FACULTY OF SCIENCE

SYLLABI

FOR

M.Sc. MICROBIOLOGY FOR CHOICE BASED CREDIT SYSTEM UNDER THE FRAMEWORK OF HONOURS SCHOOL SYSTEM

1ST TO 4TH SEMESTER

EXAMINATIONS 2020-2021, 2021-2022, 2022-23
OUTLINES OF TESTS, SYLLABI AND COURSES OF READING FOR M.Sc. (HONS SCHOOL) (SEMESTER SYSTEM) IN MICROBIOLOGY 1ST TO 4TH SEMESTER EXAMINATION 2020-2021, 2021-2022, 2022-2023
(For Choice Based Credit System under the framework of Honours School System)

<table>
<thead>
<tr>
<th>M.Sc (HS) 1st Year</th>
<th>Semester</th>
<th>Course No.</th>
<th>Course Title</th>
<th>Credits</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>MMIC C-1</td>
<td>Advances in Microbial Ecology</td>
<td>4</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MMIC C-2</td>
<td>Pathogenesis of Infectious diseases</td>
<td>4</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MMIC C-3</td>
<td>Newer approaches in diagnostic Microbiology</td>
<td>4</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MMIC C-4</td>
<td>Combined Practical-1</td>
<td>6</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MMIC GE-1</td>
<td>Swayam Paper-I*</td>
<td>2</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Second</td>
<td>MMIC C-5</td>
<td>Fermentation Technology</td>
<td>4</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MMIC C-6</td>
<td>Advances in Molecular Biology &amp; Biotechnology</td>
<td>4</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MMIC C-7</td>
<td>Advances in Immunoprophylaxis &amp; Immunotherapy of Infections</td>
<td>4</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MMIC C-8</td>
<td>Combined Practical-2</td>
<td>6</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MMIC GE-2</td>
<td>Swayam Paper-II*</td>
<td>2</td>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>

Total Credits = 40
Total Marks = 1000

<table>
<thead>
<tr>
<th>M.Sc (HS) 2nd Year</th>
<th>Semester</th>
<th>Course No.</th>
<th>Course Title</th>
<th>Credits</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Third</td>
<td>MMIC C-9</td>
<td>IPR, Biosafety, Bioinformatics and Biostatistics</td>
<td>4</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MMIC C-10</td>
<td>Advanced Topics in Microbiology –I (Seminar)</td>
<td>4</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MMIC C-11</td>
<td>Advanced Topics in Microbiology –II (Paper)</td>
<td>4</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MMIC C-12</td>
<td>Project Training Report &amp; Presentation</td>
<td>4</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MMIC C-13</td>
<td>Research Work (Review)**</td>
<td>2</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MMICGE-3</td>
<td>Swayam Paper-III*</td>
<td>2</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Fourth</td>
<td>MMIC C-14</td>
<td>Journal Club</td>
<td>2</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MMIC C-15</td>
<td>Research Work (Thesis)**</td>
<td>14</td>
<td>350</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MMIC C-16</td>
<td>Research Work (Viva Voce)**</td>
<td>4</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Total Credits = 40
Total Marks = 1000
Generic Elective (GE) subjects are to be selected by the students from the following pool of subjects available on “Swayam”, Free online free education portal (https://swayam.gov.in/) as recommended by UGC. Courses delivered through SWAYAM are available free of cost to the learners, however students wanting certifications shall be registered, shall be offered a certificate on successful completion of the course, with a little fee. At the end of each course, there will be an assessment of the student through proctored examination and the marks/grades secured in this exam could be transferred to the academic record of the students. UGC has already issued the UGC (Credit Framework for online learning courses through SWAYAM) Regulation 2016 advising the Universities to identify courses where credits can be transferred on to the academic record of the students for courses done on SWAYAM.

