SCHOOL OF LIFE SCIENCES, SAMBALPUR UNIVERSITY

M.Sc. MICROBIOLOGY COURSE OUTLINE

Course	Course Title	Credit hours	Marks
	SEMESTER- I		
MB-411	Fundamentals of Physical Sciences and Biophysics	4 CH	100
MB-412	Fundamentals of Biochemistry and Biophysical Chemistry	4 CH	100
MB-413	Bio-instrumentation and Techniques	4 CH	100
MB-414	Fundamentals of Microbiology and Molecular Biology	4 CH	100
MB-415	Practical on MB-411 and MB-412 (Biophysics and Biochemistry)	2 CH	50
MB-416	Practical on MB-413 & MB-414 (Instrumentation and Microbiology	2 CH	50
		20 CH	500
	SEMESTER- II		
MB-421	Ecology, Biodiversity and Biostatistics	4 CH	100
MB-422	Cell Biology	4 CH	100
MB-423	Genetics	4 CH	100
MB-424	Immunology	4 CH	100
MB-425	Practical on MB-421 and MB-422 (Ecology, Biostatistics and Cell Biology)	2 CH	50
MB-426	Practical on MB-423 & MB-424 (Genetics and Immunology)	2 CH	50
		20 CH	500
	SEMESTER- III		
MB-511	Bioinformatics and Computer Application	4 CH	100
MB-512	Mycology, Phycology and Microbial Diseases	4 CH	100
MB-513(A) or (B)	Special paper-I A: Environmental Microbiology B: Industrial Microbiology	4 CH	100
MB-514	Practical Based on MB-531	2 CH	50
MB-515	Practical on MB-533	2 CH	50
MB-516	Industrial Visit and Report Submission	2 CH	50
MB-517	Seminar	2 CH	50
		20 CH	500
	SEMESTER- IV		
MB-521	Microbial Physiology and Microbial Genetics	4 CH	100
MB-522	Microbial Genomics and Proteomics	4CH	100
MB-523 (A) or (B)	Special paper-II: A: Medical Microbiology B: Food Microbiology	4 CH	100
MB-524	Practical on MB-541 and MB-542	2 CH	50
MB-525	Practical on MB-543	2 CH	50
MB-526	Project Work, Dissertation and Viva	4 CH	200
		20CH	500
	Total Course Credit	80 CH	2000
	Environmental studies and disaster management (In First semester)	2 CH	50
	Inter-disciplinary course (Open elective) (In Second Semester)	3 CH	75
	Entrepreneurship Development Programme (In third Semester	2 CH	50
	MOOCS course (One paper in Second or Third Semester)	3 CH	75
	GRAND TOTAL =	90 CH	2250

Preamble of Microbiology Syllabus

Microbiology is an advance and applied Biological Sciences course where the principles of Physics, Chemistry, Mathematics and other Physical Sciences are integrated together and applied and tested in the living systems. In other words, Microbiology is the conglomeration of physical and natural sciences at the level of higher learning and is very important for Microbiology students to understand the basic principles and theories of Physical sciences to solve Biological problems. So the major objective of the programme is to establish a fundamental foundation of understandings and skill based knowledge of Physical Sciences to be applied in living systems which will enable the students to pursue advance research in modern Microbiology for solving upcoming critical problems.

M.Sc. Microbiology syllabus has been designed to equip the students with subject domain knowledge and technical skills pertaining to both physical and biological sciences. The course also aims to train the students in all areas of Microbiology with unique combination of some interdisciplinary courses, few compulsory papers, some elective papers and some specialization courses. Apart from this, students have the opportunity for exposure to cutting-edge technologies, modern equipment facilities and advance trainings to gear up their scientific aptitude to build their career and become part of Nation building. After completion of the course, students are made aware about the current social and environmental issues and how the living organisms including plants, animals and microbes are important for humanity and also for their relevance towards national economy and food security. After obtaining Post-graduate degree, the students may be quite competent and efficient to set up, design and execute research projects using various tools and techniques learned by them in the areas like modern instrumentation techniques, biophysical chemistry, biostatistics, computer applications, genetics, molecular biology, physiology, biochemistry, microbiology, ecology, radiation biology, developmental biology, genetic engineering etc. and develop Scientific temperament and research attitude for solving any sort of Microbiology related problems.

Mission

M1.Sambalpur University shall strive to educate society for generations by providing transformative education with deep disciplinary knowledge and concern for environment.

M2. To develop problem solving, leadership and communication skill in student participants to serve the organization of today and tomorrow.

M3. To aim for the holistic development of the students by giving them value based ethical education with concern for society.

M4. To foster entrepreneurial skills and mindset in the students by giving lifelong learning to make them responsible citizens.

Programme Specific Outcomes (PSOs)

PSO1. Understand the nature and basic concepts of modern Microbiology to solve the upcoming censorious problems.

PSO2. Analyze the relationships among different concepts of different branches of Microbiology and their integration together for generation of useful products with societal relevance.

PSO3. Perform procedures and experiments as laid down in the areas of modern Microbiology and find out leads for advance learning and also for new discovery.

PSO4. Apply the basic concepts learned from the course and execute them in real situations for the benefit of humanity.

Programme Outcomes (POs)

After completing the PG courses in Life Sciences, the student will be capable of

PO1. Critical thinking: Take informed actions after identifying the assumptions in the areas of Microbiology that frame our thinking and actions.

PO2.Effective Communication: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language.

PO3. Social Interaction (Interpersonal Relation): Elicit views of others, mediate disagreements and prepared to work in a team.

PO4. Entrepreneurship Capability: Demonstrate qualities to be prepared through scientific experimentations to become an Entrepreneur in different branches of Life Sciences.

PO5. Ethics: Recognize different value systems, understand the moral dimensions and accept responsibility for them.

PO6.Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.

PO7. Life-long Learning: Acquire the ability to engage in independent and life-long learning in the context of scientific and socio-technological changes.

FIRST SEMESTER

MB-411	**Fundamentals of Physical Sciences and Biophysics**	**4CH**	**100 marks**

OBJECTIVE

This paper contains four units Fundamentals of Physical Sciences and Biophysics. Each unit contains a description of the principles related to that unit, well-supported by mathematical derivations of equations, descriptions of laboratory experiments, historical background etc; with solved examples that explain equation just derived or the concept just discussed. These courses will help in fixing the Ideas firmly in student's mind. The examples discussed are used to encourage students for participation in discussions and motivate towards advance learning in the field.

PROGRAMME EDUCATION OBJECTIVES (PEOs): After studying Fundamentals of Physical Science in the curriculum, students will be able to:

PEO1. Understand the nature and basic concepts of Fundamentals of Physical Sciences and Biophysics relating to M.Sc. degree in Life Sciences.
PEO2. Analyze the relationships among different concepts of Physical Sciences and Biophysics.
PEO3. Perform procedures as laid down in the areas of study.
PEO4. Apply the basic concepts learned to execute them.

COURSE OUTCOMEs (COs): After studying Fundamental of Physical Sciences and Biophysics in the curriculum, students will be able to:

CO1. Remember and understand the basic concepts of Physical sciences and Biophysics.

CO2. Analyze the various concepts to understand them through laboratory experiments/case studies.

CO3. Apply the knowledge in understanding practical problems.

CO4. Execute/create the projects or field assignment as per the knowledge gained in the course curriculum.

COURSE

Unit-I: Basic Physics: Concept of Physics, Fundamental and Derived Quantities, Units and Dimensions, their conversions and their uses, Order of Magnitudes; The forces: Gravitational, Electromotive and Nuclear forces; Different forms of energies, Kinetic vs Potential energy, Mass-energy equivalence, Surface tension, Viscosity, Photoelectric effect.

Unit-II: Photo-biophysics: Light absorption, emission and quantum transfer mechanism, laws of photochemistry, quantum yield and inductive resonance, photochemistry of photosynthesis and vision, UV-induced DNA damage and repair mechanisms, ionising and non-ionising radiations, effect of ionising radiations on biomolecules and cells and photo-protective mechanisms in plants during stress.

Unit-III: Physico-chemical Study of Matter: Atomic models of atom, Waves and wave functions, Quantum mechanics of Hydrogen atom, Nuclear Forces, Nuclear stability, basic concepts of radioactivity, Spectrum, Kinds of spectrum, UV & IR spectrum.

