Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Structure and Curriculum of

Post Graduate Programme of Science and Technology

M.Sc. in Microbiology

Approved by

Board of Studies

in

Microbiology

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

w.e.f. June, 2023

(In Accordance with NEP-2020)

CERTIFICATE

I hereby certify that the documents attached are the Bonafide copies of the Curriculum of **M.Sc. in Microbiology** Programme to be effective from the **Academic Year 2023-24.**

Date: 4-08-2023

Place: Latur

(Dr. K.G. Maske)
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.K.G.Maske** Head, Department of Microbiology, Rajarshi Shahu Mahavidyalaya (Autonomous), Latur	Chairperson	HoD
2	**Dr. NAGOBA B. S.** Assistant Dean (R D), Professor of Microbiology, MIMSR Medical College, Latur- 413 512 (MS), India	Member	V.C. Nominee
3	**Dr. Ulhas 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.D.V.Vedpathak** Department of Microbiology, Rajarshi Shahu Mahavidyalaya (Autonomous), Latur	Member	Faculty Member
9	**Dr.K.I.Momin** Department of Chemistry, Rajarshi Shahu Mahavidyalaya (Autonomous), Latur	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. K. G. Maske)

Chairperson

Board of Studies in Microbiology

Shiv Chhatrapati Shikshan Sanstha's

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Faculty of Science and Technology

Structure for Postgraduate Degree Programme in Microbiology

Year Level	Sem	MMC		Lab Course	RM	OJT/FP	RP	Cum. Cr	Marks	Degree
		Mandatory	**Elective**		RMC 4Cr	NA	NA	**20Cr**	Theory: 1Cr=25M Lab Course: 1Cr=50M	
I 6.0	**I**	MMC I 3Cr MMC II 3Cr MMC III 3Cr	MEC I 3Cr	LC-I 1Cr LC-II 1Cr LC-III 1Cr LC-IV 1Cr						**PG Diploma (After 03 Year B.Sc. Degree)**
	II	MMC IV 3Cr MMC V 3Cr MMC VI 3Cr	MEC II 3Cr	LC-V 1Cr LC-VI 1Cr LC-VII 1Cr LC-VIII 1Cr	NA	OJT-I 4Cr /FPI 4Cr	NA	**20Cr**	OJT/FP: 1Cr=25M	
	Total	**MMC 18Cr**	**MEC 06Cr**	**LC-8Cr**	**RMC 04Cr**	**OJT/FP 04Cr**	**NA**	**40Cr**		
Exit Option: PG Diploma with 40 Credits After 03 Year B.Sc. Degree										
II 6.5	**III**	MMC VII 3Cr MMC VIII 3Cr MMC IX 3Cr	MEC III 3Cr	LC-IX 1Cr LC-X 1Cr LC-XI 1Cr LC-XII 1Cr	NA	NA	RP-I 4Cr	**20Cr**	RPI & RPII: 1Cr=25M	**PG Degree (After 03 Year UG Degree)**
	IV	MMC X 3Cr MMC XI 3Cr MMC XII 3Cr	MEC IV 3Cr	LC-XIII 1Cr LC-XIV 1Cr LC-XV 1Cr LC-XVI 1Cr	NA	NA	RP-II 6Cr	**22Cr**		
	Total	**MMC 18Cr**	**MEC 06Cr**	**LC-8Cr**	**NA**	**NA**	**RP 10 Cr**	**42Cr**		
Cum. Total of I & II Year		**MMC 36Cr**	**MEC 12Cr**	**LC-16Cr**	**RMC 04Cr**	**OJT/FP 04Cr**	**RP 10Cr**	**40+42 =82 Cr**		**82 Credits**
Exit Option: Two Years 04 Sem. PG Degree with 82 Credits After 03 Year UG Degree										

Abbreviations:

1. MMC : Major Mandatory Course
2. MEC : Major Elective Course
3. RMC : Research Methodology Course
4. OJT : On Job Training (Internship/Apprenticeship)
5. FP : Field Project
6. RP : Research Project
7. Cum. Cr : Cumulative Credit

Shiv Chhatrapati Shikshan Sanstha's

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Department of Microbiology

M.Sc.Microbiology

Year & Level	Semester	Course Code	Course Title	Credits	No. of Hrs.
6.0	I	601MIB1101 (MMC I)	Microbial Physiology	03	45
			Lab course I	01	30
		601MIB1102 (MMC II)	Enzyme Technology	03	45
			Lab course II	01	30
		601MIB1103 (MMCIII)	Food and Dairy Microbiology	03	45
			Lab course III	01	30
		601MIB1201 MEC-I (A) Or MEC-I(B)	Advances in Virology Or Microbial Nanotechnology	03	45
			Lab course IV	01	30
		601MIB1301 (RMC)	Research Methodology Course	04	100
	II	601MIB2101 (MMC IV)	Microbial Metabolism	03	45
			Lab course V	01	30
		601MIB2102 (MMC IV)	Microbial Genetics	03	45
			Lab course VI	01	30
		601MIB2103 (MMC IV)	Microbial Diversity and Extremophiles	03	45
			Lab course VII	01	30
		601MIB2201 MEC-I (A) Or MEC-I(B)	Ecology and Environmental Microbiology OR Applied Mycology and phycology	03	45
			Lab course VIII	01	30
		OJT-I/Field Project (FP) 601MIB2401	OJT/ Field Project	04	120
				20	
Total Credits (Semester I & II) Major+ MEC				**40**	

Shiv Chhatrapati Shikshan Sanstha's

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Faculty of Science

Programme Outcomes (POs) for M.Sc. Programme	
PO1	
PO2	
PO3	
PO4	
PO5	
PO6	
PO7	

Programme Outcomes (POs) for M.Sc. Programme	
PO No.	Upon completion of this programme the students will be able to
PO 1	Implement knowledge about various methodological and analytic approaches that are used within the specialization.
PO 2	Apply the skills in planning and performing and handling scientific instruments during laboratory experiments
PO 3	Apply the scientific method and hypothesis testing in the design and execution of experiments, hypothesis generation, collection and analysis of data, and interpretation and presentation of results.
PO 4	Execute Skill to communicate scientific outcomes to the general public and experts by writing well structured reports; through scientific publications and posters, and by Oral presentations
PO 5	Demonstrate the ability to identify key questions in microbiological research optimize research methods, and analyze outcomes by adopting scientific methods
PO 6	Demonstrate entrepreneurship abilities, innovative thinking, planning, and setting up small-scale enterprises.
PO 7	Evaluate and predict the technological, ethical, social and environmental impacts associated with the microbiological activities and their by acknowledges health, safety and environment (HSE) issues in handling chemicals and microbiological materials.

Semester - I

Shiv Chhatrapati Shikshan Sanstha's

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Department of Microbiology

Course Type: MMC-I

Course Title: Microbial Physiology

Course Code: 601MIB1101

Credits: 03 **Max. Marks: 75** **Lectures: 45Hrs.**

Learning Objectives:

LO.1 Understand Metabolic diversity, phototrophy and chemolithotrophy.

LO.2 Understand Bacterial respiration

L O.3 Understand electron transport chain and modes of energy generation.

LO.4 Understand structure and organization of membrane and permeation

LO.5 Understand bacterial sporulation.

Course Outcomes:

After completion of course the student will be able to-

CO1 Describe and compare chemolithotrophic and phototrophic bacteria.

CO2 Explain in depth principle and mechanism of aerobic and anaerobic respiration in microorganisms.

CO3 Describe methods to study diffusion of solutes in bacteria.