1. Bioorganic and biophysical chemistry  
2. Organic spectroscopy  
3. Application of spectroscopic methods in molecular structure determination  
4. Environmental chemistry  
5. Forensic chemistry and explosives  
6. Forensic biology and serology  
7. Food laws and standards  
8. Technology of fermented, cheese, ice-cream and by-products

**Research Work:** The research work for thesis will start from third semester and will be continued in the fourth semester. The weight age will be of 50 marks in third semester. At the end of semester third, students will submit their literature work in the form of a Review on the topic selected. There will be a presentation before a panel of teachers from the department.
SYLLABI OF CORE COURSES OF READING

Pattern of instructions for Paper Setter:

Question papers will have FOUR sections. Examiner will set a total of NINE questions comprising TWO questions from each PART and ONE compulsory question of short answer types covering the whole syllabus. Students will attempt FIVE questions in all including ONE question from each PART and the compulsory question. All Questions will carry equal marks, unless specified.

M.Sc (H.S.) 1st Year in MICROBIOLOGY
FIRST SEMESTER

MMIC C-1: ADVANCES IN MICROBIAL ECOLOGY

Credits : 4
Marks 80+20 (internal assessment) = 100

Objective: The syllabus has been designed to make students aware of the microbial interactions with environment including their natural habitat and adaptations, the fundamental processes of extreme thermophiles along with their stress resistance mechanism. Also, the course deals with the application of various molecular techniques to study microbial ecology and effect of various biotechnological processes on microbes.

UNIT-I

Microbial Ecology: Introduction, scope, historical overview, its relation with general ecology, microbial diversity- bacterial, archaeal & eucaryal diversity; fungal diversity; cyanobacterial diversity.

Natural Environment of Microorganisms: Habitat and its microbial inhabitants; Atmosphere- characteristics & stratification, atmosphere as habitat and medium for microbial dispersal, microorganisms in atmosphere; Hydro-Ecosphere- (1) fresh water habitats, composition & activity of fresh water microbial communities (2) Marine habitats characteristics and stratification of the ocean, composition and activity of marine microbial communities; Litho-Ecosphere- microbiology of rocks & soils, deep subsurface microbiology.

Microbe-Plant interactions- Interactions with plant roots :Rhizosphere, Mycorrhizae, Nitrogen-fixation in nodules, nitrogen fixing associations between rhizobia and legumes, non-leguminous nitrogen-fixing mutualistic relationships, interactions with aerial plant structures, microbial disease of plants :plant pathogens, bacterial, fungal & viral diseases of plants ;

Microbe-Animal interactions- Microbial contribution to animal nutrition, predation on microorganisms by animals, cultivation of microorganisms by animals food & food processing, commensal & mutualistic intestinal symbionts, digestion within rumen

UNIT-II

Microbial Communities & Ecosystem: Structure & dynamics of microbial communities, diversity & Stability of microbial communities; population selection within communities: r & K Strategies; Succession within microbial communities; microbial communities in nature microbes within Macro-communities, their structure & functions.
Introduction to Microbiome:- Definition of microbiome, various types of microbiomes - gut microbiomes, human microbiome (genital, skin, oral microbiomes, respiratory microbiomes) Animal microbiomes, Plant microbiomes and Environmental Microbiomes

Microbial adaptations: Abiotic limitations to microbial growth-Liebig’s Law of the minimum, Shelford’s law of Tolerance, environmental determinants: temperature, radiation, pressure, salinity, water activity, movement, hydrogen ion concentration, redox potential, magnetic force, organic compounds, inorganic compounds.

UNIT-III

Application of molecular techniques to microbial ecology: Nucleic acid extraction from soil and sediment, gene probe technology to study soil microbiology and biochemistry.

Molecular Approaches to Phylogeny: DNA markers, RAPD, Molecular Phylogenetics, 16s and 18s rRNA technique, Denaturing Gradient Gel Electrophoresis (DGGE), metagenomic DNA, total RNA, metabolites extraction and processing from different types of ecological niches.

