# ORDINANCES FOR

# 2- Year Post-graduate Course

# M.Sc. Applied Microbiology
# (Under Self Finance Scheme)

# From the session 2021-22


## 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 months 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

| S.No. | Course no. | Name of the course | Internal (M.M.) | External (M.M.) |
|---|---|---|---|---|
| | | **FIRST SEMESTER** | | |
| 1 | AM 101 | Instrumentation and Microbial Techniques | 50 | 50 |
| 2 | AM 102 | Microbial Diversity- Prokaryotes and Viruses | 50 | 50 |
| 3 | AM 103 | Microbial Diversity- Eukaryotes | 50 | 50 |
| 4 | AM 104 | Biostatistics, Computer Applications and Bioinformatics | 50 | 50 |
| 5 | AM 105 | **Practical** | | 100 |
| | | **SECOND SEMESTER** | | |
| 6 | AM 201 | Microbial Physiology and Biochemistry | 50 | 50 |
| 7 | AM 202 | Microbial Genetics, Molecular Biology and Genetic Engineering | 50 | 50 |
| 8 | AM 203 | Agricultural Microbiology | 50 | 50 |
| 9 | AM 204 | Microbial Environmental Technology | 50 | 50 |
| 10 | AM 205 | **Practical** | | 100 |
| | | **THIRD SEMESTER** | | |
| 11 | AM 301 | Medical Microbiology | 50 | 50 |
| 12 | AM 302 | Molecular and Clinical Microbiology | 50 | 50 |
| 13 | AM 303 | Food and Dairy Microbiology | 50 | 50 |
| 14 | AM 304 | Industrial Microbiology | 50 | 50 |
| 15 | AM 305 | **Practical** | | 100 |
| | | **FOURTH SEMESTER** | | |
| 16 | AM 401 | Project Report including Viva-voce | 400 | |
| 17<br>18<br>19<br>20 | AM 402<br>AM 403<br>AM 404<br>AM 405 | Medical Microbiology<br>Industrial Microbiology<br>Agricultural Microbiology<br>Environmental Microbiology | Any one of 4 | 100 |
| | | **Total Marks** | **2000** | |

# Course 1, Code- AM 101: Instrumentation and Microbial Techniques

**Unit I:** Microscopy and 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, quaternary ammonium compounds, aldehydes and sterilizing gases; evaluation of antimicrobial agent effectiveness (evaluation of efficacy of disinfectants, determination of phenol coefficient), 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. maintenance of anaerobic bacteria, and accessing non-culturable bacteria.

**Unit IV:** Basic principles and applications of spectrophotometry and 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, HPTLC 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; Ultracentifugation; Dialysis, Ultrafiltration; Lyophilization.

## Suggested Readings (Latest Editions):


1. Nelson D and Cox MM. (2010). Lehninger's Principles of Biochemistry. W.H. Freeman and Company, New York.
2. Wilson K. and Walker J. (2013). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.
3. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hill.
4. Upadhyaya and Nath (2015) Biophysical chemistry, Himalaya pub. House.
5. T.A.Brown (2016). Gene cloning and DNA analysis, an introduction,Wiley Blackwell pub.
6. B.D.Singh (2015). Biotechnology, Kalyani publication.

## Practical based on the course Instrumentation and Microbial Techniques

1. To study the various equipments and apparatus used in microbiology.
2. To prepare and sterilize various culture media used in experimental microbiology.
3. Preparation of Basic Liquid Medium (Broth), Solid medium (Agar)
4. To prepare and sterilize nutrient agar, slants, stabs, deep tubes and Petri plates.
5. Techniques of pure culture isolation-pour plate, spread plate, streak plate.
6. Isolation of Microbial colony from soil, water, air and milk.
7. To determine total viable cells in a bacterial culture by plate count method or serial dilution method.
8. To study the bacterial morphology by simple (monochrome) staining.
9. To study the bacterial morphology by negative staining.
10. To study the bacterial morphology by Gram's staining.
11. To study the bacterial morphology by acid fast or Ziehl-Neelsen staining method.
12. To carry out thin layer chromatography (mixture of amino acids).
13. Isolation of plasmid DNA from *E. coli*.
14. Electrophoresis of isolated DNA sample.
15. TLC separation of amino acids.

