MIC 1532 **FOOD AND DAIRY MICROBIOLOGY** **5Hrs/ Wk - 5Cr**

This course is designed to make students understand the nutritional significance of day today food, its composition, factors influencing spoilage,microbes causing spoilage and preservation procedures for different kinds of foods. It provides information about food - borne infection and intoxication. This curriculum also facilitates the understanding about composition, types of milk, microbial spoilage, qualitative analyses, preservation of milk and milk products. The students will also gain knowledge about fermented food products, food sanitation and regulatory bodies.

Specific Learning Outcomes (SLO):

Upon successful completion of this course, student will be able to

- Gain knowledge about food composition, balanced diet and food preservation methods
- Acquire knowledge about spoilage of foods and food – borne diseases
- Understand the fundamentals of milk microbiology
- Know about production of various types of dairy and other fermented products
- Understand the significance of food safety

UNIT – I Food microbiology and preservation: Food composition – food groups – balanced diet - scope and role of microbiologist in food industry - factors influencing microbial growth – intrinsic and extrinsic factors - food preservation methods – physical, chemical, biological methods.

UNIT – II Food spoilage and food - borne diseases: Sources - types of food spoilage - spoilage of cereals, vegetables and fruits, meat, fish, egg and poultry. Food - borne diseases – intoxication and food poisoning – bacterial, fungal and viral food - borne diseases.

UNIT – III Milk microbiology: Composition – types of milk - microbes in milk - contamination – pasteurization - spoilage and preservation of milk – microbial analyses of milk and milk products– adulteration of milk – packaging.

UNIT – IVFermentedfood products: Microbes involved in fermentation - starter cultures - butter milk, cream, yoghurt, kafir, acidophilus milk - cheese and its types. Fermented vegetables – sauerkraut and pickles.

UNIT – V Food safety: Food quality assurance - GMP – HACCP, food sanitation. International agencies – federal and state agencies – FDA – regulation - health of employees.

TEXTBOOK

William C. Frazier and Dannis C. Westhoff (1997) Food Microbiology, 4th edn, Tata McGraw – Hill, New Delhi.

REFERENCES

1. Michael P. Doyle, Larry R. Beuchat and Thomas J. Montville (1997) Food Microbiology – Fundamentals and Frontiers, ASM Press, Washington D.C.
2. Sukumar De (1997) Outlines of Dairy Technology - Oxford University Press, New Delhi.
3. Martin R Adams and Mourice O Moses (2008) Food Microbiology, 3rd edn, The Royal Society of Chemistry, UK.

MIC 2403 FUNDAMENTALS OF PHARMACOLOGY 5Hrs/Wk-4Cr

This course will familiarize students with general concepts of drugs and drug action in man at the level of molecules, cells, and tissues. It provides ample understanding about the battle against diseases at the cellular and molecular level. The students will explore the pharmacological effect of drugs, the specific biochemical processes with which they affect the molecular target and interactions. Emphasis will also given to the Pharmaceutical regulations, clinical trials, marketing and patenting. This would help the students with an awareness of the wide scope of applications of microorganisms in industry; the applications of fermentation technology and potentials for future development.

Specific Learning Outcomes (SLO)
Upon successful completion of this course, the student will be able to:

- Understand the fundamentals of pharmacology.
- Integrate and evaluate the properties of drugs.
- Know the competency of drugs and their action
- Explore on pharmacopoeial standards.
- Discover the use of microorganisms in production of useful products.

UNIT I Introduction to Pharmacology: History and scope of pharmacology- Drug and Classification, sources of drugs-plant, animal, microbial and synthetic drugs. Discovery of drugs, Drugs and Diseases- control measures.

UNIT II Drug targets: Introduction-structure, function, and cellular location of ligand-gated channels, enzymes, nuclear hormone receptors, Carrier Proteins, Structural proteins, G-protein receptors, Nucleic Acids, Lipids and Carbohydrates. Agonists, Antagonists and partial agonists.

UNIT III Pharmacodynamics and Pharmacokinetics: Drug absorption, distribution, metabolism-biotransformation of drugs, Drug excretion-. Drug dosage-Routes of drug Administration- Mechanism of drug action- drug assay- Drug toxicity and side effects.

UNIT IV Pharmacology and Pharmaceutical Regulations: Drug Formulations- Dosage Preparation, Drug load- Stability. Clinical trials- phases; Regulatory bodies- FDA, IDA, NDA, Fast Tracking, Orphan Drugs, Labeling; Scientific code regulations- GLP and GMP. Marketing- Patenting of drugs.

