M. Sc. SYLLABUS

MICROBIOLOGY

CHOICE BASED CREDIT SYSTEM (CBCS)

(Revised w.e.f. JUNE – 2016)

Re-Accredited Grade 'A' by NAAC

DEPARTMENT OF BIOSCIENCES

SAURASHTRA UNIVERSITY

RAJKOT – 360 005

DEPARTMENT OF BIOSCIENCES

The UGC-CAS Department of Biosciences was established in 1969 by Late Prof. S.C. Pandeya as the founder Head of the Department. On the recommendations of the University Grants Commission, an integrated Post – Graduate Course in Biology was started as first of its kind in the Country. Later on, keeping Integrated Biology as the theme for the first year of the course, the academic programme was diversified into Plant Sciences, Animal Sciences and Microbiology, which were more recently renamed as M.Sc. in Botany, Microbiology and Microbiology from the academic session 2007. From the academic session 2004-05, another M. Sc. Programme in Biotechnology was started. The Department initially started with its base in Environmental Sciences and in few years it took leadership in the field of ecology. Gradually, other areas of research, such as; Plant Physiology, Animal Physiology & Toxicology, Marine Biology& Coastal Ecology, Neurobiology, Ornithology, Wildlife Biology, Fisheries Biology, Insect Biology, Microbiology and Molecular Biology were also integrated into the thrust areas.

THE FACULTY

At present, 11 faculty members (out of total 14 sanctioned positions) are conducting PG teaching and research in a wide array of research fields.

Name	**Designation**	**Research Fields**
MICROBIOLOGY		
Dr. S. P. Singh	Professor & **Head**	Microbiology, Extremophiles, Microbial enzymes, Protein Engineering, Metagenomics
Dr. R. K. Kothari	Professor	Microbiology, Virology
Dr. B. R. M. Vyas	Associate Professor	Microbiology, Degradation of Xenobiotics, Probiotics
Ms. J. H. Patel	Assistant Professor	Microbiology
Dr. S. D. Gohel	Assistant Professor	Microbiology, Extremophiles, Microbial enzymes
Dr. V.H. Raval	Assistant Professor(Contractual)	Microbiology, Extremophiles, Microbial enzymes
BOTANY		
Dr. Vrinda S. Thaker	Professor	Plant Physiology, Plant Biotechnology & Tissue Culture
Dr. Sumitra V. Chanda	Professor	Plant Physiology, Biochemistry & Herbal Technology
Dr. Nilesh S. Panchal	Professor	Plant Ecology, Desert Ecology, Environmental Science
Dr. Jigna Tank	Assistant Professor	Plant Physiology, Plant Molecular Biology
Dr. M.J.kaneria	Assistant Professor(Contractual)	Plant Physiology, Biochemistry & Herbal Technology
Dr. Kiran Chudasama	Assistant Professor(Contractual)	Plant Physiology, Plant Biotechnology
MICROBIOLOGY		
Dr. Rahul Kundu	Professor	Marine Biology & Coastal Ecology, Physiology & Toxicology
Dr. Varsha M. Trivedi	Assistant Professor	Arachnology, Insect Biology & Insect Pest Management, Avian Biology, Wildlife
Dr. Shweta Pathak	Assistant Professor(Contractual)	Marine Biology & Toxicology

1. THE COURSE

The M.Sc. Course in Microbiology is a full time curriculum, run for 2 years, spread over 4 semesters, with four theory Papers (three core and one interdisciplinary / multidisciplinary) and one combined practical in first two semesters. The last two semesters offer choice of courses to the students where two core courses and one elective (to be chosen from three available) courses will be taught. Any elective course will be taught only when prerequisite number of the student enrols for that course. The minimum required number of student to run a course varies from course to course and to be decided by the Staff Council of the Department from time to time. A semester will be of about 100 working days. At the starting of Semester-III, students will be offered a Dissertation which is an original piece of research work and is partfulfilment for the degree, to be carried out by the student and submitted at the end of the fourth semester for evaluation. The elective courses and subject of dissertation should be decided by the student at the beginning of the 3rd Semester.

1.1 EDUCATIONAL STUDY TOUR

The Educational study tour (s)is ***compulsory***and***part of the Curriculum to study different ecosystems, botanical, zoological and microbiological places of interest anywhere in the country***. Since the tour or tours are part of the curriculum, these can be conducted during any or all of the four semesters. The study tours can be undertaken anywhere within India to meet the academic demand. The students shall make Tour Reports and submit them during the IV Semester Examination for their evaluation. However, in special cases, alternative of the educational tour will be decided and assigned to the student concerned, by the Staff Council of the Department.

1.2 SEMINARS

Regular seminars will be organised on I and II Semesters and it is compulsory. Presentation on relevant topics, mostly from syllabus (oral and / or poster), is mandatory for the enrolled student. For each seminar, a student will be given marks, which will be added in the III Semester marksheet.

1.3 ATTENDANCE

Admitted students have to attend all the Lectures, Practicals and Seminars. A minimum prescribed attendance as per University rules is required to sanction a term grant. Students whose term is not granted will not be allowed to appear in the examination, and will have to join the same semester in the following year.

1.4. EXAMINATIONS

At the theory examinations, there shall be questions from the four units and all the questions are compulsory. Theory Examinations will be held at the end of each semester. However, Internal Examinations will be conducted by the Department during the ongoing Semester dates of which will be decided by the Staff Council. Students are required to apply in the prescribed application form for appearing in the Semester- end Theory Examination along with the necessary examination fees on the date to be notified by the University. The semester wise distribution of the courses and papers are given below.

2. SEMESTERWISE DISTRIBUTION OF MARKS:

SEMESTER-I:

4 Papers (100 Marks each*)	: 400	
1 Combined Practical	: 200	**600**

SEMESTER-II:

4 Papers (100 Marks each*)	: 400	
1 Combined Practical	: 200	**600**

SEMESTER-III:

3 Papers (100 Marks each*)	: 300	
1 Combined Practical	: 150	**500**
Seminars	: 50	

SEMESTER-IV:

3 Papers (100 Marks each*)	: 300	
1 Combined Practical	: 150	**450**
Tour / Field Work	: 50	
M.Sc. Dissertation (Thesis:150& Viva 50)	: 200	**250**
Grand Total	**:**	**2400**

* 70 Theory + 30 Internal

2.1. EVALUATION OF PAPERS

The theory papers will be having a weightage of 100 marks each. Out of 100 marks, 30 marks are in the form of Internal Examinations. The written Semester end examination for a paper will be of 70 marks from 4 units. The question paper will be of 70 Marks. The question papers will be of 5 questions. However, these are subjected to changes as per University rules prevailing at that time.

