

ORDINANCES FOR

3- year Post-graduate Course

**M.Sc. Medical Microbiology
(under Self Finance Scheme)**

From the session 2016-17

**Department of Microbiology
Ch. Charan Singh University
Meerut**

OVERVIEW

The increasing incidence of microbial infections worldwide is being compounded by the rapid evolution of drug-resistant variants and opportunistic infections by other organisms. In response to a high level demand of competent medical microbiologists, this three year course of M.Sc. (Medical Microbiology) has been specifically designed for graduates who wish to develop their skills as medical microbiologists. The programme aims to train the students at a significant level of theoretical and practical understanding which will facilitate those wishing to follow a career in laboratory diagnosis (microscopy, cultural, physiological, biochemical and serological tests including molecular methods) of various pathogen/diseases significant to public health.

Our medical microbiology course is unique because the student will spend full one year practical training in a medical college and/or pathological and diagnostic laboratories/centre duly recognized by competent bodies.

AIMS

We aim to give a significant level of theoretical and practical understanding and diagnosis/identification of various human pathogens e.g. bacteria, fungi, viruses, parasites etc. with the help of various laboratory diagnostic methods including molecular techniques. The course contents are designed in such a way that the student may also pursue his career as academician in medical and industrial microbiologists besides setting up his own diagnostic laboratory. The students will be exposed to recent advances in molecular diagnostics techniques in clinical identification and management of significant diseases of public health.

ORDINANCES

All rules for conduct of examination pattern, pass percentage and admissions shall be the same as for other post-graduate courses in the Faculty of Science on the University campus. Internal and external examination shall be as indicated in the given Table. The pattern of internal assessment shall be decided by the Department however, it will mainly include tests, quizzes, seminars, term papers, group discussions and home assignments. A candidate will have to complete a project in the final fourth & fifth semester (*i.e.* third year) for a period 8 to 10 months. Project/Practical work related to sample testing/diagnosis will be completed in collaboration with L.L.R.M. Medical College, Meerut (a constituent college of the University). Additionally collaboration for Project/Practical work related to sample testing/diagnosis may be done with other local pathological and diagnostic laboratories if the adequate facilities are available there. Course Coordinator in consultation with at least any two member of Board of Studies will select the local pathological and diagnostic laboratories. A part of the Project/Practical work will also be done in Department of Microbiology. One of the supervisors for project

work may be opted from outside the University where the candidate shall complete the project work. After the completion of Project/Practical work the candidate shall submit a detailed project report/thesis and will make an open presentation for 20-30 minutes. He will defend his/her experimental design, results and conclusions before the Board of Examiners. At the end of fifth/sixth semester (Third year), there shall also be a practical examination of 12 h spread over two days which shall include an objective examination also for which the paper shall be set by the Board of Examiners (Internal as well as External jointly), appointed by the competent body/officer of the University who shall be normally the Vice-Chancellor. Objective examination shall be for maximum 100 marks and shall be based on practical work related to diagnosis of diseases. Number of questions shall be decided by the Board of Examiners. The Department shall be free to alter the sequence of courses in any semester depending upon the resources available.

Number of seats and fee structure

Initially there should be only 20 seats which may be altered depending upon the facilities available in the Department. Reservation shall apply as per the policy of the University for other courses on the campus. This course is approved under self finance scheme of the University/State Govt. and annual tuition fee of Rs. 75,000/- (Rs. Seventy five thousand) is suggested which shall include the project fee if any. However, the fee structure may be altered depending upon the resources available.

Eligibility for Admission

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

Appointment of Examiners

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

COURSE STRUCTURE

Following course structure is approved

**M.Sc. (Medical Microbiology) Three year course syllabus,
Ch. Charan Singh University, Meerut
Effective from the session 2016-2017**

S.N.	Course Code	Name of the course	Internal (M.M.)	External (M.M.)
		<u>FIRST SEMESTER</u>		
1	MM 101	General Microbiology	50	50
2	MM 102	Microbiological Tools and Techniques	50	50
3	MM 103	Human Anatomy	50	50
4	MM 104	Human Physiology	50	50
5	MM 105	Practical		100
		<u>SECOND SEMESTER</u>		
6	MM 201	Systematic Bacteriology	50	50
7	MM 202	Medical Mycology	50	50
8	MM 203	Human and Animal Virology	50	50
9	MM 204	Biochemistry and Haematology	50	50
10	MM 205	Practical		100
		<u>THIRD SEMESTER</u>		
11	MM 301	Molecular Immunology	50	50
12	MM 302	Microbial Genetics, Molecular Biology and Genetic Engineering	50	50
13	MM 303	Laboratory Diagnosis in Clinical Microbiology	50	50
14	MM 304	Biostatistics and Medico-informatics	50	50
15	MM 305	Practical		100
		<u>FOURTH SEMESTER</u>		
16	MM 401	Parasitology	50	50
17	MM 402	Epidemiology: Disease Control and Public Health	50	50
18	MM 403	Pharmaceutical Microbiology	50	50
19	MM 404	Nutritional Therapy	50	50
20	MM 405	Practical		100
		<u>FIFTH & SIXTH SEMESTER (Third Year)</u>		
		Project work: Practical work related to sample testing/diagnosis in collaboration with L.L.R.M. Medical College, Meerut including local clinics. Practical work will also be done in Department. Submission of detailed report/thesis, presentation of work, conduct of practical examination including viva-voce examination.		
21	MM 501	PRACTICAL (2 days) INCLUDING OBJECTIVE		400
22	MM 502	THESIS/REPORT		600
		<u>TOTAL</u>		