UNIT V Microbial Aspects of Pharmaceutical Processing: Ecology of microorganisms in pharmaceutical industry-Sterile pharmaceutical products-Production of antibiotics, immunological products- Quality control-Bioassays.

TEXT BOOK

Patrick, G (2002), Medicinal Chemistry, First Edition, Viva Books Private Limited, (ISBN-81-7649-271-X).

REFERENCES

1. Stephen P. Denyer, Norman A. Hodge and Sean P. Gorman (2004), Hugo and Russell's Pharmaceutical Microbiology, Seventh Edition, Black Well Publishers, UK.
2. Prescott L.M, Cecil G. Dunn (2004) Industrial Microbiology, 4th edn, CBS Publishers & Distributors, New Delhi.
3. Vyas, S.P., (2002) Pharmaceutical Biotechnology CBS Publishers &Distributors, Ne4w Delhi.

MIC 2536 INDUSTRIAL MICROBIOLOGY 5 Hrs/Wk – 5 Cr

This course deals with the development of industrial Microbiology and role of Microbiologist in industries. This course also explains the screening, development and preservation of industrially important strains and also emphasizes the formulation of media. The other part elucidates the types of fermentations, bioreactors, downstream process and the production of various fermented products.

Specific Learning Outcome (SLO):
Upon successful completion of this course, student will be able to

- understand the source for microorganisms of industrial importance from the environment
- Manipulate the microorganisms to produce more of these useful products
- understand the types of fermentation and bioreactors
- summarize the recovery of products
- know that microorganisms are important in the production of many useful products

UNIT – I History and Scope: Development – Contributions of Louis Pasteur and fermentation – discovery of antibiotics – growth of industrial fermentations – Applied branches of Industrial Microbiology and role of Microbiologist in industries.

UNIT – II Screening and development of strains: Isolation – crowed plate, auxanography and other methods – development and improvement – Mutation and Genetic engineering techniques. Preservation of cultures – Storage – agar slants, lyophilization and liquid nitrogen.

UNIT – III Formulation of media: Preparation of media – source and components – Agricultural and industrial waste – saccharide, starch, cellulose, nitrogen, enhancers and precursors - Medium sterilization.

UNIT – IV Fermentation and Bioreactors: Fermentation process - surface, solid state, submerged, batch and continuous fermentation – Fermentors – components of basic fermentor – pH, temperature, foam controlling device – shaft, baffle, impeller and sparger – Types of fermentors – batch and continuous fermentors, aerated and agitated fermenters and air lift fermenter.

UNIT – V Downstream processing and fermented products: Recovery of intracellular and extracellular products – removal of insoluble components – product isolation – purification – polishing. Fermented products – production of alcohol – beverages –industrially important enzymes – foods – organic acids – antibiotics and other medically important products.

TEXT BOOK

Patel A. H., (2012) Industrial Microbiology, 1st Edition, Macmillan Publishers, India.

Crueger, W., Crueger, A., and Brock, T. D. (2005) Biotechnology: A Textbook of Industrial Microbiology, 3rd Edn, Panima Publishing Corporation, New Delhi.

El – Mansi E.M.T and C.F.A. Bryce (2005) Fermentation Microbiology and Biotechnology, Replika Press Pvt. Limited, India.

REFERENCES

1. Peter F. Stanbury, Allan Whitaker, Stephen J. (2009) Principles of Fermentation Technology, 2nd Edition Hall Elsevier Science Ltd.
2. Prescott L.M, Reed G. Dunn (2004) Industrial Microbiology, 4th Edition, CBS Publishers & Distributors, New Delhi.

MIC 2537 BIOINSTRUMENTATION 5Hrs/Wk-5Cr

This course will introduce the students with the basic principles of techniques that are used routinely in modern biochemistry and molecular biology. The course focuses on separation techniques includes electrophoresis, chromatography and centrifugation. It deals with measurement of light absorption of colored substances in solutions using colorimeter and spectrophotometer. The last section is to provide knowledge on radioactivity and their applications in modern research field.

Specific learning outcomes (SLO):

At the completion of the course, the student will be able to,

- Explain the separation of molecule using electrophoresis and chromatography.
- To gain knowledge on centrifugation.
- Acquire knowledge on colorimeter and spectrophotometer.
- Understanding the radioisotope techniques and application in modern research.