3.0 ADMISSION

Academic year of the University begins from June. The lectures and practicals of the third semester starts immediately. The same for the first semester usually commences immediately after admissions. The admission process is as per the criteria laid down by the University, through written admission test and personal interview.

3.1 Eligibility:

The candidate with B.Sc. degree in Microbiology with at least II class is eligible for admission to M.Sc. Microbiology course. Students, who have cleared B.Sc. with Microbiology as the second subject in S.Y. B.Sc. will also be considered for admission, provided the seats are available. A total of 20 seats are available in the Microbiology stream out of which 10 seats are on Self-Financed basis. Students will be admitted as per the reservation policy in effect from time to time, as directed by the University.

Candidates applying for admission should attach certified true copies of their B.Sc. examination mark sheets and passing certificate. In case of Saurashtra University's students, the candidates have to submit Transfer Certificate (TC) from the college last attended by them. Candidates coming from Universities other than Saurashtra University, have to submit Eligibility Certificate, immediately on obtaining admission, followed by submission of Transfer/ Migration Certificate.

The M.Sc. courses run by this Department are full time studies and as such, a student admitted to the Department cannot join any other courses or study, or take up any paid service.

Limited number of seats in the University Hostel is available to the students admitted to the Department. Desirous students will have to apply in prescribed form available from the Rector of the Hostels. Some scholarships and free-ships are awarded to the students as per the University Rules.

Last date for receiving the application forms and the date and time of Admission Interview are shown in the application form. ***THE CANDIDATE SHOULD BRING ALL ORIGINAL MARK SHEETS, CERTIFICATES ETC. AT THE TIME OF THE INTERVIEW.***

3.2 Fee Schedules : As per University rules as applicable from time to time in both Grant-in-Aid and Self-Finance Schemes

3.3 Registration : Students admitted to the first semester in each of the streams will have to get registration as post-graduate students of this University. No transfer will be given to any student once registered for a particular stream.

M.Sc. Microbiology Syllabus

CHOICE BASED CREDIT SYSTEM (CBCS)

(Total 96 Credits)

Course Code	Course Name	Hours /Week	Credits
	SEMESTETR - I		
Micro - 101	Cell Biology (Core)	04	04
Micro - 102	Molecular Biology, Genetics & Evolution (Core)	04	04
Micro - 103	Biodiversity & Biosystematics (Core)	04	04
Micro - 104	Biostatistics and Bioinformatics** (Multidisciplinary / Interdisciplinary)	04	04
Micro - 105	Combined Practical Course	14	08
Micro - 106	Seminar Course - 1	02	00
	TOTAL		**24**
	SEMESTETR - II		
Micro - 207	Biochemistry (Core)	04	04
Micro - 208	Biotechnology & Immunology (Core)	04	04
Micro - 209	Environmental Science (Core)	04	04
Micro - 210	Analytical Techniques** (Multidisciplinary / Interdisciplinary)	04	04
Micro - 211	Combined Practical Course	14	08
Micro - 212	Seminar Course - 2	02	00
	TOTAL		**24**
	SEMESTETR - III		
Micro - 313	Genome Organization and Regulation of Gene expression (Core)	04	04
Micro - 314	Fermentation Technology - I (Core)	04	04
	Elective Course** (any one of the following)	04	04
Micro - 315	Environmental Biotechnology I (Elective)		
Micro - 316	Food Biotechnology (Elective)		
Micro - 317	Molecular Biotechnology (Elective)		
Micro - 318	Combined Practical Course	08	04
Micro - 425	Dissertation / Project Course: Part-1*	09	00
Micro-106+212	Seminar Course (1 + 2)*	00	02
	TOTAL		**18**
	SEMESTETR - IV		
Micro - 419	Molecular Phylogeny And Diversity (Core)	04	04
Micro - 420	Extremophiles (Core)	04	04
	Elective Course** (any one of the following)	04	04
Micro - 421	Biomolecular Engineering (Elective)		
Micro - 422	Fermentation Technology II (Elective)		
Micro - 423	Environmental Biotechnology II (Elective)		
Micro - 424	Combined Practical Course	08	04
Micro - 425	Dissertation / Project Course*	09	12
Micro - 426	Educational Tour / Field Work Course*	00	02
	TOTAL		**30**
	GRAND TOTAL	**144**	**96**

***** (a) ***Dissertation / Project Course*** commences in III Semester but evaluated and Grade Points are to be added in 4th Semester. (b) ***Educational Tours / Field Works Course*** may be carried out in any Semester or all Semesters, but evaluated and Grade Points are to be added in the 4th Semester. (c) ***Seminar / Tutorial Course*** may be carried out in first two Semesters but will be evaluated and Grade Points are to be added in the 3rd Semester.

