Swami Ramanand Teerth Marathwada University Nanded
Choice Based Credit System (CBCS)) Learning Outcome Based Course Structure (New scheme)
Faculty of Science and Technology
Subject: 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	DSEMBI (Section A)	Microbial Genetics (P – XII)	03	45	10	40	50	2
	DSEMB I[Section B I] **OR** DSEMB I[Section B II]	Microbial Metabolism (P – XIII A) **OR** Nitrogen Metabolism (P – XIII B)	03	45	10	40	50	2
VI Semester	DSEMBII (Section A)	Molecular Biology (P-XIV)	03	45	10	40	50	2
	DSEMB II [Section B I] **OR** DSEMB II [Section B II]	Industrial Microbiology (P – XVA) **OR** Pharmaceutical Microbiology (P – XVB)	03	45	10	40	50	2
Annual Practicals / Skill	DSEMBP I [DSEMB I & II Section A]	Practicals Based on P – XII & P -XIV (P -XVI)	04	10 Practical	10	40	50	2
	SECMB III (AOR B)	Enzyme Technology (A) **OR** Molecular Biology Techniques (B)	03	45	25	25	50	(02) *
Annual Practicals / Skill	DSEMBP II [DSEMB 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
	SECMB IV (A OR B)	Bioprocess Technology (A) **OR** Good Manufacturing Practices (B)	03	45	25	25	50	(02) *
	Total Credits Semester V & VI							12 (04*)

DSEMB – Discipline Specific Elective Microbiology
DSEMBP – Discipline Specific Elective Microbiology Practical
SECMB – Skill Enhancement Course Microbiology
ESE – End Semester Examination
CA – Continuous Assessment

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॥ सा विद्या या विमुक्तये ॥

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

"ज्ञानतीर्थ" परिसर, विष्णुपुरी, 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 3(f) and 12(B), NAAC Re-accredited with 'A' Grade

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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. २६/५१–२०२१च्या 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.

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Outline and Salient Feature:

B. Sc. Third year Microbiology syllabus is crafted to serve the need of choice-based credit system course structure to orient and practically train students in the field of Microbiology. The course is specifically bringing discipline elective and skilled enhanced courses together dealing additional domain of knowledge in this field of study where in DSE course based on microbial genetics and molecular biology is concerned with genes, mutation, recombination, DNA replication, transcription, translation, associated phenomena and their manipulation and techniques of such manipulation.

Another DSE course (with choice) provide an option to learn diverse metabolic events occurring in view of the particular microorganisms and its environment and agriculture and to relate this information to a biology as a whole. This course is giving emphasis on enzymology, microbial metabolism, nitrogen metabolism and also offer industrial microbiology or pharmaceutical Microbiology as DSE courses is an area of applied microbiology which deals production of various useful end products on large scale.

Skill enhanced courses on enzyme, bioprocess technology, GMP and molecular biology techniques is well suited to understand application of scientific and engineering skills to the processing of materials by microorganisms.

Utility:

The syllabus of B. Sc. Third year microbiology course will orient and train the students in view of microbial genetics and molecular biology, occurrence of metabolic events and its relation to environment and agriculture, Industrial and Pharmaceutical Microbiology to understand and apply this knowledge for carrier orientation.

SE Course will provide additional opportunity for a student to develop skills of interest in this field of study.

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.

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Swami Ramanand Teerth Marathwada University Nanded
Choice Based Credit System (CBCS)) Learning Outcome Based Course Structure (New scheme)
Faculty of Scienceand Technology
Subject: Microbiology
Semester:V
Paper Name: MicrobialGeneticsDSEMBI (Section A)|
Paper Number: XII

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

Specific Program Outcome:

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

Specific Course Outcome:

Microbial Genetics coursemakes students to understand the evidencegiven to prove DNA and RNA as genetic material, properties of DNA as genetic material, and structure of prokaryotic chromosome. They also comprehend knowledge of the DNA replication process in prokaryotes, genetic recombination, and genetic material transfer among the microorganisms through transformation, conjugation and transduction.

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome	Number of Lectures
Unit – I The Genetic Material	1. Evidences for DNA as genetic material i. Griffith Experiment, Avery et al Experiments, ii. Hershey and Chase Experiment 2. Discovery of RNA as viral genetic material i. Gierer and Schramm Experiment (TMV) 3. Properties of DNA as Genetic Material 4. Chemical stability of DNA and its information content	Able to understand the evidences given for DNA and RNA as genetic material and properties of DNA as genetic material and how chemical stability of DNA and its information content prevents the lost of information	**09**