Unit-IV: Molecular interactions: Dipole and dipole moments, induced and transient dipole, unit charge, charge-charge interaction, charge-dipole interaction, dipole-dipole interaction, hydrogen bonding, Van der Waal's interaction, role of weak electrostatic interactions in the stability of proteins (α-helix and β-pleated sheets), nucleic acids, bio-membranes, liposomes, micelles, artificial lipid bilayers and structure of water, protein folding.

SUGGESTED READINGS:

1. Text book of Physics by Barik, Das, Sharma.
2. Essentials of Physical Chemistry by Arun Bahl, B S Bahl & G.D. Tuli.
3. Text books in mathematics published by NCERT, India.
4. Concepts of Physics by H C Verma.
5. IIT Chemistry by O P Agarwal.
6. PMP Certification Mathematics by V Subramanian & R Ramachandran.

7. Electrical Interactions in Molecular Biophysics: An Introduction. Raymond Gabler. Academic Press, New York.

MB-412	Fundamentals of Biochemistry and Biophysical Chemistry	4 CH	100 marks

OBJECTIVE

The objective of this particular paper is to provide an advance understanding of course principles in biochemistry, biophysical chemistry and their experimental basis. It will enable the students to understand the various aspects of biochemistry, biophysical chemistry and its importance in daily life. Further it can be utilized for clinical diagnosis, manufacturing of biological products and treatment of diseases.

PROGRAMME EDUCATION OBJECTIVES (PEOs): After studying Biochemistry and Biophysical Chemistry in the curriculum, students will be able to:

PO1. Understand the nature and basic concepts of Biochemistry and Biophysical Chemistry.
PO2. Analyze the relationships among different concepts of Biochemistry and Biophysical Chemistry.
PO3. Perform procedures as laid down in the areas of study.
PO4. Apply the basic concepts learned to execute them.

COURSE OUTCOMEs (COs): After studying Biochemistry and Biophysical chemistry in the curriculum, students will be able to:

CO1. Remember and understand the basic concepts of Biochemistry and and Biophysical Chemistry.

CO2. Analyze the various concepts to understand them through laboratory experiments/case studies.

CO3. Apply the knowledge in understanding practical problems.

CO4. Execute/create the projects or field assignment as per the knowledge gained in the course curriculum.

COURSE

Unit-I: Biophysical chemistry: pH and Buffers, Ionic strength, Buffer strength, Buffering zone and preparation of buffers, Molecularity and kinetic order of reaction, Theories of reaction rate, Laws of thermodynamics and biology – Concept of free energy, Entropy, Q_{10} and Arrhenius equation.

Unit II: Structure of Biomolecules: Polysaccharides, starch and glycogen as reserve fuel; Cellulose as structural polysaccharides; Lipids: triglycerides and spingosides, conjugated and complex lipids. Structure and conformation of nucleic acids. Proteins: molecular organization, protein structure (Primary, Secondary, Tertiary and Quaternary).

Unit-III: Metabolism and Bioenergetics: Glycogenesis and glycogogenolysis, HMP shunt, Gluconeogenesis and its physiological significance; Oxidation of fatty acids. Electron transport in mitochondria and chloroplast; Basic principles of oxidative and photophosphorylation.

Unit-IV: Enzymes: Classification of enzymes, concept of active site and its analysis, Mechanism of enzyme catalysis (with examples), Michaelis-Menten, Linewever-Burke plot, Eddy-Hoftsee plot and Hans plot, Factors affecting enzyme catalysis, Enzymes inhibitions, Allosteric enzymes.

SUGGESTED READINGS:

1. Fundamental of Biochemistry by J. L. Jain.
2. IIT Chemistry by O P Agarwal.
3. Principles of Biochemistry by Lehninger, David L. Nelson and Michael M. Cox
4. Biochemistry by Jeremy M. Berg, John L. Tymoczko and Lubert Stryer
5. Principles of Biochemistry by Donald Voet, Judith G. Voet and Charlotte W. Pratt

MB-413	Bioinstrumentation and Techniques	4 CH	100 marks

OBJECTIVE:

Bioinstrumentation and Techniques paper involves the principles and use of various instruments used to quantify various aspects of Biological materials. Cutting-edge instruments not only enable new discoveries but help to make the production of knowledge more efficient. Many newly developed instruments are important because they enable us to explore phenomena with more precision and speed.

PROGRAMME EDUCATION OBJECTIVES (PEOs): After studying Bionstrumentation and Techniques in the curriculum, students will be able to:

PEO1. Understand the basic concepts and principles of different instruments used in Life Sciences.
PEO2 Analyze the different biological materials using the instruments and techniques.
PEO3. Perform procedures as laid down in the areas of study.
PEO4. Apply the basic concepts learned to execute them.

COURSE OUTCOMEs (COs): After studying Bionstrumentation and Techniques in the curriculum,, students will be able to:

CO1. Remember and understand the basic concepts of Bionstrumentation and Techniques used in Life Sciences.

CO2. Analyze the various concepts to understand them through laboratory experiments/case studies.

CO3. Apply the knowledge in understanding practical problems.

CO4. Execute/ create projects or field assignment as per the knowledge gained in the course curriculum..

COURSE

Unit-I: Spectrophotometry – laws of absorption of light, absorption and action spectra, colorimeter and spectrophotometer, double and single beam spectrophotometer, visible and UV-spectrophotometry, applications of spectrophotometry, Fluorescence and Flurometry. Centrifugation – Principles, Types: Density gradient and differential centrifugation. Principle and types of chromatography (Paper, Column, Affinity and Ion-exchange).

Unit-II: pH metry, Bomb calorimetry, Flame photometry, Oxygen polarography, Principle and application of Gel Electrophoresis (Agarose, PAGE, SDS-PAGE and IEF).

Unit-III: Radioactivity; Principle and application of G.M. Counter and Liquid Scintillation counter, Microscopy (Compound, Phase contrast, Fluorescence, Confocal); Electron Microscopy (TEM, SEM and STEM); Remote sensing and its application.

Unit-IV: Principle and application of the instrumental technique: X-ray crystallography, OD and CRD, Infra Red (IR), Nuclear Magnetic Resonance and Electron Spin Resonance spectroscopy. MALDI-TOF, MS-MS; Flow cytometry, Cytofluorometry and FACS; Atomic absorption spectroscopy (AAS); FISH, IRGA.

SUGGESTED READINGS:

1. Learning Radiology: Recognizing the Basic by William Herring
2. Handbook of HPLC-HPTLC (PB 2021) by R.K. Nema
3. Applications of MALDI-TOF Spectroscopy 2013 Edition by Zongwei Cai, Shuying Liu , Springer
4. Physical Biochemistry by David Freifelder
5. Modern Experimental Biochemistry by Rodney Boyer
6. Molecular Cloning by Sambrook Russel
7. Principles and Techniques of Biochemistry and Molecular Biology. Edited: Wilson and Walkers.

MB-414	Fundamentals of Microbiology and Molecular Biology	4 CH	100 marks

OBJECTIVE:

Microbiology is a broad discipline and students have a wide range of options for the study of microbiology including: microbial physiology, microbial genetics, microbial ecology, pathogenesis, immunology, virology, parasitology, epidemiology, evolution and diversity. Microbiology is a laboratory-based science, and as such, our curriculum supports laboratory components in most of the courses taught in the program. Molecular biology deals with nucleic acids and proteins and how these molecules interact within the cell to promote proper growth, division, and development. It is a large and ever-changing discipline. This course will emphasize the molecular mechanisms of DNA replication, repair, protein synthesis.

PROGRAMME EDUCATION OBJECTIVES (PEOs):

PEO1. Understand the nature and basic concepts of Microbiology and Molecular Biology relating to M.Sc. degree in Life Sciences.
PEO2. Analyze the relationships among different concepts of Microbiology and Molecular Biology.
PEO3. Perform procedures as laid down in the areas of study.
PEO4. Apply the basic concepts learned to execute them.

COURSE OUTCOMEs (COs): After studying Microbiology and Molecular Biology in the curriculum, students will be able to:

CO1. Remember and understand the basic concepts of Microbiology and Molecular Biology.

CO2. Analyze the various concepts to understand them through laboratory experiments/case studies.

CO3. Apply the knowledge in understanding practical problems.

CO4. Execute/ create projects or field assignment as per the knowledge gained in the course curriculum.