DISSERTATION (Elective): Any one subject is to be chosen (Subjects offered may change from time to time depending on the availability of expertise)

** Elective and Multidisciplinary / Interdisciplinary courses may or may not have practical and/or field work.

M.Sc. Microbiology
DETAILED SYLLABUS
Semester - I

Micro. 101: CELL BIOLOGY

Unit-1 : Cell Structure & Cell Cycle

1.1 Cell Concept, Ultrastructure of Plasma Membrane, microbial and Plant Cell Wall
1.2 Ultrastructure of Nucleus and Nucleolus. Pore Complex of Nuclear envelop
1.3 Ultrastructure of Chromosome, Chromosomal Models, Special types of chromosomes
1.4 Cell Cycle, G_1/S Transition, Cyclines and cyclin dependent kinases. Regulation of CDK- cycline activity

Unit-2 : Cellular Organization

2.1 Mitochondria: Membrane Organization, Biogenesis and role in cellular energetics
2.2 Chloroplasts: Ultrastructure, biogenesis, Photosynthetic units and reaction centres
2.3 Ultrastructure and functions of Lysosome, Peroxisomes & Glyoxisomes
2.4 GERL System and its functions. Vacuoles and their role in cell structure and function

Unit-3 : Cytoskeleton, Cellular Transport & Sorting

3.1 Cytoskeleton: Ultrastructure and functions of Microtubules, microfillaments and associated proteins
3.2 Cytoskeleton: Ultrastructure and functions of Actin, Myosin, IF and associated proteins
3.3 Intracellular Junctions and their functions. Ca^{++} dependent homophillic and non-homophillic cell-cell adhesion
3.4 Transport across cell membrane: diffusion, active transport and pumps, uniports, symports and antiports

Unit-4 : Cellular Communication, Apoptosis and Cancer

4.1 Cell surface receptors and their mode of action. Phenomenon of exocytosis and endocytosis
4.2 Second messenger system, MDP kinase pathways
4.3 Apoptosis: Mechanism and significance
4.4 Cell biological approach of cancer, AIDS

Micro. 102: MOLECULAR BIOLOGY, GENETICS & EVOLUTION

Unit-1. Population Genetics

1.1 Principles of Mendalian genetics
1.2 Hardy-Weinberg genetic equilibrium, Natural selection
1.3 Genetics of Speciation
1.4 Origin of life: Coacervates, Miller's experiment, theories of organic evolution

Unit-2. DNA as a hereditary material

2.1 Structure of Nucleic acids, Structural differences in prokaryotic and eukaryotic DNA
2.2 DNA constancy and C-value paradox,
2.3 DNA replication and DNA methylation
2.4 Linkage and genetic (chromosome) mapping

Unit-3. Gene structure and function (Prokaryotic and Eukaryotic)

3.1 Loci, alleles, and Gene structure
3.2 Genetic code
3.3 Transcription
3.4 Translation

Unit-4. Structural Changes in DNA material and Extra Chromosomal inheritance

4.1 Molecular basis of spontaneous and induced mutations,
4.2 Chromosomal aberration
4.3 DNA damage and repair
4.4 Extra-chromosomal inheritance

Micro. 103: BIODIVERSITY & BIOSYSTEMATICS

Unit – 1: Biodiversity

1.1 Basic Concepts of Biodiversity: Genetic, species and ecological diversity.
1.2 Terrestrial, Marine Biodiversity, Eco-tourism and Biodiversity. Conservation and Sustainable use of Biodiversity. Ecosystem monitoring and Rehabilitation.
1.3 Threats to Biological Diversity: Habitat Destruction, Invasive species, Disease, Over-exploitation, Pollution, Climate change and Biodiversity.
1.4 Structure and functions of the Convention on Biological Diversity (CBD), CBD mechanisms and working bodies. National Action Plan.

Unit – 2: Microbial Taxonomy

2.1 Principles of systematics and classification of microbes.
2.2 Introduction to akaryotes, virus, archea& bacteria, cyanobacteria and prokaryotes
2.3 Fungus like protists: Cellular slime moulds, plasmodial slime moulds. General features of Fungus
2.4 Classification of Zygomycetes, Ascomycetes, Basidiomycetes, Mycorrhizea

Unit – 3: Plant Taxonomy

3.1 Principles of systematics and classification of Plants.
3.2 General features and Classification of green protists like diatom, dinoflagellates, lichens and algae
3.3 Non-tracheophytes (Mosses) and Non-Seed Tracheophytes (Ferns and Fern allies).
3.4 Seed plants: Gymnosperm and Angiosperms

Unit – 4: Animal Taxonomy

4.1 Principles of systematics and classification of Animals.
4.2 Classification of Protista (Flagellates, Amoebas, Ciliates and Apicomplexans).
4.3 Major invertebrate phyla, Lower chordates
4.4 Vertebrates: Fish, Amphibia, Reptiles, Birds and Mammals

Micro. 104: BIOSTATISTICS AND BIOINFORMATICS

Unit – 1: **Basics and concepts of Biostatistics**

1.1 Data, Tabulation, Classification, Frequency distribution and Graphics
1.2 Measure of Central Tendency – Mean, Mode & Median: Definition, Objectives, Merits, Demerits & Uses
1.3 Measure of Dispersion – Range, Variance, Standard deviation, Coefficient of Variation
1.4 Confidence limit and confidence interval

Unit – 2: **Statistical tests in Biology**

2.1 Student's t-test: Paired and Unpaired
2.2 Analysis of Variance
2.3 Regression and Correlation analysis
2.4 Chi-square test

Unit – 3: **Basics of Bioinformatics and Biological Database**

3.1 Introduction of Bioinformatics (Biological and IT links), Basic terminology
3.2 Application of bioinformatics in various fields: Medicine, Agriculture, Industries etc.
3.3 Types of biological database, File formats and Structure of database
3.4 Primary and Secondary database

Unit – 4: Sequence alignment, Gene prediction and Basic concepts of Omics

4.1 Sequence alignment: Nucleotide and Protein sequences, Pairwise and multiple sequence alignment, Phylogenic relationship and importance of the study
4.2 Gene prediction: Gene structure in prokaryotic and eukaryotic systems, Prediction tools for the gene
4.3 Genomics: Definition and importance of the study
4.4 Other Omics (Transcriptomics, Proteomics and Metabolomics: Definition and importance of the study)

Micro. 105: COMBINED PRACTICAL COURSE

101. Cell Biology

1. Preparation of paraffin blocks of animal tissue – Understanding the cytological and histological techniques
2. Section cutting, spreading and staining methods, Microscopy
3. Supra – vital Cytological staining of cellular organelles
4. Cellular metabolites: Permanent Cytological Staining
5. Nucleic Acids: Permanent Cytological Staining
6. Cytogenetics: Onion root tip squash preparation for mitosis
7. Dipteran salivary gland squash preparation for giant chromosome
8. Cytological Staining of Barr body
9. Cytogenetics: Stages of meiosis
10. Histological and Cytological Staining of Drumstick
11. Enzyme histochemistry&Cytochemistry
12. Observations on permanent cytological slides