UNIT-IV

Anaerobic Microbiology: Introduction to anaerobic techniques, measurement isolation and identification of methanogenic and other anaerobes.

Marine Microbiology: Equipments and tools for sampling, Marine Microbial diversity, Natural Bioactive compounds from marine micro-organisms.

Environmental assessment of biotechnological processes: Ecological consequences of the release of genetically engineered microorganism, risk assessment and methods used to study the effect of genetically engineered microorganism on environment. Regulation of biotechnology processes.

BOOKS FOR READING

JOURNALS
1. Microbial Ecology
3. Biodegradation
4. FEMS Microbiology Ecology
5. Microbiology in Health and Disease
Objective: The course contents are designed to understand the disease process associated with various group of microorganisms collectively based on signs and symptomatology.

UNIT-I

General principles of infectious diseases.

Entry of microorganisms into the body: Role of defences and host receptors. Organisms gaining entrance through skin, respiratory tract, intestinal tract, pharynx, urogenital tract, conjunctiva, interference by normal flora and exit of organisms from the body. Events occurring immediately after the entry of the microorganisms in host in relation to establishment of infections. Growth in epithelial cells spread of intracellular organisms & tissue tropism.

UNIT-II

The encounter of the microbe with the phagocytes and cells of RE system of the body. Phagocytosis by phagocytic cells, strategies in relation to phagocytosis, consequences of functional defects of phagocytic cells on pathogenesis and evaluation of phagocytic functions.

Immune responses to infections: Mechanisms of lymphocyte activation, role of lymphokines and related factors in induction of humoral and cell mediated immune responses.

UNIT-III

The spread of microbes through the body: direct and indirect spread, microbial factor promoting spread, spread via lymphatic, blood and via other pathways.

Recovery from infection: Role of specific (immunological) and non-specific factors in tissue repairs wound healing and resistance to reinfection.

Failure to eliminate microbes. Various aspects of latency with and without shedding of infectious agents.

UNIT-IV

Microbial strategies in relation to immune responses: Immune tolerance immune suppression, molecular mimicry, induction of ineffective antibodies antibody mopping, antigenic variation, avoidance of immune responses and interference to immune response induction.

Mechanisms of tissue injury in relation to bacterial infection: infection with no cell or tissue damages, direct damage by micro-organisms, extra cellular enzymes, indirect damage via inflammation, immune responses and diarrheal etiologies.

Susceptibility and resistance: Role of hosts and microbial genetic factors, hormonal and emotional stresses on host microbes’ interactions, environmental factors.
BOOKS FOR READING

6. Virulence mechanisms of bacterial pathogens edited by Brogdm KA, Roth JA, Stawton TB,
7. Bolin CA, Minion FC, & Wannemuehler, ASM Press Washington DC
8. Clinical Immunology By Catherine Sheelan Publisher: Lippincot NY

Apart from above books, further reading should be done from Journals & reviews like

1. Journal of Medical Microbiology
2. Journal of Infectious diseases
3. Infection and Immunity
4. Visit on line internet sites for advancements in the field of pathogenesis of various Infectious diseases.
Objective: The course aims to apprise the students about various new approaches being used in the diagnosis of various diseases.

UNIT I

Enzyme Immunoassays:
Comparison of enzymes available for enzyme immuno assays. Conjugation of enzymes
Solid phases used in enzyme immuno assays. Homogeneous and heterogeneous enzyme
immuno assays. Enzyme immuno assays after immuno blotting. Enzyme immuno
histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno
assays. Applications of enzyme immuno assays in diagnostic microbiology

UNIT II

Molecular methods in clinical microbiology:
Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism
and plasmid finger printing in clinical microbiology
Laboratory tests in chemotherapy:
Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests:
Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated
procedures for antimicrobial susceptibility tests.