UNIT-I Chromatographic techniques: General principles- Types- Paper, Adsorption, TLC, gel filtration, Ion-exchange, GC-MS, GLC and HPLC- Applications.

UNIT-II Centrifugation techniques: Basic principles of sedimentation-relative centrifugal force-conversion of G to rpm- rotors -types of centrifuges (clinical, high speed, refrigerated and ultra)- - Applications.

UNIT-III Colorimetry- Beer-Lambert's law- complementary color- standard graph preparation.Spectrophotometer- UV and Visible- IR, X-ray crystallography and atomic absorption spectrophotometry- applications.

UNIT-IV Electrophoretic techniques: General principles- types of electrophoresis- AGE, PAGE, 2-D, Iso-electric focusing, and immunoelectrophoresis.

UNIT-V Radio isotopic techniques: Radioactive substance- radioactivity- Detection and measurement of radioactivity- GM counter, Scintillation counter, Autoradiography- Applications- safety aspects.

TEXT BOOKS

Wilson.K and J. Walker, (1994) Practical Biochemistry – Principles and Techniques, Cambridge Press, New York.

Palanivelu.P (2001) Analytical Biochemistry and Separation Techniques.A Laboratory Manual 2nd edn. Published by Tulsi Book Centre, Madurai, Tamil Nadu.

REFERENCES

1. Voet D and G Voet (1995) Biochemistry II edn. John Wiley and sons, New York.
2. John G. Webster (2004) Bioinstrumentation, Student Edition. John Wiley & Sons Ltd.

MIC 3243 **BIOINFORMATICS** **3Hrs/Wk – 2Cr**

Generation of abundant molecular biological information, especially the genetic and protein sequences, would made the human mind to exhaust when if tried to compare and contrast so as to find out the links or homology between sequences. Fortunately, at this juncture a perfect blend of molecular biology and computer evolved the discipline bioinformatics making molecular biologists to explore extensively. In this course, data generation, biological databases, data storage, data retrieval, sequence alignment and application of bioinformatics were given emphasis.

Specific Learning Outcomes (SLO):
Upon successful completion of this course, the student will be able to:

- Understand and work with computational tools of bioinformatics
- Perform biological sequence (DNA, RNA, Protein)analytical studies
- Undertake phylogenetic relation analysis

UNIT I Fundamentals of Computer: Introduction to Computers: – Characteristics of Computers. Classification of Computers – Programming Languages: Machine Language – Assembly Language – Features of commonly used operating systems e.g. DOS, Windows, UNIX, and LINUX. Input Devices- Keyboard – Mouse - Trackball – Output Devices – Dot Matrix Printer – Inkjet – Laser Printer – LCD & LED Printers: Hard Disk – CD –DVD – primary memory, Introduction to Internet.

UNIT II Basics of Internet Use and Search Engines: Fundamentals of Internet, WWW, HTML, URLs Browsers, Netscape/Opera/Explorer Search Engines: Google, PUBMED, NCBI EMBL, GENBANK, Entrez, Unigene, PDB, SwissProt, And TrEMBL. Introduction to search; Indices, Boolean, Fuzzy and neighbouring search.

Unit III Bio-informatics Basics: Bio-informatics- Its Definitions, Introduction, History - Objectives, Applications, Its need, Scope, Opportunities in Bioinformatics. Emerging areas of Bioinformatics - Bioinforrnatics scenario in India and the rest of the world.Origin of Bioinformatics, Overview of available Bioinformatics resources on the web NCBI/ /EBI/EXPASY etc.

UNIT IV Sequences used in Bioinformatics: Central dogma - DNA, RNA,Protein. Dawn of sequencing.Features of the DNA, Protein, and RNA molecules.

UNIT VBiological Databases: Introduction to data types and Source. Population and sample, Classification and Presentation of Data.Quality of data, private and public data sources.General Introduction of Biological Databases; Types of Biological Databases, Nucleic acid databases (NCBI, GenBank, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB).

TEXT BOOK

Lesk, A.M. (2002) Introduction to Bioinformatics. Oxford University Press.

Atwood T K, Parry Smith D J and Phukan S. Introduction to bioinformatics, Pearson Education, Ltd. & Dorling Kindersley Publishing Inc., 2013 - New Delhi, India.

