SAURASHTRA UNIVERSITY

RAJKOT

(ACCREDITED GRADE "A" BY NAAC)

FACULTY OF SCIENCE

Syllabus for

M. Sc. (MICROBIOLOGY)

Choice Based Credit System

With Effect From: 2016-17

Department of Microbiology
Course Structure and Scheme of Examination
For Choice Based Credit System (CBCS)
(Total 96 credits)
Effective from June 2016

M. Sc. Microbiology
Program Outcomes (PO)

PO1:
Academic Competence

Understanding of the subject with respect to structure, diversity, metabolisms and applications of the microorganisms is extensively developed. It also involves structure and function of biological molecules. At the end, the students gain depth of scientific knowledge regarding microorganisms.

PO2:
Critical thinking

Students are expected to develop skills in conducting practical, designing experiments and analyzing the data reaching to conclusions. The theoretical base is developed on the various aspects of microorganisms and ability to solve the problems.

PO3:
Research and development

Students gain ideas and competence regarding research and data analysis which will be highly useful to them in higher studies and exploring job opportunities. They acquire abilities for self direction and originality in tackling and solving problems and implementing tasks at professional levels.

PO4:
Personal and Behavioural Competence

Professional skills concerning biochemical analysis, carrying out experiments and developing ability in specific areas of microorganisms are also developed.

PO5:
Effective Communication

During this programme, the students develop the ability for articulation of ideas, scientific writing and report reporting, conference presentations and delivering seminars. They also develop conversational competence and effective verbal and written.

PO6:

Social Competence

The students will develop abilities to manage projects in order to achieve objectives and ability to work in team.

PO7:

Self directed and Continuous learning

The students are expected to develop competence to proceed for higher studies and searching for job avenues.

M. Sc. Microbiology
Program Specific Outcomes (PSO)

PSO1:

To develop competence and knowledge and skills to pursue a career in research, industry and in academic set up

PSO2:

To develop skin and competence in experimental work related to microbiology, molecular biology and biochemistry towards solving problems.

PSO3:

Learning techniques and approaches in analytical areas, biochemistry, Microbiology, Molecular biology and Bioinformatics.

PSO4:

To develop broad based knowledge in the Cell biology, Metabolism, Biochemistry, Genetics, Immunology, fermentation industries and Enzymology.

PSO5:

Dissertation helps students in developing skill in research. They get exposure to hands on training of a small research project work, and learn research methodology, reviewing literature and citation of the previously work done in the field. They get exposure of analyzing the experimental data and report writing. With these skills they get to know and follow biodiversity act of regional and national Biodiversity Act body for sample collection process.

PSO6:

Field Work: In Nature, Industries & Agricultural Farms: organizational aspects of the field work, Social & Scientific interaction with the experts, Sampling & Preservation of Samples, Data Collection, Sample preservation

Semester -1

Subject Code	Title of the Course	Course Credits	No. of Hrs. Per Week	Weightage For Internal Examination	Weightage For Semester End Examination	Total Marks	Duration of Semester End Exam in Hrs.
	Core						
Micro - 101	Cell Biology (Core)	04	04	30	70	100	2.5
Micro - 102	Molecular Biology, Genetics & Evolution (Core)	04	04	30	70	100	2.5
Micro - 103	Biodiversity & Biosystematics (Core)	04	04	30	70	100	2.5
	Interdisciplinary						
Micro - 104	Biostatistics and Bioinformatics	04	04	30	70	100	2.5
Micro - 105	Combined Practical Course	08	14	-	-	200	06
Micro - 106	Seminar Course - 1	00	02	-	-	-	-
Total		24				600	

Semester -2

Subject Code	Title of the Course	Course Credits	No. of Hrs. Per Week	Weightage For Internal Examination	Weightage For Semester End Examination	Total Marks	Duration of Semester End Exam in Hrs.
	Core						
Micro - 207	Biochemistry (Core)	04	04	30	70	100	2.5
Micro - 208	Biotechnology & Immunology (Core)	04	04	30	70	100	2.5
Micro - 209	Environmental Science (Core)	04	04	30	70	100	2.5
	Interdisciplinary						
Micro - 210	Analytical Techniques	04	04	30	70	100	2.5
Micro - 211	Combined Practical Course	08	14	-	-	200	06
Micro - 212	Seminar Course - 2	00	02	-	-	-	-
Total		24				600	

Semester -3

Subject Code	Title of the Course	Course Credits	No. of Hrs. Per Week	Weightage For Internal Examination	Weightage For Semester End Examination	Total Marks	Duration of Semester End Exam in Hrs.
	Core						
Micro - 313	Genome Organization and Regulation of Gene expression (Core)	04	04	30	70	100	2.5
Micro - 314	Fermentation Technology - I (Core)	04	04	30	70	100	2.5
	Elective (Any One)						
Micro - 315	Environmental Biotechnology I (Elective)	04	04	30	70	100	2.5
Micro - 316	Food Biotechnology (Elective)	04	04	30	70	100	2.5
Micro - 317	Molecular Biotechnology (Elective)	04	04	30	70	100	2.5
Micro - 318	Combined Practical Course	04	08	-	-	150	06
Micro - 425	Dissertation / Project Course: Part-1*	00	09	-	-	-	
Micro-106+212	Seminar Course (1 + 2)*	02	00				
Total		18				600	