COURSE:

Unit-I: Historical resume of microbiology, an overview of the microbial world (Bacteria, Archea, Eukaryote). Classification of Archea and Eubacteria as per Bergey's manual; Microbial phylogeny. Structural organization of prokaryotic cell (bacterial cell wall, capsule, flagella, pilli, pronucleus, ribosomes, plasmid).

Unit-II: Bacterial nutrition and nutritional category, Bacterial culture: Synchronous and asynchronous culture, continuous culture and chemostat principle. Bacterial growth: phases of growth, Mathematical expression of growth, generation time, specific growth rate. Bacterial metabolism: Glucose dissimilation pathways, Bacterial respiration with organic and inorganic reductant, Chemolithotrophy. General principle of bacterial conjugation, transduction and transformation. Bacterial pathogenecity and anti-microbial compounds.

Unit-III: Genetic organization of Prokaryotes and Eukaryotes including nuclear genome and organellar genome; DNA as the genetic material; Central dogma of Molecular Biology; DNA replication: Models of DNA replication, Enzymes of DNA replication, Transcription: Components of transcription machinery in Prokaryotes and Eukaryotes, Trancriptional factors, Transcription process (initiation, elongation and termination); Post-transcriptional processing, m-RNA stability, m-RNA editing; Gene silencing.

Unit-IV:, Translation: Genetic Code- Principle of translation, Translation machinery in Prokaryotes and Eukaryotes (t-RNA, Aminoacyl synthetase, Ribosome), Translation process (initiation, elongation and termination); DNA repairs mechanism, DNA recombination (site-specific and homologous) mechanisms and its significance. Regulation of gene expression: Constitutive and Induced gene expression; Regulation of gene expression in Prokaryotes and Eukaryotes; Operon concept (Lac, Ara, Trp and His).

SUGGESTED READINGS:

1. Brock Biology of Microorganisms (12th edition) by Madigan and John M. Martinko, Paul V. Dunlap, David P. Clark Benjamin Cummings; 2008.
2. Microbiology. Sixth edition, International edition by Prescott, L. M., J. P. Harley and D. A. Klein. 2005., Mc Graw Hill.
3. Microbiology. Fifth edition by Pelczar, T. R. and M. J. Chan and N. R. Kreig. 2006, Tata Mc Graw-Hill INC. New York.
4. Fundamentals of Microbiology & Immunology by Ajit Banerjee and Nirmalya Banerjee 2008.. New Central Book Agency (P) Limited.
5. A Textbook of Microbiology, 4th Edn. by R C Dubey and D K Maheshwari , S. Chand Publishing.
6. Gene – VIII by B. Lewin, Pub: Jones and Barlett .
7. Molecular biology of the gene 5th Edn. by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine and R. Losick, Pub: Cold Spinger Harbr Laboratory Press.

8. Molecular Biology of the cell 4th Edn. by B. Alberts, D. Brey, J Lewis, M. Raff, K. Roberts and J.D. Watson, Pub: Garland Science
9. The cell: A molecular Approach. by G.M. Cooper and R.E. Hausman

MB-415	**Practical on Bioinstrumentation, Biophysics and Biochemistry**	**2 CH**	**50 marks**
MB-416	**Practical on Microbiology and Molecular Biology**	**2 CH**	**50 marks**
	Total =	**20 CH**	**500 marks**

SECOND SEMESTER

MB-421	**Ecology, Biodiversity, and Biostatistics**	**4 CH**	**100 marks**

OBJECTIVE:
Ecology is the paper to understand the nature of environmental influences on individual organisms, their populations and communities at the level of biosphere. It will also deal with the local distribution of animals in various habitats and the influence of the deterioration of habitats on the population and the community as a whole. The objective of Biostatistics is to advance statistical science and its application to problems of biology including human health and disease, with the ultimate goal of advancing statistics. The role of biostatisticians is an important one, especially when it comes to designing studies and analyzing data from research problems.

PROGRAMME EDUCATION OBJECTIVES (PEOs): After studying Ecology, Biodiversity and Biostatistics, the students will be able to:

PEO1. Remember and understand the basic concepts of Ecology, Biodiversity and Biostatistics.
PEO2. Analyze the relationships among different concepts of Ecology, Biodiversity and Biostatistics.
PEO3. Perform procedures as laid down in the areas of study.
PEO4. Apply the basic concepts learned to execute them.

COURSE OUTCOMEs (COs): After studying Ecology, Biodiversity and Biostatistics in the curriculum, students will be able to:

CO1. Remember and understand the basic concepts of Ecology, Biodiversity and Biostatistics.
CO2. Analyze the various concepts to understand them through laboratory experiments/case studies.
CO3. Apply the knowledge in understanding practical problems.
CO4. Execute/ create projects or field assignment as per the knowledge gained in the course curriculum.

Unit-I:
Concepts of environment and ecosystem: Biotic and abiotic interactions; Cybernetic nature of ecosystem; stability through feedback control and through redundancy of components; resistance and resilience stability, Gaia hypothesis; Concept of limiting factors- Liebig's law, Shelford's law; Ecological indicators. Energy in the environment: Laws of thermodynamics, energy flow in the ecosystem; Primary productivity and secondary productivity. Food chain, food web, trophic levels. Ecological pyramids, Ecological efficiencies, Biogeochemical cycles- patterns and types (CNP).

Unit-II:

Population Ecology: Concept of population and population attributes: Density, natality, mortality, survivorship curves, life table, age structure, population growth forms, Concept of carrying capacity and environmental resistance, Life history strategies, r- and k- selection, Biological scaling (allometry), , Concept of habitat and niche, Quantitative features and attributes of community, Community dynamics: trends and significance, Climax theory, Co-evolution of species populations in the community. Concepts of Resource: Biotic & Abiotic Resources, Renewable and Nonrenewable resources, Exhaustible and non-exhaustible resources. Resource Conservation and Management, Concept of Sustainable Development,

Unit-III:

Biodiversity: Definition, importance, Magnitude and global accumulation of biodiversity; diversification through geological time scale; Levels of biodiversity. Measurement of biodiversity: Species richness & abundances, diversity indices – Shannon, Simpson & Fisher's Alpha. Biodiversity and various ecosystem services; Valuation of ecosystems and species:. Biodiversity prospecting and indigenous knowledge systems, community biodiversity registers. Attributes of biodiversity: keystone species, flag ship species, indicator species, rare species, vulnerable species, and endangered species; Latitudinal gradients of biodiversity and mega biodiversity. Methods of biodiversity conservation (i*n situ* and e*x situ*, and germplasm conservation)

Unit-IV:

Biostatistics: Concept of biostatistics, Measures of central tendency and dispersion; probability distributions (Binomial, Poisson and normal); Sampling distribution; Difference between parametric and non-parametric statistics; Confidence Interval; Errors; Levels of significance; Test of significance: Regression and Correlation; t-test; Analysis of variance; X^2 test; Basic introduction to Multivariate statistics.

SUGGESTED READINGS:

1. Fundamentals of Ecology by Eugene P. Odum and Gary W. Barrett ,(2009) Amazon.in
2. Fundamentals of Ecology by S. Dash, M. Dash, 3rd Edition, Mcgraw Higher Ed
3. Concepts of Ecology by Concepts of Ecology (1995) by Edward J. Kormondy
4. Mayr, E. 1969. Principles of Systematic Zoology. McGraw Hill Book Company,Inc., NY. 24.
5. Biostatistics: Theory and Application by G.B.N Chainy, G. Mishra, P.k. Mohanty, Kalyani Publishers.
6. Introductory practical Biostatistics by B.N.Mishra, M.K. Mishra, Naya Prokash publication, Calcutta

MB-422	**Cell Biology**	**4 CH**	**100 marks**

OBJECTIVE: Membrane Biology associated with cellular transport along with cell signaling is key events in cell metabolism. Basic physiological processes in relation to different kinds of radiation largely influence cell dynamics and thus survival. This paper comprises of four units, namely Cellular organization and cell organelles, Cell dynamics and Cell signaling, Cellular Transport, and Cellular Radiation Physiology. Each unit contains a description of the principles related to that unit, well-supported by different examples, descriptions of laboratory experiments, historical background etc. with solved equations that explain the concept. These courses will help in fixing the Ideas firmly in student's mind which will bring them to a habit of being excellent scientific temperament.