102. Molecular Biology, Genetics &Evolution

1. To confirm thalassemia by NESTROFT (Necked Eye Single Tube RBCs Osmotic Fragility Test)
2. To induce polyploidy in root of Allium cepa and observe cytological changes in cell
3. To study karyotype of human chromosome
4. Identification of normal male and female karyotype
5. Identification of Turner syndrome using Karyotype
6. Identification of Klinefelter syndrome using the karyotype
7. Identification of Down syndrome using the karyotype
8. Identification of Edwards syndrome using the karyotype
9. To perform linkage analysis and Map construction with example
10. To perform Pedigree analysis and Probabilities with example
11. Staining of Microbial Cells: Monochrome, Negative & Gram Staining
12. Bacterial Motility (Hanging Drop Method)
13. Bacteriological Media Composition & Preparation and Bacterial Cultivation Methods

103. Biodiversity & Biosystematics

1. General features & classification of Invertebratesup to class or order
2. General features & classification of vertebrates up to class or order
3. General features and classification of diatoms, dinoflagellates, lichens and algae
4. General features and classification of non-tracheophytes and non-seed tracheophytes
5. General features and classification of Gymnosperms
6. General features and classification of angiosperms
7. Negative staining, Differential staining (Gram's staining)
8. Specialized staining: Capsule staining, Spirocheck staining, Metachromatic granule staining, Cell wall staining
9. Hanging drop techniques for motility

104. Biostatistics& Bioinformatics

Biostatistics:

1. Frequency Distribution
2. Standard Deviation and Coefficient of Variation
3. Confidence limits for the population mean
4. Students 't' test
5. Analysis of Variance
6. Regression and Correlation
7. Chi Square Test

Bioinformatics :

8. Basic Terminologies in Bioinformatics
9. Biological databases
10. NCBI Search for Gene Sequences
11. UniProt Knowledgebase (UniProt KB) Search for Protein Sequences
12. RCSB PDB search for Protein 3D Structures

13. Pair wise Sequence Alignment using NCBI BLAST
14. Pair wise Sequence Alignment using Bio edit
15. Multiple Sequence alignment using CLC Protein Workbench
16. Multiple Sequence alignment using Clustal X
17. Analysis of 3 D structure of protein by Rasmol

M.Sc. Microbiology: SEMESTER - II

Micro. 207: BIOCHEMISTRY

Unit – 1 : Carbohydrates, Lipids and Fatty Acid metabolism
1.1 Monosaccharides and disaccharides: Types and properties
1.2 Polysaccharides: Homopolysaccharides and hetropolysaccharides
1.3 Classification and properties of simple and compound lipids
1.4 Function of lipids, Metabolism of fatty acids: Beta oxidation

Unit – 2 : Protein Structure and Function
2.1 Properties of amino acid, titration curves and function of proteins
2.2 Primary and Secondary structure of protein
2.3 Tertiary structure of protein, Ramchandran Plots
2.4 Quaternary structure of protein: globular and fibrous

Unit – 3 : Enzymes: Basic Concepts and Kinetics
3.1 An introduction to enzymes: Nomenclature and classification
3.2 Principles and mechanism of enzymes catalysis: single and multisubstrate, Coenzymes and cofactors
3.3 Kinetic properties of enzymes, Michaelis-Menten Model, Double reciprocal plot
3.4 Enzyme Inhibition: Competitive, Non- competitive, Uncompetitive and Mixed type

Unit – 4 : Metabolism: Basic Concepts and Regulation
4.1 Concept of Bioenergetics: laws of thermodynamic, Entropy and Enthalpy, Energy rich compounds and electron carriers
4.2 Glycolysis and Citric Acid Cycle
4.3 Other pathways of carbohydrate metabolism ED, Pentose Phosphate, Glyoxylate, Gluconeogenesis
4.4 Allosteric proteins, Feedback inhibition

Micro. 208: BIOTECHNOLOGY & IMMUNOLOGY

Unit – 1 : Biotechnology -1.
1.1 Bioremediation: Principles and Methods,
1.2 Techniques of immobilization of enzymes & cells
1.3 Applications of Immobilized Enzymes & Cells
1.4 Principles and techniques of animal tissue culture

Unit – 2 : Biotechnology -2
2.1 Basics of genetic engineering
2.2 DNA isolation techniques
2.3 Restriction enzymes, Gene targeting
2.4 Vectors : plasmids, cosmids and phages, Host vector system, Screening of the recombinant clones

Unit – 3 : Plant Tissue culture
3.1 Principles and Techniques of Plant Tissue Culture
3.2 Basic Steps of Plant Tissue Culture
3.3 Selection of Plant Culture Media
3.4 Types of Plant Tissue Cultures

Unit – 4 : Immunology
5.1 Antigen Antibody: Structure of Ig, Ig Classes & Biological Activities, Factors Influencing Immunogenicity, Monoclonal Antibodies
5.2 Innate and Adaptive Immune System
5.3 Antigen-Antibody Interactions: ELISA Test, Agglutination, Precipitation, Immunofluorescence
5.4 Delayed and Immediate Hypersensitive Reactions, Autoimmunity

Micro. 209: ENVIRONMENTAL SCIENCE

Unit-1 Environment
1.1 Definition, principles and Scope of Environmental science.

1.2 Earth, Man and Environment, Ecosystems, Pathways in Ecosystems, Physico-chemical and Biological factors in the Environment, Geographical classification and zones.
1.3 Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere.
1.4 Scale of Meteorology, pressure, temperature, precipitation, humidity, radiation and wind.
1.5 Atmospheric stability, inversions and mixing heights, windroses

Unit-2 Ecosystem
2.1 Definition, Principles and scope of ecology, Human ecology and human settlement,
2.2 **Ecosystems:** Structure and functions, abiotic and Biotic components, food chains, food web, ecological pyramids, population, community ecology and parasitism, prey-predator relationships
2.3 Biomes of the world
2.4 Overview of Sanctuaries, National park and Botanical garden

Unit-3 Pollution
4.1 Air: Natural and anthropogenic sources of pollution, primary and secondary pollutants, Transport and diffusion of pollutants. Gas laws governing the behavior of pollutants in the atmosphere. Methods of monitoring and control of air pollution SO_2, NOx, CO, SPM. Effects of pollutants on human beings, plants, animals, materials and on climate, Acid rain, Air Quality Standards
4.2 Water: Types, Sources and consequences of water pollution, physic-chemical and bacteriological sampling and analysis of water quality. Standards, sewage and waste water treatment and recycling. Water quality standard
4.3 Soil: Physico-chemical as bacteriological sampling as analysis of soil quality, Soil pollution control, Industrial waste effluents and heavy metals, their interactions with soil components. Degradation of different insecticides, fungicides and weedicides in soil. Soil organic and inorganic components
4.4 Global Environmental problems: Ozone depletion, global warming and climatic change, clean development mechanism.