REFERENCES

1. Zoe Lacroix and Terence Critchlow (2003) Bioinformatics – Managing Scientific Data, Morgan Kaufmann Publishers, New Delhi.
2. Andreas D. Baxevanis and Francis B. F. Francis Ouellette (2006) Bioinformatics – A Practical Guide to the Analysis of Genes and Proteins, Wiley – Interscience, Inc, Publications, USA.
3. Setubal, J. and Meidanis, J. (1996) Introduction to Computational Molecular Biology. PWS Publishing Co., Boston.

MIC 3636 MEDICAL LABORATORY TECHNOLOGY 6Hr/Wk-6Cr

This course is meant for developing the knowledge and technical skills necessary to perform basic laboratory tests. Emphasis is given on use and maintenance of laboratory equipment, quality control and biosafety techniques. Collection of samples inclinical biochemistry, clinical pathology, haematology and blood banking analysis and interpretation of results will be dealt with.

Specific Learning Outcomes (SLO):
Upon successful completion of this course, student will able to

- understand the infrastructure of the laboratory
- perform the biochemical tests
- perform the haematological tests
- explain the preparation of biopsy slides
- understand the diagnosis of body fluids

UNIT IOrganization of the laboratory: Safety precautions in laboratory - personal cleanliness and care with regard to infected materials and chemical burns — Maintenance and applications of biomedical instruments – haemocytometer, Gluco meter, Sphygmomanometer - Disposal of bio-medical wastes.

UNITIIClinical Biochemistry: Disorders and diagnosis of carbohydrate metabolism – diabetes mellitus, lipids metabolism – hypercholesterolemia , Protein metabolism – phenylketonuriaand tyrosinemia.

UNITIIIClinical Pathology: Types of clinical specimens: urine, feces, sputum, CSF, Semen. Methods of collection –transportation- handling. Physical – chemical - microscopical and microbiological examination of clinical specimen.

UNIT IVHaematology: Laboratory preparation – Blood components, Collection of blood, Determination of Haemoglobin, blood cell count, bleeding time - clotting time – Prothrombin time, Estimation of ESR, Anemia and its types, Leukemia, blood banking.

UNIT VHistopathology: Preparation of specimen, paraffin section, embedding- frozen section, fixation, microtome –types, decalcification, deparaffinization, staining.

TEXT BOOK
Godkar, P. B. Godkar D. P (2002). A Text Book for Medical Lab Technology, 2nd edition, Bhalami Publishing House, Mumbai.

MIC 3732 ENVIRONMENTAL & AGRICULTURAL MICROBIOLOGY 7Hrs/Wk-7Cr

The main objective of this course is to make the students familiar with microorganisms without which human could not survive as these microbes occur in large number in most natural environment and bring about many desirable and undesirable changes. Beside their role in evolution of life on this planet, the microbial activity is linked directly with processing and removal of dead bodies and sewage. Thus, their role as scavengers is encouragable. The study of this course will help the students to develop the sustainable environment.

Student learning outcomes (SLO):

At the conclusion of the course, the student will be able to,

- Recognize the basic concepts of ecosystem.
- Familiarize with the positive and negative roles of organisms.
- Understand the interactions between organisms and environment.
- Explore the basic needs in the field of agriculture.
- Summarize the traditional agricultural practice to be followed.

UNIT IMicrobiology of Air & Water: Atmospheric dispersal of microbes- Microbial diversity of thermophiles-Mesophiles-Psychrophiles - deep sea- hyper saline habitats and metal-contaminated environments. -Air-borne diseases-control of bio- aerosols- air sanitation. Microbial communities in pelagic & benthic habitats- biological analysis of water sampling - Microbial processes in waste water treatment.

UNIT IIMicrobial Interactions: Microbe–microbe Interactions – Mutualism, Commensalism, and Amensalism, Microbe–plant interactions – Phylloplane- Phyllosphere-Rhizosphere and Mycorrhizae.

UNIT IVSoil microbiology: Soil - general properties -soil microflora-microbes in soil surface and different zones of soil – role of microbes in soil fertility – soil and environmental influence on microbes - decomposition of plant and animal residues by microorganisms in soil.

UNIT IV Bioremediation & Biodegradation: Bioremediation and its types- Principles and application of Bioaccumulation- Xenobiotics- Microbial degradation of hydrocarbons. Biodegradation of pesticides.

UNIT VRole of microbes in sustainable agriculture: Traditional agricultural practice and organic farming. Applications of microbes in agriculture.Bio fertilizers- symbiotic and non-symbiotic microorganisms – vermicomposting - bio pesticides- bacterial, fungal and viral.

