SENGUNTHAR ARTS AND SCIENCE COLLEGE

(Autonomous)

(Affiliatedto PeriyarUniversity,Salem and Approved by AICTE,NewDelhi)
AnISO9001:2015Certified Institution.Recognised under section2(f) and12(B)of theUGCAct,1956and Accredited byNAAC withA+
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SYLLABUS

M.Sc.,MICROBIOLOGY

(CBCS –LOCF)

(With effect from the AcademicYear2024-25onwards)

I YEAR

S.No	Part	CourseCategory	Course code	Title of the course	Hrs/ Week			Credit Points	Max Marks		
					L	T	P		CIA	ESE	Total
SEMESTER –I											
1	I	Core - I	**24S1PMI01**	Introductory Microbiology and Microbial Diversity	7	-		5	25	75	100
2	I	Core II	**24S1PMI02**	Immunology, Immunomics and Microbial Genetics	7	-		5	25	75	100
3	I	Core III	**24S1PMIP01**	Practical-I	-	6		4	40	60	100
4	I	Elective I	**24S1PMIE01**	Forensic Science	5	-		3	25	75	100
			24S1PMIE02	Health Hygiene							
			24S1PMIE03	Micro Algal Technology							
5	I	Elective II	**24S1PMIE04**	Bioresearch Instrumentation	5	-		3	25	75	100
			24S1PMIE05	Herbal Technology and Cosmetic Microbiology							
			24S1PMIE06	Essentials of Laboratory Management and Biosafety							
Total					**24**	**06**		**20**			

S.No	Part	CourseCategory	Course code	Title of the course	Hrs/ Week			Credit Points	Max Marks		
					L	T	P		CIA	ESE	Total
SEMESTER –II											
1	I	Core IV	**24S2PMI03**	Medical Bacteriology and Mycology	6	-		5	25	75	100
2	I	Core V	**24S2PMI04**	Medical Virology and Parasitology	6	-		5	25	75	100
3	I	Core VI	**24S2PMIP02**	Practical-II	-		6	5	40	60	100
4	I	Elective III	**24S2PMIE07**	Epidemioloy	5	-		3	25	75	100
			24S2PMIE08	Clinical Diagnostic Microbiology							
			24S2PMIE09	Bioremediation							
5	I	Elective IV	**24S2PMIE10**	Bioinformatics	5	-		3	25	75	100
			24S2PMIE11	Nanobiotechnology							
			24S2PMIE12	Clinical Research and Clinical Trials							
6	II	Skill Enhancement Course: I	**24S2PMIN01**	Vermitechnology	4	-		2	25	75	100
7	III	Common Paper	**24S2PHR01**		2			1			
Total					**24**	**06**		**24**			

COREI–INTRODUCTORY MICROBIOLOGY AND MICROBIAL DIVERSITY

Unit	Details	No. of Hours
I	**Historical Foundations and Scope of Microbiology:** Contributions of Antonie von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Germ theory of disease, Development of various microbiological techniques and golden era of microbiology. Role of microorganisms in Medical microbiology and immunology, Industrial Microbiology, Agricultural microbiology.	18
II	**Microscopy**- Bright field and dark field microscopy, Fluorescence Phase contrast Microscopy, Electron Microscopy (SEM &TEM), Confocal microscopy and Micrometry. Staining methods – Simple, Differential and Special staining.	18
III	**Cell organization**: Bacterial Structure, properties and biosynthesis of cellular components – Cell wall and. Sporulation. Growth and nutrition – Nutritional requirements, Growth curve, Batch culture, Synchronous growth, Measurement of growth and factors affecting growth. Fungi - Distribution, morphology, classification, reproduction and economic importance, Algae - Distribution, morphology, classification, reproduction and economic importance	18
IV	**Laboratory techniques:** Sterilization, Disinfection and its validation. Pure cultures techniques – Cultivation of Anaerobic organisms. Automated Microbial identification systems. Maintenance and preservation of pure cultures. Culture collection centres –National and International(**NRMC, IMTECH, ATCC& PCCC)**. **Poster Preparation**	18
V	**Extremophiles:** Thermophiles - Classification, Thermophilic archaebacteria and its applications. Methanogens - Classification, Habitats, applications. Alkaliphiles and Acidophiles - Classification, discovery basin, its cell wall and membrane. Barophiles- Classification and its applications. Halophiles - Classification, Osmoadaptation / halotolerance - Applications of halophiles. **Self Study- economic importance of extremophiles**	18
	Total	90
• **Poster preparation – related to the above topic are to be considered for internal exam only**		