UNIT-III

Mechanised and automated methods in clinical Microbiology for microbial
identification:-
Manual biochemical system, Mechanised automated systems, Immunological methods,
Substrate profile systems.
Serological techniques & Immuno-mapping:- Agglutination, Counter Current Immuno
Electrophoresis, Dot Blot Assay, Western Blot, Radioimmunoassay, Idiotypic Network
(Classification, internal imaging and applications).
Chromatographic techniques: Size exclusion chromatography, ion exchange
chromatography, affinity chromatography, GLC, HPLC.

UNIT-IV

Cytodiagnostic techniques:- Flowcytometry and cell sorting, Immuno florescence, Electron
Microscopy (Types of Electron Microscopy, concepts and operations with applications).
Transgenic animals:-Development, applications
Research methodology:-Planning, execution, analysis, paper writing and thesis writing
Ethics in Research:-Ethical issues pertaining to animal study, handling and disposal of
radioactive waste and pathogenic micro-organisms.

**Books for Reading**
Credits : 6
Marks 120+30 (internal assessment) = 150

Objective: The course aims to make the students to perform the practicals pertaining to the courses MMIC C-1, MMIC C-2 and MMIC C-3.

LIST OF PRACTICALS of MMIC C-1:

1. To enumerate microorganisms from different natural habitats.
2. To determine the microbial biomass from different natural habitats.
3. To study the bacterial ecology of fresh water environment.
4. To study the microbial diversity of soil.
5. To study the fungal diversity in soil and forest litter.
6. To study the microbial ecology of the rhizosphere and determination of rhizospheric effect.
7. To study the microbial ecology of the phylosphere.
8. To study the methods of obtaining axenic culture of microorganisms from different natural habitats.
9. To study the methods of long and short term preservation of bacterial, fungal and actinomycetous culture.
10. To isolate mycophages from natural environment.
11. To isolate the culturable microbial endophytes from different plant species.
12. To study the effect of various salt concentrations on bacterial, actinomycetes and fungal growth.
13. To study the effect of various concentrations of dyes on bacterial, actinomycetes and fungal growth.
14. To study the effect of osmotic pressure on bacterial, actinomycetes and fungal growth.
15. To study of growth forms of lichens (crustose, foliose, fruticose) on different substrata. Study of thallus and reproductive structures (soredia, apothecium) through permanent slides.
16. To study the lethal effects of temperature on bacterial and fungal growth (Thermal Death Point, TDP)
17. To study the lethal effects of temperature on bacterial and fungal growth (Thermal Death Time, TDT)
18. To study the effect of different pH on bacterial and fungal growth.

LIST OF PRACTICALS of MMIC C-2:

Experiments on virulence traits of pathogens
1. Determination of hemolysin production
   • Determination of cytolytic activity
   • Quantification of hemolysin
2. Cell surface hydrophobicity  
3. Hemagglutination  
4. Siderophore Production  
5. Adhesins; Bacterial Uroepithelial Cells (UECs) Adherence Assay  
6. Acid tolerance response  
7. Non specific resistance: bactericidal activity of lysozyme and serum; Death kinetics of test strains; determination of serum bactericidal activity

**Isolation and characterization of pathogens and non-pathogens**

8. Study of micro flora of skin  
10. Isolation and differentiation of *Streptococcus* species associated with dental carries and dental plaque.  
11. Principles of laboratory diagnosis; Isolation and characterization of pathogens from sore throat and stool sample.  
12. Urinary tract infection diagnosis  
13. Identification of given unknown cultures (encountered frequently in clinical specimens)

**LIST OF PRACTICALS of MMIC C-3:**

1. Thin Layer Chromatography  
2. Paper chromatography  
3. Molecular sieve chromatography  
4. Polyacrylamide gel electrophoresis  
5. Extraction of Outer Membrane Proteins and the estimation of Protein content.  
6. Enzyme Linked Immunosorbent Assay  
7. Dot Blotting  
8. Visit to CIL for Electron Microscopy and High Pressure Liquid Chromatography  
9. Visit to PGI for demonstration of Flow Cytometry
M.Sc (H.S.) 1st Year in MICROBIOLOGY
FIRST SEMESTER

MMIC GE-1

Credits : 2
Marks: 40+10 (internal assessment) = 50

Generic Elective (GE-1) subject is to be selected by the students from the following pool of subjects available on “Swayam”, Free on line free education portal (https://swayam.gov.in/) as recommended by UGC.