Total Marks 3000

COURSE 1, Code- MM 101: GENERAL MICROBIOLOGY

Unit I- Discovery of Microbial world; History of Microbiology; Scope and relevance of Microbiology; Role of microbes in disease; Current status of microbes in the living world: Haeckel's three kingdom concept, Whittaker's five kingdom concept, Eight kingdom system of classification of Cavalier Smith; Classification and salient features of bacteria according to the Bergey's manual of Determinative Bacteriology.

Unit II- General account of Prokaryotes: Size, shape and arrangement of bacteria; Structure and function of Gram positive and Gram negative cell wall, cell membrane, cytoplasmic matrix, inclusion bodies, nucleoid, flagella, pilli and endospores; Reproduction and recombination in Gram positive and Gram negative bacteria.

Unit III- History and discovery of viruses; Nature of viruses; General characters of viruses; Infection and replication; Nomenclature and classification of viruses; Purification and quantitative assays of viruses; Bacteriophage : Structure and life cycle pattern of T-even phage and λ phage.

Unit IV- General characters of Eukaryotic microbes: ultra structure and organization of a typical eukaryotic cell; Classification of eukaryotic microbes (Fungi, Algae, Protozoans, Nematodes and Cestodes); Evolutionary relationship of each group based on modern system of classification.

Unit V- Physical, chemical and Biological hazard: Safety in microbiological labs; Quality assurance in microbiological laboratories; Hospital and laboratory waste disposal and management; Decontamination; antiseptics.

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 Hill
5. Bisen, P.S. (2014). Microbes in Practices, I K international publication house.
6. Sharma P.D. (2015-16). Microbiology, 3rd edn, Rastogi publications.
7. J.G.Black (2015) –Microbiology, 9th edition, Wiley publication.

COURSE 2, Code- MM 102: Microbiological Tools and Techniques

Unit I- Preparation of culture media; Types of culture media: simple media, complex media, synthetic media, enriched media, selective media, indicator media, differential media, anaerobic media; Sterilization and Disinfection; Pure culture techniques: streak plate, pour plate and spread plate method; Maintenance of pure culture; Methods of preservation of various microbes.

Unit II- Introduction to Clinical Microbiology; occurrence of infections, infections of special concern, routes in infections; Microbiological safety cabinets; Handling of Hazardous materials.

Unit III- Microscopy: Specimen preparation and basic principles for the examination of microbes by light, phase-contrast, dark field, confocal, fluorescent and electron (transmission and scanning) microscopy; Micrometry and micro densitometry. Chromatography (paper, thin layer, column, partition, gel filtration, ion-exchange and affinity chromatography); GLC and HPLC.

Unit IV- Principles and applications of Electrophoresis (one and two dimensional for proteins and DNA); Iso-electric focusing; Autoradiography, Centrifugation; Ultra-centrifugation; Dialysis and Ultra filtration; Lyophilization in microbiological studies.

Unit V- Fractionation of microbial cells; Separation of different cell organelles and chemical analysis of microbial cells for carbohydrates, proteins, amino acids, lipids and nucleic acids.

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 3, Code-MM 103: HUMAN ANATOMY

Unit I- General Anatomy: Introduction to anatomy; Anatomical terminology, anatomical plane; Organization of human body tissues and organ systems; Cellular organization of tissues and organs; Cell division.

Skin: Structural and functional anatomy of skin.

Unit II- Muscular System: Different types of muscles and their gross structure; Structure of sarcomere; Origin & insertion, tendons; Aponeurosis; Wasting and degeneration of muscles

Skeletal System: Components of axial and appendicular skeleton; Development of bones; various joints, their structure and function.

Digestive System: Morphology of gastro-intestinal system; Microflora of digestive tract; Structure of different digestive and associated glands.

Unit III- Respiratory System: General anatomy of lungs, pleura, broncho- pulmonary segments, intercostal muscles and diaphragm.

Cardiovascular System: Various components of blood-vascular system; Blood and connective tissue; Haemopoiesis; Structure of various parts of heart; Lymph circulation, lymph-nodes and lymphoid tissues.

Unit IV- Urinogenital System: Structure and function of kidneys, ureters, urinary bladder and urethra; General outline of male and female genital systems; Formation of semen; Spermatogenesis; Structure of sperm; Menstrual cycle and normal pregnancy.

Endocrine System: Different endocrine glands and their secretions; Neuro-endocrinal controls.

Unit V- Nervous System: Various types of nerves and structure of different parts of the brain and spinal cord; various somatic sensations; Neuromuscular junctions

Special Sense Organs: Gross structure and function of eye, ear, nose and tongue.

