Dr. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD

CIRCULAR NO.SU/Sci. & Tech./Colleges./NEP/16/2023

It is hereby inform to all concerned that, the syllabi prepared by the Board of Studies & Ad-hoc Boards and recommended by the Dean, Faculty of Science & Technology, the Hon'ble Vice-Chancellor has accepted **the following curriculum of All Post Graduate Degree Courses as per Norms of National Education Policy – 2020 under the Faculty of Science & Technology run to the Affiliated Colleges, Dr.Babasaheb Ambedkar Marathwada University** in his emergency powers under section 12(7) of the Maharashtra Public Universities Act, 2016 on behalf of the Academic Council as appended herewith.

Sr.No.	Syllabi of Affiliated BAMU, Aurangabad.	Semester
1.	M.Sc.Zoology	Ist and IInd Semester
2.	M.Sc.Microbiology	Ist and IInd Semester
3.	M.A/M.Sc.Mathematics	Ist and IInd Semester
4.	M.Sc.Geology	Ist and IInd Semester
5.	M.Sc.Biophysics	Ist and IInd Semester
6.	M.Sc.Bioinformatics	Ist and IInd Semester
7	M.Sc. Information Technology	Ist to IVth Semester
8.	M.Sc.Computer Science	Ist to IVth Semester
9.	M.Sc.Botany	Ist and IInd Semester
10.	M.Sc.Enviornmental Science	Ist and IInd Semester

This is effective from the Academic Year 2023-24 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.
REF.NO.SU/NEP/2023/ 8752-60
Date:- 08.08.2023.

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Deputy Registrar,
Academic Section

Copy forwarded with compliments to :-

1] **The Principal of all concerned affiliated Colleges, Dr. Babasaheb Ambedkar Marathwada University,.**
2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

Copy to :-

1] The Director, Board of Examinations & Evaluation, Dr.BAMU,A'bad.

2] The Section Officer,[M.Sc.Unit] Examination Branch,Dr.BAMU,A'bad.
3] The Programmer [Computer Unit-1] Examinations, Dr.BAMU,A'bad.
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DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD

FACULTY OF SCIENCE & TECHNOLOGY

2 Year P.G. Programme in Science (M.Sc.)

As per National Education Policy-2020

(To be implemented from academic year 2023-24)

Course Structure and Curriculum

(Affiliated Colleges)

(Outcome based credit System)

SUBJECT: MICROBIOLOGY

INDEX

Preamble

National Education Policy (NEP) 2020 envisages Higher education plays an extremely important role in promoting human as well as societal wellbeing and in developing India. It expects that higher education must enable individual to study one or more specialized areas of interest at a deep level. The NEP also expects that higher education must prepare students for more meaningful and satisfying lives and work roles and enable economic independence. In view of this the new M.Sc. Microbiology program offered by the Dr. Babasaheb Ambedkar Marathwada University has been prepared as per the Credit Framework guidelines of National Education Policy (NEP) 2020.

This M.Sc. (Microbiology) Programme is of four semester, two years duration. These two years are divided into four semesters with the provision for exit at the end of first year. The evaluation of candidates will be done through various examinations under grade system during and at the end of each semester separately for theory and practical papers as per the credits offered for each course.

The M.Sc. (Microbiology) Programme is of total 88 credits, with 22 credits for each semester. Each semester is having three Discipline Specific Core (DSC) major courses along with their respective practical courses. Students have to choose one Discipline Specific Elective (DSE) along with its practical per semester from the list of Elective Course provided in pool/ basket. There will be a course related to skill or advanced technology in all these four semesters. Besides this there will be a course related to Research Methodology in First Semester. There will be separate credits for course related to On Job Training in second semester that can be completed by students in vacation period. Along with this there shall be course, Research Project RP-1 and RP-2 to be completed in III and IV Semester. The M.Sc. Microbiology programme shall include various learning activities viz., assignment, student seminar, group discussion, research paper reading and presentation. Students will be evaluated through Continuous Assessment (CA) and Semester End Examination (SEE). The Departmental Committee will develop the framework for research projects/dissertations and will be applicable to the course.

The M. Sc. Microbiology programme will enable students to develop deep level understanding to acquire ability to apply the process of science by formulating hypotheses and design experiments based on the scientific method. Student will be able to analyse and interpret results from a variety of microbiological experiments. They will be able to use quantitative reasoning by using mathematical calculations to solve problems in microbiology. Along with this the program aim to inculcate effective communication and collaboration skills with other disciplines.

More importantly it will result in developing understanding the relationship between science and society by recognizing and discussing logical, scientific and ethical issues in microbiology. The expected outcome of the program will be developing skilled persons with ability to pursue careers in the industry and applied research where microbial systems are increasingly used. The following pages of this document provide the structural framework, teaching scheme, evaluation schemes and the detailed contents of the syllabus.

ORDINANCE AND REGULATIONS:

- **Ordinance:**

➢ Any person with Bachelor's degree in Science from this University or the degree from any other statutory University recognized as equivalent shall be eligible for admission to the degree of Master of Science (M. Sc.) in Microbiology

➢ A student shall be held eligible for admission to the M. Sc. Microbiology Course provided she/he has passed the degree examination with Microbiology as a principal subject or with a Microbiology equivalent to all semesters.

- **Regulation:**

➢ As per NEP 2020 the M. Sc. degree will be awarded only after successful completion of written and practical university examinations.

➢ The entire course of M. Sc. shall be of 84 credits (2100 marks) for Theory + Practical. There shall be internal evaluation of 40% for theory papers.

➢ The theory examination shall be split up into four semesters.

➢ The commencement and conclusion of each semester shall be notified by the University from time to time.

➢ There shall be a University examination for theory at the end of each semester whereas there will be annual practical exam at the end of each year. The evaluation of examinations will be done by internal and external examiners.

➢ In each semester there shall be three theory major core papers and three practical based on core courses along with one elective theory and practical based on elective course

➢ There shall be mandatory on job training, Research methodology and Research project.

Infrastructure, instrumental library & other facilities required for M. Sc. Course in Microbiology (for 25 students intake capacity).

1. Two laboratories (for Part I and Part II) each measuring at least 1000 Sq. Ft. with sufficient number of tables and stools. Lab should be provided with basic Instruments such as autoclave, incubator, oven, pH meter, hot plate, cyclo mixers, water bath shakers, colorimeter, fridge, distillation plant etc.

2. A culture room with a laminar air flow measuring 300 Sq. Ft.

3. An Instrumentation Room with Double door, Air Conditioner for sophisticated Instruments measuring 500 Sq. Ft.

4. Two Lecture halls (for Part I and Part II) with Overhead projector facility and measuring 400 Sq. Ft. with tables and chairs.

5. A media preparation and a store room at least 400 Sq. Ft.

6. A computer Laboratory with 4 – 5 computers with printer and internet facility.

LIST OF BASIC INSTRUMENTS REQUIRED FOR M. Sc. PRACTICALS

1. Laminar Air Flow.
2. Compound Microscope
3. Autoclave
4. Incubators
5. Hot Air Oven.
6. BOD Incubators
7. pH Meter
8. Water Bath Incubator Shaker
9. Colorimeter
10. Spectrophotometer
11. Hot Plate.
12. Electrophoretic Apparatus
13. Orbital Incubator Shaker
14. High Speed Centrifuge - (10000 RPM)
15. Distillation Apparatus (Single & Double)
16. Refrigerators
17. Paper Chromatography Cabinet
18. Weighing Balances
19. Bacterial Filter Assembly
20. General Purpose Centrifuge.
21. Vortex Mixers
22. Magnetic Stirrers
23. UV Cabinet
24. TLC Apparatus
25. Water Bath Shakers
26. Rotary Shaker
27. Columns for Chromatography
28. Fraction Collector
29. Distillation Apparatus

OTHER REQUIREMENTS

The department should have required chemicals, dehydrated media, stains, acids, Solvents, fine chemicals, enzymes, anti-sera immunodiagnostic kits, and Specific microbial cultures with known genetic markers and glass-wares to implement and conduct the prescribed syllabus.

LIBRARY FACILITY

The library should have ample no of prescribed text books, reference books recommended in the prescribed syllabus and the library should also subscribe National and International and Scientific Magazines.