1. Bioorganic and biophysical chemistry
2. Organic spectroscopy
3. Application of spectroscopic methods in molecular structure determination
4. Environmental chemistry
5. Forensic chemistry and explosives
6. Forensic biology and serology
7. Food laws and standards
8. Technology of fermented, cheese, ice-cream and by-products
M.Sc (H.S.) 1st Year in MICROBIOLOGY
SECOND SEMESTER

MMIC C-5: FERMENTATION TECHNOLOGY

Credits : 4
Marks 80+20 (internal assessment)=100

Objective: This course aims to provide fundamentals of fermentation technology and microbial process development for the production and recovery of various value-added products including the industrial chemicals, whole cells, bio-fuels, metabolites for use in food and medical industry.

UNIT-I

Microbial Process Development: Microbial types & technology; Process development strategies, Trophophase- Idiophase relationship in production of secondary products, Role of secondary metabolites in the physiology of organisms producing them, Over production of microbial metabolites.

Types of Fermentations: Batch, continuous & fed batch fermentation.

Growth Kinetics: Growth curve, Algebra of microbial growth, kinetic model of growth, Scale up principle and different methods of scaling up.

Down stream Processing: Separation of cells & insoluble products, cell disruption, separation of soluble products, Purification techniques, product polishing.

UNIT-II

Fermenter Configurations:

Design of Fermenters: components of fermenter, body construction, sealing, baffles, aeration system (sparger), exit gas cooler, agitation,

Types of Fermenters: i) Submerged fermenter systems: stirred tank fermenter, air lift fermenter, fluidised bed bioreactor, packed bed bioreactor, bubble column fermenter; ii) Solid-State Fermenter Systems: Laboratory and Industrial Scale SSF Fermenter.

Control & Monitoring of Fermentation system: monitoring & controlling of temperature, agitation & foam sensing.

UNIT-III

Alcohol-Based Fermentation Industries: Production of Beer, Wines, Spirits & Vinegar.

Production of Metabolites as bulk Chemicals or as inputs in other Processes:
Production of organic acids, Industrial Alcohol & Biofuels: Production of lactic acid, propionic acid, butyric acid, itaconic acid, ethanol, butanol, hydrogen, microbial electricity. Production of amino acids. Production of Glutamic acid.

UNIT-IV
Production of Whole Cells for Food related purposes: Single cell Proteins, Production of Yeasts (food, feed, alcohol yeasts & Yeast products), Microbial insecticides, *Rhizobium* Inoculants.

Production of Commodities of Pharmacological Importance: Production of antibiotics-Beta-Lactam antibiotics, search for new antibiotics, Fermentation conditions of microbial transformations in steroids & sterols.


**BOOKS FOR READING**

a) Essential

4. Industrial Microbiology by Casida.
5. Industrial Microbiology by Prescott.

b) Further readings

M.Sc (H.S.) 1st Year in MICROBIOLOGY
SECOND SEMESTER

MMIC C-6: ADVANCES IN MOLECULAR BIOLOGY & BIOTECHNOLOGY

Credits : 4
Marks 80+20 (internal assessment)=100

Objectives: To apprise the students with advanced techniques and applications of Molecular Biology and recombinant DNA Technology. This course will help the students in further research in this area.