COREII: IMMUNOLOGY, IMMUNOMICS AND MICROBIAL GENETICS

Unit	Details	No. of Hours
I	**Physiology of immune system:** Cells and organs of Immune System. T and B lymphocytes – Origin, development, differentiation, lymphocyte subpopulation in humans. Innate immunity- Complement, Toll-like receptors and other components. Acquired immunity – Active and Passive immunity. Antigens - features associated with antigenicity and immunogenicity. Basis of antigen specificity. MHC genes and products, Structure of MHC molecules, Genetics of HLA Systems – Antigens and HLA typing.	20
II	**Immunoglobulins:**Theories of antibody production. Generation of antibody diversity. Monoclonal and polyclonal antibodies. Complement system – mode of activation- Classical, Alternate and Lectin pathways, biological functions. Antigen recognition – TCR, Diversity of TCR, Humoral Immunity, CMI – Cell mediated cytotoxicity, DTH response. Hypersensitivity – Types and mechanisms, Autoimmunity, Tumor Immunity and Transplantation immunology. Immunodeficiency-Primary immunodeficiency and Secondary immunodeficiencies.	20
III	**Immunohematology:** Genetic basis and significance of ABO and other minor blood groups in humans, Bombay blood group, Secretors and Non-secretors, Rh System and genetic basis of D-antigens. Diagnostic Immunology - Precipitation reaction, Immunodiffusion methods - SRID, ODD. Immunoelectrophoresis - Rocket and Counter current electrophoresis. Agglutination - Hemagglutination - Hemagglutination inhibition. Labeled Assay- Immunofluorescence assay, Radio immunoassay, FISH, ELISA. Flow cytometry. Immune regulation mechanisms – immuno-induction, immuno- suppression, immuno- tolerance, immuno-potentiation, Immunomodulation. Role of cytokines, lymphokines and chemokines. Introduction to Vaccines and Adjuvants - Types of vaccines.Immunomics - Introduction and Applications.	25
IV	**Genomic Structure of prokaryotic and eukaryotic:** Prokaryotic genomic structure. Eukaryotic genome - Structure of chromatin, chromosome, centromere, telomere, nucleosome. Modifications-methylation, acetylation, phosphorylation and its effect on structure and function of chromatin, DNA methylation and gene imprinting, organelle genome. **Power point presentation**	13
V	**Gene Transfer Mechanisms:** Conjugation and its uses. Transduction, Generalized and Specialized, Transformation– Natural Competence and Transformation. Transposition and Types of Transposition reactions. Insertion sequences, complex and compound transposons – T10, T5, and Retroposon. Mechanism – Transposons of *E. coli*, Bacteriophage and Yeast. Importance of transposable elements in horizontal transfer of genes and evolution. **Self study–Application of Molecular diagnosisin Microbiology.**	12
	Total	90

- **Powerpoint preparation – related to the above topic are to be considered for internal exam only**

CORE III– PRACTICAL - I

Unit	Details	No. of Hours
I	Microscopic Techniques: Light microscopy: Hay infusion broth. Wet mount to show different types of microbes, hanging drop. Sterilization methods: moist heat, dry heat, and filtration. staining techniques - Simple staining, Gram's staining, Acid fast staining, Meta chromatic granule staining, Spore, Capsule, Flagella.	20
II	Media Preparation: Preparation of liquid, solid and semisolid media. Agar deeps, slants, plates. Preparation of basal, enriched, selective and enrichment media. Preparation of Biochemical test media, media to demonstrate enzymatic activities.Microbial Physiology: Purification and maintenance of microbes. Streak plate, pour plate, and slide culture technique. Aseptic transfer. Direct counts –Total cell count, Turbidometry. Viable count - pour plate, spread plate. Bacterial growth curve. Effect of physical and chemical factors on growth. Anaerobic culture methods.	20
III	Blood Grouping, Rh Typing Identification of various immune cells by morphology – Leishman staining, Giemsa staining Agglutination Reactions- Latex Agglutination reactions- RF, ASO, CRP. Detection of HBs Ag by ELISA. Precipitation reactions in gels– Ouchterlony double immunodiffusion (ODD) and Rocket immuno electrophoresis and counter current immuno electrophoresis.	20
IV	Preparation of lymphocytes from peripheral blood by density gradient centrifugation. Purification of immunoglobulin–Ammonium Sulphate Precipitation. Separation of IgG by chromatography using DEAE cellulose or Sephadex.	10
V	Western Blotting – Demonstration. Isolation of genomic DNA from *E. coli* and analysis by agarose gel electrophoresis Estimation of DNA using colorimeter (Diphenylamine reagent) Separation of proteins by polyacrylamide gel electrophoresis (SDS-PAGE) UV induced mutation and isolation of mutants by replica plating technique. Plasmid DNA isolation from *E.coli*. RNA isolation from yeast. RNA estimation by Orcinol method.	20
	Total	90

ELECTIVE I - FORENSIC SCIENCE

Unit	Details	No. of Hours
I	**History of Development of Forensic Science in India**- Definition, history and development of forensic science. Scope and need of forensic science in present scenario. Branches of forensic science. Tools and techniques of forensic science. Duties of a forensic scientist.	12
II	**Forensic Science Laboratories in India**- Organizational setup of a forensic science laboratory. Central and State level laboratories in India. Mobile forensic science laboratory and its functions. Forensic microbiology - Types and identification of microbial organisms of forensic significance.	12
III	**Forensic serology:** Definition, identification and examination of body fluids - Blood, semen, saliva, sweat and urine. Forensic examination and identification of hair and fibre.	12
IV	**Forensic DNA Typing:** Introduction, history of DNA typing. Extraction of DNA from blood samples - Organic and Inorganic extraction methods. DNA fingerprinting - RFLP, PCR, STR. DNA testing in disputed paternity. **Power point Presentation-** DNA testing in disputed paternity.	12
V	**Forensic toxicology:** Introduction and concept of forensic toxicology. Medico legal post mortem and their examination. Poisons - Types of poisons and their mode of action. **Self study-Testing of chemical nature of poisionous material**.	12
	Total	60