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	5. Structure of prokaryotic Chromosomes i. *E. coli*- The model genetic organism		
Unit – II Prokaryotic DNA replication	1. General Concepts of DNA Replication 2. Semi Conservative DNA Replication 3. Replicon Model (Cairns Model), Precursors and Enzymes of DNA Replication 4. Mechanism of DNA Replication: Initiation, Elongation (Beta Clamp and Progressive Polymerases) and Termination 5. Replication in *E. coli* (In Short)	Have developed an incredibly good understanding about DNA replication process	12
Unit – III Molecular Recombination in Bacteria	1. General Perspective of Genetic Recombination (with Holliday Model as example) 2. Homologous Recombination in *E. coli* (Initiation, Synapsis, Branch Migration, and resolution) 3. Types of Recombination i. Site Specific Recombination (Integrative and Excessive Recombination) ii. Illegitimate Recombination (Non-Homologous Recombination) iii. Transposition: iv. Transposable elements in Prokaryotes v. Insertion Sequence	Developed a good knowledge about genetic recombination by which modification of characters or new characters arise in bacteria	12
Unit – IV Genetic Exchange in bacteria	1. Transformation i. Introduction and History ii. Mechanism of transformation Competence, Binding, Penetration, Synapsis and Integration. 2. Conjugation i. Discovery of conjugation in bacteria ii. Properties of F plasmid/Sex factor iii. Hfr strains and their formation iv. Mechanism of Conjugation v. F 'factor and Sexduction 3. Transduction i. Introduction and discovery ii. Generalized and Specialized transduction iii. Abortive transduction	Developed a good knowledge about the three well known mechanisms by which genetic material is transferred among the microorganisms namely transformation, transduction, and conjugation	12

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References:

1. **Biochemistry** by Jeremy M Berg, John L Tymoczko, and LubertStryer International 5th Edition, Publisher: W. H. Freeman & Company
2. **Essentials of Molecular Biology**by David Freifelder (2002), Publisher: NarosaPublishing House.
3. **Fundamental Bacterial Genetics** by Nancy Trun and JenanineTrumphy (2003),Publisher: Blackwell Publishing
4. **General Microbiology** (5th edn.) Stanier R. Y., Ingraham, J.L., Wheelis, M. L., Painter, P.R.(2008), Publisher: Macmillan Press Ltd, London
5. **General Microbiology (Vol. I and II)** Powar, C.B. and Daginawala,H.F.(2008), Publisher:Himalaya publishing house
6. **Genetics a conceptual approach** (3rd ed.) by Benjamin A. Pierce (2008) Publisher: W.H. Freeman and Company.
7. **Genetics-A molecular approach** (2nd /3rd ed.) by Peter J. Russell (2006)
8. **Modern Microbial Genetics**, Second Edition. Edited by Uldis N. Streips, Ronald E.Yasbin. Publisher: Wiley-Liss, Inc.
9. **Principles of Genetics** by R. H. Tamarin, (2004) Publisher: Tata McGraw Hill.
10. **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.
11. **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.
12. **Manual of Methods for Pure Culture Study,** by A. B. Solunke, P. S. Wakte, V. D. Hamde, and R. S. Awasthi, Nirmal Publication Delhi (India)

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Swami Ramanand Teerth Marathwada University Nanded
Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Scienceand Technology
Subject: Microbiology
Semester: V
Paper Name: Microbial MetabolismDSEMBI (Section B I)
Paper Number: XIII A

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

Specific Program Outcome:

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

Specific Course Outcome:

Microbial Metabolism coursemakes students to get the knowledge of enzymes, physicochemical properties of enzymes, nomenclature and classification of enzymes, mechanism of action of enzyme and factors affecting the enzyme activity. Students become capable of differentiating the catabolic and anabolic process and also defining the role of different pathways in generating the ATP, different fermentation products such as ethanol, lactic acid etc.

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome	Number of Lectures
Unit – I Enzymes	1. Definition, Physicochemical properties of enzymes 2. Coenzymes and Cofactors 3. Nomenclature and Classification of enzymes 4. Mechanisms of enzyme action 5. Specificity of enzymes 6. Enzyme kinetics: Michaelis-Menten equation 7. Factors affecting enzyme activity 8. Inhibition of enzyme activity:	Have acquired the knowledge of meaning of enzymes, physicochemical properties of enzymes, nomenclature and classification of enzymes, mechanism of enzyme action and factors affecting the enzyme activity	**15**

