

ORDINANCES FOR

2- year Post-graduate Course

**M.Sc. Microbiology
(under Choice Based Credit System)**

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. (Microbiology) has been designed to train the student with different fields of microbiology technology. In first three semesters, the student will study all courses of Microbiology and in final fourth semester, he/she will have an option to select any two of the four Electives offered by the Department. Besides two Electives, the student will also have a choice of two optional open electives which he can study in any of the regular Departments of University Campus. The course contents are designed in such a way that the student may either pursue his career as an academican or may secure jobs in pharmaceutical industry, food industry, agricultural sector, environmental pollution control departments and quality control industries *etc.*

AIMS

We aim to give a significant level of theoretical and practical understanding in four specialized Elective fields of Microbial Technology *viz-* Microbial Technology-I (Immuno-diagnostics); Microbial Technology-II (Products and Process Development); Microbial Technology-III (Environmental Conservation and Management) and Microbial Technology IV (Agricultural Management). The Department will also organize two optional Electives *viz* Food Safety and Quality Control; Public Health and Hygiene which will be optional and shall be open even to the students of other Departments.

ORDINANCES

All rules and regulations 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. Credit points for the courses shall be the same as decided for other courses of Faculty of Science. 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. The Department shall be free to alter the sequence of courses in any semester depending upon the resources available.

*open elective to be selected from courses offered by other CBCS departments.

Each open elective carries 4 credits.

Ist Semester open elective are self-study courses and the limit of credits earned can be upto 8 credits.

In IInd and IIIrd semester open elective courses offered by other departments one in each semester (IInd and IIIrd) can be qualified to the extent of total 4+4=8 credits.

In IVth semester, courses offered by other CBCS departments in IInd Semester may be additionally qualified. Total minimum 12 open elective credits to maximum 20

credits can be earned by any candidate. In each semester SGPA will be granted including credits of open elective.

Finally after IVth Semester CGPA will be granted.

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.

Eligibility for Admission

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

Appointment of Examiners

Course Coordinator/Head of the Department 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. (Microbiology) syllabus, C.C.S. University, Meerut
Effective from the session 2017-18 (CBCS based)**

S.N.	Code no.	Name of the course	Credits		Internal (M.M.)	External (M.M.)
		FIRST SEMESTER	Th	P		
1	GM 101	Microbial Techniques	4	2	40	40
2	GM 102	Prokaryotes and Acellular Microbes	4	2	40	40
3	GM 103	Microbial Diversity- Eukaryotes	4	2	40	40
4	GM 104	Biostatistics, Computer Applications and Bioinformatics	4	2	40	40
		*Open Elective	4	--	--	--
		Total Credits of Theory	20	--	--	--
5	GM 105	Total Practical	--	8	--	80
		SECOND SEMESTER	Th	P		
6	GM 201	Microbial Growth and Physiological Diversity	4	2	40	40
7	GM 202	Microbial Genetics, Molecular Biology and RDT	4	2	40	40
8	GM 203	Microbes and Agriculture	4	2	40	40
9	GM 204	Environmental Microbiology	4	2	40	40
		*Open Elective	4	--	--	--
		Total Credits of Theory	20	--	--	--
10	GM 205	Total Practical	--	8	--	80
		THIRD SEMESTER	Th	P		
11	GM 301	Medical Microbiology	4	2	40	40
12	GM 302	Molecular Immunology	4	2	40	40
13	GM 303	Food and Dairy Microbiology	4	2	40	40
14	GM 304	Industrial Microbiology	4	2	40	40
		*Open Elective	4	--	--	--
		Total Credits of Theory	20	--	--	--
15	GM 305	Total Practical	--	8	--	80
		FOURTH SEMESTER	Th	P		
16	GM 401	Microbial Technology-I (Immuno-diagnostics)	4	2	40	40
17	GM 402	Microbial Technology-II (Products & Process Development)	4	2	40	40
18	GM 403	Microbial Technology-III (Environmental Conservation & Management)	4	2	40	40
19	GM 404	Microbial Technology-IV (Agricultural Management)	4	2	40	40
		*Open Elective	4	--	--	--
		Total Credits of Theory	20	--	--	--
20	GM 405	Total Practical	--	8	--	80
		Total Marks			640	960

Code- GM 101: 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, quaternary 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):

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.