INSTRUCTIONS

1. M.Sc. Course of Microbiology is divided into four semesters.
2. Each Semester will have core theory, core practical papers and elective theory and practical.
3. The department should complete a minimum of 80% practicals of each paper.
4. Theory of one credit paper will have 1 lecture each of 1 hr and practical will have 2 hrs duration per week
5. There should be regular seminars and tutorials on immerging topics of subject concerned for students.

Vision

To provide quality education and training in Microbiology, fostering innovation, excellence, and cutting-edge research in the field, while producing skilled professionals who contribute to advancements in healthcare and environmental sustainability. Make them enable to contribute to science in general and nation economy in particular.

Mission

- To impart knowledge and microbiology skill for making student ready for future,
- To develop the attitude of analytical thinking in students through various activities throughout the programme, such as seminar, group discussion, blended learning, research projects and practical.
- To provide a comprehensive and rigorous education in Microbiology, equipping students with a deep understanding of microbial life, its interactions, and applications. Through state-of-the-art research, interdisciplinary collaborations, and experiential learning, to cultivate a community of scientists capable of addressing global challenges, promoting scientific discovery, and improving the quality of life through microbiological advancements.

To implement revised National Education Policy, and make systematic arrangements for learning and create learner friendly environment so that students will develop knowledge, skills and confidence to work for various organizations and for self-employment in this competitive world.

Program Outcomes (PO)

On completion of program students will be able to

1. Acquire ability to apply the process of science by formulating hypotheses and design experiments based on the scientific method.
2. Analyse and interpret results from a variety of microbiological experiments
3. Use quantitative reasoning by using mathematical calculations to solve problems in microbiology.
4. Communicate and collaborate with other disciplines effectively
5. Identify credible scientific sources to interpret and evaluate the evidences
6. Understand the relationship between science and society by recognizing and discussing logical, scientific and ethical issues in microbiology.
7. Exhibit ability to pursue careers in the industry and applied research where microbial systems are increasingly employed.

Program specific outcomes (PSO)

On completion of program students will be specifically able to

1. Prepare and view specimens for examination using light microscopy
2. Apply techniques to isolate, identify and maintain microorganisms.
3. Enumerate microorganisms from various samples
4. Independently handle microbiological equipment and methods.
5. Exercise Safe microbiology practices.
6. Plan, design, execute experiments and interpret, document and present findings.

Class: M.Sc. First Year Semester: First Semester Subject: MICROBIOLOGY

Course Code	Course Title	Teaching Scheme (Hrs./ Week)	Credits Assigned	Nature Of Course	Mode Of Instruction
I SEMESTER					
MIC-AC/MJ/500 T	General Microbiology and Microbial Diversity	**2**	**2**	Core/Mandatory	Theory
MIC-AC/MJ/501 T	Bioenergetics and Enzymology	**2**	**2**	Core/Mandatory	Theory
MIC-AC/MJ/502 T	Techniques in Microbiology	**2**	**2**	Core/Mandatory	Theory
MIC-AC/MJ/503	Basic Biostatistics	**4**	**2**	Core/Mandatory	Practical/Lab work
MIC-AC/MJ/500 P	Lab Course Based On MIC-AC/MJ/500 T	**4**	**2**	Core/Mandatory	Practical/Lab work
MIC-AC/MJ/501 P	Lab Course Based On MIC-AC/MJ/501 T	**4**	**2**	Core/Mandatory	Practical/Lab work
MIC-AC/MJ/502 P	Lab Course Based On MIC-AC/MJ/502 T	**4**	**2**	Core/Mandatory	Practical/Lab work
MIC-AC/DSE/504 A/B/C	A-Microbial Taxonomy	**2**	**2**	DSE/ELECTIVE	Theory
Any amongst the list	B-Biological Database Systems			DSE/ELECTIVE	Theory
	A Or B	**4**	**2**	DSE/ELECTIVE	Practical
	C-any Online certification course from NPTEL /SWAYM /MOOC of equivalent credits { with biology basis }	**4**	**4**	DSE/ELECTIVE	(IN CASE OF MOOC / NPTEL COURSE, RULES OF COURSE CONDUCTING AGENCY WILL BE BINDING)
MIC-AC/RM/505	Research Methodology	**4**	**4**	RESEARCH METHODS/ Mandatory	Theory

Class: M.Sc. First Year: MICROBIOLOGY
First Semester: (Choose any one from the pool of courses) - ***DSC-Based on specialisation**
1. **MIC-AC/MJ/500 T :** General Microbiology and Microbial Diversity

MIC-AC/MJ/500 P : General Microbiology and Microbial Diversity (Practical)
MIC-AC/MJ/501 T : Bioenergetics and Enzymology
MIC-AC/MJ/501 P: Bioenergetics and Enzymology (Practical)
MIC-AC/MJ/502 T: Microbial techniques
MIC-AC/MJ/501 P: Microbial techniques (Practical)
MIC-AC/MJ/503 : Basic Biostatistics
2. **MIC-AC/DSE/504** (T/P): (Choose any one from Pool /Basket)

A: Microbial Taxonomy (Theory 3 Cr. + Practical 1 Cr.)
B: Biological Databases System (Theory 3 Cr. + Practical 1 Cr.)
C: Any Online certification course from NPTEL /SWAYM /MOOC of equivalent credits {with biology basis}
3. **MIC-AC/RM/505** Research Methodology in Microbiology (4 Cr.)

Class: M.Sc. First Year Semester: Second Semester Subject: MICROBIOLOGY

Course Code	Course Title	Teaching Scheme (Hrs./ Week)	Credits Assigned	Nature Of Course	Mode Of Instruction
II SEMESTER					
MIC-AC/MJ/550 T	Virology, Bacteriology, Parasitology	**2**	**2**	Core/Mandatory	Theory
MIC-AC/MJ/551 T	Microbial Physiology	**2**	**2**	Core/Mandatory	Theory
MIC-AC/MJ/552 T	Food Microbiology	**2**	**2**	Core/Mandatory	Theory
MIC-AC/MJ/553	Applied and Industrial Microbiology	**2**	**2**	Core/Mandatory	Practical/Lab work
MIC-AC/MJ/550 P	Lab Course Based On MIC-AC/MJ/550 T	**4**	**2**	Core/Mandatory	Practical/Lab work
MIC-AC/MJ/551 P	Lab Course Based On MIC-AC/MJ/551 T	**4**	**2**	Core/Mandatory	Practical/Lab work
MIC-AC/MJ/552 P	Lab Course Based On MIC-AC/MJ/552 T	**4**	**2**	Core/Mandatory	Practical/Lab work
MIC-AC/DSE/554 A/B/C	Pharmaceutical Microbiology	**2**	**2**	DSE/ELECTIVE	Theory
	Bioethics, Biosafety and IPR				
	A or B	**4**	**2**	DSE/ELECTIVE	Practical
	any Online certification course from NPTEL /SWAYM /MOOC of equivalent credits { with biology basis }	**4**	**4**	DSE/ELECTIVE	(IN CASE OF MOOC / NPTEL COURSE, RULES OF COURSE CONDUCTING AGENCY WILL BE BINDING)
MIC-AC/OJT/555	On The Job Training/ Field Project	**4**	**4**	Core/Mandatory (CHOICE BASED)	INDUSTRIAL TRAINIG/FIELD WORK/ Practical/Lab work

Class: M.Sc. First Year: MICROBIOLOGY
Second Semester:
1. **MIC-AC/MJ/550 T**: Bacteriology, Virology, Parasitology
MIC-AC/MJ/550 P: Bacteriology, Virology, Parasitology (Practical)
MIC-AC/MJ/551 T: Microbial Physiology
MIC-AC/MJ/551 P: Microbial Physiology (Practical)
MIC-AC/MJ/552 T: Food Microbiology
MIC-AC/MJ/552 P: Food Microbiology (Practical)
MIC-AC/MJ/553: Applied and Industrial Microbiology
2. **MIC-AC/DSE/504** (T/P): (Choose any one from Pool /Basket)

A: Pharmaceutical Microbiology/ Bioethics, Bio safety and IPR (Theory 3 Cr. + Practical 1 Cr.)
B: Pharmaceutical Microbiology/ Bioethics, Bio safety and IPR (Theory 3 Cr. + Practical 1 Cr.)
C: Any Online certification course from NPTEL /SWAYM /MOOC of equivalent credits {with biology basis}
3. **MIC-AC/OJT/555** OJT/FP-1: (4 Cr.)