- **Power point Presentation – related to the above topic are to be considered for internal exam only**

ELECTIVE I - HEALTH AND HYGIENE

Unit	Details	No. of Hours
I	**Importance of Hygiene:** Factors affecting health, health habits and practices. Recognizing positive & negative practices in the community. Scientific principles related to health.	12
II	**Nutrition and Health:** Balanced diet, Food surveillance, food Fortification, adulteration and preventive measures. Health laws for food safety. Environmental and housing hygiene, Ventilation and lighting.	12
III	**Personal hygiene and Physical Practices:** physical exercises and their importance – Walking, jogging, yoga and meditation, stress relief, Sun bathing, Colon Hygiene. Health destroying habits and addictions-Pan, Supari, ganja, drinking, smoking, tea and coffee. International control of health, WHO. **Powerpoint Presention:** My Physical Practices	12
IV	**Mental hygiene and health**: factors responsible, developmental tasks, basic needs, emotional stability. Mental hygiene and health in infancy, early childhood, adolescence, adult hood and oldage. Mental health occupational hazards.	12
V	**Health programme and Health Policy:** Determinants of health, Key Health Indicators, Health Education, Malaria control, Tuberculosis control, AIDS control programmes and Immunization Programmes. Family planning, Reproductive And Child health programmes (RCH). National Health Policy of Govt. of India. **Self study-RDA and Malnutrition.**	12
	Total	60

- **Powerpoint Presention – related to the above topic are to be considered for internal exam only**

COREI–ELECTIVE I: MICRO ALGAL TECHNOLOGY

Unit	Details	No. of Hours
I	**Introduction to Phycology:** General characteristics. Classification of algae according to Fritsch. Salient features of different groups of algae. Identification methods. Economically important microalgae.	12
II	**Isolation and culturing of Algae:** Growth media. Isolation and enumeration of microalgae. Laboratory cultivation and maintenance. Outdoor cultivation - Photobioreactors - construction, types and operation; raceway ponds - Heterotrophic and mixotrophic cultivation - Harvesting	12
III	**Commercial values of Microalgae**: Algal single cell proteins (*Spirulina* and *Dunaliella*). Microalgae as aquatic, poultry and cattle feed. Microalgal biofertilizers. Value-added products from microalgae. Pigments - microalgal carotenoids and Phycobiliproteins their commercial applications. Polyunsaturated fatty acids as active nutraceuticals. Microalgal secondary metabolites - Pharmaceutical and cosmetic applications.	12
IV	**Phycoremediation**: Domestic and industrial waste water treatment. High-rate algal ponds and surface-immobilized systems - Treatment of gaseous wastes by microalgae. Sequestration of carbon dioxide. Scavenging of heavy metals by microalgae. Negative effects of algae. Algal blooms, algicides for algal control.	12
V	**Microalgae as feed stock for production of biofuels:** Carbon-neutral fuels. Lipid-rich algal strains - *Botryococcus braunii*. Drop-in fuels from algae -hydrocarbons and biodiesel, bioethanol, biomethane, biohydrogen and syngas from microalgae biomass. Biocrude synthesis from microalgae. Analysis of algae biofuels. **Self study –** Manufacturing of Algal biofuels	12
	Total	60

CORE I–ELECTIVE II: BIOINSTRUMENTATION

Unit	Details	No. of Hours
I	**Basic laboratory Instruments:** Aerobic and anaerobic incubator – Biosafety Cabinets - Fume Hood, pH meter, Lyophilizer, Flow cytometry. Centrifugation techniques: Basic principles of centrifugation - Standard sedimentation coefficient - measurement of sedimentation co-efficient; Principles, methodology and applications of differential, rate, zonal and density gradient centrifugation- Applications In determination of molecular weight.	12
II	**Biomolecules separation Techniques:** Chromatographic Types- Thin layer chromatography, Paper Chromatography, Liquid chromatography (LPLC &HPLC), Adsorption, ion exchange, Gel filtration, affinity, Gas liquid (GLC). Flash Chromatography and Ultra Performance convergence chromatography. Two dimensional chromatography. Stimulated moving bed chromatography (SEC).	12
III	**Separation of Biomolecules by Electrophoresis:** General principles - electrophoretic mobility – supportive materials – electro endosmosis – types (horizontal, vertical and two dimensional electrophoresis)- Principle and applications - paper electrophoresis, Serum electrophoresis, starch gel electrophoresis, Disc gel, Agarose gel, SDS – PAGE, Immunoelectrophoresis. Blotting techniques-Southern, northern and western blotting.	12
IV	**Spectroscopic techniques:** Principle, simple theory of absorption of light by molecules, electromagnetic spectrum, instrumentation and application of UV- visible, Raman, FTIR spectrophotometer, spectrofluorimetry, Atomic Absorption Spectrophotometer, Flame spectrophotometer NMR, ESR, Emission Flame Photometry and GC-MS. Detection of molecules in living cells - FISH and GISH.	12
V	**Radioisotopic techniques:** Principle and applications of tracer techniques in biology. Radioactive isotopes - radioactive decay; Detection and measurement of radioactivity using ionization chamber, proportional chamber, Geiger- Muller and Scintillation counters, auto radiography and its applications. Commonly use di-isotopes in biology, labeling procedures and safety aspects. **Self study- Standard Operating Procedures.**	12
	Total	60