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	Competitive, Non-competitive and Uncompetitive inhibition. 9. Regulation of enzyme activity: Allosteric enzymes, Multienzyme system and Isoenzymes.		
Unit – II Microbial Metabolism	1. Introduction to metabolism, catabolism and anabolism with examples. 2. Role of nucleotides in metabolism: Nucleotides as building blocks of nucleic acids; ATP as currency of cell; Pyridine and Flavin nucleotides. 3. Basic pathways of carbohydrate catabolism: EMP, HMP, ED, and PKP, TCA cycle. 4. β-Oxidation of saturated and unsaturated fatty acids	Student capable of - differentiating the catabolic and anabolic process - explaining the role of ATP in the metabolism - describing the role of different pathways in producing ATP	**15**
Unit – III Mechanisms of Energy Transformations in Microorganisms	1. Respiration, Photosynthesis and Fermentation (Basic concepts). 2. Generation of ATP: Oxidative Phosphorylation, Photophosphorylation and Substrate level Phosphorylation. 3. Biochemical mechanisms of respiration in Heterotrophs and Chemoautotrophs. 4. Respiratory electron transport chain in bacteria. 5. Characteristics of Bacterial RETC and It's Components.	Student capable of differentiating concepts of aerobic and anaerobic respiration and how these aremanifested in the form of different metabolic pathwaysin microorganisms.	**08**
Unit – IV Microbial Fermentations	1. Ethanol fermentation by yeasts and bacteria. 2. Lactic acid fermentation: Homo and Heterolacta fermentation. 3. Mixed acid fermentation. 4. Acetone-Butanol fermentation. 5. Butanediol fermentation. 6. Succinic acid fermentation.	Developed a good knowledge about the production of different fermented products	**07**

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 and Company.
3. S. C. Rastogi. '***Biochemistry***'. Tata McGraw Hill Publishing Company, New Delhi.
4. Gottschalk G. '***Bacterial Metabolism***'. Springer, New York.
5. Doelle H. W. '***Bacterial Metabolism***'. Elsevier, New Delhi.
6. Sandikar B. M. '***Basic Biochemistry and Microbial Metabolism***'. Himalaya Publishing House, Mumbai.
7. Moat A. G., Foster J. W. and Spector M. P. '***Microbial Physiology***'. Wiley-India.
8. Conn E. E. and Stmph P. K. '**Outlines of Biochemistry**' John Wiley & Sons, New Delhi.

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9. **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.

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Swami Ramanand Teerth Marathwada University Nanded
Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Scienceand Technology
Subject: Microbiology
Semester: V
Paper Name: Nitrogen MetabolismDSEMBI(Section B II)
Paper Number: XIII B

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

Specific Program Outcome:

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

Specific Course Outcome:

Nitrogen Metabolism coursemakes students understand

- The role of nitrogen fixers in environmental Nitrogen Cycle,
- Microbiology and biochemistry of oxidation of Ammonia. Nitrite and Denitrification.
- Biosynthesis of purine, pyrimidine, and catabolism of nucleotides
- Different pathway to synthesis the amino acids

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome	Number of Lectures
Unit – I Fixation of Molecular Nitrogen	1. Nitrogen Fixing Organisms 2. Biochemical mechanism of Nitrogen Fixation 3. Structure and properties of Nitrogenase 4. Regulation of Nitrogenase	Have learned the process of nitrogen fixation by microorganisms	**10**
Unit – II Biochemistry of Bacterial Nitrification/Denitrification	1. Microbiology and Biochemistry of i. Oxidation of Ammonia and Hydroxyl amine ii. Electron transport pathway coupled to	Student capable of explaining the microbiology and biochemistry of oxidation of ammonia, nitrite, and	**12**

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	oxidation of Ammonia iii. Oxidation of Nitrite iv. Denitrification	denitrification	
Unit – III **Nucleotide Metabolism**	1. Biosynthesis of Purine 2. Biosynthesis of Pyrimidine 3. Catabolism of Nucleotides	Acquired the metabolism behind the biosynthesis of purine and pyrimidine and also understand the catabolism of nucleotides	**11**
Unit – IV **Biosynthesis of Amino acids**	1. Biosynthesis ofOxaloacetate and Pyruvate families of amino acids 2. Phosphoglycerate family of amino acids 3. α – oxoglutaratefamily of amino acids 4. Aromatic amino acids **5.** Histidine Synthesis	Gained knowledge of biosynthesis of different amino acids by different pathways.	**12**

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 and Company.
3. S. C. Rastogi. **'*Biochemistry*'.** Tata McGraw Hill Publishing Company, New Delhi.
4. Gottschalk G. **'*Bacterial Metabolism*'.** Springer, New York.
5. Doelle H. W. **'*Bacterial Metabolism*'.** Elsevier, New Delhi.
6. Sandikar B. M. **'*Basic Biochemistry and Microbial Metabolism*'.** Himalaya Publishing House, Mumbai.
7. Moat A. G., Foster J. W. and Spector M. P. **'*Microbial Physiology*'.** Wiley-India.
8. Conn E. E. and Stmph P. K. **'Outlines of Biochemistry'** John Wiley & Sons, New Delhi.
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Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Scienceand Technology
Subject: Microbiology
Semester: VI
Paper Name:Molecular BiologyDSEMBII(Section A)
Paper Number: XIV

