ORDINANCES FOR

2- year Post-graduate Course

M.Sc. Applied Microbiology
(under Self Finance Scheme)

From the session 2016-17

Department of Microbiology
Ch. Charan Singh University
Meerut
OVERVIEW

In view of the increasing demand of competent microbiologists, this four semester (two year) course of M.Sc. (Applied Microbiology) has been designed to train the students in applied aspects of microbiology. The course contents are designed in such a way that the student may either pursue his career as an academician or may secure jobs in pharmaceutical industry, food industry, agricultural sector, environmental pollution departments and quality control industries etc.

AIMS

We aim to give a significant level of theoretical and practical understanding and diagnosis/identification of various human pathogens. Specialization shall be allowed in the fields of Medical Microbiology/Industrial Microbiology/Environmental Microbiology/Agricultural Microbiology based on 4-6 month practical training in national laboratories of repute or in other Universities engaged in high quality research in microbiology or in industries based on microbiology.

ORDINANCES

All rules for conduct of examination pattern, pass percentage and admissions shall be the same as for other post-graduate courses in the Faculty of Science on the University campus. Internal and external examination shall be as indicated in the given Table. The pattern of internal assessment shall be decided by the Department however, it will mainly include tests, quizzes, seminars, term papers, group discussions and home assignments. A candidate will have to complete a project in the fourth semester for a period 4 to 6 months. The Project may also be completed in Department of Microbiology. One of the supervisors for project work may be opted from outside the University where the candidate shall complete his/her project work. After the completion of Project work the candidate shall submit a detailed project report/thesis and will make an open presentation for 20-30 minutes. He/she will defend his/her experimental design, results and conclusions before the Board of Examiners to be appointed by the competent body/officer of the University who shall normally be the Vice-Chancellor. The specialization shall be granted on the basis of project report in any one of the field of Medical Microbiology/Industrial Microbiology/Environmental Microbiology/Agricultural Microbiology. Besides, the project report, the candidate will also appear in written examination in the field of his/her specialization. The question paper will be set jointly by the internal and external examiner both who shall also the examiners of his/her project report. The question paper will consist of short questions including objective type to test thorough knowledge of the candidate in the field of specialization. The answer sheets will be
jointly evaluated by the same Board of Examiners who will set the question paper. The Department shall be free to alter the sequence of courses in any semester depending upon the resources available.

**Number of seats and fee structure**

Initially there should be only 20 seats which may be altered depending upon the facilities available in the Department. Reservation shall apply as per the policy of the University for other courses on the campus. This course is approved under self finance scheme of the University/State Govt. and annual tuition fee of Rs. 50,000/- (Rs. Fifty thousand) is suggested which shall include the project fee if any. However, the fee structure may be altered depending upon the resources available.

**Eligibility for Admission**

Minimum eligibility for admission in this two year M.Sc. (Applied Microbiology) course shall be undergraduate degree/B.Sc. (Biology group/Medical/ Paramedical and Allied subjects).

**Appointment of Examiners**

Course Coordinator is authorized to make a proposal of the examiners (both for theory and practical examination) in consultation with the members of Board of Students either through telephonic conversation or through electronic media. Alternately, a meeting of Board of Studies may be convened.

**COURSE STRUCTURE**

Following course structure is approved:
# M.Sc. (Applied Microbiology) Syllabus, C.C.S. University, Meerut

Effective from the session 2016-2017

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Course no.</th>
<th>Name of the course</th>
<th>Internal (M.M.)</th>
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<td>AM 101</td>
<td>Instrumentation and Microbial Techniques</td>
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<tr>
<td>2</td>
<td>AM 102</td>
<td>Microbial Diversity- Prokaryotes and Viruses</td>
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<td>3</td>
<td>AM 103</td>
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<td>4</td>
<td>AM 104</td>
<td>Biostatistics, Computer Applications and Bioinformatics</td>
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<td>12</td>
<td>AM 302</td>
<td>Molecular Immunology</td>
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<td>Project Report including Viva-voce</td>
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<td><strong>Total Marks</strong></td>
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Course 1, Code- AM 101: Instrumentation and Microbial Techniques

Unit I: Microscopy & Staining techniques: Basic principles for the examination of microbes by light, dark field, phase contrast, confocal, fluorescent and electron (transmission and scanning) microscopy; Micrometry; Specimen preparation and basic principles of Simple, Gram’s stain, Capsule, Endospore, Flagella, Acid fast and Nuclear/Geimsa’s staining.