CO4 Explain process of sporulation in bacteria

Unit No.	Title of Unit & Contents	Hrs
I	**Bacterial Chemolithotrophs and Phototrophs**	**12**
	1 Chemolithotrophs: Physiological groups 2 Ammonia oxidation by members of genus Nitro groups, Nitrate oxidation by nitro group of genera. 3 Oxidation of molecular hydrogen by *Hydrogenomonas* species 4 Ferrous and sulfur/sulfide oxidation by *Thiobacillus* species. 5 Phototrophs :Photosynthetic microorganisms and Photosynthetic pigments 6 Generation of reducing power by cyclic and non cyclic photophosphorylation, 7 Electron transport chain in photosynthetic Bacteria 8 Carbon dioxide fixation pathways	

Unit No.	Title of Unit & Contents	Hrs
	Unit Outcomes: UO 1. Student will be able explain different physiological groups of microorganisms . UO 2. Student will be able elaborate assimilation and dissimilation of inorganic compounds	
II	**Bacterial Respiration**	**12**
	1 Bacterial aerobic respiration 2 Components of electron transport chain. 3 Free energy changes and electron transport 4 Oxidative phosphorylation and its theories of ATP formation 5 Inhibition of electron transport chain. 6 Electron transport chain in some heterotrophic bacteria 7 Mechanism of oxygen toxicity, Catalase, Super oxide dismutase. 8 Bacterial anaerobic respiration 9 Electron transport chain in some anaerobic bacteria. 10 Nitrate, Carbonate and Sulfate as electron acceptors.	
	Unit Outcome: UO 1. Student will be able to explain aerobic and anaerobic respiration. UO 2. Student will explain electron transport chain and oxidative phosphorylation	
III	**Bacterial Permeation**	**12**
	1. Structure and organization of membrane (Glyco-conjugants and Proteins in membrane system), 2. Methods to study diffusion of solutes in bacteria 3. Diffusion : Passive diffusion and Facilitated diffusion 4. Different mechanisms of active transport: Proton motive force, PTS 5. Role of permeases in transport, Different permeases in *E.coli*. 6. Transport of amino acids and Inorganic ions in microorganisms and their mechanisms.	
	Unit Outcomes: UO 1. Student will be able to describe mechanism of permeation UO 2. Student will be able to explain structure and organization of membrane	

Unit No.	Title of Unit & Contents	Hrs
IV	Microbial Stress Responses	**09**
	1. Osmotic Stress and Osmoregulation 2. Aerobic to Anaerobic Transitions 3. Oxidative Stress 4. pH Stress and Acid Tolerance 5. Thermal Stress and the Heat Shock Response 6. Nutrient Stress and the Starvation—Stress Response 7. Bacterial sporulation : Sporulating bacteria and Molecular architecture of spores. 8. Induction and stages of Sporulation 9. Influence of different factors on sporulation. 10. Cytological and macromolecular changes during sporulation. 11. Heat resistance and sporulation	
	Unit Outcomes: UO 1. Student will apply this knowledge during cultivation of microorganisms. UO 2. Student will be able to describe bacterial sporulation.	

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. Brocks Biology of Microorganisms (Eleventh Edition) by Michael T. Madigan, John M. Martinko (2006), Pearson Prentice Hall.
5. Microbial physiology and metabolism by D. R. Caldwell (1995) Brown Publisher.
6. Microbial physiology by A. G. Moat, J. W. Foster & M. P. Spector (1999), Wiley.
7. Prokaryotic Development by V. W. Burn & I. J. Shimkots (2000). ASM. Press.
8. The Bacteria. Volume by I.C. Gunsalus and Rogery Stainer. Academic Press.
9. Advances in Microbial Physiology, by A. H. Rose. Academic Press. New York.
10. Applied microbial physiology: A practical Approach by P. Rhodes & P. Stansbury (1997), IRL Press, New York.

11. Bacterial physiology and Metabolism by Byung Hong Kim & Geoffrey Michael Gadd (2008), Cambridge University Press.
12. Microbial physiology and metabolism by D. R. Caldwell (1995) Brown Publisher.
13. Microbial physiology by A. G. Moat, J. W. Foster & M. P. Spector (1999), Wiley.
14. Prokaryotic Development by V. W. Burn & I. J. Shimkots (2000). ASM. Press.
15. The Bacteria. Volume by I.C. Gunsalus and Roger Y. Stainer. Academic Press.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Microbiology

Course Type: Lab Course

Course Title: Lab Course –I (Based on MMC-I)

Course Code: 601MIB1104

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

Leaning Objectives

L O 1. To study cultivation of phototropic bacteria

L O 2. To understand uptake of nutrients in Bacteria.

L O 3. To study sporulation and effect of environmental factors on spore germination in Bacillus sp

L O 4. To learn methods for cultivation of chemolithotrophs

Course outcomes

After completion of course the student will be able to-

CO 1. Isolate photosynthetic bacteria.

CO2. Design experiment to determine iron oxidation rate in *Thiobacillus ferooxidans*

CO3. Design experiment to determine sulfur oxidation rate in *Thiobacillus thiooxidans.*

CO4. Design experiment to study effect of different environmental factors on spore germination of *Bacillus* sp

Practical No.	Unit
1	Isolation of photosynthetic bacteria.
2	Glucose uptake by *E. coli / Sacchromyces cerevisiae* [Active and Passive diffusion].
3	Effect of UV, pH on spore germination of *Bacillus* sp.
4	Effect of disinfectants, chemicals and heavy metal ions on spore germination of *Bacillus* sp.
5	Determination of Iron Oxidation Rate of *Thiobacillus ferrooxidans.*
6	Determination of Sulfur Oxidation Rate of *Thiobacillus thiooxidans.*
7	Enrichment and cultivation of chemolithotrophis bacteria.
8	Estimation of calcium ions present in Sporulating bacteria by EDTA method.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

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Department of Microbiology

Course Type: MMC-II

Course Title: ENZYME TECHNOLOGY

Course Code: 601MIB1102

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives

LO 1. To understand structure ,working and function of biocatalyst.

LO 2. To understand different extraction and purification methods for biocatalyst.

LO 3. To study use of biocatalyst in different industries.

LO 4. To study methods of immobilization of enzymes

LO 5. To study Enzyme inhibition and kinetics

Course outcomes

After completion of course the student 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

CO 5. Explain application of biocatalyst in different industries

Unit No.	Title of Unit & Contents	Hours
I	**Enzyme as a biocatalyst and Enzyme Engineering**	**12**
	1. An introduction to enzymes, A brief History 2. The naming and classification of enzymes 3. Structure and function of enzymes 4. Co-enzymes , Metal ions as co-factors and enzyme activators 5. Specificity of enzyme action 6. Monomeric and Oligomeric enzymes 7. Mechanism of enzyme action- with reference to chymotrypsin. 8. Modification of enzymes: chemical, enzymatic and by mutagenesis. 9. Application of Site directed mutagenesis to study structure –function relationship of enzyme	
	Unit Outcome: UO 1.Student will explain Nomenclature of enzymes.	

Unit No.	Title of Unit & Contents	Hours
	UO 2. Student can explain enzyme modification.	
II	**Enzyme Kinetics and Enzyme Inhibition**	**12**
	1. Kinetics of single-substrate enzyme-catalysed reactions 2. Enzyme kinetics: Steady state kinetics, Brigs Haldane equation, Michaelis Menten equation, The Monod-Wyman-Changeux (MWC) Model, the Koshland-Nemethy-Filmer (KNF) Model. 3. Enzyme inhibition-Reversible and Irreversible inhibition, competitive, noncompetitive and uncompetitive inhibition, with suitable example and their kinetics studies. 4. Kinetics of multi-substrate enzyme-catalysed reactions. Examples of possible mechanisms**.** 5. Allosteric enzymes and metabolic regulation**,**Types of allosteric regulation and their significance in metabolic regulation . Cooperativity, kinetics study (Hillsequation).	
	Unit Outcome: UO 1. Student will be able to explain Enzyme kinetics of bacteria using simple and differential staining techniques. UO 2. Student will be able to describe allosteric enzyme inhibition. .	
III	**Extraction and Purification of Microbial Enzyme**	**12**
	1. Importance of Enzyme purification. 2. Different sources of enzyme, Extracellular and Intracellular enzyme, Physical and Chemical methods used for cell disintegration. 3.Enzyme fractionation by precipitation (using Temperature, Salt, pH etc.), 4.Enzyme purification by Liquid-liquid extraction, Dialysis, Ionic Exchange, Gel electrophoresis, Affinity chromatography and other special purification methods. 5. Enzyme crystallization technique, Criteria of purity of enzyme, Pitfalls in working with pure enzyme.	
	Unit Outcomes: UO 1. Student will be able to apply techniques of enzyme purification.	

Unit No.	Title of Unit & Contents	Hours
	UO 2. Student can apply Enzyme crystallization technique.	
IV	**Immobilization and Applications of Microbial enzymes**	**09**
	1. Properties of Immobilized enzyme. 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 enzyme	
	Unit Outcome: UO 1. Student will be able to describe Methods of immobilization UO 2. Student will be able to apply this enzyme techniques	

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. JohnWiley and Sons,New York.

5. Methods of Enzymatic Analysis by Hans Ulrich. Bergmeyer, Academic Press.
6. Methods in enzymology by W. A. AWood. 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

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(Autonomous)

Department of Microbiology

Course Type: Lab Course

Course Title: Lab Course –II (Based on MMC-II)

Course Code: 601MIB1105

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

Learning Objectives

LO 1. To study technique for Microbial production of enzymes

LO 2. To study methods of enzyme purification.

LO 3. To study effect of different parameters on enzyme activity.

LO 4. To study enzyme inhibition and activation.

LO 5. To study enzyme kinetics.

Course outcomes

After completion of course the student will be able to-

CO 1. Design experiment for production of enzyme.

CO 2. Design experiment for Extraction, Purification of enzyme.

CO 3. Prepare and use immobilized enzymes.

CO 4. Determine effect of different parameters on enzyme.