GENERAL MICROBIOLOGY AND DIVERSITY

MIC-AC/MJ/500 T **Credits 2** **Marks 50 (30 hrs)**

Course Objectives

- To understand the microbial biodiversity
- To acquaint with ecology
- To understand the morphology, physiology, and significance of extremophilic microbes

Course Outcomes

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

- Comprehend the biodiversity
- Familiarize with various ecological niche and microbial interactions
- Recognize the morphology, physiology, and significance of extremophilic microbes

Unit - I

Ecology

Introduction to microbial biodiversity – distribution, abundance, ecological niche.Types-Bacterial, Archael and Eucaryal. General characters of actinomycetes, fungi, algae, protozoa and yeasts

Community ecology: community structure, benevolent interactions, control withinthe microbial communities of rhizosphere- antagonistic interactions, (competition,antibiosis, predation etc.). Rhizosphere. **Mycorrhiza:** Host-fungus specificity, host fungus interactions, rhizosphereenvironment and recognition phenomenon, interaction of mycorrhizal fungi with non-hostplants, functional capability.

Unit II

Thermophiles: hyperthermophilic habitats and ecological aspects.

Extreme ThermophilicArchaebacteria, Thermophily, commercial aspects of thermophiles.

Applications of thermozymes. Methanogens: Classification, Habitats, applications.

Unit III

Alkalophiles: Classification, alkaline environment, soda lakes and deserts, calciumalkalophily, applications.

Acidophiles: Classification, life at low pH, acidotolerence, applications.

Halophiles: Classification, cell walls and membranes – Purplemembrane, compatible solutes. Osmoadaptation / halotolerence. Applications of halophilesand their extremozymes.

Barophiles: Classification, high-pressure habitats, life under pressure, barophily,death under pressure.

GENERAL MICROBIOLOGY AND DIVERSITY (PRACTICAL)

MIC-AC/MJ/500 P **Credits 2** **Marks 50 (60 hrs)**

1. Isolation of thermophiles from hot water spring [Study at least one enzyme].
2. Studies on halophiles isolated from seawater. [Pigmentation and Salt tolerance]
3. Studies on alkalophiles isolated from Lonar water/sea water. [Study at least one enzyme]
4. Biogenic methane production using different wastes.
5. Isolation of *Thiobacillusferrooxidans*and *Thiobacillusthiooxidans*cultures from metal sulfides, rock coal and acid mine waters.
6. Estimation of microbial species diversity in microecosystem
7. Detection of siderophore production by *Azospirillum*and *Pseudomonas*
8. Slide culture technique for yeast isolation.
9. Cover slip culture technique for actinomycetes identification

REFERENCES:

1. Extremophiles by Johri B.N. 2000. Springer Verlag. , New York
2. Microbial Diversity by Colwd, D. 1999, Academic Press.
3. Microbial Life in Extreme Environments. Edited by D. J. Kushner. Academic Press.
4. Microbiology of Extreme Environments. Edited by Clive Edward. Open University Press. Milton Keynes.
5. Microbiology of Extreme Environments and its potential for Biotechnology. Edited by M.S. Da Costa, J.C. Duarate, R.A. D. Williams. Elsevier Applied Science, London.
6. Extreme Environment. Mechanism of Microbial Adaptation. Edited by Milton R. Heinrich. Academic Press.
7. Thermophiles. General, Molecular and Applied Microbiology. Edited by Thomas D. Brock. Wiley Interscience Publication.
8. Microbiology: Dynamics and Diversity by Perry.
9. Microbial Ecology. Fundamentals and Applications by. Ronald M. Atlas and Richard Bartha. 2nd and 4th Edition. The Benjamin Cummins Publication Co. Inc.
10. Microbial Ecology. 2nd Edition. by R. Campbell. Blackwell Scientific Publication.
11. Brocks Biology of Microorganisms. 8th Edition. (International Edition - 1997) by Michael T. Madigan, John M. Martinko. Jack Parker. Prentice Hall International Inc.
12. Advances in Applied Microbiology. Vol. 10. Edited by Wayne W. Umbreit and D. Pearlman. Academic Press.
13. Macan, T. T. (1974). Freshwater Ecology. Longman Group Ltd., London,.
14. Meadows, P. S. and J. I. Campbell. (1978). An introduction to Marine Science. Blackie & Son Ltd., Glasgow. 15. Richards, B.N. (1987). Microbiology of Terrestrial Ecosystems. Longman Scientific & Technical, New York.

Bioenergetics and Enzymology

MIC-AC/MJ/501 T **Credits 2** **Marks 50 (30 hrs)**

Course Objectives

- To understand concepts of bioenergetics and metabolic pathways of microorganisms
- To study the metabolic pathways of industrially important fermentation product
- To know the properties, kinetics, and significance of microbial enzymes

Course Outcomes

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

- Elucidate the bioenergetics and microbial metabolic pathways
- Cognizant about the metabolic pathways of industrially important fermentation product
- Demonstrate the properties, kinetics, and significance of microbial enzymes

Unit – I Introduction to bioenergitics, Catabolic pathways and its regulation

Principles of Bioenergetics, laws of thermo dynamics, Central role of ATP in metabolism, , Concept of energy rich compounds and intermediates, Common types of reactions involved in metabolism

Carbon fuel and its oxidation

Catabolism of carbohydrates : EMP, HMP, ED, Phosphoketolase pathway, TCA cycle, Glyoxylate bypass. Anaplerotic sequences, overview catabolism of different carbohydrates (Fructose, Lactose, Mannose, Allose, Gluconate, Mannitol, Arabinose), Bacterial fermentations (alcohol and lactic acid), Catabolism of hydrocarbons and fatty acids.

Unit – II Biosynthesis of Macromolecules

Biosynthesis of amino acids (formation of glutamic acids, conversion of glutamic acid to glutamine, proline and arginine, formation of alanin, serinine, glycine and cysteine), aromatic amino acids, **Biosynthesis of Purines and Pyrimidines**. **Biosynthesis of fatty acids**, **Biosynthesis of carbohydrates** viz. glycogen, **enzymatic synthesis of reserve materials** - glycogen, polyphosphates and polyhydroxybutyrate (PHB)

Unit – III Introduction to Enzymes and Enzyme kinetics

Classification of enzymes into seven major groups with suitable examples, Enzyme kinetics: Michaelis - Menton equation and its significance in studies. Lineweaver-Burke plot, Haldane-Briggs relationship, sigmoidal kinetics, steady state kinetics and transient phases of enzyme reaction. Allosteric enzymes, Isozymes, Ribozymes, abzymes and Extremozymes

Bioenergetics and Enzymology (Practical)

MIC-AC/MJ/501 P **Credits 2** **Marks 50 (60 hrs)**

1. Quantitative estimation of amino acids by Rosen's method
2. Quantitative estimation of proteins by Folin-Lowry/Bradford's method
3. Quantitative estimation of sugars by Sumner's/ Anthrone's method
4. Production of $\alpha - amylase$ using submerged/solid-state fermentation
5. Production of protease by bacterial species using submerged/solid-state fermentation
6. Partial purification of $\alpha - amylase$/ protease
7. Studies on enzyme kinetics of $\alpha - amylase$/ protease (Optimization parameters viz. Substrate concentration, enzyme concentration, reaction temperature, reaction pH, Km, Vmax and metal ions as activators/inhibitors)

References

1. Understanding Enzymes by Trevor Palmer
2. Enzyme Kinetics by Paul Engel. 1977. John Wiley and Sons. Inc., New York.
3. Enzymes by Dixon and Webb, 3 rd Edition 1979. Academic Press, New York
4. Biochemistry by Stryer 5th Edition WH Freeman 2001
5. Laboratory techniques in Biochemistry and Molecular Biology by Work and Work.
6. Principles of Enzyme Kinetics. 1976. by Athel Cornish - Bowden.Butterworth and Co.
7. Fundamentals of Enzymology. 3rd Edition by Price
8. Biochemistry by Chatwal
9. Methods in Enzymology by Drolittle
10. Biochemistry by Garrett
11. Principles of Biochemistry. 2 nd Edition by Horton
12. Biochemistry by Voet.
13. Methods of Biochemical Analysis by David Glick, John Wiley and Sons, New York.
14. Biotechnology Vol. VIII and VII A edited by H. J. Rehmen and G. Reed.
15. Bacterial metabolism 2nd edition by H. W. Doelle
16. Advances in microbial physiology Vol. VII and XXIV edited by A. H. Rose, J Morris D. W. Tempest.