ELECTIVE II: HERBAL TECHNOLOGY AND COSMETIC MICROBIOLOGY

Unit	Details	No. of Hours
I	**Concepts of Herbal medicine:** Indian medicinal plants: Scope and Applications of Indian medicinal plants in treating bacterial, fungal and viral diseases. Basic principles involved in Ayurvedha, Sidha, Unani and Homeopathy.	12
II	**Collection and authentication of selected Indian medicinal plants:** *Emblica officinalis, Withania somnifera, Phyllanthus amarus, Tinospora cordifolia, Andrographis paniculata, Piper longum, Ocimum sanctum, Azardirchata indica, Terminalia chebula, Allium sativum*. Preparation of extracts- Hot and cold methods. Preparation of stock solutions. **Case Study-Identification of any one Herbal Plant**	12
III	**Antimicrobial activity of selected Indian medicinal Plants:** In vitro determination of antibacterial and fungal activity of selected whole medicinal plants/ parts – well-diffusion methods. MIC - Macro and micro dilution techniques. Antiviral activity- cell lines- cytotoxicity, cytopathic and non-cytopathic effect.	12
IV	**Cosmetic Microbiology:** Need for cosmetic microbiology, Scope of cosmetic microbiology- Role of microbes in cosmetic preparation. Preservation of cosmetics. Antimicrobial properties of natural cosmetic products – Garlic, neem, turmeric, aloe vera and tulsi. Sanitary practices in cosmetic manufacturing - HACCP protocols in cosmetic microbiology.	12
V	**Microbiological test for Cosmetics:** Antimicrobial preservative efficacy, microbial content testing and biological toxicological testing. Validation methods -bioburden and Pharmacopeial microbial assays. Preservatives of cosmetics - Global regulatory and toxicological aspect of cosmetic preservatives. **Self study-Making herbal Antirepellents product like mosquito coil.**	12
	Total	60
• **Case Study – related to the above topic are to be considered for internal exam only**		

ELECTIVE II: ESSENTIALS OF LABORATORY MANAGEMENT AND BIOSAFETY

Unit	Details	No. ofHours
I	**Principles of Laboratory Management:** General laboratory facilities, Occupational safety- Lab accidents - Fires, chemical burns, slips and falls, Animal bites. Cuts from broken glass. Toxic fume inhalation. General laboratory rules, Good laboratory practice (GLP). Laboratory plan.	12
II	**Laboratory hazards:** Chemical hazards- Safe handling of chemicals and gases, hazard labels and symbols. Material safety datasheet (MSDS), Chemical handling - Fume hood, Storage of chemicals. Chemical Waste Disposal Guideline. Physical hazards - Physical agent data sheets (PADS), Electric hazards- Electrical shock, Electrical explosions, Electrical burns. Safe work practices. Potential ignition sources in the lab. Stages of Fire. Fire Extinguishers. Fire Response.	12
III	**Safety precautions & First aid for laboratory accidents:** Personal protective equipment (PPE), Proper attire (Eye/Face Protection, laboratory coats, gloves, respirators. Disposal/Removal of PPE. Emergency equipment safety - Showers/ Eye Washes. Laboratory security and emergency response. First aid for - Injuries caused by broken glass, Acid/Alkali splashes on the skin, swallowing acid/alkali, burns caused by heat, electric shock.	12
IV	**Introduction to Biosafety**: Biological safety cabinets. Primary containment for biohazards. Biosafety levels of specific microorganisms recommended biosafety. Risk groups with examples - Risk assessment.Packing, sending, transport, import and export of biological agents. Hygiene, disinfection, decontamination, sterilization. **Case studies - Safe working, hand hygiene**	12
V	**Biosafety regulations and guidelines:** Centers for disease control and prevention and the National institutes of health. Recombinant DNA advisory committee (RDAC), Institutional biosafety committee(IBSC), Review committee on genetic manipulation(RCGM), Genetic engineering approval committee (GEAC). Implementation of biosafety guidelines. **Self Study-Members of various Committees**	12
	Total	60
• **Case studies – related to the above topic are to be considered for internal exam only**		

