Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Structure and Curriculum of Two-Year Degree Programme

Postgraduate Programme of Science and Technology

M.Sc. in Microbiology

Approved by

Board of Studies in Microbiology

Rajarshi Shahu Mahavidyalaya, Latur

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w.e.f. June, 2023

(In Accordance with NEP-2020)

Academic Year: 2023-24

Review Statement

The NEP CELL reviewed the Curriculum of **M.Sc. in Microbiology** Programme to be effective from the **Academic Year 2023-24.** It was found that, the structure is as per the NEP-2020 guidelines of Govt. of Maharashtra.

Date: 09/08/2023

Place: Latur

NEP CELL
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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: 14/07/2023

Place: Latur

(Dr. K.G. Maske)
Chairperson
Board of Studies in Microbiology
Rajarshi Shahu Mahavidyalaya, Latur
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Members of Board of Studies in the Subject Microbiology

Sr. No.	Name	Designation	In position
1	**Dr.K.G.Maske** 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. U. 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 M. S. Dharane** Sr.Scientist, Division of Biochemical Sciences,Dr. Homi Babha Road,Pashan, NCL, Pune	Member	P.G. Alumni
8	**Dr.D.V.Vedpathak**	Member	Faculty Member
9	**Dr.K.I.Momin**	Member	Member from same Faculty

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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

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Department of Microbiology

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Department of Microbiology

PG Skeleton in Accordance with NEP-2020

Illustrative Credit Distribution Structure for Two Year M.Sc. Degree

Year Level	Sem	Major		Lab Course	RM	OJT/FP	RP	Cum. Cr	Marks	Degree
		Mandatory	**Elective**		RMC 4Cr	NA	NA	**20Cr**	Theory: 1Cr=25M Lab Course: 1Cr=50M	**PG Diploma (After 03 Year B.Sc. Degree)**
I 6.0	**I**	Major I 3Cr Major II 3Cr Major III 3Cr	MEC I 3Cr	LC-I 1Cr LC-II 1Cr LC-III 1Cr LC-IV 1Cr						
	II	Major IV 3Cr Major V 3Cr Major 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	**Major 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**	Major VII 3Cr Major VIII 3Cr Major 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 B.Sc. Degree)**
	IV	Major X 3Cr Major XI 3Cr Major XII 3Cr	MEC IV 3Cr	LC-XIII 1Cr LC-XIV 1Cr LC-XV 1Cr LC-XVI 1Cr	NA	NA	RP-II 6Cr	**22Cr**		
	Total	**Major 18Cr**	**MEC 06Cr**	**LC-8Cr**	**NA**	**NA**	**RP 10 Cr**	**42Cr**		
Cum. Total of I & II Year		**Major 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									

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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

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Faculty of Science

Department of Microbiology

M.Sc. in Microbiology

Year & Level	Semester	Course Code	Course Title	Credits	No. of Hrs.
I 6.0	I	601MIB1101 MMC-I	Microbial Physiology	04	60
		601MIB1104	Lab Course-I	01	30
		601MIB1102 MMC-II	Enzyme Technology	04	60
		601MIB1105	Lab Course-II	01	30
		601MIB1103 MMC-III	Food and Dairy Microbiology	04	60
		601MIB1106	Lab Course-III	01	30
		601MIB1201 MEC-I (A) OR 601MIB1202 MEC-I(B)	Advances in Virology OR Microbial Nanotechnology	04	60
		601MIB1203 OR 601MIB1204	Lab Course-IV OR Lab Course-V	01	30
		601MIB1301 RMC	Research Methodology	04	60
	Total Credits			**20**	
	II	601MIB2101 MMC-IV	Microbial Metabolism	04	60
		601MIB2104	Lab Course-VI	01	30
		601MIB2102 MMC-V	Microbial Genetics	04	60
		601MIB2105	Lab Course-VII	01	30
		601MIB2103 MMC-VI	Microbial Diversity and Extremophiles	04	60

