Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Structure and Curriculum of Four Year Multidisciplinary Degree (Honors/Research) Programme with Multiple Entry and Exit option

Undergraduate Programme of Science and Technology

B.Sc. (Honors/Research) in Microbiology (IIIrd Year)

Board of Studies in

Microbiology

Rajarshi Shahu Mahavidyalaya, Latur (Autonomous)

w.e.f. June, 2025

(In Accordance with NEP-2020)

Review Statement

The NEP CELL reviewed the Curriculum of **B.Sc. in Microbiology** Programme to be effective from the **Academic Year 2025-26.** It was found that, the structure is as per the NEP-2020 guidelines of Govt. of Maharashtra.

Date: 11/04/2025

Place: Latur

NEP CELL
Rajarshi Shahu Mahavidyalaya,
Latur (Autonomous)

CERTIFICATE

I hereby certify that the documents attached are the Bonafide copies of the Curriculum of **B.Sc. (Honors/Research) in Microbiology** Programme to be effective from the **Academic Year 2025-26.**

Date: 15-06-2025
Place: Latur

(Dr. D. V. Vedpathak)
Chairperson
Board of Studies in Microbiology
Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Members of Board of Studies in the Subject Microbiology
Under the Faculty of Science and Technology

Sr. No.	Name	Designation	In position
1.	**Dr. D. V. Vedpathak** Head, Department of Microbiology, Rajarshi Shahu Mahavidyalaya, Latur (Autonomous)	Chairperson	HoD
2.	**Dr. B. S. Nagoba** Assistant Dean (R D), Professor of Microbiology, MIMSR Medical College, Latur- 413 512 (MS), India	Member	V.C. Nominee
3.	**Dr. Ulhas K. Patil** Government Institute of Science Aurangabad	Member	Academic Council Nominee
4.	**Dr A. M. Deshmukh** Former Professor and President, Microbiologist Society of India	Member	Academic Council Nominee
5.	**Dr. Manmohan Bajaj** Product Manager, BIOGENE INDIA, New Delhi	Member	Expert from outside for Special Course
6.	**Dr. Vinodkumar Patil** Director, Dyna Biotech 98/A5, Hadapsar Industrial Estate Bhd. Kirloskar Pneumatic Co., Hadapsar, Pune	Member	Expert from Industry
7.	**Dr Mahesh S. Dharane** Sr. Scientist, Division of Biochemical Sciences, Dr. Homi Babha Road,Pashan, NCL, Pune	Member	P.G. Alumni
8.	**Dr. K. I. Momin**	Member	Member from same Faculty

From the Desk of the Chairperson…

The National Education Policy lays particular emphasis on the development of the creative potential of each individual. NEP-2020 has conceptualized the idea to develop well rounded competent individuals for making the nation a self-reliant and global leader.

Department of Microbiology has developed a curriculum framework to encompass the goals of NEP 2020. Microbiology is study of microorganisms such as bacteria, protozoa, algae, fungi, viruses, etc. These studies integrate cytology, physiology, ecology, genetics and molecular biology, evolution, taxonomy and systematics with a focus on microorganisms. It is one of the significant branches of sciences to understand the principles of life which has roots in the study of various microbial systems. Microbiology has been at the forefront of research in industry, environment, agriculture, food, dairy, medicine and biology. It is one of the rapidly growing and applied areas of the science. Many job opportunities available for student in this stream. Trained manpower is required in industrial production of microbial products. Considering rural and agro based life background and awareness about the general health and hygiene, our curriculum is designed to educate our students in various important microbiological domains, as well as to promote and develop skills and competencies that have great value.

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Rajarshi Shahu Mahavidyalaya, Latur

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Index

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science and Technology

Structure for Four Year Multidisciplinary Undergraduate Degree Programme (B.Sc. III) in Microbiology Multiple Entry and Exit (In accordance with NEP-2020)

Year & Level	Sem	Major		Minor DSM	GE/ OE	VSC, SEC (VSEC)	AEC/ VEC	OJT, FP, CEP, RP	Credit per Sem.	Cum./Cr. per exit
		DSC Mandatory	DSE Elective							
III 5.5	V	DSC IX: 04 Cr. DSC X: 04 Cr.	DSE I:04 Cr	DSM III: 04 Cr. DSM IV: 02	NA	VSC III: 02 Cr.	VEC-III Evs studies : 02 Cr.	NA	22	44
	VI	DSC XI: 04 Cr. DSC XII: 02 Cr. IKS-02 Cr.	DSE II: 04 Cr	DSM IV: 04 Cr.	NA	SEC-V: 02 Cr.	NA	Academic Project/ IAPC/OJT/FE: 04 Cr	22	
	Cum. Cr.	**Major: 16**	**DSE: 8 Cr**	**Minor: 8Cr**	**NA**	**VSC: 04**	**VEC III: 02 Cr.**	**AP-04 Cr**	**44**	
Exit Option: Award of UG Diploma in Major with 44 Credits and Additional 04 Credits Core NSQF Course/Internship or continue with Major and Minor										

Abbreviations:

1.	DSC	: Discipline Specific Core (Major)
2.	DSE	: Discipline Specific Elective (Major)
3.	DSM	: Discipline Specific Minor
4.	GE/OE	: Generic/Open Elective
5.	VSEC	: Vocational Skill and Skill Enhancement Course
6.	VSC	: Vocational Skill Course
7.	SEC	: Skill Enhancement Course
8.	AEC	: Ability Enhancement Course
9.	MIL	: Modern Indian Languages
10.	IKS	: Indian Knowledge System
11.	FSRCE	: Fostering Social Responsibility & Community Engagement
12.	VEC	: Value Education Course
13.	OJT	: On Job Training
14.	FP	: Field Project
15.	CEP	: Community Engagement Programme
16.	CC	: Co-Curricular Course
17.	RP	: Research Project/Dissertation
18.	SES	: Shahu Extension Services

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Microbiology

B.Sc. (Honors/Research) Microbiology

Year & Level	Semester	Course Code	Course Title	Credits	No. of Hrs.
III 5.5	V	(DSC-IX) 301MIB5101	Molecular Microbiology	03	45
		301MIB5103	Lab Course-IX	01	30
		(DSC-X) 301MIB5102	Enzymology	03	45
		301MIB5104	Lab Course-X	01	30
		DSE I-(a) 301MIB5201	Microbial Metabolism	03	45
		301MIB5202	Lab Course-I	01	30
			OR		
		DSE I-(b)	Basics of Bioinformatics	03	45
			DSE I-(b)-Lab Course	01	30
		Minor I (DSM III)	Microbial Genomics	03	45
			DSM-III-Lab Course	01	30
		Minor II (DSM IV)	Microbial Analysis of Water and Food	01	30
			DSM-IV-Lab Course	01	30
		(VSC-IV) 301MIB5501	Quality control in Packed Drinking Products	02	45
		(VEC-III)	Environmental Studies	02	30
	Total Credits			**22**	
	VI	(DSC-XI) 301MIB6101	Microbial Genetics	03	45
		301MIB6103	Lab Course-XI	01	30
		(DSC-XII) 301MIB6102	Agricultural Microbiology (IKS)	03	45
		301MIB6104	Lab Course-XII	01	30
		DSE II-(a) 301MIB6201	Industrial Microbiology	03	45
		301MIB6202	Lab Course-II	01	30
			OR		
		DSE II-(b)	Pharmaceutical Microbiology	03	45
			DSE II-(b)- Lab Course	01	30
		Minor III (DSM V)	Microbial Analysis of Air and Soil	03	45
			DSM-V-Lab Course	01	30
		(VSC-IV) 301MIB6501	Bio-analytical Tools	02	45
		(FP/RP)	Academic Project	04	45
	Total Credits			**22**	
Total Credits (Semester V & VI)				**44**	

Faculty of Science & Technology After the completion of the B.Sc. programme, a student will have obtained:

Programme Outcomes (POs) for B.Sc. Programme	
After the completion of the B.Sc. programme, a student will have obtained:	
PO 1	**Disciplinary Knowledge** Comprehensive knowledge of science subjects which constitute the graduate programme and execution of scientific knowledge in the specific area.
PO 2	**Scientific Outlook** The qualities of a science graduate such as observation, precision, analytical mind, logical thinking, clarity of thought and expression and systematic approach.
PO 3	**Self-Directed Life-long Learning** Ability to appear for various competitive examinations or choose the post graduate programme or other related programme of their choice.
PO 4	**Research Skills** Functional knowledge and applications of instrumentation and laboratory techniques to do independent experiments interpret the results and develop research ethos.
PO 5	**Problem Solving Skills** Analytical and logical skills and critical thinking to extract information from qualitative and quantitative data, formulate and solve problems in a systematic and rational manner.
PO 6	**Professional Competence and Ethics** Aptitude and skills to perform the jobs in diverse fields such as science, engineering, industries, survey, education, banking, development and planning, business, public service, self-business etc. with human rationale and moral values.

Programme Specific Outcomes (PSOs) for B.Sc. Microbiology (Honors/Research)	
PSO No.	Upon completion of this programme the students will be able to
PSO 1	**Academic Competence** Comprehensive knowledge in the underlying principles of Microbiology, basics in Microbiology and Biomolecules, Methods, Microbial nutrition and growth, fundamentals of immunology, Environmental Microbiology, Production of Biofertilizer, Agricultural Microbiology.
PSO 2	**Scientific Outlook** Scientific temperament with the help of experiments and practical's in Microbiology such as observation of microorganism through microscope, use of microbial techniques, experiments to test physiochemical factors, perform hematological procedures
PSO 3	**Personal and Professional Competence** Competence to do awareness about hematological, microorganisms and causation of diseases, environmental, agricultural issues and can work to solve the environmental issues with the help of knowledge in Microbiology.
PSO 4	**Entrepreneurial Competence** Capacity to move in the start-up of bio fertilizer, pathology lab, Food Fermentation, Production of Probiotics for good health, medical services or work for the conservation of environment or can work in such organizations.
PSO 5	**Research Competence** An ability to work over minor and preliminary research in human health, environmental issues, production of various secondary metabolites of human benefit by fermentation processes and other related issues.

