Shiksha Mandal's
Bajaj College of Science, (Autonomous) Wardha

M.Sc. I Syllabus

Microbiology

2023-2024

(As Per New Education Policy)

DICIPLINE SPECIFIC COURSE (DSC) – 1

Microbial Metabolism (MM)

PG- MB (08) - S1-T1

Course outcomes:
After successfully completing this course, students will be able to:
CO1: Students will be able to correlate specific aspects of Bioenergetics andMetabolism
CO2: Students will be able to identify and differentiate between major classes ofbiological molecules like protein and Nucleic acids with its chemistry and metabolism

CO3: Students will be able to Gain an understanding of photosynthesis, anoxygenicphotosynthesis and chemolithotrophy.
CO4: Students will be aware of the mechanism and types of Nitrogen and Sulphurmetabolism and methanogenesis.
CO5: Overall the course describes the Microbial metabolism in detail

UNIT-I: - Bioenergetics and metabolism
Concept of entropy, enthalpy, Redox potential, ATP as energy currency, Glycolysis, TCA Cycle, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers. Biosynthesis of cell wall polysaccharides and bacterial peptidoglycan.
Lipid:-Membrane lipids, biosynthesis of membrane phospholipids, ketone bodies.

UNIT-II: - Proteins and Nucleic acids
Proteins:-Determination and characteristics of alpha-helix and β-sheets. Concept of protein domain and motif, common motifs and their role in metabolism, protein folding and denaturation curves, role of Chaperones and chaperonins, Conformation of Proteins: Ramchandran plot.
Nucleic acids:-Confirmation of nucleic acids: helix (A, B, Z), t-RNA, micro-RNA). secondary structure of RNA, purine and pyrimidine biosynthesis, degradation and regulation, De Novo and salvage pathway, Inhibitors.

UNIT-III: - Photosynthesis
Anoxygenic photosynthesis:- Green sulphur and purple phototrophic bacteria.
Oxygenic photosynthesis:- Cyanobacteria.
CO_2 fixation-C_3, C_4 and CAM pathways
Chemolithotrophy:- Hydrogen oxidation and autotrophy in hydrogen bacteria. Iron oxidation.
Bioluminiscence

UNIT-IV:-Nitrogen and Sulphur metabolism and methanogenesis.
Nitrification and Anammox. Nitrate reduction and Denitrification. Nitrogen fixation: Symbiotic, nonsymbiotic. Mechanism of nitrogen fixation and role of nitrogenase enzyme, Sulphate reduction. Methanogenesis, Acetogenesis.

Enzymology and Techniques (ET)

PG- MB (08)- S1-T2

Course outcomes:

After successfully completing this course, students will be able to:

CO1: Students will be able to understand general characteristics of enzymes(Terminologies) and

CO2: Students will learn the different mechanisms of enzyme catalysis.

CO3: Students will be able to Gain an understanding of enzyme kinetics and regulation**CO4:** Students will be able to understanding the various biochemical techniques based on enzymes like biosensors

CO5: Overall the course describes the Enzymology and Techniques in detail

UNIT-I: - Fundamentals of Enzyme

Classification and Nomenclature of enzymes, Membrane bound enzymes, isoenzymes and marker enzymes. Constituitive and inducible enzymes, Multienzyme complexes (PDH, FAS), Abzymes, Ribozymes

UNIT-II: - Catalytic mechanisms:

Acid –base catalysis, covalent catalysis, metal ion
cofactors, proximity and orientation effects, preferential binding.
mechanism of action of lysozyme and serine proteases.

UNIT-III: - Enzymes kinetics and regulation

Evaluation of kinetic parameters, Kinetics of bisubstrate reaction, multistep reactions, kinetics of enzyme inhibition, Allosterism: Kinetic analysis of allosteric enzymes Covalent Modification, Feed -back inhibition. Immobilized Enzymes: Concept, Methods of Immobilization, Kinetics, Immobilized bioreacter.