# 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 II:** Principles of classification of microbes: Morphological, metabolic and molecular criteria for the classification, a brief introduction to major group of bacteria. Molecular and recent approaches to bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Salient features of Bergey's Manual of Systematic bacteriology. General characteristics including Ultra-structure of Bacteria, Archaea and Cyanobacteria.

**Unit III:** Extreme environments and extremophiles; Microbial diversity in different ecosystems (thermophiles, halophiles, mesophiles, thermophiles, acidophiles, alkalophiles, barophiles and other extremophiles) and their biotechnological applications. A brief account of genetic recombination in bacteria (transformation, conjugation and transduction).

**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):**


1. Bergey's manual systematic Bacteriology(2011) 2nd edition
2. Prakash S. Bisen (2012). Microbes-concepts and applications, Wiley-Blackwell.
3. J.D.S.Panwar (2012)-Fundamentals of Microbilogy-S.R.S Pub
4. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hil
5. Bisen, P.S. (2014). Microbes in Practices, I K international publication house pvt Ltd.
6. Sharma P.D. (2015-16). Microbilogy, 3rd edn, Rastogi publications
7. J.G.Black(2015) –Microbiology, 9th edition, Wiley publication

## Practical Based on the course Microbial Diversity- Prokaryotes and Viruses

1. Preparation of various models based on History of Microbiology.
2. Determination of growth of bacteria by spectrophotometrically.
3. Demonstration of pour plate, spread plate and streak plate methods.
4. Preparation of bacterial growth curve.
5. Isolation and characterization of thermophiles.
6. Isolation and characterization of psychrophiles.
7. Isolation and characterization of osmophiles.
8. Isolation and characterization of acidophiles.
9. Isolation and characterization of alkalophiles.
10. Isolation and characterization of halophiles.
11. Isolation and characterization of cyanobacteria.
12. Demonstration of bacteriophage typing.
13. Preparation of various models based on structure of viruses.
14. Study of virus infected plant material.

# 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 III:** Heterothallism; sex hormones in fungi; physiological specialization and phylogeny of fungi. Parasexual life cycle; Economic importance of fungi. Lichen and their symbiotic relationship. Economic importance of lichens.

**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):**


1. Chatterjee K.D. (2015). Parasitology, Calcutta publication.
2. David Greenwood (2015). Medical Microbiology, 18th edition.
3. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hill.
4. J.G. Black(2015) –Microbiology, 9th edition, Wiley publication
5. Lee. R. E. (Latest Edition). Phycology, Cambridge University Press, Cambridge.
6. Talaro K.P. & Talaro A. (Latest Edition). Foundations in Microbiology (6th Ed.), McGraw-Hill College Dimensi.
7. Sharma, P.D. (2016). Mycology and Phyotopathology, Rastogi Publications, Meerut

## Practical Based on the course Microbial Diversity- Eukaryotes

1. Preparation of moist chamber for fungal isolation.
2. Isolation of fungi from soil.
3. Isolation of fungi from rhizospehere.
4. Isolation of fungi from different food sources.
5. To isolate fungi present in soil samples and calculate their relative abundance and frequency of occurrence
6. To study the fungal morphology by lactophenol cotton blue staining.
7. To study the fungal morphology by potassium hydroxide mounting.
8. Preparation of permanent fungal mounts.
9. Collection of different types of lichens.
10. Study of dimorphism in yeast.
11. Demonstration of permanent slides of mitosis and meosis.
12. Demonstration of permanent slides of *Entamoeba, Giardia, Trichomonas, Leishmania, Trypanosoma,* and *Plasmodium*.
13. Isolation of various algae from different habitats.

# 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 II:** Probability: Basic concepts related to probability theory, classical probability. Probability Distributions: Introduction and simple properties of Binomial, Poisson and Normal Distributions and their applications in biology. Sampling: Concept of sampling and sampling techniques.