Semester - V

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Rajarshi Shahu Mahavidyalaya, Latur

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Faculty of Science

Department of Microbiology

B. Sc. Third Year (Semester- V)

Course Type: DSC IX

Course Title: Molecular Microbiology

Course code: 301MIB5101

Credit: 03 **Hours: 45** **Marks: 75**

Learning Objectives:

LO 1 To study the basic concepts of genetic material.
LO 2 To study of the damage of DNA and its repair mechanisms
LO 3 To study the genetic exchange in prokaryotes
LO 4 To understand the transposition and recombination processes.

Course Outcomes:

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

CO 1 Describe the basic concepts of bacterial mutations.
CO 2 Understand the damage of DNA and its repair mechanisms
CO 3 Understand the genetic exchange in prokaryotes
CO 4 Understand the transposition and recombination processes

Unit No.	Title of Unit & Contents	Hrs.
I	**DNA: Structure, replication and properties**	**10L**
	1. Structure of DNA. 2. Forms of DNA 3. Properties: physical, chemical, spectral and thermal properties. 4. Topology of DNA 5. Stability of DNA and its information content 6. Replication of DNA 7. Models of DNA Replication 8. DNA methylation in prokaryotes	
	Unit Outcomes: UO 1. Students understand and able to explain the structural integrity of genetic material UO 2 Students able to explain how the genetic information is stored and inherited in the next progeny	
II	**Genes and Genomes**	**10**
	1. Genome and structure of bacterial gene 2. Plasmon and plasmids 3. Gene as recon, muton and cistron 4. Overlapping genes 5. Genome size and complexity. 6. Genome organization of *E. coli.*	
	Unit Outcome: UO 1. Students able to understand the different types of genome organization. They able	

Unit No.	Title of Unit & Contents	Hrs.
	to compare the complexity of genome and cellular organization UO 2 Students able to illustrate the genome organization	
III	**Gene Expression**	**13L**
	1. Transcription: Structure of RNA Polymerase (RNAP), Structure of mRNA and the Process of transcription 2. Characteristics of Genetic code. 3. Translation: Structure of Ribosomes, t-RNA and the Process of Translation 4. Regulation of gene Expression: *i.* The *lac* Operon of *E. coli* *ii.*The *trp* Operon of *E. coli* iii. Quorum sensing iv. Bacteriophage gene regulation 5. Post Translational Modification 6. Transcriptional and Translation Regulation (Promoters, Alternative promoters and σ-factors, Ribosome binding, Codon usage and stringent response)	
	Unit Outcomes: UO 1. Students able to understand synthesis and regulation of proteins UO 2 Students able to explain the machinery and the process required for protein synthesis	
IV	**Gene cloning**	**12L**
	1. Introduction, Definition and Purpose of Cloning 2. Outline of gene cloning procedure (shot gun method) 3. Cloning vectors: pBr322, Cosmids, M13 4. Insertion of target DNA into vector: by using of linkers and adaptors 5. Screening of recombinants: Insertional inactivation, Colony hybridization 6. Methods of gene transfer: $CaCl_2$ Transformation, Electroporation	
	Unit Outcomes: UO 1. Students will get the knowledge of recombinant DNA technology UO 2 Students will understand the various advanced technology used in gene transfer	

Learning Resources:

1. Principles of Gene Manipulation and Genomics; Third edition; S.B. Primrose and R.M. Twyman Blackwell Publishing
2. Analysis of Genes and Genomes Richard J. Reece John Wiley & Sons Inc
3. Genetics-A molecular approach (2nd /3rd ed.) by Peter J. Russell
4. Genetics a conceptual approach (3rd ed.) by Benjamin A. Pierce. Publisher: W. H.Freeman and Company.
5. Principles of Genetics by R. H. Tamarin. Publisher: Tata McGraw Hill.
6. Essentials of Molecular Biology by David Freifelder. Narosa Publishing House.
7. Gene biotechnology, second revised edition, Jogdand S. N., Himalaya PublishingHouse
8. Molecular Biology and Genetic Engineering by Narayanan, Moni, Selvaraj, Singh,Arumugam. Saras Publication. Nagercoil, Kanyakumari.
9. Modern Microbial Genetics, Second Edition. Edited by Uldis N. Streips, Ronald E.Yasbin. Wiley-Liss, Inc.
10. Fundamental Bacterial Genetics by Nancy Trun and Jenanine Trumphy. BlackwellPublishing.
11. Advanced molecular biology, A concise reference. Richard M. Twyman. BIOSScientific Publishers Limited. Oxford OXl4R E, UK.
12. Modern Microbial Genetics, Second Edition. Edited by Uldis N. Streips, Ronald E. Yasbin. Publisher: Wiley-Liss, Inc.
13. Principles of Genetics by R. H. Tamarin, (2004) Publisher: Tata McGraw Hill.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Faculty of Science

Department of Microbiology

B. Sc. Third Year (Semester- V)

Course Type: Lab course

Course Title: Lab Course IX (based on DSC IX)

Course code: 301MIB5103

Credit: 01 **Hours: 30** **Marks: 50**

Learning Objectives:

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

LO 1 To design and perform experiments for isolation of Lac mutants

LO 2 To design and perform experiments for isolation of genomic and plasmid DNA

LO 3 To study method for agarose gel electrophoresis of DNA

LO 4 To study method for amplification of DNA using PCR

Course Outcomes:

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

CO 1 Design and perform experiments for isolation of Lac mutants

CO 2 Design and perform experiments for isolation of genomic and plasmid DNA

CO 3 Perform agarose gel electrophoresis of DNA

CO 4 Describe amplification of DNA using PCR

Practical No.	Unit
1	Studies on gene expression in *E. coli* with reference to Lac operon.
2	Isolation of chromosomal DNA (*E. Coli*)
3	Quantitative Analysis of DNA by DPA method
4	Isolation of plasmid DNA
5	Isolation of RNA (*Yeast*)
6	Agarose gel electrophoresis of DNA
7	Amplification of DNA by PCR.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science

Department of Microbiology

B. Sc. Third Year (Semester- V)

Course Type: DSC X

Course Title: Enzymology

Course code: 301MIB5102

Credit: 03 **Hours: 45** **Marks: 75**

Learning Objectives:

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

LO 1 To study general characteristics and kinetics of enzymes.

LO 2 To study enzyme inhibition and regulation of enzyme.

LO 3 To understand different extraction and purification methods for biocatalyst

LO 4 To study use of biocatalyst in different industries.

Course Outcomes:

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

CO 1 Describe roles of biocatalyst in living system.

CO 2 Describe allosteric regulation and their significance in metabolic regulation.

CO 3 Describe different immobilization techniques

CO 4 Explain mechanism of enzyme action and application of biocatalyst in different industries.

Unit No.	Title of Unit & Contents	Hrs.
I	**Enzyme and enzyme kinetics**	**12L**
	1. Enzyme as a Biocatalyst: Definition, Importance and History (In Detail) i. Structure of enzyme, Physico chemical nature, Apoenzyme and cofactors.Prosthetic group, coenzymes and metal cofactors. ii Active site and its silent features iii. Classification of enzymes iv. General properties of enzyme v. Types of enzymes: extracellular, intracellular, constitutive, inducible, endoenzyme and exoenzyme vi. Mechanism of enzyme action –Lock and key hypothesis, induced fit model. 2. Enzyme kinetics – i. Michaelis–Menten equation ii. Applications (Lineweaver-Burk Plot) iii. Steady state kinetics	

Unit No.	Title of Unit & Contents	Hrs.
	3. Factors influencing enzyme activity i. Temperature ii. pH iii. Substrate concentration iv. Enzyme concentration	
	Unit Outcomes: UO 1. Students will be able to understand the classification of enzymes UO 2 Students will be able to understand the enzyme kinetics	
II	**Enzyme inhibition and Regulation**	**11**
	1. Enzyme inhibition i. Reversible Inhibition ii. Competitive Inhibition iii. Non-Competitive Inhibition iv. Uncompetitive Inhibition v. Irreversible Inhibition vi. Substrate and Product Inhibition 2. Allosteric enzymes regulation (Homotropic and Heterotrophic Regulation) 3. Co-operativity (Hills equation) 4. Isoenzymes	
	Unit Outcome: UO 1. Students will be able to understand enzyme inhibition UO 2. Students will be able to understand enzyme regulation	
III	**Microbial Enzyme Production, Extraction and Purification**	**12**
	1. Microbial Production: i. Amylase ii. Protease iii. Lipase 2. Importance of Enzyme purification. 3. Different sources of enzyme, Extracellular and Intracellular enzyme, Physical and Chemical methods used for cell disintegration. 4. Enzyme fractionation by precipitation (using Temperature, Salt, pH etc.) 5. Enzyme purification by Liquid-liquid extraction, Dialysis, Ionic Exchange, Gel electrophoresis, Affinity chromatography and other special purification methods. 6. Enzyme crystallization technique, Criteria of purity of enzyme, Pitfalls in working with pure enzyme.	
	Unit Outcomes: UO 1. Students will be able to understand industrial production of enzymes UO 2 Students will be able to understand enzyme purification methods	
IV	**Immobilization and Applications of Microbial enzymes**	**10**
	1. Properties of Immobilized enzyme.	

Unit No.	Title of Unit & Contents	Hrs.
	2. Methods of immobilization: Adsorption, Covalent bonding Entrapment and Membrane confinement. 3. Analytical, Therapeutic and Industrial applications of immobilized enzymes. 4. Microbial enzymes in Textiles, Leather, Wood Industries and Detergent, Enzymes in clinical diagnosis, 5. Enzyme sensors for clinical processes and environment analysis. 6. Enzymes as therapeutic agents, Extremozymes, Solventogenic enzymes	
	Unit Outcomes: UO 1. Students will be able to explain enzyme immobilization methods UO 2 Students will be able to analyze application of enzymes	

Learning Resources:

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

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science

Department of Microbiology

B. Sc. Third Year (Semester- V)

Course Type: Lab course

Course Title: Lab Course X (based on DSC X)

Course code: 301MIB5104

Credits- 1 **Maximum Marks: 50** **Hours: 30**

Learning Objectives:

LO 1 To study activity of different enzymes.
LO 2 To study effect of different parameters on enzyme activity.
LO 3 To study methods of immobilization of enzymes
LO4 To study hydrocarbon degrading microorganisms.