Unit-4 Environmental Impact Assessment
3.1 Introduction to environment impact analysis, Environmental impact statement and environmental management plan, Impact Assessment methodologies
3.2 Generalized approach to impact analysis
3.3 Procedure for reviewing environmental impact analysis and statement
3.4 Principles of Remote sensing and its applications of environmental sciences, Application of GIS in Environmental management

Micro. 210: ANALYTICAL TECHNIQUES

Unit – 1 : Microscopy and Autoradiography
1.1 Theories of Tissue fixation and staining techniques
1.2 Principles of Transmission and Scanning Electron microscopy
1.3 Principles of Phase Contrast and Fluorescence Microscopy
1.4 Principle and applications of Autoradiography

Unit – 2 : Spectroscopy
2.1 Basic principles of Spectroscopy, UV, IR, Raman, ESR, ORD
2.2 CD and structure of proteins using NMR and ESR
2.3 Neutron and X-Ray diffraction for elucidation of 3D structure
2.4 Molecular modelling, Mass Spectrometry

Unit – 3 : Chromatographic techniques
3.1 Basic Principle and types of Chromatography
3.2 Gas Chromatography, GC-MS, LC – MS / MS
3.3 Ion Exchange Chromatography, gel permeation, Affinity and reverse phase chromatography
3.4 HPLC and FPLC

Unit – 4 : Centrifugation and Electrophoretic Techniques
1.1 Principle and applications of Centrifugation techniques
1.2 Basic principles of Electrophoresis, Agarose gel, native and SDS-PAGE
1.3 Isoelectric focusing, 2D-PAGE and their uses in protein research
1.4 Fractionation and Blotting Techniques

Micro. – 211 : COMBINED PRACTICAL COURSE

207. Biochemistry: Suggested Laboratory Work

1. To prepare a titration curve of a weak acid with a strong base
2. To prepare a titration curve and determine the pK and pI value of an amino acid
3. Qualitative analysis of Carbohydrates
4. To prepare a calibration curve of reducing sugars by DNSA
5. Extraction and estimation of reducing and non-reducing sugars by DNSA method.
6. To prepare a calibration curve of protein by Folin-Lowry method
7. Extraction and estimation of protein by Folin-Lowry method
8. To prepare a calibration curve of amino acid using Ninhydrin reaction method
9. Extraction and estimation of free amino acid content in germinating seeds by ninhydrin reaction method
10. To prepare a calibration curve for para nitrophenol
11. Estimation of enzyme acid phosphatase activity from given plant material
12. Determination of Vmax and Km
13. To separate amino acids by ascending paper chromatography
14. To determine acid value of fats and oils
15. To determine saponification value of fats and oils
16. Protein purification Table

208. Biotechnology: Suggested Laboratory Work

1. Isolation & Identification of Bacteria, Yeasts & Fungi
2. Biochemical Tests: Metabolic Activities of Enteric Bacteria: Sugar Fermentation, IMViC, H2S production, Phenylalanine DeaminaseUrea Hydrolysis, Nitrate Reduction, Amylase, Protease
3. Detection of Extracellular Alkaline Protease, amylase from Haloalkaliphilic Actinomycetes
4. Determination of Alkaline Protease from Haloalkaliphilic Actinomycetes using Anson-Hagihara's Method
5. Concept of Totipotency
6. Direct ELISA Technique
7. Indirect ELISA Technique
8. Antigen preparation
9. Preparation of plant tissue culture media
10. Callus culture from leaf material
11. To perform the ouchterlony double diffusion.
12. To learn the technique of Immunoelectropheresis
13. To learn the technique of radial immunodiffusion.
14. To learn the technique of agglutination.
15. To perform sandwich DOT ELISA test for antigen.
16. To perform Rocket Immunoelectrophoresis
17. To perform Western Blot Technique
18. To isolate genomic DNA from bacterial isolate

209. Environmental Science: Suggested Laboratory Work

1. To determine color of soil by physical observation and to determine water holding capacity
2. To determine field capacity of soil
3. To determine temperature soil by thermometer.
4. To determine soil-moisture by oven drying
5. To determine soil texture
6. To estimate the amount of organic carbon by Walkley and Black titration method
7. To estimate total nitrogen from given soil
8. To estimate the amount of Ca from given soil sample
9. To estimate the amount of Mg from given soil sample
10. To determine the amount of carbonate in the soil by rapid test
11. To determine the amount of nitrate by rapid test
12. To determine the base deficiency of soil by rapid test
13. To determine reductivity of soil by rapid test
14. To determine the amount of organic carbon by Walkley's and Black's titration method
15. To determine the amount of chloride by rapid test
16. To determine Calcium Carbonate in the Soil.

