DEPARTMENT OF MICROBIOLOGY
CH. CHARAN SINGH UNIVERSITY, MEERUT
Program: M.Sc.
Program Code: AM
Program (Specific): M.Sc. Applied Microbiology
Year of Implementation: 2021-2022

Program Outcomes

After successful completion of M.Sc. Applied Microbiology program, the students would be able

PO1: To get opportunities in higher education. They are also developed on the professional front. It also provides opportunities for career advancement in teaching, research, and industries

PO2: To integrate interdisciplinary thinking and practice.

PO3: To analyse a problem, identify and define the specific requirements with respect to the specific organism, appropriate to its management, and plan strategies for their solution

PO4: To design, implement and evaluate information systems, processes, components, or programs and source cost-benefit efficient alternatives to meet desired needs, goals, and constraints

PO5: To deploy and use effective skills, tools, and techniques required for an industry/ organization or institute

P06: To live a life inculcated with higher values which enable them to withstand the challenges of life.

Program Specific Outcomes

PSO1. After successful completion of M.Sc. Applied Microbiology, students will gather substantive knowledge to pursue his/her career in areas of Biochemistry, Medical Microbiology, Environmental and Food Sciences, Molecular Biology and Biotechnology.

PSO2. Develop an exploratory mind-set along with problem-solving and analytical skills, to enable a smooth progress into the area of research and teaching.

PSO3. Accumulate skills such as critical scientific thinking needed for data analysis. The comprehensive curriculum grooms the students into industrially efficient scientific manpower.

PSO3. It makes them able to take up challenges and contribute in to the development of the world.

PSO4. It makes them equipped with knowledge to clear lectureship and fellowship exams like UGC/ CSIR – NET, SET/ ISRO/DRDO and other competitive exams

PSO5. It provides students the insight of planning and conducts complex research projects, such as improving sterilization procedures or developing new drugs to combat infectious diseases

Courses/ Papers and their Outcomes (COs)

Semester	Course Code	Course Title	Course Outcome
I	AM 101	Instrumentation and Microbial Techniques	After completion of this course, the student will be able to **CO1.** Learn the concept of sterile techniques for isolation of microbes in pure culture, and understand the principles of optical microscopy including generation of contrast. **CO2.** Gain knowledge about the instrumentation, working principle and applications of varied forms of spectroscopy needed to study bio-molecules and crystal structures. **CO3.** Understand chromatographic techniques for separation of bio-molecules. **CO4.** Understand the working principle behind electrophoresis, and study of antigen-antibody interactions, including applications for the identification of microbes. **CO5.** Learn centrifugation techniques, and forms of electron microscopy for the purification and characterization of microorganisms.
	AM 102	Microbial Diversity-Prokaryotes and Viruses	**CO1.** Know about bacterial and archaeal diversity in a morphological and phylogenetic context. **CO2.** Understand the modern methodology and principles of classification of bacteria and archaea. **CO3.** Learn the process of genetic recombination in bacteria (transformation, conjugation and transduction). **CO4.** Know how to classify and compare the morphological and genomic characteristics of viruses. **CO5.** Understand the working principle of cultivation and purification of viruses.
	AM 103	Microbial Diversity-Eukaryotes	**CO1.** Learn the diversity of fungi and algae along with their comparative structure and classification. **CO2.** Learn the detail structure of eukaryotic cell. **CO3.** Learn about the pathogenic aspects of the various groups of microorganisms, their disease cycles and control measures**.** **CO4.** Understand the modern methodology and principles of classification of fungi **CO5.** Understand the characteristics of pathogenic nematode and protozoa.

	AM 104	Biostatistics, Computer Applications and Bioinformatics	**CO1.** Demonstration the ability to choose methods appropriate to research aims and objectives. Understand the limitations of particular research methods. Develop skills in qualitative and quantitative data analysis and presentation. Develop advanced critical thinking skills. **CO2.** Restate the principal concepts about biostatistics, collect data relating to variable/ variables which will be examined and calculate descriptive statistics. **CO3.** Existing software effectively to extract information from large databases and to use this information in computer modelling. **CO4.** Knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics. **CO5.** Ability to understand the software concepts and their applications.
	AM 105	Practical	AM 101- AM 104
II	AM 201	Microbial Physiology and Biochemistry	**CO1.** Understand the structure of macromolecules and their basic building blocks. **CO2.** Know the mechanisms of ATP generation by microbes, and importance of heterotrophic metabolism, fermentation and chemolithotrophy. **CO3.** Learn the generation of ATP in a light driven process and pathways of CO_2 fixation by phototrophic microorganisms. **CO4.** Understand how enzymes, the biological catalysts, work and factors affecting their catalytic function. **CO5.** Know about nucleic acids and their building blocks, enzyme specificity, energy-rich compounds and biological nitrogen fixation.
	AM 202	Microbial Genetics, Molecular Biology and Genetic Engineering	**CO1.** Understand the regulation of transcription through the various operons, and the mechanics of translation in bacteria. **CO2.** Know about enzymes, vectors and cloning strategies in genetic manipulation. **CO3.** Learn about recombinant DNA technology and methods of DNA sequencing. **CO4.** Understand the protocol for cloning of a DNA fragment in a plasmid vector, transformation of bacterial cells and screening of cDNA libraries to identify a clone of interest. **CO5.** Learn techniques in molecular biology such as PCR, RFLP and DNA microarray that are useful in diagnosis.