Practical No.	
1	Microbial production, Extraction, Purification and confirmation of alpha amylase / Lipase.
2	Determination of efficiency of enzyme purification by measuring specific activity at various stages viz. Salt precipitation, dialysis, electrophoresis etc.
3	Effect of pH and Temperature on enzyme activity (amylase/ lipase)
4	Studies on enzyme activation and inhibition of extracted alpha amylase / Lipase. Effect of heavy metal ions, Chelating agents activators and inhibitors.
5	Immobilization of cells and enzyme using sodium alginate and egg albumin and measurement of enzyme activity (amylase / Lipase).
6	Studies on impact of immobilization of enzyme activity in terms of temperaturetolerance and Vmax and Km using various forms of alpha amylase/ Lipase

7	Determination of molecular weight of enzyme using PAGE technique.

Learning Resources:

1. Methods in enzymology. Volume22-Enzyme purification and related techniques. Edited by William B.Jakob . 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 (1985), Ellis Horwood.
5. Methods in Enzymology by W. A. Wood (1980) Academic Press New York.
6. Methods of Enzymatic Analysis by Hans Ulrich. Bergmeyer (1974) Verlag Chemie

Shiv Chhatrapati Shikshan Sanstha's

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Department of Microbiology

Course Type: MMC-III

Course Title: Food and Dairy Microbiology

Course Code: 601MIB1103

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives

LO 1. To distinguish the significance of microorganisms in food production and food spoilage

LO 2. To bestow knowledge about food preservation principles and methods

LO 3. To make aware about food born infections and intoxications and control measures to prohibit them

LO4. To understand the concepts of quality assurance in food and regulations emphasized about it.

Course outcomes

After completion of course the student will be able to-

CO 1. Apply methods of production and preservation of various commonly used foods

CO 2. Biochemical changes and food spoilage causing microorganisms.

CO 3. Able to explain abut food born diseases and the Government regulatory practices& policies laid down for food safety to the society

CO 4. Explain the beneficial role of microorganisms and their enzymes in modern food production industries.

Unit No.	Title of Unit & Contents	Hours
I	**Industrial Food fermentations**	**12**
	1. Activities of lactic acid bacteria in food : antimicrobial, health promoting effect –Probiotic. 2. Biochemical activities, production and preservation of Soy sauce and Rice Wine, Tempeh(Moulds fermentation) 3. Biochemical activities, production and preservation of Saurkraut and Kimchi ,olives and cucumbers (Fermented vegetables) 4. Biochemical activities, production and preservation of Fermented Meat – Sausages 5. Biochemical activities, production and preservation of Fermented	

	Fish 6. Production and application of SCP 7. Fermented milk products (Cheese, acidophilus milk, yoghurt) 8. Biochemical activities, production and preservation of Pickles and Indian fermented foods (Dosa, Idli)	
	Unit Outcome: UO 1. Student will prepare Fermented milk products UO 2. Student will apply food preservation method	
II	**Food spoilage and preservation**	**12**
	1. General types of microbial food spoilage 2. Factors affecting food spoilage 3. Spoilage of: fruits, vegetables, milk products, Egg, poultry, fish and meat products 4. Food preservation : Radiations - UV, Gamma and microwave. 5. Heat Processing:Pasteurization and Appertization, Quantifying the Thermal Death of Microorganisms: D and z Values , Aseptic Packaging. 6. Chemical preservatives: Organic Acids and Esters ,Nitrite ,Sulfur Dioxide , Natamycin Naturally occurring antimicrobials.	
	Unit Outcome: UO 1. Student will be able to describe microbial food spoilage. UO 2. Student will be able to use food preservation methods.	
III	**Quality assurances in foods**	**12**
	1. Food borne infections and intoxications: Staphylococcal , Campylobacter, Clostridium, Listeria. 2. Mycotoxins in food: Aflatoxin and Rubratoxin. 3. Phycotoxins in food. 4. Quality assurance: Microbiological quality standards of food. 5. Government regulatory practices and policies: FSSAI, FDA, EPA, HACCP, ISI, AGMARK.	
	Unit Outcomes: UO 1. Student will be able to explain food borne infections and intoxications UO 2. Student can explain about Microbiological quality standards of	

	food.	
IV	**Advanced Food Microbiology**	**09**
	1. Applications of microbial enzymes in food and dairy industry Protease, Lipases, Amylases, Pectinase 2. Probiotics and their applications 3. Production of Mushroom and Spirulina . 4. Genetically modified food. 5. Utilization of byproduct Whey, Molasses	
	Unit Outcome: UO 1. Student will be able to describe Applications of microbial enzymes in food and dairy industry UO 2. Student will be able prepare SCP	

Learning Resources:

1. Food Microbiology. 2nd Edition By Adams Basic Food Microbiology by Banwart George J. Food Microbiology: Fundamentals and Frontiers by Dolle
2. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2 by Joshi.
3. Fundamentals of Dairy Microbiology by Prajapati.
4. Essentials of Food Microbiology. Edited by John Garbult. Arnold International Students Edition.
5. Microbiology of Fermented Foods. Volume II and I. Brian J.Wood. Elsiever Applied Science Publication.
6. Microbiology of Foods by John C. Ayres. J. Orwin Mundt. William E. Sandinee. W. H. Freeman and Co.
7. Dairy Microbiology by Robinson. Volume II and I
8. Food Microbiology: Fundamentals and Frontiers. 2nd Edition by Michaell P. Doyle, Larry R. Beuchat and Thomas I. Montville (Eds.), ASM Publications
9. Fundamental Food Microbiology, Bibek Ray, ArunBhunia. 2013. Fifth Edition. CRC Press .
10. Food Spoilage Microorganism C Blackburn.2006. ms. Woodhead Publishing
11. Applied Dairy Microbiology Elmer H. Marth, James Steele. 2001., Second Edition. CRC Press.
12. .Food Microbiology. Frazier W.C. and Westhoff C.D. 2008 Tata Mc Graw Hill Publishing Company Limited, New Delhi. Indian Edition.
13. Modern Food Microbiology, Jay James M., Loessner, Martin J., Golden, David A. 2004.. 7th ed

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Department of Microbiology

Course Type: Lab Course

Course Title: Lab Course –IV(Based on MMC-III)

Course Code: 601MIB1106

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

Learning Objectives

LO 1. To study technique for Microbial production of enzymes

LO 2. To study methods of enzyme purification.

LO 3. To study effect of different parameters on enzyme activity.

LO 4. To study enzyme inhibition and activation.

LO 5. To study enzyme kinetics.

Course outcomes

After completion of course the student will be able to-

CO 1. Design experiment for production of enzyme.

CO 2. Design experiment for Extraction, Purification of enzyme.

CO 3. Prepare and use immobilized enzymes.

CO 4. Determine effect of different parameters on enzyme.

Practical No.	
1	Production and estimation of lactic acid by *Lactobacillus* Sp. or *Streptococcus* Sp.
2	Extraction and estimation of diacetyl
3	Sauerkraut fermentation
4	Isolation of food poisoning bacteria from contaminated foods, Dairy products.
5	Production of Mushroom / *Spirulina.* Production of fermented milk by *Lactobacillus acidophilus*
6	Preservation of potato/onion by UV radiation
7	Determination of molecular weight of enzyme using PAGE technique.
8	Rapid analytical techniques in food quality control using microbial Biosensors

Learning Resources:

1. Food Microbiology: A Laboratory Manual, Ahmed E.Y. and Carlstrom C. 2003. John Wiley and Sons, Inc. New Jeresy
2. Fundamental Food Microbiology, Bibek Ray, ArunBhunia. 2013. Fifth Edition. CRC Press .
3. Food Spoilage Microorganism C Blackburn.2006. ms. Woodhead Publishing
4. Applied Dairy Microbiology Elmer H. Marth, James Steele. 2001., Second Edition. CRC Press.
5. Food Microbiology. Frazier W.C. and Westhoff C.D. 2008 Tata Mc Graw Hill Publishing Company Limited, New Delhi. Indian Edition.
6. Modern Food Microbiology, Jay James M., Loessner, Martin J., Golden, David A. 2004,7th ed. Springer

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Microbiology

Course Type: MEC-I

Course Title: Advances in Virology

Course Code: 601MIB1201

Credits: 03 **Max. Marks:75** **Lectures: 45 Hrs.**

Learning Objectives

LO 1. Study classification of viruses virus evolution and emergence of new virus

LO 2. Understand the ultra structure and life cycle of viruses.

LO 3. Methods used for cultivation and assay of viruses

LO 4. Understand mechanism of replication of viruses

LO 5.Understand the pathogenesis of viral infections

LO 6. Understand prevention and control of viral diseases, approach to the therapeutic strategies in virus infection ,preparation of vaccines, antiviral drugs.