SEMESTER -II

CORE IV–MEDICAL BACTERIOLOGY AND MYCOLOGY

Unit	Details	No. of Hours
I	**Pathogenesis of Bacterial Infection:** Normal flora of human body, Bacterial virulence factors, Regulation of bacterial virulence factors. Collection, transport, storage and processing of clinical specimens, Microbiological examination of clinical specimens, antimicrobial susceptibility testing. Handling and maintenance of laboratory animals – Rabbits, guinea pigs and mice.	20
II	**Pathogenesis of G+ve Bacteria:** Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by species of *Staphylococci*, *Streptococci*, *Pneumococci*, *Neisseriae*., *Bacillus*, *Corynebacteria*, *Mycobacteria* and *Clostridium*	20
III	**Pathogenesis of G-ve Bacteria:** Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by Enterobacteriaceae members, *Yersinia, Pseudomonas, Vibrio, Mycoplasma, Helicobacter, Rickettsiae, Chlamydiae, Bordetella, Francisella, Spirochaetes-Leptospira, Treponema* and *Borrelia*. Nosocomial, zoonotic and opportunistic infections -prevention and control. **Field Visit- Report Preparation (Clinical Lab- Processing of sample)**	20
IV	**Superficial Mycoses:** Morphology, taxonomy and classification of fungi. Detection and recovery of fungi from clinical specimens. Dermatophytes and agents of superficial mycoses. *Trichophyton, Epidermophyton & Microsporum*. Yeasts of medical importance – *Candida, Cryptococcus*. Mycotoxins. Antifungal agents, testing methods and quality control.	15
V	**Systemic mycoses:** *Histoplasma, Coccidioides, Sporothrix, Blastomyces.* Fungi causing Eumycotic Mycetoma, Opportunistic fungi-Fungi causing secondary infections in immune compromised patients. Immunodiagnostic methods in mycology- Recent advancements in diagnosis. Antifungal agents. **Self study – Development of multidrug resistance**	15
	Total	90
• **Field Visit& Report Preparation – related to the above topic are to be considered for internal exam only**		

CORE V–MEDICAL VIROLOGY AND PARASITOLOGY

Unit	Details	No. ofHours
I	**General features of viruses**: Structure and Classification - viroids, prions, satellite RNAs and virusoids. Cultivation of viruses - embryonated eggs, experimental animals and cell cultures. Purification and Assay of viruses – Physical and Chemical methods (Electron Microscopy, Protein and Nucleic Acids studies). Infectivity Assays.	20
II	**Mode of infection, Pathogenesis, diagnosis and Prevention and Control of viral infection:** DNA Viruses- Pox , Herpes , Adeno , Papova and Hepadna , RNA Viruses- Picorna, Orthomyxo, Paramyxo, Rhabdo, Rota, HIV and other Hepatitis viruses, Arbo – Dengue virus, Ebola virus, Emerging and re-emerging viral infections.	20
III	**Bacteriophages:** ΦX 174, M13, MU, T4, lambda, Pi; Structural organization, life cycle and phage production. Lysogenic cycle-typing and application in bacterial genetics.	15
IV	**Medical Parasitology:** Classification, host-parasite relationships. Epidemiology, life cycle, pathogenic mechanisms, laboratory diagnosis, treatment for the following: Protozoa causing human infections – *Entamoeba,* Aerobic and Anaerobic amoebae, *Giardia, Trichomonas, Balantidium. Toxoplasma, Cryptosporidium, Leishmania,* and *Trypanasoma.*	15
V	**Medical Helmithology:** Classification, life cycle, pathogenicity, laboratory diagnosis and treatment for Cestodes – *Taenia Solium, T. Saginata, T. echinococcus*. Trematodes – *Fasciola hepatica, Fasciolopsis Buski, Paragonimus, Schistosomes*. Nematodes - *Ascaris, Ankylostoma, Trichuris, Trichinella, Enterobius, Strongyloides* and *Wuchereria*. Other parasites causing infections in immune compromised hosts and AIDS. Cultivation of parasites. Anti-protozoan drugs**. - Diagnosis of parasitic infections – Serological and molecular diagnosis.**	20
	Total	90

CORE-PRACTICAL –II

Unit	Details	No. of Hours
I	Staining of clinical specimens - Wet mount, Differential and Special staining methods. Isolation and identification of bacterial pathogens from clinical specimens - Biochemical identification tests. Enumeration of bacteria in urine to detect significant bacteriuria.	20
II	Examination of different fungi by Lactophenol cotton blue staining and KOH staining. Cultivation of fungi and their identification - *Mucor, Rhizopus, Aspergillus, Penicillium.*.Identification of Dermatophytes. Isolation and characterization of bacteriophage from natural sources by phage titration. Cultivation of viruses –Egg Inoculation methods. Diagnosis of Viral Infections – ELISA –HIA. Spotters of viral inclusions and CPE-stained smears	20
III	Examination of parasites in clinical specimens - Ova/cysts in faeces . Floatation methods-simple Saturated salt solution method – Zinc sulphate methods, Sedimentation methods- Formal ether method. Blood smear examination for malarial parasites. Thin smear by Leishman's stain – Thick smear by J.B. stain. Identification of common arthropods of medical importance - spotters of *Anopheles, Glossina, Phlebotomus, Aedes,* Ticks and mites	20
IV	Screening for Enzyme producers (amylase /protease). Optimization of parameters for Amylase production. Screening for Organic acid producers (acetic acid/lactic acid). Screening for Antibiotic producers. Immobilization of microbial cells and enzyme and its assessment,	15
V	Immobilization of microbial cells and enzyme and its assessment. Microbiological assay of antibiotics by cup plate method, Antimicrobial sensitivity testing - Kirby Bauer method and Stokes method. Minimum inhibitory concentration (MIC) test. Minimum bactericidal concentration (MBC) test.	15
	Total	90