Suggested Readings (Latest Edition): -

1. Drake (2014). Gray's Anatomy
2. B. D. Chaurasia (2013). BD Chaurasia's Human Anatomy Regional and Applied Dissection and Clinical.
3. Waugh (2014). Ross and Wilson Anatomy and Physiology in Health and Illness.
4. Ken Saladin (2015). Saladin's Anatomy and Physiology 7th Edition.
5. Gerard J. Tortora, Bryan H. Derrickson (2014) Principles of Anatomy and Physiology, 14th Edition.
6. Elaine Marieb and Katja Hoehn (2013). Human Anatomy & Physiology, 9th Edition.
7. Seeley (2006). Anatomy and physiology, Mc Graw Publications.
8. David. Shier (2004), Hole's Human Anatomy and Physiology, Mc Graw Publications.
9. William, P.L., Bannioter, L.H., Berry, M.M. and Collins, P. (Latest Edition) *Gray's Anatomy*, International Student's Edition.
10. Elaine N. Marieb (2001). Human anatomy and Physiology, Wesley.

COURSE 4, Code- MM 104: HUMAN PHYSIOLOGY

Unit I- General Physiology: Functional organization of cell; Structure of cell membrane and transport across membrane; Body fluids: Homeostasis.

Skin: Different Mechanisms involved in Body temperature regulation; Pyrexia and Hypothermia; Sense receptors of skin.

Muscular System: Basis of muscle contraction; Duration curve; Starling law; Electrical-biphasic and monophasic action potential; Chemical, thermal and physical changes; Isometric and isotonic contraction.

Unit II- Blood: Composition, physical properties and function of blood; Plasma proteins and their functions; Erythropoiesis and its control; Structure, function and fate of RBC's; Haemoglobin and its functions; Pathophysiology of Anaemias; Structure and functions of Leukocytes; Immunity; Thrombopoiesis, structure and function of Platelets; Physiology of Clotting and Fibrinolysis; Blood groups and Physiological basis of transfusion medicine.

Cardiovascular System: General Introduction of Cardiovascular system; Cardiac cycle and Heart sounds; Interpretation of normal Electrocardiogram; Cardiac output and Cardiac failure; Venous return; Heart rate and its regulation; Structure and organization of vascular tree; Arterial blood pressure and pathophysiology of Hypertension, angina and infarction.

Unit III- Digestive System: General principles of Gastro-Intestinal functions; Composition, Function and regulation of secretion of Saliva, Gastric Juice, Pancreatic Juice, Succus entericus and Bile; Movements of GIT; Digestion and absorption of Fats, Proteins and Carbohydrates; Functions of Liver and LFT.

Respiratory System: Functional anatomy of Respiratory System; Mechanics of breathing: Mechanism of Inspiration and Expiration; Intra-pleural and Intra-alveolar pressures, Compliance, Surfactant, Air-way resistance and Work of breathing; Respiratory membrane and diffusion of gases; Pulmonary circulation; Composition of Gases and Partial Pressures; Oxygen and Carbon-dioxide transport; Lung volume, Capacities and Lung function tests.

Unit IV- Reproductive System: Sex determination and development of puberty, Male sex hormones and Female sex hormone and their function; menstrual cycle; ovulation and contraceptives, Pregnancy; function of placenta and lactation

Excretory System: Gross and minute structure of kidney; Features of renal circulation; Mechanism of formation of urine; GFR and tubular function; Renal function tests; Physiology of micturition.

Unit V- Nervous System: Functioning of Autonomic Nervous System; Higher neural regulation of ANS. **Special Senses:** Functional anatomy of the Eye; Optics of vision; Visual pathways; Sense of hearing; Auditory pathway; Vestibular apparatus; Sense of Taste; Sense of Smell.

Suggested Readings (Latest Edition): -

1. Kim E. Barrett, Susan M. Barman (2015). Ganong's Review of Medical Physiology, Twenty-Fifth Edition
2. Gary D. Hammer, Stephen J. McPhee (2014). Pathophysiology of Disease: An Introduction to Clinical Medicine
3. Maxine A. Papadakis (2016). CURRENT Medical Diagnosis and Treatment.
4. Dennis L. Kasper, Anthony S. Fauci (2015). Harrison's Principles of Internal Medicine 19/E
5. Hall, Vaz and, Mario Vaz (2013). Guyton & Hall's Textbook of Medical Physiology
6. Vasudeva Neelam (2014). Inderbir Singh's Textbook of Human Histology.
7. Waugh (2014). Ross and Wilson Anatomy and Physiology in Health and Illness.
8. Bruce M. Koepfen (Author), Bruce A. Stanton (2014). Berne & Levy Physiology, 6th
9. Ken Saladin (2015). Saladin's Anatomy and Physiology 7th Edition.
10. Gerard J. Tortora, Bryan H. Derrickson (2014) Principles of Anatomy and Physiology, 14th Edition.
11. Bryan H. Derrickson (2016). Human Physiology
12. Elaine Marieb and Katja Hoehn (2013). Human Anatomy & Physiology, 9th Edition.

