GENERAL INSTRUCTIONS
AND
COURSE CURRICULUM
FOR
M. Sc. MICROBIOLOGY
Effective from July 2009

DEPARTMENT OF BIOTECHNOLOGY
HIMACHAL PRADESH UNIVERSITY
SUMMER HILL, SHIMLA-171005
M.Sc. MICROBIOLOGY PROGRAMME

GENERAL INSTRUCTIONS/GUIDELINES FOR EXECUTION OF CURRICULUM

1. The M.Sc. Microbiology programme will be of two years duration spread over four semesters.

2. There will be sixteen courses for M.Sc. Microbiology programme. In the first, second and third semester, there will be five courses. However, in fourth semester there will be only research project work. In each semester (excluding fourth semester) there will be one elective course and two laboratory courses. Course No. 401 will consist of research project report only.

3. The distribution of marks in each course for theory, practical and internal assessment will be as per details given in the OUTLINES OF COURSES FOR M. Sc. MICROBIOLOGY.

4. The split for internal assessment will be: i) Two internal assessment tests of 7.5 marks in each course. The date of each of these internal assessments for each of the course shall be notified by the Chairman of the Department at the beginning of the semester. The remaining five marks shall be awarded by considering the class attendance record of the students. The criteria to be followed shall be: i) Without condonation of lectures upto 75% 1 mark; 76-80% lectures 2 marks, 81-85% lectures 3 marks; 86-90% lectures, 4 marks; 91% and above lectures 5 marks.

5. For internal assessment, the concerned teacher will examine the students in his/her subject by giving multiple choice questions (MCQ of 0.5 mark each) covering the syllabus/topics taught in the classes. The Coordinator of the programme will notify the date sheet for internal assessment tests at the beginning of semester/academic calendar. In case a student is absent in the internal assessment test, the student will explain in writing the reason for absence to the Coordinator of the programme. Such cases will be discussed in the Departmental Council/Staff Council and if it finds the reason given by the student valid, it will recommend to the Coordinator of the programme to allow the student to sit in such test separately.

6. The candidate who regularly attends teaching/ practical classes and maintains 75% attendance in each of the courses/ practicals shall be permitted to sit in the semester examinations.

7. Any candidate who intends to participate in intra-university or inter-university cultural/ sports/ extracurricular function(s) shall get her/ his name recommended by the Chairperson/ Coordinator Microbiology Programme for being considered for any such participation(s) and benefit(s) if any, thereof.

8. The project work will be in the specialized area of the Microbiology. The project work will start from the third semester. The students will submit the project report by the due date as fixed by the Examination Branch. The Departmental Council will evaluate these. There will be a viva-voce examination on the project report by the Departmental Council. If the Coordinator of the programme feels, he may invite an External Expert for evaluation of the Project Reports. The evaluation of the Project Report and Seminar will be of 200 and 100 marks, respectively.

9. The admission to M.Sc. Microbiology programme of Himachal Pradesh University at campus as well as admission to M.Sc. Microbiology programme offered by institutions affiliated to Himachal Pradesh University will be through a Combined
Entrance Examination conducted by Himachal Pradesh University Shimla or as decided by Himachal Pradesh University from time to time.

Eligibility for admission will be Bachelor Degree under 10+2+3 pattern of Education in Sciences with any of the subjects i.e. Microbiology, Biochemistry, Biotechnology, Genetics and Molecular Biology, Botany or Zoology or MBBS/ B.V.Sc from any Institute/ University recognized by the Himachal Pradesh University, Shimla/ University Grant Commission, New Delhi with at least 50% marks OR a Degree of a University recognized as equivalent by the Vice-Chancellor for the purpose.

- The tuition fee and other monthly/annual charges will be as per University rules.
### OUTLINES OF COURSES FOR M. Sc. MICROBIOLOGY

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title of course</th>
<th>Marks</th>
<th>Total Marks</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Theory</td>
<td>Practical</td>
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<tr>
<td>Semester I</td>
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<tr>
<td>101</td>
<td>Bacteriology</td>
<td>80</td>
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<tr>
<td>102</td>
<td>Virology</td>
<td>80</td>
<td>-</td>
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<tr>
<td>103</td>
<td>Mycology &amp; Phycology</td>
<td>80</td>
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<tr>
<td>104</td>
<td>Biochemistry</td>
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<td>105</td>
<td>Immunology</td>
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<tr>
<td>P-101</td>
<td>General Microbiology</td>
<td>-</td>
<td>80</td>
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<tr>
<td>P-102</td>
<td>Biochemical &amp; Biophysical Techniques</td>
<td>-</td>
<td>80</td>
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<td><strong>Total Marks in Semester I</strong></td>
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<td>400</td>
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<tr>
<td>Semester II</td>
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<tr>
<td>201</td>
<td>Molecular Biology &amp; Microbial Genetics</td>
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<tr>
<td>202</td>
<td>Recombinant DNA Technology</td>
<td>80</td>
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<tr>
<td>203</td>
<td>Infection &amp; Immunity</td>
<td>80</td>
<td>-</td>
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<td>204</td>
<td>Medical Microbiology</td>
<td>80</td>
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<tr>
<td>205</td>
<td>Biostatistics</td>
<td>80</td>
<td>-</td>
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<tr>
<td>P-201</td>
<td>Molecular Biology &amp; Recombinant DNA</td>
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<td>80</td>
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<tr>
<td></td>
<td>Technology</td>
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<tr>
<td>P-202</td>
<td>Diagnostic Microbiology &amp; Immunology</td>
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<td><strong>Total Marks in Semester II</strong></td>
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<tr>
<td>301</td>
<td>Environmental Microbiology</td>
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<td>302</td>
<td>Food Microbiology</td>
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<td>303</td>
<td>Industrial Microbiology</td>
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<tr>
<td>304</td>
<td>Computers &amp; Bioinformatics</td>
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<tr>
<td>P-301</td>
<td>Applied Microbiology I</td>
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<tr>
<td>P-302</td>
<td>Applied Microbiology II</td>
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<tr>
<td>Elective (any one)</td>
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<td>EL-301</td>
<td>Metabolic Engineering</td>
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<td>EL-302</td>
<td>Microbial Enzymes</td>
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<td>EL-303</td>
<td>Microbial Genomics &amp; Proteomics</td>
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<td><strong>Total Marks in Semester III</strong></td>
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<td>Semester IV</td>
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<tr>
<td>401</td>
<td>Research Project Report</td>
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<td>P-401</td>
<td>Seminar and Viva-Voce</td>
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<tr>
<td><strong>Total Marks in Semester IV</strong></td>
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<td><strong>Grand Total (Semester I-IV)</strong></td>
<td></td>
<td>1200</td>
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* The Departmental Council will evaluate the research project report and will conduct viva-voce examination of the students.
SYLLABUS FOR M.SC. MICROBIOLOGY