Techniques in Microbiology

MIC-AC/MJ/502 T **Credits 2** **Marks 50 (30 hrs)**

Course Objectives

- To study the principles, need and care of laboratory instruments
- To understand theory, principles of chromatographic, electrophoretic, spectrophotometric and radioisotope techniques
- Get detail applications of various instrument and techniques in microbial field

Course Outcomes

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

- Explain the principles, need and SOP of laboratory instruments
- Pertain the theory, principles of chromatographic, electrophoretic, spectrophotometric and radioisotope techniques
- Demonstrate various instruments and techniques

Unit – I Chromatographic techniques

Planar chromatography- theory, principle of separation, resolution, types of planar chromatography

Paper chromatography and thin layer chromatography- principle, working and applications, HPTLC- construction, working, advantages

Column chromatography- theory, principles of separation, resolution, retention time, retention volume, gel filtration chromatography, ion-exchange chromatography, affinity chromatography, hydrophobic interaction chromatography

High performance liquid chromatography- principle, construction, working, sampling devices, chromatographic matrices and columns, detectors, result interpretation

Gas chromatography- GLC and GSC, principle, working, sampling devices, chromatographic matrices and columns, detectors, result interpretation

Unit– II Microscopy and Electrophoretic techniques

Optical microscopy- types (compound light, dark field microscopy, phase-contrast microscopy, fluorescence microscopy, confocal microscopy), principles, construction, optical design, image formation, magnification, resolution

Electron microscopy- types (transmission electron microscopy, scanning electron microscopy), principles, construction, electron sources, lenses, apertures, optical design, image formation, magnification, resolution, staining techniques, visualization of biological specimens, chemical

analyses (energy dispersive spectroscopy), immunocytochemistry, advantages and limitations of electron microscopy.

Probe microscopy- scanning tunnelling and atomic force microscopy with respect to principles, construction, working, imaging of biological specimens, applications, advantages and limitations.

Electrophoresis- theory, principles of separation, resolution, types of electrophoresis- zone electrophoresis and moving boundary electrophoresis

Paper electrophoresis- theory, construction, working and applications

Gel electrophoresis- theory, types of gels (starch, agarose, poly acrylamide, native and denaturing) with advantages and disadvantages, construction, working, sample preparation, staining

Electrophoretic techniques- preparative and non-preparative, isotachophoresis, gradient gel, tube gel electrophoresis, isoelectric focusing, capillary, microchip and 2-D electrophoresis, autoradiography

Applications of electrophoresis- bioseparations, bioanalyses

Unit– III Spectroscopy

Components of electromagnetic radiation and their applications, spectroscopy- general principles

Spectroscopic techniques with respect to principle, construction, techniquesand applications- UV-visible, fluorescence, turbidometry, nephlometry, infra-red, Raman, nuclear magnetic resonance, atomic absorption and atomic emission, mass

Techniques in Microbiology (Practical)

MIC-AC/MJ/502 P **Credits 2** **Marks 50 (60 hrs)**

1. Studies on pH titration curves of amino acids/ acetic acid and determination of pKa values and Handerson-Hasselbach equation.

2. Separation of bacterial lipids/amino acids/sugars/organic acids by TLC

3. Separation of bacterial lipids/amino acids/sugars/organic acids by Paper Chromatography

4. Separation of proteins/nucleic acids by horizontal/vertical gel electrophoresis

5. Study of UV absorption spectra of macromolecules (protein, nucleic acid, bacterial pigments)

6. Demonstration of HPLC/GC for separation of sample components

7. Demonstration of PCR for DNA amplification

8. Separation of proteins by column chromatography

References

1. Instrumental Methods of Analysis. 6th Edition by H.H. Willard, L.L. Merritt Jr. and others. 1986. CBS Publishers and Distributors.
2. Instrumental Methods of Chemical Analysis. 1989 by Chatwal G and Anand, S. Himalaya Publishing House, Mumbai.
3. A Biologists Guide to Principles and Techniques of Practical Biochemistry. 1975 by Williams, B.L. and Wilson, K.
4. Spectroscopy. Volume 1.Edited by B.B. Straughan and S. Walker.Chapman and Hall Ltd.
5. Gel Electrophoresis of Proteins- A Practical Approach by Hanes.
6. Chromatography: Concepts and Contrasts- 1988 by James Miller. John Wiley and Sons. Inc., New York.
7. Analytical Biochemistry by Holme.
8. Introduction to High Performance Liquid Chromatography by R. J. Hamilton and P. A. Sewell.
9. Spectroscopy by B.P. Straughan and S. Walker.
10. Practical aspects of Gas Chromatography and Mass Spectrometry 1984 by Gordon M. Message, John Wiley and Sons, New York.
11. Gel Chromatography by TiborKremmery. Wiley Publications.
12. Douglas B. Murphy, Fundamentals of light microscopy and electronic imaging, 2001, Wiley-Liss, Inc. USA.
13. David B. William and C. Barry Carter, Transmission electron microscopy- a textbook for material science, Springer US, 2nd ed., 2009.

Basic Biostatistics

MIC-AC/MJ/503 T **Credits 2** **Marks 50 (30 hrs)**

Course Objectives

- To understand various statistics terminologies and their significance in microbiology
- To get familiar with various computation tools of biostatistics
- To know-how about research methodology

Course Outcomes

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

- Apply the principles of statistics for designing microbiological experiment, statistical analysis, and interpretation of results
- Operate and solve exercise using computation statistics software
- Get acquitted with basic approach of research methodology

Unit –I Introduction to Biostatistics

Basic definitions and applications, Sampling: Representative sample, sample size, sampling bias and sampling techniques. Data collection and presentation: Types of data, methods of collection of primary and secondary data, methods of data presentation, graphical representation by histogram, polygon, ogive curves and pie diagram.

Unit –II Measures of central tendency

Mean, Median, Mode.

Measures of variability: Standard deviation, standard error, range, mean deviation and coefficient of variation. Correlation and regression: Positive and negative correlation and calculation of Karl-Pearsons co-efficient of correlation, Linear regression and regression equation and multiple linear regression, ANOVA, one and two way classification, Calculation of an unknown variable using regression equation.

Unit – III Tests of significance

Tests of significance: Small sample test (Chi-square t test, F test), large sample test (Z test) and standard error. Introduction to probability theory and distributions, (concept without deviation) binomial, poison and normal (only definitions and problems) Computer oriented statistical techniques. Frequency table of single discrete variable, bubble spot, computation of mean, variance and standard Deviations, t test, correlation coefficient

Practical learning using Microsoft Excel

1. Representation of statistical data by
   A) Histogram B) Ogive Curve C) Pie Diagram
2. Determination of statistical averages/ central tendencies
   A) Arithmetic mean B) Median C) Mode
3. Determination of measures of dispersion
   A) Mean deviation B) Standard deviation and Coefficient of variation
4. Tests of significance
   A) Chi square test B) t-Test C) Standard Error

References

1. Statistics in biology, Vol. 1 by Bliss, C.I.K. (1967) McGraw Hill, NewYork.
2. Practical Statistics for experimental biologist by Wardlaw, A.C. (1985).
3. Statistical Methods in Biology - 2000 by Bailey, N.T. J. English Univ. Press.
4. Biostatistics - 7th Edition by Daniel
5. Fundamental of Biostatistics by Khan
6. Biostatistical Methods by Lachin
7. Statistics for Biologist by Campbell R.C.(1974)Cambridge University Press ,UK.

A) MICROBIAL TAXONOMY (T)

MIC/DSE/504 T **Credits 2** **Marks 50 (30 hrs)**

Course Objectives

- To understand microbial diversity and their significance in microbiology
- To get familiar with various methods for identification and classification of bacteria and viruses
- To acquaint with Bergey's Manual, molecular phylogenetic

Course Outcomes

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

- Explain the principles, need and significance of classification
- Use knowledge for identification of bacteria
- Use tools for phylogenetic analysis

Unit I

General characteristics and outline of classification of Archaea

Extremophiles: general characteristics of acidophilic, alkaliphilic, barophilic microorganisms

General characteristics and outline classification of Actinomycetes

Fungi: General characteristics and outline of classification of fungi,

Unit II

Outline and overview of classification of microorganisms- Haeckel three Kingdom classification, Whittaker five Kingdom classification, and Woese's three domain classification, classification of fungi, and virus.