COURSE 5, Code- MM 105: Practical (Based on course 1-4)

COURSE 6, Code- MM 201: Systematic Bacteriology

Unit I- Classification of medically important bacteria; Normal flora of human body and its importance; Commensals and Pathogenic microorganisms; Culture and growth of bacteria; Morphological, Physiological and Biochemical Tests for the identification of bacteria; Nosocomial infections; Antimicrobial susceptibility test; Genetic basis of drug resistance.

Unit II- Important human infections caused by Gram-positive cocci, their pathogenesis, lab diagnosis, prevention and control: Staphylococcus (Skin infections, Musculoskeletal, Respiratory, Central nervous system, Endovascular and Urinary infections, Toxic Shock Syndrome and Scalded Skin Syndrome), Coagulase negative Staphylococcus and Micrococcus, Streptococcus (Respiratory, Skin and Genital infections), other hemolytic and anaerobic Streptococci, Pneumococcus (Otitis media, Sinusitis, Pneumonia).

Unit III- (A) Important human infections caused by Gram-negative cocci, their pathogenesis, lab diagnosis, prevention and control: Neisseria (Meningitis, Septicemia, Gonorrhoea), Moraxella.
(B) General characters, morphology, pathogenesis, lab diagnosis, prevention and control of diseases caused by: Mycoplasma (Pneumonic and Genital infections), Rickettsia (Typhus fever and spotted fever), Chlamydia (Trachoma, Inclusion conjunctivitis, Infant pneumonia), Spirochaetes (Syphilis), Actinomycetes (Actinomycosis), Nocardia (Nocardiosis).

Unit IV- (A) Important human diseases caused by Gram-positive bacilli, their pathogenesis, laboratory diagnosis, prevention and control, e.g. Corynebacterium (Diphtheria), Bacillus (Anthrax Food poisoning), Listeria (Listeriosis), Clostridium (Gas gangrene, Food poisoning and other infection, tetanus).

(B) Important diseases caused by Mycobacterium (Tuberculosis, Leprosy), their pathogenesis, laboratory diagnosis, prevention and control; Atypical *Mycobacteria*.

Unit V- Important human infections caused by Gram-negative rods, their pathogenesis, lab diagnosis, prevention and control: Escherichia coli (Urinary tract infections), Klebsiella (Bronchopneumonia), Enterobacter (Wound, Respiratory and Urinary infections), Proteus (UTI), Salmonella (Enteric fever, Food poisoning), Shigella (Bacillary dysentery), Vibrio (Cholera), Campylobacter (Diarrhoea), Pseudomonas (Nosocomial infections), Haemophilus (Influenza, Meningitis, Bronchitis), Brucella (Brucellosis), Yersinia (Plague).

Suggested reading (Latest Edition):

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 Hill
5. Bisen, P.S. (2014). Microbes in Practices, I K international publication house pvt Ltd.
6. J.G. Black (2015) –Microbiology, 9th edition, Wiley publication
7. Jawetz, Melnick and Adelberg's, (Latest Edition) *Medical Microbiology*, Mc Graw Hill Publishers.

COURSE 7, Code- MM 202: MEDICAL MYCOLOGY

Unit I- General characteristics and classification of medically relevant fungi, morphology and reproduction of fungi, isolation and identification of fungi; yeast and yeast like fungi of medical importance: *Candida*, *Cryptococcus*, *Malassezia*, *Trichosporon*, *Saccharomyces*; Mycelial fungi of medical importance: *Aspergillus*, *Zygomycetes*, *Fusarium* and *Piedra*; dimorphic fungi, economic importance of fungi.

Unit II- Collection, storage and transport of clinical samples, laboratory diagnosis of important fungal diseases: Serodiagnosis, plating techniques; Mold identification based on spore/ conidium counting; culture media for fungi: Bird seed agar, Brain heart infusion agar, CHROM agar *Candida*, dermatophyte test medium, inhibitory mold agar, Mycosel agar, Yeast extract phosphate agar, Sabouraud's dextrose agar (SDA).

Unit III- Dermatophytosis: Superficial mycosis eg. ringworm, superficial candidiasis, pityriasis, otomycosis, Mycotic keratitis, superficial infections of skin, nail, hair; Subcutaneous mycosis eg. Mycetoma, chromoblastomycoses, sporotrichosis; Systemic mycoses eg. Coccidioidomycosis, histoplasmosis, blastomycoses, paracoccidioidomycoses, cryptococcosis, rhinosporidiosis, aspergillosis, systemic candidiasis, zygomycosis, pneumocystosis, penicillosis marneffeii; other opportunistic mycosis.

Unit IV- Mycotoxocoses: Mode of action of aflatoxins, ochratoxins, trichothecenes, fumonisins, zearalenones, patulin, penicillic acid and ergotoxins; Methods of detoxication, prevention and treatment.

Unit V- Common laboratory contaminant fungi; susceptibility test: Macrodilution, microdilution, colorimetric method and spectrophotometric methods, agar diffusion method; antifungal agents, antifungal therapy.