**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 and 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):**


1.Bailey, NT J (2000). Statistical Methods in Biology. English Univ. Press.
2.Campbell R.C (Latest Edition). Statistics for Biologist. Cambridge University Press, UK.
3.Sinha PK (Latest Edition). Fundamentals of computers. BPB Publication, New Delhi
4.Jonathan, P. 2008. Bioinformatics & Functional Genomics.
5. B.D.Singh(2015). Biotechnology, Kalyani Publication.
6. Sharma and Munjal(2015). A test book of Bioinformatics, Rastogi publication.

## Practical Based on course Biostatistics, Computer Applications and Bioinformatics

1. Representation of statistical data by
    1. Histogram
    2. Curves
    3. Pie diagrams
2. Determination of averages or Central tendencies (Mean, Mode, Median)
3. Determination of measures of dispersion (Mean deviation, Standard deviation and Coefficient of variation, Quartile deviation)
4. Application of Tests of significance (Chi-Square test, student t-test, Standard error)
5. Applications of computers in biology using MS-office (MS-Word, Excel, Power point)
6. Introduction to LAN Networking
7. Introduction to Internet (E-Mail, File Transfer Protocol, Usenet, Telnet).
8. Introduction to different primary and secondary databases.
9. To access scientific data from Literature data bases (PUBMED, LITDB, Medline)
10. To access nucleic acid databases for retrieval of gene sequence.
11. To access protein databases for retrieval of amino acid sequence of target protein.
12. To perform multiple sequence alignment using BLAST.

# Course 5, Code- AM 105: Practical based on the above courses

# Course 6, Code- AM 201: Microbial Physiology and 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, phycobilliproteins); Oxygenic and non-oxygenic photosynthesis in prokaryotes, electron transport chain and phosphorylation; Calvin cycle; effect of light, temperature, pH, and $CO_2$ 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):**


1. Nelson D and Cox MM. (2010). Lehninger's Principles of Biochemistry. W.H. Freeman and Company, New York.
2. Voet D and Voet JG. (2013). Principle's of Biochemistry. John Wiley and sons New York.
3. Moat AG and Foster J W (Latest Edition). Microbial Physiology. John Wiley and Sons, New York.
4. Stryer. L (2003). Biochemistry. W. H. Freeman and Co.
5. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hil
6. J.L. Jain(2015).Fundamentals of Biochemistry, S. Chand and Co.
7. U. Satyanarayan(2015). Biochemistry, Elsevier

# Practical based on course Microbial Physiology and Biochemistry

1. To carry out qualitative analysis of Carbohydrates
2. To carry out qualitative analysis of Lipids
3. To carry out qualitative analysis of amino acids
4. To carry out qualitative analysis of Proteins
5. To perform biochemical test of starch hydrolysis.
6. To perform biochemical test of casein hydrolysis.
7. To carry out estimation of DNA by Diphenylamine method
8. To carry out estimation of RNA by Orcinol method
9. To carry out estimation of protein by Biuret method.
10. To carry out separation of amino acid by Paper Chromatography and determination of Rf value TLC of fatty acids/lipids
11. To detect presence of reducing sugar using Benedict's test.
12. Determination of absorption maxima of given sample using spectrophotometer.
13. To demonstrate carbohydrate metabolism (oxidation and fermentation of Glucose) in microorganisms
14. To demonstrate Fat hydrolysis (lipase activity) by bacteria
15. To study ability of microorganisms to hydrolyze gelatin
16. To demonstrate degradation of sulphur containing amino acids by bacteria

# 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 and eukaryotes. Structural features of RNA (mRNA, tRNA, rRNA). Transcription in prokaryotes and 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 and Ti plasmid). Gene transfer mechanisms: transformation, transduction, and conjugation.

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

**Unit IV**- Basic steps of r-DNA technology. Restriction endonucleases. Cloning vectors: general properties, plasmids, bacteriophages, cosmids, shuttle vectors, bacterial artificial chromosomes. Eukaryotic cloning vectors for yeast, and animal cells. Gene libraries: genomic library (Shot gun approach), c DNA library (Different methods for synthesizing c DNA molecules).