		601MIB2106	Lab Course-VIII	01	30
		601MIB2201 MEC-II (A) OR 601MIB2202 MEC-II(B)	Ecology and Environmental Microbiology OR Applied Mycology and phycology	04	60
		601MIB2203 OR 601MIB2204	Lab Course-IX OR Lab Course-X	01	30
		601MIB2401 FP-I	Field Project	04	60
	Total Credits			**20**	
Total Credits (Semester I & II)				**40**	

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Programme Outcomes (POs) for M.Sc. Programme	
After the completion of the M.Sc. programme, a student will have obtained:	
PO1	**Disciplinary Masters Knowledge**Comprehensive in-depth relevant scientific knowledge and its execution in the specific area of study.
PO2	**Scientific Outlook** The qualities such as observation, precision, analysis, logical thinking, clarity of thought and expression and systematic approach to work on research projects and explain scientific phenomena
PO3	**Problem Solving Skills** Analytical skills to solve problems, evaluate situations and act responsibly to communicate, cooperate and lead the team.
PO4	**Interpersonal Skills and Ethics** Ability to integrate professional ethics and scientific knowledge in life, organization, society and individual to fulfill the needs of mankind in both moral and material aspects.
PO5	**Self-Directed Life-long Learning** Ability to prepare for NET, SET, GATE and other national and international competitive examinations.
PO6	**Professional Competence** Ability to apply the knowledge independently for continuous personal and professional development and identify business opportunities and initiate action to achieve it.
PO7	**Research and Related Skills** Technical know-how about identification of local issues and develop lab to land solutions for the benefit of society at large.

Programme Specific Outcomes (PSOs) M.Sc. in Microbiology	
PSO No.	After the completion of the M.Sc. Microbiology, a student will have obtained:
PSO1	**Academic Competence:** In-depth knowledge in Advanced Virology, Microbiology in Food and Dairy, Bioinstrumentation Microbial Genetics and Metabolism, Enzymology , Bioprocess Engineering, Immunology, Advanced Molecular Biology, Microbial Diversity And Extremophiles, Quantitative Biology, Fermentation Technology, Medical and Pharmaceutical Microbiology, Ecology and Environmental Microbiology and Microbial Bioinformatics, Genomics and Proteomics
PSO2	**Scientific Outlook** Aptitude to address the increasing need for skilled scientific manpower with an understanding of research ethics in Microbial science. Apply the scientific temperament analyzing microorganisms to contribute to application, advancement and impartment of knowledge in the field of microbiology and molecular biology globally.
PSO3	**Personal and Professional Competence** Capability to empower himself/herself with laboratory training to prepare for careers in broad range of Microbial science fields. Ability to analyse samples and data obtained from experiments, field visits, projects, survey and will make scientific draft/report for solving problems.
PSO4	**Entrepreneurial Competence** Skillfulness to start their own labs to serve in the field of Medical science. Apply knowledge of Microbiology to enter in start-up of Food Processing and Bakery Products and related industries and occupation. They will exhibit self-learning, discipline and logical approach.
PSO5	**Research Competence:** An ability to assess and identify research problem using Microbial techniques and instrumentation and with the help of integrated knowledge do the experiments, interpret the data and findings and provide valid conclusion.

Semester - First

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Course Type: MMC-I
Course Title: Microbial Physiology
Course Code: 601MIB1101

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

Learning Objectives:

LO 1. To understand Metabolic diversity, phototrophy and chemolithotrophy
LO 2.To understand Bacterial respiration, electron transport chain and modes of energy generation.
LO 3. To understand structure and organization of membrane and permeation
LO 4. To understand bacterial sporulation

Course Outcomes:

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

CO 1.Describe and compare chemolithotrophic and phototrophic bacteria.

CO 2.Explain in depth principle and mechanism of aerobic and anaerobic respiration in microorganisms.

CO 3.Describe methods to study diffusion of solutes in bacteria.

CO 4.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 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.	
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.	

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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.
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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.