TEXT BOOKS

Atlas R and Bartha R (1998) Microbial Ecology 4th edn. Benjamin/Cummings Publishing Co,Inc.California.
SubbaRao NS (2000) Soil Microbiology 4th edn.Oxford & IBH, New Delhi.

REFERENCES

1. Alexander M (1977) Introduction to Soil Microbiology. Wiley, New York.
2.Rheinheimer G (1980) Aquatic Microbiology 2nd edn. Wiley New York.
3. Mitchell R (1992) Environmental Microbiology Wiley-John Wiley Sons, Inc Publications, New York.

MIM 4522 **Medical Microbiology** **7Hrs/5Cr**

This course is to provide the students with detailed insight in epidemiology, pathogenesis, prevention and treatment of important infectious diseases, and contemporary issues and novel developments in the field of Medical Microbiology. As the (re-) emergence of infectious diseases and antimicrobial resistance development, the course will also address the global health aspects of infectious diseases.

Specific Learning Outcome:

Upon successful completion of this course, students will be able to

- understand the epidemiology, stages, types of infections and interactions of microorganism with host
- learn the methods in collection and processing of clinical specimens and prevalence and development of hospital-acquired infections
- know the origins and mechanisms of antimicrobial resistance and bioterrorism
- comprehend the evolution of human microbiome along with changing lifestyle and health trends
- acquire understanding of pathogenesis, transmission of infection, diagnosis, prevention and treatment of clinical significant bacterial and fungal pathogens
- acquire understanding of pathogenesis, transmission of infection, diagnosis, prevention and treatment of clinical significant viral and parasite pathogens

I. **Introduction to Medical Microbiology:** History; Epidemiology – Infection: stages and types, Host-microbe interactions, microbial pathogenesis; Human microbiome in health and disease: Nosocomial infections, Antimicrobial resistance; Bioterrorism; collection and processing of clinical specimens.

II. **Medical Bacteriology:** Epidemiology, pathogenesis, clinical manifestation, diagnosis, treatment and prevention of *Staphylococcus*; *Streptococcus*; *Neisseria*; *Corynebacterium*; *Bacillus*; *Enterobacteriaceae, Vibrio*, *Mycobacterium*; *Spirochetes*; *Mycoplasma; Rickettssia*; *Chlamydia*.

III. **Medical Mycology:** Epidemiology, pathogenesis, clinical manifestation, diagnosis, treatment and prevention of superficial and cutaneous mycoses; subcutaneous mycoses; systemic mycoses caused by dimorphic fungi; opportunistic mycoses; fungal and fungal-like infections of unusual or uncertain etiology; mycotoxins and mycotoxicoses.

IV. **MedicalVirology:** Epidemiology, Pathogenesis, Clinical Manifestation, Diagnosis, Treatment and Prevention of Adenoviruses, Human Herpesviruses, Poxviruses,Picornaviruses, Paramyxoviruses, Orthomyxoviruses, Rhabdoviruses, Reoviruses, Retroviruses, Hepatitis Viruses, Unconventional Slow Viruses: Prions, Recent evolutions – Zika, Dengue, Chikungunya, MERS, SARS, Ebola

V. **Medical Parasitology:** Epidemiology, pathogenesis, clinical manifestation, diagnosis, treatment and prevention of Protozoans; Amoeba; Flagellates; Ciliates; Helminths

Textbooks:

1. Murray PR., Rosenthal KS and Pfaller, MA. (2015). *Medical Microbiology*, 8th ed. Elsevier Health Sciences.
2. Ryan, KJ and Ray CG. (2014). *Medical microbiology*. McGraw Hill.

MIM 5426 Food and Industrial Microbiology 5Hrs/5Cr

This course deals with the basics of food, their composition and factors responsible for spoilage. Emphasis will be given to preservative methods, their merits, contamination, preservations and spoilage of various foods. It also provides knowledge about food borne diseases. Equal importance is given to the basic concepts of fermentation, isolation, improvement of microbes, designing of media, fermenter and their types. This course also highlights the recovery of products and production of fermented foods and other products.