UNIT-IV: - Techniques

Techniques for isolation and purification of enzymes, methods for enzyme assay.
Protein: ligand binding studies: association and dissociation constants, co-operative ligand binding
MWC or concerted model, sequential model.
Enzyme biosensors: General concept, glucose biosensor. Industrial applications of enzymes (Amylase, Protease, Cellulase), Protein Engineering: Concept and methods with examples of therapeutic protein

Advance Techniques in Microbiology (ATM)

PG- MB (08) - S1-T3

Course outcomes:

After successfully completing this course, students will be able to:

CO1: Students will be able to understand the important aspects of advancebiophysical techniques used in microbiology

CO2: Students will learn the working and principles of various instruments likeelectro[horess, centrifugation and chromatography

CO3: Students will gain knowledge of important microscopy techniques from basic toadvanced one.

CO4: Students will be able to understand the applications of advanced technique indifferent aspects of life sciences .

CO5: This course overall gives the understanding of instrumentation in life sciences,which is needed in industry as well as research laboratories.

UNIT-I: - Biophysical Techniques-I

Analysis of biomolecules: UV/visible spectrophotometer, fluorescence, circular dichroism,

Structure determination: X-ray diffraction and NMR; analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods

UNIT-II: -Biophysical Techniques-II

Electrophoresis: Agarose Gel, SDS-page, two-dimensional gel electrophoresis, capillary electrophoresis, immuno-electrophoresis. Centrifugation and ultracentrifugation,Chromatography: Principle, design and applications of TLC, HPTLC, GC, HPLC, Gel filtration.

UNIT-III: -Microscopical Techniques.

Electron Microscopy: SEM, TEM. Fluorescent Microscopy, Laser scanning, confocal microscopy. Scanning tunneling and atomic force microscopy. Immunoelectron microscopy, Cryoelectron microscopy.

UNIT-IV: -Other advance techniques

Western, Southern and Northern blotting techniques, transcriptional start point mapping, flouroscence photobleaching recovery, flow cytometry, In-situ localization by techniques such as FISH & GISH.

Membrane structure and Signal Transduction (MSST)

PG- MB (08) - S1-T4

Course outcomes:

After successfully completing this course, students will be able to:

CO1: Students will be able to understand the important aspects of cell biology likemembranes and organelles.

CO2: Students will learn the structure and function of membranes and organelles

CO3: Students will understand the important things about cellular transport and theirenergetics.

CO4: Students will learn about the detailed concept of signal transduction.

CO5: This knowledge will increase students' interest in research based on cell biologyand signal transduction and they can be hired on such research projects

UNIT-I: - Structure and organization of membrane and cell organelles
Structure of Model Membrane, Lipid bilayer and membrane proteins, Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast), Structure & function of cytoskeleton and its role in motility.

UNIT-II: - Membrane Transport
Active and Passive transport, uniport, ATP powered pumps, non-gated ion channels, cotransport by symporters and antiporters, transepithelial transport.

UNIT-III: - Signal Transduction I
General concept of cell signaling, G-protein coupled receptors and their effectors.
RTK and MAP Kinases. Down regulations of pathways, JAK-STAT pathway

UNIT-IV: - Signal Transduction II
Basic two component system in bacteria and plants, Histidine kinase pathway, Sporulation as a model of bacterial signal transduction, osmoregulatory pathways, Light signaling in plants, Heat shock proteins,Mating types of yeast.

PRACTICAL-I

PG- MB (08) - S1-P1

Course outcomes:

CO1: This course explains the enzyme activity determination of important hydrolyticenzymes

CO2: Students will learn about the effect of different physical factors

CO3: Students will able to isolate and purify the enzyme

CO4: Students will able to isolate and identify Nitrogen fixing bacteria such asAzotobacter ,Rhizobium etc

CO5: students will be able to isolate Siderophore producing bacteria.

1) Detection of Uraease enzyme activity,
2) Determination of kinetic constant of amylase: - Amylase activity, Vmax. Km.
3) Effect of pH and temperature on amylase activity.
4) Effect of inhibitors on amylase activity.
5) Estimation of protein by Lowry's method.
6) Production, isolation and purification of enzyme and determination of fold purification (any one enzyme)
7) Estimation of sucrose in presence of glucose.
8) UV absorption of proteins, DNA and RNA.
9) Isolation and identification of Nitrogen fixing bacteria such as Azotobacter, Rhizobium etc.
10) Isolation of Siderophore producing bacteria.

