agricultural Microbiology and acquire knowledge and understanding of the Agricultural microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others. 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, 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. 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 to enable him to identify challenging society problems and plan his professional carrier to develop innovative solutions for such problems.

Specific Course Outcome:

Agricultural Biotechnology course makes students understand

- The role of microorganisms in Agriculture
- Production of microbial Biofertilizers
- Use of microorganisms in Biogas and Biodiesel production
- Tissue culture techniques
- Application of Tissue culture techniques in Agriculture.

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome	Number of Lectures
Unit – I Biofertilizers	1. Production and field applications of Biofertilizers: i. Rhizobium ii. Azotobacter iii. Blue green algae iv. Mycorrhizae v. Azospirillum	The students has acquired knowledge of Production and field applications of Biofertilizers	**10**
Unit – II Biofuels	1. Ethanol: Industrial Production of Ethanol and its application 2. Biogas: Production of Biogas, Stages of methanogenesis, Biochemistry of methane formation, Application of Biogas 3. Hydrogen Production and conversion of light energy, its application.	Student capable of understanding and developed skill in Biogas Production, Ethanol Production and gained knowledge about Biodiesel producing plants	**12**

	4. Biodiesel production: Biodiesel producing plants, industrial production its application.		
Unit – III **Plant Cell Cultures**	1. Basic Requirements for Tissue culture laboratory 2. Formulation of tissue culture medium 3. Collection of ex - plant materials 4. Callus culture, suspension culture, embryo culture, meristem culture, anther culture 5. Callus formation and its culture 6. Organogenesis and micro-propagation 7. Application of Plant tissue culture	Have acquired the knowledge of Tissue culture techniques and its application.	**12**
Unit – IV **Secondary metabolites and Transgenic Plants**	1. Secondary metabolites from Cell Cultures 2. Secondary metabolites from Immobilized plant cells 3. Transgenic Plants 4. Transgenic Plants for crop improvement 5. Transgenic Plants as bioreactors: Vit A, nutritional quality and edible vaccine	Has acquired a fairly good knowledge of Secondary metabolites and Transgenic Plants for crop improvement. .	**11**

References:

1. Biochemistry byChatwal.
2. Biochemistry byGarrett.
3. Biochemistry by Lubeststryer.
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 , AcademicPress.
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, PrenticeHallpublication.
19. Stanbury P.F, Whittekar, A and Hall SJ, Principles offermentation Technology,PergamonPress.
20. Trehan K., Biotechnoogy, New age Internationalpublisher.
21. West and Toad, text book of Biochemistry Oxford andIBH

Swami Ramanand Teerth Marathwada University Nanded
Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Science and Technology
Subject: Agricultural Microbiology
Semester: VI
Paper Name: Environmental Biotechnology DSEAMBII (Section B II)
Paper Number: XV B

Credits: 02 (Marks: 50) **Periods: 45**

The aim of the undergraduate degree in Agricultural Microbiology is to make students knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Agricultural Microbiology and acquire knowledge and understanding of the Agricultural microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others. 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, 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. 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 to enable him to identify challenging society problems and plan his professional carrier to develop innovative solutions for such problems.

Specific Course Outcome:

Agricultural Biotechnology course makes students understand

- Types of pollution
- Sources of pollution
- Fossil fuels as energy source
- Microbial bioremediation of pesticides and Xenobiotic compounds and Phytoremediation
- Conservation of biodiversity

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome	Number of Lectures
Unit – I Environmental Pollution	1. Introduction to environment and pollution 2. Types of pollution - air, water and land pollution 3. Types of pollutants– inorganic, organic and biotic sources 4. Sources of pollution – domestic waste, agricultural waste, industrial effluents and municipal waste 5. Climate change, greenhouse gases and global warming 6. Impact of pollution on environment and measurement methods	The students has acquired knowledge of Types of pollution, global warming.	**10**
Unit – II Bioenergy and Bio-fuels	1. Renewable and non-renewable energy resources 2. Fossil fuels as energy source and their impact on environment 3. Non-conventional source –	Student capable of understanding Fossil fuels Production of biofuels.	**11**