PROGRAMME EDUCATION OBJECTIVES (PEOs): After studying Cell Biology in the curriculum, students will be able to:

PEO1. Understand the nature and basic concepts of Cell Biology relating to M.Sc. degree in Life Sciences.
PEO2. Analyze the relationships among different concepts of Cell Biology.
PEO3. Perform procedures as laid down in the areas of study.
PEO4. Apply the basic concepts learned to execute them.

COURSE OUTCOMEs (COs): After studying Cell Biology in the curriculum, students will be able to:

CO1. Remember and understand the basic concepts/principles of Cell Biology.

CO2. Analyze the various concepts to understand them through scientific experimentations/ case studies.

CO3. Apply the knowledge in understanding practical problems.

CO4. Execute/create the projects or field assignment as per the knowledge gained in the course curriculum.

COURSE:

Unit-I: Cell as the basic structural and functional unit of living system, prokaryotic and eukaryotic cells, plant and animal cells, organization of different organelles in the cell and their interaction, mitochondria, chloroplast, endoplasmic reticulum, Golgi bodies, lysosomes and peroxisomes. Role of cell organelles during cell division and cell cycle.

Unit-II: Cell dynamics and Cell signaling: The dynamics of cell and its evolution, Architecture and life cycle of cells, Overview of cell to cell signaling at intercellular communications, Cell surface receptors and their role in signal transduction, G-protein coupled receptors and RTKs, 2nd messengers and signaling pathways, Regulation of signaling pathway.

Unit-III: Cellular Transport: Passive and active transport, co-transport and counter transport mechanisms, Diversity of transporter proteins in the cell membrane, diffusion and bulk flow, carrier mediated transport, Kinetics of transport, Concept of water potential, its components, units and measurement, Ion channel proteins and aquaporins.

Unit-IV: Cellular Radiation Physiology: Basic radiation biophysics, UV and ionizing radiations, radiation effects on cell and sub-cellular components (nucleic acids and proteins), Dose response curves in prokaryotes and eukaryotes; Split dose technique and concept of dose LD_{50}.

SUGGESTED READINGS:

1. Essential Cell Biology by Albert et al.
2. Cell Biology by Gerald Karp
3. Fundamentals of Radiation Biology by P. Umadevi
4. Radiation Biology for Radiologist by Eric J. Hall
5. Molecular Cell Biology by Lodish et al.
6. A manual of Laboratory Experiences in Cell Biology by C E Gasque.
7. Cells by Lewin et al.

MB-423	Genetics	4 CH	100 marks

OBJECTIVE

The objective of this study is to have an understanding of the inheritance and expression of genes. Students in M.Sc. Microbiology should have a clear concept on various terminologies used in genetics. This course will help to understand the processes responsible for maintaining the stability of the genetic material and the processes that bring about variation in genetic pool.

PROGRAMME EUCATION OBJECTIVES (PEOs): After studying Genetics in the curriculum,, students will be able to:

PEO1. Understand the basic concepts of Genetics.
PEO2. Analyze the relationships among different concepts within the framework of Genetics.
PEO3. Perform procedures as per the areas of study.
PEO4. Apply the basic concepts learned to execute them.

COURSE OUTCOMEs (COs): After studying Genetics in the curriculum, students will be able to:

CO1. Remember and understand the basic concepts and principles of Genetics.

CO2. Analyze the various concepts to understand them through scientific experimentations/case studies.

CO3. Apply the knowledge in understanding practical problems.

CO4. Execute/create the projects or field assignment as per the knowledge gained in the course curriculum.

COURSE

Unit-I: Mendelian principles: Dominance, segregation, independent assortment; Extensions of Mendelian principles: Co-dominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. Extra-chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.

Unit-II: Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests. Gene mapping methods: Linkage maps, Tetrad analysis, Pedigree analysis, lod score for linkage testing, Mapping with molecular markers, Mapping by using somatic cell hybrids, Development of mapping population in plants. Quantitative genetics: Polygenic inheritance, Heritability and its measurements, QTL analysis.

Unit-III: The origin of genetic variability through mutation (Spontaneous and chemical mutation, Frame-shift mutation, point mutations and chromosomal abberations).Causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Structural & numerical changes of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications, Genetic diseases and syndromes.

Unit IV: Population Genetics: Gene pool, Gene frequency, Hardy Weinberg genetic equilibrium and the factors influencing it, Gene flow and Genetic drift.

SUGGESTED READINGS:

1. Genetics by Sinnot, Don, Dobjanasky.
2. Genetics by Strickberger.
3. Genetics by Gardner.
4. Concepts of Genetics by Klug and Cumming.

5. Applied Genetics by Emmanuel, Ignacimuthu and Vincentet

6. Molecular biology of the gene 5th Edn. by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine and R. Losick, Pub: Cold Spinger Harbr Laboratory Press.

7. Introduction to Genetic Analysis 12th Edn. by Griffith et. al.

MB-424	Immunology	4 CH	100 marks

OBJECTIVE: This paper contains four units, namely Basics of Immunity, Immunoglobulins, Immunological techniques. Each unit contains a description of the principles related to that unit, well-supported by different examples, descriptions of laboratory experiments, historical background etc; with solved equations that explain the concept discussed. This paper will help in fixing the Ideas firmly in student's mind. The examples discussed in the class-room are used to encourage students to participate in discussions.

PROGRAMME EUCATION OBJECTIVES (PEOs): After studying Immunology in the curriculum, students will be able to:

PEO1. Understand the basic nature and concepts of Immunology
PEO2. Analyze the relationships among different concepts.
PEO3. Perform procedures as per the areas of study.
PEO4. Apply the basic concepts learned to execute them.

COURSE OUTCOMEs (COs): After studying Immunology in the curriculum, students will be able to:

CO1. Remember and understand the basic concepts of Immunology.

CO2. Analyze the various concepts to understand them through case studies.

CO3. Apply the knowledge in understanding practical problems.

CO4. Execute the projects or field assignment as per the knowledge gained in the course curriculum.

COURSE:

Unit-I: Basics of immunity, Immunity related organs: Primary lymphoid organs, Secondary lymphoid organs in the human body, Leucocyte in immune function, Antigen: Properties of antigen, Immunogenicity, Antigenicity, haptens, Adjuvants, B-cell epitopes, T-Cell epitopes, Antigen presenting Cells, Antigen processing and presentation

Unit – II: B-Cell activation and proliferation, T-Cell activation, maturation, Humoral immune response, Cell mediated immune response, Complement System: Complement components, Complement activation, Classical pathway, Alternative pathway, regulation of complement system

Unit-III: Immunoglobulins – classification, structure and properties, primary and secondary immune response, Genetic basis of generation of antibody diversity, Antigen-antibody interaction. T-cell receptors, Major histocompatibility complex proteins. Interleukins.

Unit-IV: Brief idea regarding Immunology of – Allergy, AIDS, Organ transplantation, Cancer and autoimmune diseases. Experimental techniques like – agglutination, precipitin formation, Immunodiffusion (SRID and DRID). Immunoelectrophoresis – types and uses, Radio Immuno Assay (RIA), ELISA, Western Blotting.

SUGGESTED READINGS:

1. Immunology by Ivan Roitt, Jonathan Brostoff and David Male
2. Immunology by Kuby et al.
3. Fundamentals of Immunology by Willium Paul.
4. Principles of Immunology by N V Shastri

MB-425	**Practical on Ecology, Biodiversity and Biostatistics**	**2 CH**	**50 marks**
MB-426	**Practical on Genetics, Cell Biology and Immunology**	**2 CH**	**50 marks**

THIRD SEMESTER

MB-511	**Bioinformatics and Computer Application**	**4 CH**	**100 marks**

OBJECTIVE

They will learn storing the biological data, developing the tools that are essential to processing the data, and the important goal of this is to exploit the computational tools for analyzing the data that simply depicts the results. The computational education of biologists is changing to prepare students for facing the complex datasets of today's life science research.

PROGRAMME EUCATION OBJECTIVES (PEOs): After studying Bioinformatics and Computer Application in the curriculum, students will be able to:

PEO1. Understand the basic the basic nature and basic concepts of Bioinformatics and Computer Application
PEO2. Analyze the relationships among different concepts related to tools and techniques related to Bioinformatics and Computer Application.
PEO3. Perform procedures as per the areas of study.
PEO4. Apply the basic concepts learned to execute them to analyse different datasets.