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

**Suggested Readings (Latest Editions):**


1. David P Clark (2010). Cell and Molecular Biolgy
2. Robert J. Brooker (2011). Genetics, Analysis and principles, Mc Graw Hill.
3. J.E. Krebs (2011). Lewin's Genes X, Jones Pub.
4. T.A.Brown (2010). Gene cloning of DNA Analysis. Wiley Blackwell.
5. J D Watson (2008), Molecular biology
6. Jeff Hardin, Gregory Bertoni, Lewis J. Kleinsmith (2012). Becker's Word of the cell.
7. William. D Stans Field (2012). Molecular and cell Biolgy, Mc Graw Hill pub.
8. Gerald Karp (2014). Cell Biology, Wiley Blackwell, Pub.

## Practical based on course Microbial Genetics, Molecular Biology and Genetic Engineering

1. Isolation of plasmid DNA from *E. coli*.
2. Determination of Tm of DNA and RNA.
3. Electrophoresis of isolated DNA sample.
4. Isolation of bacteria from various samples by enrichment techniques and their identification by conventional biochemical and molecular methods.
5. Restriction digestion analysis by agarose gel electrophoresis.
6. Restriction digestion analysis by polyacrylamide gel electrophoresis.
7. Isolation of plasmid from mix cultures.
8. Isolation of genomic DNA.
9. Amplification of DNA by PCR
10. RAPD analysis
11. RFLP analysis
12. Separation and analysis of proteins by SDS-PAGE

# Course 8, Code- AM 203: Agricultural Microbiology

**Unit I:** 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 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, Rusts and smuts), rice (BLB, BLS and false smut) barley (stripe, powdery mildew), maize (downy mildew), sugarcane (red stripe, ratoon 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: 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:** Microorganisms as biofertilizers: Biofertilizers and symbiotic associations: *Rhizobium*, ***Bradyrhizobium,*** *Azospirillum*, ***Frankia,*** *Azotobacter*, Mycorrhiza and actinorrhiza in plant nutrition and stress tolerance; Commercial production of biofertilizers. Biological Nitrogen fixation (mechanism), nitrification, denitrification, ammonification, transamination and deamination reactions. Plant growth promoting rhizobacteria; (PGPR), BGA, SRB and PSB.

**Unit V:** Biodeterioration of agricultural produce; Mycotoxins; Diseases of food products during transmit and storage and their management. Microbes in agriculture waste management.

**Suggested readings (Latest edition)**


1. Sharma, P.D. (2016). Plant Pathology, Rastogi publications
2. Rao, N.S.S. (2015). Soil Microbiology. Oxford & IBH Publishing Co., New Delhi.
3. Jeffery C. Pommerville (2014). Alcamo's Fundamental Microbiology, Jones pub.
4. Ghulam Hassan Dar (2010).Soil Microbiology and Biochemistry
5. Agrios G. N. 2005. Plant Pathology. 5th Edition, Academic Press, San Diego.
6. Christon J. H. 2001. A Manual of Environmental Microbiology. ASM Publications.
7. Forster C. F. & John DA 2000. Environmental Biotechnology. Ellis Horwood Ltd. Publication.

# Practical based on course Agricultural Microbiology

1. To study the effect of moisture content and organic matter on microbial activity, by estimating hydrolysis of FDA
2. To determine microbial activity in the soil by measuring $CO_2$ evolution, and to study the effect of moisture content and organic matter on microbial activity
3. To determine the following enzyme activities in the soil sample: Amylase, Cellulase, Xylanase, Protease, and Phosphatase
4. Laboratory methods for studying soil-borne diseases

   a. Isolation of soil-borne pathogens from plant tissue and soil.

   b. Physical extraction of pathogens from soil.

   c. Molecular methods for detection and identification of pathogens in plants and soil. By monoclonal antibody based tests and PCR.

   d. Quantification of population of pathogens in soil and estimation of inoculum potential by MPN and dilution end point methods.

   e. Chemical control of soil-borne pathogens using Acylanilide and Alkyl phosphonates.
5. Isolation of pathogen from vegetables and fruits.
6. Biochemical and physiological tests for detection of pathogens in fruits and vegetables, e.g; Arginine hydrolysis for Pseudomonas.
7. To determine biological control activity of microbes against plant pathogens.
8. To demonstrate different processes of composting.
9. To study the microflora of rhizosphere and phyllosphere.
10. To study the different plant microbe interactions.

# 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. Aero-microbiology; Allergic disorders; Bioaerosols; Biowarfare agents; Air sampling of bioaerosols; microbial indicators for air pollution.

