SYLLABUS 2015-16

M.Sc. MICROBIOLOGY

Scheme of the papers and marks distribution for each paper and practical

M.Sc. Previous Examination

<table>
<thead>
<tr>
<th>Theory Papers</th>
<th>Duration</th>
<th>Max Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper 1</td>
<td>3 Hrs.</td>
<td>100</td>
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<tr>
<td>Paper 2</td>
<td>3 Hrs.</td>
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<tr>
<td>Paper 3</td>
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<tr>
<td>Paper 4</td>
<td>3 Hrs.</td>
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</tr>
<tr>
<td>Combined Practical</td>
<td>2 Days (6Hrs every day)</td>
<td>200</td>
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<tr>
<td>Experimental work</td>
<td></td>
<td>150</td>
</tr>
<tr>
<td>Seminar Presentation</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Tour report*</td>
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<td>0</td>
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<tr>
<td>Record</td>
<td></td>
<td>10</td>
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<tr>
<td>Viva-voce</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
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<td>600</td>
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* Tour report: To be prepared after a study tour to industries/academic institutions of repute.

M.Sc. Final Examination

<table>
<thead>
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<th>Theory Papers</th>
<th>Duration</th>
<th>Max Marks</th>
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<tbody>
<tr>
<td>Paper 5</td>
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<td>Paper 6</td>
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<td>Paper 7</td>
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<tr>
<td>Paper 8</td>
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</tr>
<tr>
<td>Combined Practical</td>
<td>2 Days (6Hrs every day)</td>
<td>200</td>
</tr>
<tr>
<td>Experimental work</td>
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<td>Seminar</td>
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<td>Record</td>
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<tr>
<td>Viva-voce</td>
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<tr>
<td>Dissertation (to be evaluated by an external examiner through presentation and viva voce)</td>
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</tr>
<tr>
<td>Total</td>
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<td>600</td>
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Dissertation to be done preferably in some outside research institute/industry.

Eligibility:

In the light and looking at the interdisciplinary nature of Microbiology, eligibility with respect to subject at graduation level is as below:

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B.Sc. with one of the subject of life sciences or bachelor degree in Microbiology/Biotechnology/Biochemistry/Genetics/Medicine/Agriculture/Horticulture/Forestry/Wild life/Pharmacy/Veterinary/Life Sciences with 50% marks.

M.Sc. Previous Examination

Paper: 1 General Microbiology, Bacteriology and Virology

Note: The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt 5 questions in all, selecting one question from each unit.

UNIT-I
History and Scope of Microbiology, Culturable and unculturable bacteria. Microbial Taxonomy: Taxonomic ranks. Polyphasic classification; Phenetic classification, Numerical taxonomy, Phylogenetic classification. Major characteristics used in taxonomy (Classical and Molecular characteristics); Microbial phylogeny; Bergey’s manual of systematic bacteriology. Ultra structure, chemistry and function of prokaryotic and eukaryotic cells with special reference to bacteria, protozoa, algae and fungi.

UNIT –II

UNIT-III
General Characters of:-
Important Bacteria- *Escherichia*, *Salmonella*, *Vibrio*, *Proteus*, *Bacillus*, *Lactobacillus*, *Streptococcus*, *Staphylococcus*, *Corynebacterium*, *Treponema*, *Mycobacterium*, *Pseudomonas*, *Klebsiella*, *Thiobacillus*, *Spirochaetes*, *Azotobacter*, *Rhizobium*, *Beijerinki*, *Acetobacter*, *Streptomyces*, *Clostridium*.
Characters of Special group of organism as:- Archaebacteria, Photosynthetic bacteria, Nitrogen fixing bacteria, Spirochaetes, Mycoplasma, Rickettsia, Bdelovibrio.
Important Fungi - *Dictyostelium, Rhizopus, Saccharomyces, Candida, Trichoderma, Penicillium, Gliocladium, Fusarium, Helminthosporium, Alternaria, Albigo.*

Important Protozoa - *Entamoeba, Trypanosoma, Plasmodium, Coccidia, Giardia.*

Important Cyanobacteria/Algae: - *Nostoc, Oscillatoria, Scenedesmus.*

**UNIT –IV**

Virology: Brief outline on discovery of viruses, nomenclature and classification of viruses: distinctive properties of viruses; Electron microscopic morphology and ultra structure; Classification of viruses. DNA and RNA viruses, Replication of different group of viruses. Cultivation of viruses in embryonated eggs, experimental animals, Primary & secondary cell cultures; suspension cell cultures and monolayer cell cultures; assay of viruses physical and chemical methods (Protein, nucleic acid, radioactivity, trackers, electron microscopy)- Infectivity assay (plaque method, end point method).