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

Specific Program Outcome:

The aim of the undergraduate degree in Microbiology is to make students knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Microbiology and acquire knowledge and understanding of the microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others. Their understanding, knowledge and skills in 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 good microbiological practices and also developed broad perspective of the discipline of Microbiology 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 coursemakes students understand

- Characteristics of genetic code, structure of RNAP and ribosome, and gene expression in term of transcription and translation process
- The concept of mutation, types of mutation and repair of DNA
- Gene regulation at transcriptional and translational level, the Lac Operon and Trp Operon of *E. coli*
- Tools and the methods for genetic engineering

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome	Number of Lectures
Unit – I **Gene Expression**	1. Genetic code 2. Characteristics of Genetic code: Triplet code, comma free, non-overlapping, degenerate, start and stop signals and wobble hypothesis 3. Structure of RNA Polymerase (RNAP) 4. Process of transcription 5. Structure of Ribosome	the students - Has acquired knowledge of genetic code, structure of RNAP and ribosome, and gene expression in term of transcription and translation process	**10**

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	6. Process of Translation 7. Bacterial Transcriptional and Translational Cycle		
Unit – II **Mutagenesis and DNA Repair**	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 4. Mechanism of Induced Mutation: Physical and Chemical Mutagenic agents 5. Repair of DNA by i. Photo-reactivation ii. Nucleotide Excision Repair (NER) iii. Base Excision Repair (BER) iv. Mismatch Excision Repair (MER)	Student capable of clarifying - the concept of mutation, - types of mutation - repair of DNA	**10**
Unit – III **Regulation of Gene expression in Prokaryotes**	1. Gene regulation at Transcription level: Repressors, Activators, Sigma factor and Attenuation 2. Gene regulationat Translation level 3. The lac Operon of E. coli 4. The trp Operon of E. coli 5.	Has acquired the knowledge of gene regulation at transcriptional and translational level. Capable of explaining the Lac Operon and Trp Operon of *E. coli*	**11**
Unit – IV **Molecular Techniques and Applications**	1. Introduction, Definition and purpose of Cloning 2. Tools for molecular cloning i. Enzymes: Restriction endonucleases, DNA ligases, alkaline phosphatase, DNA Modifying enzymes ii. Vectors: Plasmids-pBR322, Bacteriophage-Phage λ, Cosmids 3. Methods of Gene Transfer i. Transformation ii. Electroporation iii. Liposome Fusion	Has acquired a fairly good knowledge of the tools and the methods for genetic engineering.	**14**

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	iv. Transduction 4. Screening Strategies (In short) i. Insertional Inactivation ii. Immunochemical Methods iii. Colony hybridization 5. Application:Expression of Human insulin gene in *E. coli*		

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: NarosaPublishing 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: SarasPublication,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 JenanineTrumphy (2003),Publisher: Blackwell Publishing.r: 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.

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Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Scienceand Technology
Subject: Microbiology
Semester: VI
Paper Name:Industrial MicrobiologyDSEMBII(Section B I)
Paper Number: XV A

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

Specific Program Outcome:

The aim of the undergraduate degree in Microbiology is to make students knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Microbiology and acquire knowledge and understanding of the microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others. Their understanding, knowledge and skills in 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 good microbiological practices and also developed broad perspective of the discipline of Microbiology 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 coursethe students

- Are capable of describing a large number of substrates that are used for theindustrial fermentation processes
- Have developed an understanding of different types of reactors or fermenters whichare 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 fermentativeproduction of organic acids, alcohols, enzymes, antibiotics and various foods in the industry
- Has acquired knowledge of various physical parameters which affect production of industrialproducts 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. Role of Microbiologist in Industrial Microbiology	the students - Has acquired knowledge of scope and development in Industrial Microbiology.	**10**

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	3. Bioreactor (Definition, Ideal Design and characteristics, Working of Auxiliary equipment) 4. Types of Fermenter: laboratory fermenter, pilot plant fermenter, industrial fermenter, Horton sphere. Batch, continuous, Tubular, fed batch, fluidised bed reactor, tower fermenter (In brief) 5. Computer application in fermentation technology	- Has knowledge of bioreactor, types of fermenter	
UNIT II – Microbesin Industrial Microbiology	1. Introduction, Screening 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)	Student capable of enlightening - Screening techniques - Strain improvement - Inoculum development	**09**
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	Has acquired a fairly good knowledge and skill for production of fermentation products.	**14**

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	in synthesis of the product, Product recovery operations, and uses of following: i. Beverages: Wine ii. Organic acid: Citric acid iii. Antibiotics: Penicillin iv. Biofertilizers: Legume inoculants v. Bioinsecticide: Thuricide vi. Amino acids: Glutamic acid vii. Enzymes: Fungal Amylase		

REFERENCES:

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.