UNIT-I

Molecular genetics:
General genetics: Plasmid stability and incompatibility; codon preferences, transposition of genes, homologous recombination.
Signal transduction: Signal transduction in prokaryote (two component signaling) and eukaryotes (GPCR, RTKs, Guanylyl cyclase, ligand gated ion channels, nuclear receptors), Adrenaline and rhodopsin signaling, Insulin and JAK-STAT signaling pathway.
Molecular basis of pathogenesis: Molecular Koch postulate, Pathogenicity island, LPS and PAMPs, host and species specific tropism.
Regulation of gene expression in prokaryotes and eukaryotes: Epigenetics, Promoters, enhancers, methylation, acetylation etc.

UNIT-II

Genomics and proteomics:
Genomics: New generation sequencing, pyrosequencing, illumina sequencing, solid DNA sequencing, nanopore sequencing.
Proteomics: Proteome, protein profiling, structural proteomics (NMR, X-ray crystallography, Mass spectrometry), protein chips, biomarkers, application of proteomics.

UNIT-III

Molecular biological techniques:
PFGE, DNA microarray, antisense RNA, RNAi and microRNA, phage display, Ribozymes, DNA foot printing and oligonucleotide mediated site directed mutagenesis.

UNIT-IV

Application of molecular biology in Biotechnology:
Industry: Protein engineering of industrially important enzymes
Agriculture: N2 fixation; transfer of pest resistance genes to plants
Forensic science: Solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using methods of DNA finger printing.
Health: Stem cell technology, gene therapy, molecular diagnostics, hybridoma technology for monoclonal antibodies.

BOOKS FOR READING

JOURNAL AND REVIEWS FOR CONSULTATION:
- Various volumes of methods in Enzymology
- Annual Reviews of Molecular Biology, Biochemistry, Genetics, and Microbiology, Microbiological reviews, Trends in Biotechnology.

Note: Students are also advised to be online (various internet sites) for genomics/proteomics and other advancements in the field of Molecular Biology, Biotechnology.
M.Sc (H.S.) 1st Year in MICROBIOLOGY
SECOND SEMESTER

MMIC C-7: ADVANCES IN IMMUNOPROPHYLAXIS AND IMMUNOTHERAPY OF INFECTIONS

Credits : 4
Marks 80+20 (internal assessment) =100

Objectives: To give insight into therapeutic and prophylactic measures of various human and animal diseases.

UNIT-I
Disease amenable to control by vaccination, rationale of immunization, controlled studies of vaccines, hazards of immunization, vaccination schedules.
Vaccines produced by conventional means to control major infectious disease: man and animals. Immune responses to vaccination.

UNIT-II
Viral Vectored vaccine, Bacterial Vectored vaccine, Rabies Vaccine, Salmonella Vaccine, BCG Vaccine, Malarial Vaccine, Cholera Vaccine, DPT Vaccine, Hepatitis vaccine, Polio vaccine, MMR vaccine, Combinational Vaccine/Super vaccine, Anthrax vaccine.

UNIT-III
Modern approaches to live virus vaccines, live bacterial vaccines and their application against tumor antigens immune modifiers in vaccines.
AIDS : HIV testing: product development strategies, approaches to HIV, vaccine design.
Idiotype vaccines and immune toxins

UNIT-IV
Plant expression systems for the production of vaccines.
Recombinant DNA vaccines.
Adjuvants & their future development.
Contraceptive vaccine development: future prospects.
Commercial & regulatory aspects of vaccines production and distribution.

BOOKS FOR READING

M.Sc (H.S.) 1st Year in MICROBIOLOGY
SECOND SEMESTER

MMIC C-8: COMBINED PRACTICAL-2

Credits : 6
Marks: 120+30 (internal assessment) = 150

Objective: The course aims to make the students to perform the practicals pertaining to the courses MMIC C-5, MMIC C-6 and MMIC C-7.