Virus classification: LHT System, Baltimore and ICTV classification of virus.

Unit III

Bacterial classification (Bergey's Manual of systematic Bacteriology). Bacterial taxonomy– Binomial Nomenclature, Identification characters-morphological, staining, physiological, biochemical and molecular (mol % G+C,nucleic acid hybridization, 16SrRNA sequencing) characters, methods-Numerical, nucleic acid and Phylogenetics.

MICROBIAL TAXONOMY (P)

MIC/DSE/504 P **Credits 2** **Marks 50 (60 hrs)**

1. Isolation and identification of Halophilic/acidophilic/alkaliphilic/thermophilic bacteria
2. Determination G+C content of DNA.
3. Study of ICTV database
4. Construction of Phylogenetic tree

REFERENCE BOOKS

1. Introductory Mycology by C. J. Alexopoulus (7th ed) Wiley Eastern Pvt. Ltd., New Delhi.
2. Bergey's Manual of Systemic Bacteriology (2nd ed) Springer, USA.
3. Basic Bacteriology (3rd ed) by C. Lamanna and F. Mallette The William and Wilkins Company. Calcutta.
4. Fundamental Principles of Bacteriology (3rd ed) by A. J. Salle TMH Publishing Company, New Delhi.
5. The Yeasts by A.H. Rose
6. General Microbiology (5th ed) by R. Y. Stanier and others
7. The Prokaryotes: A handbook on the Biology of Bacteria by Martin Dworkin (Editor- in- Chief) and others Springer
8. Developmental Microbiology by J. F. Peberdy Blackie & Sons, Glasgow

B) **BIOLOGICAL DATABASE SYSTEMS (T)**

MIC-AC/DSE/504 T **Credits 2** **Marks 50 (30 hrs)**

Course Objectives

- To understand biological databases and their applications in microbiology
- To acquaint with various nucleic acid, protein, sequence and structure databases
- To familiarize with sequence and structure file format

Course Outcomes

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

- Use various databases
- Use knowledge for specific retrieval of sequence information
- Frame queries for retrieval of desired information from databases

Unit- I Bioinformatics and its Applications

Introduction to Bioinformatics: Introduction and overview of History of Bioinformatics, relationship between molecular evolution and bioinformatics. Structure function relationship, Nature of biological data, Applications of Bioinformatics

Unit – II

Biological Databases: Types and importance

Nucleotide sequence databases; Primary nucleotide sequence databases- EMBL, GenBank, DDBJ (Sequence file format, sequence submission and retrieval of information).

Overview of Secondary nucleotide sequence databases,Protein sequence database – SWISS PROT, TrEMBL, PIR, MIPS

Unit – III

Protein Family database – PFAM, PROSITE, PRINTS, BLOCKS,

Protein Structure database – PDB

Protein structural classification database - SCOP, CATH

B) BIOLOGICAL DATABASE SYSTEMS (PRACTICAL)

MIC-AC/DSE/504 P **Credits 2** **Marks 50 (60 hrs)**

1. Use of Internet /software for sequence nucleotides and protein databases.
2. Studies of public domain databases for nucleic acid and protein sequences.
3. Sequence retrieval from nucleic acid databases.
4. Protein structure retrieval from PDB.
5. Protein structure visualization by using RASMOL, CN -3D software

REFERENCES

1. Bioinformatics. 1998 by Baxevanis
2. Bioinformatics 2000 by Higgins and Taylor OUP.
3. Nucleic acid Research 2023. Jan. Genome database issue.
4. The Internet and the new Biology: Tools for Genomics and Molecular Research by Peruski, Jr. and Peruske (ASM) 1997.
5. Functional Genomics. A Practical Approach Edited by Stephen P Hunt and Rick Liveey (OUP) 2000.
6. DNA microarrays: A practical approach edited by Mark Schena (OUP)
7. Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins. 2nd Edition by Baxevanis.
8. Bioinformatics: Sequence, structure and Data Bank: A Practical Approach by Higgis.
9. Bioinformatics - from Genomes to drug. 2 volumes by Lenganer.
10. Bioinformatics Methods and Protocols - Misener.

C) Any Online certification course from NPTEL /SWAYM /MOOC of equivalent credits {with biology basis}

MIC-AC/DSE/504 P **Credits 2** **Marks 50 (60 hrs)**

Research Methodology

MIC-AC/RM/505 T **Credits 4** **Marks 100 (60 hrs)**

Course Objectives

- To define research and describe the research process and research methods
- To understand qualitative research and methods used to execute and validate qualitative research
- To know how to apply the basic aspects of the research process in order to plan and execute a research project.
- To provide insight into the processes that lead to the publishing of research.
- To be able to present, review and publish scientific articles

Course Outcomes

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

- understand and explain research process
- Do systematic literature survey, formulation of a research topic, study design, analysis and interpretation of data.
- Design a research approach for a specific research issue of their choice.
- Select a suitable analytical method for a specific research approach.
- Demonstrate a good understanding of how to write a research report.
- critically assess published quantitative research with regard to the statistical methods and approaches adopted
- create a research document for implementation research project

Course Contents:

Part – 1 (02 credits : 30 Contact Hours)

Unit - I: Research Fundamentals: (10 Hrs.)

Introduction: Definition, objectives of the research, characteristics of research, importance of research, types of research- Qualitative, Quantitative, descriptive, analytical, fundamental/basic, applied, conceptual, empirical, limitations encountered in research, research methodology and research methods.

The process of research-Research Methodology: Literature search, sources of literature, types of literature, cross-referencing, keeping records, selection of research problem, hypothesis and hypothesis testing, research design, planning experiments, independent and dependent variables, experimental controls, data analysis and interpretation, concept of measurement and problems in measurement, levels of measurement- nominal, ordinal interval, ratio, validity and reliability, reporting the findings- progress/project report/thesis/dissertation.

Unit- II: Research funding- writing proposals and reports (10 Hrs.)

Research institutes, research funding agencies, reasons for funding research, cxpcctations of funding agencies, profile of investigators, interdisciplinary and collaborative research.

Writing a research proposal/research scheme/concept note/synopsis- topic of research, background to the research, definition of the problem, current status of work (National and International), hypothesis, objectives, plan of work (monthly/quarterly, yearly), experimental methods including special facilities/instruments, available facilities, sampling methods, field visits, data processing/analyses, interpretation, budgetary requirements- manpower, equipment, chemicals/consumables, proposed time frame, expected outcome, limitations, if any.

Writing a project report (annual report/completion report)- title, table of contents, background/introduction, methodology, results and interpretation, conclusions, future directions, appendices, bibliography, outcome of the project, publications/patents emanating from the research work, audited statement of accounts/final utilization.

Unit – III: Scientific writing and presentation- thesis/dissertation, research paper (10 Hrs.)

Writing a thesis/dissertation- classic 5-chapter model- abstract, table of contents, background to the research, review of literature/introduction, research design and implementation OR material and methods, presentation and analysis of findings OR results, discussion and conclusions, referencing styles and list of references, appendices, acknowledgements

Writing a research paper- title, author names and affiliations, abstract, key words, introduction, material and methods, results, discussion, acknowledgements, references, formatting guidelines, ethics of writing a research paper, plagiarism, language, avoiding common mistakes, journal metrics, impact factor, citations.

Data presentation- Objectives of presentation, presentation style, effective communication skills, scales used for presentation (nominal, ordinal, interval, percentage, ratio), pie charts, bar charts, histogram, line graphs, tables.