Unit II: Basic principles and methods of sterilization: control of microorganisms by physical methods: heat, filtration and radiation; chemical methods: phenolics, alcohols, halogens, heavy metals, quartenary ammonium compounds, aldehydes and sterilizing gases; evaluation of antimicrobial agent effectiveness. Principle and functioning of LAF.

Unit III: Basic principles and methods of media preparation: types of culture media: simple media, complex media, synthetic media, enriched media, selective media, indicator media, differential media, anaerobic media; pH and buffers; Pure culture techniques: streak plate, dilution plate and spread plate method; maintenance of pure cultures; methods of preservation of various microbes.

Unit IV: Basic principles and applications of spectrophotometry & Chromatography: Beer-Lambert law; interaction of radiation with matter, absorption of radiation, emission of radiation; UV-Vis spectrophotometry, Fluorimetry, Flame photometry and atomic absorption spectrophotometry; Chromatography (paper, thin layer, column, gel filtration, ion-exchange and affinity chromatography); GLC, HPLC and FPLC.

Unit V: Miscellaneous techniques: Principles and applications of Electrophoresis for protein and DNA; Iso-electric focusing and 2-D gel electrophoresis; Autoradiography, X-Ray diffraction; Centrifugation; Ultracentrifugation; Dialysis, Ultrafiltration; Lyophilization.

Suggested Readings (Latest Editions):

Course 2, Code- AM 102: Microbial Diversity- Prokaryotes and Viruses

Unit I: Discovery of microbial world; History, Scope and relevance of Microbiology; Current thoughts on microbial evolution including the origin of life; Introduction to microbial biodiversity – distribution, abundance, ecological niche of bacteria and archaea.


Unit III: General characteristics including cell structure of bacteria and Archaea; Extreme environments and extremophiles; General characteristics of thermophiles, psychrophiles, osmophiles, acidophiles, alkaliphiles and halophiles including ecology, adaptation and biotechnological applications. General characteristics of Cyanobacteria- ultrastructure and economic importance.

Unit IV: General characters, nomenclature, classification, morphology and ultra-structure of viruses; Capsid and their arrangement; Cultivation of viruses using embryonated eggs, experimental animals and cell cultures (Cell-lines, cell strains and transgenic systems). Purification of viruses by adsorption, precipitation, enzymes, serological methods (haeme agglutination and ELISA). Assay of viruses (physical and chemical methods).

Unit V: Bacteriophages: Structure and life cycle patterns of T-even phages; One step growth curve; Bacteriophage typing; Structure of Cyanophages, Mycophages; General characters and structure of viroids, satellites and prions and major diseases caused by them.

Suggested Readings (Latest Editions):

Course 3, Code- AM 103: Microbial Diversity-Eukaryotes

Unit I: General characteristics of eukaryotic microbes; Ultrastructure and organization of a typical eukaryotic cell (membrane structure and functions, cytoskeleton, intracellular compartments---nucleus, mitochondria, chloroplast and their genetic organization); Structure and organization of chromatin; cell cycle; Classification of eukaryotic microbes; Evolutionary relationship of each group based on modern systems of classification.

Unit II: Current status of fungi and their classification including organisms belonging to Protozoa, Stramimipila (=Chromista) and Eumycota (true fungi), Thallus organization, asexual and sexual reproduction in Myxomycota, Oomycota, Zygomycota, Ascomycota and Basidiomycota.


Unit IV: General characteristics of algae; Classification of algae; Somatic structure, asexual and sexual reproduction of microbiologically important genera of Chlorophyceae, Phaeophyceae, Bacillariophyceae, Rhodophyceae and Dinophyceae. Algal nutrition, ecology and biotechnology; Economic importance of algae.

Unit V: General characteristics of Protozoans; and Nematodes; Difference between protozoans and nematodes; Structure and reproduction of microbiologically important genera of protozoans (Entamoeba, Giardia, Trichomonas, Leishmania, Trypanosoma, Plasmodium) and Nematodes: Ancylostoma, Ascaris lumbricoides, Necator; Cestodes: Taenia solium, Taenia saginata, Diphyllobothrium, Echinococcus granulosus and Trematodes: Paragonimus, Fasciola hepatica, Schistosoma; Difference between Protozoans and Nematodes.

Suggested Readings (Latest Editions):

Course 4, Code- AM 104: Biostatistics, Computer Applications and Bioinformatics

Unit I: Presentation of data; Frequency distributions; Graphical representation of data by histogram, polygon, frequency curves and pie diagram. Measures of central tendency: Mean, median and mode; Measures of dispersion: Mean deviation, standard deviation, variance, Standard error, coefficient of variation; Correlation and regression : properties, nature, coefficient of correlation, rank correlation, linear regression and regression equations and multiple linear regression, significance of correlation and regression.