**UNIT-V**

Bacteriophage structural organization; life cycle; one step growth curve; transcription; DNA replication; eclipse phase; phage production; burst size; lytic- lysogenic cycle; bacteriophage typing; application in bacterial genetics; brief details on M13,Mu, T4, 2, R17, *Salmonella* phages, Lamda, P1 *Coli* phage. Common 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 and without vectors. Brief details of RNA viruses Picorna, Ortho Myxo, Paramyxvo, Toga and other arthropod viruses, Rhabdo, Rota, HIV and other Oncogenic Viruses; DNA viruses; Pox, Herpes, Adeno SV40; Hepatitis viruses, viral vaccines.

**Paper: 2. Microbial Genetics, Molecular Biology and Techniques of Genetic Engineering**

*Note:* The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt 5 questions in all, selecting one question from each unit.

**UNIT-I**

Bacterial genome, Plasmids: Structure, classification, copy control, incompatibility, F-factor, col and R plasmids.
Gene transfer in bacteria: Transformation, transduction, conjugation (F+, F- and Hfr cells), Genetic map, Genetic mapping of *E. coli*. Bacteriophage:, Mutation *versus* adaptation, Luria Delbruck experiment and significance, Mutagenesis: Spontaneous and induced mutations, deletions, insertion and point mutations, physico-chemical agents of mutation, mutant selection.

**UNIT-II**
Genetic Material : Chemical composition and organization, 3-D structure of DNA, linking number, topological properties, super coiling of DNA, packaging of DNA in pro & eukaryotes. DNA denaturation and renaturation, Coding and non-coding DNA, repetitive DNA sequences, DNA replication – mechanism, enzymology and repair mechanism, inhibitors of DNA replication, DNA damage, DNA recombination. Transposons and mechanism of transposition.

**UNIT-III**
Transcription in pro and eukaryotes, Reverse transcription, inhibitors of transcription, post transcriptional processing.
Translation in pro and eukaryotes, Genetic code properties. Inhibitors of translation, post translational modifications, Protein transport.
Mechanism of gene regulation, catabolite repression, Lac and tryptophan operon, ara operon, cis-acting elements, transacting factors, positive and negative regulation , inducers and co-repressors. Negative regulation; regulation by attenuation. Antitermination - N protein and nut sites, binding sites on DNA, Global regulatory responses : heat shock response, stringent response and regulation by small molecules such as ppGpp(p) and cAMP.

**UNIT-IV**
Nucleic Acid Hybridization: Southern, Northern, Western Blotting, DNA finger printing, Foot printing, Gel retardation assay, Restriction endonucleases, Restriction mapping, Polymerase chain reaction, gene sequencer, Gel electrophoresis (DNA, RNA and Protein).
DNA and RNA sequencing, *(16S-23S rRNA)*, DNA Probes and their applications, RFLP, RAPD, AFLP, STS, Use of micro arrays to study gene expression.

**UNIT-V**

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Genetic Engineering: detailed account of Enzymes (Ligases, topoisomerases, Gyrase, Nuclease), Cloning vehicles, plasmids pBR322, PUC18, ss & ds Phage vector, phagemids, cosmids, BAC, YAC, MAC, Expression vectors.

Gene transfer techniques: chemical, electroporation, microinjection, particle bombardment, Agrobacterium mediated gene transfer.

Screening of recombinants, Reporter gene, general account of onco genes. Construction of cDNA and genomic library, Site directed mutagenesis. Applications of genetic engineering in agriculture, industry and medical, Biosafety regulations, Intellectual property rights, Patenting laws in India.

Paper: 3. Microbial Physiology, Biochemistry and Bioinstrumentation

Note: The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt 5 questions in all, selecting one question from each unit.