Course Outcomes:

After the completion of this course, students will be able to:
CO 1 Design and perform experiments to study activity of different enzymes.
CO 2 Design and perform experiments to determine effect of different parameters on enzyme activity.
CO 3 Design and perform immobilization of enzymes
CO4 Perform experiment to isolate hydrocarbon degrading microorganisms.

Practical No.	Unit
1	Study of enzymes (Casienase, Catalase).
2	Study of enzymes (Lecithinase, Cellulase, Amylase)
3	Estimation of enzyme activity
4	Determination of Km for amylase
5	Effect of pH and Temp on Enzyme activity
6	Isolation of hydrocarbon degrading microorganisms
7	Study of bio-surfactant producing Microorganisms

Shiv Chhatrapati Shikshan Sanstha's

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(Autonomous)
Faculty of Science
Department of Microbiology
B. Sc. Third Year (Semester- V)

Course Type: DSE I (a)
Course Title: - Microbial Metabolism
Course code: 301MIB5201
Credit: 03 **Hours: 45** **Marks: 75**

Learning Objectives:

LO.1 To Understand universal physiological laws its applicability in biological processes.
LO.2 To Understand importance of carbohydrate as prime energy source.
LO.3 To Understand how biomolecules are synthesized in bacterial cell.
LO.4 To Understand utilization of lipids as energy source.
LO.5 To Understand utilization of less energy rich compounds.

Course Outcomes:

After completion of course the student will be able to-
CO1 Describe thermodynamic laws of energy.
CO2. Describe various pathways of carbohydrate and lipid utilization.
CO3 Describe various pathways of synthesis of biomolecules.
CO4 Describe process of energy extraction form nontraditional sources

Unit No.	Title of Unit & Contents	Hrs.
I	**Metabolism and Bioenergetics**	**12**
	1. Definitions: i. Metabolism ii. Catabolism iii. Anabolism **2.** Comparison of catabolism and anabolism **3.** Regulation of Metabolic pathways **4.** Scope of thermodynamics. Laws of Thermodynamics. **5.** Concept of enthalpy, free energy and equilibrium constant, Gibbs free energy equation, determination of feasible reaction, coupled reactions. **6.** Determination of free energy of hydrolytic and biological oxidation reduction reactions, under standard and non-standard conditions. **7.** Structure and properties of ATP **8.** Atkinson's energy charge theory.	
	Unit Outcomes: UO 1. Student will be able explain different Concept of enthalpy, free energy. UO 2 Student will be able Standard Free energy change of hydrolysis of ATP and other high energy compounds.	
II	**Carbohydrate Metabolism**	**12**

Unit No.	Title of Unit & Contents	Hrs.
	1. Properties of Monosaccharide **2.** Major Carbohydrate catabolic pathways, their regulation and significance: EMP, HMP, ED, PKP, TCA, **3.** Glyoxylate bypass, **4.** Anaplerotic Sequences. **5.** RETC (Respiratory Electron Transport Chain) **6.** Gluconeogenesis	
	Unit Outcome: UO 1. Student will be able to explain Major Carbohydrate catabolic pathways UO 2 Student will be able to explain Electron transport chain in microorganisms	
III	**Anaerobic Respiration and Fermentation**	**9**
	1. Anaerobic respiration definition and example **2.** Alcohol Fermentation: Ethanol fermentation by Yeasts, the Pasteur effect, Ethanol Fermentation by Bacteria **3.** Lactate Fermentation i. Homo and Hetero Fermentative Pathways **4.** Mixed Acid and 2, 3-Butanediol Fermentation **5.** Butyrate and Butanol- Acetone Fermentation **6.** Propionate, Succinate, Formate, Acetate, Methane and Sulphate.	
	Unit Outcomes: UO 1. Student will explain different Fermentations UO 2 Student will be able to explain Anaerobic Respiration	
IV	**Metabolism of Organic Nitrogenous Compounds, lipids and hydrocarbons**	**12**
	1. Introduction to Biosynthesis of Amino acid i. L-Lysine synthesis from Oxaloacetate ii. Valine, Proline synthesis iii. Aromatic amino acids synthesis: Chorismate and tryptophan. **2.** Biosynthesis of purine and pyrimidine nucleotide **3.** Lipid Biosynthesis: Biosynthesis of palmitate, its role in other fatty acid synthesis. **4.** β-Oxidation of fatty acids. **5.** Microbial synthesis, Degradation and regulation of glycogen, Poly-phosphate, Polyβ hydroxybutyrate (PHB) production. **6.** Microbial degradation of aliphatic and aromatic hydrocarbon	
	Unit Outcomes: UO 1. Student will be able to describe Biosynthesis of Amino acid through different families, Nucleic acid metabolism and Lipid Biosynthesis for industrial production UO 2 Student will be able to describe Microbial degradation of hydrocarbon	

Learning Resources:

1 Advances in Microbial Physiology, by A. H. Rose. Academic Press. New York.
2 Applied microbial physiology: A practical Approach by P. Rhodes & P. Stansbury (1997), IRL Press, New York.
3 Bacterial physiology and Metabolism by Byung Hong Kim & Geoffrey Michael Gadd (2008), Cambridge University Press.
4 Bacterial metabolism by Gerhard Gottschalk (second edition), (1986) Springer Verlag New York Inc.
5 Bacterial metabolism by H. W. Doelle (Second edition), (2005), Academic press, Inc.
6 Biochemistry, Seventh Edition by Jeremy M. Berg, John L. Tymoczko and LubertStryer (Dec 24, 2010), W.H. Freeman & Company.
7 Chemolithoautotrophic bacteria: Biochemistry and environmental biology by TateoYamanaka, (Jan. 2008). Springer.
8 Lehninger: Principles of Biochemistry by Albert L. Lehninger, Michael Cox and DavidL. Nelson (4 May 2004), W. H. Freeman.
9 Microbial Biochemistry (Second Edition) by G.N. Cohen, (2011) Springer Dordrecht Heidelberg London New York.
10 Segel Irvin H. (1997) Biochemical Calculations 2nd Ed., John Wiley and Sons, New York 11 Garrett, R. H. and Grisham, C. M. (2004) Biochemistry. 3rd Ed. Brooks/Cole, Publishing Company, California.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Faculty of Science

Department of Microbiology

B. Sc. Third Year (Semester- V)

Course Type: Lab course

Course Title: Lab Course-I (Based on DSE I-a)

Course code: 301MIB5202

Credits- 1 **Maximum Marks: 50** **Hours: 30**

Learning Objectives:

LO 1. To understand Methods Estimation of different types of biomolecules.
LO 2. To understand membrane component and its chemical nature.
LO 3. To understand what kinds of reserve food components are present in microbes LO 4. Understand endogenous metabolism in bacteria

Course Outcomes:

After completion of course the student will be able to-
CO 1. Explain types of reserve food material
CO 2. Estimate Biomolecules
CO 3. Determine Membrane composition
CO 4. Isolate Microbes involved in hydrocarbon degradation.

Practical No.	Unit
1	Isolation and identification of Reserve food material (Glycogen / Polyphosphate/ PHB) of *B. megaterium*.
2	Demonstration of endogenous metabolism in *B. megaterium* or *E. coli* and their survival under saturation condition.
3	Quantitative estimation of amino acid by Rosen's method
4	Quantitative estimation of sugar by Sumners method.
5	Quantitative estimation of protein by Folin Lowry/Biuret method
6	Preparation and analysis of polar lipids from S. aureus and *E. coli*
7	Isolation of hydrocarbon degraders

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)
Faculty of Science
Department of Microbiology
B. Sc. Third Year (Semester- V)

Course Type: DSE I (b)
Course Title: Basics of Bioinformatics
Course code: --
Credit: 03 **Hours: 45** **Marks: 75**

Learning Objectives:

1. To understand role bioinformatics in biological data analysis
2. To understand application biological database and various online tools.
3. To use of computer base software to manipulate genomic database.
4. To understand source of proteomics and genomics database.

Course Outcomes:

After completion of course the student will be able to-

CO 1.understand various bioinformatics tools, databases available and sequence analysis.Gain knowledge on database concept, management, and retrieval along with utilization in gene and protein analysis.

CO 2. Retrieve information from available databases and use them for microbial identifications and drug designing.

CO 3. Gain ability to modify gene and protein structures in simulated systems.

CO 4. Gain basic knowledge of statistics and tools used for several quantitative analyses in microbiology. Studying proteins. Proteomics databases.

Unit No.	Title of Unit & Contents	Hrs.
I	**Basics of Bioinformatics**	**10**
	1. Introduction: Definition, history, components, and applications of bioinformatics. **2.** Internet and bioinformatics. **3.** Database: Database management system (DBMS) **4.** Searching sequence databases using BLAST and FASTA	
	Unit Outcomes: UO 1. Student will be able to understand Basics of Bioinformatics UO 2 Student will be able to explain database algorithms BLAST and FASTA	
II	**Biological databases and Sequence alignment**	**13**
	1. Biological databases: PubMed, Metadatabase (Entrez-NCBI), Nucleic acid sequence databank (DDBJ, GenBank and EMBL). **2.** Protein databases: Sequence database (PIR, Swiss-Prot, Pfam, and PROSITE) **3.** Structure database (PDB), Classification database (CATH and	