COURSE 101: BACTERIOLOGY

Maximum Marks - 80
Teaching Hours - 45

Note: Examiner will set 09 (nine) questions covering all topics/sections of the syllabus and at least one question from each section. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

Unit 1
Morphology and ultra structure of bacteria - morphological types - cell walls of archaebacteria - gram negative - gram positive eubacteria, L-forms - cell wall synthesis, antigenic properties - capsule types, composition and function, cell membranes - structure - composition - properties.

Unit 2

Unit 3

Unit 4

Unit 5
Classification of microorganisms - introduction - Haeckel's three kingdom concept - Whittaker's five kingdom concept - three domain concept of Carl Woese, Basis of microbial classification, Classification and salient features of bacteria according to the Bergey's manual of determinative bacteriology, cyanobacteria, prochlorons and cyanelles.

Books:
SYLLABUS FOR M.SC. MICROBIOLOGY

COURSE 102 : VIROLOGY

Maximum Marks - 80  
Teaching Hours - 45

Note: Examiner will set 09 (nine) questions covering all topics/sections of the syllabus and at least one question from each section. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

Unit 1: General Virology
Brief outline on discovery of viruses, nomenclature and classification of viruses; distinctive properties of viruses; morphology and ultrastructure; capsids and their arrangements; types of envelopes and their composition-viral genome, their types and structures; virus related agents (viroids, prions).

Unit 2: General Methods of Diagnosis and Serology
Cultivation of viruses in embryonated eggs, experimental animals, and cell cultures; primary and secondary cell cultures; suspension cell cultures and monolayer cell cultures; cell strains, cell lines and transgenic systems; serological methods – haemagglutination and HAI; complement fixation; immunofluorescence methods, ELISA and Radioimmunoassays; assay of viruses – physical and chemical methods (protein, nucleic acid, radioactivity tracers, electron microscopy) – Infectivity assay (plaque method, end point method) – Infectivity assay of plant viruses.

Unit 3: Bacterial Viruses
Bacteriophage structural organization; life cycle; one step growth curve; transcription; DNA replication; eclipse phase; production; burst size; lysogenic cycle; bacteriophage typing; application in bacterial genetics; brief details on M13, Mu, T3, T4 and Lambda P1.

Unit 4: Plant Viruses
Classification and nomenclature; effects of viruses on plants; appearance of plants; histology, physiology and cytology of plants; common virus diseases of plants; paddy, cotton, tomato and sugarcane; viruses of cyanobacteria, algae, fungi, life cycle; type species of plant viruses like TMV, Cauliflower Mosaic Virus and Potato Virus X; transmission of plant viruses with vectors (insects, nematodes, fungi) and without vectors (contact, seed and pollens); diagnostic techniques in seeds; seed stocks and diseased plants (seed morphology, seedling symptomatology, indicator plants, serological methods, histochemical tests and fluorescent microscopy); prevention of crop loss due to virus infection – virus-free planting material; vector control.
Unit 5: Animal Viruses

Classification and nomenclature of animal human viruses; epidemiology, lifecycle, pathogenicity, diagnosis, prevention and treatment of RNA viruses Picorna, Ortho myxo, Paramyxo, Toga and other arthropod viruses, Rhabdo, Rota, HIV and other Oncogenic viruses; DNA viruses; Pox, Herpes, Adeno, SV 40; Hepatitis viruses. Viral vaccines (conventional vaccines, genetic recombinant vaccines used in national immunization programmes with examples, newer generation vaccines including DNA vaccines with examples) interferons and antiviral drugs.

Books:
SYLLABUS FOR M.SC. MICROBIOLOGY

COURSE 103 : MYCOLOGY & PHYCOLOGY

Maximum Marks - 80
Teaching Hours - 45

Note: Examiner will set 09 (nine) questions covering all topics/sections of the syllabus and at least one question from each section. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

Unit 1

Unit 2
Ascomyctina ï Hemiascomycetes, plectomycete, pyrenomycetes, Discomycetes, laboulberiomyces, oculoascomycetes. Basidiomycotina teliomycetes, hymenomycetes, Deuteromycotina ï hypomycetes, coelomycetes, blastomycetes.