Suggested Readings (Latest Edition): -

1. David Greenwood (2015). Medical Microbiology, 18th edition.
2. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hill.
3. J.G. Black(2015) –Microbiology, 9th edition, Wiley publication
4. Jawetz, Melnick and Adelberg's, (Latest Edition). *Medical Microbiology*, Mc Graw Hill Publishers.
5. T.M. Butt (2001). Fungi as Biocontrol agents, CABI Publication.
6. G.D. Rodson (2007). Exploitation of Gungi, Cambridge pub.

COURSE 8, Code- MM 203: Human and Animal Virology

Unit I- Origin and development of concept of virology; Collection of clinical samples; Diagnostic techniques for viral diseases: Detection of viral antigens, nucleic acids and specific antibodies; Virus isolation by conventional and non-conventional methods: monolayers, shell vials, lymphocyte cultures, animal and embryonated eggs; Virus identification: Immunofluorescence, Immunoperoxidase test, Neutralization, Light microscopy and Electron microscopy.

Unit II- Pathogenesis of virus infection; Host cell responses to virus infection: Interferons and Apoptosis; Replication of DNA and RNA viruses; Antiviral drugs and their mechanism of action; Viral vaccines; Use of Bacteriophages in bacterial identification; Use of animal viruses as vectors.

Unit III

Human diseases caused by Orthomyxoviruses (Influenza), Paramyxoviruses (Mumps, Measles, Respiratory Syncytial Virus), Picornaviruses (Enteroviruses, Rhinoviruses), Poxviruses (Small pox, Cow pox, Molluscum Contagiosum), Herpesviruses (HSV-1, HSV-2, Varicella-Zoster, Cytomegalovirus, Epstein-Barr virus), Human Retroviruses (HTLV-1, HTLV-2, HIV), Adenovirus, Viral hepatitis.

Unit IV- Nature of viral zoonoses: Rabies, Haemorrhagic fevers, Yellow fever, Colorado tick fever, Vesicular Stomatitis, Viral Encephalitis (Japanese encephalitis, Venezuelan equine encephalitis, Eastern and Western equine encephalitis, St. Louis encephalitis, Murray valley encephalitis); Emerging and re-emerging zoonoses.

Unit V- Prions: Structure, replication and diseases caused by them; Transplantation associated viral infections; Tumour viruses and human cancers: Burkitt's lymphoma, Nasopharyngeal carcinoma, T-cell leukemia, Hepatocellular carcinoma, Kaposi's sarcoma, Skin cancer; Viroids; Emerging and re-emerging viral diseases.

Suggested Readings (Latest Edition): -

1. David Greenwood (2015). Medical Microbiology, 18th edition.
2. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hill.
3. J.G. Black(2015) –Microbiology, 9th edition, Wiley publication
4. Jawetz, Melnick and Adelberg's, (Latest Edition). *Medical Microbiology*, Mc Graw Hill Publishers.
5. S. Ram Raddy (2012) Essential of Virology, Scientific Pub.
6. Jane . Flint (2015) Principle of Virology, ASN Press.

COURSE 9, Code- MM 204: BIOCHEMISTRY AND HAEMATOLOGY

Unit I- Carbohydrates: classification, structure and function, chemical and physical properties; Structure, properties and importance of starch, cellulose, glycogen and chitin. Carbohydrate metabolism: Glycolysis, TCA cycle, Electron transport chain; Metabolism of glycogen: Glycogenesis, Glycogenolysis; Metabolism of Galactose.

Unit II- Proteins: structure, classification, chemical bonds involved in stability of protein structure, protein configuration, protein sequencing, peptide synthesis, biological role of proteins. Protein metabolism: transamination, deamination, urea cycle, and metabolism of essential amino acids.

Unit III- Lipids: classification, structure and properties, oxidation of fatty acids: saturated, unsaturated and odd-chain fatty acids; Biosynthesis of lipids and its regulation; Biological role of lipids.

Unit IV- Enzymes: classification and nomenclature; mechanism of enzyme action: active site, enzyme kinetics, enzyme inhibition, regulation of enzyme activity, allosteric enzymes; Clinical applications of enzymes.

Unit V- Haematology: Introduction; Specimen collection and processing for clinical chemistry; Clinical examination of blood, blood collection methods of capillary puncture and venipuncture; haemocytometer: RBC, WBC and platelet count; Blood cell morphology and differential count; Haematology tests; Erythrocyte sedimentation rate; Principles of automated haematology; Hematocrit test; Bleeding disorders and its laboratory diagnosis; Blood-Bank and its management.