Unit III: Testing of hypotheses: Some basic concepts, Errors in hypothesis testing; critical region; Students t-test for the significance of population mean and the difference between two population means; Paired t-test; Chi square test for population variance, goodness of fit and for the independence of two attributes in a contingency table; F-test for the equality of two population variance; Analysis of variance- One-way and two-way analysis of variance.

Unit IV: Introduction to Computers : Definition, Components of computer, Classification of Computers, Generation of Computers; Number system; Introduction to Software; Translators (Compiler & Interpreter); Basics for operating systems (MS-DOS, Windows, Unix and Linux); Introduction to MS Office (MS-Word, MS-Excel, MS-Power Point); Introduction to Networking, Internet (E-Mail, File Transfer Protocol, Usenet, Telnet).

Unit V: Introduction to Bioinformatics: Definition and scope; Search engines: tools for web search; Introduction to biological databases (NCBI, EBI, DDBJ, GenBank, PDB, NDB and MMDB), Introduction to BLAST and FASTA; Brief idea about important softwares for microbiological studies.

Suggested Readings (Latest Editions):


Course 5, Code- AM 105: Practical
Course 6, Code- AM 201: Microbial Physiology & Biochemistry

Unit I: Nutritional groups of microbes, nutritional uptake; transport across the membranes and cell wall (diffusion, passive diffusion, active transport, group translocation and iron uptake); Physiology of growth and kinetics, Growth curve, measurement of growth (biomass, turbidity, dry weight, protein content); environmental factors affecting microbial growth.

Unit II: Photosynthesis: Adsorption light, photosynthetic and accessory pigments, (chlorophyll, bacteriochlorophyll, carotenoides, phycobiliproteins); Oxygenic and non-oxygenic photosynthesis in prokaryotes, electron transport chain and phosphorylation; Calvin cycle; effect of light, temperature, pH, and CO₂ on the rate of photosynthesis; Photosynthetic yield and Photorespiration.

Unit III: Respiratory metabolism: Glycolytic pathway of carbohydrates breakdown, Embden Meyer Hoff pathway, Kreb's cycle, and Entner-Duodoroff pathway, Phospho-ketolase pathway; Pentose phosphate pathway; oxidative and substrate level phosphorylation; Gluconeogenesis, glyoxylate cycle, reverse TCA cycle; Fermentation of carbohydrates, homo and heterolactic fermentation.

Unit IV: Carbohydrates: Structure and properties of starch, cellulose, hemicellulose, glycogen and their derivatives; structure of lignin; General characters of fats, saturated and unsaturated fatty acids, biosynthesis of fatty acids, oxidation of fatty acids; distribution and functions of lipids in microbes.

Unit V: Classification, structure and properties of proteins, Structure of amino acids, Classification of essential amino acids based on polarity, protein sequencing, peptide synthesis; methods of protein purification. Classification and nomenclature of enzymes; mechanism of enzyme action, enzyme inhibition, allosteric enzymes, enzyme kinetics. Principles of Physical chemistry; Thermodynamic principles in biology; Energy rich bonds; Weak interactions; Bioenergetics.

Suggested Readings (Latest Editions):

Course 7, Code- AM 202: Microbial Genetics, Molecular Biology and Genetic Engineering

Unit I- Nucleic acids as genetic information carriers, DNA structure, types of DNA. DNA replication in prokaryotes & eukaryotes. Structural features of RNA (mRNA, tRNA, rRNA). Transcription in prokaryotes & eukaryotes.

Unit II- Regulation of gene expression. Basic features of the genetic code. Protein synthesis in prokaryotes and eukaryotes. Recombination: general principles. Plasmids (types of plasmids- F plasmids, R plasmids, Col plasmids & Ti plasmid). Gene transfer mechanisms: transformation, transduction, and conjugation.

Unit III- Mutations: spontaneous mutation, Induced mutagenesis- mutagens (physical mutagens: non ionizing & ionizing radiations; chemical mutagens: Base analogues, alkylating agents, deaminating agents, intercalating agents & others), molecular mechanism of mutagenesis. DNA repair mechanism: repair by direct reversal, excision repair, recombinational repair & SOS repair.


Unit V- Molecular Techniques; Principles, methods & their applications in medical diagnosis -such as PCR, Southern Blotting, Northern Blotting, RFLP, RAPD, Western Blotting, DNA finger printing and DNA sequencing. Microbial genetic & design of vaccines; for TB & leprosy. DNA vaccines design & advantages. Recombinant vaccines.