17. To determine phosphate content in the soil
18. To study the meteorological apparatus
19. To determine the alkalinity of given water sample.
20. To determine acidity of given water sample.
21. Dissolved oxygen (DO)
22. Biological oxygen demand (BOD)
23. Chemical oxygen demand (COD)
24. Bacteriological analysis by MNP
25. Color, turbidity, odour and pH, TS, TDS ans TSS
26. Chloride estimation
27. Sulfate estimation
28. Ca-Mg Hardness/ Estimation of total hardness of water by EDTA method.
29. Phosphorus Phosphate estimation(ascorbic acid method)
30. Estimation of Nitrite-Nitrogen of given water sample

210. Analytical Technique: Suggested Laboratory Work

1. Demonstration of a state-of-the-art compound microscope with Brightfield, Phase-Contrast, Fleuroscence and Darkfield operational details.
2. Demonstration of computer controlled brightfield microscopy
3. Demonstration of Image capturing and Image analysis by Image Analysis software
4. Determination of various image analysis parameters (cell or tissue length, width, diameter etc.) by using both microscopy and image capturing and analyses.
5. Demonstration of Stereo zoom dissecting microscope
6. Determination of various image analysis parameters (Tissue or Organism length, width, diameter etc.) by using both microscopy and image capturing and analyses.
7. Localization of anthocyanin in plant tissue
8. Localization of phenols in plant tissue
9. Localization of Tannins in plant tissue
10. Localization of alkaloids in plant tissue
11. Localization of lignins in plant tissue
12. Localization of starch in plant tissue
13. Localization of flavanoids in plant tissue
14. Determination of molecular mass of Protein by size exclusion chromatography (Theoretical)
15. PCR amplification of gene
16. DNA sequencing of the amplified gene
17. Electrophoresis of PCR product

M.Sc. Microbiology Semester III

MICRO-313: GENOME ORGANIZATION AND REGULATION OF GENE EXPRESSION (CORE PAPER I)

UNIT-1

1.1 Basic Logic behind genome organization, Histone proteins: evolutionary trend and structure of nucleosomes
1.2 Various levels of genome in organization
1.3 Histone like proteins in prokaryotes and genome organization in prokaryotes
1.4 Histone like proteins in archaebacteria and archaeal Genome Organization

UNIT-2

2.1 Regulation of gene expression in prokaryotes: The Operon model of regulation
2.2 Inducible and repressible operons with the examples of *lac*, *trp* and arabinose operons
2.3 Genetic analysis and positive and negative control of *lac* operon; 3- Dimensional structure of *lac* repressor and mechanism of it's binding to DNA
2.4 Regulation of gene expression in eukaryotes: Transcriptional control, RNA splicing mechanism, Translational and post-translational control

UNIT-3

3.1 Genetic exchange in Prokaryotes
3.2 Molecular basis of conjugation among prokaryotes,Genetic exchange by conjugation involving prokaryotes and eukaryotes
3.3 Molecular mechanism of transformation and transduction
3.4 Plasmid Biology: Control of replication, Plasmid distribution and stability

UNIT-4

4.1 Transposons, viroids and prions
4.2 Viral replication and its control
4.3 Genetic regulation of lysogenic / lytic control, λ-phage
4.4 Genetics of Streptomyces and Yeast

MICRO-314: FERMENTATION TECHNOLOGY-I (CORE PAPER II)

UNIT-1

1.1 Screening of industrially important microorganisms
1.2 Strain improvement: Molecular approaches, Directed evolution & selection
1.3 Preservation of industrial microorganisms, Quality control of preserved stock cultures
1.4 Substrates for microbial fermentations, Foam in microbial processes and antifoam agents

UNIT-2

2.1 Basic concept and design of bioreactor
2.2 Bioreactor design for genetically-engineered microorganisms and Baculo-virus
2.3 Aeration and agitation
2.4 Kinetics of batch and continuous process

UNIT-3

3.1 Sterilization of media and air, Scale up of sterilization
3.2 Containment categorization and aseptic operation
3.3 Viral safety for biotech products
3.4 Production of foreign protein by heterologous expression system: Important factors, Bioprocess strategies

UNIT-4

4.1 Monitoring and control process: Fundamentals of process control, Feed-back control, Factors to be controlled in bioreactor
4.2 Computer applications in fermentations, on line process monitoring
4.3 Biosensors in bioprocess monitoring and control: Biological elements and transduction technology
4.4 Applications of biosensors

MICRO-315: ENVIRONMENTAL BIOTECHNOLOGY- I (ELECTIVE PAPER-I)

UNIT-1

1.1 Methods to study Microbial ecology
1.2 Nutritional types of Microbes
1.3 Microbial habitats and ecology
1.4 Biogeography; Fitness of microorganisms as geochemical agents

UNIT-2

2.1 Interactions with a single microbial population: Allee's principle, positive interaction, negative interaction
2.2 Interactions between diverse microbial populations: Neutralism, commensalism, synergism, mutualism, ammensalism, parasitism
2.3 Biotransformation of Fe, Mn, Phosphorous

UNIT 3

3.1 Biodegradation-Parameters influencing biodegradation
3.2 Types of Biodegradation Reaction
3.3 Methods to study Biodegradation
3.4 Various Degrees of Degradation of Organic compounds

UNIT 4

4.1 General principles of Biodeterioration
4.2 Biodeterioration of wood, pulp & paper, cotton textiles, leather
4.3 Biodeterioration of plastics
4.4 Biodeterioration of rubber

MICRO-316: FOOD BIOTECHNOLOGY (ELECTIVE PAPER II)

UNIT-1

1.1 Starter cultures and their biochemical activities; production of alcoholic beverages
1.2 Production of Single cell protein and Baker's yeast; Mushroom cultivation
1.3 Food and dairy products: Cheese, bread and yogurt.
1.4 Fermented vegetables – Saurkraut; Fermented Meat – Sausages

UNIT-2

2.1 "Novel microorganisms eg. LAB (Probiotics), Cyanobacteria, methylotrophs enzyme biotransformations,
2.2 Role of Plant tissue culture for improvement of food additives; color and flavor
2.3 Genetic modifications of microorganisms; detection and rapid diagnosis
2.4 Genetically modified foods and crop

UNIT-3

3.1 Food borne infections and intoxications; with examples of infective and toxic types, Clostridium, Salmonella, Staphylococcus
3.2 Mycotoxins in food with reference to Aspergillus species
3.3 Food preservation: canning, dehydration, ultrafiltration, sterilization, irradiation
3.4 Chemical and naturally occurring antimicrobials; Biosensors in food industry

UNIT-4

4.1 Quality assurance: Microbiological quality standards of food
4.2 Intellectual property rights and animal welfare
4.3 Government regulatory practices and policies. FDA, EPA, HACCP, ISI.
4.4 Risk analysis; consumer and industry perceptions