Unit No.	Title of Unit & Contents	Hrs.
	SCOPE). **4.** Molecular visualizing tool (RasMol and MOLMOL) **5.** Sequence alignment: Pair wise alignment, global and local alignment. Similarity matrices (PAM, BLOSUM). **6.** Pair wise sequence alignment using dynamic programming (Needleman-Wunsch and Smith-Waterman algorithms) **7.** Phylogenetics: Molecular Evolution, Phylogenetic tree-types constructions and basic tools for phylogenetic analysis.	
	Unit Outcome: UO 1. Student will be able to understand biological databases UO 2 Student will be able to understand Multiple sequence alignment	
III	**Microbial Genomics**	**12**
	1. Microbial Genome Structure and organization. Principles of microbial genomics such as sequencing, assembly of microbial genomes **2.** Methods for gene sequence analysis, types of genomics, analysis of gene expression, significance of genome sequencing. Microbial genome projects, Human Microbiome Project. **3.** DNA analyses for repeats (Direct and inverted) **4.** Benefits of Pharmacogenomics.	
	Unit Outcomes: UO 1. Student will be able to understand Microbial Genomics UO 2 Student will be able to explain Pharmacogenomics	
IV	**Microbial Proteomics**	**10**
	1. Types of proteomics, tools for proteomics- separation and isolation of proteins. **2.** Protein Structure Visualization, Comparison, Protein structure prediction. Homology or comparative modelling. **3.** Protein function prediction- Introduction to the concepts of molecular modelling. **4.** Structure based drug designing by automated docking. Introduction to Molecular Docking	
	Unit Outcomes: UO 1. Student will be able to understand Microbial Proteomics UO 2 Student will be able to understand Docking mechanism	

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Learning Resources:

1. Bioinformatics Methods and Protocols - Misener.
2. Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins. 2nd Edition by Baxevanis.
3. Bioinformatics - from Genomes to drug. 2 volumes by Lenganer.
4. Bioinformatics 2000 by Higgins and Taylor OUP.
5. Bioinformatics and molecular evolution-P.G. Higgs & T. K. Attwood, 2005 Blackwell Publishing.
6. Bioinformatics by David Mount.
7. Bioinformatics by Prakash S. Lohar., MJP publisher.
8. Data Mining for Genomics and Proteomics-Analysis of Gene and Protein Expression Data by D. M. Dziuda, Willey publishers
9. Genomics-Fundamentals and Applications by Supratim Choudhart & David B., Carlson
10. Bioinformatics: Sequence, structure and Data Bank: A Practical Approach by Higgis.
11. Computer analysis of sequence data by Colte.
12. Essential Bioinformatics by Jin Xiong 2006 Cambridge University press
13. Introduction to Bioinformatics in Microbiology by Henrik Christensen 2018, Springer Nature Switzerland AG
14. Functional Genomics. A Practical Approach Edited by Stephen P Hunt and Rick Liveey (OUP) 2000.
15. Introduction to Bioinformatics by Altwood.
16. Protein Engineering: Principles and Practice by Cleland.
17. Microarray- Gene expression Data analysis by Causton, Brazma 2003 Blackwell Publishing
18. Protein Biotechnology by Felix Franks. Humana Press, Totowa, New Jersey.

Web sites for Proteomics and Genomics

1) www.geneprot.com.
2) www.hybrigenis.com
3) www.mdsproteomics.com
4) www.stromix.com

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Faculty of Science

Department of Microbiology

B. Sc. Third Year (Semester- V)

Course Type: Lab course

Course Title: Lab Course-__ (Based on DSE I-b)

Course code: --

Credits- 1 **Maximum Marks: 50** **Hours: 30**

Learning Objectives:

LO 1. To study data validation by using statistical analysis.
LO 2. To study implementation of statistical formulas to different types of data.
LO 3. To learn computer application.

Course Outcomes:

CO 1. Students apply statistical knowledge and to correlate statistically extracted value by performing knowledge based practical.
CO 2. Students also acquire skill to represent data by using the computer knowledge of MS Word, Excel and power point presentation.

Practical No.	Unit
1	Studies of public domain databases for nucleic acid and protein sequences.
2	Determination of protein structure (PDB) by using RASMOL software
3	Genome sequence analysis by using BLAST algorithm
4	Protein sequence analysis by using BLAST algorithm

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Faculty of Science
Department of Microbiology
B. Sc. Third Year (Semester- V)

Course Type: Minor (DSM III)
Course Title: Microbial Genomics
Course Code: --
Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1 To study the basic concepts of genetic material.
LO 2 To study of the amplification and sequencing of genetic material
LO 3 To study the genetic material (DNA) extracted directly from an environmental sample
LO 4 To understand the recombination processes.

Course Outcomes:

After the completion of this course, students will be able to:
CO 1 Describe the basic concepts of genetic material.
CO 2 Understand the amplification and sequencing of genetic material
CO 3 Understand the study of the genetic material (DNA) extracted directly from an environmental sample
CO 4 Understand the recombination processes

Unit No.	Title of Unit & Contents	Hrs.
I	**Structures of DNA and RNA**	**12**
	1. DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation. DNA topology – linking number, topoisomerases; Organization of DNA Prokaryotes, Viruses. **2.** RNA Structure and types	
	Unit Outcomes: UO 1. Students understand and able to explain the structural integrity of genetic material UO 2 Students able to explain how the genetic information is stored and inherited in the next progeny	
II	**DNA Amplification and DNA sequencing**	**10**
	1. PCR: Basics of PCR, RT-PCR, Real-Time PCR **2.** Sanger's method of DNA Sequencing: traditional and automated sequencing **3.** Primer walking and shotgun sequencing	
	Unit Outcome: UO 1. Student will be able to describe Nucleic acid amplification UO 2 Student will be able to describe Nucleic acid sequencing	

Unit No.	Title of Unit & Contents	Hrs.
III	**Metagenomics**	**13**
	1. Different types of metagenomic: Viral, bacterial, fungal, algal and protozoan metagenomics **2.** Steps involved in Metagenomics **3.** Basic methods and techniques for metagenomics study: sequencing technology, gene-expression systems, single-cell analyses. **4.** Applications of metagenomics: metagenomics of the human microbiome, bio-prospecting novel genes, metagenomics for industrial bioproducts, metagenomics for bioremediation, plant-microbe interactions, metagenomics and ecosystems biology	
	Unit Outcomes: UO 1. Students will be able to understand the exploration and analysis of unculturable microorganisms present in environmental samples UO 2 Students will be able to apply exploitation of these genes for synthesis of biomolecules by adapting genetic engineering techniques	
IV	**Gene cloning**	**12**
	1. Introduction, Definition and Purpose of Cloning 2. Outline of gene cloning procedure (shot gun method) 3. Cloning vectors: pBr322, Cosmids, M13 4. Insertion of target DNA into vector: by using of linkers and adaptors 5. Screening of recombinants: Insertional inactivation, Colony hybridization 6. Methods of gene transfer: CaCl2Transformation, Electroporation	
	Unit Outcomes: UO 1. Students will get the knowledge of recombinant DNA technology UO 2 Students will understand the various advanced technology used in gene transfer	

Learning Resources:

1. D. Marco (Ed.), Metagenomics: Theory, Methods and Applications,1st Edn., Caister Academic Press, 2010.
2. W. R. Streit and R. Daniel (Eds.), Metagenomics: Methods and Protocols, 1st Edn., Humana Press, 2010
3. K. E. Nelson (Ed.), Metagenomics of the Human Body, 1st Edn., Springer, 2010.
4. D. Marco (Ed.), Metagenomics: Current Innovations and Future Trends,1st Edn., Caister Academic Press, 2011
5. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford,
6. U.K.
7. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
8. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
9. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
10. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education
11. Brown TA. (2007). Genomes-3. Garland Science Publishers
12. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Faculty of Science

Department of Microbiology

B. Sc. Third Year (Semester- V)

Course Type: Lab course

Course Title: Lab Course-__ based DSM III

Course code: --

Credit: 01 **Hours: 30** **Marks: 50**

Learning Objectives:

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

LO 1 To design and perform experiments for isolation of genome from soil

LO 2 To design and perform experiments for isolation of plasmid DNA

LO 3 To study method for quantitative analysis DNA

LO 4 To study method for quantitative analysis RNA

Course Outcomes:

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

CO 1 Design and perform experiments for isolation of genome from soil

CO 2 Design and perform experiments for isolation of plasmid DNA

CO 3 Study method for quantitative analysis DNA

CO 4 Study method for quantitative analysis RNA

Practical No.	Unit
1	Quantitative analysis of DNA
2	Quantitative analysis of RNA
3	Isolation of genome from soil
4	Isolation of plasmid from bacteria

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Faculty of Science
Department of Microbiology
B. Sc. Third Year (Semester- V)

Course Type: Minor (DSM IV)
Course Title: Microbial Analysis- Water and Food
Course Code: --
Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1. To study microbiology of water
LO 2. To study methods used for microbiological analysis of water
LO 3. To study microbial contamination of food & preservation methods
LO 4. To study methods used for microbiological analysis of food

Course Outcomes:

After completion of the course, students will be able to-
CO 1. Explain microbial contamination of water
CO 2. Describe methods used for microbiological analysis of water
CO 3. Explain microbial contamination of food
CO 4. Describe methods used for microbiological analysis of food & milk

Unit No.	Title of Unit & Contents	Hrs.
I	**Water Microbiology**	**10**
	1. Natural waters: Atmospheric, surface, stored and ground water. Definitions: Fresh water (ponds, lakes, streams) and Marine water (estuaries, the sea). **2.** Aquatic environment: Temperature, hydrostatic pressure, light, salinity, turbidity, Planktons and other microorganisms. **3.** Domestic water: water borne diseases, nuisance microorganisms. **4.** Bacteriological evidence of pollution: Fecal pollution, significance of indicator microorganisms.	
	Unit Outcomes: UO 1. Student will be able describe Aquatic environment UO 2 Student will be able describe water borne diseases	
II	**Microbiological analysis of water and safety measures**	**12**
	1. Microbiological examination of water: Membrane filter technique, Tests for presence of coliforms (quantitative and qualitative), IMVC test, Elevated temperature test. 2. Safety of drinking water: Boiling, chlorination, radiation and ionization	
	Unit Outcome:	

Unit No.	Title of Unit & Contents	Hrs.
	UO 1. Student will be able to explain microbiological examination of water UO 2 Student will be able describe safety measures for drinking water	
III	**Microbiological analysis of food**	**13**
	1. Sources of microorganisms in foods and milk. 2. Common food borne bacteria-Starter Culture-Lactic acid bacteria. 3. Microbiological examination of food: DMC, SPC, Differential enumeration, 4. Microbiological examination of Milk: MBRT, Resazurin test.	
	Unit Outcomes: UO 1. Student will be able to describe microbial contamination of food UO 2 Student will be able to describe microbial examination methods for food and milk	
IV	**Spoilage of food and food preservation methods**	**10**
	1. Food Spoilage: Classification of foods depending upon ease of spoilage, Different types of spoilages with suitable examples, biochemical types of microorganisms in milk. 2. Principles and applications of food Preservation techniques: Asepsis, use of high temperatures (milk pasteurization and phosphatase test, canning), freezing, dehydration, radiation (UV and Gamma rays), osmotic pressure; use of chemicals- Vinegar, Benzoic acid. 3. Food borne diseases: Staphylococcal poisoning and Salmonellosis.	
	Unit Outcomes: UO 1. Student will apply this to explain microbial spoilage food and milk UO 2 Student will apply this to explain food Preservation techniques	