ELECTIVE –III EPIDEMIOLOGY

Unit	Details	No. ofHours
I	**Fundamentals of epidemiology:** Definitions of epidemiology – Epidemiology of infectious diseases in Public Health. Natural history of disease - Historical aspects of epidemiology. - Epidemiologic Triad - Agent factors, host factors and environmental factors. Transmission basics - Chain of infection, portal of entry. Modes of transmission -. Agents and vectors of communicable diseases of public health importance and dynamics of disease transmission. Epidemiology of Zoonosis - routes of transmission of bacterial, viral, parasitic and fungal zoonotic agents.	12
II	**Tools of Epidemiology:** Measures of Disease - Prevalence, incidence. Index case. Risk rates. Descriptive Epidemiology - Cohort studies, measuring infectivity, survey methodology including census procedures. Surveillance strategies - Disease surveillance, geographical indication system, outbreak investigation in public health and contact investigation.	12
III	**Epidemiological aspects of diseases of national importance:**. Vector borne diseases in India. Diarrhoeal diseases.Viral haemorrhagic fevers. Mycobacterial infections. Sexually transmitted diseases. Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome. Emerging disease threats - Severe Acute Respiratory Syndrome (SARS), Covid-19, Ebola, MDR-TB, Malaria, Avian flu. Dengue, Swine Flu, Chikungunya. Epidemiology, prevention, and control of non-communicable diseases - Asthma, Malignancy, diabetes mellitus,eye diseases, Dental disorders. Emerging and Re-emerging Diseases.	12
IV	**Mechanisms of Antimicrobial resistance:** Multidrug Efflux pumps, Extended Spectrum β-lactamases (ESBL). Hospital acquired infections - Factors, infection sites, mechanisms, Role of Multidrug resistant pathogens. Role of *Pseudomonas, Acinetobacter, Clostridium difficile*, HBV, HCV, Rotavirus, *Cryptosporidium* and *Aspergillus* in Nosocomial infections. Prevention and management of nosocomial infections.	12
V	**National Programmes related to Communicable and Non-Communicable diseases**:National Malaria Eradication Programme, Revised National Tuberculosis Control Programme, Vector Borne Disease Control Programme, National AIDS Control Programme, National Cancer Control Programme and National Diabetes Control Programme. Biochemical and immunological tools in epidemiology - Biotyping, Serotyping, Phage typing, FAME (Fatty acid methyl ester analysis), Protein profiling. **Self study - Curie Point PyMS (Pyrolysis Mass spectrometry) Molecular typing method.**	12
	Total	60

ELECTIVE –III CLINICAL AND DIAGNOSTIC MICROBIOLOGY

Unit	Details	No. of Hours
I	**Applied Anatomy & Physiology:** Study of the structure of a cell.– Normal anatomical structure, Histology & Functions (Physiology) of the following systems. The circulatory system (Heart– & Blood Vessels) The Respiratory system The Digestive system, Lymphatic system, Urinary system ,Central nervous system .	12
II	**Microbiology Laboratory Safety Practices**: General Safety Guidelines, Handling of Biological Hazards, Diagnostic procedures - General concept of Clinical specimen collection, transport, storage and general processing in Microbiology laboratory - Specimen acceptance and rejection criteria.	12
III	**Diagnosis of microbial diseases**: Clinical, differential, Microbiological, immunological and molecular diagnosis of microbial diseases. Modern and novel microbial diagnostic methods. Automation in Microbial diagnosis.	12
IV	**Antibiotic sensitivity tests:** Disc diffusion - Stokes and Kirby Bauer methods, E test - Dilution - Agar dilution & broth dilution - MBC/MIC - Quality control for antibiotics and standard strains.	12
V	**Nosocomial Infections**: Common types, sources, reservoir and mode of transmission, pathogenesis and control measures. Emerging and Re-emerging infections. Hospital Infection Control Committee (HICC) – Functions. Infectious health care waste disposal - Biomedical waste management	12
	Total	60