Part – 1 (02 credits: 30 Contact Hours)

Presentations, Case studies, Assignments, Tutorials based on Module I to III **(30 Hrs.)**

Students are expected to do the Following:

i) Select Broad topic of Research Project (to be implemented from second semester onwards)
ii) Read the Basic concepts / fundamentals of broad topic
iii) Identify 05 SCOPUS / WEB OF SCIENCE Indexed Journals related to broad topic
iv) Search and download 20 research articles from above research Journals
v) Do systematic review of above 10 research articles
vi) While doing review of each of above mentioned 20 research articles, students are expected prepare notes on following points

a) What are the objectives of the research article?
b) What methodology has been adopted?
c) What are prominent results?
d) How these results of relevant to the latest development of the subject?
e) What is novelty of research article?

f) What are prominent shortcomings of this research a presented in this research article?
g) What are your plans to address those shortcoming?
vii) Draft the title of research project
viii) Draft hypothesis
ix) Draft Objectives and Methodology
x) Draft expected outcome of the research project

At the end of the assignment, students are expected to prepare a report having following points

i) Fine-tuned title of Research Project
ii) Background to the research topic with current National and International status
iii) Hypothesis
iv) Objectives
v) Material and Methods
vi) Detailed Experimental plan
vii) Expected outcome
viii) References

References:

1. Research Methodology by Dr. S. L. Gupta, Hitesh Gupta; International Book House Pvt Ltd **(2013),** ISBN-10: 8191064278, ISBN-13: 978-8191064278
2. Basic Research Methods-Gerard Guthrie SAGE Publications, India, Pvt Ltd, New Delhi **(2010),** ISBN-10: 8132104579, ISBN-13: 978-8132104575
3. Research Methodology-methods and techniques By C. R. Kothari, New Age International Publishers **(2011)** ISBN 978-81-224-1522-3
4. Principles of Research Methodology- Phyllis G. Supino, Jeffrey S. Borer; Springer, Verlag New York **(2012),** ISBN-ebook: 1461433592, ISBN (Hardcover): 978-1461433590
5. Research Design Qualitative, Quantitative. and Mixed Methods Approaches- John W. Creswell; SAGE Publications Ltd, UK **(2011),** ISBN-9780857023452
6. Research Methodology -A Step-by-Step Guide for Beginners- Ranjit Kumar; Sage Publications Ltd**(2010)**, ISBN- 1849203016.
7. Scientific Writing and Communication- Angelika Hofmann; Oxford University Press, US **(2010),** ISBN-13-: 978-0 199947560, ISBN-10: 01 99947562
8. Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded- Joshua Schimel, Oxford University Press, **(2011)**, ISBN: 9780199760237
9. Handbook of Scientific Proposal Writing- A.YavuzOruc; CRC Press, Taylor & Francis group **(2011)**, ISBN: 9781439869185

Virology, Bacteriology, Parasitology

MIC-AC/MJ/550 T **Credits 2** **Marks 50 (30 hrs)**

Course Objectives

- To aware the virus, classification, and their significance
- To abreast about bacteriology and Parasitology
- To understand the viral multiplication and pathogenic role of viruses, bacteria and parasites along with control of virus and newly emerging virus

Course Outcomes

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

- Explicate the virus, classification, and their significance
- Comprehend the viral multiplication and pathogenic role of viruses, bacteria and parasites.
- Understanding about diagnosis and control of virus, bacteria and parasites

Unit I Virology

History of virology, general characteristics Ultrastructure of virus,classification of viruses(LHT, Baltimore system, ICTV), viroids, prions, satellite virus.

Mechanism of virus adsorption and entry into the host cell,

Bacteriophages – Molecular basis of Lytic and lysogenic replication;One step growth curve

DNA and RNA viruses– Overview of mechanism of genome replication, Transcription and translation.

Host and virus factors involved in pathogenesis, patterns of infection, pathogenesis of animal viruses Adenovirus, Herpes virus, Picorna virus, Poxvirus and Orthomyxovirus, Oncogenic viruses.

Control of viral infections: Viral vaccines and chemotherapeutic agents.

Virus neutralization by antibody and interferons

Unit 2 Bacteriology

Overview Ultrastructure of bacteria cell;

Pathogenic Bacteria: Morphological characteristics, Pathogenesis and Laboratory diagnosis includingrapid methods of following pathogenic bacteria;

Klebsiella pneumoniae; Pseudomonas aeruginosa: Streptococcus pneumoniae.

New emerging infections:-*community associated Methicilin resistantStaphylococcus aureus* (MRSA), *Multi drugresistant tuberculosis.*

Unit 3 Parasitology

Basic concept of Host-pathogen interaction, Basic concept of Parasites,

Classification of Parasites, Host, Types of host, Relationship between host and parasites.

Introduction, A-etiology, pathogenicity, life cycle, lab diagnosis and treatment:

Leishmania, Amoeboids (*Entamoeba histolytica*), Sporozoans (*Plasmodium* spp), *Giardia lamblia; Plasmodium vivax,Trepanoma,*Echinococcus, Ascaris,

Lab Diagnosis: Different specimens of parasitology, Collection & transportation.

Processing of parasitological specimens

Virology, Bacteriology, Parasitology (Practical)

MIC-AC/MJ/550 P **Credits 2** **Marks 50 (60 hrs)**

1. Isolation of Bacterial/ Plant/ Animal Viruses
2. Plaque assay
3. One step growth curve for determination for virus titre.
4. Cultivation and assay of viruses using embryonated eggs and Tissue culture Technique.
5. Isolation and identification of following pathogenic bacteria and parasites:
    a. *Klebsiella pneumoniae; Pseudomonas aeruginosa: Streptococcus pneumoniae,*
    b. Demonstration of parasites in pathological sample

REFERENCES: -

1. Introduction to modern virology 4 th Edition by Dimmock N J, Primrose S. B. 1994. Blackwell scientific publications. Oxford.
2. Virology 3rd edition by Conrat H. F. ., Kimball P. C. and Levy J. A. 1994. Prentice Hall, Englewood Cliff, New Jersy.
3. Text Book on Principles of Bacteriology, Virology and Immunology, Topley and Wilson 1995.
4. Applied Virology. 1984. edited by EdnordKurstak. Academic Press Inc.
5. Introduction to Modern Virology by Dimmock.
6. Virology : principles and applications by John Carter and Venetia Saunders.
7. Principles of virology ,—4th edition by Jane Flint, Vincent R. Racaniello, Glenn F. Rall, Anna Marie Skalka, with Lynn W. Enquist.
8. Stainer, R.Y, Ingraham, J.L, Wheelis, M.L, and Painter, P.R (2013). General Microbiology,MacMillan Press Ltd. UK.
9. Ananthanarayan, Paniker and ArtiKapil (2013) *Textbook of Microbiology,* 9th Edition. Universities Press.
10. Fundamentals of Baceriology- A. J. Salle
11. Prescott's Microbiology , 11th Edition
12. Medical parasitology' by Chatarjee, 3th edition
13. Medical Microbiology and Immunology' by Warren Levinson, eighth Edition, Lange Medicalbooks/ McGraw-Hill Publication

Microbial Physiology

MIC-AC/MJ/551 T **Credits 2** **Marks 50 (30 hrs)**

Course Objectives

- To acquaint various life process like photosynthesis, respiration and fermentation, anaerobic respiration, and bacterial sporulation
- To understand bacterial membrane transport
- To understand the concept of chemolithotrophy and nitrogen metabolism

Course Outcomes

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

- Understand various life process like photosynthesis, respiration and fermentation, anaerobic respiration, and bacterial sporulation
- Elucidate bacterial membrane transport
- Discuss the concept of chemolithotrophy and nitrogen metabolism

Unit – 1 Photosynthesis

Energy consideration in photosynthesis, light and dark reaction, electron carriers in photosynthesis, Organization of photo system I and II, cyclic and non-cyclic flow of electrons, Z scheme, Hill reaction, photolysis of water. Bacterial photosynthesis: scope, electron carriers, Photosynthetic reaction center, cyclic flow of electrons, bacterial photophosphorylation in various groups of phototrophic bacteria, electron donors other than water in anoxygenic photosynthetic bacteria.

Unit – 2 Bacterial Respiration and chemolithotrophy

Aerobic Respiration: Mitochondrial electron transport chain, structure and function of ATPase (bacterial and mitochondrial), generation and maintenance of proton motive force, oxidative phosphorylation, inhibitors and un-couplers of electron transport chain and oxidative phosphorylation, Atkinson's energy charge, phosphorylation potential and its significance, Energy generation in all groups of chemolithotrophs- oxidation of molecular hydrogen by *Hydrogenomonas*species, ferrous and sulfur/sulfide oxidation by *Thiobacillus* species.