**Unit II:** Soil microorganisms and their significance in soil quality management. Microbial successions within and above the soil; biogeochemical cycles- C, N, S, P, Fe, Mn, Hg. Factors affecting microbial community in soil. Microbiomics and microbial interactions: Microflora of ruminants; Microbe-microbe interactions (Symbiosis, mutualism, commensalism, amensalism, competition, antibiosis)

**Unit III:** Microbes and heavy metal tolerance; Biocorrosion of metals; Microbe metal interactions (bioleaching, biomining, biohydrometallurgy); Containment of acid mine drainage applying biomining, abatement of heavy metal pollution, degradation of pesticides. Biosorption.

**Unit IV:** Microbial degradation, deterioration and bioremediation; Biodegradation of xenobiotics (biomagnifications) including pesticides and military chemicals (explosives and gases); Enhanced petroleum recovery; Integrated microbial bioremediation including oil spills; Role of biosurfactants. Role of microorganisms in organic matter decomposition (cellulose, hemi cellulose, lignin).

**Unit V:** Microbes and water potability- Microbial growth patterns in aquatic environments. Purification of potable water; Sanitary analysis of water (indicator microbes and methods of their detection); Standards (tolerable levels) of water quality of fecal contamination. Microbes in solid waste and sewage management; Sanitary landfills and composting; 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):**


1. Sharma, P.D. (2016). Environmental Microbiology, Rastogi Publications.
2. Prakash S. Bisen (2014). Microbes in practice-I K international publication house pvt ltd.
3. Prakash S. Bisen (2012). Microbes-concepts and applications Willey BlackWell Pub.
4. Pepper IL, Gerba CP and Brusseau ML (2006). Environmental and Pollution Science. Academic Press. USA
5. Forster CF and John DA (2000). Environmental Biotechnology. Ellis Horwood Ltd. Publication.
6. Christon JH (Latest Edition). A Manual of Environment al Microbiology. ASM Publications.
7. Maier RM, Pepper IL and Gerba CP (2000). Environmental Microbiology. Academic Press. USA
8. Michel R (Latest Edition). Introduction of Environmental Microbiology.

## Practical Based on course Microbial Environmental Technology

1. To measure the D.O. of the given water samples.
2. To measure the BOD of the given water samples.
3. To measure the COD of the given water samples.
4. To determine the effect of temperature on microbial growth.
5. To determine the effect of pH on microbial growth.
6. To determine the effect of oxygen on microbial growth.
7. To study the production of lignocellulolytic enzymes (cellulases, hemicellulases and lignin degrading enzymes such as Lip, Mnp and Laccase.
8. To study the fungal degradation of lignocellulosic biomass (Crop byproducts).
9. To study the use of cellulases in saacharification of cellulosic material.
10. To study the microbiological quality of water samples from different sources.
11. To study the decolorization of distillery or textile industrial waste.
12. Determination of potability of water by MPN method.

## Course 10, Code- AM 205: Practical based on the above courses

# Course 11, Code- AM 301: Medical Microbiology

**Unit I:** Classification of medically important bacteria; Normal microflora 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: Phycomycosis; Candidiasis; Dermatophytosis; Aspergillosis; Otomycosis; Cutaneous and subcutaneous mycoses; Systemic mycoses; Opportunistic 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; anti-parasitic agents and susceptibility test.

**Suggested Readings (Latest Editions):**


1. Kenneth. J. Ryan (2010) Sheris's Medical Microbiology,Mc Graw Hill.
2. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hill.
3. Greenwood D (2015). Medical Microbiology, 18th Edition, Elsvier.
4. Murray PR, Pfaller MA, Tenover FC and Yolken RH (2007). Clinical Microbiology. ASM Press.
5. K.D Chattergy (2015). Parasitology, CBS Pub.
6. Harvey, R.A., Champe, P.C. and Fisher, B.D. (Latest Edition). Lippincott's Illustrated Reviews: Microbiology. Lippincott Williams and Wilkins, New Delhi/New York.