Specific Learning Outcome:

Upon successful completion of this course, student will be able to

- gain knowledge about the basic concepts of food composition and its properties
- learn the principles and techniques of preservation and preservatives
- understand the contamination, preservation and spoilage about various foods
- know about the fermentation, fermenters and recovery of products
- comprehend the mechanisms behind recovery of fermented products
- appreciate the role of microorganisms in the production of fermented food products

I. **Food and its preservation:** Classification of foods; composition of food – intrinsic and extrinsic factors; Principle methods of preservation – asepsis – removal – anaerobic conditions – Uses of high temperature and low temperature – Drying – radiation – food additives – antimicrobials – inorganic and organic and developed preservatives.

II. **Contamination and spoilage of foods:** Vegetables and fruits, meat and meat products, fish and other sea foods, egg and poultry, cereals and its products, milk and milk products – food borne diseases – Bacterial, fungal and viral

III. **Fermentation technology:** Isolation, preservation and improvement of industrially important microorganisms – formulation of media – fermenter design – control of temperature, pH and foam – Computer applications in fermenter. Types of fermenter – Batch, continuous and air lift fermenter.

IV. **Downstream process:** Recovery of fermented products – separation – centrifugation, chromatography, filtration and flocculation – Extraction - Purification – concentration – precipitation, ultra-filtration and reverse osmosis – Drying and Crystallization.

V. **Fermented foods and other products:** SCP – beverages – pickles – Sauerkraut – cheese – yogurt - bakery products - antibiotics – enzymes – organic acids – amino acids and vitamins - probiotics

Textbooks:

1. Doyle MP, Beuchat LR and TJ Montville. (2012).*Food Microbiology: Fundamentals and Frontiers*. 4th Ed. ASM Press, Washington DC.
2. Patel AH. (2012).*Industrial Microbiology*. 2nd Ed. Macmillan India Limited.

References:

1. Frazier WC and DC Westhoff. (2013).*Food Microbiology*. 4th Ed. Tata McGraw Hill, New Delhi.
2. Adams K. (2000).*Food Microbiology*. 2nd Ed. Panima, New Delhi.
3. Stanbury, PF., Whitaker, A. and Stephen JH. (2003).*Principles of Fermentation Technology*. 2nd Ed. Butterworth-Heinemann Elsevier Ltd, Oxford, United Kingdom.

MIM 5228 Lab.in Food and Industrial Microbiology 3Hrs/2Cr

This lab courses provides the microbial analyses and grading of various foods such as bakery foods, beverages and soft drinks, pickles, confectioneries, eggs and milk and its products. This course will train the students to examine microbes from spoiled foods. Preparation of wine and immobilization technique will also be covered in this course.

Specific Learning Outcome:

Upon successful completion of this course, student will be able to

- analyze different kinds of foods
- identify microorganisms from spoiled foods
- gain information about fermentation and immobilization

List of Experiments:

1. Microbial analyses of bakery products.
2. Microbial analyses of carbonated beverages and soft drinks.
3. Microbial analyses of pickles
4. Microbial analyses of confectioneries
5. Microbial examination of eggs

6. Microbial analyses of milk and milk products.
7. Grading of milk quality using Methylene Blue Reduction Test
8. Analysis of fruits and vegetable spoilage by survey method
9. Examination of microorganisms from spoiled foods
10. Production of wine by anaerobic fermentation
11. Immobilization of yeast and bacteria
12. Crowded plate technique for screening antibiotic producing microorganisms
13. Visit to food industries

Reference:

1. Cappucino R. (2017).*Microbiology – A Laboratory Manual*, 6th Ed. Benjamin/ Cumming Publication Co, California

MIM 5536 Immunotechniques & Immunotechnology 5 Hrs/5Cr

The course deals with the principles, procedures and applications of advanced immunological tools and techniques. The immunological techniques include detection and testing of antigens and antibodies, complement and cellular assays. A section on experimental animal models is included. Immunotechnology includes methods in the production of monoclonal, recombinant antibodies, their applications in clinical diagnosis and treatment. Conventional and modern strategies in vaccine development and their applications are also dealt with.