Minimum seven experiments must be performed in the semester.

PRACTICAL-II

PG- MB (08)- S1-P2

Course outcomes:

After successfully completing this course, students will be able to:

CO1: This course explains the techniques of Genetics and protein biology

CO2: Students will learn about Subcellular organelles and isolation of Markerenzymes.

CO3: The performance of various molecular techniques will be understood

CO4: Students will learn various techniques of protein isolation and analysistechniques

1) Separation of DNA by agarose gel electrophoresis
2) Separation of amino acids by paper chromatography.
4) Separation of serum proteins by paper electrophoresis.
5) Thin layer chromatography.
6) SDS-Page of proteins.
7) Performance of affinity chromatography.
8) Performance of Gel filtration chromatography.
9) Demonstration of Western blotting technique
10) Ion exchange chromatography
11) Separation of Subcellular organelles and isolation of Marker enzymes
12) Demonstration of HPLC and GC.

Minimum seven experiments must be performed in the semester.

Bajaj College of Science, Wardha (Autonomous)

Department of Microbiology

M. Sc. I Semester I, NEP 2023-24

Research methodology (RM)

[4 Credits]

Course Objectives:
1. Gain a comprehensive understanding of research methodology and its fundamental concepts.
2. Develop the ability to critically evaluate and select appropriate research methods for different types of research.
3. Acquire skills in data collection, analysis, and interpretation using various statistical techniques.
4. Enhance proficiency in technical writing, research reporting, and adherence to research ethics and academic integrity.

Course Outcomes:
After learning research methodology course, students will be able to
1. Identify and describe the characteristics of different types of research, including basic, applied, and patent-oriented research.
2. Apply scientific thinking and problem identification techniques in the research process.
3. Apply descriptive and inferential statistical analysis techniques to analyze and interpret research data and understand the concept of hypothesis and its importance in research, and apply appropriate research methods.
4. Develop skills in technical writing, research reporting, and the proper structure and organization of research documents and gain awareness of research ethics, academic integrity, and the importance of avoiding plagiarism and academic malpractice.

Syllabus

Module 1: Research basics and perception of research

1.1 Definition: research, research methodology, discovery, invention and innovation
1.2 General and specific characteristics of research, types of research (basic, applied and qualitative, quantitative, conceptual, empirical, patent oriented).
1.3 Steps of Action (basic) research, objectives of basic research, characteristics of investigators.
1.4 Scientific thinking- characters, steps in process of scientific thinking, Steps in problem identification, criteria for selecting problem, and sources of scientific problems.

1.5 Review of literature- meaning, need, and objectives, structure of review of literature, sources of literature collection, Simple rules of structuring (writing) literature review. Identifying gaps in present knowledge

Module 2: Biostatistics and Data Analysis

2.1 Definition of statistics and biostatistics, Statistical terms and notations: Population, Sample, variable, types of variables (Qualitative, quantitative), parameter, observation, Data etc

2.2 Methods of data collection: Sampling, methods of sampling, sampling errors, non sampling errors

2.3 Central tendency and Measures of central tendency: Mean, Arithmatic, Geomatric, Harmonic, Average of positions: mode, and median, Merits and demerits and their applicability

2.4 Measures of variance and dispersion: range, standard deviation, standard error

2.5 Application of Microsoft Excel in statistical analysis (statistical functions and spreadsheets in MS-Excel)

Module 3: Scientific Writing and IPR

3.1 Research report- Concept and need of research report and scientific writing, Types of research report, Essential steps for writing scientific manuscript/research paper, structure of project report, structure of project proposal, structure of thesis, use of software's for writing thesis

3.2 Types of Scientiffic publications: magazines, journals, reviews, newsletters

3.3 Layout of research paper, various reference styles, Annotated Bibliographies

3.4 Research Indicators and Metrics: Impact factor, Cite score, h-index, i10 index, Citation index

3.5 Intellectual Property Rights (IPR): Introduction to IPR, Patents, Trademarks, Geographical Indicators, Copyrights. Importance of IPR