Course outcomes

After completion of course the student will be able to-

CO 1.Describe the basic steps in virus replication and disease.

CO 2. Describe general characteristics of viruses of viruses.

CO 3. Describe structure of viruses and their replicative cycle.

CO 4.Apply means of prevention and control of viral diseases.

CO 5.The student will be able to evaluate problems in modern virology including areas of virus biology, pathogenesis, and disease control.

Unit No.	Title of Unit & Contents	Hrs.
I	**Classification, Cultivation and Detection of Viruses**	**12**
	1. Brief outline on discovery of viruses, nomenclature and classification of viruses Introduction and Definitive properties of viruses 2.Classification of viruses-International Committee on Taxonomy of viruses (ICTV), 3.Structure based classification 4.Baltimore classification and Homes classification,	

	5. LHT system of classification, 6. Morphology and Ultra structure of Viruses . 7.Cultivation of Viruses: Cell culture, Embryonated egg and Laboratory animals 8. Assay of viruses: Measurement of infectious units, Efficiency of plating. 9. Measurement of virus particles and their components: One step growth cycle ,Physical (Electron microscopy),Chemical methods (Protein and Nucleic acid studies),Infectivity assay	
	Unit Outcome: UO 1. Student will explain definitive properties of viruses UO 2. Student will perform cultivation of viruses	
II	**Multiplication of Viruses**	**12**
	1. Introduction, 2. Architecture of cell surfaces, 3. Multiplication of viruses: Interaction of viruses with cell receptors, Uptake of macromolecules by cells, Mechanism of virus entry into cells, Transport of viral genome into the cell nucleus. 4. Genomic replication of Viruses (DNA/RNA), mRNA production by animal viruses, Mechanism of RNA synthesis, Transcription mechanism and Post transcriptional processing. 5. Translation of viral protein, Assembly, Exit and Maturation of progeny virions .	
	Unit Outcome: UO 1. Student will be able to describe multiplication of viruses. UO 2. Student will be able to genomic replication of Viruses	
III	**Viral Pathogenesis**	**12**

	1. Mechanisms of Pathogenesis :Animal Models of Human Diseases 2. Patterns of Infection , Incubation Period 3. Mathematics of Growth Correlate with Patterns of Infection 4. Acute Infections ,Persistent Infections ,Latent Infections 5. "Slow" Infections ,Abortive Infections ,Transforming Infections 6. Viral Virulence , Measuring Viral Virulence ,Alteration of Viral Virulence . 7. Viral Virulence Genes 8. Pathogenesis of animal viruses (Adenovirus, Herpes virus, Picorna virus) 9. Pathogenesis of plant viruses (TMV) and Insect viruses (NPV). 10. Host cell transformation by viruses and oncogenesis of DNA and RNA viruses	
	Unit Outcomes: UO 1. Student will be able to explain mechanisms of Pathogenesis . UO 2. Student can explain about viral Virulence.	
IV	Bacterial Viruses , Viral vaccines and antiviral drugs	**09**
	1. Introduction 2. Bacterial Viruses-Bacteriophage structural organization; life cycle: lytic and lysogenic cycle, 3. Application of bacteriophages; brief details on M13,Mu,T7,T4, Lamda and P1. Viruses of Cyanabacteria, algae, fungi. 4. Viral vaccines, Preparation of viral vaccines, New vaccine technology 5. Antiviral drugs 6. Virus evolution and Emergence of new viruses.	
	Unit Outcome: UO 1. Student will be able to describe different techniques in cultivation of viruses. UO 2. Student will be able to describe steps in replication of genome of RNA viruses and DNA viruses	

Learning Resources:

1. An Introduction to Viruses by S. B. Biswas & Amita Biswas (2009), Vikas Publishing House PVT LTD.
2. Applied Virology Research: New Diagnostic Procedures by Edouard Kurstak, R. G. Marusyk, F. A. Murphy (1984), Academic press Inc.
3. Brocks Biology of Microorganisms (Eleventh Edition) by Michael T. Madigan, John M. Martinko (2006), Pearson Prentice Hall.
4. Clinical Virology Manual by Steven C. Specter, Richard L. Hodinka, Danny L. Wiedbrauk, Stephen A. Young (2009), ASM Press.
5. Introduction to Modern Virology 4 Th Edition by N. J. Dimmock & S. B. Primrose (1994), Blackwell Scientific publications, Oxford.
6. Notes on Medical Virology, 10th Edition by Morag C. Timbury (1994).
7. Principles of Virology: Molecular Biology, Pathogenesis and Control by S. J. Flint, L.W. Enquist, V. R. Racaniello, A. M. Skalkaj (2009), ASM Press, Washington.
8. Principles of Molecular Virology (4th edn.), Edward Arnold & A. J. Cann (2005). Academic Press, London.
9. Text Book on principles of bacteriology, Virology and Immunology by Topley and Wilsons (19

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Microbiology

Course Type: MEC-II

Course Title: Microbial Nanotechnology

Course Code: 601MIB1202

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1. Explain basic of Microbial Nanotechnology like History, applications, Terminologies etc.

LO 2. Differentiate between physical, chemical, and biological methods used for synthesizing nanoparticles.

LO 3. Explain the process of biosynthesis of nanoparticles by various groups of microorganisms.

Course Outcomes:

After completion of course the student will be able to-

CO 1. Understand the historical development of Microbial nanotechnology and its applications in various fields.

CO 2. Define and explain the terminologies related to Microbial nanotechnology, such as nanoparticles, biogenic nanoparticles, nanowires, thin films, nanomedicine, quantum dots, nanocomposites, nanopores, and nanospheres.

CO 3. Identify colloidal nanostructures and provide examples of nanostructures found in nature After completion of this course, the students will be able to –

CO 4. Understand the microbial nanotechnology

CO 5. Understand the nano-particle synthesis

CO 6. Understand the methods for preparation for nanoparticles.

Unit No.	Title of Unit & Contents	Hrs.
I	**Unit I: INTRODUCTION TO NANOWORLD**	**12**
	1.History and applications of Bionanotechnology in various fields. 2.Terminologies: nanoparticles, Biogenic nanoparticles, nanowires, thin films, nanotechnology, bionanotechnology, nanomedicine, quantum Dots, nanocomposite, nanopores, nanospheres. 3. Colloidal Nanostructures. 4.Examples of Nanostructures in nature.	
	Unit Outcomes: UO 2. Student will be able to explain the historical development of	

Unit No.	Title of Unit & Contents	Hrs.
	bionanotechnology UO 1. Student will be able to describe terminologies of bionanotechnology	
II	**Unit II: MOLECULAR NANOTECHNOLOGY**	**12**
	1. Biomolecules as nanostructures and their applications. 2. Uses of nanoparticles - cancer therapy-manipulation of cell and biomolecules. 3. Cytoskeleton and cell organelles Synthesis of nanoparticles-physical, chemical and biological. 4. Biosynthesis of nanoparticles by various groups of microorganisms, Microorganisms synthesizing silver nanoparticles , Mechanism involved in silver nanoparticles biosynthesis, Process design for industrial scale synthesis of nanoparticles. 5 Nanomachines -virus based.	
	Unit Outcome: UO 1. Student will be able to understand applications of bionanotechnology. UO 2. Student will be able to understand the methods for preparation for nanoparticles	
III	**Unit III: PROPERTIES AND CHARACTERISATION OF NANOMATERIALS**	**12**
	1. Functions and Biological applications of Silver, Gold and Titanium nanoparticles. 2. Physical and chemical properties of nanoparticles. Interaction of nanoparticles with biomolecules-Interaction of nanomaterial with proteins and with cells. 3. Characterization of nanoparticles - UV-Vis spectroscopy, Electron Microscopy - HRTEM, SEM, AFM, EDS, XRD, F-IR and DLS.	
	Unit Outcomes: UO 1. Student will be able to differentiate between physical, chemical, and biological methods used for synthesizing nanoparticles. UO 2. Student will be able to differentiate Physical and chemical properties of nanoparticles	

Unit No.	Title of Unit & Contents	Hrs.
IV	**Unit IV: Applications of nanoparticles in biology**	**09**
	1. Drug delivery - protein mediated and nanoparticle mediated. 2. Uses of nanoparticles in MRI, DNA and Protein Microarrays, Cell labeling . 3. Nanotechnology and nanoparticles in health sectors. 4. Toxicology of nanoparticles , Nanoparticles for Dosimetry . 5. Advantages of nanoparticles - drug targeting, protein detection, MRI, development of green chemistry - commercial viability of nanoparticles. 6. Disadvantages - health risk associated with nanoparticles, inadequate knowledge on nanoparticles research.	
	Unit Outcomes: UO 1. Student will be able to understand Advantages and disadvantages of nanoparticles in drug targeting, protein detection, MRI. UO 2. Student will be able to understand Uses of nanoparticles.	