# Practical Based on course Medical Microbiology

1. To prepare various basic, selective, enrichment and enriched media used for isolation of medically important bacteria from clinical samples.
2. To perform various biochemical tests (IMVIC, oxidase, catalase, urea utilization test, sugar utilization and $H_2S$ production on TSI agar slant) used for identification of medically important bacteria.
3. To perform sugar fermentation tests for identification of medically important bacteria.
4. Demonstration normal microbial flora of skin, mouth and throat.
5. Isolation and identification of Staphylococcal species using suitable media, staining techniques and biochemical tests.
6. Isolation and identification of Streptococcal species using suitable media, staining techniques and biochemical tests.
7. Isolation and identification of enteric fever causing bacteria (*Salmonella typhi*) using suitable media and biochemical tests.
8. Microbiological analysis of urine specimens.
9. Microbiological analysis of stool specimens.
10. Microbiological analysis of blood specimens.
11. Microbiological analysis of sputum specimens
12. To determine antibiotic sensitivity for Gram negative and Gram positive bacteria by disc diffusion method
13. To determine Minimal Inhibitory Concentration (MIC) and Minimal Bactericidal concentration of an antibiotic for test bacteria.
14. To evaluate antimicrobial chemical agents by log reduction method.

# Course 12, Code Course AM 302: Molecular Immunology

**Unit I:** Introduction to the immune system: Innate immunity; anatomic, physiological, phagocytic and inflammatory barriers. Adaptive immunity; natural and artificial immunity. Cells involved in immune response: lymphoid lineage (producing B and T lymphocytes) and Myeloid lineage (phagocytes: macrophages, neutrophils and eosinophils and auxillary cells; basophils, mast cells and platelets). Organs involved in immune system: primary and secondary lymphoid organs.

**Unit II:** Antigens: preparation of antigens, types of antigens- haptens, superantigens and cluster of differentiation molecules (CDs), Processing and presentation of antigens. Immunoglobulins: structure and types of immunoglobulins, genetic diversity of immunoglobulins, catalytic antibodies. B-cell biology and T-cell biology (major histocompatibility complex (MHC) molecules). HLA and H-2 systems.

**Unit III:** Vaccines immunizations: types of vaccines (DNA vaccines, recombinant DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines) and 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 and γ), TNF, interleukins (1-16), hematopoietins and chemokines, Regulation of immune response.

**Unit V:** Monoclonal antibodies: hybridoma technology, applications of monoclonal antibodies. Antigen-Antibody reactions in vitro: agglutination reactions (Widal, Haemagglutination), precipitation reactions (Immunodiffusion, Immuno electrophoretic method), Immunoblotting, ELISA, RIA, fluorescence immunosorbent assay, immuno-electronmicroscopy.

**Suggested Readings (Latest Editions):**


1. Riott I M ( 2003). Essentials of Immunology. Blackwell Scientific Publishers, London.
2. Claus D (2005). Immunology- Understanding of Immune System. Wiley - Liss, New York.
3. William P (Latest Edition). Fundamentals of Immunology.
4. Abbas (2004). Cellular and Molecular Immunology.
5. Benjamin (2004). Immunology- A short Course.
6. Tizard Ian R (2009). Immunology. An introduction, 4th Edition.
7. Kindt, Goldsby and d Osborne (2013). Kuby Immunology. MacMillan Higher Education.

# Practical Based on course Molecular Immunology

1. Preparation of different models based on immunology.
2. Slide agglutination test.
3. Tube agglutination test / Passive agglutination.
4. To prepare soluble antigen by different methods.
5. To seperate serum and plasma from blood.
6. To precipitate immune-globulins by ammonium sulphate and to determine total protein contents.
7. To determine Blood group and Rh factor by slide agglutination test
8. To perform Ouchterlony double diffusion test for detection of antigen and antibody reaction and to demonstrate relationship between antigens.
9. To perform Radial immuno-diffusion test for detection of antigen and antibody reaction and for quantification of antigens.
10. To perform immune-electrophoresis for separation of antigens and for detection of antigen and antibody reaction
11. To perform ELISA for assay of antibodies in serum sample against given antigen.
12. Demonstration of Widal test.
13. Demonstration of haem-agglutination test.

# 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, HACCP, Indices of food sanitary quality and sanitizers, Cultural and rapid detection methods of food borne pathogens in foods and introduction to predictive microbiology.