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. J.L. Jain(2015).Fundamentals of Biochemistry, S. Chand and Co.
4. U. Satyanarayan(2015). Biochemistry, Elsevier
5. Bhagavan, N.V. (Latest Editions) *Medical Biochemistry*. Academic Press.
6. Chatterjee, M.N. and Shinde, R. (Latest Editions) *Textbook of Medical Biochemistry*. Medical Publishers
7. Sachdev, K.N. (Latest Editions) *Clinical Pathology and Clinical Bacteriology*, JayPee Brothers, Medical Publishers

COURSE 10, Code- MM 205: Practical (Based on course 6-9)

COURSE 11, Code- MM 301: MOLECULAR IMMUNOLOGY

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

Unit II- Antigens and Immunogenicity: structure and general properties of antigens, preparation of antigens, types of antigens-haptens, super-antigens; Cluster of differentiation molecules (CDs); Antigen recognition molecules; Major histocompatibility complex (MHC); T-cell receptor and B-cell receptor; Molecular features of Antigenic Determinants.

Unit III- Immunoglobulins : structure and types of Immunoglobulins; Genetic diversity of Immunoglobulins; Antigen-antibody interaction; Binding of Immunoglobulins to antigen; B-cell biology and T-cell biology; Complement system.

Unit IV- Immunoassays for diagnosis of infectious diseases: Agglutination, Precipitation, Immunodiffusion, Immunoelectrophoresis, Immunoblotting, ELISA, RIA, Fluorescent antibody assay, Immunoelectron microscopy, Opsonization and Neutralization.

Unit V- Immune system in health and disease: Infections and vaccines; Types of Vaccines and their characteristics, principles of vaccination and immunization of test animals; Monoclonal antibodies and Hybridoma technology; Applications of monoclonal antibodies; Immune disorders: Hypersensitivity reaction, Autoimmune diseases, Immunodeficiency, Transplantation rejection, Tumour immunology, Immunology and AIDS, Immunity to bacterial, viral, parasitic and fungal infections.

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 12, Code- MM 302: MICROBIAL GENETICS, MOLECULAR BIOLOGY AND GENETIC ENGINEERING

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

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

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

Unit 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. Jeff Hardin, Gregory Bertoni, Lewis J. Kleinsmith (2012). Becker's Word of the cell.
6. William. D Stans Field (2012). Molecular and cell Biology, Mc Graw Hill pub.
7. Gerald Karp (2014). Cell Biology, Wiley Blackwell, Pub.

COURSE 13, Code- MM 303: LABORATORY DIAGNOSIS IN CLINICAL MICROBIOLOGY

Unit I- Collection, transport and storage of clinical specimens; Specimen processing (Bacteriology, Virology, Mycology and Parasitology); Prevention and control of laboratory acquired infections; Identification of Microorganisms; Different staining techniques: simple, Gram's staining, Ziehl-Neelsen method for AFB, Flurochrome staining, Leishman's staining, Giemsa's staining and special staining methods to demonstrate granules, capsule and endospores.

Unit II- Laboratory diagnosis of diarrhoea, dysentery, food poisoning, sore-throat, pyrexia of unknown organs, STD, UTI, RTI and upper respiratory tract infections.

Unit III- Haemoglobin estimation; Blood collection: capillary puncture, venipuncture; White blood cells (WBC), Red blood cells (RBC) and Platelet count; Preparation of peripheral blood smear; Staining and Differential Leucocyte Count (DLC); Erythrocyte Sedimentation Rate (ESR), Packed Cell Volume (PCV) or Haematocrit, and Absolute values; Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC); Blood grouping.

Unit IV- Clinical pathology: physical, chemical and microbiological examination of urine, stool, CSF and blood culture; Semen analysis; Pregnancy test and throat swab culture.

Unit V- Infection in clinical practice: Infections of the Skin and Tissues, Respiratory tract, Gastrointestinal tract and related organisms, Urinary tract, Genital tract, Central nervous system, Eye and surrounding structure, Bone and Joints, Congenital and Neonatal infections, Hospital patients infections, Immunocompromised patients's infections.

Suggested Readings (Latest Edition): -

1. Sangeeta Sharma (2010) Medical Laboratories management, Viva Publications.
2. Murray, P.R., Baron, E.J., Tenover, F.C. and Tenover, R.H. (latest Edition) *Manual of Clinical Microbiology*, American Society for Microbiology, ASM Press.
3. Akhil Bansal (2012). Basic of body fluids analysis of undergraduate and post graduate students. Pvt Ltd.
4. Fleming, D.O., Richardson, J.H., Tulis, J.J. and Tenover, D. (latest Edition) *Laboratory Safety: Principles and Practices*, ASM Press, Washington, D.C.
5. Truant, AL (latest Edition). *Manual of Commercial Methods in Clinical Microbiology*, ASM Press Washington, D.C.
6. Estridge, B.H., Reynolds, A.P. and Walters, N.J. (latest Edition). *Basic Medical Laboratory Techniques*, Delmar, Thomson Learning.

COURSE 14, Code- MM 304: BIOSTATISCS and MEDICO-INFORMATICS

Unit I- Computer System: Definition; Components (Input/Output Unit, Control Unit, Primary Storage Unit, Arithmetic and Logic Unit); Types of Memory; Communication Pathways (Control Bus, Address Bus, Data Bus); Classification of Computers (according to logic & size), Generation of Computers; Introduction to Software; Definition; Classification of Software; Introduction to Internet; Internet basics for Microbiologist (Electronic mail, Downloading files with anonymous FTP, Gopher, World Wide Web).