Specific Learning Outcome:

Upon successful completion of this course, students will be able to

- perform and understand the mechanism behind serological assays
- learn the types and principles of effector cell assays and immunofluorescence techniques
- comprehend experimental animal models, systems and vaccine technology
- gain knowledge in techniques involved in synthesis of monoclonal antibodies
- understand the genetic engineering and biotechnological strategies behind recombinant antibodies
- appreciate the applications in clinical diagnosis and treatment

I. **Serological assays:** Precipitation-double immunodiffusion, Radial immunodiffusion – Immunoelectrophoresis and other types. Agglutination – direct, viral, haemagglutination, passive; reverse passive agglutination – column agglutination technology, agglutination inhibition. Immunochromatography, evaluation of

I. **Introduction to Cell**: universal principles, properties, origin and evolution of cells, prokaryotic and eukaryotic cell structure and function, cells as experimental models: *E. coli*, yeasts, vertebrates; tools of cell biology: light and electron microscopy, subcellular fractionation, growth of animal cells and plant cells

II. **Membranes and Transport Mechanisms**: membrane structure and function, dynamics, pumps, carriers, channels, physiology; cellular organelles and membrane trafficking, posttranslational targeting of proteins, mitochondria, chloroplasts, peroxisomes, endoplasmic reticulum, secretory membrane system and golgi apparatus, endocytosis and the endosomal membrane, processing and degradation of cellular components

III. **Cell Communication**: signaling mechanisms, plasma membrane receptors, protein hardware for signaling, second messengers, integration of signals; cellular adhesion and the extracellular matrix, extracellular matrix molecules, cellular adhesion, intercellular junctions, connective tissues

IV. **Cytoskeleton and Cell Movement**: cytoskeleton and cellular motility, actin and actin-binding proteins, microtubules and centrosomes, intermediate filaments, motor proteins, intracellular motility, cellular motility, muscles

V. **Cell Division, Apoptosis, and Cancer**: cell cycle, G1phase and regulation of cell proliferation, S phase and DNA replication, G2 phase, responses to DNA damage, and control of entry into mitosis, mitosis and cytokinesis, meiosis, programmed cell death; cancer: principles and overview

Textbooks:

1. Geoffrey, M., Cooper, H., & Robert, E. (2015). *Cell: A Molecular Approach*. Sinauer Associates Incorporated, U.
2. Pollard, T. D., &Earnshaw, W. C. (2017). *Cell biology*. 3rd Edition. Elsevier

References:

1. Plopper, G., Sharp, D., & Sikorski, E. (Eds.). (2013). *Lewin's Cells*. Jones & Bartlett Publishers.
2. Karp, G. (2016). *Cell and Molecular Biology: Concepts and Experiments 8th Edition with Plus Set*. John Wiley & Son.
3. Alberts, B., Bray, D., Hopkin, K., Johnson, A., Lewis, J., Raff, M., ... & Walter, P. (2017). Molecular Biology of The Cell. Garland Science.
4. Alberts, B., Bray, D., Hopkin, K., Johnson, A., Lewis, J., Raff, M., ... & Walter, P. (2013). *Essential cell biology*. Garland Science.
5. Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D., & Darnell, J. (2016). *Molecular cell biology* (Vol. 8). New York: WH Freeman.

complement, complement components in disease, complement fixation test. ELISA, RIA and Immunoblotting.

II. **Effector cell assays and conjugation techniques:** Assays for human lymphocytes and monocytes – T & B lymphocyte assays- flow cytometry-lymphocyte activation, mixed lymphocyte culture & cell mediated lympholysis – Enumeration of NK cells, monocyte, macrophage assays – neutrophil functional assays. Antibody labelling- radioisotopes-enzymes and fluorochromes, avidin- biotin conjugation and protein A & G.

III. **Experimental animal models, systems and immunofluorescence techniques:** Inbred strains – strategies in developing inbred strains – types – adoptive transfer systems – SCID mice and SCID human mice – Gene targeted knock out mice – Inducible gene targeting – the cre/lox system. Immunofluorescence – Direct, indirect, transmitted and epi-illumination fluorescence microscopy.

IV. **Monoclonal antibodies:** MAb through hybridoma technology production strategies – enrichment techniques – applications – nomenclature of MAbs: Rabbit monoclonal antibodies – advantages: humanizing monoclonal antibodies – HamA, HAcA and RHAs

V. **Recombinant antibody fragments:** Production strategies – display systems – expression system: types – catalytic antibodies (abzymes) – immunotoxins – chimeric antibodies – bispecific antibodies – single chain FV – diabodies – tetrabodies – intrabodies, plantibodies – plastibodies – applications.

Textbook:

Sheehan C. (1997). *Clinical Immunology*. 2nd Ed. Lippincott Williams and Wilkins NY.