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Department of Microbiology

Course Type: Lab Course
Course Title: Lab Course –I (Based on MMC-I)
Course Code: 601MIB1104
Credits: 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO 1. To study cultivation of phototropic bacteria
LO 2. To understand uptake of nutrients in Bacteria.
LO 3. To study sporulation and effect of environmental factors on spore germination in Bacillus sp.
LO 4. To learn methods for cultivation of Chemolithotrophs.

Course Outcomes:

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.*
CO 4. Design experiment to study effect of different environmental factors on spore germination of *Bacillus* sp

Practical No.	Experiment
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.

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Department of Microbiology

Course Type: MMC-II
Course Title: Enzyme Technology
Course Code: 601MIB1102
Credits: 03 **Max. Marks: 75** **Lectures: 45Hrs.**

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 enzyme inhibition and kinetics

Course Outcomes:

After completion of the 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	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. UO 2. Student can explain enzyme modification.	
II	**Enzyme Kinetics and Enzyme Inhibition**	**12**

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Unit No.	Title of Unit & Contents	Hours
	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. 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	

Unit No.	Title of Unit & Contents	Hours
	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. John Wiley and Sons, New York.
5. Methods of Enzymatic Analysis by Hans Ulrich. Bergmeyer, Academic Press.
6. Methods in enzymology by W. A. A Wood. Academic Press.
7. Advances in enzymology by Alton Meister, Interscience Publishers.
8. Topics in enzymes and fermentation biotechnology by L.N.Weiseman, John Wiley and Sons.
9. Understanding enzymes by T. Palmer.
10. Enzymes by Dixon and Webb. Academic Press.
11. Enzyme kinetics by Segel, Academic press

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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 Wiley and Sond Inc., New York.
3. Biotechnology, volume 7 A- enzymes in biotechnology 1983 Edited by H.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

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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
LO 4. 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	

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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 –III (Based on MMC-III)
Course Code: 601MIB1101
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 and 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

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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 the pathogenesis of viral infections , prevention and control of viral diseases

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.

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.	

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	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

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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).

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Department of Microbiology

Course Type: MEC-II

Course Title: Microbial Nanotechnology

Course Code: 601MIB1202

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

Learning Objectives:

LO1. Explain basic of Microbial Nanotechnology like History, applications, Terminologies etc.
LO2. Differentiate between physical, chemical, and biological methods used for synthesizing nanoparticles.
LO3. Explain the process of biosynthesis of nanoparticles by various groups of microorganisms.

Course Outcomes:

After completion of course the student will be able to-

CO1. Understand the historical development of Microbial nanotechnology and its applications in various fields.
CO2. Define and explain the terminologies related to Microbial nanotechnology, such as nanoparticles, biogenic nanoparticles, nanowires, thin films, nanomedicine, quantum dots, nanocomposites, nanopores, and nanospheres.
CO3. Identify colloidal nanostructures and provide examples of nanostructures found in nature After completion of this course, the students will be able to –
CO4. Understand the microbial nanotechnology
CO5. Understand the nano-particle synthesis
CO6. 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 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.	

Unit No.	Title of Unit & Contents	Hrs.
	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 nonmaterial 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	
IV	**Unit IV: Applications of nanoparticles in biology**	**09**

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Unit No.	Title of Unit & Contents	Hrs.
	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.

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Department of Microbiology

Course Type: Lab Course
Course Title: Lab Course- IV (Based on MSE-II)
Course Code: 601MIB1204
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 immunoglobulin & 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

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Semester - Second

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Department of Microbiology

Course Type: MMC-IV
Course Title: Microbial Metabolism
Course Code: 101MIB2101
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 ToUnderstand 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 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,	

Unit No.	Title of Unit & Contents	Hrs
	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- histidine synthesis. 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. 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:

1 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

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VerlagNew York Inc.
5 Bacterial metabolism by H. W. Doelle (Second edition), (2005), Academic press, Inc.
6 Biochemistry, Seventh Edition by Jeremy M. Berg, John L. Tymoczko and LubertStryer (Dec 24, 2010), W.H. Freeman & Company.
7 Chemolithoautotrophic bacteria: Biochemistry and environmental biology by TateoYamanaka, (Jan. 2008). Springer.
8 Lehninger: Principles of Biochemistry by Albert L. Lehninger, Michael Cox and DavidL. Nelson (4 May 2004), W. H. Freeman.
9 Microbial Biochemistry (Second Edition) by G.N. Cohen, (2011) Springer Dordrecht Heidelberg London New York.
10 Segel Irvin H. (1997) Biochemical Calculations 2nd Ed., John Wiley and Sons, New York 11.Garrett, R. H. and Grisham, C. M. (2004) Biochemistry. 3rd Ed. Brooks/Cole, Publishing Company, California.

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

Course outcomes

After completion of course the student will be able to-

CO 1. Explain types of reserve food material
CO 2. Estimate Biomolecules
CO 3. Determine Membrane composition
CO 4.Isolate Microbes involved in hydrocarbon degradation.

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

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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 Outcome: UO 1.Student will explain Bacterial DNA Replication UO 2. Student can explain DNA repair pathways.	
II	**Bacterial Transcription and Translation Process**	12

Unit No.	Title of Unit & Contents	Hours
	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 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.	

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Unit No.	Title of Unit & Contents	Hours
	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 No.: 971-81-8318-832-6

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Course Type: Lab Course
Course Title: Lab Course –VI (Based on MMC-V)
Course Code: 601MIB2105
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.

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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 Scientificpublishers, Oxford.
3. Molecular biotechnology: principles and application of Recombinant DNA II byBernard R. Glick and J. Pastemak, ASM publication.
4. PCR application. Protocol for functional genomics by Michael A. Innis. David H., Gelfand John J. Sninsky, Academic Press.
5. PCR technology- principles and application for DNA amplification by Henry AErilch (Ed) Stockton Press. 1989.
6. Route maps in gene technology by M.R. Walker and R. Rapley, Blackwell science, Oxford.
7. Molecular cloning by Sambrook J, Fritsch E.F and Maniatis, cold spring harborlaboratory 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.

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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, barophiles, 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.

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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.

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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 thermo stable 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.

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Course Type: MEC II (A)

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
CO3. Able to understand and interpret Biodeterioration of paints, paper & Leather.
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	

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	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.

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Department of Microbiology

Course Type: Lab Course

Course Title: Lab Course –VIII ,Based on MEC II (A)

Course Code: 601MIB2203

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 to 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.

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Department of Microbiology

Course Type: MEC II (B)

Course Title: Applied Mycology and Phycology

Course Code: 601MIB2202

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

Learning Objectives

LO1. To understand the applied Phycology
LO 2.To study general characters, occurrence and distribution of algae and fungi in nature.
LO 3.To study Importance of algae and Lichens
LO 4.To Understand the Mycology and its applications.

Course outcomes

After successful completion of course students are able to

CO 1.Describe in detail general characters , occurrence and distribution and importance algae
CO 2.Describe in detail general characters, occurrence and distribution of fungi in nature.
CO 3. Explain Lichens and Mycorrhiza
CO 4.Apply knowledge for solving environmental problems

Unit No.	Title of Unit & Contents	Hrs.
I	**Phycology**	**12**
	1. Algae: Introduction of Algae, Occurrence and distribution. 2. Thallus structure, characteristics, nutrition, classification and reproduction. 3. Brief account of Chlorophyta, Bacillariophyta; Phaeophyta; Rhodophyta; Algal ecology 4. and algal biotechnology. 5. Algae as pollution indicators and eutrophication agent . 6. Role of algae in bioremediation. 7. Role of algae in global warming and environmental sustainability. 8. biofertilizer cyanobacteria and selected microalgae in agriculture- biofertilizer and algalization, 9. Importance of algae in production of algal pigments, biofuels, hydrogen production, important bioactive molecule.	
	Unit Outcomes: UO 1.	
II	**Mycology**	**12**
	1. Fungi: Introduction of fungi ,Occurrence and distribution, somatic structure, hyphal growth, nutrition, heterothallism,	