Unit II- Database System: Definition; Purpose of Database System; Advantages of Database System; Components of Database System (Data, Hardware, Software & Users), Database Administrator; Data. Administrator; Data Models (Relational, Network, Hierarchical); Three Level Architecture for Database System (Internal Level; Conceptual Level; External Level).

Unit III- Biological Databases: Introduction to Bioinformatics; Biological Databases System (Nucleic Acid Sequence Database, Protein Sequence Database & Protein Structure) Important bioinformatics websites (NCBI, EBI, SIB, etc.); Information Retrieval through ENTREZ; BLAST Programs; (BLASTP, BLASTN, BLASTX, TBLASTN, TBLASTX); CLUSTALX; PRIMER Designing Software; Restriction Enzyme Software.

Unit IV- Frequency distribution; measures of central tendency (mean, median and mode); Measures of dispersion: mean deviation and standard deviation. Correlation and regression: Scatter Diagram, Coefficient of Correlation, Rank correlation. Lines of Regression. Probability: Basic concepts related to probability theory, classical probability. Probability distributions: Introduction and simple properties of Binomial, Poisson, Normal and skewed distribution and their applications in biology. Sampling: Concept of sampling and sampling techniques.

Unit V- 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.

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 15, Code- MM 305: Practical (Based on course 11-14)

COURSE 16, Code- MM 401: Parasitology

Unit I- General characters of parasites, parasitological terminology, basics of parasitology, introduction to pathogenic parasites: Pathogenecity and Epidemiology of parasitic infections; parasitic infection versus host resistance , Epidemiology of infectious diseases; Classification of pathogenic protozoa and helminths with characterstisc of each class.

Unit II- Classification, pathogenesis, laboratory diagonosis,treatment and prevention of intestinal and urogenital diseases caused by protozoan: *Entamoeba*, *Giardia*, *Balantidium Blood and tissue protozoa*, *Trichomonas*, *Leishmania*, *Trypanosoma*, *Toxoplasma* and *Plasmodium*.

Unit III- Classification, pathogenesis, laboratory diagonosis, treatment and prevention of intestinal and urogenital diseases caused by Helminths: cestodes; *Taenia*, *Diphyllobothrium*, *Echinococcus*, *Hymenolepism* and Trematodes: *Paragonimus*, *Fasciola and*, *Schistosoma*. Nematodes; *Ancylostoma*, *Ascaris*, *Necator and Waucheria*.

Unit IV- Common Arthropods and other vectors viz. Mosquito, sand fly, ticks, mites, Cyclops, louse, mysis; The role of vector in causing disease, elimination and control of vectors.

Unit V- Host-Parasite interaction: Symbiosis and Parasitism-Ecological Aspects of Parasitism-Parasite-Host Interaction-Sources of parasitic infections. Detection and identification of parasites: Examination of stool, intestinal content, Urine sputum and blood; antiparasitic agents and susceptibility tests.

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. Talaro K.P. & Talaro A. (Latest Edition). Foundations in Microbiology (6th Ed.), McGraw-Hill College Dimensi.
6. H.Srinivasa (2013). Text book of Medical Parasitology-protozoology and Helminthology.
7. Liu Chang Xing (Latest Edition). Medical Microbiology and Parasitology.

COURSE 17, Code- MM 402: Epidemiology: Disease Control and Public Health

Unit 1: History of epidemiology, basic vocabulary and processes used in the science of epidemiology, routes of transmission of disease, incidence and prevalence rates, non communicable and communicable infection, healthcare associated infection- nosocomial infections, microorganism responsible for nosocomial infection, epidemiology of nosocomial infection.

Unit 2: Studies of infectious notifiable diseases as AIDS, anthrax, botulism, cholera, gonorrhoea, encephalitis, hepatitis, rabies, syphilis, tetanus, tuberculosis, typhoid, yellow fever with their signs, symptoms, diagnostic test, chemotherapy and vaccines availability.

Unit 3: Health and Disease: Basic Concepts and Definition, Disease Control and Levels of Prevention, Determinants and Indicators of Health, Health situation and Trends in India. Genesis and Development of the concept, Healthcare versus Medical Care, Approaches to Public Health, Primary Health care, Millennium developmental Goals.

Unit 4: Environment and Health: Environmental degradation and human pathology, Examination of living/ working environment & its impact on human health; Laws on Environmental protection, the Right to a safe biosphere.

Unit 5: Nutrition and Health: Classification and Nutritional profiles of various foods and drinks, Balanced diet, Diet survey, consumption unit, nutritional classification, Nutritional problems e.g. LBW, PEM, Xerophthalmia, IDD, etc. Nutritional factors in selected/ major diseases (Cardiovascular, Diabetes, Obesity, Cancer), Food toxicity, socio-ecology of nutrition; Industrial and Occupational Health: Industrial and Occupational hazards and accidents, Occupational diseases and their prevention.