ELECTIVE –III BIOREMEDIATION

Unit	Details	No. ofHours
I	**Bioremediation**: Bioaugmentation - Ex-situ and in-situ processes; Intrinsic and engineered bioremediation. Major pollutants and associated risks; organic pollutant degradation. Microbial aspects and metabolic aspects. Factors affecting the process. Recent developments and significance.	12
II	**Microbes involved in Waste Water treatment:** BOD, COD, dissolved gases, removal of heavy metals, total organic carbon removal. Secondary waste water treatments - use of membrane bioreactor. Aquaculture effluent treatment. Aerobic sludge and landfill leachate process. Aerobic digestion.	12
III	**Microbes involved in solid wastes:** Composting of solid wastes, anaerobic digestion - methane production and important factors involved, Pros and cons of anaerobic process, sulphur, iron and nitrate reduction, hydrocarbon degradation, degradation of nitroaromatic compounds. Bioremediation of dyes, bioremediation in paper and pulp industries. Aerobic and anaerobic digesters – design. Various types of digester for bioremediation of industrial effluents. **Preparation of Compost using solid Waste**	12
IV	**Microbial leaching of ores:** Bioleaching of copper and iron. Biotransformation of heavy metals and xenobiotics. Petroleum biodegradation - reductive and oxidative. Dechlorination. Biodegradable of plastics and super bug.	12
V	**Phytoremediation of heavy metals in soil:** Basic principles of phytoremediation - Uptake and transport, Accumulation and sequestration. Phytoextraction. Phytodegradation. Phytovolatilization. Phytostabilization – Organic and synthetic amendments in multi metal contaminated mine sites. Rhizodegradation. Role of Arbuscular mycorrhizal fungi and plant growth promoting rhizobacteria in phytoremediation. **Power point Presntation- Phytoremedial Plants**	12
	Total	60

- **Preparation of Compost – related to the above topic are to be considered for internal exam only**

ELECTIVE –IV BIOINFORMATICS

Unit	Details	No. ofHours
I	**Biological Data Mining:** Exploration of Data Mining Tools. Cluster Analysis Methods. Data Visualization. Biological Data Management. Biological Algorithms – Biological Primary and Derived Databases. Concept of Alignment, Pairwise Sequence Alignment (PSA), Multiple Sequence Alignment (MSA), BLAST, CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).	12
II	**Phylogenetic Tree Construction:** Concept of Dendrograms. Evolutionary Trees - Distance Based Tree Reconstruction - Ultrametric trees and Ultrametric distances – Reconstructing Trees from Additive Matrices - Evolutionary Trees and Hierarchical Clustering - Character Based Tree Reconstruction - Maximum Parsimony Method, Maximum likelihood method - Reliability of Trees – Substitution matrices – Evolutionary models.	12
III	**Computational Protein Structure prediction:** Secondary structure – Homology modelling- Fold recognition and ab initio 3D structure prediction – Structure comparison and alignment – Prediction of function from structure. Geometrical parameters – Potential energy surfaces – Hardware and Software requirements-Molecular graphics – Molecular file formats- Molecular visualization tools.	12
IV	**Prediction of Properties of Ligand Compounds:** 3D Autocorrelation -3D Morse Code-Conformation Dependent and Independent Chirality Codes –Comparative Molecular Field Analysis – 4 D QSAR –HYBOT Descriptors – Structure Descriptors – Applications – Linear Free Energy Relationships – Quantity Structure - Property Relationships – Prediction of the Toxicity of Compounds	12
V	**Molecular Docking:** Flexible - Rigid docking- Target- Ligand preparation- Solvent accessibility- Surface volume calculation, Active site prediction- Docking algorithms- Genetic, Lamarckian - Docking analyses- Molecular interactions, bonded and nonbonded - Molecular Docking Software and Working Methods. Genome to drug discovery – Subtractive Genomics – Principles of Immunoinformatics and Vaccine Development.	12
	Total	60

ELECTIVE –IV NANOBIOTECHNOLOGY

Unit	Details	No. ofHours
I	**Nanobiotechnology:** general features of nanoparticles, Classification of nanomaterials based on their dimensions (0D, 1D, 2D and 3D materials), based on realization (The First, second, third and fourth generation materials) of their applications, Need for nanomaterials and the risks associated with the materials.	12
II	**Fabrication of Nanomaterials:**Top-down and Bottom-up approaches, Solid phase synthesis-milling, Liquid phase synthesis-Sol-gel synthesis, colloidal synthesis, micro emulsion method, hydrothermal synthesis and solvo thermal synthesis, Vapour/Gas phase synthesis-Inert gas condensation, flame pyrolysis, Laser ablation and plasma synthesis techniques. Microbial synthesis of nanoparticles. **Hands on Training :Synthesis of Silver Nanopartiles**	12
III	**Characterization of nanoparticles**: Based on particle size/morphology- Dynamic light scattering (DLS),Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Atomic force microscopy(AFM), Based on surface charge-zeta potential, Based on structure –X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), Energy dispersive X-ray analysis (EDX),Based on optical properties- UV – Spectrophotometer, Based	12
IV	**Nano-medicine**s: Surface modified nano particles, MEMS/NEMS based devices, peptide/DNA coupled nanoparticles, lipid and inorganic nano particles for drug delivery, Metal/metaloxide nano particles as antibacterial, antifungal and antiviral agents. Toxicity of nanoparticles and Toxicity Evaluation. **Animated PPT Preparation- Nano particles for drug delivery**	12
V	**Nanomaterials in diagnosis:** Imaging, nanosensors in detection of pathogens. Treatment of surface water, ground water and waste water contaminated by toxic metal ions, organic and inorganic solutes and microorganisms.	12
	Total	60
• **Hands on Training - related to the above topic are to be considered for internal exam only**		