LIST OF PRACTICALS of MMC C-5:

1. To study the effect of substrate concentration (glucose) on growth of E. coli cells, and to estimate Monod’s kinetic parameters.
2. To demonstrate different phases of a batch culture to estimate the Monod’s parameters, growth yield and productivity of E. coli.
3. To study the alcoholic fermentation.
4. To produce the wine from grapes etc.
5. To perform the surface and solid fermentation.
6. To perform the primary and secondary screening of microbial enzymes.
7. To perform the primary and secondary screening of penicillin.
8. To study the instrumentation & working of laboratory fermenters.
9. To study the process of fed batch fermentation.
10. Isolation of fermentative yeasts from natural biodiversity.
11. Evaluation of fermentability range of yeasts with respect to pentoses and hexoses.
12. Production of cellulases, xylanases, mannanases and pectinases by solid and liquid state fermentations.
13. Scale-up studies on the production of industrially important enzymes by solid as well as submerged state fermentations
14. Determination of pH versus activity and temperature versus activity profiles of suitable industrially important enzymes.
15. Bioconversion of a corn grain, a typical starchy biomass residue into fermentable sugars using laboratory produced amylases and determination of rate of sugar formation, conversion efficiencies and yields.
16. Fermentation of sugars released from hydrolysis of corn biomass into ethanol and study of fermentation kinetics including the rate of sugar utilization, rate of ethanol production, rate of yeast multiplication and determination of fermentation efficiency and product yield.

LIST OF PRACTICALS of MMIC C-6:

1. To isolate and purify plasmid DNA
2. To isolate and purify chromosomal DNA
3. To perform the restriction digestion of plasmid DNA.
4. To perform the partial digestion of genomic DNA.
5. To perform the alkaline phosphatase treatment of plasmid DNA.
6. To perform the elution of DNA from agarose gel by various methods:
   a) GuanidiumHCl method
   b) Electroelution method
   c) LMP (Low Melting Point) agarose method
   d) Commercial Kit method
7. To perform the ligation of partially digested genomic and plasmid DNA
8. To perform the transformation using electroporation
9. Screening of library
10. To perform nucleotide sequence analysis using various bioinformatic tools.
11. To perform PCR.

LIST OF PRACTICALS of MMIC C-7:
1. Preparation of killed Vaccines and monitoring of its purity
2. Immunization of animal with killed vaccine. Assessment of antibody level by IHA/ELISA
3. Capsule as the subunit vaccine: its preparation and quantification.
4. Immunization of animals with capsular vaccine using Freund’s Complete Adjuvant and incomplete adjuvant as an adjuvant.
5. Outer cell membrane as the subunit vaccine: its preparation, quantification and monitoring its purity by SDSPAGE electrophoresis followed by immunization.

M.Sc (H.S.) 1st Year in MICROBIOLOGY
SECOND SEMESTER

MMIC GE-2
Credits : 2
Marks: 40+10 (internal assessment) = 50

Generic Elective (GE-2) subject is to be selected by the students from the following pool of subjects available on “Swayam”, Free online free education portal (https://swayam.gov.in/) as recommended by UGC.
1. Bioorganic and biophysical chemistry
2. Organic spectroscopy
3. Application of spectroscopic methods in molecular structure determination
4. Environmental chemistry
5. Forensic chemistry and explosives
6. Forensic biology and serology
7. Food laws and standards
8. Technology of fermented, cheese, ice-cream and by-products
Objective: The major emphasis of this course is to make students learn about the legal, safety and public policy issues raised due to the rapid progress in Biotechnology and development of new products. They will also be made aware with various tools of Bioinformatics and Biostatistics and their applications in biotechnology.

Unit I


Unit II

Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms

Biosafety Guidelines: Biosafety guidelines and regulations (National and International); The Cartagena protocol on biosafety, Geneva Protocol, Biosafety management: Key to the environmentally responsible use of Biotechnology Environment protection act. Kyoto protocol Transgenic organisms and biosafety issues.