Code- GM 102: Prokaryotes and Acellular Microbes

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: Current status of microbes in the living world, Brief developmental History of the evolution of three domain of life. Modern trends in microbial taxonomy including RNA world. Salient features of Bergey's Manual of Determinative bacteriology.

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):

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 Microbiology-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). Microbiology, 3rd edn, Rastogi publications
7. J.G.Black(2015) –Microbiology, 9th edition, Wiley publication

Code- GM 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 Phytopathology, Rastogi Publications, Meerut

Code- GM 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 & 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.

Code- GM 105: Practical (based on courses 1 to 4)

Code- GM 201: Microbial Growth and Physiological Diversity

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 CO₂ on the rate of photosynthesis; Photosynthetic yield and Photorespiration.

Unit III: Respiratory metabolism: Glycolytic pathway of carbohydrates breakdown, Embden Meyer Hoff pathway, Krebs 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

Code- GM 202: Microbial Genetics, Molecular Biology and RDT

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 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, & 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 & 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
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 Biology, Mc Graw Hill pub.
8. Gerald Karp (2014). Cell Biology, Wiley Blackwell, Pub.

Code- GM 203: Microbes and Agriculture

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, 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: 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 transmit and storage and their 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.

Code- GM 204: Environmental Microbiology

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):

- 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.

Code- GM 205: Practical (based on courses 6 to 9)

Code- GM 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: 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; antiparasitic 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, Elsevier.
4. Murray PR, Pfaller MA, Tenoer FC and Tenover 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.

Code Course GM 302: Molecular Immunology

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

Unit II: Antigens: preparation of antigens, types of antigens- haptens, superantigens & cluster of differentiation molecules (CDs), Processing and presentation of antigens.. Immunoglobulins: structure & types of immunoglobulins, genetic diversity of immunoglobulins, catalytic antibodies. B-cell biology & 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) & 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.

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.

Code - GM 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):

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

Code GM 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 I (b) : Fermentation technology: microbial growth kinetics in batch, continuous & fed-batch fermentation process. Stirred aerobic bioreactor: principles & designing. Other types of bioreactors. Raw materials used in fermentation media. Solid state fermentation & submerged fermentation: their advantages & disadvantages.

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(vitaminB₁₂, 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.

Unit V : Industrial enzymes production : Cellulases, Xylanases, Proteases, Amylases, Lipases & 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

Code- GM 305: Practical (based on courses 11 to 14)

Code GM 401: MICROBIAL TECHNOLOGY-I **(IMMUNO-DIAGNOSTICS)**

UNIT-I: Modern Immunological Therapy: Kinetics of immune response and memory; Hybridoma technology; production and purification of monoclonal antibodies; Antibody engineering, Antibody as in vitro and in vivo probes; Immunotoxins, Immunodiagnosics and Immunotherapeutics. Immunoassay: solid immunoassay & their chemistry, Immunocytochemistry, Immunohistochemistry, Immunoediting, Immune surveillance theory.

UNIT-II: Molecular Oncology: Detection of recognized genetic aberrations in clinical samples; types of cancer causing alterations revealed by next generation sequencing of clinical isolates; predictive biomarkers for personalized oncotherapy of human disease such as chronic myeloid leukemia, colon, breast, lung cancer and melanoma as well as matching targeted therapies with patients and preventing toxicity of standard systemic therapies; Tumor evasion of the immune system, Cancer immunotherapy.

UNIT-III: Commercial Immunodiagnostic kits for common diseases: Dengu, HIV/AIDS, Chikun gunya, ELISA kit, Rapid diagnostic test kit, BCG, Typhoid.