UNIT-I

UNIT-II
Cell metabolism: anabolic principles and synthesis of fatty acids, lipids, amino acids and proteins in microbes.
Studies of biosynthesis of hormones, Synthesis of vitamins and their role as coenzymes, Synthesis of cell membrane and cell wall of microbes, Synthesis of RNA and DNA in microbes.

UNIT-III

UNIT-IV
Carbohydrate: anabolism, autotrophy, aerobic and anaerobic photosynthesis, autotrophic generation of ATP, Fixation of CO₂ in Microorganism, Calvin cycle.
Catabolic break down of carbohydrates proteins and lipids
Oxidative and substrate level phosphorylation, Reverse TCA cycle,
Gluconeogenesis, Pasture effect; Fermentation of carbohydrates: homo and heterolactic fermentations.

UNIT –V
Electrophoresis: zonal techniques, supporting medium, vertical, submarine and gradient electrophoresis. Isoelectric focusing.
Centrifugation general principal and types, Spectroscopy: Beer-Lambert relationship components of a spectrophotometer, type of detectors; UV-Vis spectrophotometry, atomic absorption spectroscopy. Application of spectroscopy. Separation methods: principles, general methods of separation; methods based on polarity (absorption chromatography, liquid chromatography, gas-liquid chromatography), methods based on ionic nature (ion-exchange chromatography), methods based on shape (affinity chromatography), HPLC.

Note: The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt 5 questions in all, selecting one question from each unit.

UNIT-I
Definition of statistics, symbols, notations and terminology of statistics: Sampling and estimation of population parameters, Random sampling, Sampling size in random sampling, stratified two stage cluster and sequential sampling, Bias in sampling Presentation of research results, Graphic presentation.

UNIT-II
Interval Data: Construction of a histogram, interpretations of histogram, the normal distribution, the mean, mode, median and standard deviation, representing the normal curve, uncertainty in estimation of a mean, comparison of means and variances.
Statistical treatment of proportion data. Chi square test, goodness of fit.
Count data: examples of count data (bacterial cell count, radioactivity, colony and plaque counts), statistical treatment to count data. Poisson distribution, Standard error, confidence limits of counts.

UNIT-III
Simple Probability: Regression and Correlation, simple linear regression, Coefficient of determination. Brief introduction to the need and application on curvilinear and multiple regression, Searching for the best regression. Common misuses of the technique Correlation coefficient and the tests of the significance.
Use of partial correlation and partial covariance Detecting association between a pair of species. Cole’s measure of association and point correlation coefficient.
Statistical basis of biological assays: Response-Dose metamer, direct and indirect assay, statistical analysis of LD50.

UNIT-IV
Computer applications: Computers and their organization, Hardware, software, operating system (Command line and WIMP) Elementary idea about programming languages and application packages for microbiologists, Data processing and presentation (Spreadsheet and Statistical analysis) LIMS, computer graphics, Computer : use in microbiology, CAL in microbiology, Use of computer as audio visual aid.

UNIT-V

PRACTICAL
Isolation and identification of Bacteria.
Isolation and identification of important Fungi.
Morphology of important Protozoa, Algae and Viruses.
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Oculometry, Microbial biochemical tests
Staining of Bacteria, Fungi and Spores.
Media preparation and incubation methods.
Microbial studies of air, water, food, sewage and soil.
Chick embryo inoculation for viruses.
Biochemical test for Carbohydrate, fats, proteins
Practical’s based on enzyme kinetics.
Isolation of carbohydrates, proteins and fats.
Chromatographic separation methods for pigments and Amino acids.
Isolation of plasmids.
Studies of bacteriophages.
Quantitative and qualitative analysis of DNA/RNA.
PCR amplification of DNA
Electrophoresis of DNA/RNA/Protein.
Isolation of DNA/RNA from plant, animal cell, bacteria.
Restriction digestion, ligation of DNA and cloning

M.Sc. Final Examination

Paper: 5. Industrial and food Microbiology

Note: The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt 5 questions in all, selecting one question from each unit.

UNIT-I
Introduction to fermentation processes, history of fermentation process.
Bioreactors: Design and components- vessel materials, baffles, impellers, inoculation and sampling devices etc., biohazard and containment.
Use of biosensors in fermentation process.
Types of bioreactors: airlift, fluidized bed, micro carrier, photo bioreactor, stirred bioreactor.
Immobilization of cells and its industrial application (Pharmaceutical, food and chemical industries).