MICRO-317: MOLECULAR BIOTECHNOLOGY (ELECTIVE PAPER III)

UNIT-1 Proteomics techniques

1.1 Techniques in gene detection and expression: Southern hybridization
1.2 Northern hybridization, western hybridization, PCR and RT-PCR
1.3 Peptide sequencing and synthesis; principles and strategies for protein sequencing.
1.4 Design of primers from ammo acids sequences

UNIT-2 DNA- protein interaction techniques:

2.1 Gel mobility shift assay, DNA-protein cross-linking assay,
2.2 Dnase I foot printing and Sl nuclease mapping
2.3 Protein- protein interactions: chemical cross-linking.
2.4 Yeast-2-hybid, Yeast-3-hybid approaches: Principles and applications

UNIT-3 Reporter genes

3.1 Significance and various types of reporter gene systems
3.2 Chloramphenicol acetyl transferase (cat), neomycin phosphoryl transferase II (nptII)
3.3 Luciferase and β- galactosidase system: applications in expression studies
3.4 Kinetics and promoter probing

UNIT-4 Vectors and Expression Systems

4.1 Significance of expression of genes into foreign hosts (*E.coli, Bacillus, Pistia* systems)
4.2 Various types of vectors and their stability in host
4.3 Different types of hosts and their relevance in gene expression
4.4 Edible vaccines and other foreign proteins expressed in plants

M.Sc. Microbiology-Semester IV

MICRO-419: MOLECULAR PHYLOGENY AND DIVERSITY (CORE PAPER-I)

UNIT-1

1.1 Microbial evolution and phylogeny
1.2 Molecular basis of microbial classification**,** phylogenetic trees and three domain universal phylogenetic tree
1.3 Chronometers and chronological distances, paradox in establishing evolutionary distances, methods of 16S rRNA analysis
1.4 Isolation of nucleic acid and analysis of microbial diversity

UNIT-2

2.1 Cultivable vs. non-cultivable microbes,
2.2 Genetic heterogeneity among non-cultivable, Molecular methods for studying non-cultivable microbes viz. PCR, DGGE, TGGE, RFLP, T-RFLP, ARDRA, nucleic acid hybridization and SIP
2.3 Metabolic potential of non-cultivable microbes
2.4 Evolutionary and Biotechnological significance of non-cultivable microbes

UNIT-3

3.1 Distinguishing features of Gram-negative Proteobacteria
3.2 Proteobacteria: alpha and beta groups
3.3 Proteobacteria: Delta & epsilon group
3.4 Gram-negative Non-proteobacteria

UNIT 4

4.1 Gram-positive bacteria: Actinobacteria (High G+C)
4.2 Low G + C bacteria
4.3 Bacilli, Lactobacilli
4.4 Clostridia

MICRO-420: EXTREMOPHILES (CORE PAPER-II)

UNIT-1

1.1 Introduction to extremophiles
1.2 Extreme Environments and distribution of extremophiles
1.3 Extremophilic bacteria and archaea
1.4 Eukaryotic extremophiles

UNIT 2

2.1 Archaea - taxonomic position, distinguishing features and Phylogenetic groups
2.2 Ecology and habitats of Archaea
2.3 Physiology and adaptive strategies of Archaea
2.4 Biotechnological potential of Archaea

UNIT-3

3.1 Life at hyper-extremities: Thermophilic Archaea and bacteria
3.2 Hyperthermophiles: habitats and ecological aspects, thermophily, Protein stability in hyper-extremophiles, Applications of thermozymes
3.3 Psychrophies: distribution and diversity, adaptation
3.4 Acidophiles: Classification, life at low pH, acid tolerance, applications

UNIT-4

4.1 Halophiles: Life at hyper salinity, Taxonomy and ecology, Osmoadaptation / halotolerance, Applications of halophiles and their extremozymes
4.2 Alkaliphiles: Isolation and classification, Physiology of alkaliphiles, genetic analysis of alkaliphily
4.3 Methanogens: diversity, physiology and habitats, bioenergetics and unique biochemistry of methanogenesis, syntrophy and methanogenesis, applications
4.4 Barophiles: Classification, high-pressure habitats, life under pressure, barophily

MICRO-421: BIMOLECULAR ENGINEERING (ELECTIVE PAPER-I)

UNIT-1

1.1 Molecular forces in protein structure
1.2 Peptide geometry
1.3 Alpha helix and the beta sheet and its role in protein function
1.4 Domains and topology with reference to catalytic action

UNIT-2

2.1 Protein folding: A General Account
2.2 Molecular chaperones and their cellular functions, role of chaperones in folding of extremophilic proteins
2.3 Molecular chaperone- assisted protein folding and mechanistic details of the action
2.4 *In-vitro* protein folding and it's biotechnological significance

UNIT-3

3.1 Significance and methods of protein engineering
3.2 Directed evolution and gene shuffling, Evolution and mutator strains; Pathway evolution
3.3 Creation of genetic heterogeneity and screening for novel traits
3.4 Recombinant biocatalysts and their commercial ramification; codon bias and enhanced gene expression

UNIT-4

4.1 Variants of PCR and its applications: General principle, Real Time/q-PCR, nested PCR, asymmetric PCR, Hot start PCR, inverse PCR, Multiplex PCR, Reverse Transcriptase PCR, RACE PCR (Rapid Amplication of C-DNA Ends)
4.2 Strategies for primer designing for known and unknown sequences, Bioinformatics approaches
4.3 DNA Sequencing: General principle, automated sequencing, pyro-sequencing, DNA chip technology, oligonucleotide array detector, Next generation sequencing
4.4 Molecular cloning, selection of recombinant clones, gene library, molecular tagging of expressed proteins

MICRO-422: FERMENTATION TECHNOLOGY II (ELECTIVE PAPER II)

UNIT-1

1.1 An introduction to downstream processes
1.2 Microbial cell separation and disintegration
1.3 Extraction and purification of fermentation products
1.4 Drying and crystallization