UNIT-IV: Common Vaccine development: Licensed vaccines, Viral Vaccines (Poliovirus vaccine-inactivated and Live, rabies vaccines, Hepatitis A& B vaccines), Bacterial Vaccine (Anthrax vaccines, Cholera vaccines, Diphtheria toxoid), Parasitic vaccine (Malaria Vaccine).

UNIT-V: Vaccine Production: The vaccine industry, vaccine manufacturing, Evolution of adjuvants across the centuries, New generation vaccines (bacterial, viral), Edible vaccines, Vaccine additives and manufacturing residuals, Regulation and testing of vaccines.

Suggested Readings (Latest Editions):

1. Riott I M (2003). Essentials of Immunology. Blackwell Scientific Publishers, London.
2. Murray PR, Pfaller MA, Tenover FC and Tenover RH (2007). Clinical Microbiology. ASM Press.
3. Tizard Ian R (2009). Immunology. An introduction, 4th Edition.
4. Kenneth. J. Ryan (2010) Sheris's Medical Microbiology, Mc Graw Hill.
5. Kindt, Goldsby and d Osborne (2013). Kuby Immunology. MacMillan Higher Education.
6. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hill.
7. Greenwood D (2015). Medical Microbiology, 18th Edition, Elsevier.

Code- GM 402: MICROBIAL TECHNOLOGY - II **(PRODUCTS AND PROCESS DEVELOPMENT)**

UNIT-I Bioprocess technology: Microbial growth patterns and kinetics in batch culture, Microbial growth parameters. Quantitative analysis of microbial growth by direct & indirect methods, Role of diffusion in Bioprocessing, Different regulatory mechanisms involved in controlling the catabolic and anabolic processes of microbes. Basic concepts of computer modelling and optimization in bioprocess applications.

UNIT-II Bioreactor design: General requirements of fermentation process, types of fermentation and fermenters; batch, fed batch and continuous. Solid state and submerged fermentation. Microbial growth kinetics-Monod equation, Stoichiometry of cell growth-mass and energy balances, yield coefficients, growth limiting substrate and yield factors, factors of optimization, rheology of fermentation fluids, Oxygen transfer kinetics.

UNIT-III Details of the process, parameters and materials - for industrial production of Antibiotics (penicillin, streptomycin and their derivatives), Biopharmaceuticals (Insulin/Interferon), Role of microbes in milk and dairy products, Food fermentation- bread, cheese, vinegar, yogurt, sour milk, oriental fermented foods. Production of starter culture (LAB) for dairy industries. Microbial biomass: Single cell proteins and myco-protein.

UNIT-IV Biofertilizers and biopesticides Plant Growth Promoting Rhizobacteria (PGPR) – mycorrhiza, Mass production of biofertilizers and quality control. Biopesticides - microbial pesticides, Bioconversion of waste for fuels: production of CH₄, bioethanol, biogas and other hydrocarbons, biodiesel and H₂ as fuel by microbes; Immobilization of microbial enzymes and whole cells and their applications in industries. Industrial enzymes production: Cellulases, Xylanases, Proteases, & Amylases

UNIT-V Fundamentals of Bioentrepreneurship: decision making for starting a venture, sources of financial assistance, approaching the sources for loan, statutory and legal requirements of starting a company, assessment of market demand for product, developing distribution channels: pricing/ policies/ competition/ promotion/ advertising, negotiation strategy with various agencies, Human resource development

Suggested Readings (Latest Editions):

1. Cruger, W. and Anneliese Cruger, A. 2005. Biotechnology, A text book of industrial Microbiology, Panima Publishers, New Delhi, 2nd Edition
2. Casida, L.E. 2010. Industrial Microbiology, Willey Eastern Ltd, New Delhi, 1st Edition
3. Stanbury, P.F. and Whitaker, A. 2005. Principles of Fermentation Technology, Pergamon Press, Oxford, 2nd Edition
4. Okafar, N. 2007. Modern Industrial Microbiology and Biotechnology, 1st Edition

Code- GM 403: Microbial Technology-III **(Environmental Conservation and Management)**

Unit 1: Environmental Conservation and Energy Management: Principles and Strategies for conservation of environment; Energy management measures in steam systems- losses in boiler, energy conversion in refrigeration and air conditioning system, Energy efficient motors, Electrical energy management.