ELECTIVE –IV CLINICAL RESEARCH AND CLINICAL TRIALS

Unit	Details	No. ofHours
I	**Introduction to Clinical Research:** An Overview, Different types of Clinical Research. Clinical Pharmacology: Pharmacokinetics, Pharmacodynamics, Pharmacoepidemiology, Bioavailability, Bioequivalence, Terminologies and definition in Clinical Research. Drug Development Process: Drug Discovery Pipeline, Drug Discovery Process. Preclinical trail, Human Pharmacology (Phase-I), Therapeutic Exploratory trail (Phase-II), Therapeutic Confirmatory Trail (Phase-III) and Post marketing surveillance (Phase-IV).	12
II	**Ethical Considerations and Guideline in Clinical Research:** Historical guidelines in Clinical Research-Nuremberg code, Declaration of Helsinki, Belmont report. International Conference on Harmonization (ICH)-Brief history of ICH, Structure of ICH & ICH Harmonization Process, Guidelines for Good Clinical Practice. Regulation in Clinical Research-Drug and cosmetic act, FDA, Schedule-Y- Ethics Committee and their responsibilities. Clinical Research Regulatory Submission & approval Process- IND, NDA and ANDA submission Procedure. DCGI submission procedure. Other Regulatory authorities- EMEA, MHRA,	12
III	Clinical Trial Management: Key Stakeholders in Clinical Research, Ethics Committees and Institutional Review Board, Responsibilities of Sponsor. Responsibilities of Investigator, Protocol in Clinical Research Clinical Trial Design, Project Planning Project Managements - Informed Consent, Investigator's Brochure (IB), Selection of an Investigator and Site, Patient screening, Inclusion and exclusion criteria, Randomization, Blinding. Essential Documents in clinical research -IB, ICF, PIS, TMF, ISF, CDA & CTA.	12
IV	**Quality Assurance, Quality Control & Clinical Monitoring:** Defining the terminology-Quality, Quality system, Quality Assurance & Quality Control-QA audit plan. 21 CRF Part 11, Site Auditing, Sponsor Compliance and Auditing, SOP For Clinical Research-CRF Review & Source Data Verification, Drug Safety Reporting Corrective and preventative action process.	12
V	**Business Development in the Clinical Research Industry**: Introduction & Stages of Business Development-Start-up Phase, Growth Phase, Maturity Phase, Decline Phase. Outsourcing in Clinical Research, Reasons for outsourcing to contract research organizations, The India Advantage, Scope and Future of CRO, List of Clinical Research Organizations in India. Role of business development manager. **Self study – Role of IT companies in Clinical Research Organizations.**	12
	Total	60

SKILL ENHANCEMENT COURSE- I: VERMITECHNOLOGY

Unit	Details	No. of Hours
I	**Introduction to Vermitechnology:** Definition, history, growth and development in India and other countries, significance. Vermiculture – scope and importance; common species for culture; Environmental parmeters; culture methods – wormery – breeding techniques; indoor and outdoor cultures - monoculture and polyculture – merits and demerits, factors affecting distribution of earthworms in soil.	6
II	**Earthworm Biology and Rearing:** Key to identify the species of earthworms. Taxonomy Anatomy, physiology, reproduction and Vital cycle, (alimentation, fecundity, annual reproducer potential) and limiting factors (gases, diet, humidity, temperature, PH, light, and climatic factors) for *Eisenia fetida* and *Eudrilus eugeniae*. **Train the Student to Identify the *Eisenia fetida* and *Eudrilus***	6
III	**Vermicomposting Process:** Feeds for Vermitech systems- Animal manures- Kitchen Waste and Urban waste- Paper pulp and card board solids- Compost and waste products- Industrial Wastes. a)Basic process- Initial pre-composting phase b) Mesophilic phase- Maturing phase c)Stabilization phase- Mechanism of Earthworm action. Methods of vermicomposting- a) windrows system; b) wedge system; c) container system-pits, tanks & cement rings; commercial model; beds or bins-top fed type, stacked type, d) Continuous flow system.	6
IV	**Trouble Shooting of Vermicompost:** Temperature-Aeration-Acidity- Pests and Diseases- Ants, rodents, Birds, Centipedes, sour crop, Mite pests. Odour problems. Separation techniques- Light Separation-Sideways Separation-Vertical Separation-Gradual transfer. Harvesting Earthworms- manual method- migration method. Packing & Nutritional analysis of vermicompost.	6
V	**Applications of Vermiculture:** Use of Vermi castings in organic farming/horticulture, as feed/bait for capture/culture fisheries; forest regeneration. Application quantity of vermicompost in Agricultural fields- crops, fruits, vegetables & flowers. By-products and value-added products- Verm wash- vermicompost tea-vermi meal-enriched vermicompost-pelleted vermicompost. **Self study :Toxic chemical substances in raw materials**	6
	Total	30
• **Train the Student to Identify – related to the above topic are to be considered for internal exam only**		