Learning Resources:

1. A textbook of Microbiology, Dubey R. C. and D. K. Maheshwary. (2012), S Chand and Company. New Delhi, India.
2. Brock Biology of Microorganisms, Bender K. S., Buckley D. H., Stahl D. A., Sattley W. M. And Madigan M. T. (2017). E-Book, Global Edition. United Kingdom: Pearson Education.
3. Elementary Microbiology, Vol. I and II. Dr. A. H Modi, Akta Prakashan. Nadiad
4. Essentials of Microbiology, Jain A. and Jain P. (2019). Elsevier- India.
5. Fundamental Principles of Bacteriology, Salle A. J. (McGraw-Hill Book Co. New York and London 1973) 7th Edition
6. Fundamentals of Microbiology, Frobisher M., (W. B. Saunders, Philadelphia, 1962) 7th edition.
7. General Microbiology . Stanier R. Y., Ingraham J. L., Wheelis M. L. and Painter P. R., (Macmillan Education Ltd., London, 2001) 5th edition.
8. General microbiology ,Volume I. Powar C. B. and Daginawala H. I. (2005).. Himalaya Publishing House Private Limited, Pune, India.
9. General microbiology, Volume II. Powar C. B. and Daginawala H. I. (2005). Himalaya Publishing House, Private Limited, Pune, India
10. Microbiology: An Application based Approach, Pelczar M. J. Jr., Chan E.C.S. and Krieg N. R. (2010). McGraw-Hill Education (India) Private Limited, New Delhi, India.
11. Food Microbiology. 2nd Edition By Adams Basic Food Microbiology by Banwart George J. Food Microbiology: Fundamentals and Frontiers by Dolle
12. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2 by Joshi.
13. Fundamentals of Dairy Microbiology by Prajapati.
14. Microbiology of Fermented Foods. Volume II and I. Brian J.Wood. Elsiever Applied Science Publication.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Faculty of Science

Department of Microbiology

B. Sc. Third Year (Semester- V)

Course Type: Lab Course
Course Title: Lab Course-__ (Based on Minor IV)
Course Code: --

Credits: 01 **Max. Marks: 50** **Hours: 30**

Learning Objectives:

LO 1. To study methods used for bacteriological analysis of water.
LO 2. To study methods used for bacteriological analysis of food.
LO 3. To study methods used for bacteriological analysis of milk**.**

Course Outcomes:

After completion of the course, students will be able to-
CO 1. Design an experiment for microbiological analysis water
CO 2. Design an experiment to Confirm presence of fecal coliforms.
CO 3. Perform microbiological analysis of Milk
CO 4. Perform microbiological analysis of food.

Practical No.	Unit
1	Bacteriological examination of water for potability - Quantitative analysis: MPN
2	Bacteriological examination of water for potability –Qualitative: Presumptive, confirmed, completed test
3	Test for fecal coliforms: IMViC tests
4	Bacteriological analysis of milk: Reductase test
5	Microbial analysis of fermented food.
6	Microbial analysis of spoiled food
7	Detection of food poisoning bacteria from food sample

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Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Faculty of Science
Department of Microbiology
B. Sc. Third Year (Semester- V)

Course Type: VSC III
Course Title: Quality control in Packed Drinking Products
Course code: 301MIB5501
Credit-2 **Maximum Marks: 50** **Lectures: 45**

Learning Objectives:

After the completion of this course, students will be able to:
LO 1 Understand the concept of quality control and its importance in the production of packed drinking products
LO 2 Recognize the key quality parameters for packed drinking products
LO 3 Explain the various quality control processes involve in the production of packed drinking products

Course Outcomes:

After the completion of this course, students will be able to:
CO 1 Explain the fundamental principles of quality control and their application in the packed drinking product industry
CO 2 Apply various quality control techniques
CO 3 Analyze and interpret test result, identify trends and patterns and make informed decision about product quality

Unit No.	Title of Unit & Contents	Hrs.
I	**Quality Control in Beverage Production**	**15**
	1. Quality Issues in Beverage Industry 2. Microbiological Quality Control for Beverage Industry 3. Sensory Analysis for Beverage Quality Control 4. Quality Management for Beverages	
	Unit Outcomes: UO 1. Students will be able to detect microbial contamination in packed drinking products UO 2 Student will be able to ensure consistency in product quality	
II	**Practicals**	**30**

Unit No.	Title of Unit & Contents	Hrs.
	1. Microbiological Analysis of Laboratory Air: Solid impingement 2. Sterility testing of Hot Air Oven 3. Sterility testing of Autoclave 4. Standardization of UV Spectrophotometer 5. Standardization of Laminar Air flow 6. Bacteriological examination of water for potability - Quantitative analysis: MPN 7. Quantitative estimation of starchy content of Malt 8. Estimation of Pectic substances: Gravimetric Method 9. Estimation of reducing sugar by DNSA method 10. Estimating Grape Maturity by Titratable Acidity 11. Production of Alcoholic Beverage: Beer 12. Production of Alcoholic Beverage: Wine 13. Production of Non-Alcoholic Beverage: Orange juice 14. Cell quantity analysis of Beverages by turbidometric method	

Learning Resources:

1. Quality Control In Beverage Production: An Overview. Rana Muhammad Aadil*, Ghulam Muhammad Madni*, Ume Roobab*, Ubaid ur Rahman*, Xin-An Zeng *National Institute of Food Science and Technology.
2. Ensuring Beverages Excellence: A Quality control Guide. Swetha Vasudevan, Jeevtha Gada Chengaiyan.
3. Beverage Quality and Safety. Edited by Tammy Foster & Purendu C. Vasavada, Institute of Food Technologists.
4. Guide to Microbiological Control in Pharmaceuticals & Medical Devices. Stephen P. Denyer & Rosamund M. Baird
5. Industrial Microbiology an introduction. Michael J. Waites, Neil L. Morgan, John S. Rockey & Gary Higton
6. Industrial Microbiology fundamentals and applications. Agrawal & Parihar.
7. Laboratory Manual in Microbiology. Balkrishna M. Sandikar & Shaileshkumar V. Mamdapure.

Semester - VI

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Faculty of Science

Department of Microbiology

B. Sc. Third Year (Semester- VI)

Course Type: DSC- XI

Course Title: MICROBIAL GENETICS

Course code: 301MIB6101

Credit-3 **Maximum Marks: 75** **Lectures: 45**

Learning Objectives:

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

LO 1 To study the basic concepts of bacterial mutations.

LO 2 To study damage of DNA and its repair mechanisms

LO 3 To understand the genetic exchange in prokaryotes

LO 4 To understand the transposition and recombination processes.

Course Outcomes:

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

CO 1 Describe the basic concepts of bacterial mutations.

CO 2 Understand the damage of DNA and its repair mechanisms

CO 3 Understand the genetic exchange in prokaryotes

CO 4 Understand the transposition and recombination processes.

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Unit No.	Title of Unit & Contents	Hrs.
I	**Mutations**	**10**
	1. Evidences for spontaneous mutations: Replica plate techniques, Fluctuation test 2. Spontaneous mutation: Mispairing of Bases due to Tautomerism, Deamination, Depurination and Damage due to Oxidative Metabolism 3. Types of Mutations: Somatic, Base-pair substitutions, Frame shift, Suppresser, Phenotypic effect of mutations 4. Induced mutations: Physical and Chemical Mutagenic agents 5. Ames Test to identify chemical mutagens	
	Unit Outcomes: UO 1. Student will be able to understand DNA damage UO 2 Student will be able to describe DNA mutation	
II	**Repair of DNA damage**	**10**
	1. Introduction 2. Photo-reactivation 3. SOS system 4. Nucleotide Excision Repair (NER)	

Unit No.	Title of Unit & Contents	Hrs.
	5. Base Excision Repair (BER) 6. Mismatch Excision Repair (MER) **Unit Outcome:** UO 1. Student will be able to understand DNA repair mechanism UO 2 Student will be able to explain cell survival after DNA damage	
III	**Recombination and transposable elements**	**11**
	1. Types of recombination process: **i.** Homologous Recombination in *E. coli* (Holliday Model) Initiation, Synapsis, Branch Migration and resolution. ii. Site Specific Recombination (Integrative and Excessive Recombination) iii. Illegitimate Recombination (Non-Homologous Recombination) 2. Transposition: i. Transposable Elements in Prokaryotes ii. Insertion sequences, Transposons **Unit Outcomes**: UO 1. Student will be able to understand recombination processes. UO 2 Student will be able to understand the transposition process	
IV	**Gene transfer in bacteria**	**14**
	1. Transformation: Mechanism of transformation (Competence, Binding, Penetration, Synapsis and Integration) **2.** Conjugation: Discovery of conjugation in bacteria, Mechanism of Conjugation, Formation of Hfr, F' and Sexduction **3.** Transduction: Discovery of transduction in bacteria, Generalized and Specialized transduction, Abortive transduction **Unit Outcomes**: UO 1. Student will be able to understand the genetic exchange in prokaryotes UO 2 Student will be able to understand the production of recombinant organism	

Learning Resources:

1. Biochemistry by Jeremy M Berg, John L Tymoczko, and Lubert Stryer International 5th Edition, Publisher: W. H. Freeman & Company
2. Essentials of Molecular Biology by David Freifelder (2002), Publisher: Narosa Publishing House.
3. Fundamental Bacterial Genetics by Nancy Trun and Jenanine Trumphy (2003), Publisher: Blackwell Publishing
4. Genetics-A molecular approach second edition, Brown T. A., Chapman & Hall, London
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. Genetics a conceptual approach (3rd ed.) by Benjamin A. Pierce (2008) Publisher: W.H. Freeman and Company.
8. Genetics-A molecular approach (2nd /3rd ed.) by Peter J. Russell (2006)
9. Modern Microbial Genetics, Second Edition. Edited by Uldis N. Streips, Ronald E. Yasbin. Publisher: Wiley-Liss, Inc.
10. Principles of Genetics by R. H. Tamarin, (2004) Publisher: Tata McGraw Hill.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Faculty of Science