Unit II: Industrial wastewater treatment- Removal of heavy metals, nitrogen and phosphorus, Membrane filtration, electrolysis and evaporation; Biological treatment processes; Chemical oxidation processes, save Ganga by shifting industries from urban areas.

Unit III: Waste water Reuse and Residual Management- Common effluent treatment plants, Zero effluent discharge system, Quality requirements for waste water reuse, industrial reuse, Residuals of industrial waste water treatment.

Unit IV: Sewage treatment and sanitation: Fundamentals of sewage treatment; Septic tank with depression DEWATS, intermittent sand filters. Methods of Sewage disposal, Recycle and reuse of sewage. Solid waste management, Sanitation practices at individual and community level with particular reference to “swachhta mission”.

Unit V: Bioresource Management and Landfill: Renewable and Nonrenewable sources of energy and their management, Wild life management and conservation of biosphere. Disposal of electronic waste and landfills.

Suggested readings (Latest Editions):

1. Waste Water Engineering – Treatment, Disposal & Reuse 3rd Ed. Metcalfe & Eddy. Inc. Tata McGraw Hill Pub. Co. 1995.
2. T. H. Tietenberg: Environmental & Natural Resource Economics, 2nd, Ed. Scott. Foreman Pub. Company
3. Rodgers & Panwar 1988, Planning Protected Area Network in India, Vol. I & II.
4. T. N. Khoshoo (1988) Environment Concerns and Strategies. Ashish Pub. House, Delhi.
5. Pachauri R. K. & Sridharan (1997), Looking back to Think Ahead, The Energy Research Institute, New Delhi
6. R. F. Dasmann (1968) Environment Conservation: John Willey and Sons, New York.
7. Air Pollution by Perkin, H. G. (1974)
8. Fundamentals of Air Pollution by Stern, A. C., Henry Wohlers, G. R. Richard, Boudal, W. and William Lowry, P. (1973).

Code- GM 404: Microbial Technology-IV **(Agricultural Management)**

Unit 1: Agribusiness environment and Policy: Agribusiness definition and nature, components of agribusiness management, changing dimensions of agribusiness, structure of agriculture, policy control and regulations relating to the industrial sector with specific reference to agro industries, Role of agriculture in Indian economy, problems and policy changes relating to farm supplies, Farm production, agro processing, agricultural marketing, agricultural finance.

Unit II: Agricultural Marketing and Management: Marketing of agriculture in a developing economy, Indian market performance analysis, marketing, price spread and efficiency, wholesaling and its process, marketing strategy, planning target, retail marketing, international marketing and finance, Agricultural marketing system, government policies, buffer stock preparations, co-operative policies, forward trading, future market strategies.

Unit III: Agro based Industries of Western UP: Sugarcane Industry, its management and utilization of its by products, use of agricultural waste in Paper industry – its management, small scale agro based industries like chips, fruit juices, jams, pickles.

Unit IV: Preservation of agro based food products: Management of cold storages, Storage of foods and vegetables in cold stores – their management and quality control.

Unit V: Concept of management: Managing science or art, skills of a manager, significance of goals in organizations, product/market organization problem discovery, Nature of managerial decision making.

Suggested readings (Latest Editions):

1. P. L. Nuthall, Farm business management : the core skills, Wallingford UK ; Cambridge
2. S.C. Panda, Farm Management and Agricultural Marketing, New Delhi.
3. S. Diwase, Indian agriculture and Agribusiness management, Scientific Publisher, Delhi.
4. S. S. Reddy, Agricultural Economics, Oxford Publishing House, Delhi.