	biomass as source of bioenergy 4. Types of biomass – plant, animal and microbial biomass 5. Production of biofuels: biodiesel, ethanol 6. Production of biomethane, biohydrogen		
Unit – III Bioremediation	1. Microbial treatment of waste water (sewage of industrial effluent) - aerobic and anaerobic methods 2. Solid waste and management; Bioremediation – concepts and types (in-situ and ex-situ); 3. Bioremediation of toxic metal ions – biosorption and bioaccumulation 4. Microbial bioremediation of pesticides and Xenobiotic compounds 5. Phytoremediation- concepts and application	Have acquired the knowledge of Bioremediation and Phytoremediation.	**12**
Unit – IV Biodegradation and Restoration of Environment	1. Introduction, Role of microorganisms in biodegradation of pollutants 2. Degradation by genetically engineered microorganisms, 3. Factors affecting microbial degradation, 4. Composting of organic wastes, 5. Conservation of biodiversity.	Has acquired a fairly good knowledge of biodegradation of pollutants and Composting of organic wastes.	**12**

References:

1. Text Book of Biotechnology - By H.K. Das (Wiley Publications)
2. Biotechnology -By H.J. Rehm and G. Reed. VIH Publications, Germany
3. Biogas Technology - By b.T. Nijaguna
4. Biotechnology - By K. Trehan
5. Industrial Microbiology - By L.E. Casida
6. Food Microbiology - By M.R. Adams and M.O. Moss
7. Introduction to Biotechnology - By P.K. Gupta
8. Essentials of Biotechnology for Students - By Satya N. Das
9. Bioethics – Readings and Cases - By B.A. Brody and H. T. Engelhardt. Jr. (Pearson Education)
10. Biotechnology, IPRs and Biodiversity - By M.B. Rao and Manjula Guru (Pearson Education)
11. Bioprocess Engineering - By Shuler (Pearson Education)
12. Essentials of Biotechnology - By Irfan Ali Khan and AtiyaKhanum (Ukaaz Publications)

Swami Ramanand Teerth Marathwada University Nanded
Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Science and Technology
Subject: Agricultural Microbiology
Paper Name: Practicals Based on P – XII & P – XIV (DSEAMBP I [DSEAMB I & II Section A])
Paper Number: XVI

Credits: 02 **Marks: 50**

(Annual practical Based on [DSEAMB I& II (Section A)] (Practical syllabus requires four periods per batch per week for 2 consecutive days B.Sc. Third year practical includes studies of growth of microorganisms and life activities of Microorganisms. These studies need two consecutive days for completion of practical.)

Specific Program Outcome:

The aim of the undergraduate degree in Agricultural Microbiology is to make students knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Agricultural Microbiology and acquire knowledge and understanding of the Agricultural microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others. 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, 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. 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 to enable him to identify challenging society problems and plan his professional carrier to develop innovative solutions for such problems.

Specific Course Outcome:

By this annual practical course, the students

1. Acquired the practical skill for extraction, purification, and study of DNA Profile.
2. Developed understanding and skill for studying the effect of different mutagens on growth of *E. coli*
3. Acquired the practical skill for extraction and purification of RNA from *S. cerevisiae*
4. Developed understanding and skill for studying genetic material transfer by conjugation and transduction
5. Developed practical skills for determination of MIC and LD50 of Streptomycin

1. Purification of chromosomal/plasmid DNA and study of DNA profile.
    i. Confirmation of nucleic acid by spectral study.
    ii. Quantitative estimation by diphenylamine test.
    iii. DNA denaturation and determination of Tm and G + C contents.
    iv. Agarose gel electrophoresis of DNA.
2. Effect of UV radiations
    i. To study the survival pattern of *E.coli*/yeast
    ii. Repair mechanisms in *E.coli* / yeast (Dark and Photo reactivation).
3. Isolation of antibiotics resistant Bacterial Mutants by Physical/ Chemical agents.
4. Ampicillin selection method for isolation of auxotrophic mutants.
5. Extraction and purification of RNA from *S. cerevisiae*.
6. Studies on gene expression in *E. coli* with reference to Lac operon.
7. Study of Conjugation in *E. coli*.
8. Restriction digestion and Agarose gel electrophoresis of DNA.
9. Generalized Transduction in *E. coli* using p1 phage
10. Determination of MIC and LD50 of Streptomycin

