

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

**Board of
Studies in
Microbiology
Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
[UG III Year]**

**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

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**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.



(Dr. D. V. Vedpathak)

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	e) DSM – IV : Microbial Analysis of Water and Food	
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7	Curriculum : Semester-VI	
	c) DSC-XI : Microbial Genetics	
	d) DSC-XII (IKS) : Agricultural Microbiology (Vedic Agricultural Microbiology)	
	c) DSE – II(a) : Industrial Microbiology or DSE – II(b) : Pharmaceutical Microbiology	
	d) DSM – V : Microbial Analysis of Air and Soil	
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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



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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)	Molecular Microbiology	03	45	
			Lab Course-IX	01	30	
		(DSC-X)	Enzymology	03	45	
			Lab Course-X	01	30	
		DSE I	Microbial Metabolism	03	45	
			Lab Course-XI	01	30	
			OR			
			Basics of Bioinformatics	03	45	
			Lab Course-XI	01	30	
		Minor I (DSM III)	Microbial Genomics	03	45	
			Lab Course-XII	01	30	
		Minor II (DSM IV)	Microbial Analysis of Water and Food	01	30	
			Lab Course-XIII	01	30	
		(VSC-IV)	Quality control in Packed Drinking Products	02	45	
		(VEC-III)	Environmental Studies	02	30	
	Total Credits				22	
	VI	(DSC-XI)	Microbial Genetics	03	45	
			Lab Course-XIV	01	30	
		(DSC-XII)	Agricultural Microbiology	01	15	
			Lab Course-XV	01	30	
			DSC specific IKS: Vedic Agriculture Microbiology	02	30	
		DSE II	Industrial Microbiology	03	45	
			Lab Course-XVI	01	30	
			OR			
			Pharmaceutical Microbiology	03	45	
			Lab Course-XVII	01	30	
		Minor III (DSM V)	Microbial Analysis of Air and Soil	03	45	
			Lab Course-XVIII	01	30	
		(VSC-IV)	Bio-analytical Tools	02	45	
		(FP/RP)	Academic Project	04	45	
Total Credits				22		
Total Credits (Semester V & VI)				44		



Shiv Chhatrapati Shikshan Sanstha's

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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.



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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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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. Plasmid and plasmids 3. Gene as recon, muton and cistron 4. Overlapping genes 5. Genome size and complexity. 6. Genome organization of <i>E. coli</i>.	

Unit No.	Title of Unit & Contents	Hrs.
	Unit Outcome: UO 1. Students able to understand the different types of genome organization. They able 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>i.</i> The <i>lac</i> Operon of <i>E. coli</i> <i>ii.</i> The <i>trp</i> Operon of <i>E. coli</i> <i>iii.</i> Quorum sensing <i>iv.</i> 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 OX14R 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.



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

Course Type: Lab course

Course Title: DSC IX based Lab Course 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 <i>E. coli</i> with reference to Lac operon.
2	Isolation of chromosomal DNA (<i>E. Coli</i>)
3	Quantitative Analysis of DNA by DPA method
4	Isolation of plasmid DNA
5	Isolation of RNA (<i>Yeast</i>)
6	Agarose gel electrophoresis of DNA
7	Amplification of DNA by PCR.



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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 - Temperature - pH - Substrate concentration - 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 - Reversible Inhibition - Competitive Inhibition - Non-Competitive Inhibition - Uncompetitive Inhibition - Irreversible Inhibition - Substrate and Product Inhibition 2. Allosteric enzymes regulation (Homotropic and Heterotropic Regulation) 3. Co-operativity (Hill's 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: - Amylase - Protease - 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. Volume 22-Enzyme purification and related techniques. Edited by William B. Jakoby. Academic press, New York.
2. Allosteric enzymes – kinetic Behaviour. 1982. by B.I Kurganov. John Wiley and sons Inc., New York.
3. Biotechnology, volume 7 A- enzymes in biotechnology 1983 Edited by H.J. Rehm and G. Reed Verlag Chemie.
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. Wood. Academic Press.
7. Advances in enzymology by Alton Meister, Interscience Publishers.
8. Topics in enzymes and fermentation biotechnology by L.N. Weisman, 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



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Faculty of Science

Department of Microbiology

B. Sc. Third Year (Semester- V)

Course Type: Lab course

Course Title: DSC X based Lab Course 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 (Caseinase, 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