Department of Microbiology

B. Sc. Third Year (Semester- VI)

Course Type: Lab course

Course Title; Lab course- XI (Based on DSC –XI)

Course code: 301MIB6103

Credit- 1 **Maximum Marks: 50** **Hours: 30**

Learning Objectives:

LO1 To study replica plate technique and isolate mutant strains.
LO2 To study effect of UV radiation on bacteria
LO3 To study recombination in bacteria
LO4 To determine effect of chemical and physical mutagens on bacteria

Course Outcomes:

After the completion of this course, students will be able to:
CO1 Design experiments replica plate technique and isolate mutant strains.
CO2 Determine effect of UV radiation on bacteria
CO3 Design experiments to recombination in bacteria
CO4Design experiment to determine effect of chemical and physical mutagens on bacteria

Practical No.	Unit
1	Replica plate Technique.
2	Effect of UV radiations to study the survival pattern of E. coli /yeast.
3	Repair mechanisms in E. coli / yeast (Dark and Photo reactivation)
4	Isolation of antibiotics resistant Bacterial Mutants by Physical mutagenesis
5	Isolation of antibiotic-resistant mutants by chemical mutagenesis.
6	Ampicillin selection method for isolation of auxotrophic mutants.
7	Study of Conjugation in E. coli.
8	Isolation of lac mutant of E coli

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Faculty of Science
Department of Microbiology
B. Sc. Third Year (Semester- VI)

Course Type: DSC- XII (IKS)
Course Title: Agricultural Microbiology
Course code: 301MIB6102
Credit- 3 **Maximum Marks: 75** **Lectures: 45**

Learning Objectives:

LO 1. To study sustainable agriculture, microbial interactions and their role in soil fertility.
LO 2. To study agronomically important microorganisms
LO 3. To study in brief common plant pathogens.
LO4 To describe isolation of *Tricoderma* & *Bacillus subtilis* from soil.

Course Outcomes:

After the completion of this course, students will be able to:
CO1 Explain diversity of microorganism in soil.
CO2 Explain the occurrence distribution of agronomically important microorganisms in soil.
CO3 Describe various Plant pathogens.
CO5 Demonstrate isolation of *Tricoderma* & *Bacillus subtilis* from soil.

Unit No.	Title of Unit & Contents	Hrs.
I	**Agronomical importance of Microbial communities in soil**	12
	1. Nature of sustainable Agriculture and Microbes 2. Importance of soil microbial community 3. Microbial diversity in soil 4. Interaction between microorganisms and soil fauna 5. Potassium mobilizing Microorganisms. 6. Zinc Solubilizing Microorganisms **7.** Sulphur-oxidizing Microorganisms	
	Unit Outcomes: UO 1. Student will be able to understand and explain the importance of microorganisms in modern agricultural practices UO 2 Student will be able to describe the various potentials of microorganisms applicable in ecofriendly agricultural practices	
II	**Plant Pathology**	12
	1. Plant Pathogens: Bacterial, Fungal and Viral **2.** Modes of transmission of plant diseases. **3.** Plant diseases:	

Unit No.	Title of Unit & Contents	Hrs.
	i) Citrus Canker, ii) Tikka disease of groundnut, iii) Bacterial Blight of Pomegranate, iv) Bacterial wilt v) Downy mildew, vi) Fusarial wilt disease	
	Unit Outcome: UO 1. Student will be able to analyze various forms of common plant diseases UO 2 Student will be able to suggest the biological control measures	
III	**Agriculture in the Vedic period**	**11**
	1.An introduction to Vedic Agriculture 2. Division of soil, Land and village settlement 3. Conservation of soil 4. Manure and Manuring 5. Plant Protection measures	
	Unit Outcomes: UO 1. Student will come across the knowledge of traditional agricultural practices UO 2 Student will be able to understand the methods for provision of nutrients and protection plants used from vedic period	
IV	**Jaivik Krishi**	**10**
	1. Introduction: Organic farming 2. Kunapajala 4. Beejamrit 5. Jeevamrit **6.** Amritpani	
	Unit Outcome: UO 1. Student will be able to understand the concept and importance of organic farming UO 2 Student will be able to explain preparation of traditional plant growth promoting formulations	

Learning Resources:

1. Soil Microbiology - An exploratory approach - Mark Coyne.
2. Agricultural Microbiology - N. Mukherjee and J. Ghosh.
3. Introduction to Soil Microbiology - Martin Alexander IInd Edition.
4. Agricultural Microbiology - Rangaswamy and Bhagyaraj IInd Edition
5. Plant diseases - R. S. Singh.
6. Plant pathology - R. S. Mehrotra.
7. Diseases of crop plants in India - G. Rangaswamy.
8. Principles of Soil Science - M. M. Rai.
9. Soils and Soils Fertility- 6th edition-Frederick R.Troeh (Blackwell publishing Co.) 10. Soil Microbiology- Singh, Purohit, Parihar. (Agrobios India , 2010)
10. Soil Microbiology and Biochemistry – Ghulam Hassan Dar (New India Publishing Agency, 2010)
11. Vedic Microbiology (A Scientific Approach), RC Dubey, Motilal Banarasidass International, Delhi, 2021
12. Vedic Microbiology (Gurus of Vedic Microniology), Chakradhar F. Anjista, ShrijiKurup, Vinayak printing press, Shahdra, Delhi, 2020
13. वैदिक कृषि विज्ञान - Vedic Agricultural Sciences, Devendra Kumar Gupta, Pratibha Prakashan, 2012
14. A Review on Traditional Ayurveda Formulations and their Therapeutic Importance. Dr. Komal P. Motghare, Dr. Vaibhav Yeokar. Journal of Drug Delivery and Therapeutics. s. 2019; 9(3):650-653
15. Pandemic Infectious Diseases W.S.R. to Sankramak Roga: a review based on ayurveda samhitas. Dr. Ashwini Kumar Vidyarthi and Dr. Suraj Khodre. World journal of pharmaceutical and medical research. 2020,6(7), 262-264
16. Fermented products of India and its implication: A review Gitanjali B. Sathe and S. Mandal. Asian J. Dairy & Food Res, 35 (1) 2016 : 1-9
17. Krumi (Microorganisms) in Ayurveda- A critical review. Meena Shamrao Deogade1, Shiva Rama Prasad Kethamakka. Published online in http://ijam. co. in
18. Mira Roy, Agriculture in the vedic period, Indian Journal of History of Science, 44.4 (2009) 497-520

Course Type: Lab course
Course Title: Lab course XII (Based on- DSC- XII)
Course code: 301MIB6104
Credit- 1 **Maximum Marks: 50** **Lectures: 30**

Learning Objectives:

LO 1. To study sustainable agriculture, microbial interactions and their role in soil fertility.
LO 2. To study Agronomically important microorganisms
LO 3. To study in brief common plant pathogens.
LO4 To describe isolation of Tricoderma & Bacillus subtilis from soil.

Course Outcomes:

After the completion of this course, students will be able to:
CO1 Explain diversity of microorganism in soil.
CO2 Explain the occurrence distribution of Agronomically important microorganisms in soil.
CO3 Describe various Plant pathogens.
CO5 Demonstrate isolation of Tricoderma & Bacillus subtilis from soil.

Practical No.	Unit
1	Isolation of Tricoderma from soil
2	To determine antimicrobial activity of the isolated Tricoderma spp.
3	Isolation of Bacillus subtilis from soil
4	Study of Bacillus subtilis as a Bio-controlling agent
5	To study symptoms of the plant diseases: Citrus Canker, Tikka disease of groundnut
6	Cropping system
7	Harvesting
8	Production of Jeevamrit

Rajarshi Shahu Mahavidyalaya, Latur

Faculty of Science
Department of Microbiology
B. Sc. Third Year (Semester- VI)

Course Type: DSE II-a
Course Title: Industrial Microbiology
Course code: 301MIB6201
Credit- 3 **Maximum Marks: 75** **Lectures: 45**

Learning Objectives:

LO 1 To study scope of industrial microbiology.
LO 2 To study method for isolation of industrially important strains of bacteria and upstream processing
LO3 To study methods recovery and purification of industrial products.
LO4 To study production of beverages, antibiotics, organic acids and ethanol

Course Outcomes:

After the completion of this course, students will be able to:
CO 1 Describe scope of industrial microbiology.
CO 2 Describe the methods used for isolation of industrially important strains of bacteria and upstream processing
CO3 Describe recovery and purification of industrial products.
CO4 Perform microbial production of beverages, antibiotics, organic acids and ethanol.