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Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Scienceand Technology
Subject: Microbiology
Semester: VI
Paper Name: Pharmaceutical MicrobiologyDSEMBII (Section B II)
Paper Number: XV B

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

Specific Program Outcome:

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

Specific Course Outcome:

By Pharmaceutical Microbiology coursethe students

- Acquired detailed knowledge of antimicrobial agents, their chemical nature, andmechanism of action and basis of resistance of microbes to these antimicrobials, formulations involving different antimicrobials, stabilization of formulations
- Developed understanding of different types of disinfectants/antiseptics and their specific uses, and evaluation of their bactericidal and bacteriostatic actions, basic knowledge ofcell cultures.
- Developed practical skills for testing pharmaceutical products for sterility testingand pyrogenicity testing using different methods

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome	Number of Lectures
Unit – I Microbiology and Pharmaceuticals	1. Introduction, Overview and application of Pharmaceutical Microbiology 2. Microbiological tests useful for Pharmaceutical sector 3. Role of microbiologist in Laboratory Management	the students - Has acquired applications of Pharmaceutical Microbiology. - Has knowledge of Microbiological tests useful for pharmaceutical sector	**10**

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	and Design		
UNIT II – Good Laboratory Practice and Safety techniques	1. Introduction to Good Laboratory Practice and safety, Pharmacopeia, and microbiological test 2. Bioburden determination – Total microbial count, units of Measurement, Non sterile products and microbial limit testing, In-process material assessment Presterilization bioburden assessment, alternative methods of bioburden Assessment 3. Specified and objectionable microorganisms- indicator microorganisms 4. Determining which microorganism are objectionable and assessing risk	Student capable of explaining : - Good laboratory practices and safety - Bioburden determination tests - Specified and objectionable microorganisms	**11**
Unit – III Contamination and infection control	1. Microbial spoilage, infection risk and contamination control 2. Laboratory evaluation of non-antibiotic and antimicrobial agents 3. Chemical disinfectants, antiseptics and preservatives 4. Non-antibiotics, antimicrobial agents, mode of action and resistance 5. Sterilization procedures and sterility assurance.	Has acquired the knowledge and skill of contamination control, laboratory evaluation test for nonantibiotic antimicrobial agents, chemical disinfectants and sterilization procedures.	**12**
Unit – IV Pharmaceutical Product Manufacture	1. Pharma products microbial origin: i. Dextran ii. Vitamin (riboflavin) fermentation iii. Enzyme – Streptokinase 2. Sterile Pharmaceutical Products i. Injections, non-injectionable sterile fluids ii. Ophthalmic preparation iii. Absorbable haemostatics iv. Surgical ligatures and sutures 3. The manufacture and quality control of immunological	Has acquired a fairly good knowledge and skill for production of Pharma products of microbial, sterile pharmaceutical products.	**12**

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	products i. Vaccines ii. Immune sera iii. Human immunoglobulin 4. Recombinant DNA techniques i. Somatostatin ii. Insulin iii. Interferon		

References:

1. **Good Manufacturing Practices for Pharmaceuticals** by Sydney H. Willing, Murray. M. Tuckerman, Willam S. Hitching IV. Second edition Mercel Dekker NC New York
2. **Pharmaceutical Biotechnology** by S. P. Vyas & V. K. Dixit. CBS publishers& distributors, New Delhi
3. **Pharmaceutical Microbiology** by W. B. Hugo & A. R. Russel Sixth Edition. Blackwell Scientific Publications
4. **Pharmacognosy** by Gokhle S. D., Kokate C.K. Edition: 18 Nirali Publication
5. **Biotechnology** – Expanding Horizon by B. D. Singh, First Edition, Kalyani Publication, Delhi.

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Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Science and Technology
Subject: Microbiology
Paper Name:Practicals Based on P – XII & P – XIV(DSEMBP I [DSEMB I & II Section A])
Paper Number: XVI

Credits: 02 **Marks: 50**

(Annual practical Based on [DSEMB I& II (Section A)] (Practical syllabus requires fourperiods per batch per week for 2 consecutive days B.Sc. Third year practical includesstudies of growth of microorganisms and life activities of Microorganisms. Thesestudies need two consecutive days for completion of practical.)

Specific Program Outcome:

The aim of the undergraduate degree in Microbiology is to make students knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Microbiology and acquire knowledge and understanding of the microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others. Their understanding, knowledge and skills in 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 good microbiological practices and also developed broad perspective of the discipline of Microbiology 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 practicalcourse,the students

- Acquired the practical skill for extraction, purification, and study of DNA Profile.
- Developed understanding and skill for studying the effect of different mutagens on growth of *E. coli*
- Acquired the practical skill for extraction and purification of RNA from *S. cerevisiae*
- Developed understanding and skill for studying genetic material transfer by conjugation and transduction
- 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.