COURSE OUTCOMEs (COs): After studying Bioinformatics and Computer Application in the curriculum, students will be able to:

CO1. Remember and understand the basic concepts Bioinformatics and Computer Application.

CO2. Analyze the various concepts to understand them through case studies.

CO3. Apply the knowledge in understanding practical problems.

CO4. Execute the projects or field assignments as per the knowledge gained in the course curriculum.

COURSE

Unit-I:

Major Bioinformatics Resources: NCBI, EBI, ExPASy, RCSB, BLAST, FASTA; Sequence Database:Nucleotide Sequence Database- GenBank, EMBL, DDBJ; Protein Sequence Databases:Uniprot-KB: SWISS-PROT, TrEMBL, UniParc; Structural Database:PDB, MMDB, CATH, FSSP, DALI, SCOP;Open access bibliographic resources and literature databases: PubMed, BioMed central, public library of sciences (PloS), CiteXplore.Retrieval System:Entrez, Information Retrieval System: SRS.

Unit-II:

Sequence Alignment:Similarity and Homology, Optimal Alignment, Global Alignment, Local Alignment, Pairwise and Multiple Sequence Alignment, Alignment Scoring Scheme, Quality of Sequence Alignment, Distance and Similarity, Hamming Distance, Edit Operation, Gaps & Insertions, Scoring Matrix (PAM, BLOSUM), Dot Plots;

Dynamic Programming: The Needleman and Wunsch Algorithm, The Smith-Waterman Algorithm.

Unit-III:

Phylogenetics:Methods and steps of phylogenetic analysis; Classification of phylogeny: graphs, trees and cladograms.

Concept of Molecular Modelling:
Patterns, motifs and Profiles in sequences; Structure classification of proteins (Primary, Secondary, Tertiary, Quaternary). Protein structure prediction (Secondary & Tertiary), Protein databank (PDB),Homology Modelling, Model Validation - SAVES Server, Ramachandran Plot.Protein-Nucleic Acid interaction. Visualization Tools.

Unit IV

Prediction Tools: Phylogenetic Trees and Phylogenetic Analysis tools, Gene Prediction tools
Protein Structure & Function Prediction tools. ModellingTools: Tools for 3D Protein Modelling. Visualization Tools : iCn3D, PyMol

SUGGESTED READINGS:

1. Essential Bioinformatics by Jin Xiong; Cambridge University Press (2006). ISBN-13 - 978-0521600828.

2. Bioinformatics: Sequence and Genome Analysis, David Mount, CBS Publishers & Distributors. ISBN-13: 9788123912417.

3. Problems and Solutions in Biological Sequence Analysis by Mark Borodovsky, Svetlana Ekisheva; Cambridge University Press (2006). ISBN-9780521612302.

4. RNA Sequence, Structure, and Function: Computational and Bioinformatic Methods by Jan Gorodkin & Walter L. Ruzzo (2014). ISBN-9781627037082

5. Protein Bioinformatics: An Algorithmic Approach to Sequence and Structure Analysis by Ingvar Eidhammer, Inge and Jonassen (2009) William R. Taylor Wiley India Pvt Ltd. ISBN-13- 978-8126522729

MB-512	Mycology, Phycology and Microbial Diseases	4 CH	100

OBJECTIVE

The students will get familiarity about the Mycology, Phycology, Microbial Diseases and its application in Microbiology for human welfare. The important goal of this is to exploit the knowledge and learn various aspects of economic importance of useful microbes and management of microbial diseases. The teaching will educate and prepare a student for scientific research.

PROGRAMME EUCATION OBJECTIVES (PEOs):

After studying Mycology, Phycology and Microbial Diseases in the curriculum, students will be able to:

PEO1. Understand the basic nature and concepts of Mycology, Phycology and Microbial Diseases.

PEO2. Analyze the relationships among different concepts related to Mycology, Phycology and Microbial Diseases.

PEO3. Perform procedures as per the areas of study.

PEO4. Apply the basic concepts learned for entrepreneurship and scientific research.

COURSE OUTCOMEs (COs): After studying Mycology, Phycology and Microbial Diseases in the curriculum, students will be able to:

CO1. Remember and understand the basic concepts Mycology, Phycology and Microbial Diseases.

CO2. Analyze the various concepts to understand them through case studies.

CO3. Apply the knowledge in understanding practical problems.

CO4. Execute the projects or field assignments as per the knowledge gained in the course curriculum.

COURSE

Unit-I: Mycology: Historical introduction to Mycology. Present criteria used in distribution and classification of fungi with reference to vegetative and reproductive structures. Fungal Systematics: Occurrence, structure and Life cycle–Slime molds, Oomycetes, Chytridiomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes. Heterothallism, Sex hormones in fungi, Lichens, Mycorrhiza (Ectomycorrhiza, Endomycorrhiza, Vesicular Arbuscular Mycorrhiza); Fungal disease, Interaction between fungi and other organisms.

Unit-II: Phycology: Algae in diversified habitats (terrestrial, fresh water, marine); Algal nutrition; Classification of algae, Criteria for classification of algae; Range of thallus organization: cell structure, reproduction, sexuality in algae. Pigments, reserve food, flagella etc. Green algae, Diatoms, Euglenoids, Brown Rhodophyta, Pyrrophyta, Algal ecology and algal biotechnology.

Unit-III: Principles of Microbial Diseases: Classification of medically important microorganisms. Normal microbial flora of human body; Origin of normal flora; normal flora and human host.

Epidemiology of Infectious Disease: Epidemiological Terminology, Measuring Frequency, Recognition of an Epidemic, The Infectious Disease Cycle, Bioterrorism and Preparedness, Diseases caused by Viruses, Prions, Bacteria, Fungi, and Protists.

Unit-IV: Microbial infection: Source of infection for man, vehicles or reservoirs of infection, exogenous infection. Pathogenesis: Microbial Pathogenicity; Transmissibility, Infectivity and Virulence. Opportunistic pathogens; True pathogens; Toxigenicity; Invasiveness; Other aggressins (Hyaluronidase), Coagulase, Fibrinolysins or Kinase; Depolymerizing enzymes (mucinase, lipases, proteases, nucleases, collagenase, neuraminidase); Organotropism, Variation and Virulence.

SUGGESTED READING:

1. Alexendra and Bold. 1999. Introduction to Mycology. Academic Press.
2. Alexopoulos, C.J. and C.W. Mims 1979. Introduction to Mycology (3rd Ed.)Wiley Eastern Ltd., New Del
3. Burnett J.H., Publisher: Edward, Arnold Crane Russak: Fundamentals of Mycology.
4. David Greenwood, Richard C and Slack B. Medical Microbiology. ELBS Churchill Livingstone.
5. E.Moore –Landeekeer: Fundamentals of the fungi, Publisher: Prentice Hall.
6. L. Barsanti, Paolo Gualtieri: Algae: anatomy, biochemistry, and biotechnology
7. Linda E. Graham, James Graham, James M. Graham: Algae (2009)
8. Mackie and McCartney: Medical Microbiology Vol 1: Microbial infection, Vol 2: Practical medical microbiology. Churchill Livingstone.
9. Rajesh Bhatia R. Essentials of Medical Microbiology.Jayjee Brothers.
10. Saminathan M.S. Biotechnology in Agriculture. McMillan.
11. Steinhaus. 1963. Insect Pathology. Vol I & II. Academic Press, New York.
12. Subba Rao. 2000. Soil Microbiology. 4th Ed. Oxford & IBH
13. Subba Rao. Biofertilizers in Agriculture. Oxford & IBH
14. Subba Rao. Recent Advances in Biological Nitrogen Fixation.Oxford & IBH.
15. Text of Microbiology: R. Ananthanarayanan and C.K.J. Panicker, Orient Longman.

MB-513 (A)	**Special paper-I (A) Environmental Microbiology**	**4 CH**	**100**

OBJECTIVE

The students will get familiarity about the Environmental Microbiology and its application in Microbiology for human welfare. The important goal of this is to exploit the knowledge and learn various aspects of application of microbes in different environment. The teaching will educate and prepare a student for abatement of environmental pollution and scientific research.

PROGRAMME EUCATION OBJECTIVES (PEOs):

After studying Environmental Microbiology in the curriculum, students will be able to:

PEO1. Understand the basic nature and concepts of Environmental Microbiology.
PEO2. Analyze the relationships among different concepts related to Environmental Microbiology.
PEO3. Perform procedures as per the areas of study.
PEO4. Apply the basic concepts learned for abatement of environmental pollution and scientific research.