Unit 3

Unit 4
Fungi and ecosystem: effect of environment on growth, prevention of fungal growth. saprophytes, substrate groups and nutritional strategies substrate successions, fungi and bioremediation, parasitism, mutualism and symbiosis with plants and animals, attack on fungi by other microorganisms.

Unit 5
Distribution of algae, classification of algae, algal nutrition, algal thallus, algal reproduction, green algae, diatoms, euglenoids, brown Rhodophyta, pyrophyta, Algal ecology and algal biotechnology.

Books:
5. Fundamentals of the fungi. E Moore ï Landeekeer, Publisher: Prentice Hall
SYLLABUS FOR M.SC. MICROBIOLOGY

COURSE 104 : BIOCHEMISTRY

Maximum Marks - 80  
Teaching Hours - 45

Note: Examiner will set 09 (nine) questions covering all topics/sections of the syllabus and at least one question from each section. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

Unit 1
Composition of living matter, biochemistry of bacterial, animal and plant cell, specialized components of microorganisms and their structure and function.

Unit 2
Enzymes as biocatalysts, enzyme classification, specificity, active site, activity unit, isozymes. Enzyme kinetics: Michaelis-Menten equation for simple enzymes, determination of kinetic parameters, multistep reactions and rate limiting steps, enzyme inhibition, allosterism, kinetic analysis of allosteric enzymes, principles of allosteric regulation.

Unit 3
Structural features and chemistry of macromolecules; nucleic acid, proteins, carbohydrates and lipids and biomolecules such as antibiotics, pigments and other secondary metabolites.

Unit 4
Bioenergetics and strategy of metabolism: flow of energy through biosphere, strategy of energy production in the cell, oxidation-reduction reactions, coupled reactions and group transfer, ATP production, structural features of biomembranes, transport, free energy and spontaneity of reaction, G, G^0, G'_0 and equilibrium, basic concepts of acids, base, pH and buffers.

Unit 5
Cell metabolism: catabolic principles and break down of carbohydrates, lipids, proteins and nucleic acids, biosynthesis of macromolecules, hormone regulation of metabolism, vitamins and their role as coenzymes.

Books:
SYLLABUS FOR M.SC. MICROBIOLOGY

COURSE 105 : IMMUNOLOGY

Maximum Marks - 80
Teaching Hours - 45

Note: Examiner will set 09 (nine) questions covering all topics/sections of the syllabus and at least one question from each section. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

Unit 1: Immune System
History of immunology, cells and tissues involved in immune system; virulence and host resistance; immune responses innate immunity, acquired immunity; immunohematology blood groups, blood transfusion and Rh-incompatibilities.

Unit 2: Antigens and Antibodies
Antigens structure and properties, types, iso- and alloantigens, haptens; adjuvants, antigen processing and specificity; lymphokines; immunoglobulins structure, heterogeneity, types and sub-types, properties (physico-chemical and biological); theories of antibody formation; monoclonal antibodies and their applications.

Unit 3: Antigen-antibody reactions
In-vitro methods: agglutination, precipitation, complement fixation, immunofluorescence, ELISA, radio-immuno assay, immuno-histochemical staining; in vivo methods: skin tests and immune complex demonstration; applications of these methods in diagnosis of microbial diseases.

Unit 4: Complement
Complement components, pathways and complement deficiencies.

Unit 5: Hypersensitivity
Immediate and delayed; antibody mediated Type-I anaphylaxis, Type-II Antibody dependent cell cytotoxicity, Type-III immune-complex mediated reactions and Type-IV cell mediated hypersensitivity reactions; respective diseases, immunological methods of their diagnosis.

Books:
1. Immunology - Janis Kuby
2. Essentials of Immunology (6th Edition) - Ivan Roitt
3. Cellular and Molecular Immunology - Abul K. Abbas, Andrew H. Lichtman and Jordan S
4. Immunology: An Introduction - Ian R. Tizard
5. Fundamentals of Immunology William E. Paul, Raven Press.
SYLLABUS FOR M.SC. MICROBIOLOGY

COURSE P-101 : GENERAL MICROBIOLOGY
Total Marks – 100 (Practical examination-80, Internal assessment-20)


(IV) Isolation and identification of bacteria and fungi.


References:

COURSE P-102 : BIOCHEMICAL & BIOPHYSICAL TECHNIQUES
Total Marks – 100 (Practical examination-80, Internal assessment-20)


(II) Laboratory rules and safety regulations, first aid.

(III) Principles of colorimetry: verification of Beer’s law, estimation of a selected protein, finding out lmax, relation between O.D. and percentage transmission. Isolation and quantification of DNA from microorganisms or other sources.

(IV) pH, pK, Henderson-Heasselbach equation, preparation of buffers.

(V) Separation of amino acids by paper chromatography.

(VI) Isolation of phospholipids from liver and their separation by thin layer chromatography.

(VII) Separation of haemoglobin and blue dextran by gel filtration.

(VIII) Ion exchange chromatography: CM cellulose and DEAE cellulose.

(IX) Cell fractionation into nuclear, mitochondrial and cytoplasmic fraction; estimation of marker enzymes.

(X) Factors affecting enzyme activity: temperature, substrate, concentration and pH using any stable enzyme and kinetics of enzyme activity.