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Unit No.	Title of Unit & Contents	Hrs.
	physiological specialization in fungi, 2. Fungi and ecosystem; saprophytic parasitic, mutualistic and symbiotic relationship with plants and animals. Classification of fungi. 3. Reproduction in fungi: asexual, sexual and parasexual. 4. Study of the different classes of Fungi with reference to occurrence, somatic structure and life cycle and economic importance representing the following genera: Acrasiomycetes (*Dictyosteluim*), Myxomycetes (Endosporus and exosporus), Chytridiomycetes (*Neocallimastrix*), Oomycetes (*Phytopthora*), Zygomycetes (*Rhizopus*), Ascomycotina (Hemiascomycetes- *Saccharomyces,* Plectomycetes - *Penicillium*	
	Unit Outcome: UO 1.	
III	**Importance of fungi**	**12**
	1. Fungi in Industry: Production of alcohol and organic acids. 2. Fungi in Medicine: Types of metabolites used in medicine and production of antibiotics. 3. Fungi in Agriculture and Forestry. Fungi as biopesticides: mycofungicides, weedicides, and insecticides. 4. Fungi as human and animal parasites (medical mycology) 5. Fungi as food: Mushrooms: Types of mushrooms, biology and growth of mushrooms, nutritional and medicinal value of edible mushrooms; Fungal protein (Yeast and Fusarium).	
	Unit Outcome: UO 1.	
IV	**Lichens and Mycorrhiza**	**09**
	1. Lichens: ascolichens, basidiolichens, deuterolichens. 2. Mycorrhiza: ecto-, endo-, ectendo-VAM. 3. Fungi as insect symbionts. 4. Fungi as bio control agents, attack of fungi on other microorganisms. 5. Potential application in Agriculture, environment, industry, food. 6. Role of fungi in Bio deterioration of wood, paper, textile. Myxotoxins, quorum sensing in fungi.	

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Unit No.	Title of Unit & Contents	Hrs.
	Unit Outcome: UO 1.	

1. Alexopoulos, C.J. and C.W. Mims 1979. Introduction to Mycology (3rd Ed.)
2. Wiley Eastern Ltd., New Del
3. Charlile M. & Watkinson S.C. The Fungi, Publisher: Academic Press.
4. E.Moore –Landeekeer: Fundamentals of the fungi, Publisher: Prentice Hall.
5. L. Barsanti, Paolo Gualtieri: Algae: anatomy, biochemistry, and biotechnology
6. Ayhan Demirbas, M. Fatih Demirbas: Algae Energy: Algae as a New Source of Biodiesel (2010)
7. Linda E. Graham, James Graham, James M. Graham: Algae (2009)
8. Burnett J.H., Publisher: Edward, Arnold Crane Russak: Fundamentals of Mycology.
9. Topley And Wilson's Microbiology And Microbial Infections by Collier, Balows, Sussman. Edward Arnold.
10. Constantine J. Alexopoulos,Introductory Mycology.
11. JagdishChander ,Text Book of Medical Mycology JagdishChander, Mehta Publishers, New Delhi .
12. Mehrotra ,An Introduction to mycology by New Age International

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Department of Microbiology

Course Type: Lab Course

Course Title: Lab Course –VIII (Based on MSE II (B)

Course Code: 601MIB2204

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

Learning Objectives

LO 1. To understand isolation techniques used for fungi.
LO 2.To study of isolation and identification of algae and fungi
LO 3.To study production of enzyme and organic acids using
LO 4.To study production of industrially important enzymes and organic acids.

Course outcomes

After completion of course the student will be able to-

CO 1. Demonstrate techniques for observation of fungi and algae
CO 2. Design experiment for production of industrially important enzymes and organic acids using fungi.
CO 3. Demonstrate techniques for cultivation of algae.
CO 4. Design experiment for production of SCP.