Learning Resources:

1. Introduction to Nanotechnology, Parthasarathy, B.K. (2007).
2. Bionanotechnology. Volume 7 of Synthesis Lectures on Biomedical Engineering. Morgan & Claypool Publishers. Elisabeth Papazoglou and Aravind Parthasarathy (2007) .
3. Microbial Bionanotechnology: Biological Self-assembly Systems and Biopolymer-based Nanostructures Bernd Rehm (Ed) (2006). Horizon Bioscience.
4. Bionanotechnology: Global prospects. David E. Reisner, Joseph D. Bronzino (2009). CRC Press.
5. Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology ,Ehud Gazit(2007).Imperial College Press, London
6. Nanotechnology: Principals and Practices, Sulabha K. Kulkarni, (2009 Revisededition) Capital Publishing company, New Delhi.

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Microbiology

Course Type: Lab Course

Course Title: Lab Course –IV (Based on MEC I)

Course Code: 601MIB1203

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

Learning Objectives

LO 1. Understand methods used for isolation of viruses.

LO 2. Understand and design experiments to study growth of viruses

LO 3. Understand and design experiments to study transduction .

Course outcomes

After completion of course the student will be able to-

CO 1. Design experiment for isolation of bacteriophage.

CO 2. Design experiment for cultivation of and assay of viruses.

CO 3.Perform diagnosis of plant viral diseases.

CO 4. Determine virus titre.

Practical No.	Experiment
1	Isolation of coliphage by plaque formation assay.
2	One-step growth curve for determination of virus titre.
3	Induction of lambda lysogen by UV radiations.
4	Studies on Specialized transduction.
5	Isolation of lambda DNA and their characterization.
6	Amplification of lambda DNA by PCR.
7	Cultivation and assay of virus using embryonated eggs and tissue culture Technique.
8	Study of symptoms of plant viral diseases by simple detached leaf technique

Learning Resources:

1. An Introduction to Viruses by S. B. Biswas & Amita Biswas (2009), Vikas Publishing House PVT LTD.
2. Applied Virology Research: New Diagnostic Procedures by Edouard Kurstak, R. G. Marusyk, F. A. Murphy (1984), Academic press Inc.
3. Brocks Biology of Microorganisms (Eleventh Edition) by Michael T. Madigan, John M. Martinko (2006), Pearson Prentice Hall.

4. Clinical Virology Manual by Steven C. Specter, Richard L. Hodinka, Danny L. Wiedbrauk, Stephen A. Young (2009), ASM Press.
5. Introduction to Modern Virology 4 Th Edition by N. J. Dimmock & S. B. Primrose (1994), Blackwell Scientific publications, Oxford.
6. Notes on Medical Virology, 10 Th Edition by Morag C. Timbury (1994).
7. Principles of Virology: Molecular Biology, Pathogenesis and Control by S. J. Flint, L.W. Enquist, V. R. Racaniello, A. M. Skalkaj (2009), ASM Press, Washington.
8. Principles of Molecular Virology (4th edn.), Edward Arnold & A. J. Cann (2005). Academic Press, London.
9. Text Book on principles of bacteriology, Virology and Immunology by Topley and Wilsons (1995).

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Microbiology

Course Type: Lab Course

Course Title: Lab Course- IV (Based on MEC-II)

Course Code: 601MIB1203

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

Learning Objectives

LO1. Explore the synthesis, fabrication, and characterization techniques used in nanotechnology, including top-down and bottom-up approaches

LO 2. Study isolation of nanoparticles from different sources

LO 3. Understand the fundamental principles and concepts of nanotechnology, including nanoscale phenomena, properties, and behavior of materials at the nanoscale.

Course outcomes

After completion of course the student will be able to-

CO 1.Acquire practical skills in working with nanomaterials , nanodevices, and nanosystems.

CO 2.Demonstrate an understanding of the current challenges and future prospects of nano biotechnology.

CO 3.Apply theoretical concepts to design and conduct experiments related to nano biotechnology.

Practical No.	Practical
1	Synthesis of nanoparticles from microbiological sources
2	Affinity purification of immunoglobulins & quantification
3	Demonstration of Imaging techniques: SEM/TEM/Bio-AFM (Natural Sample sources)
4	Bioconjugation of nanoparticles with proteins/antibodies/DNA
5	Synthesis of Nanoparticles from plant materials

Learning Resources:

1. Handbook of Thin Film Deposition, Hartmut Frey, Hamid. R. Khan Editors.
2. Elements of X-ray diffraction, B. D. Cullity, Creative Media Partners, LLC.
3. Instrumental Methods of Analysis,Hobart H. Willard, John A. Dean, Lynne L. Merritt D.Van Nostrand Company.
4. Fundamentals of Molecular Spectroscopy by C. N. Banwell, McGraw-Hill

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Computer Science

Course Type: RMC

Course Title: Research Methodology

Course Code: 601COS1301

Credits: 04 **Max. Marks: 100** **Lectures: 60 Hrs.**

Learning Objectives:

LO1. To enable to student to understand and work methods and concepts related Research.

LO2. To enable the student to develop research proposal and to work with research problem.

LO3. To develop broad comprehension of research area.

Course Outcomes:

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

CO1. Examine the basic aspects of Research methods

CO2. Apply and integrate the basic concepts Collection and analysis of data.

CO3. Know the of report writing and evaluation methods.

CO4. Examine the plagiarism by using various apps.

Unit No.	Title of Unit & Contents	Hrs.
I	**Introduction and Methods of Research**	**15**
	1. Meaning of Research, Objectives of Research, Types of Research, 2. Research Approaches, Significance of Research, Research Methods Versus Methodology, Research and Scientific Methods, 3. Research Processes, Criteria for Good Research 4. Research Problem, Selecting the Problem, Necessity of Defining the Problem, Techniques Involved in Defining a Problem	
	Unit Outcome: UO1. Examine the basic aspects of Research methods	
II	**Research Design and Sampling**	**15**
	1. Meaning and Need for Research Design, Features of A Good Design. 2. Important Concepts Relating to Research Design: Dependent and Independent Variables, Extraneous Variables, Control, Research Hypothesis, Experimental and Non-Experimental Hypothesis –Testing Research, Experimental and Control Group	

	3. Different Research Designs: Research Design in Case of Exploratory Research Studies, Research Design in Case of Hypothesis- Testing Research Studies, Basic Principles of Experimental Designs, Important Experimental Designs 4. Sampling Design, Steps in Sample Design, Criteria of Selecting a Sampling Procedure, Characteristics of A Good Sample Design, Different Types of Sample Design	
	Unit Outcome: UO1. Apply and integrate the basic concepts Collection and analysis of data.	
III	**Data Collection and Data Processing**	**15**
	1. Measurements in Research, Measurement Scales, Sources of Errors in Measurement. 2. Collection of Primary Data: Observation Method, Interview Method, Through Questionnaires, Through Schedules, Difference Between Questionnaire and Schedule 3. Collection of Secondary Data, Selection of Appropriate Methods for Data Collection, Case Study Method 4. Data Processing, Processing Operations: Editing, Coding, Classification, Tabulation, Graphical Representation, Types of Analysis, Statistical Tools and Techniques Of Data Analysis-Measures Of Central Tendency, Dispersion.	
	Unit Outcome: UO1. Know the of report writing and evaluation methods	
IV	**Report Writing and Evaluations**	**15**
	1. Principles of Report Writing and Guide Lines According to Style Manuals. 2. Writing and Presentation of Preliminary, Main Body and Reference Section of Report. 3. Evaluation of Research Report. 4. Methods to Search Required Information Effectively, Reference Management Software Like Zotero/ Mendeley, Software for Paper Formatting Like Latex/ MS Office. 5. Software for Detection of Plagiarism.	
	Unit Outcome: UO1. Examine the plagiarism by using various apps.	

Learning Recourses: -

1. Bajpai S. R. (1975) Methods of Social Survey and Research, Kitabghar, Kanpur.
2. Hans Raj (1988) Theory and Practice in Social Research, Surjeet Publication, Kolhapur.
3. Krishnaswami O. R. (1988) Methodology of Research in Social Science, Himalaya Pub. House.
4. Sadhu, Singh, Research Methodology in Social Science Bhandarkar, Research Methodology
5. Kothari, C. R. (2005) Quantitative Technique, New Delhi, Vikas Publication House.
6. Gautam, N. C. (2004) Development of Research tools, New Delhi, Shree Publishers.
7. Gupta, Santosh (2005) Research Methodology and Statistical Techniques, Deep and Deep Publications.
8. Chandera A. and Sexena T. P. (2000) Style Manual, New Delhi, Metropolitan Book Comp. Ltd.
9. Shukla, J. J. (1999) Theories of Knowledge, Ahmadabad, Karnavati Publication.
10. Bhattacharya, D. K. (2004) Research Methodology, New Delhi, Excel Books.
11. Brymann, Alan and Carmer, D. (1995) Qualitative data analysis for social scientist, New York, Routledge Publication.
12. Best J. W. and Khan J. V. (2005) Research in Education New Delhi, Prentice Hall India.