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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 Books:

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.
5. Laboratory Manual in Microbiology by Balkrishna M, Sandikar and Shaileshkumar V. Mamdapure, Kripa Drishti Publications, Pune, 2021

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Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Science and Technology
Subject: Microbiology
Paper Name:Practicals Based on P – XIII A & B& P – XVA & B (DSEMBP II [DSEMB I & II Section B I& II])
Paper Number: XVII

Credits: 02 **Marks: 50**

(Annual practical Based on [DSEMB I& II (Section B)] (Practical syllabus requires fourperiods per batch per week for 2 consecutive days B.Sc. Third year practical includesstudies of growth of microorganisms and life activities of Microorganisms. Thesestudies need two consecutive days for completion of practical.)

Specific Program Outcome:

The aim of the undergraduate degree in Microbiology is to make students knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Microbiology and acquire knowledge and understanding of the microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others. Their understanding, knowledge and skills in 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 good microbiological practices and also developed broad perspective of the discipline of Microbiology 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 byindustrial fermentation processes, like citric acid, penicillin, wine etc.
- Have acquired the knowledge to study the enzymes, production of enzymes

1. Estimation of reducing sugar by Sumner's method.
2. Estimation of Amino acids by Rosen's method
3. Study of enzymes (Lecithinase, Gelatinase, Urease, Caseinase, Catalase)
4. Fermentative production of Production of amylase
5. Effect of various physicochemical parameters on amylase activity (pH, Temp)
6. Primary screening of antibiotic producers, amylase producers, organic acid producers
7. Production of Penicillin (Surface / submerged)
8. Fermentative production of Wine & and its estimation by Titrable acidity
9. Production of Citric acid (Surface / submerged) & its estimation by Titrable acidity

10. Production of Biofertilizer (*Azotobacter*)
11. Bioassay of Penicillin
12. Bioassay of therapeutic enzyme glucose oxidase
13. Determination of antimicrobial activity of chemical compound (Phenol)
14. Sterility testing by using *Bacillus stearothermophilius / Bacillus subtilis*

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

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Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Scienceand Technology
Subject: Microbiology
Semester: V
Paper Name: Enzyme Technology (SECMBIII A)
Paper Number: Skill - III

Credits: 02 **Marks: 50**

Specific Program Outcome:

The aim of the undergraduate degree in Microbiology is to make students knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Microbiology and acquire knowledge and understanding of the microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others. Their understanding, knowledge and skills in 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 good microbiological practices and also developed broad perspective of the discipline of Microbiology 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 developed a particularly good understanding of sources of enzymes and their applications in various fields.
- Have developed skill for isolation, Purification, and Immobilization of enzymes.
- To understand the importance of enzymes in day today life.

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome
Unit I **Introduction**	i. Sources of enzymes and their classes ii. Application of enzymes in a. Industrial paper and textile b. Biomedical and in drug design c. Dairy, food and brewing industry d. Artificial enzymes and Recombinant enzymes e. Enzymes as biosensors	Have developed a particularly good understanding of sources of enzymes and their applications in various fields.
Unit II **Methods of enzyme isolation**	i. Cell lysis methods – a. Osmotic shock b. Enzyme lysis c. Homogenization d. Ultra-centrifugation ii. Concentration of enzymes by a. Precipitation (Ammonium sulphate)	Have developed skill for isolation, Purification, and Immobilization of enzymes.

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	b. Dialysis of protein c. Heat treatment d. Nucleic acid removal	
Unit III **Enzyme purification, characterization based on**	i. Size and mass (centrifugation, GPC Gel Permeation chromatography, Dialysis and ultracentrifugation) ii. Polarity (ion exchange electrophoresis iii. Changes in solubility (change in pH, Change in ionic strength, salting in or salting out) iv. Change in dielectric strength by isoelectric focusing and adding organic solvent, hydrophobic interaction chromatography v. Specific binding sites (Affinity chromatography, Affinity elution, Dye – ligand chromatography, immune adsorption chromatography, co – valent chromatography)	
Unit IV **Immobilization of enzymes methods**	i. Adsorption ii. Covalent bonding iii. Entrapment and membrane confinement iv. Application in - analytical, therapeutic, industrial	
Practical **Practice**	1. Fungal Amylase i. Production ii. Isolation methods iii. Purification methods iv. Assay and activity procedure v. Immobilization techniques of fungal amylase	This lab course aims to provide the students. - To understand the importance of enzymes in day today life. - To practically isolate and purify particular enzyme

References: -

1. A Manual for Biochemistry Protocols by Markus R. Wenk and Aaron Zefrin Fernandis Published by World Scientific Publishing Co. Pte. Ltd.
2. Enzymes in Industry Production and Applications Edited by Wolfgang Aehle Third, Completely Revised EditionWILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2007.
3. Enzymes In Food Biotechnology Production, Applications, and Future ProspectsEdited by Mohammed Kuddus, Academic Press, Elsevier, 2019.
4. Enzyme Immobilization Advances in Industry, Agriculture, Medicine, and the Environment by Alka Dwevedi, © Springer International Publishing Switzerland 2016.
5. Enzymes in Food Technology Edited by Robert J. Whitehurst and Maarten van Oort Second edition, © Blackwell Publishing Ltd, 2010.