Practical No.	Experiment
1	Isolation and identification of fungi from different sources .
2	Production of enzyme , fungal amylase using submerged and solid state fermentation.
3	Production of organic acids using fungi.
4	Collection and study of basidiomycetous fungi
5	Study and culturing of yeasts.
6	study yeast dimorphism, Isolation and identification of algae from different habitats,
7	Culturing of algae under lab conditions,
8	Study hydrogen and bioethanol production by algae,
9	Algae as a source of SCP
10	Study pollution control by algae

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References

1. Bisen P.S., Varma K.: Handbook of Microbiology CBS Publishers and Distributors, Delhi. Amita
2. Biswas S.B Biswas ,Introduction to viruses: Vikas Publishing House Pvt. Ltd., New Delhi.
3. Dubey H.C.:A textbook of fungi and Viruses, Vikas Publishing House Pvt. Ltd. Delhi.
4. Dubey R.C. and D.K,Maheshwary, A textbook of Microbiology S Chand and Co. New Delhi.
5. Frobisher, Hinsdill, Crabtee, Goodheart: Fundamentals of microbiology: W.B. Saundrs Company,
6. U.S.A. Toppan Company Ltd., Japan.
7. Salvador Edward Luria, James E. Darnell, Jr., David Baltimore, Allan Campbell Luria: General Virology, Wiley.
8. Modi H.A.: Elementary Microbiology (Fundamentals of Microbiology) Vol. II Ekta Prakashan, Nadiad, Gujrat.
9. Parasher Y.K.: Modern Microbiology : Campus Books International: New Delhi
10. Pelczar Michael J., Jr./E.C.S Chan, Elements of Microbiology: McGraw, Hill International Book Company, New Delhi.

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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.

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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.

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Semester End Examination Paper Pattern

Pattern - I

Course : Theory **Max. Marks : 45** **Time: 2 Hrs**

Q.1 **Answer the following questions (3 Marks each)** **12 Marks**

a) Based on Unit - I

b) Based on Unit - II

c) Based on Unit - III

d) Based on Unit - IV

Q.2 **Answer any THREE of the following (5 Marks each)** **15 Marks**

a) Based on Unit - I

b) Based on Unit - II

c) Based on Unit - III

d) Based on Unit - IV

Q.3 **Answer any ONE of the following** **08 Marks**

a) Based on Unit – I

b) Based on Unit – II

Q.4 **Answer any ONE of the following** **10 Marks**

a) Based on Unit - III

b) Based on Unit – IV

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Semester End Examination Paper Pattern

Pattern - I

Course : Theory **Max. Marks : 60** **Time: 2.30 Hrs**

Q.1 **Answer the following questions (4 Marks each)** **16 Marks**

a) Based on Unit - I

b) Based on Unit - II

c) Based on Unit - III

d) Based on Unit - IV

Q.2 **Answer any THREE of the following (6 Marks each)** **18 Marks**

a) Based on Unit - I

b) Based on Unit - II

c) Based on Unit - III

d) Based on Unit - IV

Q.3 **Answer any TWO of the following** **(8 Marks each)** **16 Marks**

(Based on any two Units)

a)

b)

c)

Q.4 **Answer any ONE of the following** **10 Marks**

(Based on remaining two Units)

a)

b)

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Semester End Examination Paper Pattern

Pattern - I

Course : Numerical **Max. Marks : 60** **Time: 2.30 Hrs**

Q.1 **Answer the following questions (4 Marks each)** **16 Marks**

a) Based on Unit - I

b) Based on Unit - II

c) Based on Unit - III

d) Based on Unit - IV

Q.2 **Answer any TWO of the following (9 Marks each)** **18 Marks**

(Based on any two units)

a)

b)

c)

Q.3 **Answer any ONE of the following** **16 Marks**

(Based on remaining two units)

a)

b)

c)

Q.4 **Answer any ONE of the following** **10 Marks**

(On any Unit)

a)

b)

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