COURSE OUTCOMEs (COs): After studying Environmental Microbiology in the curriculum, students will be able to:

CO1. Remember and understand the basic concepts Environmental Microbiology.

CO2. Analyze the various concepts to understand them through case studies.

CO3. Apply the knowledge in understanding practical problems.

CO4. Execute the projects or field assignments as per the knowledge gained in the course curriculum.

COURSE

Unit-I: Aquatic Microbiology: Water ecosystems: types – fresh water (ponds, lakes, streams); marine habitats (estuaries, mangroves, deep sea, hydrothermal vents, saltpans, coral reefs). Zonations of water ecosystems - upwelling- eutrophication - food chain. Potability of water - microbial assessment of water quality - water purification-brief account of major water borne diseases and their control measures.

Unit-II: Soil Microbiology: Classification of soils- Physical and chemical characteristics, micro flora of various soil types (Bacteria and nematodes in relevance to soil types); Rhizosphere-phyllosphere-brief account of microbial infections, symbiosis-mutalism-commensalism-competition-amensalism-synergism-parasitism-predation; biogeochemical cycles and the organisms: carbon, nitrogen, phosphorus and sulphur; biofertilizers- biological nitrogen fixations - nitrogenase enzyme - *nif* genes; symbiotic nitrogen fixation - (*Rhizobium*, *Frankia*) - non symbiotic microbes – *Azotobacter* – *Azospirilium* -(Vesicular Arbuscular Mycorrhizae -VAM) - ecto, endo, ectendomycorrhizae - rumen microbiology.

Unit-III: Waste treatment: Wastes-types-solid and liquid wastes; characterization-solid-liquid; treatments - physical, chemical, biological – aerobic – anaerobic – primary – secondary - tertiary; Solid waste treatment- saccharification – gasification - composting, Utilization of solid wastes - food (Single cell protein (SCP), mushroom, yeast); fuel (ethanol, methane); fertilizer (composting), liquid waste treatment – trickling - activated sludge - oxidation pond - oxidation ditch. Subterranean microbes and bioremediation

Unit–IV: Role of Microbes in environment: Microbiology of degradation of xenobiotics in the environment, ecological considerations, decay behaviour, biomagnification and degredative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants and pesticides. bioaccumulation of metals and detoxification, Biopesticides, Biodegradation of lignin, Biodeterioration of Paper, leather, wood, textiles, metal-mode of deterioration - microbes involved in deterioration – its advantages – mode of prevention. Biomining of metals using microbes, Genetically Modified Organisms (GMOs) released and its environmental impact assessment and ethical issues.

SUGGESTED READING:

1. Microbial Ecology: Fundamentals and Applications (4th Edition) by Ronald M. Atlas, Richard Bartha.

2. Brock Biology of Microorganisms (14th Edition) by Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl, Thomas Brock
3. Environmental Microbiology 3rd Edition by Ian L. Pepper, Charles P. Gerba, Terry J. Gentry.
4. Soil Microbiology 3rd Edition by Robert L. Tate III
5. Environmental Microbiology: From Genomes to Biogeochemistry 2nd Edition by Eugene L. Madsen
6. Wastewater Microbiology by Toni Glymph
7. Manual of Environmental Microbiology by Cindy H. Nakatsu, Robert V. Miller, Suresh D. Pillai
8. Environmental Microbiology of Aquatic and Waste Systems by Nduka Okafor
9. Processes in Microbial Ecology by David L. Kirchman
10. Advances in Applied Bioremediation (Soil Biology Book 17) by Ajay Singh, Ramesh C. Kuhad, Owen P. Ward
11. Microbial Ecology of the Oceans (3rd Edition) by Josep M. Gasol , David L. Kirchman.
12. Soil Microbiology by Selman A. 1888-1973 Waksman
13. Soil Microbiology, Ecology and Biochemistry 4th Edition by Eldor Paul
14. Modern Soil Microbiology, Third Edition by Jan Dirk van Elsas, Jack T. Trevors, Alexandre Soares Rosado , Paolo Nannipieri
15. Introduction to Soil Microbiology by Martin Alexander
16. Prescott's Microbiology 11th Edition by Joanne Willey
17. EcEldowney S, Hardman DJ, Waite DJ, Waite S. (1993). Pollution: Ecology and Biotreatment – Longman Scientific Technical.

MB-513 (B)	**Special paper-I (B): Industrial Microbiology**	**4 CH**	**100**

OBJECTIVE

The students will get familiarity about the Industrial Microbiology and its application in Microbiology for human welfare. The important goal of this is to exploit the knowledge and learn various aspects of application of microbes in different environment. The teaching will educate and prepare a student for abatement of environmental pollution and scientific research.

PROGRAMME EUCATION OBJECTIVES (PEOs):

After studying Industrial Microbiology in the curriculum, students will be able to:

PEO1. Understand the basic nature and concepts of Industrial Microbiology.
PEO2. Analyze the relationships among different concepts related to Industrial Microbiology.
PEO3. Perform procedures as per the areas of study.
PEO4. Apply the basic concepts learned for improvement of Industrial Microbiology and scientific research.

COURSE OUTCOMEs (COs): After studying Industrial Microbiology in the curriculum, students will be able to:

CO1. Remember and understand the basic concepts Industrial Microbiology.

CO2. Analyze the various concepts to understand them through case studies.

CO3. Apply the knowledge in understanding practical problems.

CO4. Execute the projects or field assignments as per the knowledge gained in the course curriculum.

COURSE

Unit-I: General consideration: Metabolic pathways and metabolic control mechanisms, primary and secondary metabolites. Fermentation in batch culture: Microbial growth kinetics, measurements of growth (cell number, direct and indirect methods) growth and nutrient, growth and product formation, heat evolution, effect of environment (temperature, pH, high nutrient concentration) media formulation. Sterilization, Kinetics of thermal death of microorganisms, batch and continuous sterilization.

Unit-II: Continuous culture: Continuous culture system, productivity, product formation. Aeration and agitation, power requirement oxygen transfer kinetics, concepts of Newtonian and Non-Newtonian fluids apparent viscosity, foam and antifoam. Scale-up, instrumentation control, physical and chemical environment sensors, downstream process.

Unit-III: Water Purification and Sanitary Analysis: Waste Water Treatment, Micro-organisms Used in Industrial Microbiology, Microorganism Growth in Controlled Environments, Major Products of Industrial Microbiology, Biodegradation and Bioremediation by Natural Communities, Bioaugmentation, Microbes as Products, Impacts of Microbial Biotechnology.

Unit-IV: Industrial production of microbial products and IPR: Industrial production of citric acid, lactic acid, enzymes (alpha-amylase, lipase, xylase, pectinases, proteases), acetone- butanol, lysine and glutamic acid. Modern trends in microbial production of bioplastics (PHB, PHA), bioinsectices (thuricide), biopolymer (dextran, alginate, xanthan, pullulan), Biofertilizers (microbial based), Single Cell Protein and production of biological weapons with reference to anthrax. Biomethanation. Production of bioethanol from sugar, molasses, starch and cellulosic materials. Ethanol recovery. Microbial production of hydrogen gas, biodiesel from hydrocarbons. Some industrial techniques for whole cell and enzyme immobilization. Application and advantages of cell and enzyme immobilization in pharmaceutical, food and fine chemical Industries. Intellectual Property Rights (IPR), Patents, Trademarks, Copyrights, Secrets, Patenting of biological materials, international co operation, obligations with patent applications, implication of patenting, current issues, hybridoma technology etc. Patenting of higher plants and animals, transgenic organisms and isolated genes, patenting of genes and DNA sequences, plant breeders right and farmers rights.