(XI) Study of isoenzymes of lactate dehydrogenase by PAGE

(XII) Various Agglutination reactions: Widal, Haemagglutination etc.
SYLLABUS FOR M.Sc. MICROBIOLOGY

COURSE 201: MOLECULAR BIOLOGY & MICROBIAL GENETICS

Maximum Marks - 80                  Teaching Hours - 45

Note: Examiner will set 09 (nine) questions covering all topics/sections of the syllabus and at least one question from each section. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

Unit 1
Nucleic acids as genetic information carriers: experimental evidence, DNA structure: historical aspects and current concepts, melting of DNA. DNA replication: general principles, various modes of replication, isolation and properties of DNA polymerases, proof reading, continuous and discontinuous synthesis. Asymmetric and dimeric nature of DNA polymerase, exonuclease activity in eukaryotic DNA polymerases. Superhelicity in DNA, linking number, topological properties, mechanism of action of topoisomerases.

Unit 2

Unit 3
Structural features of RNA (rRNA, tRNA and mRNA) and relation to function. Initiator and elongator class of tRNA, ribosome binding site on mRNA and corresponding site on rRNA, peptidyl transferase activity of 23S rRNA. Transcription: general principles, basic apparatus, types of RNA polymerases, steps: initiation, elongation and termination, inhibitors of RNA synthesis. Polycistrionic and monocistrionic RNAs. Control of transcription by interaction between RNA polymerases and promoter regions, use of alternate sigma factors, controlled termination: attenuation and antitermination.

Unit 4
Regulation of gene expression: operon concept, catabolite repression, instability of bacterial RNA, positive and negative regulation, inducers and corepressors. Negative regulation - E. coli lac operon; positive regulation - E. coli ara operon; regulation by attenuation - his and trp operons; antitermination - N protein and nut sites in I. DNA binding proteins, enhancer sequences and control of transcription. Identification of protein - binding sites on DNA. Global regulatory responses: heat shock response, stringent response and regulation by small molecules such as ppGpp and cAMP, regulation of rRNA and tRNA synthesis.
Unit 5

Basic features of the genetic code. Protein synthesis: steps, details of initiation, elongation and termination, role of various factors in the above steps, inhibitors of protein synthesis. Synthesis of exported proteins on membrane-bound ribosomes, signal hypothesis. In vitro transcription and translation systems. Microbial genetics and design of vaccines. BCG and design of vaccine for TB and leprosy. DNA vaccines, design and advantages.

Books:
1. Genes VII. Lewin, Oxford University Press.
SYLLABUS FOR M.SC. MICROBIOLOGY

COURSE 202: RECOMBINANT DNA TECHNOLOGY

Maximum Marks - 80  
Teaching Hours - 45

Note: Examiner will set 09 (nine) questions covering all topics/sections of the syllabus and at least one question from each section. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

Unit 1
Gene as unit of mutation and recombination. Molecular nature of mutations; mutagens. Spontaneous mutations — origin, Core techniques and essential enzyme used in rDNA technology. Restriction digestion, ligation and transformation.

Unit 2

Unit 4

Unit 3

Unit 5
DNA sequencing Methods: dideoxy and chemical method. Sequence assembly. Automated sequencing. Genome sequencing and physical mapping of genomes.

Books:
2. Molecular cloning. 3 volumes. CSH press.
SYLLABUS FOR M.S.C. MICROBIOLOGY

COURSE 203: INFECTION & IMMUNITY

Maximum Marks - 80       Teaching Hours - 45

**Note:** Examiner will set 09 (nine) questions covering all topics/sections of the syllabus and at least one question from each section. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

**Unit 1: Principles of Medical Microbiology**
Classification of medically important microorganisms; Microbial pathogenicity; transmissibility, infectivity and virulence; opportunistic pathogens, true pathogens; toxigenicity, invasiveness, other aggressins (Hyaluronidase), coagulase, fibrolysins or kinase; depolymerizing enzymes (mucinase, lipase, proteases, nucleases, collagenases, neuraminidase); brief account of protozoa (*Entamoeba, Giardia, Leishmania, Trypanosoma, Plasmodium* and *Balantidium*) and helminth parasites (*Schistosoma, Taenia, Echinococcus, Ascaris, Trichiuris, Hookworms and Wuchereria*) of man and their diseases.

**Unit 2: Vaccines**
Immunization, types of vaccines, immunological principles of vaccinations, routes of vaccinations; immunological memory; vaccines in use: Poliomyelitis, BCG, DPT, Bird Flu, Hepatitis-A & B, Rabies virus.

**Unit 3: Immuno-parasitology**
Immunity to amoebiasis, trypanosomiasis, leishmaniasis, malaria, filarasis, hookworm infections and ascariasis.

**Unit 4: Immunity to viruses**
Brief account of viral diseases of man (HERPES, Arbo-viruses, Papova viruses, Influenza virus, Hepatitis A, B & C) virological parameters, spread and transmission; cellular vs humoral immunity to viruses; immunological mechanisms of viral persistence; cancer immunology; immuno-surveillance; immuno-pathology and immune response to HIV.

**Unit 5: Immunity to bacteria**
Brief account of intra-cellular bacteria and diseases they causes; cell mediated immunity in antibacterial defense; role of cytokines; local immunity; antigens of intra-cellular bacteria; phagocytes and bacterial infections.