UNIT-II
Isolation, preservation and maintenance of industrially important microorganisms.
Selection and screening of microorganism for industrial processes.
Formulation of fermentation media: energy source, water, nitrogen source, minerals, chelators, growth factors, buffers, precursors, inhibitors and antifoam agents, Optimization of media. Media and air sterilization.

UNIT-III
Types of fermentation processes with kinetics: Batch, continuous: internal and external feed back system and fed batch: variable and fixed volume system.
Downstream processing: foam separation, cell disruption, industrial scale centrifugation, liquid-liquid extraction, solvent recovery, chromatography, two phase aqueous extraction, supercritical fluid extraction, drying and crystallization.

UNIT-IV
Production process for food supplements: Yeast (Bakers, food and fodder), Single cell protein (SCP), Single cell and Single cell oil (SCO).
Production process for acids: Lysine, Glutamic acid, lactic acid and Citric acid.
Production process for alcohols and alcoholic beverages: Ethanol, Beer, Wine and Whisky.
Production process for food products: Sauerkraut, Bread, Cheese, Yoghurt.
Production process of enzymes for amylases and proteases.
Production process for antibiotics: penicillin, streptomycin and tetracycline.
Production of vitamins: Vitamin B, Riboflavin fermentation

UNIT-V
Production of non-microbial product through GEMs: insulin, interferon, cell growth factors, tissue plasminogen activator. Biogums, Bioplastic (PHB, PHA), Biochips and nanotechnology. Steroid transformation. Production of bioinsecticides.
Vaccine types: live, attenuated and recombinant and their production.

Note: The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt 5 questions in all, selecting one question from each unit.

UNIT-I
Aero Microbiology: Droplet nuclei, aerosol, assessment of air quality, solid - liquid - impingement methods, brief account of air borne transmission of microbes - viruses, bacteria and fungi, their diseases and preventive measures. Assessment of air quality for microbial loads.


UNIT-II
Inter species interactions: Antagonism, competition, commensalisms, synergism, parasitism and predation. Gansse’s and Hardin’s principles of competition. Defense mechanisms (specific and non specific) of microorganisms.
Beneficial interactions of microbes with animals: Symbiosis of roaches and bacteriods, bacteria and protozoa, algae and invertebrates. Symptiotic cellulose digestion in insects and vertebrates. Rumen microbiology, digestion, fermentation and detoxification by microbes, factors influencing rumen microbes.

UNIT-III

UNIT-IV

UNIT-V
Biodeterioration and biodegradation: microbial degradation of paints, plastics, rubber, pharmaceuticals, paper, leather, wood, wool, petroleum and petroleum products, degradation of

**Paper: 7. Geomicrobiology, Soil & Agricultural Microbiology**
Note: The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt 5 questions in all, selecting one question from each unit.

**UNIT-I**
Geomicrobiology: Origin of microbial life, Chemical and Biological evolution. Geomicrobiology of fossil fuels. Bioleaching and biomining.

**UNIT-II**
 Decomposition of Plant Litter: Microbes involved, fermentation of plant litter, Agricultural and urban waste compost, vermicompost, mushroom compost, silage, methane production, biogas plants.
Microbiology of Rhizospheres, phyllosphere and spermosphere, Mycorrhizal associations, Rhizobial and actinorhizal root nodules and stem nodules and nitrogen fixation.

**UNIT-III**
Plant Diseases: Physiology of parasitism, mechanism of disease resistance, host parasite relationship. Symptomatology and control measure of various diseases.
Viral diseases: TMV, Yellow vein mosaic of Bhindi, Papaya leaf curl, Cucumber mosaic and Tobacco necrosis.
Bacterial diseases: Citrus canker, Crown gall
Fungal diseases: Green ear of bajra, Cotton wilt, Tikka disease of groundnut, Wheat rusts and Loose and Covered smuts.
Mycoplasmal diseases: Witches broom of potato, Stripe disease of sugarcane

**UNIT-IV**
Microbial pathogens of plant roots and shoots, their control by competition and antagonism; importance of *Trichoderma viride; T.harzianum; Streptomyces, Rhizobacteria, Mycorrhiza and Thiobacillus* on the ©MGSU BIKANER
control of plant root pathogens; control of aerial pathogens, prophylaxis, pre-inoculation, and immunization with avirulent pathogens; role of microorganisms in protecting the wounds of trees; techniques of application of microorganisms for control of microbial diseases; seed treatment, aerial spray and soil treatment

UNIT-V

Microbial pesticides: biology and chemistry of the biocidal component, mode of action, effect on target organisms, production technology and commercial microbial pesticides.