Reference:

1. Laboratory Exercises in Microbiology, Fifth Edition Harley−Prescott
2. Microbiology – A laboratory Manual 10th edition by James Cappuccino and Natalie Sherman
3. Microbiological Applications Lab Manual, Eighth Edition by Benson
4. Hiper Teaching Kit published by Himedia Laboratories Pvt. Ltd.

Swami Ramanand Teerth Marathwada University Nanded
Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Science and Technology
Subject: Agricultural Microbiology
Paper Name: Practicals Based on P – XIII A & B & P – XVA & B
[DSEAMBP II (DSEAMB I & II Section B I& II)]
Paper Number: XVII

Credits: 02 **Marks: 50**

(Annual practical Based on [DSEAMB I& II (Section B)] (Practical syllabus requires four periods per batch per week for 2 consecutive days B.Sc. Third year practical includes studies of growth of microorganisms and life activities of Microorganisms. These studies need two consecutive days for completion of practical.)

Specific Program Outcome:

The aim of the undergraduate degree in Agricultural Microbiology is to make students knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Agricultural Microbiology and acquire knowledge and understanding of the Agricultural microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others. 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, 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. 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 to enable him to identify challenging society problems and plan his professional carrier to develop innovative solutions for such problems.

Specific Course Outcome:

By the end of this annual practical course, the students

- Have acquired the skill for primary screening of antibiotic producer, amylase producer and organic acid producer.
- Have acquired a detailed knowledge and skill of number of products which are produced by industrial fermentation processes, like citric acid, penicillin, wine etc.
- Have acquired the knowledge about tissue culturetechniques
- Preparation of artificial seeds
- Production of Biofertilizers

1. Primary screening of antibiotic producers fromsoil.
2. Primary screening of organic acid producers fromsoil.
3. Production of citric acid by *Aspergillus niger*sp.
4. Downstream processing and estimation of citricacid.
5. Extraction of amylase, protease, lipases, from bacterial and fungalsp.
6. Bioassay of Penicillin/Streptomycin
7. Alcohol production by S.cerevisiae
8. Estimation of alcohol by specific gravitymethod
9. Preparation of plant tissue culturemedia
10. Callus culturedevelopment
11. Preparation of artificial seeds
12. Production of Biofertilizers: Rhizobium / Azotobactersp.
13. Demonstration ofVAM
14. Production ofSCP
15. Production of hydrogen or biogas using cow/cattle dung
16. Identification and characterization of bioremediation microorganisms.

Reference:

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. Hiper Teaching Kit published by Himedia Laboratories Pvt. Ltd.

Swami Ramanand Teerth Marathwada University Nanded

Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)

Faculty of Science and Technology

Semester - V

Subject: Agricultural Microbiology

Paper Name: Plant Molecular Biology Techniques (SECAMB III A)

Paper Number: Skill - III

Credits:02 **Marks: 50**

Specific Program Outcome:

The aim of the undergraduate degree in Agricultural Microbiology is to make students knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Agricultural Microbiology and acquire knowledge and understanding of the Agricultural microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others. 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, 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. 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 to enable him to identify challenging society problems and plan his professional carrier to develop innovative solutions for such problems.

Specific Course Outcome:

By the end of this skill course, the students

- Have acquired good understanding of enzymes involved in Plant genetic engineering and cloning methodologies.
- Have acquired the skill required for handling procedures of genetic engineering.