**Books:**
1. Immunology - Janis Kuby
2. Essentials of Immunology (6th Edition) - Ivan Roitt
3. Cellular and Molecular Immunology - Abul K. Abbas, Andrew H. Lichtman and Jordan S
4. Immunology: An Introduction - Ian R. Tizard
SYLLABUS FOR M.S.C. MICROBIOLOGY

COURSE 204 : MEDICAL MICROBIOLOGY

Maximum Marks - 80  Teaching Hours - 45

Note: Examiner will set 09 (nine) questions covering all topics/sections of the syllabus and at least one question from each section. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

Unit 1
Early discovery of pathogenic microorganisms, development of bacteriology as scientific discipline; contributions made by eminent scientists. Classification of medically important microorganisms; Normal microbial flora of human body; role of resident flora; normal flora and the human host.

Unit 2
Establishment, spreading, tissue damage and anti-phagocytic factors; mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts. Role of aggressins, depolymerising enzymes, organotropisms, variation and virulence. Organs and cells involved immune system and immune response.

Unit 3
Classification of pathogenic bacteria. *Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Cornebacterium, Bacillus, Clostridium*, Non sporing Anaerobes, Organisms belonging to *Enterobacteriacea*, Vibrios, Non fermenting gram negative bacilli *Yersinia, Haemophilus, Bordetella, Brucella, Mycobacteria, Spirochaetes, Actinomycetes, Rickettsiae, Chlamdiae*.

Unit 4
General properties of Viruses: Viruses host interactions; Pox viruses; Herpes virus, adeno viruses, picarno viruses, orthomyxo viruses, paramyxo viruses, arboviruses, rhabdo viruses, hepatitis viruses; oncogenic viruses; Human immuno deficiency viruses (AIDS). Dermatophytes, dimorphic fungi, opportunistic fungal pathogens. Description and classification of pathogenic fungi and their laboratory diagnosis.

Unit 5
Laboratory control of antimicrobial therapy; various methods of drug susceptibility testing, antibiotic assay in body fluids. Brief account on available vaccines and schedules; passive prophylactic measures; Noscomical infection, common types of hospital infections and their diagnosis and control.

Books:
SYLLABUS FOR M.SC. MICROBIOLOGY

COURSE 205 : BIOSTATISTICS

Maximum Marks - 80  Teaching Hours - 45

Note: Examiner will set 09 (nine) questions covering all topics/sections of the syllabus and at least one question from each section. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

Unit I
Principles and practice of statistical methods of biological research, samples and populations; Measures of central tendencies: mean, mode, median and ogives; Measures of dispersion: range, standard deviation and variance 5

Unit II
Linear correlations: product moment coefficient of correlations, Spearman’s rank difference correlation methods; Regression analysis: simple regression, regression lines, regression equations, regression equations in case of correlation tables. 4

Unit III
Probability distribution: addition and multiplication theorems, Baye’s theorem, Binomial, Poisson, and normal distribution. 3

Unit IV
Parametric tests: F and T tests, X^2 test, X^2 test as a test of independence and goodness of test, experimental design. 3

Unit V
Statistical inference: hypothesis testing, significance level, two-tailed and one-tailed tests of hypothesis, Test of significance: concept and basic terminology of large and small sample, means, difference between means. Analysis of variance: assumptions, techniques of analysis of variance and analysis of variance in one-way techniques.

Books:
SYLLABUS FOR M.SC. MICROBIOLOGY

COURSE P-201 : MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY

Total Marks – 100 (Practical examination-80, Internal assessment-20)

(I) Single colony isolation and checking genetic markers.
(II) One step growth curve of bacteriophage T4. Spontaneous and induced mutations in isolation of antibiotic resistant and auxotrophic mutants.
(III) Selective enrichment of auxotrophic and antibiotic mutants.
(IV) Genetic mapping by conjugation and P1 transduction.
(V) Transposon mutagenesis.
(VI) Gene fusion using bacteriophage Mu.
(VII) Isolation of chromosomal DNA from E. coli. Estimation of DNA by spectrophotometry, plasmid DNA isolation and restriction digestion. Agarose gel electrophoresis.
(VIII) DNA cloning using plasmid vectors and in E. coli expression vectors.
(IX) Analysis of recombinant proteins using polyacrylamide gel electrophoresis.
(X) Southern and Northern blotting.
(XI) Restriction mapping of plasmids
(XII) PCR analysis
(XIII) DNA sequencing. Sanger’s method.

Books:
2. Molecular cloning Vol 1-III
COURSE P-202: DIAGNOSTICS MICROBIOLOGY & IMMUNOLOGY
Total Marks – 100 (Practical examination-80, Internal assessment-20)

(I) Fixation of smears for microscopy by different methods
(II) Different staining techniques
- Simple (Loeffer’s polychrome methylene blue and Negative staining)
- Gramâ staining
- Ziehl-Neelson method for AFB
- Fluorochrome staining
- Leishmanâ staining
- Giemsaâ staining
- Special staining methods to demonstrate granules, capsules and spores
(III) Preparation of culture media: Simple tissue culture methods for growing different pathogenic microorganisms
(IV) Conventional and rapid methods of isolation and identification of pathogenic bacteria, fungi.
(V) Anaerobic culture method
(VI) Principles of automated methods for diagnostic microbiology
(VII) Isolation of pure cultures and preservation techniques
(VIII) Drug susceptibility testing by various methods
(IX) Diagnostic immunologic principles and methods
- precipitation method
- Agglutination method
- ELISA method
- Immunodiffusion
- Immunoelectrophoresis
- Widal test
- Haemagglutination
(X) Separation of serum protein by electrophoresis
(XI) Separation and characterization of lymphocytes from blood.
(XII) Demonstration of lymphocyte sub population.