Microbial insecticides; advantages of microbial insecticides, limitations-Mass production techniques; fermentation, formulation of insecticides, carrier materials quality control etc; compatibility of microbial and chemical insecticides; suitable insecticides for major pests; field application of microbial insecticides and its perpetuation.

**Paper: 8. Medical Microbiology & Immunology**

**Note:** The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt 5 questions in all, selecting one question from each unit.

UNIT –I
Early discovery of pathogenic microorganisms. Normal microbial flora of human body; role of the resident flora. Noscomical infection, common types of hospital infections and their diagnosis and control. 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, depolymerizing enzymes, organotropisms, variation and virulence.

UNIT-II
**Important diseases of human beings** (short description of causal agent, pathogenesis, diagnosis, vaccine and treatment)

**Bacterial diseases:** Typhoid, Syphilis, Cholera, Gonorrhoeae, Tuberculosis, Diphtheria, Tetanus, Plague Botulism, Meningitis, Pneumonia, Entritis.

**Viral diseases:** Influenza, Herpes, AIDS, Rabies, SARS, Human Pox, Yellow fever, Encephalitis Mumps and Measles.

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**Fungal diseases**: Ringworm, Histoplasmosis.

**Mycoplasmal diseases**: inflammation of genitals, upper respiratory tract infection

**Important bacterial** (Anthrax, Black quarter, Tuberculosis, Brucellosis, Contagious pleuro pneumonia) and **viral** (Foot and mouth disease, Rinderpest, Cow pox, Sheep pox, Rabies, blue tongue) **diseases of domestic animals** (causal agent epidemiology, pathogenesis, diagnosis, vaccine and treatment).

**UNIT-III**
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; Prokaryotic signaling mechanisms: Quorum sensing and bacterial pheromones, intracellular signaling, signaling pathways.

**UNIT-IV**

**UNIT-V**
**Transplantation**; Graft rejection, mechanism and prevention, HLA and disease.
**Autoimmunity**; Organ specific and systemic, Autoantibodies, experimental models

**PRACTICAL**
Isolation and cultivation of *Azotobacter, Rhizobium, Azospirillum, Cyanobacteria, Actinomycetes, Mycorrhiza.*
Soil analysis and soil microbial count.
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Studies of soil protozoa.
Studies of soil Mycology.
Studies of bacterial, fungal and viral diseases and their diagnosis.
Study of airborne pollen and fungal spores.
Microbial examination of water, food and milk.
Laboratory production of Penicillin, Curd, Mushroom, Fermented food
Activity of amylase, cellulase and catalase.
Effect on growth of microbes-
Temperature, (b) Aeration, (c) pH, (d) Nutrients.
Normal micro flora studies of skin, Respiratory tract, Gastro-intestinal tract, uro-genital tract and
important organisms causing disease in the above mentioned tracts.
Study of Leprosy, Tuberculosis, Brucellosis, Typhoid, Cholera, Syphilis, Meningitis, Herpes, AIDS
disease of human beings by visiting near by hospital.
Study of Mastitis, Metritis, Anthrax, Rinderpest and Ranikhet, disease in animals and birds by visiting
near by animal hospital.
Isolation of one pathogenic organism.
Ochterlony double diffusion, agglutination test, Fluorescent Antibody test.
Examination blood.
Examination urine.
Examination sputum.
Blood group and Rh factor.
ELISA test for AIDS.
Cultivation of animal cells.
Callus growth technique.
Testing of milk by MBRT.
Serological tests: Radio immuno-diffusion, Immuno-electrophoresis, DOT ELISA, Sandwich ELISA,

**Suggested Readings**
Co., Minnesota.

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Felller W. Introduction to probability theory and its applications, Asia Publishing House, Mumbai.

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Jayaraj, S. (1985). Microbial control and pest management


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