**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), Bacteriocins.

**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. Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.

**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):**


1. Butt, TM, Jackson CW and Magan N (2004). Fungi as Biocontrol agent. CABI Publishing, UK.
2. Adams (2004). Food Microbiology.
3. Prajapati (2007). Fundamentals of Dairy Microbiology.
4. John C, Ayres OM, William ES (2004). Microbiology of Foods. W. H. Freeman and Co.
5. Robinson (Latest Edition). Dairy Microbiology.
6. Jay JM (2000). Modern Food Microbiology. Van Nostraaand Reinhold Co., New York.
7. Andrew Proctor (2011). Alternatives to conventional food processing, RSC pub.
8. Frazer WC and Westhoff DC (2014). Food Microbiology. Mcgraw Hill, New York.
9. B.D. Singh (2015). Biotechnology, Kalyani Publication
10. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.

# Practical based on course Food and Dairy Microbiology

1. Microbiological examination of foods.
2. Bacterial counts of food samples.
3. Quantitative analysis of milk by standard plate count method.
4. Isolation and counting of faecal bacteria in water.
5. Test of quality of milk by methylene blue reduction test.
6. Isolation of lactobacillus from curd.
7. Isolation of bacteria and fungi from spoiled food.
8. Microbial populations in fruit juices, soft drinks and ice cream.
9. Isolation of lipolytic organisms from butter.
10. Detect the presence of antibiotic in milk samples.
11. Production of sauerkraut by microbial fermentations.
12. To prepare yoghurt in laboratory.
13. Production of citric acid from whey.
14. Production of single cell protein.

# Course 14, Code AM 304: Industrial Microbiology

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

**Unit I (b):** Fermentation technology: microbial growth kinetics in batch, continuous and fed-batch fermentation process**.** Stirred aerobic bioreactor: principles and designing. Airlift, Fluidized Bed, Packed Bed, Photobioreactor, and Membrane bioreactor. Raw materials used in fermentation media. Solid state fermentation and submerged fermentation: their advantages and disadvantages.

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

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

**Unit V:** Industrial enzymes production: Cellulases, Xylanases, Proteases, Amylases, Lipases and Pectinases and their applications. Bioconversion of waste for fuels (ethanol and methane). Mushroom cultivation. Petroleum microbiology. Patent protection for biological inventions.

**Suggested Readings (Latest Editions):**


1. Reed G (2004). Industrial Microbiology. CBS Publishers (AVI Publishing Co.)
2. Stanbury PF, Whitekar A. and Hall (2006). Principles of Fermentation Technology. Pergaman. McNeul and Harvey.
3. Creuger and Creuger (2005). Biotechnology- A textbook of Industrial Microbiology, Panima pub.
4. Casida LE (2010). Industrial Microbiology, Wiley Eastern.
5. Atlas RM (Latest Edition). Petroleum Microbiology. Macmillan Publishing Co.
6. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hil
7. B.D. Singh (2015). Biotechnology, Kalyani Publication

## Practical Based on course Industrial Microbiology

1. To demonstrate strain improvement of industrially important bacteria or yeast by mutagenesis and selection of improved strains.
2. Introduction of fermenter (Assembly and dismantling).
3. Production of alcohols in shake flask cultures at laboratory scale.
4. Production of citric acid in shake flask cultures at laboratory scale.
5. To study the effect of salt concentration, metal and dyes on microbial growth.
6. Isolation of amylase producing microorganisms from Soil and their detection
7. To isolate antibiotic producing microorganisms form soil.
8. To isolate Penicillium species producing penicillin and to evaluate its activity.
9. Demonstration of SSF techniques.
10. Production of wine from grapes.
11. Production of bio-ethanol from agricultural waste.
12. To study mushroom production.
13. Production and application of various enzymes.

## Course 15, Code- AM 305: Practical based on the above courses

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| **AM 401: Project Report including Viva-voce** | **400 marks** |
| **AM 402: Medical Microbiology (specialization)** | **100 marks** |
| **AM 403: Industrial Microbiology (specialization)** | |
| **AM 404: Agricultural Microbiology (specialization)** | |
| **AM 405: Environmental Microbiology (specialization)** | |

**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.**