Books:
SYLLABUS FOR M.S.C. MICROBIOLOGY

COURSE 301: ENVIRONMENTAL MICROBIOLOGY

Maximum Marks - 80  
Teaching Hours - 45

Note: Examiner will set 09 (nine) questions covering all topics/sections of the syllabus and at least one question from each section. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

Unit 1

Aerobiology: Droplet nuclei, aerosol, assessment of air quality, - solid ï liquid ï impingement methods. Brief account of air borne transmission of microbes ï viruses ï bacteria and fungi, their diseases and preventive measures.

Unit 2

Aquatic microbiology: Water ecosystems ï types ï fresh water (ponds, lakes, streams) ï marine habitats (estuaries, mangroves, deep sea, hydrothermal vents, salt pans, coral reefs). Zonation of water ecosystems ï upwelling ï eutrophication ï food chain. Potability of water ï microbial assessment of water quality ï water purification ï brief account of major water borne diseases and their control measures.

Unit 3

Soil Microbiology: Classification of soils ï physical and chemical characteristics, microflora of various soil types (bacteria and nematodes in relevance to soil types; rhizosphere ï phyllosphere) ï a brief account of microbial interactions symbiosis ï mutualism ï commensalism ï competition ï parasitism ï predation; biogeochemical cycles and the organisms, carbon, nitrogen, phosphorus and sulphur, biofertilizers ï biological nitrogen fixation ï nitrogenase enzyme ï nif genes; symbiotic nitrogen fixation ï (Rhizobium, Frankia) ï nonsymbiotic microbes ï Azotobacter, - Azospirillium ï (vesicular arbuscular mycorrhizae - VAM) - ecto, endo, ectendomycorrhizae ï rumen microbiology.

Unit 4

Waste treatment: Wastes ï types ï solid and liquid wastes characterization ï solid ï liquid; treatments ï physical, chemical, biological ï anaerobic ï primary ï secondary ï tertiary; solid waste treatment ï saccharification ï gasification ï composting, Utilization of solid wastes ï food (SCP, mushroom, yeast): fuel (ethanol, methane) fertilizer (composting), liquid waste treatment ï trickling ï activated sludge ï oxidation pond ï oxidation ditch. Subterranean microbes and bioremediation.
Unit 5

Books:
SYLLABUS FOR M.S.C. MICROBIOLOGY

COURSE 302 : FOOD MICROBIOLOGY

Maximum Marks - 80
Teaching Hours - 45

Note: Examiner will set 09 (nine) questions covering all topics/sections of the syllabus and at least one question from each section. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

Unit 1
Food as substrate for microorganisms: Microorganisms important in food microbiology - Molds, Yeasts and Bacteria - General characteristics - classification and importance. Principles of food preservation. Asepsis - Removal of microorganisms, (anaerobic conditions, high temperatures, low temperatures, drying). Factors influencing microbial growth in food - Extrinsic and intrinsic factors; Chemical preservatives and Food additives. Canning, processing for heat treatment - D, Z and F values and working out treatment parameters.

Unit 2
Contamination and spoilage: Cereals, sugar products, vegetables, fruits, meat and meat products, Milk and Milk products - Fish and sea foods - poultry - spoilage of canned foods. Detection of spoilage and characterization.

Unit 3
Food-borne infections and intoxications: Bacterial and nonbacterial - with examples of infective and toxic types - Brucella, Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio, Yersinia, Nematodes, protozoa, algae, fungi and viruses. Foodborne outbreaks laboratory testing procedures; Prevention measures - Food sanitation in manufacture and retail trade; Food control agencies and its regulations, Plant sanitation - Employee health standards - waste treatment - disposal - quality control.

Unit 4
Food fermentations: bread, cheese, vinegar, fermented vegetables, fermented dairy products; Experimental and Industrial production methods. Spoilage and defects of fermented dairy products - oriental fermented foods, their quality standards and control.
Unit 5
Food produced by Microbes: Fermented foods, microbial cells as food (single cell proteins) | mushroom cultivation. Bioconversions | Production of alcohol | fermented beverages | beer and wine. Steroid conversion | Industrial enzymes production | amylases, proteinases, cellulases; Amino acid production | glutamic acid and lysine productions. Genetically modified foods.

Books:
SYLLABUS FOR M.SC. MICROBIOLOGY

COURSE 303 : INDUSTRIAL MICROBIOLOGY

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<th>Maximum Marks - 80</th>
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**Note**: Examiner will set 09 (nine) questions covering all topics/sections of the syllabus and at least one question from each section. Out of the nine questions, there will be an objective type question covering the entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

**Unit 1**
Biotechnological innovations in the chemical industry, biocatalyst in organic chemical synthesis, efficiency of growth and product formation, microbial growth kinetics, measurement of growth (cell number, direct and indirect methods), growth and product formation, effect of environment (temperature, pH, high nutrient concentration), growth stoichiometry, maintenance energy requirement and maximum biomass, yield, P/O quotients, metabolite overproduction and growth efficiency.

**Unit 2**
Media formulation. Sterilization, kinetics of thermal death of microorganisms, batch and continuous sterilization. Shake flask, stirred tank airlift fermenter, fed batch continuous and immobilized cell reactor.

**Unit 3**
Aeration and agitation, power requirement, oxygen transfer kinetics, concepts of Newtonian and Non-Newtonian fluids, plastic fluid apparent viscosity, foam and antifoam. Large scale production.

**Unit 4**
Metabolic pathways and metabolic control mechanism, industrial production of citric acid, enzymes, ethanol, acetic acid, production and diversification of antibodies. Biofertilizers, biopesticides, mushroom production, fermented food/beverages, Biopolymers.