Semester - II

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Microbiology

Course Type: MMC-IV

Course Title: Microbial Metabolism

Course Code: 601MIB2101

Credits: 03 **Max. Marks: 75** **Lectures: 45Hrs.**

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 synthesize 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	**Thermodynamics and Bioenergy Transduction**	**12**
	1. Scope of thermodynamics. Laws of Thermodynamics. 2. Concept of enthalpy, free energy and equilibrium constant, Gibbs free energy equation, 3. Determination of free energy of hydrolytic and biological oxidation reduction reactions, under standard and non-standard conditions. 4. High energy compounds, Structure and properties of ATP 5. Standard Free energy change of hydrolysis of ATP and other high energy compounds, coupled reactions, determination of feasible reaction. 6. Atkinson's energy charge theory.	

Unit No.	Title of Unit & Contents	Hrs
	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**
	1. Major Carbohydrate catabolic pathways, their regulation and significance: EMP, HMP, ED, PKP, 2. TCA, Methyl glyoxylate bypass, Anaplerotic Sequences. 3. Fermentations: Ethanol, Lactate, Butyrate and Butanol-acetone, Mixed Acid, 2, 3- butandiol, Propionate, Succinate, Acetate, Methane and Sulphate.	
	Unit Outcome: UO 1. Student will be able to explain Major Carbohydrate catabolic pathways UO 2. Student will explain different Fermentations	
III	**Metabolism of Organic Nitrogenous Compounds**	**12**
	Biosynthesis of Amino acid 1 Oxaloacetate and Pyruvate families, 2 Phosphoglycerate family, 3 α-Oxoglutarate family, 4 Aromatic amino acids and L- histidinesynthesis. 5 Nucleic acid metabolism: Biosynthesis and Catabolism of purine and pyrimidine nucleotide.	
	Unit Outcomes: UO 1. Student will be able to describe Biosynthesis of Amino acid through different families UO 2. Student will be able to explain Nucleic acid metabolism	
IV	**Metabolism of lipids and hydrocarbons**	**09**
	1. Lipid Biosynthesis: Biosynthesis of palmitate, its role in other fatty acid synthesis. 2. Lipid Biosynthesis:Biosynthesis of Membrane Phosopholipids 3. B-Oxidation of fatty acids. 4. Microbial synthesis, Degradation and regulation of glycogen, Poly-phosphate, Polyβ hydroxybutyrate (PHB) production.	

Unit No.	Title of Unit & Contents	Hrs
	5 Microbial degradation of aliphatic and aromatic hydrocarbon	
	Unit Outcomes: UO 1. Student will apply this knowledge of Lipid Biosynthesis for industrial production UO 2. Student will be able to describe Microbial degradation of hydrocarbon	

Learning Resources:

16. Advances in Microbial Physiology, by A. H. Rose. Academic Press. New York.
17. Applied microbial physiology: A practical Approach by P. Rhodes & P. Stansbury (1997), IRL Press, New York.
18. Bacterial physiology and Metabolism by Byung Hong Kim & Geoffrey Michael Gadd (2008), Cambridge University Press.
19. Bacterial metabolism by Gerhard Gottschalk (second edition), (1986) Springer VerlagNew York Inc.
20. Bacterial metabolism by H. W. Doelle (Second edition), (2005), Academic press, Inc.
21. Biochemistry, Seventh Edition by Jeremy M. Berg, John L. Tymoczko and LubertStryer (Dec 24, 2010), W.H. Freeman & Company.
22. Chemolithoautotrophic bacteria: Biochemistry and environmental biology by TateoYamanaka, (Jan. 2008). Springer.
23. Lehninger: Principles of Biochemistry by Albert L. Lehninger, Michael Cox and DavidL. Nelson (4 May 2004), W. H. Freeman.
24. Microbial Biochemistry (Second Edition) by G.N. Cohen, (2011) Springer Dordrecht Heidelberg London New York.
25. 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

(Autonomous)

Department of Microbiology

Course Type: Lab Course

Course Title: Lab Course –V (Based on MMC-IV)

Course Code: 601MIB2104

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

Leaning Objectives

LO 1. To Understand Methods Estimation of different types of biomolecule.

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 and it's estimation.

CO 3. Determine Membrane composition and it's isolation

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/Biuretmethod.
6	Preparation and analysis of polar lipids from *S. aureus* and *E.coli*.
7	Isolation of hydrocarbon degraders
8	Isolation and identification of Reserve food material (Glycogen / Polyphosphate/ PHB) of *B. megaterium.*

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Microbiology

Course Type: MMC-V

Course Title: MICROBIAL GENETICS

Course Code: 601MIB2102

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives

LO 1. To Understand fundamental molecular processes like replication transcription translation.

LO 2. To Understand how the cell information is changes due to chemical and physical factors.

LO 3. To Understand cell defense mechanism to recollect the correct information.

LO 4. To Understand regulatory mechanism for gene expression.

LO 5. To Understand horizontal gene transfer in microbes and its role in mapping.

Course outcomes

After completion of course the student will be able to-

CO 1. Describe protein machinery involved in basic function of cell.

CO 2. Describe various pathways of damage repair system.

CO 3.Describe importance of gene regulation.

CO 4.Describe how microbes exchange information between them.

Unit No.	Title of Unit & Contents	Hours
I	**Bacterial DNA Replication, Damage and Repair**	**12**
	1 Bacterial DNA Replication : Enzymes involved in replication. Initiation of Replication. origin and replication fork, Fidelity of replication, Extrachromosomal replicon. 2 Types of damage: Spontaneous damage, Thermal damage, Damage due to radiation, Oxidative damage, Hydrolytic damage, Alkylation, DNA damaging agents. 3 DNA repair pathways: Damage reversal, Base Excision repair, Nucleotide excision repair, Methyl directed mismatch repair, Very short patch repair, Recombination repair, SOS system.	

Unit No.	Title of Unit & Contents	Hours
	Unit Outcome: UO 1.Student will explain Bacterial DNA Replication UO 2. Student can explain DNA repair pathways.	
II	**Bacterial Transcription and Translation Process**	**12**
	1.Structure of RNA polymerase (RNAP), Transcription factors, 2. Structure and Functions of different types of RNA 3. Structure of Promoter Transcription cycle and Fidelity of transcription. 4. Structure of ribosomes, 5.Genetic code, Initiation complex, Activation and functioning of tRNA, Translation cycle, Polysomes, 6. Post-translational modifications (PTMs) and Recycling.	
	Unit Outcome: UO 1. Student will be able to explain RNA polymerase UO 2. Student will be able to describe Transcription and translation process	
III	**Regulation of Gene Expression in Bacteria**	**12**
	1. Modes of regulation of Gene Expression: Co-ordinate regulation, Auto regulation, Negative and Positive regulation, stringent response, Lac operon, Trp operon, Arabinose operon. 2.Transcriptional regulation: Regulation by repressors and activators, Alternative sigma factors, Regulation of RNAP activity, Regulation of transcription termination (regulation by attenuation). 3. Translational regulation: Regulation at the level of initiation, Elongation and Termination. 4. Regulation of gene expression in bacteriophages Introduction to Quorum-sensing Regulation of Gene Expression in bacteria.	
	Unit Outcomes: UO 1. Student will be able to Explain modes of regulation of Gene Expression in bacteria UO 2. Student will be able to Explain modes of regulation of Gene	

Unit No.	Title of Unit & Contents	Hours
	Expression in bacteriophages.	
IV	**Genetic Recombination and Mapping in Bacteria**	**09**
	1.Background and perspectives of Genetic Recombination. 2.Introduction to different types of genetic maps. 3.Molecular mechanism of gene transfer and genetic mapping by:Co-transformation in Transformation, Interrupted Mating and Time-of-Entry in Conjugation, 4. Linkage maps by breakage and re-joining in Transduction 5.Use of Transposons in Genetic Mapping.	
	Unit Outcome: UO 1. Student will be able to describe Molecular mechanism of gene transfer . UO 2. Student will be able to describe genetic mapping	

Learning Resources:

1. Gene VIII by Benjamin Lewin (2007), Oxford University Press.
2. Microbial genetics by David Freifelder (1987) Jones and Bartlett.
3. Microbial Genetics by Stanley R. Maloy, John E. Cronan, David Freifelder(1994) Jones and Bartlett Publishers.
4. Modern Microbial Genetics, 2nd Edition. Uldis N. Streips, Ronald E. Yasbin(2002), Wiley.
5. Molecular biology of the gene, 4th Edition, Vol. I, by James D. Watson, Nancy H. Hopkins, Jeffrey W. Roberts, Joan ArgetsingerSteitz and Alan M. Weiner (2005) The Benjamin/Cummings Publ. Co.
6. Molecular Genetics of Bacteria by Jeremy W. Dale, Simon F. Park (2013), John Viley& Sons, Ltd.
7. Organization of Prokaryotic Genome by Robert Charlebois (1999).
8. Recombinant DNA by James D. Watson (1992), W. H. Freeman.
9. Glossary in Biotechnology and Genetic Engineering and Biographies of Related Scientists Handbook (2008) by Shiva C. Aithal and Nikhilesh S. Kulkarni. Pub. Himalaya Publishing House, Book Edition & Year of Publication: 1st, 2008. ISBN

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Microbiology

Course Type: Lab Course

Course Title: Lab Course –VI (Based on MMC-V)

Course Code: 601MIB2104

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

Learning Objectives

LO 1. To understand Basic molecular techniques.