Unit III

Introduction to Bioinformatics and Biological Databases
Biological databases-nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, Mode of data storage-File formats-FASTA, Genbank and Uniprot, Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB

**Sequence Alignments, Phylogeny and Phylogenetic trees**

Local and Global Sequence alignment, pair wise and multiple sequence alignment. Scoring an alignment, scoring matrices, PAM & BLOSUM series of matrices

Types of phylogenetic trees, Different approaches of phylogenetic tree construction-UPGMA, Neighbour joining, Maximum Parsimony, Maximum likelihood

**Unit IV**

**Statistical methods:** Scope of statistics: utility and misuse. Principles of statistical analysis of biological data. Sampling parameters. Difference between sample and Population, Sampling Errors, Censoring, difference between parametric and non-parametric statistics; Sampling Distributions, Standard Error, Testing of Hypothesis, Level of Significance and Degree of Freedom; Large Sample Test based on Normal Distribution, Small sample test based on t-test, Z-test and F test; Confidence Interval; Distribution-free test-Chi-square test; Basic introduction to Multivariate statistics, etc.

**BOOKS FOR READING**

MMIC C-10: ADVANCED TOPICS IN MICROBIOLOGY-I (SEMINAR)

Credits : 4
Marks: 80+20 (internal assessment) = 100

The students will be assigned various advanced topics in Microbiology and will be asked to deliver seminars on these.

MMIC C-11: ADVANCED TOPICS IN MICROBIOLOGY-II (PAPER)

Credits : 4
Marks: 80+20 (internal assessment) = 100

The students will be examined through a written test covering various advanced topics on which the students delivered seminars as part of MMI 5302

MMIC C-12: SUMMER TRAINING, PROJECT TRAINING REPORT & PRESENTATION

Credits : 4
Marks: 80+20 (internal assessment) = 100

The students will be sent on 4-6 weeks summer training in various research institutes/industries for on the spot training and will be asked to submit a project report after the training which will be evaluated after making a presentation on the same.
M.Sc (H.S.) 2nd Year in MICROBIOLOGY
THIRD SEMESTER

MMIC C-13: Research Work (Review)

Research Work: The research work for thesis will start from third semester and will be continued in the fourth semester. The weight age will be of 50 marks in third semester. At the end of semester third, students will submit their literature work in the form of a Review on the topic selected. There will be a presentation before a panel of teachers from the department.

M.Sc (H.S.) 2nd Year in MICROBIOLOGY
THIRD SEMESTER

MMIC GE-3

Credits : 2
Marks: 40+10 (internal assessment) = 50

Generic Elective (GE-3) subject is to be selected by the students from the following pool of subjects available on “Swayam”, Free online free education portal (https://swayam.gov.in/) as recommended by UGC.
1. Bioorganic and biophysical chemistry
2. Organic spectroscopy
3. Application of spectroscopic methods in molecular structure determination
4. Environmental chemistry
5. Forensic chemistry and explosives
6. Forensic biology and serology
7. Food laws and standards
8. Technology of fermented, cheese, ice-cream and by-products
M.Sc (H.S.) 2nd Year in MICROBIOLOGY
FOURTH SEMESTER

MMIC C-14: JOURNAL CLUB

The students will present and discuss the recent papers published in the journals of repute
Credits : 2
Marks: 40+10 (internal assessment) = 50

M.Sc (H.S.) 2nd Year in MICROBIOLOGY
FOURTH SEMESTER

MMIC C-15: THESIS

Credits : 14
Marks: 280+70 (internal assessment to be awarded by the supervisor) = 350

The students will submit a thesis after undertaking a research which will start during the IIIrd semester under the supervision of faculty members.

M.Sc (H.S.) 2nd Year in MICROBIOLOGY
FOURTH SEMESTER

MMIC C-16: VIVA VOCE

Credits : 4
Marks: 80+20 (internal assessment to be awarded by the supervisor) = 100
The students will be evaluated for their research work on the basis of an oral examination by an external examiner.