Unit No.	Title of Unit & Contents	Hrs.
I	**Introduction to Industrial microbiology and fermentation processes**	**9**
	1. Introduction, brief history and development of Industrial Microbiology. 2. Design of stirred tank fermenter and role of different parts of fermenter. 3. Types of Fermenters: laboratory fermenter, pilot plant fermenter, Horton sphere, fluidized bed reactor, Air lift fermenter, Packed bed bioreactor, Trickle bed bioreactor and Bubble column bioreactor 4. Types of fermentation processes: Batch, fed batch, continuous and solid-state fermentation. surface and submerged fermentations. 5. Importance of aeration and agitation	
	Unit Outcomes: UO 1. Student will be able to understand the development of industrial fermentation process UO 2 Student will be able to explain design of fermenters and its various types	
II	**Isolation of industrially important microbial strains and formulation of fermentation media**	**12**
	1. Isolation of industrially important microbial strains - Screening Methods (Primary and secondary), Strain improvement programme. **2.** Stock cultures, maintenance methods (Continuous metabolism	

Unit No.	Title of Unit & Contents	Hrs.
	state and suspended metabolism state). **3.** Inoculum development, Fermentation media, (substances used as raw materials for formulation of fermentation media) and its sterilization (batch and continuous). **4.** Culture collection centers	
	Unit Outcome: UO 1. Student will be able to describe the methods for isolation of industrially important microbial strains UO 2 Student will be able to describe the maintenance of microbial culture and formulation of fermentation media	
III	**Downstream processing**	**12**
	1. Introduction, Recovery and purification of fermentation products **2.** Solids (Insoluble) removal (Filtration, centrifugation, coagulation and flocculation, foam fractionation), Cell disruption. **3.** Recovery of product (liquid extraction, ion exchange adsorption, precipitation), **4.** Product Isolation and Purification (Chromatography, carbon decolourization, crystallization drying, packing). **5.** Bioassays of Amino acids and vitamins. **6.** Bioassay- Antibiotics.	
	Unit Outcomes: UO 1. Student will be able to understand the recovery and purification of fermentation products UO 2 Student will be able to extract, purify and analyze the fermentation product	
IV	**Microbial production of industrial products**	**12**
	1. Beverages (Beer, Wine) **2.** Organic acid (Citric acid, lactic acid), **3.** Antibiotics (Penicillin) **4.** Ethanol **5.** Bioinsecticide (Thuricide), Amino acids (Lysine), **6.** Enzyme (xylase, pectinases) 7. Single cell protein, Biopolymer and Biofuel production	
	Unit Outcomes: UO 1. Student will be able to apply the knowledge for production of various economically important fermentation products UO 2 Student will be able to apply their skills in various microbiology based industries	

Learning Resources:

1. Industrial Microbiology by A.H. Patel.
2. Industrial Microbiology by Prescott & Dunn.
3. Industrial Microbiology by Casida
4. Biotechnology: A text book 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 Dube

Rajarshi Shahu Mahavidyalaya, Latur

Faculty of Science
Department of Microbiology
B. Sc. Third Year (Semester- VI)

Course Type: Lab course
Course Title: Lab course- II (Based on DSE II-a)
Course code: 301MIB6202
Credits -1 **Maximum Marks: 50** **Hours: 30**

Learning Objectives:

LO1 To study primary screening and secondary methods,
LO 2 To study Bioassay of antibiotic.
LO 3 To study typical fermentation processes citric acid, wine and enzymes

Course Outcomes: Students will be able to design protocols

CO1 Isolation of industrially important microorganisms
CO 2 Fermentative production, extraction, purification and
CO3 Bioassay of penicillin and quantitative analysis of microbial products.

Practical No.	Unit
1	Primary screening of antibiotic producers.
2	Primary screening of organic acid producers
3	Bioassay of penicillin.
4	Fermentative production of citric acid (Surface / submerged) & its estimation by Titrable acidity
5	Fermentative production of wine & and its estimation by titrable acidity
6	Fermentative production of fungal amylase, extraction and purification
7	Fermentative production of ethanol using agro waste

Rajarshi Shahu Mahavidyalaya, Latur

Faculty of Science
Department of Microbiology
B. Sc. Third Year (Semester- VI)

Course Type: DSE II-b
Course Title: Pharmaceutical Microbiology
Course code: --
Credit- 3 **Maximum Marks: 75** **Lectures: 45**

Learning Objectives:

LO 1. To understand different antimicrobial substance and their mode of action
LO 2. To understand maintenance of antimicrobial substance
LO 3. To working of biosensors and its application.
LO 4. To understand different parameters and safety measures for use of antimicrobial agents.

Course Outcomes:

After completion of course the student will be able to-
CO 1. Student have the knowledge and mechanism of action of antibiotics, synthetic antimicrobial agents, chemical disinfectants, antiseptic and preservatives. Also have knowledge of antibiotic resistance in bacteria
CO 2. Student able to evaluate microbial production and spoilage of pharmaceutical products. Design manufacturing procedure. Derive pharmaceuticals products by microbial fermentation process
CO 3. Able to understand government regulatory practices, application of biosensor and microbial enzyme in pharmaceuticals.
CO 4. Able to recognize good manufacturing practices and good laboratory practices. Apply quality assurance and quality management in pharmaceuticals. Use safety in microbiology.

Unit No.	Title of Unit & Contents	Hrs.
I	**Antibiotics, synthetic antimicrobial agents**	**12**
	1. Antibiotics and synthetic antimicrobial agents (Aminoglycosides, β lactams, tetracyclines, Ansamycins, macrolid antibiotics). Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis). **2.** Antifungal antibiotics, antitumour substances. Peptide antibiotics, chloramphenicol, sulphonamides and antimicrobial agents. Chemical disinfectants, antiseptics and preservatives, **3.** Molecular principal of drug targeting, Drug delivery system in gene therapy. **4.** Bacterial resistance to antibiotics, Penetrating defences (cellular permeability barrier, cellular transport system and drug diffusion).	
	Unit Outcomes: UO 1. Student will be able to understand mechanism of action of antibiotics, synthetic antimicrobial agents UO 2 Student will be able to understand mechanism of action of	

Unit No.	Title of Unit & Contents	Hrs.
	synthetic antimicrobial agents	
II	**Microbial production and spoilage of pharmaceutical products**	**12**
	1. Microbial production and spoilage of pharmaceutical products (sterile injectable, non-injectable, ophthalmic preparation and implants) and their sterilization. **2.** Manufacturing procedure and in process control of pharmaceuticals. Other pharmaceuticals produced by microbial fermentations (streptokinase, streptodornase). **3.** New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines	
	Unit Outcome: UO 1. Student will be able to understand Microbial production of pharmaceuticals. UO 2 Student will be able to understand spoilage of pharmaceutical products.	
III	**Regulatory practices, biosensors and applications in pharmaceuticals**	**12**
	1. Financing R & D capital and market outlook, IP, BP, USP. **2.** Government regulatory practices and policies, FDA perspective. Reimbursement of drug and biological, legislative perspective. **3.** Rational drug design **4.** Biosensors in pharmaceuticals.	
	Unit Outcomes: UO 1. Student will be able to understand Regulatory practices and biosensors UO 2 Student will be able to explain applications in pharmaceuticals.	
IV	**Quality assurance and validation**	**09**
	1. Good manufacturing practices (GMP) and Good laboratory practices (GLP) in pharmaceutical industry. **2.** Regulatory aspects of quality control. Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification. **3.** Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, radiation, gaseous and filter sterilization). **4.** Chemical and biochemical indicators. Safety in microbiology laboratory	
	Unit Outcomes: UO 1. Student will be able to understand good laboratory practices in pharma industries UO 2 Student will be able to understand Quality assurance and validation	

Learning Resources:

1. Analytical Microbiology by Fredrick Kavanagh volume I &II. Academic Press New York.
Biotechnology – Expanding Horizon by B.D. Singh., First Edition, Kalyani Publication, Delhi.
Biotechnology by H.J. Rhem& Reed, vol 4 VCH publications, Federal Republic of Germany.
2. Drug carriers in biology & medicine by Gregory Gregoriadis. Acedemic Press New York.
3. Good manufacturing practices for Pharmaceuticals By Sydney H. Willing, MurrayM. Tuckerman, Willam S. Hitchings IV. Second edition Mercel Dekker NC New York.
4. Lippincott's illustrative Reviews: Pharmacology Edition: 02 Maryjnycck by Lippincott's review Publisher Pheladelphia 1997.
5. Pharmaceutical Biotechnology by S. P. Vyas& V.K. Dixit. CBS publishers & distributors, New Delhi.
6. Pharmaceutical Microbiology by W. B. Hugo & A.R. Russel Sixth Edition. Blackwell Scientific Publications.
7. Pharmacognosy by Gokhle S.D., KoKate C.K. Edition: 18, Nirali Publication.
8. Principles of medicinal chemistry Vol. 1 by Kadam S.S., Mahadik K.R., Bothra K.G. Edition: 18, Nirali Publication.
9. Quality Assurance in Microbiology by Rajesh Bhatia, Rattan LalIhhpunjani. CBS publishers & distributors, New Delhi.
10. Quality control in the Pharmaceutical industry by Murray S. Cooper Vol. 2, Academic Press New York.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Faculty of Science

Department of Microbiology

B. Sc. Third Year (Semester- VI)

Course Type: Lab Course

Course Title: Lab Course -__ (Based on DSE II-b)

Course Code: --

Credits: 01 **Max. Marks: 50** **Hours: 30**

Learning Objectives:

LO 1. To study multiple screening procedure and statistical test for pharmaceutical substances.

LO 2. To study production of multiple antimicrobial substances.

LO 3. To learn antimicrobial activity of commercially available synthetic chemicals.

Course Outcomes:

CO 1. Students able to apply bioassay procedure to for pharmaceutical products.

CO 2. Students Also acquire knowledge and skills to check microbial contamination of pharmaceutical products.

Practical No.	Unit
1	Spectrophotometric/ Microbiological method for the determination of Griseofulvin.
2	Microbial production and Bioassay of Penicillin.
3	Bioassay of Chloramphenicol/Streptomycin by plate assay method
4	Screening, Production and assay of therapeutic enzymes: Asperginase/beta lactamase.
5	Determination of MIC and LD50 of Ampicillin / Streptomycin.
6	Sterility testing by using B. subtilis.
7	Determination of D-value and Z-value for heat sterilization in pharmaceuticals.
8	Determination of antimicrobial activity of chemical compounds (like phenol, resorcinol and formaldehydes) Comparison with standard products.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Faculty of Science
Department of Microbiology
B. Sc. Third Year (Semester- VI)

Course Type: Minor (DSM V)
Course Title: Microbial Analysis- Air and Soil
Course Code: --
Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1. To study presence of microorganisms in air.
LO 2.. To study microbiological analysis methods of air.
LO 3. To study role of microorganisms in soil.
LO 4. To study microbiological analysis methods of soil.

Course Outcomes:

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

CO 1. Describe presence of microorganisms in air

CO 2. Explain microbiological analysis methods of air.

CO 3. Explain role of microorganisms in soil.
CO 4. Explain microbiological analysis methods of soil.