SUGGESTED READING:

1. An Introduction to Industrial Microbiology by K Sukesh
2. Biotechnology Industrial Microbiology: A Textbook by W. Clarke
3. Crueger's Biotechnology: A textbook of Industrial Microbiology by Wulf Crueger, Anneliese Crueger, K.R. Aneja

4. Fermentation Microbiology and Biotechnology by E. M. T. El-Mansi, C. F. A. Bryce, Arnold L. Demain, A.R. Allman
5. Industrial Microbiology by A. H. P a t e l.
6. Industrial Microbiology by David B. Wilson, Hermann Sahm, Klaus-Peter Stahmann, Mattheos Koffas
7. Industrial Microbiology by L.E. Casida
8. Industrial Microbiology: An Introduction by Michael J. Waites, Neil L. Morgan, John S. Rockey, Gary Higton
9. Microbial Biotechnology – Fundamentals of Applied Microbiology Glazer Alexander N. et.al.
10. Modern Industrial Microbiology and Biotechnology by Nduka Okafor
11. Principles and Applications of Fermentation Technology by Arindam Kuila and Vinay Sharma
12. Principles of Fermentation Technology by Peter F Stanbury, Allan Whitaker, Stephen J Hall.
13. Wine Microbiology: Practical Applications and Procedures by Kenneth C. Fugelsang, Charles G. Edwards

MB-514	**Practical Based on MB-511**	**2 CH**	**50**

MB-515	**Practical on MB-513**	**2 CH**	**50**

MB-516	**Industrial Visit and Report Submission**	**2 CH**	**50**

MB-517	**Seminar**	**2 CH**	**50**

FOURTH SEMESTER

MB-521	**Microbial Physiology and Microbial Genetics**	**4 CH**	**100**

PROGRAMME EDUCATION OBJECTIVES (PEOs):

After studying **Microbial Physiology and Microbial Genetics** in the curriculum, students will be able to:

PEO1. Understand the nature and basic concepts of Microbial Physiology and Microbial Genetics relating to M.Sc. degree in Microbiology.

PEO2. Analyze the relationships among different concepts of Microbial Physiology and Microbial Genetics.

PEO3. Perform procedures as laid down in the areas of study.

PEO4. Apply the basic concepts learned to execute them.

COURSE OUTCOMEs (COs): After studying **Microbial Physiology and Microbial Genetics** in the curriculum, students will be able to:

CO1. Remember and understand the basic concepts of Microbial Physiology and Microbial Genetics.

CO2. Analyze the various concepts to understand them through laboratory experiments/case studies.

CO3. Apply the knowledge in understanding practical problems.

CO4. Execute/ create projects or field assignment as per the knowledge gained in the course curriculum.

Unit-I: Microbial Physiology: Microbial Energetics, The role of ATP in metabolism. Microbial enzymes: Structure and Classification, Mechanism of Enzyme actions: Lock and Key model, induced fit Theory, Factors affecting rates of enzyme mediated reactions (pH, temperature and substrate and enzyme concentration), Enzyme Inhibition and Enzyme regulation.

Metabolism of Carbohydrate: Glycolysis, Citric acid Cycle and Oxidative level Phosphorylation, Fates of pyruvate. Utilization of sugars other than glucose: Lactose, Galactose, Maltose and Mannitol. Degradation of cellulose, starch and glycogen.

Fermentation Pathways: Yeast fermentation, acetic acid, lactic acid, propionic acid production pathways. Metabolite transport through membrane. Crab free effect. Regulations during fermentation.

Metabolism of other substrates: Lipid metabolism: β-oxidation, Biosynthesis of fatty acids, degradation of fatty acids. Nitrogen metabolism: Nitrogen metabolism, Biological nitrogen fixation process, symbiotic and non symbiotic nitrogen fixation. urea cycle, degradation and biosynthesis of essential and non-essential amino acids. Nucleic acid metabolism: Biosynthesis and degradation of purines and pyrimidines.

UNIT II: Microbial Photosynthesis: Photosynthetic Pigments and apparatus in bacteria. Oxygenic and An-oxygenic Photosynthesis. Autotropic CO_2 fixation and mechanism of Photosythesis. Utilization of light energy by Halobacteria.

Autotrophic Mechanisms in bacteria: Hydrogen bacteria, Nitrifying bacteria, Purple sulfur bacteria, Non-sulfur bacteria, Green sulfur bacteria, Iron bacteria, Methylotrophs. Microbial Stress Responses: Oxidative stress, Thermal stress, Starvation stress, Aerobic to anaerobic transitions.

UNIT III: Microbial Genetics

Viral Genetics: Lytic and Lysogenic cycles, Phage Phenotypes, Phenotypic Mixing, Recombination in viruses: Mutations, Recombination and Mapping.

Bacterial Genetics: Bacterial Transformation: Types of transformation mechanisms found in prokaryotes, Bacterial Conjugation: properties of the F plasmid, F+ x F - mating, F' x F- conjugation, Hfr conjugation. Transduction: Generalized and specialized transduction, Transposable elements. Mapping in bacteria. Social behavior and decision making in bacteria. Horizontal Gene transfer and its importance.

Fungal Genetics: *Neurospora*- Tetrad analysis and linkage detection - 2 point and 3 point crosses, chromatid and chiasma interference, Mitotic recombination in *Neurospora* and *Aspergillus*.

Algal Genetics: *Chlamydomonas* - unordered tetrad analysis - Recombination and Mapping, Nucleocytoplasmic interactions and gene expression in *Acetabularia*. Extranuclear (Cytoplasmic) inheritance.

Unit-IV: Mutation and mutagenesis: Nature, type and effects of mutations. Mutagenesis –physical and chemical mutagens, base and nucleoside analog, alkylating agents,interrelating agents, ionizing radiation. Induction and detection of mutation in microorganisms. Site directed mutagenesis and its applications.

SUGGESTED READING:

1. Alcomo, I.E. 2001. Fundamentals of Microbiology. VI Edition, Jones and Bartlett

Publishers, Sudbury, Massachusetts.

2. Barsanti, L, and Gualtieri, P. 2005. Algae: Anatomy, Biochemistry and

Biotechnology. Taylor and Francis New York.

3. Becker, W. M., Kleinsmith, L.J. and Hardin, J. 2000. The world of the Cell. IVth

Edition. Benjamin/Cummings.

4. Dubey, R.C. and Maheshwari, D.K. 1999**.** A Text Book of Microbiology. S. Chand

and Company Limited, Ram nagar, New Delhi.

5. Horton, H.R., Moran, L. A., Scrimgeour, K.G. Perry, M.D. and Rawn, J.D. 2006.

Principles of Biochemistry, IVth Edition. Pearson Education Internationl. London.

6. Madigan M.T., Martinko M. J. and Jack Parker. 2003. Brock Biology of

microorganisms. Pearson education., New Jercy.

7. Moat, A.G., Foster, J.W. and Spector, M.P. 2002. Microbial Physiology, 4th edn.

Wiley-Liss, Inc., New York.

8. Nelson, D.L. and Cox, M.M. 2000. Lehninger Principles of Biochemistry 3rd edn.

Printed in India by Replika Press Pvt. Ltd., New Delhi for Worth Publishers, New

York.

9. Palmer, T. 2004. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry. Affiliated East-West Press Pvt. Ltd. New Delhi.

10. Pelczar (Jr.) M. J. Chan, E. C. S. and Kreig, N. R. 1993. Microbiology, McGraw Hill Inl. Newyork.

11. Perry, J.J. and Staley, J.T. 1997. Microbiology. Dynamics and Diversity. 4th edn. Wesley Longman pub. New York.

12. Perry, J.J., Staley, J.T. and Lory, S. 2002. Microbial Life. Sinauer Associates, Publishers, Sunderland, Massachusetts.

13. Presscott, L. M. Harley, J. P. and Klein, D. A. 1999. Microbiology, International edn. 4th edn. WCB Mc Graw-Hill.

14. Schaechter, M. Ingraham, J.L. and Neidhardt, F.C. 2006. Microbe. ASM Press, Washington. D.C.

15. Stainer R. Y, Ingraha, J.L., Wheelis, M. L. and Painter, P. K . –1986, General Microbiology Mc Millan Edun. Ltd. London

16. Stanley J.T. and Reysenbach A.L.1977. Biodiversity of microbial life. John Wiley 7 Sons Inc. Publication. New York.

17. Stenesh, J. 1998. Biochemistry Vol. II, Plenum Press, New York and London.

18. Sullia, S.B. and Shantharam,, S. 2000. General Microbiology (Revised) Oxford & IBH Publishing Co. Pvt. Ltd.

19. Talaro, K. and Talaro, A.1996. Foundations in Microbiology, 2nd edition, WCB publishers.

20. Tortora, G.J., Funke, B.R. and Case, C.L. 2004. Microbiology-An Introduction. Benjamin Cummings. San Francisco.

21. Voet, D., Voet, J.G. and Pratt, C.W. 1999. Fundamentals of Biochemistry, John Wiley and Sons Inc., New York and Toranto.