Suggested Readings (Latest Editions):

1. David P Clark (2010). Cell and Molecular Biology
5. J D Watson (2008), Molecular biology
Course 8, Code- AM 203: Agricultural Microbiology

**Unit I:** Microorganisms as biofertilizers: Biofertilizers and symbiotic associations: *Rhizobium, Azospirillum, Azotobacter, Cyanobacteria, Mycorrhiza and actinorrhiza* in plant nutrition and stress tolerance; Commercial production of biofertilizers with special reference to Indian market. Biological Nitrogen fixation, oxygen and hydrogen regulation of nitrogen fixation, nitrification, denitrification and ammonifying bacteria. Pathway of nitrate assimilation in photosynthetic and non-photosynthetic systems, transamination and deamination reactions.

**Unit II:** Disease forecasting and basic principles of plant disease control. Etiology, causal organism, disease cycle and control of economically important crop diseases of wheat (Tundu, Ruts and smuts), rice (BLB, BLS and false smut) barley (stripe, powdery mildew), maize (downy mildew), sugarcane (red stripe, raton stunting, grassy shoot), vegetables (downy mildew of crucifers and cucurbits, white rust of crucifers) and pulses (wilt of pigeon pea, Phytophthora blight of pigeon pea).

**Unit III:** Microorganisms as biopesticides: Microbiology of plant surfaces; Principles and mechanism of biological control; Biocontrol agents of pathogen insect pests and weeds. Commercial reality of biopesticides limitations for Indian agriculture; Integrated pest management.

**Unit IV:** Soil microbiology: Soil as a habitat for microorganisms; Soil enzymes, Soil water and microbial activity, Soil microorganisms and nutrient cycle. Soil fertility and management of agricultural soils; Microbiology of composting; Reclamation of barren lands using microbial technology; Microbiology of plant surfaces. Rhizoplane, phylloplane and rhizosphere microbes, their interaction with plants.

**Unit V:** Biodeterioration of agricultural produce; Mycotoxins; Diseases of food products during transit and storage and their management.

**Suggested readings (Latest edition)**

Course 9, Code- AM 204: Environmental Microbial Technology

Unit I: Microbial Ecology versus Environmental Microbiology; Historical perspectives; Major fields and modern Environmental Microbiology; Overall role of microbes in ecosystem. Aeromicrobiology and aquatic microbiology-Allergic disorders; Bioaerosols; Biowarfare agents; Air sampling of bioaerosols; Microbial growth patterns in aquatic environments.

Unit II: Soil microbiology: Microbial diversity in surface soils; Microbial decomposition of organic matters; Microbial successions within and above the soil; Biogeochemical cycles- C, N, S, P, Fe, Mn, Hg..

Unit III: Microbiomics and microbial interactions: Normal microbiota of human body and microflora of ruminants body; Microbes-Animals, Microbes-plant interactions; Phyllosphere, Rhizosphere, Endophytes, PGPM, Mycorrhiza.

Unit IV: Microbial degradation, deterioration and bioremediation; Biodegradation of xenobiotics including pesticides and military chemicals (explosives and gases); Biocorrosion of metals; Microbe–metal interactions (bioleaching, biomining, biohydrometallurgy); Enhanced petroleum recovery; Integrated microbial bioremediation including oil spills; Role of biosurfactants.

Unit V: Microbes and water potability- Purification of potable water; Sanitary analysis of water (indicator microbes and methods of their detection); Standards( tolerable levels) of water quality of faecal contamination. Microbes in solid waste and sewage management- Sanitary land fills and composting; Solid waste management in India; Methods of sewage management (composition of sewage, small scale and modern sewage treatment methods – oxidation ponds, trickling filters, biodisc system); Measurement of water quality after sewage removal.

Suggested Readings (Latest Editions):


Course 10, Code- AM 205: Practical
Course 11, Code- AM 301: Medical Microbiology

Unit I: Classification of medically important bacteria; Normal flora of human body, role of the resident flora; collection of clinical samples and laboratory diagnosis of important bacterial infections, pathogenic microorganisms. Brief account of major air, water and soil borne diseases of microbial origin and their prevention and control measures.

Unit II: Bacteriology: Important human diseases caused by *Staphylococcus; Streptococcus; Neisseria; Bacillus; Corynebacterium; Clostridium*; Organisms belonging to Enterobacteriaceae (*Escherichia coli, Klebsiella, Salmonella, Shigella and Proteus*); *Pseudomonas; Haemophilus; Mycobacterium*; Antibacterial drugs and susceptibility test; Bacterial vaccines. Mechanism of drug resistance in pathogenic bacteria and fungi.