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Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Scienceand Technology
Subject: Microbiology
Semester: V
Paper Name: Molecular Biology Techniques (SECMB III B)
Paper Number: Skill - III

Credits: 02 **Marks: 50**

Specific Program Outcome:

The aim of the undergraduate degree in Microbiology is to make students knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Microbiology and acquire knowledge and understanding of the microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others. Their understanding, knowledge and skills in 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 good microbiological practices and also developed broad perspective of the discipline of Microbiology 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 genetic engineering, hybridization techniques, cloning vector, cloning methodologies.
- Have acquired the skillrequired 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, hybridization techniques, cloning vector, cloning methodologies.
Unit II **Hybridization techniques**	a. Northern, Southern & colony hybridization b. Fluorescence in situ hybridization c. Restriction map and mapping	

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	technique d. DNA Finger printing	
Unit III **Cloning vector**	a. Plasmids and their properties (pBR322, PUC18, its derivatives and construction) b. Bacteriophage λqt, 10/11 c. Cosmid vectors d. Artificial chromosome vectors – YAC, BACS e. Animal virus derived vector – SV40	
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 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.
5. Principles and Techniques of Biochemistry and Molecular Biology Edited by Keith Wilson And John Walker Seventh edition.
6. Principles of Gene Manipulation by S. B. Primrose, R. M. Twyman and R. W. Old, Sixth Edition, Blackwell Science Ltd. 2001.

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Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of ScienceandTechnology
Subject: Microbiology
Semester: VI
Paper Name: Bioprocess Technology (SECMB IV A)
Paper Number: Skill - IV

Credits: 02 **Marks: 50**

The aim of the undergraduate degree in Microbiology is to make students knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Microbiology and acquire knowledge and understanding of the microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others. Their understanding, knowledge and skills in 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 good microbiological practices and also developed broad perspective of the discipline of Microbiology 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 bioprocesses involved in manufacture of agro based products
- Have acquired skill for production of food and dairy products.
- Have acquired good knowledge of industrial waste treatment.

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome
Unit I **Agro based Bioprocesses involved in manufacture**	a. Biocompost b. Biofertilizers c. Bioinsecticides d. Biogas e. Biofuel	The students - Have acquired good understanding of bioprocesses involved in manufacture of agro based products. - Have acquired skill for production of food and dairy products. - Have acquired good knowledge of industrial
Unit II **Food and Diary bioprocesses**	Bioprocesses involved in production of a. Bread b. Idli, Dhokla, Dosa c. Pickles d. Yoghurt (curd) & buttermilk e. Cheese	

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Unit III **Industrial effluent Treatment**	a. Physical, chemical b. Biological treatment i. Aerobic treatment processes – Trickling filters, biologically aerated filters, rotating biological contactors, rotating drums, fluidized – bed systems, activated sludge processes.	waste treatment
Unit IV **Anaerobic treatment process**	a. anaerobic digestion, anaerobic digestor, anaerobic filters, up – flow anaerobic sludge blankets (UASD)	
Practical **Practice**	a. Ethanol production from Agri waste b. Idli & Dosa preparation c. Determination of COD of industrial effluent d. Determination of BOD of industrial effluent	This lab course aims to provide the students. - To study the role of microorganisms involved in treatment of sewage.

References: -

1. Biofertilizer Manual Published by FNCA Biofertilizer Project GroupJapan Atomic Industrial Forum (JAIF) – 2006.
2. Applied Microbiology published by Sanjai Saxena © Springer India 2015.
3. Biofertilizer Manualby Dr. Sueo Machi, By FNCA Biofertilizer Project Group Forum for Nuclear Cooperation in Asia (FNCA) March 2006.
4. Modern Industrial Microbiology and Biotechnology by Nduka Okafor and Benedict C. Okeke, Publisher: CRC Press, 2018.
5. Microbes as Biofertilizers and their Production Technology by S. G. BorkarWoodhead Publishing India Pvt Ltd New Delhi, India, 2015.