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Faculty of Science

Department of Microbiology

B. Sc. Third Year (Semester- V)

Course Type: DSE I (a)

Course Title: - Microbial Metabolism

Course code:

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 from nontraditional sources

Unit No.	Title of Unit & Contents	Hrs.
I	Metabolism and Bioenergetics	12
	- Definitions: i. Metabolism ii. Catabolism iii. Anabolism - Comparison of catabolism and anabolism - Regulation of Metabolic pathways - Scope of thermodynamics. Laws of Thermodynamics. - Concept of enthalpy, free energy and equilibrium constant, Gibbs free energy equation, determination of feasible reaction, coupled reactions. - Determination of free energy of hydrolytic and biological oxidation reduction reactions, under standard and non-standard conditions. - Structure and properties of ATP - 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
	Properties of Monosaccharide	

Unit No.	Title of Unit & Contents	Hrs.
	- Major Carbohydrate catabolic pathways, their regulation and significance: EMP, HMP, ED, PKP, TCA, - Methyl glyoxylate bypass, - Anaplerotic Sequences. - RETC (Respiratory Electron Transport Chain) - 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
	- Anaerobic respiration definition and example - Alcohol Fermentation: Ethanol fermentation by Yeasts, the Pasteur effect, Ethanol Fermentation by Bacteria - Lactate Fermentation i. Homo and Hetero Fermentative Pathways - Mixed Acid and 2, 3-Butanediol Fermentation - Butyrate and Butanol- Acetone Fermentation - 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
	- Introduction to Biosynthesis of Amino acid - L-Lysine synthesis from Oxaloacetate - Valine, Proline synthesis - Aromatic amino acids synthesis: Chorismate and tryptophan. - Biosynthesis of purine and pyrimidine nucleotide - Lipid Biosynthesis: Biosynthesis of palmitate, its role in other fatty acid synthesis. β-Oxidation of fatty acids. - Microbial synthesis, Degradation and regulation of glycogen, Poly-phosphate, Polyβ hydroxybutyrate (PHB) production. - 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 Lubert Stryer (Dec 24, 2010), W.H. Freeman & Company.
- 7 Chemolithoautotrophic bacteria: Biochemistry and environmental biology by Tateo Yamanaka, (Jan. 2008). Springer.
- 8 Lehninger: Principles of Biochemistry by Albert L. Lehninger, Michael Cox and David L. 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.



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

Course Type: Lab course

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

Course code:

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 <i>B. megaterium</i> .
2	Demonstration of endogenous metabolism in <i>B. megaterium</i> or <i>E. coli</i> 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 <i>S. aureus</i> and <i>E. coli</i>
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: DSE I- 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-

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.
2. Retrieve information from available databases and use them for microbial identifications and drug designing.
3. Gain ability to modify gene and protein structures in simulated systems.
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	

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, Wiley publishers
9. Genomics-Fundamentals and Applications by Supratim Choudhart & David B., Carlson
10. Bioinformatics: Sequence, structure and Data Bank: A Practical Approach by Higgs.
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 Livey (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-XI (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: DSM III based Lab Course XII

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: UO 1. Student will be able to explain microbiological examination of water	

Unit No.	Title of Unit & Contents	Hrs.
	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 Dagainawala H. I. (2005).. Himalaya Publishing House Private Limited, Pune, India.
9. General microbiology, Volume II. Powar C. B. and Dagainawala 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-XIII (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



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:

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	10
	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	35

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 Higon
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- V)

Course Type: DSC- XI

Course Title: MICROBIAL GENETICS

Course code:

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.

Unit No.	Title of Unit & Contents	Hrs.
I	Mutations	10
	1. Evidences for spontaneous mutations: Replica plate techniques, Fluctuation test 2. Spontaneous mutation: Mismatching of Bases due to Tautomerism, Deamination, Depurination and Damage due to Oxidative Metabolism 3. Types of Mutations: Somatic, Base-pair substitutions, Frame shift, Suppressor, 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) 5. Base Excision Repair (BER)	

Unit No.	Title of Unit & Contents	Hrs.
	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 <i>E. coli</i> (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- V)

Course Type: Lab course

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

Course code:

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

CO4 Design 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- V)

Course Type: DSC- XII

Course Title: AGRICULTURAL MICROBIOLOGY

Course code:

Credit- 1

Maximum Marks: 50

Lectures: 15

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	08
	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	07
	1. Plant Pathogens: Bacterial, Fungal and Viral 2. Modes of transmission of plant diseases. 3. Modes of transmission of plant diseases. 4. Plant diseases: i) Citrus Canker, ii) Tikka disease of groundnut, iii) Bacterial Blight of Pomegranate,	

Unit No.	Title of Unit & Contents	Hrs.
	iv) Bacterial wilt v) Downy mildew, vi) Powdery mildew vii) 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	

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)
11. Soil Microbiology and Biochemistry – Ghulam Hassan Dar (New India Publishing Agency, 2010)



Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

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

Course Type: DSC Specific IKS

Course Title: Vedic Agriculture Microbiology

Course Code:

Credits: 01

Max. Marks: 50

Lectures: 15 Hrs.

Learning Objectives:

LO 1: To understand the Vedic knowledge of microorganisms

LO 2: To Learn the Vedic agriculture practices

LO 3: To understand manuring during vedic period

LO 4: To acquire knowledge about plant disease control during vedic period

Course Outcomes:

After completion of course the student will be able to-

CO 1: Explain the role of organic farming in eco-friendly agricultural practices

CO 2: Apply microbial principles to improve soil health, plant growth and crop productivity

CO 3: Develop sustainable agricultural practices that incorporate microbial technology and Vedic principles

Unit No.	Title of Unit & Contents	Hrs.
I	Agriculture in the Vedic period	07
	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	
II	Jaivik Krishi	08
	1. Introduction: Organic farming 2. Kunapajala i. Beejamrit ii. Jeevamrit iii. Amritpani Unit Outcome:	

Unit No.	Title of Unit & Contents	Hrs.
	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. Vedic Microbiology (A Scientific Approach), RC Dubey, Motilal Banarasidass International, Delhi, 2021
2. Vedic Microbiology (Gurus of Vedic Microbiology), Chakradhar F. Anjista, Shriji Kurup, Vinayak printing press, Shahdra, Delhi, 2020
3. वैदिक कृषि विज्ञान - Vedic Agricultural Sciences, Devendra Kumar Gupta, Pratibha Prakashan, 2012
4. 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
5. 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
6. 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
7. Krumi (Microorganisms) in Ayurveda- A critical review. Meena Shamrao Deogade1, Shiva Rama Prasad Kethamakka. Published online in <http://ijam.co.in>
8. Mira Roy, Agriculture in the vedic period, Indian Journal of History of Science, 44.4 (2009) 497-520



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 XVI

Course code:

Credit- 2

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 Jeevamrut



Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

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

Course Type: DSE II-a

Course Title: Industrial Microbiology

Course code:

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	

Unit No.	Title of Unit & Contents	Hrs.
	programme. 2. Stock cultures, maintenance methods (Continuous metabolism 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 Dubey



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- XV (Based on DSE II-a)

Course code:

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



Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

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

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-

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
2. Student able to evaluate microbial production and spoilage of pharmaceutical products. Design manufacturing procedure. Derive pharmaceuticals products by microbial fermentation process
3. Able to understand government regulatory practices, application of biosensor and microbial enzyme in pharmaceuticals.
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. Academic Press New York.
3. Good manufacturing practices for Pharmaceuticals By Sydney H. Willing, Murray M. Tuckerman, William S. Hitchings IV. Second edition Marcel Dekker NC New York.
4. Lippincott's illustrative Reviews: Pharmacology Edition: 02 Maryjnyeck by Lippincott's review Publisher Philadelphia 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., Kothake 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- V)

Course Type: Lab Course

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

Course Code:

Credits: 01 Max. Marks: 50 Hours: 30

Learning Objectives:

1. To study multiple screening procedure and statistical test for pharmaceutical substances.
2. To study production of multiple antimicrobial substances.
3. To learn antimicrobial activity of commercially available synthetic chemicals.

Course Outcomes:

1. Students able to apply bioassay procedure to for pharmaceutical products.
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- V)

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 Dagainawala H. I. (2005).. Himalaya Publishing House Private Limited, Pune, India.
9. General microbiology, Volume II. Powar C. B. and Dagainawala 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-XVIII (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 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
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Faculty of Science
Department of Microbiology
B. Sc. Third Year (Semester- V)

Course type: VSC IV

Course Title: BIO-ANALYTICAL TOOLS

Course code:

Credits-02

Marks-50

Lectures-45

Learning Objectives:

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

Course Outcomes:

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

CO1 Describe principle of chromatography and 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,