**Unit 5**
Industrial strains. Strategies for selection, improvement & maintenance, large-scale production using recombinant microorganisms. Scale-up, instrumentation control, physical and chemical environment sensors, downstream processing.

**Books:**
1. Biotechnological innovations in chemical synthesis. BIOTOL. Publisher.
5. Fermentation: A practical approach. IRL.
SYLLABUS FOR M.SC. MICROBIOLOGY

COURSE 304 : COMPUTERS AND BIOINFORMATICS

Maximum Marks - 80  
Teaching Hours - 45

Note: Examiner will set 09 (nine) questions covering all topics/sections of the syllabus and at least one question from each section. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

Unit I
Computer basics. Operating systems: Windows and Unix. Hardware, software, disk operating system, multimedia network concepts. C-programming; object oriented programming.

Unit II
Word processing using MS-Word, formatting the document, tables, mail merge and spell check. Spreadsheets basics with MS Excel, labels, numerical and formula entries, basic mathematical and statistical functions, graphical representation of data

Unit III
Introduction to data structures and database concepts. Basics of Microsoft Access: Databox wizard, creating fields, properties and tables, datanet records, sorting, queries, forms and records.

Unit IV
Introduction to internet use and search engines: www, HTML, URLs, browsers: Netscape (opera) Explorer, Search engines: Google, PubMED, Sequence information sources (Structure and use on web): EMBL, GENBANK, Entrez, Unigene. Protein information sources (Structure and use on web): PDB, Swissprot, TrEMBL

Unit V
Sequence and phylogeny analysis: Detection of open reading frames (ORFs), gene identification and prediction, method of gene family identification, outline of sequence assembly, mutation matrices, pair wise alignments, introduction to BLAST (using it on web and interpreting results), multiple sequence alignment, phylogenetic analysis. Molecular modeling: introduction, dynamic simulation, conformational search, molecular modeling packages (Chem3D, Hyperchem), protein modeling, structure prediction and molecular docking.

Books:
1) Bioinformatics: Methods and Applications Genomics Proteomics and Drug Discovery, S C Rastogi, N Mendiratta, P. Rastogi, Prentice Hall of India Private Ltd
2) Bioinformatics: The Machine Learning Approach Pierre Baldi and Soren Brunak, MIT Press
3) Bioinformatics: A practical guide to the analysis of genes and proteins, Ed. By Baxvains
4) Bioinformatics online (Methods in Enzymology V. 266 computer method for macromolecular sequence), Ed. By Doolittle, Academic Press
5) Molecular Evolution: a phylogenetic approach, ROM and Holmas EC, Blackwell science
6) Bioinformatics: Sequences, structure and databanks, Des Higgins and Willie Taylor, Oxford University Press
SYLLABUS FOR M.SC. MICROBIOLOGY

COURSE P-301: APPLIED MICROBIOLOGY I

Total Marks – 100 (Practical examination-80, Internal assessment-20)

(I) Basic Design of a Laboratory Fermenter

(II) Cleaning and sterilization of Fermenter Vessel.

(III) Determination of Viability of Cells in a Yeast Culture by Methylene Blue Staining, Plate Count and Haemocytometer Methods

(IV) Determination Growth Curve in a Batch Culture.

(V) Microbial Growth kinetics-Determination of specific growth rate ($\mu_{max}$), saturation constant ($K_s$) and growth yield ($Y_{X/S}$) for Saccharomyces cerevisiae in batch culture.

(VI) Concentration of protein by ultrafiltration.

(VII) Determination of $K_{La}$ by sulphite oxidation method.

(VIII) Determination of $K_{La}$ in a bioreactor by dynamic method.

(IX) Determination of thermal death rate constant and decimal reduction time for E. coli.

(X) Disruption of microbial cells (Baker's yeast) for the release of the intracellular protein.

(XI) Bio-transformation of sucrose into high fructose syrup by immobilized cell of Saccharomyces cerevisiae

(XII) Production of Ethanol by simple/complex carbohydrate sources (media) using Sachharomyces cerevisiae.

(XIII) Production of Wine from Apple / Grape Juices by Sachharomyces cerevisiae.

(XIV) Production of Citric acid by solid-state-fermentation using Aspergillus niger.

(XV) Detection of nicotinic acid by bioassay

(XVI) Detection of number of bacteria in milk by standard plate count (SPC).

(XVII) Determination of quality of milk sample by methylene blue reduction test

(XVIII) Microbiological assay of toxins

(XIX) Role of yeast in bread making
COURSE P-302: APPLIED MICROBIOLOGY II

Total Marks – 100 (Practical examination-80, Internal assessment-20)

(I) Estimation of total solids in sewage samples.
(II) Estimation of volatile matter and fixed residues in sewage samples.
(III) Rapid detection of bacteriological quality of water with special reference to feecal Coliform.
(IV) Determination of dissolved oxygen in waste water samples.
(V) Determination of BOD of waste water samples.
(VI) Determination of COD of waste water samples.
(VII) Determination of rate of decomposition of organic matter.
(VIII) Design and operation of multistage reactor for degradation of waste water.
(IX) Isolation and purification of degradative plasmids for aromatic compounds.
(X) Word processing commands using MS-Word.
(XI) Mail Merge facility of MS-Word.
(XII) Graphical presentation using MS-Excel.
(XIII) Creation of Data tables in MS Access and simple queries with SQL.
(XIV) Online Bibliographic and patent search.
(XV) Offline Bibliographic search using Derwent Biotechnology Abstracts.
(XVI) Configuring and managing of e-mail accounts.
(XVII) Sequence information resource
(XVIII) Understanding and using on web: Embl, GEnbank, Entrez, Unigene
(XIX) Protein information resource
(XX) Understanding and using on web: PDB, Swissprot, TrEMBL
(XXI) Using BLAST and interpretation of results, multiple sequence alignment using ClustalW
SYLLABUS FOR M.SC. MICROBIOLOGY