Semester -4

Subject Code	Title of the Course	Course Credits	No. of Hrs. Per Week	Weightage For Internal Examination	Weightage For Semester End Examination	Total Marks	Duration of Semester End Exam in Hrs.
	Elective (Any One)						
Micro - 419	Molecular Phylogeny And Diversity (Core)	04	04	30	70	100	2.5
Micro - 420	Extremophiles (Core)	04	04	30	70	100	2.5
Elective (Any One)							
Micro - 421	Biomolecular Engineering (Elective)	04	04	30	70	100	2.5
Micro - 422	Fermentation Technology II (Elective)	04	04	30	70	100	2.5
Micro - 423	Environmental Biotechnology II (Elective)	04	04	30	70	100	2.5
Micro - 424	Combined Practical Course	04	08			150	06
Micro- 425	Dissertation work	12	09	-	-	200	
Micro - 426	Educational Tour / Field Work Course*	02	00			50	
Total		30				700	

SEMESTER-1

MICRO. 101: CELL BIOLOGY

Course Outcome:

CO 1: Students learn in details about comparative account of plant, animal and microbial cells, the similarities and differencies and specialities of different types of cells
CO 2: Students learn in details about organelles present in plant, animal and microbial cells, their structure and function and their importance to cells they are present in
CO 3: Students learn in details new developments about cytoskeleton, its organization and functions; an important structural part of cell important in cell division
CO 4: Students learn in details new developments about signalling and its importance in modulating cellular behaviour during development and diseased condition

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, G1/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

Course Outcome:

CO 1: Students learn in details about classical Mendelliangenetics, natural selection, how the field of genetics evolved,speciation and the evolution of diverse life in general
CO 2: Students learn in details about the various structure forms of DNA, organization of DNA in prokaryotes & Eukaryotes, synthesis of DNA in prokaryotes & Eukaryotes, and linkage and genemapping
CO 3: Students learn in details new developments about structureof gene and variant structures of genes in viruses, prokaryotes & Eukaryotes and their implications in the biology of these organisms, salient features of genetic code and the comparative account of synthesis of RNA and protein in prokaryotes & Eukaryotes
CO 4: Students learn in details new developments about the dynaic nature of DNA and the changes that can take in the hereditary material DNA, how cell responds to these changes and their implications and the orgnelles responsible for extrachromosomal inheritance

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

Course Outcome:

CO 1: Students learn in details about basic concept of biodiversity, environmental changes in the form of pollution and its implications on biodiversity at various levels
CO 2: Students learn in details about the phylogenetic and phonetic classification and taxonomy of prokaryotes & Eukaryotes

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

Course Outcome:

CO 1: Students learn in details about basic statistics and application of statistical to tools to study biological phenomenon, biodiversity, population biology and genetics
CO 2: Students learn in details about the field of bioinformatics and its applications in diverse fields such as basic biology and applied chemical and biological sciences
CO 3: Applications of bioinformatic tools in understanding the genetics of biological cell forms, their evolution and the classification and taxonomy of diverse life

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
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

SEMESTER 2

MICRO. 207: BIOCHEMISTRY

Course Outcome:

CO 1: Students learn in details about fundamental chemical components of cell, their structure and function
CO 2: Students learn in details about enzymes and their nomenclature , classification, chemistry and biology,
CO 3: General concept of bioenergentics, energy-generating biochemical reactions na dhow cell uses this energy for the synthesis of new cell

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

Course Outcome:

CO 1: Students learn in details about the causes of pollution, priority environmental pollutants and their behaviour in Nature and how biological principles can be exploited especially microbes to develop technologies for pollution abatement, development of enzyme formulations that improve the value of biocatalysts, and techniques to cultivate animal and plant cells in vitro and its varied applications
CO 2: basic information and tools required to gene manipulation and immunological principles

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

Course Outcome:

general well-being of the life on the surface of the planet
CO 2: Students learn how pollution is generated by anthropogenic activities and how it can damage globally and locally our environment, food web and life in general
CO 3: methods to evaluate the damge caused to environment and its probable short term and long term implications

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 SO2, 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

Course Outcome:

CO 1: Students learn in details about different techniques useful in the study and research of biological sciences, various microscopic techniques, sample preparation and staining, various spectroscopic techniques like UV-Vis, IR and MS, chromatographic techniques for the separation and identification of metabolites

CO 2: Students learn about techniques for the physical separation of cells and cellular metabolites by centrifugation, and electrophoretic separation of protein and nucleic acids

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

SEMESTER 3

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

Course Outcome:

CO 1: In this paper, students will learn new advances in genome organization in various prokaryotic systems.