	AM 203	Agricultural Microbiology	**CO1.** To learn the various habitats of soil microorganisms and parameters of Soil. **CO2.** To understand the sign, symptoms and etiological agents of various plant diseases. **CO3.** To learn the principle, mechanism and production of biopesticides. **CO4.** To learn the principle, mechanism and production of biofertilizers. **CO3.** To learn the principle and mechanism of biodetrioration, agriculture waste management.
	AM 204	Microbial Environmental Technology	**CO1.** Understand biomes, ecosystems, ecological pyramids and trophic levels in food chains and food webs. **CO2.** Learn about the diversity of microbes in aquatic environments, factors affecting their growth, and water-borne diseases caused by infectious microbes. **CO3.** Understand the concept of oxygen demanding wastes through BOD and COD, water pollution and its remediation, and waste management. **CO4.** Define remarkable role of microbes in cycling of nutrients, and study species interactions and associations in soil affecting physiology and growth of plants. **CO5.** Learn about microbes thriving in harsh environments, microbial blooms and their adverse effects, and methods of sampling air borne microbes.
	AM 205	Practical	AM 201- AM 204
III	AM 301	Medical Microbiology	**CO1.** Provides learning opportunities in the basic's principles of medical microbiology and infectious disease. **CO2.** Covers mechanisms of infectious disease transmission, principles of aseptic practices and the role of the human body normal micro flora. **CO3.** Provides the conceptual basis for understanding pathogenic microorganism and the mechanisms by which they cause disease in the human body. **CO4.** Provides opportunities to develop informatics and diagnostic skills, including the use and interpretation of laboratory tests in the diagnosis of infectious diseases. **CO5.** Understand the importance of pathogenic bacteria in human disease with respect to infections of the respiratory tract, gastrointestinal tract, urinary tract, skin and soft tissue.
	AM 302	Molecular and Clinical	**CO1.** Understand pathogenesis and the role of toxins, enzymes and host factors in infection

		Immunology	and disease. **CO2.** Know about diseases caused by diverse microorganisms with emphasis on emerging diseases and pandemics. **CO3.** Learn about the oncogenic viruses and cell transformation, and understand the importance of antimicrobial agents and drug resistance. **CO4.** Get an overview of immunology with a detailed account of molecular and cellular interactions that control innate and adaptive immunity. **CO5.**Understand the concept of autoimmunity, hypersensitive and allergic responses of the host and to learn methods of inducing immunity against the pathogen in the host.
	AM 303	Food and Dairy Microbiology	**CO1.** Understand the significance and activities of microorganisms in food **CO2.** Know the characteristics of food borne, water borne and spoilage microorganism and methods for their isolation, detection and identification. **CO3.** Learn the use of standard methods and procedures for the microbiological analysis of food. **CO4.** To understand the types and methods of microbial food production. **CO5.** To learn the importance of microbes and microbial enzymes applications in industry
	AM 304	Industrial Microbiology	**CO1.** Understand industrial fermentation, manipulation of microbial strains, and techniques for producing optimal product. **CO2.** Learn about diseases caused by contaminated food stuffs and the lab tests for detecting the causal microorganisms. **CO3.** Learn of the valuable products obtained from industrially important microbes. **CO4.** Know about the ubiquitous presence of microbes, hence contamination of food items and food spoilage, and factors affecting their growth. **CO5.** Know the physical and chemical techniques utilized worldwide in food preservation.
	AM 305	Practical	AM 301- AM 304
IV	AM 401	Medical Microbiology	Students will carry out six months dissertation training at various reputed institutes of India. The project/dissertation works will enable students to learn the basic working of microbiological laboratories, and provide intensive hands-on training to learn new
	AM 402	Industrial Microbiology	
	AM 403	Agricultural Microbiology	

	AM 404	Environmental Microbiology	horizons of microbiology and related life sciences field and to shape their career towards industries and research organization. This project/ dissertation make the students more industrially competent.
	AM 405	Viva Voce	

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Syllabus

Semester	Course Code	Course Title	Syllabus
I	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.
	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
	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
	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.
	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). 3. Principle's of Biochemistry. John Wiley and sons New York. 4. Moat AG and Foster J W (Latest Edition). Microbial Physiology. John Wiley and Sons, New York. 5. Stryer. L (2003). Biochemistry. W. H. Freeman and Co. 6. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hil 7. J.L. Jain(2015).Fundamentals of Biochemistry, S. Chand and Co. 8. U. Satyanarayan(2015). Biochemistry, Elsevier
II	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.
	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.
	AM 204	Microbial Environmental 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.
	AM 301	Medical Microbiology	**Unit I:** Classification of medically important bacteria; Normal micro 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: 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. Greenwood D (2015). Medical Microbiology, 18th Edition, Elsvier. 3. Murray PR, Pfaller MA, Tenover FC

			and Yolken RH (2007). Clinical Microbiology. ASM Press. 4. K.D Chattergy (2015). Parasitology, CBS Pub. 5. 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.
	AM 302	Molecular and Clinical 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.
	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.
	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 (vitaminB_{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