LO 2. To Understand isolation techniques of DNA,RNA and Plasmid.

LO 3. To Understand and design experiments to study gene expression in bacteria.

LO4. To study effect of UV radiations on the survival pattern of *E. coli* /yeast.

Course outcomes

After completion of course the student will be able to-

CO 1. Isolate DNA, RNA, and Plasmid

CO 2. Study bacterial conjugation.

CO 3. Isolate bacterial mutants.

CO 4. Demonstrate Agarose gel electrophoresis of DNA.

Practical No.	
1	Purification of chromosomal/plasmid DNA and study of DNA profile.
2	Confirmation of nucleic acid by spectral study-Quantitative estimation by diphenylamine test.DNA denaturation and determination of Tm and G+C contents. Agarose gel electrophoresis of DNA.
3	To study effect of UV radiations on the survival pattern of *E. coli* /yeast. Repair mechanisms in
4	Isolation of antibiotics resistant mutants by chemical mutagenesis.
5	Ampicillin selection method for isolation of autotrophic mutants.
6	Extraction and purification of RNA from *S. cerevisiae*.
7	Studies on gene expression in *E. coli* with reference to Lac operon.
8	Study of conjugation in *E. coli*.
9	Restriction digestion and Agarose gel electrophoresis of DNA.
10	Generalized transduction in *E. coli* using p1 phage.

Learning Resources:

1. Methods in enzymology guide to molecular cloning techniques, vol. 152 S. L. Berger. Academic press. Inc, san Diegn, 1996.
2. Molecular biotechnology (2nd edition), by S.B. Primrose, Blackwell Scientific publishers, Oxford.
3. Molecular biotechnology: principles and application of Recombinant DNA II by Bernard R. Glick and J. Pastemak, ASM publication.
4. PCR application. Protocol for functional genomics by Michael A. Innis. DavidH., Gelfand John J. Sninsky, Academic Press.
5. PCR technology- principles and application for DNA amplification by Henry A Erilch (Ed) Stockton Press. 1989.
6. Route maps in gene technology by M.R. Walker and R. Rapley, Blackwellscience, Oxford.
7. Molecular cloning by Sambrook J, Fritsch E.F and Maniatis, cold spring harbor laboratory press, New York.
8. Principles of Gene Manipulation and Genomics, Third Edition. S.B. Primrose,S.B. and R.M. Twyman, Blackwell Publishing Company, Oxford, UK. 2006.
9. Gene Cloning and DNA Analysis: An Introduction. Fifth Edition. T.A.Brown, WileyBlackwell, UK. 2006.
10. Ethics of Emerging Technologies: Scientific Facts and Moral Challenges. JohnWiley and Sons Inc. Thomas F. Budinger and Miriam D. Budinger. 2006.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Microbiology

Course Type: MMC-VI

Course Title: Microbial Diversity and Extremophiles

course code: 601MIB2103

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives

LO 1. Understand microbial habitat.

LO 2. Understand physiology of Archaea family of bacteria.

LO 3. Understand how microbes live in extreme condition.

LO 4. Understand process of isolation and use of Extremophiles microbes.

LO 5. Understand complex diversity of microbes.

Course outcomes

After completion of course the student will be able to-

CO 1.Understand and explain distribution, abundance and ecological niches of microbes, Construct, Demonstrate Phylogenetic relationship between Bacterial, Archael, Eucaryal.

CO 2. Describe primitive life form and adaptation of microbes to it.

CO 4.Describe and explain the microbial diversity present in different

CO 5.extreme environment.

CO 6. Describe distribution, abundance, classification of Extremophiles.

Unit No.	Title of Unit & Contents	Hours
I	**Biodiversity and Thermophiles**	**12**
	1. Introduction to microbial diversity, the fundamental similarity of all living things, facets of microbial diversity, Types-Bacterial, Archael, Eucaryal, Characteristics and Classification of Archae (Methanogens). 2 Classification, Hyper- thermophilic habitat and ecological aspects. Molecular basis of thermo - stability, Heat stable enzymes and metabolism, Genetics of thermophiles, Minimal complexity model systems. 3 Commercial aspects of thermophiles and application of	

	thermoenzymes.	
	Unit Outcome: UO 1. Student will describe microbial diversity UO 2. Student will explain Commercial aspects of thermophiles and application of thermoenzymes	
II	**Acidophiles and Alkalophiles**	**12**
	1.Acidophiles- Classification, life at low pH, acido - tolerance, applications. 2. Alkalophiles-Isolation, Distribution and Taxonomy. Cell structures - Flagella, Cell wall, Cell membrane. Physiology - Growth conditions, Mutants, Antiporters and alkaliphily. Intracellular enzymes. Molecular biology- Alkalophiles as DNA sources, secretion vectors, promoters. 3. Enzymes of alkaliphiles and their applications.	
	Unit Outcome: UO 1. Student will be able to describe Acidophiles UO 2. Student will be able to Enzymes of alkaliphiles and their applications.	
III	**Psychrophiles**	**12**
	1.Conditions for microbial life at low temperature Climate of snow and ice, limits for life at subzero temperature. 2. Microbial diversity at cold ecosystem – snow and glaciers ice, subglacial environments, psychropiezophiles, permafrost, anaerobic and cyanobacteria in cold ecosystem, microalgae in Polar Regions. 3.Molecular adaptations to cold habitats –Membrane components and cold sensing,cold adapted enzymes, cryoprotectants and ice binding proteins, role of exopolymers in microbial adaptations to sea ice.	
	Unit Outcomes: UO 1. Student will be able to explain Microbial diversity at cold ecosystem UO 2. Student can explain about Molecular adaptations of Psychrophiles to cold habitats	
IV	**Halophiles and Barophiles**	**09**

	1 Halophiles- Classification, Halophilicity and Osmotic protection, Hypersaline Environments, Eukaryotic and prokaryotic halophiles Halobacteria – cell wall. Membranes, compatible solutes, osmoadaptations or halotolerance, Applications of halophiles and the ir extremozymes. 2. Barophiles- Classification, high pressure habitat, life under pressure, barophily, death under pressure.	
	Unit Outcome: UO 1. Student will be able to describe Halophiles UO 2. Student will be able to describe Barophiles-	

Learning Resources:

1. Advances in applied microbiology. Vol.X, by Wayne W. Umbreit and D. Pearlman Academic Press.
2. Brock biology of Microorganisms. XI by Michael T. Madigan, John M. Martinko. Pearson Education International.
3. Extreme environment. Metabolism of microbial Adaptation by Milton R., Heinirich Academic Press.
4. Microbial ecology. Fundamental and applications by Ronald M. Atlas and Richard Bartha. II and IV edition.
5. Microbial Ecology. IInd edition by R. Campbell. Blackwell scientific publication.
6. Microbial life in extreme Environment by D.J. Kushner. Academic Press.
7. Microbiology of extreme Environment and its potentials for Biotechnology by N. S. Da Coasta, J. C. Duarata,, R.A.D. Williams. Elsisver applied science, London
8. Thermophiles. General, Molecular and applied Microbiology by Thomas D.Brock. Wiley Interscience publication.
9. Microbial ecology, Larry L. Barton and Diana E. Northup, Wiley-Blackwell.
10. Principles of microbial diversity, James W. Brown, American Society for Microbiology press.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Microbiology

Course Type: Lab Course

Course Title: Lab Course –VII (Based on MMC-VI)

Course Code: 601MIB2106

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

Learning Objectives

LO 1 . Moderately advanced skills in working with microbes such as Pathogens. Understand microbial habitat.

LO 2 . Understand how microbes live in extreme condition.

LO 3. Understand process of isolation and use of Extremophiles microbes.