COURSE EL-301 : METABOLIC ENGINEERING

Maximum Marks - 80

Teaching Hours - 45

Note: Examiner will set 09 (nine) questions covering all topics/sections of the syllabus and at least one question from each section. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

Unit 1
Introduction to metabolic engineering: Concept and importance of metabolic engineering, improvement of microbial strain and fermentation processes by metabolic engineering.

Unit 2.
Regulation of metabolic pathways: Regulation of enzyme activity, regulation of enzyme concentration, regulation of metabolic network. tools of metabolic engineering.

Unit 3.
Metabolic engineering in practice: Enhancement of productivity, extension of substrate range, extension of product spectrum and novel products, improvement of cellular properties, intervention in health and diseases, xenobiotics degradation.

Unit 4. Metabolic flux analysis:
Theory, detection of elementary flux modes in biochemical network, metabolic flux distribution in Corynebacterium glutamicum during growth and lysine overproduction.

Unit 5.
Application of metabolic flux analysis: Calculation of theoretical yield, amino acid production by glutamic acid bacteria, metabolic flux in mammalian cell culture, metabolic engineering ob lactic acid bacteria, riboflavin production by Bacillus subtilis, metabolic engineering of Saccharomyces cerevisiae.

Books:

1. Metabolic Engineering by S. Y. Lee and E. P. Popoutsakis (Eds), Marcel Dekker, New York, USA.
SYLLABUS FOR M.SC. MICROBIOLOGY

COURSE EL-302 : MICROBIAL ENZYMES

Maximum Marks - 80  Teaching Hours - 45

Note: Examiner will set 09 (nine) questions covering all topics/sections of the syllabus and at least one question from each section. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

Unit I
Natures of Enzymes—Structural and Functional aspects, physiological significance of enzymes, classification and nomenclature, importance of the study of enzymes.

Unit II
Rate of enzyme catalyzed reactions, rate laws and rate constants, Michaelis Menton’s hypothesis, significance and determination of Km and, Vmax, enzyme inhibition—reversible and irreversible inhibition, competitive, non-competitive and uncompetitive inhibition, effect of physicochemical factors on enzyme activities.

Unit III
Introduction and history of industrially important microbial enzymes, biochemistry and physiology of microbial enzyme production mechanism, regulation of enzyme synthesis, location and secretion of enzymes.

Unit IV
Introduction, occurrence, mechanism of action, methods of industrial production and applications of amylases, proteinases, cellulases, pectinases, glucose oxidase, glucose dehydrogenase, glucose isomerase, B galactosidase, and invertases. Recovery of Microbial Enzymes, Introduction cell disruption, precipitation, solid/liquid separation, chromatographic techniques and drying.

Unit V
Immobilization, development of immobilization techniques, specific examples of immobilized microbial enzymes useful in food systems and biotechnology, immobilized enzymes reactors. Exploitation of microbial enzymes in food systems and biotechnology, increasing yields of extracellular enzymes—strain selection, environmental control, genetic regulatory controls, genetic recombination and gene amplification techniques.

Books:
1. Enzyme Technology - M.F. Chaplin and D.C. Bucks
2. Industrial Enzymology i Godfrey and West
3. Enzyme i Copeland
4. Enzymes in Industry i W. Gerhartz
SYLLABUS FOR M.SC. MICROBIOLOGY

COURSE EL-303 : MICROBIAL GENOMICS & PROTEOMICS

Maximum Marks - 80  
Teaching Hours - 45

Note: Examiner will set 09 (nine) questions covering all topics/sections of the syllabus and at least one question from each section. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

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

Unit 2
Sequence analysis: computational methods, homology algorithms (BLAST) for proteins and nucleic acids, open reading frames, annotations of genes, conserved protein motifs related structure/function (PROSITE, PFAM, ProfileScan), DNA analysis for repeats (direct and inverted), palindromes, folding programmes.

Unit 3
Use of Internet, public domain databases for nucleic acid and protein sequences (EMBL, GenBank), database for protein structures (PDB).

Unit 4
DNA microarray, printing or oligonucleotides and PCR products on glass slides, nitrocellulose paper. Whole genome analysis for global patterns of gene expression using fluorescent labeled cDNA or end labeled RNA probes. Analysis of single nucleotide polymorphisms using DNA chips.

Unit 5
Proteome analysis: Two-dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by mass spectroscopy. Protein microarray. Advantages and disadvantages of DNA and protein microarrays.

Books:
2. DNA microarrays: A practical approach edited by Mark Schena.
SYLLABUS FOR M.SC. MICROBIOLOGY

COURSE 401 : RESEARCH PROJECT REPORT

Maximum Marks - 200

Each of the candidates will carry out the project work assigned to him/her. The candidate will submit three bound copies of the research project work performed by him/her duly certified by the guide/supervisor. The project report should cover the summary, introduction, materials and methods, results and discussion and references. The references will be arranged alphabetically under the format given below:

Referred Journal


Book


Thesis


Website

www.elsevier.com