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 academician 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.

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 2016-17 (CBCS based)

S.N.	Code no.	Name of the course	Credit Points	Internal (M.M.)	External (M.M.)
		FIRST SEMESTER			
1	GM 101	Microbial Techniques		50	50
2	GM 102	Prokaryotes and Acellular Microbes		50	50
3	GM 103	Microbial Diversity- Eukaryotes		50	50
4	GM 104	Biostatistics, Computer Applications and Bioinformatics		50	50
5	GM 105	**Practical**			100
		SECOND SEMESTER			
6	GM 201	Microbial Growth and Physiological Diversity		50	50
7	GM 202	Microbial Genetics, Molecular Biology and RDT		50	50
8	GM 203	Microbes and Agriculture		50	50
9	GM 204	Environmental Microbiology		50	50
10	GM 205	**Practical**			100
		THIRD SEMESTER			
11	GM 301	Medical Microbiology		50	50
12	GM 302	Molecular Immunology		50	50
13	GM 303	Food and Dairy Microbiology		50	50
14	GM 304	Industrial Microbiology		50	50
15	GM 305	**Practical**			100
		FOURTH SEMESTER			
16	GM 401	Microbial Technology-I (Immuno-diagnostics)			
17	GM 402	Microbial Technology-II (Products & Process Development)			
18	GM 403	Microbial Technology-III (Environmental Conservation & Management)			
19	GM 404	Microbial Technology-IV (Agricultural Management)			
		Total Marks			

Course 1, 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, quartenary ammonium compounds, aldehydes and sterilizing gases; evaluation of antimicrobial agent effectiveness. Principle and functioning of LAF.

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

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

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

Course 2, 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 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

Course 3, 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 Phyotopathology, Rastogi Publications, Meerut

Course 4, 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.

Course 5, Code- GM 105: Practical (based on courses 1 to 4)

Course 6, 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 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

Course 7, 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 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.

Course 8, 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. Biolological 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.

Course 9, Code- GM 204: Environmental Microbialogy

Unit I: Microbial Ecology versus Environmental Microbiology; Historical perspectives; Major fields and modern Environmental Microbiology; Overall role of microbes in ecosystem. Aeromicrobilogy 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 bioremeadiation; Biodegradation of xenobiotics including pesticides and military chemicals (explosives and gases); Biocorrsion 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.

Course 10, Code- GM 205: Practical (based on courses 6 to 9)

Course 11, 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; Oppurtunistic mycoses; Antifungal agents and susceptibility test.

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

Suggested Readings (Latest Editions):

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.

Course 12, 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 electrophorectic 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.

Course 13, 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

Course 14, 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(vitaminB_{12}, riboflavin & vitamin A).

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

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.
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Course 15, Code- GM 305: Practical (based on courses 11 to 14)