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome
Unit I **Enzymes involved in genetic engineering**	a. Restriction endonucleases type I, II, and III (Nomenclature and Classification, activity) b. DNA ligase – i. properties and specificities ii. Activity and mode of Action c. S Nuclease d. DNA Polymerase e. Phosphatase f. Reverse transcriptase	The students - Have acquired good understanding of enzymes involved in genetic engineering, cloning vector, cloning methodologies.
Unit II **Plant DNA isolation**	a. Methodsof Plant DNAisolation i. Fragmentationmethod ii. Shot – gunmethod iii. cDNAmethod b. cloning vector isolation – Tiplasmids	
Unit III **Plant HybridizationTechniques**	a. Protoplast Fusion and SomaticHybridization b. Methods of Isolation of Protoplast c. Purification, culture and regeneration ofprotoplast d. Fusionproducts.	

Unit IV **Cloning methodologies**	a. Insertion of Foreign DNA into the host cells – transformation b. Plant transformation technology i. Basic of tumour formation ii. Features of Ti and Ri plasmids iii. Mechanism of DNA transfer iv. Use of Ti & Ri as plasmid vector		
Practical **Practice**	A. Extraction and isolation of Plant DNA B. Confirmation of DNA by spectral studies C. Agarose gel electrophoresis of DNA OR Industrial training on molecular biology techniques	This lab course aims to provide the students. - To understand the importance of enzymes involved in genetic engineering. - To study the procedure of genetic engineering.	

References: -

1. Laboratory Exercises in Microbiology, Fifth Edition Harley−Prescott
2. Microbiology – A laboratory Manual 10th edition by James Cappuccino and Natalie Sherman
3. Microbiological Applications Lab Manual, Eighth Edition by Benson
4. Hiper Teaching Kit published by Himedia Laboratories Pvt. Ltd.

Semester - V
Subject: Agricultural Microbiology
Paper Name: Tissue Culture Technique (SECAMB III B)
Paper Number: Skill - III

Credits:02 **Marks: 50**

Specific Program Outcome:

The aim of the undergraduate degree in Agricultural Microbiology is to make students knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Agricultural Microbiology and acquire knowledge and understanding of the Agricultural microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others. 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, 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. 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 to enable him to identify challenging society problems and plan his professional carrier to develop innovative solutions for such problems.

Specific Course Outcome:

By the end of this skill course, the students

- Have acquired good understanding of Plant Tissue culturetechnique.
- Have acquired the skill ofPropagation of banana by tissue culturetechnique.

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome
Unit I **Plant tissueculture**	a. Introduction b. History of tissueculture c. Importance of tissueculture d. Types of tissueculture e. Plant *in vitro* culturetechniques	The students - Have acquired good understanding of tissueculture techniques.
Unit II **Micropropagation**	a. Stages ofMicropropagation b. Proliferation of Axillary Buds c. Induction of adventitious Buds, Bulbs. d. Artificial seeds e. Somaclonal Variations f. Advantages ofMicropropagation g. Disadvantages ofMicropropagation	
Unit III **Plant tissue culture Techniques**	a. Media Components andPreparation b. Explant'spreparation c. Transfer and cultivation ofexplants d. Propagation of banana by tissue culturetechnique	

Unit IV **Applications of Tissue culture**	a. Improvement of Hybrids b. Encapsulated seeds c. Production of disease resistance Plants d. Production of Stress Resistant Plants		
Practical Practice	A. Collection of healthy banana plant from thefield B. Banana explantpreparation C. Banana Tissue culture media preparation andsterilization D. Transfer and incubation of explant in thelaboratory. E. Production of Banana Plantlets by tissueculture technique OR Tissue culture training.	This lab course aims to provide the students - To commercially produce Banana plantlets by tissueculture technique.	

References: -

1. Biotechnology – Expanding Horizon by B. D. Singh, First Edition, Kalyani Publication, Delhi.
2. Laboratory Exercises in Microbiology, Fifth Edition Harley−Prescott
3. A text book of Biotechnology by R. C. Dubey, Fourth Edition, S Chand & Company Ltd, New Delhi.

Swami Ramanand Teerth Marathwada University Nanded
Choice Based Credit System (CBCS) Learning Outcome Based Course Structure
(New scheme)
Faculty of Science and Technology
Semester - VI
Subject: Agricultural Microbiology
Paper Name: Mushroom Cultivation Techniques (SECAMB IV A)
Paper Number: Skill - IV

Credits:02 **Marks: 50**

Specific Program Outcome:

The aim of the undergraduate degree in Agricultural Microbiology is to make students knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Agricultural Microbiology and acquire knowledge and understanding of the Agricultural microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others. 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, 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. 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 to enable him to identify challenging society problems and plan his professional carrier to develop innovative solutions for such problems.