Anaerobic Respiration: Concept of anaerobic respiration, oxidized sulfur compounds, and nitrate as electron acceptor with respect to electron transport chain and energy generation, Biochemistry of methanogenesis, Biochemistry of ammonia oxidation, ammonia oxidation by members of Genus Nitroso group, nitrite oxidation by Nitro group of genera.

Unit –3 Bacterial Permeation

Structure and organization of membrane, functions of biological membrane

Different models of biological membrane, glyco-conjugants and proteins in membrane systems, solute transfer in bacteria- passive diffusion, facilitated diffusion, different mechanisms of active transport (Proton Motive Force, PTS, role of permeases in transport, transport of amino acids and inorganic ions in microorganisms and their mechanisms.

Microbial Physiology (Practical)

MIC-AC/MJ/551 P **Credits 2** **Marks 50 (60 hrs)**

1. Development of Winogradsky column for growth of different groups of bacteria
2. Isolation of Photosynthetic bacteria
3. Glucose uptake by *E. coli*/*Saccharomyces cerevisiae*by passive diffusion
4. Glucose uptake by *E. coli*/*Saccharomyces cerevisiae*by active transport
5. Determination of Iron Oxidation Rate of *Thiobacillus*.
6. Determination of Sulfur Oxidation Rate of *Thiobacillus*
7. Microbial degradation, decolorization and adsorption of organic dyes (by free and immobilized cells).
8. Demonstration of utilization of sugars by oxidation and fermentation techniques.

References

1. Microbial Physiology and Metabolism by Caldwell D.R. 1995, Brown Publishers.
2. Microbial Physiology by Moat A.G. and Foster J. W. 1999. Wiley.
3. Prokaryotic Development by Brun. Y.V. and Shimkets L.J. 2000.ASM Press.
4. Advances in Microbial Physiology. Volumes.Edited by By A.H. Rose. Academic Press, New York.
5. Applied Microbial Physiology by Rhodes.
6. Biosynthesis by Smith.
7. The Bacteria. Volumes by I.C. Gunsalus and RogeryStanier, Academic Press.
8. Microbial Physiology by Benjamin
9. Bacterial Metabolism by H.W. Doelle
10. Segel Irvin H. (1997) Biochemical Calculations 2nd Ed., John Wiley and Sons, New York.
11. Voet Donald and Voet Judith G. (1995) Biochemistry, 2nd Ed..John Wiley and sons New York.
12. White Abraham, Handler Philip, Smith Emil, Hill Rober, Lehman J. (1983) Principles of Biochemistry, Edition 6, Tata Mc-Graw Hill Companies, Inc.
13. White David (2000) Physiology and Biochemistry of Prokaryotes. 2nd Ed. Oxford University Press, New York. 14. Zubay Geoffrey (1998) Biochemistry, 4th Ed., W. C. Brown, New York.

FOOD MICROBIOLOGY

MIC-AC/MJ/552 T **Credits 2** **Marks 50 (30 hrs)**

Course Objectives

- To understand concepts in fermentation microbiology
- To complement the students with the knowledge of microbiology of food preservation and spoilage
- To acquaint the students with food preservation methods

Outcomes

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

- Know the concepts related to popular fermented food products, its microbiology and spoilage
- Understand fermented food products, food spoilage and contamination
- Understand various methods for food preservation

Unit – I Industrial Food fermentations

Introduction, food fermentation, the science and technology.

Oriental fermented foods (Soya sauce, Natto, Miso), Cerel products, mixed preparations (Idle, Dhokala, Khamang, Papadam and Jilebies), Fermented cassaea flour, fermented pea nut milk, and grape based fermented products- wine (pre fermentating, fermentative and post fermentative practices, general methods of wine preparations) , Fermented vegetables – Saurkraut, Fermented Meat – Sausages

Unit –II Food preservation methods

Food preservation by Radiations (UV, Gamma and microwave), Food preservation by low and high Temperature, chemicals and naturally occurring antimicrobials

Biosensors in food industry.

Unit – III Food spoilage and Quality assurance

Food borne infections and intoxications (bacterial) with examples of infective and toxic types –, *Clostridium, Salmonella, Shigella, Staphylococcus, Campylobacter, Listeria.*

Mycotoxins in food (Types, structures, producer organism and its toxicity).Laboratory

Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, ISI.

FOOD MICROBIOLOGY (Practical)

MIC-AC/MJ/552 P **Credits 2** **Marks 50 (60 hrs)**

1. Production of fermented batter of Idli, Khaman Dhokla, Jilebies and study of bacteria involved in them
2. Saurkraut fermentation and study of bacteria involved in it
3. Production of fermented soy sauce and pea nut milk and study of bacteria involved in them
4. Isolation and study of food infection/ food poisoning bacteria/ fungi from contaminated foods
5. Extraction and detection of toxins from food
6. Preservation of potato/onion by UV radiation
7. Rapid analytical techniques in food quality control using microbial biosensors

REFERENCES

1. Food Microbiology. 2nd Edition By Adams
2. Basic Food Microbiology by Banwart George J.
3. Food Microbiology: Fundamentals and Frontiers by Dolle
4. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2 by Joshi.
5. Fundamentals of Dairy Microbiology by Prajapati.
6. Essentials of Food Microbiology. Edited by John Garbult.Arnold International Students Edition.
7. Microbiology of Fermented Foods. Volume I and II. By Brian J. Wood.Elsiever Applied Science Publication.
8. Microbiology of Foods by John C. Ayres. J. OrwinMundt. William E. Sandinee. W. H. Freeman and Co.
9. Dairy Microbiology by Robinson. Volume II and I.
10. Food Microbiology: Fundamentals and Frontiers. 2nd Edition by Michaell P. Doyle, Larry R. Beuchat and Thomas I. Montville (Eds.), ASM Publications.
11. Bacterial Pathogenesis A Molecular Approach. 2 nd Edition.2001 by Abigail A.Salyers and Dixie D. Whitt.ASM Publications.
12. Advances in Applied Microbiology by D. Pearlman, Academic Press.
13. Microbial biotechnology- principles and applications- by Lee Yuan Kun
14. Biotechnology Vol. III and V edited by H J Rehman and G Reed
15. Applied dairy microbiology edited by Elmer Marth and James Steele.

Applied and Industrial Microbiology

MIC-AC/MJ/553 T **Credits 2** **Marks 50 (30 hrs)**

Course Objectives

- To understand concepts in milk microbiology
- To complement the students with the basic knowledge of food microbiology
- To acquaint the students with food preservation techniques

Outcomes

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

- Know the concepts related to popular/common milk products, milk examination and spoilage
- Comprehend knowledge regarding fermented food products, food spoilage and infection
- Understand diverse strategies for food preservation

UNIT – I Industrial Dairy fermentations.

Taxonomy of lactic acid bacteria present in fermented products, Acid fermented milks (Acidophilus milk, yoghurt), Slightly acid fermented milks (Cultured butter milk), Acid-alcoholic fermented milk (Kefir). Fermented milk production with extended self life (labneh). Starter cultures for fermented dairy products (*Strptococcus thermophillus*, *Lactobacillus bulgaricus*). Metabolism of starter cultures, biochemical changes in fermented milk (Fermentation of lactose to lactic acid, production of aromatic compounds, hydrolysis of proteins and lipids and Vit. B content).

Cheese- biological entities in cheese systems (Mlk, microorganisms, enzymes and other additives). Cheese production (Milk quality and composition, steps involed in mfg of cheese, preservation, classification and nutritional aspects)

Unit - II Advanced Food and dairy Microbiology

Genetically modified foods. Probiotic role of lactic acid bacteria and fermented milk products. Applications of microbial enzymes in dairy industry [Protease, Lipases], microbial anti oxidants, microbial polysaccharides as stabilizers and thinkers, flavors (esters, diaacetyl, pyrazines, lactones and terpenes, monosodium glutamate and microbial colors from molds). Production and application of Bakers Yeast, Tea, coffee and vinegar fermentation, Utilization and disposal of dairy by-product - whey.