Suggested reading (Latest Edition)

1. Kenneth. J. Ryan (2010) Sherris's Medical Microbiology, Mc Graw Hill.
2. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th ed. McGraw Hill.
3. Greenwood D (2015). Medical Microbiology, 18th Edition, Elsevier.
4. Murray PR, Tenover FC and Tenover FC and Tenover FC and Tenover FC (2007). Clinical Microbiology. ASM Press.
5. Robert S. Burlage (2012). Principles of Public Health Microbiology.
6. Ronald M Atlas, James W Snyder (2013). Hand book of Media for clinical and public health Microbiology, CRC press.

COURSE 18, Code- MM 403: Pharmaceutical Microbiology

Unit I: General Characteristics of antimicrobial drugs, Factors influencing antimicrobial drug effectiveness, Antibiotics and synthetic antimicrobial agents: Aminoglycosides, β - lactams, tetracyclines, ansamycins, antifungal antibiotics, antitumor substances; peptide antibiotics, Chloroamphenicol, sulpha drugs; disinfectants, antiseptics and preservatives.

Unit II: Mechanism of actions of antibiotics: penicillin, vancomycin (cell wall synthesis inhibition); aminoglycosides, tetracycline, chloramphenicol (protein synthesis inhibition); Rifampin, quinolones and fluoroquinolones (nucleic acid synthesis inhibition); polymyxin B (cell membrane disruption), determining the level of antimicrobial activity.

Unit III: Molecular principles of drug targeting, drug delivery system in gene therapy, bacterial resistance to antibiotics; Mode of action of non-antibiotic antimicrobial agents; Penetrating defenses- how the antimicrobial agents reach the targets, cellular permeability barrier, cellular transport system and drug diffusion.

Unit IV: Microbial contamination and spoilage of pharmaceuticals products: sterile injectibles, noninjectibles, and their sterilization; Manufacturing procedures and in process control of pharmaceuticals. Use of microbial enzymes in pharmaceuticals, biosensors, Immobilization procedures for pharmaceuticals application (Liposomes), Macromolecular, cellular and synthetic drugs carriers.

Unit V: Good manufacturing practices (GMP) and good laboratory practices (GLP) in pharmaceutical industry, regulatory aspects of quality control, Quality assurance and quality management in pharmaceuticals ISO, WHO, and US certification, chemical and biological indicators, Safety in microbiology laboratory.

SUGGESTED READING (Latest Edition)

1. Reed G (latest Edition). Industrial Microbiology. CBS Publishers (AVI Publishing Co.)
2. Kalapna Merchant (Latest Edition). Pharmacological regulation of Genes, CRC press.
3. Bhosh, Fiechter and Blakebrough Advances in Biochemical Engineering. Springer Verlag Publications.
4. Creuger and Creuger (2005). Biotechnology- A Textbook of Industrial Microbiology, Sinauer Associates.
5. Casida LE(2010). Industrial Microbiology, New Age International Publication.
6. B.D.Singh (2015). Biotechnology, Kalyani publication.

COURSE 19, Code- MM 404: Nutritional Therapy

Unit I: Sources of Nutrition, Nutritional requirements of a healthy person, Therapeutic nutrition, Nutritional supplements, Artificial nutrition, Enteral Nutrition, Parenteral Nutrition. Functional foods, types of functional foods,

Unit II: Use of Therapeutic nutrition in Nausea, Vomiting, Swallowing problems, Weight loss and related problems; Allergies and intolerances, Food allergies, Diagnosis of food allergies and intolerance, Dietary management of food allergies, Peanut allergy, Cow milk allergy. Digestive disorders and diets.

Unit III: Diabetes, types of diabetes, complications associated with diabetes, Therapeutic nutrition and management of diabetes. Heart diseases, dietary fat and cholesterol. Renal/kidney conditions, Acute Renal failure, Chronic renal failure, Eating the right amount of energy, fluid restrictions, sodium restrictions, diet and kidney stones.

Unit IV: Cancer, dietary factors associated with cancer, Cancer therapy and nutrition, nutritional side effects and suggested dietary management. Other metabolic conditions of liver, Hepatitis, Cirrhosis, Gallbladder and Pancreas and their proper functioning by management of food diets.

Unit V: Food for man: use of microbes and microbial enzymes in the improvement of nutritive quality of food, probiotics, microbiological criteria for food, fruit juices, food control.

Suggested reading (Latest Edition):

1. Adams M. R. & Moss M. O. Food Microbiology, Royal Society of Chemistry Publication, Cambridge. Pergamon Press.
2. Hobbs B. C. & Roberts D. Food poisoning and Food Hygiene, Edward Arnold (A division of Hodder and Stoughton London).
3. Robinson R. K. Dairy Microbiology, Elsevier Applied Sciences, London.
4. Jones, S., Quinn S. (2005). Textbook of Functional Medicine.
5. Jonathan V. Wright (latest Edition) Dr Wright's book of nutritional therapy
6. William C Frazier (2015). Food Microbiology, Mc Graw Hill.

COURSE 20, Code- MM 405: Practical (Based on course 16-19)

Third Year

COURSE 21, Code- MM 501: Practical

COURSE 22, Code- MM 502: Practical