Unit No.	Title of Unit & Contents	Hrs.
I	**Air Microbiology**	**10**
	1. Definition, composition and quality of air. **2.** Sources of microorganisms in air: Indoor and outdoor microflora. **3.** Importance of state of suspension- Bioaerosols: droplet, droplet nuclei and droplet infection. **4.** Significance of microorganisms present in air: With respect to human health (list of air borne diseases).	
	Unit Outcomes: UO 1. Student will be able to explain spread of microorganisms in air UO 2. Student will be able to describe air borne diseases.	
II	**Microbiological Analysis of Air**	**12**
	1. Microbiological Analysis of Air: Solid and liquid impingement, Anderson air sampler. **2.** Control of microorganisms in air: Dust control, UV radiation, laminar airflow system, masks, Bactericidal vapors.	

Unit No.	Title of Unit & Contents	Hrs.
	Unit Outcome: UO 1. Student will be able to analyze the microbiological quality of air by learning various methods UO 2 Student will be able to suggest the control measures	
III	**Soil microbiology**	**13**
	1. Soil environment: Structure and texture of soil, Organic fraction of soil (Humus) 2. Soil as growth medium for microorganisms 3. Microbial transformation of C N,S,P in soil **Unit Outcomes**: UO 1. Student will be able to determine the composition of cultivable soil UO 2 Student will be able to understand and explain the bio-geochemical turnover of important bio elements	
IV	**Microbiological Analysis of Soil**	**10**
	1. Isolation and Enumeration of Soil Microorganism **2.** Determination of total viable count of soil **3.** Study of Rhizosphere **4.** General Examination of microorganisms: Rossi and Cholodny Buried Slide Technique	
	Unit Outcomes: UO 1. Student will be able to analyze the microbial fertility of soil UO 2 Student will be able to explain the relationship between soil microorganisms and plant roots	

Learning Resources:

1. A textbook of Microbiology, Dubey R. C. and D. K. Maheshwary. (2012), S Chand and Company. New Delhi, India.
2. Brock Biology of Microorganisms, Bender K. S., Buckley D. H., Stahl D. A., Sattley W. M. And Madigan M. T. (2017). E-Book, Global Edition. United Kingdom: Pearson Education.
3. Elementary Microbiology, Vol. I and II. Dr. A. H Modi, Akta Prakashan. Nadiad
4. Essentials of Microbiology, Jain A. and Jain P. (2019). Elsevier- India.
5. Fundamental Principles of Bacteriology, Salle A. J. (McGraw-Hill Book Co. New York and London 1973) 7th Edition
6. Fundamentals of Microbiology, Frobisher M., (W. B. Saunders, Philadelphia, 1962) 7th edition.
7. General Microbiology . Stanier R. Y., Ingraham J. L., Wheelis M. L. and Painter P. R., (Macmillan Education Ltd., London, 2001) 5th edition.
8. General microbiology ,Volume I. Powar C. B. and Daginawala H. I. (2005).. Himalaya Publishing House Private Limited, Pune, India.
9. General microbiology, Volume II. Powar C. B. and Daginawala H. I. (2005). Himalaya Publishing House, Private Limited, Pune, India
10. Microbiology: An Application based Approach, Pelczar M. J. Jr., Chan E.C.S. and Krieg N. R. (2010). McGraw-Hill Education (India) Private Limited, New Delhi, India.
11. Food Microbiology. 2nd Edition By Adams Basic Food Microbiology by Banwart George J. Food Microbiology: Fundamentals and Frontiers by Dolle
12. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2 by Joshi.
13. Fundamentals of Dairy Microbiology by Prajapati.
14. Microbiology of Fermented Foods. Volume II and I. Brian J.Wood. Elsiever Applied Science Publication.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Faculty of Science
Department of Microbiology
B. Sc. Third Year (Semester- VI)

Course Type: Lab Course
Course Title: Lab Course-__ (Based on DSM V)
Course Code: --
Credits: 01 **Max. Marks: 50** **Hours: 30**

Learning Objectives:

LO 1. To study methods used for bacteriological analysis of air
LO 2. To study methods used for bacteriological analysis of soil.
LO 3. To study nitrification process.
LO 4. To study nitrogen fixing microorganisms in soil

Course Outcomes:

After completion of the course, students will be able to -
CO 1 Design an experiment for microbiological analysis of air
CO 2 Perform microbiological analysis of soil.
CO 3 Demonstrate isolation of nitrogen fixing microorganisms.

Practical No.	Unit
1	Microbiological Analysis of Air: Solid impingement
2	Microbiological Analysis of Air: liquid impingement
3	Isolation and Enumeration of Soil Microorganism
4	Study of Rhizospheric effect
5	Rossi and Cholodny Buried Slid Technique
6	To study nitrification process
7	Isolation and study of Rhizobium species from root nodules of leguminous plants. (Demonstration)
8	Isolation and study of Azotobacter sp. from soil .(Demonstration)

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Faculty of Science

Department of Microbiology

B. Sc. Third Year (Semester- VI)

Course type: VSC IV
Course Title: Bio-Analytical Tools
Course code: 301MIB6501
Credits-02 **Marks-50** **Lectures-45**

Learning Objectives:

LO 1 To expertise students to handle advanced instruments.
LO 2 To develop skills and techniques for analysis of valuable products
LO 3 To promote students for making career in pharmaceutical industries

Course Outcomes:

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

CO 1 Describe principle of chromatography
CO 2 Perform different types of chromatography.

Unit No.	Title of Unit & Contents	Hrs.
I	**Chromatography Technique**	10
	1. Introduction to the principle of chromatography. 2. Paper chromatography 3. Thin layer chromatography 4. Column chromatography: silica and gel filtration, affinity and ion exchange chromatography, HPLC	
	Unit Outcomes: UO 1. Student will be able to describe the principle of separating the compounds from a mixture and identify UO 2 Student will be able to develop their skills in chromatographic techniques	
II	**Laboratory course**	35
	1.Separation of amino acids by paper chromatography 2.Separation of sugar by paper chromatography 3.Separation of amino acids in a given sample by TLC 4.Separation of protein by column chromatography 5.Hands-on training on HPLC	

Learning Resources:

1. Ghosal, Sabari and Srivastava, Fundamentals of Bioanalytical Techniques and Instrumentation [Jan 30, 2010]
2. Fundamentals of Bioanalytical Techniques and Instrumentation [Jan 30, 2010] WILEY-VCH Verlag GmbH, D-69469 Weinheim (Federal Republic of Germany), 2001
3. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. JohnWiley& Sons. Inc.
4. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
5. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates,

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

UG First Year

Extra Credit Activities

Sr. No.	Course Title	Credits	Hours T/P
1	MOOCs	Min. of 02 credits	Min. of 30 Hrs.
2	Certificate Courses	Min. of 02 credits	Min. of 30 Hrs.
3	IIT Spoken English Courses	Min. of 02 credits	Min. of 30 Hrs.

Guidelines:

Extra -academic activities

1. All extra credits claimed under this heading will require sufficient academic input/ contribution from the students concerned.
2. Maximum 04 extra credits in each academic year will be allotted.
3. These extra academic activity credits will not be considered for calculation of SGPA/CGPA but will be indicated on the grade card.

Additional Credits for Online Courses:

1. Courses only from SWAYAM and NPTEL platform are eligible for claiming credits.
2. Students should get the consent from the concerned subject Teacher/Mentor/Vice Principal and Principal prior to starting of the course.
3. Students who complete such online courses for additional credits will be examined/verified by the concerned mentor/internal faculty member before awarding credits.
4. Credit allotted to the course by SWAYAM and NPTEL platform will be considered as it is.

Additional Credits for Other Academic Activities:

1. One credit for presentation and publication of paper in International/National/State level seminars/workshops.
2. One credit for measurable research work undertaken and field trips amounting to 30 hours of recorded work.
3. One credit for creating models in sponsored exhibitions/other exhibits, which are approved by the concerned department.
4. One credit for any voluntary social service/Nation building exercise which is in

collaboration with the outreach center, equivalent to 30 hours

5. All these credits must be approved by the College Committee.

Additional Credits for Certificate Courses:

1. Students can get additional credits (number of credits will depend on the course duration) from certificate courses offered by the college.
2. The student must successfully complete the course. These credits must be approved by the Course Coordinators.
3. Students who undertake summer projects/ internships/ training in institutions of repute through a national selection process, will get 2 credits for each such activity. This must be done under the supervision of the concerned faculty/mentor.

Note:

1. The respective documents should be submitted within 10 days after completion of Semester End Examination.
2. No credits can be granted for organizing or for serving as office bearers/ volunteers for Inter-Class / Associations / Sports / Social Service activities.
3. The office bearers and volunteers may be given a letter of appreciation by the respective staff coordinators. Besides, no credits can be claimed for any services/activities conducted or attended within the college.
4. All claims for the credits by the students should be made and approved by the mentor in the same academic year of completing the activity.
5. Any grievances of denial/rejection of credits should be addressed to Additional Credits Coordinator in the same academic year.
6. Students having a shortage of additional credits at the end of the third year can meet the Additional Credits Coordinator, who will provide the right advice on the activities that can help them earn credits required for graduation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Examination Framework

Theory:

40% Continuous Assessment Tests (CATs) and 60% Semester End Examination (SEE)

Practical:

50% Continuous Assessment Tests (CATs) and 50% Semester End Examination (SEE)

Course	Marks	CAT & Mid Term Theory				CAT Practical		Best Scored CAT & Mid Term	SEE	Total
1	2	3				4		5	6	5 + 6
		Att.	CAT I	Mid Term	CAT II	Att.	CAT			
DSC/DSE/ GE/OE/Minor	100	10	10	20	10	-	-	40	60	100
DSC	75	05	10	15	10	-	-	30	45	75
Lab Course/AIPC/ OJT/FP	50	-	-	-	-	05	20	-	25	50
VSC/SEC/ AEC/VEC/CC	50	05	05	10	05	-	-	20	30	50

Note:

1. All Internal Exams are compulsory
2. Out of 02 CATs best score will be considered
3. Mid Term Exam will be conducted by the Exam Section
4. Mid Term Exam is of Objective nature (MCQ)
5. Semester End Exam is of descriptive in nature (Long & Short Answer)
6. CAT Practical (20 Marks): Lab Journal (Record Book) 10 Marks, Overall Performance 10 Marks.