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Swami Ramanand Teerth Marathwada University Nanded
Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Scienceand Technology
Subject: Microbiology
Semester: VI
Paper Name: Good Manufacturing Practices (GMP) (SECMB IVB)
Paper Number: Skill - IV

Credits: 02 **Marks: 50**

The aim of the undergraduate degree in Microbiology is to make students knowledgeable about the various basic concepts in wide-ranging contexts, which involve the use of knowledge and skills of Microbiology and acquire knowledge and understanding of the microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others. Their understanding, knowledge and skills in 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 good microbiological practices and also developed broad perspective of the discipline of Microbiology 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 GMP and GLP.
- Have acquired practicalskill to carry sterilization of Pharmaceutical Products.

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome
Unit I **Quality Assurance & Validation**	a. GMP & GLP in pharmaceutical industry b. Regulatory aspects of quality control c. Quality assurance & quality management in industry ISO, WHO & US certification	The students - Have acquired good understanding of GMP and GLP. - Have acquired skill for Sterility testing and Validatation .
Unit II **Sterilization & sterility testing**	a. Heat sterilization b. D – value, Z – value, survival curve c. Radiation & Gaseous sterilization d. Filter sterilization	
Unit III **Validatation & in process monitoring of sterilization**	a. Physical indicators b. Chemical indicators c. Biological indicators d. Sterility testing	

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Unit IV **Design and layout of sterile product manufacturing unit**	a. Designing of microbiology laboratory b. Safety in microbiology lab	
Practical Practice	i. Bioassay of Penicillin ii. Bioassay of therapeutic enzyme Glucose Oxidase iii. Determination of MIC & LD 50 of Streptomycin iv. Determination of antimicrobial activity of chemical compounds like Phenol v. Sterility testing by using Bacillus stearothermophilus or Bacillus subtilis	This lab course aims to provide the students. - To understand the importance of GMP in Pharmaceutical Industry. - To practically carry sterilization of Pharmaceutical Products.

References: -

1. Good Design Practices for GMP Pharmaceutical FacilitiesEdited by Terry Jacobs, AIA, and Andrew A. Signore, Second Edition, CRC Press, © 2017.
2. Good Design Practices for GMP Pharmaceutical Facilitiesby Andrew A. Signore and Terry Jacobs, Publishedby Taylor & Francis Group, 2005.
3. Handbook of Pharmaceutical Manufacturing Formulations Compressed Solid Products by Sarfaraz K. Niazi, by Informa Healthcare USA, Inc Volume One Second Edition, 2009.
4. Pharmaceutical Manufacturing Handbook Production and Processes by Shayne Cox Gad, Published by John Wiley & Sons, Inc., Hoboken, New Jersey, 2008.
5. Handbook of Pharmaceutical Manufacturing Formulations Sterile Products by Sarfaraz K. Niazi, CRC Press, 2004. Volume 6.
6. Sterility, sterilisation and sterility assurance for pharmaceuticals Technology, validation and current regulations by TimSandle, Woodhead Publishing Limited, 80 High Street, Sawston, Cambridge, CB22 3HJ, UK. 2012.

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Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Science and Technology
Subject: Microbiology
Paper Name: Practicals Based on P – XII & P – XIV(DSEMBP I [DSEMB I & II Section A])
Paper Number: XVI

PROFORMA FOR PRACTICAL EXAMINATION

Time: Four hours per day per batch for two consecutive days **Marks: 40**

1. Effect of UV Radiation on survival of Yeast/Bacteria and Photo-reactivation 15

   OR

   Purification of Chromosomal/Plasmid DNA and its confirmation

2. Isolation of antibiotic resistant mutants by induced mutation 10

   OR

   Restriction digestion of DNA and its Gel Electrophoresis/Estimation of DNA/RNA

3. Studies on gene expression in *E. coli* with respect to *Lac* Operon 10

   OR

   Transformation/Conjugation/Transduction in *E. coli*

4. Viva-voce 05

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Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)
Faculty of Science and Technology
Subject: Microbiology
Paper Name: Practicals Based on P – XIII A & B & P – XVA & B (DSEMBP II [DSEMB I & II Section B I])
Paper Number: XVII

PROFORMA FOR PRACTICAL EXAMINATION

Time: Four hours per day per batch for two consecutive days **Marks: 40**

1.	Studies on enzymes Lecithinase/Gelatinase/Urease/Caseinase/Catalase (Any Three)	15
	OR	
	Penicillin Bioassay	
2.	Estimation of Reducing sugar (Sumner's method)/Amino-acid (Rosen's method)	10
	OR	
	Production of Biofertilizer/Legume Inoculants and its characterization	
3.	Estimation of Citric Acid/Wine (Titrable method)	10
	OR	
	Screening of Starch hydrolyser/Antibiotic producer/Organic acid producer	
4.	Viva- voce	05

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