UNIT-2

2.1 Biomass production; from carbohydrates; molasses, spent sulphite liquor, whey, from n-alkanes
2.2 Ethanol production: Sugar substrates; starch; cellulosic material; Microbes: yeast and bacteria
2.3 By-product, economic & energetic aspects of ethanol fermentation
2.4 Immobilization of cells and enzymes

UNIT-3

3.1 Microbial production of organic acids: Citric acid, lactic acid
3.2 Microbial production of amino acids: lysine, glutamic acid
3.3 Fermentative production of antibiotics: Penicillin and semi synthetic antibiotics
3.4 Production of vitamin B12

UNIT-4

4.1 Industrial applications of free enzymes
4.2 Production and sources of enzymes
4.3 Microbial production of commercial enzymes: protease, amylase and pectinase
4.4 Microbial production of polysaccharides: xanthan, dextran

MICRO-423: ENVIRONMENTAL BIOTECHNOLOGY II (ELECTIVE PAPER-III)

UNIT-1

1.1 Biodegratation of cellulose
1.2 Biodegratation of Hemicellulose
1.3 Biodegratation of Lignin
1.4 Biodegratation of Pectin

UNIT-2

2.1 Biodegradation of pesticides
2.2 Biodegradation of PAHs
2.3 Biodegradation of nitroaromatics
2.4 Biodegradation of chloroaromatics

UNIT-3

3.1 Acid mine drainage
3.2 Microbial methylation of mercury
3.3 Microbial methylation of arsenic
3.4 Other inorganic pollutants

UNIT-4

4.1 Bioremediation
4.2 Various strategies involving Bacteria, Archeae , Eukaryotes
4.3 Various strategies involving eukaryotes: Fungi, algae & plants
4.4 Bioremediation by Genetically modified microbes

COMBINED LIST OF PRACTICALS

SEMESTER 3

1. Estimation of DNA by diphenylamine method.
2. To perform the process of bacterial conjugation through the transfer of genes coding for antibiotic resistance.
3. Estimation of RNA by Orcinol Method.
4. Isolation of lac- mutants of *E.coli* by U.V. mutagenesis.
5. Isolation and purification of chromosomal DNA from bacteria.
6. Isolation and purification of plasmid DNA from bacteria from alkali lysis method.
7. Isolation and purification of plasmid DNA from bacteria by ion exchange chromatography.
8. Transformation of *E.coli* DH5α strain with pUC18 Plasmid.
9. To demonstrate Bacterial conjugation
10. Screening for extra cellular enzyme producing bacteria
11. To perform amylase activity
12. To study the effect of heat treatment on enzyme activity
13. Effect of substrate concentration on the enzyme activity
14. Effect of pH on the enzyme activity
15. Effect of salt concentration on the enzyme activity
16. To study the effect of heat treatment on enzyme activity
17. To study the effect of incubation time on the amylase activity Isolation and identification of *Lactobacilli* from fruits and fermented foods
18. A. Isolation of probiotic lactic acid bacteria
    B. Characterization of probiotic properties
    C. Tolerance to low pH; bile; NaCl; Phenol
    D. Antimicrobial activity
19. Sauerkraut Production
20. Wine Production
21. Isolation & Characterization of Baker's Yeast *Saccharomyces cerevisiae*
22. Isolation & Characterization of Edible Mushrooms
23. To prepare fermented cabbage (Sauerkraut)
24. pH, salt, phenol bile tolerance of probiotic bacteria
25. Antimicrobial activity of probiotic bacteria
26. Isolation of Basidiomycetes
27. Preparation of *Pleurotus ostreatus* spawn
28. Isolation of PGPR
29. Screening of PGPR
30. Phosphate solubilization studies by PGPR
31. Siderophore production by PGPR
32. HCN, NH3, Indole AA Giberallic acid production by PGPR
33. Growth on AMA
34. To carryout lab scale fermentation and recovery of amino acid (Gluatamic acid).
35. Separation and identification of amino acid (Glutamic acid) by qualitative and quantitative estimation.
36. Screening of citric acid producers by plate assay method.
37. To carry out lab scale production and estimation of citric acid.
38. Recovery of citric acid by Ca(OH)2 precipitation method.
39. Alcohol fermentation by *Saccharomyces cerevisae*.
40. Estimation of alcohol by Dichromate method. Immobilization of yeast cells by entrapment method.
41. To determine the MIC of streptomycin for *E.coli*

SEMESTER 4

1. To determine the temperature optima of α- amylase.
2. Determination of pH optima on amylase activity
3. To determine the thermal stability of enzyme α amylase
4. To determine the pH stability of enzyme α amylase
5. To determine Km and Vmax of α-amylase
6. To study the protein folding for Amylase.
7. To study the effect of enzyme concentration on α-amylase activity.

8. To study effect of enzyme inhibitor on α-amylase activity.
9. Isolation, maintenance and regeneration of protoplast from *Bacillus megaterium.*
10. To isolate and fuse protoplast of Spinach leaves
11. To study the microbiological analysis of water.
12. Microbial analysis of water sample by Standard Plate Count (SPC).
13. To estimate the total solid (TS), total dissolved solids (TDS) & total suspended solid (TSS) in given water sample.
14. To estimate Biochemical Oxygen Demand (BOD) of the given water sample.
15. Estimation of total hardness of water by EDTA method
16. To understand the basic concept of SNPs.
17. Designing of Primers.
18. To understand and perform the basic concept of GFP cloning (Green Fluorescent Protein Cloning).
19. To Perform Agarose Gel Electrophoresis of the isolated DNA.
20. A. Production of ligninolytic enzymes by White rot basidiomycetes (SSF & Stationary Cultures
    B. Production of cellulolytic enzymes by White rot basidiomycetes
    C. Production of xylanolytic enzymes by White rot basidiomycetes
    D. Degradation of textile dyes by ligninolytic enzymes of White rot basidiomycetes MnP, LIP, MIP, Laccase
    E. Winogradsky's Column
21. To perform Bavendamm's test
22. To study the production of ligninolytic enzymes by *Phanerochaete chrysosporium* grown under shallow stationary culture.
23. To study effect of H2O2 on LiP activity produced by *Phanerochaete chrysosporium*
24. To study effect of pH on LiP activity produced by *Phanerochaete chrysosporium*