Specific Course Outcome:

By the end of this skill course, the students

- Have acquired good understanding of Mushroom Cultivation technique
- Cultivation of *Agaricus bitorquis*mushroom.
- Cultivation of *Pleurotus*mushroom.

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome
Unit I **Mushroom Cultivation**	a. Introduction b. Importance ofMushroom c. Food value ofMushroom d. Uses ofMushrooms	The students - Have acquired good understanding of tissueculture techniques.
Unit II **Steps in Mushroom cultivation**	a. Mushroom farm structure, design andlayout b. Spawn Productiontechniques c. CompostingTechniques d. Methods ofSpawning e. Casingtechnique	
Unit III **Cultivation Technology of *Pleurotus*Mushroom**	a. Preparation ofSpawn b. Preparation of Substrate for *Pleurotus* mushroomcultivation c. Composting d. Spawning ofsubstrate	

Unit IV **Post Harvesting and preservation**	a. Short Term Processing and preservation ofMushroom b. Long Term processing and preservation ofMushroom c. Marketing of Mushroom.	
Practical Practice	A. Cultivation of *Agaricus bitorquis*mushroom. B. Cultivation of *Pleurotus*mushroom.	This lab course aims to provide the students - To commercially producemushroom.

References: -

1. Biotechnology – Expanding Horizon by B. D. Singh, First Edition, Kalyani Publication, Delhi.
2. Laboratory Exercises in Microbiology, Fifth Edition Harley−Prescott
3. A text book of Biotechnology by R. C. Dubey, Fourth Edition, S Chand & Company Ltd, New Delhi.

Swami Ramanand Teerth Marathwada University Nanded
Choice Based Credit System (CBCS) Learning Outcome Based Course Structure
(New scheme)
Faculty of Science and Technology
Semester - VI
Subject: Agricultural Microbiology
Paper Name: Biofertilizer Technology (SECAMB IVB)
Paper Number: Skill - IV

Credits:02 **Marks: 50**

Specific Program Outcome:
The aim of the undergraduate degree in Agricultural Microbiology is to make students knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Agricultural Microbiology and acquire knowledge and understanding of the Agricultural microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others. 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, 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. 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 to enable him to identify challenging society problems and plan his professional carrier to develop innovative solutions for such problems.

Specific Course Outcome:
Have acquired good understanding ofhave acquired good understanding of

- Types ofbiofertilizers
- Carrier material used for production ofbiofertilizer
- Rhizobium inoculant production
- Phosphate solubilizer InoculantProduction

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome
Unit I Biofertilizers	Introduction Bacterization Functions ofbiofertilizers Types ofbiofertilizers	The students - Have acquired good understanding of Biofertilizer Production.
Unit II Carriers for Biofertilizer production	Carrier material used for production ofbiofertilizer. Carrier sterilization using autoclaving and γirradiations.	
Unit III Rhizobium biofertilizer	Isolation of Rhizobiumstrain Identification of Rhizobium Rhizobium inoculant production Effect of Rhizobial inoculants on crop yield	

Unit IV Phosphate Solubilizers	Isolation of MicrobialStrains Phosphate solubilizer InoculantProduction Mass production of Phosphate solubilizer Crop response against Phosphate solubilizing microorganisms.	
Practical Practice	A. Preparation of Rhizobiumbiofertilizer B. Preparation of phosphatesolubilizer	This lab course aims to provide the students - To commercially produce biofertilizers and phosphate solubilizer.

References:

1. Kannaiyan, S. (2003). Bioetchnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
3. Reddy, S.M. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
4. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. NewDelhi.
5. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH Publications.
6. Verma, A. (1999). Mycorrhiza. Springer Verlag, Berlin.
7. Wallanda, T. et al. (1997). Mycorrhizae. Backley's Publishers,
8. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.