FACULTY OF SCIENCE

SYLLABI

FOR

M.Sc. (HONS. SCHOOL) MICROBIOLOGY
1ST TO 4TH SEMESTER

EXAMINATIONS
2018-2019

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OUTLINES OF TESTS, SYLLABI AND COURSES OF READING FOR M.Sc. (HONS SCHOOL) (SEMESTER SYSTEM) (CORE/ELECTIVE) IN MICROBIOLOGY 1ST TO 4TH SEMESTER EXAMINATION 2018-2019, 2019-2020

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<th>M.Sc (HS) 1st Year</th>
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Total Credits = 40  
Total Marks = 1000

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<th>M.Sc (HS) 2nd Year</th>
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*The research work for thesis will start from third semester  
** Internal Assessment to be awarded by the supervisor

Total Credits = 40  
Total Marks = 1000
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

MMI 4101: ADVANCES IN MICROBIAL ECOLOGY

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; Atmocosphere- 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.

(2) 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 ;

(3) 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.

**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**

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

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

**Molecular Approaches to Phylogeny:** DNA markers, RAPD, Molecular Phylogenetics, 16s rRNA technique, limitations of molecular microbial ecology.

**UNIT-IV**

**Microorganisms in Biological Control:** Microbial control of insects, pests, weeds and other disease causing 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
LIST OF PRACTICALS:

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 phyllosphere.
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.
MMI 4102: PATHOGENESIS OF INFECTIOUS DISEASES

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.

**LIST OF PRACTICALS:**

- **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 *Strept* 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 culture (encountered frequently in clinical specimens)
**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:**

**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


LIST OF PRACTICALS:

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
SECOND SEMESTER

MMI 4201: FERMENTATION TECHNOLOGY

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, Metabolic pathways for the biosynthesis of primary and secondary metabolites-nature of metabolic pathways, 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, stirrer glands & bearings, valves & steam traps,

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: temperature monitoring & controlling, gas flow rate & controlling, Liquid flow & controlling, pressure measuring & controlling, agitation measuring & controlling, foam sensing & controlling, dissolved oxygen monitoring, pH monitoring, PID (Proportional-Integral-Derivative Controller) control system.

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.

**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.

**Drug discovery in microbial metabolites**: Search for microbial products with bioactive properties: Conventional & newer methods of drug discovery.

**BOOKS FOR READING**

**a) Essential**

4. Industrial Microbiology by Casida.
5. Industrial Microbiology by Prescott.
b) Further readings


LIST OF PRACTICALS:

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.
MMI 4202: ADVANCES IN MOLECULAR BIOLOGY & BIOTECHNOLOGY

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:

1. Various volumes of methods in Enzymology
2. 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.

LIST OF PRACTICALS:

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) GuanidiniumHCl 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.
**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**

Edible Vaccine, 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**

LIST OF PRACTICALS:

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.)  2nd Year in MICROBIOLOGY
THIRD SEMESTER

MMI 5301: INTELLECTUAL PROPERTY RIGHTS, BIOSAFETY, BIOINFORMATICS AND BIOSTATISTICS

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

Biostatistics


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

MMI 5302: ADVANCED TOPICS IN MICROBIOLOGY-I

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

MMI 5303: ADVANCED TOPICS IN MICROBIOLOGY-II

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

MMI 5304: PROJECT TRAINING REPORT & PRESENTATION

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.

MMI 5305: JOURNAL CLUB

The students will present and discuss the recent papers published in the journals of repute.

FOURTH SEMESTER

MMI 5401: THESIS

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

MMI 5402: VIVA VOCE

The students will be evaluated for their research work on the basis of an oral examination by an external examiner.

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