CO 2: The students will gain the knowledge of various gene regulation and expression systems in prokaryotic and eukaryotic microbes.

CO 3: The studied related to genetic exchange in prokaryotes including mechanisms of transformation, transduction, conjugation and plasmid biology are very significant.

CO 4: The students will learn the viral systems and its genetic regulations.

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)

Course Outcome:

CO 1: Since the microorganisms have various industrial applications new screening methods and preservation of industrial microorganisms is introduced.
CO 2: The students will learn the basic and advanced concepts of fermentation including the design of bioreactor for genetically modified organisms and kinetics of fermentation process
CO 3: The studied related scale up of sterilization, viral safety for biotech productions and production of protein by heteologus expression system are very significant.
CO 4: The aspect related to automated fermentation process including biosensor technology and its applications are introduced that will raise the knowledge about recent developments in the field.

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)

Course Outcome:

CO 1: In this paper, the importance of microbial ecology and the significant role of microorganisms in biogeochemical cycles are highlighted.
CO 2: The emphasis is laid on various interactions within and between microbial populations. The students will get the knowledge about how constant microbial interactions made in natural environments.
CO 3: The students will get through various methods of biodegradation using microorganisms
CO 4: The students will learn principle and applications of various biodeterioration process made by microorganisms.

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)

Course Outcome:

CO 1: The microorganisms have various applications in food technology. So, the students will learn various processes carried out in food industries to produce fermented food.
CO 2: The role of genetically modified microorganisms and production of genetically modified foods and crops are significant aspects of food industries. The students will learn these aspects in detail
CO 3: The studied related scale up of sterilization, viral safety for biotech productions and production of protein by heterologus expression system are very significant.
CO 4: The aspect related to automated fermentation process including biosensor technology and its applications are introduced that will raise the knowledge among the students about the recent developments in the field.

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)

Course Outcome:

CO 1: A range of proteomics techniques are introduced that are significant to study.

CO 2: The emphasis is laid on DNA-protein interactions studies using various molecular methods that would develop the knowledge among the students related to molecular biology.

CO 3: The students will get through recent advancements in various reporter gene systems that are very significance in molecular biology studies.

CO 4: Various vector systems and their relevant host systems will develop the knowledge about molecular cloning and expression analysis among the students.

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

SEMESTER 4

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

Course Outcome:

CO 1: The new bacterial strains identified based on 16S rDNA gene sequencing and other molecular techniques are introduced.

CO 2: The metagenomics approach and new techniques used to indentify non-cultivable microbes are introduced.

CO 3: The students will learn unique features of various Gram-negative bacteria and their applications.

CO 4: Various Gram-positive bacteria and its ecological and industrial significance will develop the knowledge about characteristics and applications of these microorganisms among the students.

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)

Course Outcome:

CO 1: Recent advancements in the field of extremophiloes are introduced.
CO 2: The students will learn one of the important groups of extremophilic microorganisms known as Archaea and its potential biotechnological applications
CO 3: Various extremophilic microorganism including thermophiles, phychrophiles acidophiles and their adaptive mechanisms are introduced.
CO 4: The students will get through extremophilic microbes including halophiles, alkaliphiles barophiles and methanogens, their adaptive mechanisms and industrial significance.

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 hyperextremophiles,

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)

Course Outcome:

CO 1: The proteomics studies are introduced that are significant to study.

CO 2: The emphasis is laid on molecular chaperons and their role in folding of extremophilic microorganisms.

CO 3: The students will get through recent advancements in various methods of protein engineering and its significance.

CO 4: Various PCR techniques used to amply a gene of interest, molecular cloning, and next generation sequencing will develop the knowledge about recent developments in the field of molecular biology.

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

Course Outcome:

CO 1: Ranges of downstream processes are introduced that are significant in fermentation industries.
CO 2: The emphasis is laid on production processes and the concept of immobilization to increase production of desired product in fermentation industries.
CO 3: The students will get through recent advancements in microbial production of organic acids, amino acids, antibiotics and vitamins that are very significance in fermentation industries.
CO 4: The applications of various enzymes and polysaccharides produced by microbes in fermentation industries will develop the knowledge among the students.

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-

Course Outcome:

CO 1: It relates to the microorganisms which are involved in biodegradation process and its applications.

CO 2: Since microorganisms account for their biodegradation process, students will learn various biodegradations process including biodegradation of pesticides and other harmful compounds by microorganisms and there ecological significance.

CO 3: Various microbial processes used to remove inorganic pollutants from soil/other natural environments are introduced.

CO 4: The recent bioremediation strategies involving prokaryotic and eukaryotic microbes will improve the knowledge among the students.

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*

DISSERTATION PROJECT WORK

Project work/ dissertation are revised every year and upgraded every year as per the updates in the research area including extremophiles, host microbes interactions, enzymes and antibiotics produced by microbes, bioremediation, probiotics, diversity and distribution of microbes, etc. Dissertation is useful to the students as it develop the skills and increases the chances for the employability in the industrial sector.