Unit-III Quality Control in Dairy Industry

Dye reduction test (Methylene blue Reduction Test, Resazurin Test) Pasteurization methods, Microbial counts: Methods and significance, Milk borne diseases, Lactose intolerance

Applied and Industrial Microbiology

MIC-AC/MJ/553 P **Credits 2** **Marks 50 (60 hrs)**

1. Microscopic observation of milk – DMC
2. MBRT and Resazurin tests
3. Production and estimation of lactic acid by lactic acid bacteria
4. Production and estimation of diacetyl
5. Production and study of microorganisms involved in fermented milk- Curd, acidophilus milk, yoghurt, cultured butter milk, acid-alcoholic fermented milk (Kefir)

References:

1. Fundamentals of Dairy Microbiology by Prajapati
2. Dairy Microbiology by Robinson. Volume I and II.
3. Microbial biotechnology- principles and applications- by Lee Yuan Kun
4. Biotechnology Vol. III and V edited by H J Rehman and G Reed
5. Applied dairy microbiology edited by Elmer Marth and James Steele.

A) Pharmaceutical Microbiology (T)

MIC-AC/DSE/554 T **Credits 2** **Marks 50 (30 hrs)**

Course Objectives

- To develop practical skills involved in interpretation of microbiological materials and data
- To promote development of entrepreneurship and build up Professionals in Pharmaceutical Analysis, and R&D work
- To understand quality assurance validation

Course Outcomes

After successful completion of this course, students are expected to:

- Conversant in practical skills involved in interpretation of microbiological materials and data
- Explain the development of entrepreneurship and build up Professionals in Pharmaceutical Analysis, and R&D work
- Aware about quality assurance validation.

Unit I: Principles of Antimicrobial chemotherapy.

Introduction and selection of antimicrobial agents

Concept of Bioassay, therapeutic index, MIC and LD_{50}.

Penetrating defenses, as cellular permeability barriers, Cellular transport system and drug diffusion.

Definition and classification of antibiotics, with respect to their mechanism of action, Antibacterial spectrum, Structural activity and relationship (SAR), acquisition of drug resistance, pharmacokinetics and adverse drug effect β- Lactum(Penicillin, Amoxicillin, cefuroxime), aminoglycosides (Streptomycin, Gentamicin), Tetracyclines (Tetracyclin, doxicyclin) , Macrolides (Erythromycin, Azethreomycin), Peptide antibiotics (Bacitracin, polymixin,), Sulphonamides (sulfamethoxazole), co-trimoxazole and quinolones (ciprofloxacin) Chloramphenicol, trimethoprim.

Unit II: Molecular aspects of Antimicrobial Chemotherapy.

Definition, classification, Mechanism of action and examples of chemical disinfectants, antiseptic and preservatives.

Definition, classification, Mechanism of action and examples of antiviral (Acyclovir, zidovudine), Antifungal (amphotericin B, Fluconazole) and Antitumor (Bleomycin, ductinomycin) antibiotics.

Drug delivery system in gene therapy. Approaches and safety considerations associated with gene therapy. Immunological problems associated to gene therapy. Pre-requisites and candidate

diseases for human gene therapy.Drug carrier, Macromolecular, cellular, and synthetic Viral and non viral mediated gene delivery.

Introduction, concept and types of drug targeting, cellular level events of drug targeting, targeting ligands, blood cell receptors for endogenous compounds/ ligands, carrier and vesicular system for targeting, specialized liposomes for cellular drug targeting.

Unit III: Microbial Production and spoilage of Pharmaceutical Products.

Manufacturing procedure and in-process control of Pharmaceutical products: Bacterial and Viral vaccine, sterile injectables, Solid dosage forms, liquid orals and Ointments

New Vaccine production: DNA vaccines, synthetic, peptide vaccines, multivalent subunit vaccines, edible vaccines and their trials.

Microbial production and applications of therapeutic / diagnostic enzymes: Asparaginase, Streptokinase, beta lactamases

Microbial production contamination and spoilage of Pharmaceutical products (sterile injectables, ophthalmic preparations and implements) and their sterilization

Applications of Biosensors in pharmaceutical industries.

A) Pharmaceutical Microbiology (P)

MIC-AC/DSE/554 P **Credits 2** **Marks 50 (60 hrs)**

1. Isolation and screening of antibiotic producing micro-organisms (Bacteria)
2. Isolation and screening of antibiotic producing micro-organisms (Actinomycetes)
3. Production, purification and bioassay of Rifamycin/Streptomycin.
4. Bioassay of vitamin B12/B2.

REFERENCES

1. Pharmaceutical Microbiology- Edited by W. B. Hugo & A.R. Russel Sixth Edition. Blackwell Scientific Publications.
2. Lippincott's illustrative Reviews: Pharmacology Edition: 02 Maryjnycck by Lippincott's review Publisher Pheladelphia 1997.
3. Principles of medicinal chemistry Vol. 1 by Kadam S.S., Mahadik K.R., Bothra K.G. Edition: 18, Nirali Publication.
4. Pharmacognosy by GokhleS.D., KoKateC.K.. Edition: 18, Nirali Publication.
5. Biotechnology – Expanding Horizon by B.D. Singh ., First Edition, Kalyani Publication, Delhi.
6. Analytical Microbiology- Edited by Fredrick Kavanagh volume I &II. Academic Press New York.
7. Pharmaceutical Biotechnology by S. P. Vyas& V.K. Dixit. CBS publishers & distributors, New Delhi.
8. Quniolinone antimicrobial agents- Edited by David C. Hooper, John S. Wolfson. ASM WashingtonDC.
9. Quality control in the Pharmaceutical industry - Edited by Murray S. Cooper Vol. 2, Academic Press New York.
10. Biotechnology- Edited by H.J. Rhem& Reed, vol 4 VCH publications, Federal Republic of Germany.
11. Good manufacturing practices for Pharmaceuticals. By Sydney H. Willing, Murray M. Tuckerman, Willam S. Hitchings IV. Second edition Mercel Dekker NC New York.
12. Advances in Applied Biotechnology series Vol.10, Biopharmaceutical in transition., Industrial Biotechnology Association by Paine Webber,. Gulf Publishing Company Houston.
13. Drug carriers in biology & medicine Edited by Gregory Gregoriadis. Acedemic Press New York.

Quality Assurance in Microbiology by Rajesh Bhatia, Rattan Lallhhpunjani.CBS publishers & distributors, New Delhi.

B) BIOETHICS, BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS

MIC-AC/DSE/554 T **Credits 2** **Marks 50 (30 hrs)**

Course Objectives

- To give introduction to bioethics and biosafety.
- To give in-depth information about containment.
- To give knowledge about regulatory affairs of pharmaceuticals and GMO.
- To provide information about Intellectual rights.

Course outcome

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

- Understand bioethics and biosafety
- Understand contaminants in production a
- Understand issues related to GMO
- Use knowledge about intellectual property rights

UNIT - I

Bioethics - Introduction to Bioethics, Biosafety - Definition, biosafety consideration, types of containments, personal practices, primaryand secondary containment barriers (biosafety levels 1, 2, 3, 4), containment for production activities,practical consideration, possible hazards from industrial production and use of pathogens.

UNIT - II

Issues related to use of genetically modified microorganisms andtheir release in to the environment, special procedures for recombinant DNA based products.Regulatory affairs - regulatory requirements for drugs and biological products. Ethical issues related to industrial genetically manipulated microorganisms (GMM).Guidelines on biosafety in conducting research in biology / biotechnology; Ethics in use of animalsfor scientific research;

UNIT - III

Intellectual property rights - Importance of Intellectual property, history of patent concept,composition of a patent, general patent information - patent laws, patentable subject matter, apply forpatent, requirements for patentability, patent prosecution, appeals and interference proceedings,

. Patent laws in India.

B) **BIOETHICS, BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS P**

MIC-AC/DSE/554 P **Credits 2** **Marks 50 (30 hrs)**

1. Sterility testing
2. Validation of Laminar air flow unit
3. Validation of Autoclave
4. Monitoring of Laboratory environment (air/water)
5. Survey of any subject related patent/s
6. Documentation about any GM organism and or its product and associated ethical issues.

References:

1. Intellectual property rights on Biotechnology. K. Singh BCII, New Delhi.
2. Biotechnologies in developing countries present and future. 1993. A. Sasson. UNESCO Publishers.

MIC-AC/DSE/554 T **Credits 2** **Marks 50 (30 hrs)**

C) Any Online certification course from NPTEL /SWAYM /MOOC of equivalent credits { with biology basis }

MIC-/OJT/555

On Job Training/ Field Project