Unit III: Virology: Collection of clinical samples and laboratory diagnosis of important viral diseases; Mumps; Measles; Influenza; Adenovirus; Enterovirus; Rhinovirus; Poxvirus; Hepatitis; Herpesvirus; AIDS; Antiviral drugs; Viral vaccines; Interferons; Tumor viruses; antiviral agents and susceptibility test.

Unit IV: Mycology: Classification of medically relevant fungi: Collection of clinical sample and laboratory diagnosis of important human fungal diseases: Phycymycosis; Candidiasis; Dermatophytosis; Aspergillosis; Otomyocosis; Cutaneous and subcutaneous mycoses; Systemic mycoses; Oppurtunistic mycoses; Antifungal agents and susceptibility test.

Unit V: Parasitology: Important diseases caused by intestinal and urogenital protozoa: *Entamoeba; Giardia; Trichomonas*; Blood and tissue protozoa; *Plasmodium; Trypanosoma; Leishmania*; Cestodes: *Taenia*; Trematodes: *Schistosoma; Paragonimus*; Nematodes: Ascaris; Ancylostoma; Necator; their laboratory diagnosis, treatment and prevention; antiparasitic agents and susceptibility test.

Suggested Readings (Latest Editions):

Course 12, Code Course AM 302: Molecular Immunology


Unit III: Vaccines immunizations: types of vaccines (DNA vaccines, recombinant DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines) & their characteristics. Immunization of test animals, hyperimmune antisera; Prophylactic immunization; Immune Disorders: hypersensitivities, autoimmune diseases, transplantation (tissue) rejection, immunodeficiency’s.

Unit IV: Complement: Classical alternative and lectin pathway of complement activation, regulation of complement system, biological consequence of complement activation. Cytokines: interferons (α, β & γ), TNF, interleukins (1-16), hematopoietins & chemokines. Regulation of immune response.


Suggested Readings (Latest Editions):

Course 13, Code - AM 303: Food and Dairy Microbiology

Unit I: Important microbes involved in spoilage of food, meat, poultry, vegetables and dairy products; food preservation. Microbial deterioration of cereals, pulses, fish and sea-foods during storage; Common food borne pathogens, diseases caused by them and their symptoms, food borne illness, prevention and complication of food borne diseases outbreaks, epidemiology

Unit II: Bacterial and mycotoxins, Important microbes secreting toxins, chemical nature of important toxins; their role in food poisoning; physiology and mechanism of action, modification and detoxification; prevention and control of toxin contamination.

Unit III- Microbial biomass: Single cell proteins and myco-protein; Use of microbial enzymes in food; Food quality monitoring, Fermented foods and traditional fungal foods (shoya, miso, tempe etc.). Fermented vegetable, meat and milk products (cheeses, butter and yoghurt).

Unit IV- Use of microbial enzymes in food; low calorie sweeteners, Flavour modifiers; Food additives; Food quality monitoring, biosensors and immune-assays, Indian fermented foods.

Unit V- Role of microbes in milk and dairy products, Microbiological examination of milk, standard plate count, direct microscopic count and reductase test, composition of milk, sources of contamination of milk, types of microbes in milk, pasteurization of milk, ability of milk to cause disease; Manufacture of cheeses, butter, yoghurt and fermented milk.

Suggested Readings (Latest Editions):

Course 14, Code AM 304: Industrial Microbiology

Unit I (a) : Sources and characters of industrial microbes, their isolation, purification & maintenance. Screening of useful strains: primary screening & secondary screening. Strain improvement through random mutation (random & rational selection), genetic recombination & genetic engineering.


Unit II: Microbial transformations with special reference to steroids & alkaloids. Primary & secondary metabolites. Commercial production of antibiotics with special reference to penicillin, streptomycin and their derivatives.

Unit III : Microbiology & production of alcoholic beverages: malt beverages, distilled beverages, wine & champagne. Commercial production of organic acids like acetic, lactic, citric, & gluconic acids. Commercial production of important amino acids (glutamic acid, lysine & tryptophan), insulin & vitamins(vitamin B_{12}, riboflavin & vitamin A).

Unit IV: Immobilization of microbial enzymes and whole cells and their applications in industries. Food fermentations: bread, vinegar, fermented vegetables, fermented dairy products & their spoilage. Bioprocess Engineering: Downstream processing, various steps for large scale protein purification. Single cell proteins, Physiological aspects, SCP from waste materials and renewable resources.


Suggested Readings (Latest Editions):


Course 15, Code- AM 305: Practical
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<th>Course Code</th>
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<tr>
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The candidate will opt any of the above mentioned four specializations which will be based on his/her project/thesis coupled with a written examination based on short questions including objective type to test his thorough knowledge in the field of specialization opted by him/her.