22. Brooker, R. J. 1999. Genetis – Analysis and Principles. Benjamin/Cummings, an

imprient of addition Wesley longman, Inc.

23. Gardner, E. J. 1984. Principles of Genetics 7th edn. John Wiley & Sons. Inc. New York.

24. Hartl, D.L. 1994. Genetics. Jones and Bartler Publishers, London.

25. Moat, A.G., Foster, J.W. and Spector, M.P. 2002. Microbial Physiology, 4th edn.

Wiley-Liss, Inc., New York.

MB-522	**Microbial Genomics and Proteomics**	**4 CH**	**100**

PROGRAMME EDUCATION OBJECTIVES (PEOs):

After studying **Microbial Physiology and Microbial Genetics** in the curriculum, students will be able to:

PEO1. Understand the nature and basic concepts of Microbial Physiology and Microbial Genetics relating to M.Sc. degree in Microbiology.

PEO2. Analyze the relationships among different concepts of Microbial Physiology and Microbial Genetics.

PEO3. Perform procedures as laid down in the areas of study.

PEO4. Apply the basic concepts learned to execute them.

COURSE OUTCOMEs (COs): After studying **Microbial Physiology and Microbial Genetics** in the curriculum, students will be able to:

CO1. Remember and understand the basic concepts of Microbial Physiology and Microbial Genetics.

CO2. Analyze the various concepts to understand them through laboratory experiments/case studies.

CO3. Apply the knowledge in understanding practical problems.

CO4. Execute/ create projects or field assignment as per the knowledge gained in the course curriculum.

Unit 1: Whole genome analysis, preparation of ordered cosmid libraries, bacterial artificial chromosome libraries, shotgun libraries and sequencing, conventional sequencing (Sanger, Maxam and Gilbert methods), automated sequencing.

Unit II: Sequence analysis: computational methods, homology algorithms (BLAST) for proteins and nucleic acids, open reading frames, annotations of genes, conserved protein motifs related structure/function (PROSITE, PFAM, ProfileScan), DNA analysis for repeats (direct and inverted), palindromes, folding programmes. Use of Internet, public domain databases for nucleic acid and protein sequences (EMBL, GenBank), database for protein structures (PDB).

Unit III: DNA microarray, printing or oligonucleotides and PCR products on glass slides, nitrocellulose paper. Whole genome analysis for global patterns of gene expression using fluorescent labeled cDNA or end labeled RNA probes. Analysis of single nucleotide polymorphisms using DNA chips.

Unit IV: Proteome analysis: Two-dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by mass spectroscopy. Protein microarray. Advantages and disadvantages of DNA and protein microarrays.

SUGGESTED READING:

1. The internet and the new biology – Tools for genomic and molecular research: Peruski Jr and Peruski.
2. DNA microarrays - A practical approach: Edited by Mark Schena.

MB-523 (A)	**Medical Microbiology**	**4 CH**	**100**

PROGRAMME EDUCATION OBJECTIVES (PEOs):

After studying **Medical Microbiology** in the curriculum, students will be able to:

PEO1. Understand the nature and basic concepts of Medical Microbiology relating to M.Sc. degree in Microbiology.

PEO2. Analyze the relationships among different concepts of Medical Microbiology.

PEO3. Perform procedures as laid down in the areas of study.

PEO4. Apply the basic concepts learned to execute them.

COURSE OUTCOMEs (COs): After studying **Medical Microbiology** in the curriculum, students will be able to:

CO1. Remember and understand the basic concepts of Medical Microbiology.

CO2. Analyze the various concepts to understand them through laboratory experiments/case studies.

CO3. Apply the knowledge in understanding practical problems.

CO4. Execute/ create projects or field assignment as per the knowledge gained in the course curriculum.

Unit I: Early discovery of pathogenic microorganisms, development of bacteriology as scientific discipline; contributions made by eminent scientists. Classification of medically important microorganisms; Normal microbial flora of human body; role of resident flora; normal flora and the human host. Establishment, spreading, tissue damage and anti-phagocytic factors; mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts. Role of aggressins, depolymerising enzymes, organotropisms, variation and virulence.

Unit II: Classification of pathogenic bacteria: Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Cornebacterium, Bacillus, Clostridium, Non sporing anaerobes, organisms belonging to Enterobacteriacea, Vibrios, Non fermenting Gram negative bacilli Yersinia; Haemophilus; Bordetella, Brucella, Mycobacteria, Spirochaetes, Actinomycetes, Rickettsiae, Chlamdiae

Unit III: Brief account of protozoa (Entamoeba, Giardia, Leishmania, Trypanosoma, Plasmidium) and helminths parasites (Schistosoma, Taenia, Ascaris, Hookworms, Wuchereria) of man and their diseases, Immunity to amoebasis, trypanosomiasis, leishmaniasis, malaria, filarasis, hookworm and ascariasis

Unit IV: Laboratory control of antimicrobial therapy; various methods of drug susceptibility testing, antibiotic assay in body fluids. Brief account on available vaccines and schedules; passive prophylactic measures; nosocomial infections, common types of hospital infections, their diagnosis and control.

SUGGESTED READING:

1. Text of Microbiology: R. Ananthanarayanan and C.K.J. Panicker, Orient Longman.

2. Mackie and McCartney: Medical Microbiology Vol 1: Microbial infection, Vol 2: Practical medical microbiology. Churchill Livingstone.

MB-523 (B)	**Food Microbiology**	**4 CH**	**100**

PROGRAMME EDUCATION OBJECTIVES (PEOs):

After studying **Food Microbiology** in the curriculum, students will be able to:

PEO1. Understand the nature and basic concepts of Food Microbiology relating to M.Sc. degree in Microbiology.

PEO2. Analyze the relationships among different concepts of Food Microbiology.

PEO3. Perform procedures as laid down in the areas of study.

PEO4. Apply the basic concepts learned to execute them.

COURSE OUTCOMEs (COs): After studying **Food Microbiology** in the curriculum, students will be able to:

CO1. Remember and understand the basic concepts of Food Microbiology.

CO2. Analyze the various concepts to understand them through laboratory experiments/case studies.

CO3. Apply the knowledge in understanding practical problems.

CO4. Execute/ create projects or field assignment as per the knowledge gained in the course curriculum.

Unit I: Introduction and history of food microbiology, General characteristics, classification and importance of microorganisms important in food microbiology, Principles of food preservation. Asepsis– Removal of microorganisms, (anaerobic conditions, high temperatures, low temperatures, drying,

canning, food irradiation). Factors influencing microbial growth in food – Extrinsic and intrinsic factors; Chemical preservatives.

Unit II: Contamination and spoilage: Cereals, sugar products, vegetables, fruits, meat and meat products, Milk and Milk products, Fish and sea foods, poultry food, spoilage of canned foods. Detection of spoilage and characterization. Food-borne infections and intoxications: Bacterial and nonbacterial toxins with examples of infective and toxic types – Brucella, Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio, Yersinia, Nematodes, protozoa, algae, fungi and viruses.

Unit III: Food fermentations: Industrial production method for microbial starters, bread, cheese, vinegar, fermented vegetables, fermented dairy products; fermented foods, microbial cells as food (single cell proteins, mushrooms), fermented beverages: beer and wine. Amino acid production: glutamic acid and lysine. Production of probiotics and prebiotics, nutraceuticals, low calorie sweetener, food coloring and naturally occurring flavor modifiers.

Unit IV: Food quality standards, Monitoring and control, Food Adulteration, R&D innovations in food microbiology, Genetically modified foods, Need and requirements of food packaging; Containers for packaging, Dispensing devices, Food Regulations/Safety & Quality Standards & Food Laws

SUGGESTED READING:

1. Food microbiology- Royal society of chemistry: MR Adams and MO Moss.

2. Principles of fermentation technology: PF Stanbury, A Whitekar and SJ Hall, Pergamon Press.

3. Basic Food Microbiology: GJ Banwart, CBS Publishers.

MB-524	**Practical on MB-521 and MB-522**	**2 CH**	**50**
MB-525	**Practical on MB-523**	**2 CH**	**50**
MB-526	**Project Work, Dissertation and Viva**	**4 CH**	**200**