Course outcomes

After completion of course the student will be able to-

CO 1. Students are enabled to isolate thermophiles, halophiles by studying different parameters.

CO 2. Isolation of thermophiles from hot water spring (Study at least one thermostable enzyme).

Practical No.	
1	Studies on halophiles isolated from high salt habitat. (Study its pigmentation and salt tolerance phenomenon).
2	Studies on alkalophiles and its enzymes (any one) isolated form extreme alkaline environment.
3	Biogenic methane production using different wastes.
4	Isolation of Thiobacillus ferrooxidans and Thiobacillus thiooxidans culture from metal sulfides, rock coal and acid mine water.

Learning Resources:

1. Microbial Ecology. IInd edition by R. Campbell. Blackwell scientific publication.
2. Microbial life in extreme Environment by D.J. Kushner. Academic Press.
3. Microbiology of extreme Environment and its potentials for Biotechnology by N. S. Da

Coasta, J. C. Duarata,, R.A.D. Williams. Elsisver applied science, London

4. Thermophiles. General, Molecular and applied Microbiology by Thomas D.Brock. Wiley Interscience publication.
5. Microbial ecology, Larry L. Barton and Diana E. Northup, Wiley-Blackwell.

Principles of microbial diversity, James W. Brown, American Society for Microbiology press.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Microbiology

Course Type: MEC II

Course Title: Ecology and environmental microbiology

Course Code: 601MIB2201

Credits: 03 **Max. Marks:75** **Lectures: 45 Hrs.**

Learning Objectives

LO 1. To understand ecosystem structure.

LO 2. To understand waste product management.

LO 3. To understand microbial minerals and heavy metal leaching.

LO4. To understand importance of global environmental change and its solutions.

Course outcomes

After completion of course the student will be able to-

CO 1. Differentiate composition and structure of environment. Sketch Food chains, Food webs and Trophic structures, Ecological pyramid.

CO 2. Appraise Need for water management, Sources of measurement of water pollution, waste types solid and liquid. Recognize & realize Waste treatments

CO 3 Able to understand and Interpret Biodeterioration of paints, paper & Leather. Collect information about Microorganisms involved in recovery of Metals and Oil.

CO 4. Express ideas about Global environmental problems, Impacts and Management.

Unit No.	Title of Unit & Contents	Hrs.
I	**Environment and Ecosystems**	**12**
	1. Definitions: biotic and abiotic environment .The microbial habitat. 2. Dispersal: Active and passive 3. Communities and ecosystems. Community succession (Pioneer, Successive, Climax), Competition as a Structuring Force in Succession ,Adaptation(Phenotypic and Genotypic) 4. Biomass and biofilms: Changes in community structure during biofilm succession,Quorum Sensing 5. Metagenomics. 6. Food chains, Food webs and Trophic structures, Ecological pyramid. 7. Primary production and energy flow : cycling of nutrients.	

	Unit Outcome: UO 1. Student will explain Communities and ecosystems UO 2. Student will explain Food chains, Food webs and Trophic structures	
II	**Waste water and Solid Waste Treatment**	**12**
	1.Need for water management. 2.Sources of water pollution. Types of waste solid and liquid. 3. Waste characterization: physical, chemical and biological. 4. Waste treatments: Primary, Secondary and tertiary treatments. 5. Aerobic –Trickling filters, oxidation ponds. 6. Anaerobic– Anaerobic digestion, anaerobic filters & up flow anaerobic sludge. 7. Effluent treatment Schemes for Dairy, Distillery, Tannery, Sugar and Paper and textile. 8. Bioconversion of solid waste & utilization as fertilizer. 9. Bioaccumulation of heavy metal ions from industrial Effluents.	
	Unit Outcome: UO 1. Student will be able to describe Need for water management. UO 2. Student will be able to explain Bioconversion of solid waste	
III	**Biodeterioration and Biotransformation**	**12**
	1. Concept of Biodeterioration. 2. Biodeterioration of paints, paper and leather. 3. Biochemistry and Microorganisms involved in recovery of Metals . 4. Microbial transformation of Mercury and Arsenic. 5. Biremidiation of of xenobiotics in the environment: hydrocarbons, substituted hydrocarbons, Oil spills ,Pesticides. 6 .Biosensors as environmental monitors.	
	Unit Outcomes: UO 1. Student will be able to Concept of Biodeterioration. UO 2. Student can explain about Biosensors as environmental monitors	
IV	**Ecology and Agricultural Microbiology**	**09**

	1.Plant growth promoting rhizobacteria(PGPR). Mechanism of plant growth promotion. 2. Effect of inoculation with PGPR on the plant soil –microbe ecosystem 3.Interactions between PGPR and other microorganisms 4. PGPR:Bacillus, Diazotrophic bacteria, Pseudomonas,Cyanobacteria ,microalgae and AM Fungi 5. Biocontrol of plant diseases by genetically modified microorganisms	
	Unit Outcome: UO 1. Student will be able to describe . Effect of inoculation with PGPR on the plant soil UO 2. Student will be able to describe Biocontrol of plant diseases	

Learning Resources:

1. A Manual of Environmental Microbiology. 2nd Edition.2001 by Christon J. Hurst (Chief Editor), ASM Publications.
2. Advances in Waste Water Treatment Technologies. 1998. Volumes II and I by R. K. Trivedy. Global Science Publication.
3. Basic Principles of Geomicrobiology by A. D. Agate, Pune.
4. Biocatalysis and Biodegradation: Microbial transformation of organic compounds. 2000 by Lawrence P. Wacekett, C. Douglas Hershberger.ASM Publications.
5. Bioremediation by Baker K.H. And Herson D.S. 1994.MacGraw Hill Inc. N.Y.
6. Chemistry and Ecotoxicology of pollution. Edited by Des. W. Connell, G.J. Miller. WileyInterscience Publications.
7. Environmental Biotechnology by C. F. Forster and D.A., John Wase. Ellis Horwood Ltd. Publication.
8. Environmental Microbiology by Ralph Mitchell. A John Wiley and Sons.Inc.
9. Pollution: Ecology and Biotreatment by EcEldowney, S. Hardman D.J. and WaiteS. 1993. - Longman Scientific Technical.
10. Waste Water Engineering - Treatment, Disposal and Re-use by Metcalf and Eddy, Inc., Tata MacGraw Hill, New Delhi.
11. Waste Water Microbiology 2nd Edition by Bitton.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Microbiology

Course Type: Lab Course

Course Title: Lab Course –VIII (Based on DSE II)

Course Code:

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

Learning Objectives

LO 1. To study microbial waste management.

LO 2. To study microbial utilization of heavy metals and complex organic compound LO 3. To learn multiple test for measure microbial activity in water.

Course outcomes

After completion of course the student will be able to-

CO 1. Students apply different test and methods for sewage treatment

CO 2. Students able to understand role of microbes in eradication of toxic substance from environment

Practical No.	Experiment
1	Physical analysis of sewage/industrial effluent by measuring total solids, total dissolved solids and total suspended solids.
2	Determination of indices of pollution by measuring: BOD/COD of different effluents.
3	Bacterial reduction of nitrate from ground waters
4	Isolation and purification of degradative plasmid of microbes growing in polluted environments.
5	Recovery of toxic metal ions of an industrial effluent by immobilized cells.
6	Utilization of microbial consortium for the treatment of solid waste [Municipal Solid Waste].
7	Biotransformation of toxic chromium (+ 6) into non-toxic (+ 3) by *Pseudomonas* species.
8	Tests for the microbial degradation products of aromatic hydrocarbons /aromatic compounds
9	Reduction of distillery spent wash (or any other industrial effluent) BOD by bacterial cultures.

10	Microbial dye decolourization/adsorption

Learning Resources:

1. Bioremediation by Baker K.H. And Herson D.S. 1994.MacGraw Hill Inc. N.Y.
2. Chemistry and Ecotoxicology of pollution. Edited by Des. W. Connell, G.J. Miller. WileyInterscience Publications.
3. Environmental Biotechnology by C. F. Forster and D.A., John Wase. Ellis Horwood Ltd. Publication.
4. Environmental Microbiology by Ralph Mitchell. A John Wiley and Sons.Inc.
5. Pollution: Ecology and Biotreatment by EcEldowney, S. Hardman D.J. and WaiteS. 1993. - Longman Scientific Technical.
6. Waste Water Engineering - Treatment, Disposal and Re-use by Metcalf and Eddy, Inc., Tata MacGraw Hill, New Delhi.
7. Waste Water Microbiology 2nd Edition by Bitton.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

PG 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 Tutorial 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			
Research Methodology	100	10	10	20	10	-	-	40	60	100
DSC/DSE	75	05	10	15	10	-	-	30	45	75
Lab Course	50	-	-	-	-	05	20	-	25	50
Field Project	100	10	10	20	10	-	-	40	60	100

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.