Module 4: Techniques for Research, ethics and plagiarism

4.1 Methods to search research information, Online research tools: N-List, PubMed, Google Scholar

4.2 Softwares for research data presentation: MSWord and Excel, Graph and chart preparation, Power point presentation, OriginLab. Reference management softwares like Zotero/Mendley

4.3 Academic integrity, research ethics, Skills(rules) for good academic practice, Plagiarism: Understanding plagiarism and academic malpractice, detection of plagiarism usingsoftwares

References/ Books:

- Shanti Mishra, & Alok, S. (2011). *Handbook of Research Methodology: A Compendium for Scholars & Researchers*. Educreation Publishing.
- Singh, Y. kumar. (2006). *Fundamentals of Research Methodology and Statistics*. New Age International Publishers.
- Walliman, N. (2010). *Research Methods The Basics*. Routledge Taylor and Francis Group.
- Kothari, C.R. (2019) *Research Methodology: Methods and Techniques*. 4th Edition, New Age International Publishers, New Delhi.
- Khan And Irfan A and Atiya Khanum(1994) *Fundamentals Of Biostatistics*.6th Revised EdnUkaaz Publications.
- Sadguru Prasad (2012) Fundamentals of Biostatistics (Biometry). Emkay Publications
- Patrick Carey, Katherine T, Pinard et al.. (2019) New Perspectives Microsoft® Office 365® &office 2019.Introductory 2020. Course Technology Inc;
- Mosam Sinha (2017) *How to Write Thesis and Research Papers*. Raj Publications

Assignments based on Research Methodology course
Instructions:
These assignments can enhance the professional skills needed to pursue a career in research/teaching. Therefore, each PG department should identify ten assignments from the list below. Continuous evaluation will occur throughout the semester. Performance on the assignment will be graded for 40 marks.

1. **Navigate and use Google, Google Scholar, SciHub, PubMed, Web of Science, Elicit and ScienceDirect effectively to search for research papers, perform searches and retrieve relevant research papers.**
   [Suggestion/Working hours:-Dedicate a few hours each week to practice searching on these databases to continually refine your skills.]

2. **Write accurately references in APA format for various types of sources, including books, journal articles, websites, and conference papers and gain a comprehensive understanding of the Zotero platform, including its interface, features, and capabilities for managing bibliographic information.**
   [Suggestion/Working hours-Invest time in exploring and understanding the features of Zotero(https://www.zotero.org/) through guided tutorials and hands-on experience and gain proficiency in using Zotero to input, organize, and format references, and effectively manage bibliographic data]

3. **How to read research paper and develop a thorough understanding of the three-pass approach for effective note-taking from research readings.**

4. **Review and analyse collected references systematically to identify at least three prospective research problems or gaps in your domain.**
   [Suggestion/Working hours:-Review a minimum of 20 relevant references in your domain to gain a comprehensive understanding of current research trends and gaps. Dedicate focused time each week to systematically review references and refine your problem identification skill]

5. **Write at least three research objectives and three hypotheses that are well-defined, focused, and aligned with the research problem.**
   [Suggestion/Working hours:-Within one month, be able to formulate clear and relevant research objectives or hypotheses for the given research problem.Seek feedback from mentors or advisors to refine your research objectives or hypotheses and ensure their relevance and clarity.]

6. Create a graph (line/bar/pie) using Microsoft Excel. Prepare publication ready graph and write legend for the graph and table.

7. Understand structure of scientific poster. Write well-structured scientific poster that effectively communicates research findings, adheres to design principles, and captures audience attention.

8. Understand structure of oral presentation and demonstrate the ability to deliver a clear and engaging oral presentation, incorporating effective communication techniques and supporting visual aids.

9. Find out how to use the chosen plagiarism detection tool step by step to check a paper for possible instances of plagiarism.Attain the ability to use the chosen plagiarism detection tool proficiently, including uploading documents, interpreting plagiarism reports, and understanding similarity scores.

10. Write one page research proposal. Write research proposal in the format of any funding agency.

11. Write minireview article.

12. Write short communication with one table and one figure.

13. Write scientific blog.