References:

1. Goldsby RA., Kindt TJ and BA Osborne. (2013). *Kuby Immunology*. 4th Ed. WH Freeman New York.
2. Kontermann R and S Dubel. (2001). *Antibody Engineering*. Springer, Germany

MIM 5631 Environmental and Agricultural Microbiology 5Hrs/6Cr

The objective of this course is to educate the students on environmental and agricultural microbiology. Environmental microbiology includes ecology of microbes, biogeochemical cycles, biodegradation, bioaccumulation and bioremediation. In agricultural microbiology, comprehensive role of microbes as biofertilizers, biopesticides, plant growth promoting agents, plant pathogens will be dealt in detail.

Specific Learning Outcome:

Upon successful completion of this course, student will be able to

- understand the role of microorganisms in the organization and processes of the biosphere
- learn the principles behind elemental cycles and ecological interactions
- distinguish different microbiological habitats and niches
- identify the microbial ecology of different biomes and biotopes
- learn the applications of microorganisms in agricultural microbiology
- acquire knowledge of techniques and equipments in environmental sample collection, processing and storage

I. **Basics of Microbial Ecology:** biosphere organization; nature, energy and nutritional flow in ecosystems; ecological interactions; biogeochemistry – atmospheric cycles – carbon, nitrogen; sedimentary cycles - water, phosphorus, sulfur; techniques - environmental sample collection and processing techniques; measurements of microbial biomass - primary production, respiration, predation and enzymatic activities.

II. **Soil and Aeromicrobiology:** Earth environment – soil functions, physicochemical properties, types, rock and subsurface, rock varnish, cave, deep subsurface habitats; and air – aerosol, nature and control of bioaerosols, aeromicrobiological pathway, microbial survival in the air, extramural and intramural aeromicrobiology.

III. **Aquatic Microbiology:** aquatic environments - microbial habitats - physical and chemical characteristics; planktonic and benthic microbes, biofilms and microbial mats; aquatic microbial lifestyles – primary and secondary production; marine environments; freshwater environments - springs, streams and rivers, lakes; others - brackish, hypersaline, subterranean waters, wetlands; extreme environments - low and high temperature, geothermal hot springs, desiccation, UV stress, aphotic environments, deep-sea hydrothermal vents, acid mine drainage system, desert carbonate cave

IV. **Applied Environmental Microbiology:** water quality and fecal contamination - microbial source tracking; Wastewater treatment; microbial fuel cells and Biogas,

bioremediation and biodegradation – technology, biofarming; bioremediation of organic compounds and inorganic pollutants, degradation of hydrocarbons, xenobiotics, microbial weathering and biomineralization

V. **Agricultural Microbiology:** plant – microbe interaction - rhizosphere – mycorrhizae, nitrogen-fixing bacteria, plant growth promoting bacteria; phyllosphere associated microorganisms; interactions with pathogens; biocontrol of pests and pathogens; Biofertilizers – Vermicomposting, Agroforestry

Textbooks:

1. Pepper IL., Gerba CP., Gentry TJ., & Maier RM. (Eds.). (2011). *Environmental microbiology*. Academic Press.
2. Barton LL., & Northup DE. (2011). *Microbial ecology*. Wiley-Blackwell.
3. Bagyaraj DJ., & Rangaswami G. (2007). *Agricultural microbiology*. PHI Learning Pvt. Ltd.

References:

1. Black JG. (2014). *Microbiology: principles and explorations*. John Wiley & Sons.
2. Tortora GJ., Funke BR. & Case CL. (2018). *Microbiology: An Introduction*. Pearson.
3. Subba Rao NS. (2000). Soil Microbiology. 4th Ed. Oxford & IBH, New Delhi.

MIM 5342 **Lab. in Animal Cell culture** **3Hrs/3Cr**

This is a supportive course on cell culture and bioprocess technology. In cell culture part, preparation of media for animal cell culture with special emphasis on the cells of the immune system.

Specific Learning Outcome:

Upon successful completion of this course, student will be able to

- acquire knowledge in preparing animal cell culture media
- establish, maintain and sub culturing of animal cells
- gain hands on practice in primary explants and cell culture preparation
- identify the monolayer & suspension culture and their viability

List of Experiments:

1. Aseptic and Sterilization techniques
2. Preparation of media for animal cell culture
3. Primary explants culture from chick embryo
4. Primary culture of lymphoid cells
5. Primary culture of chick organ
6. Disaggregation of tissue – Physical method
7. Disaggregation of tissue – Enzymatic method

8. Primary cell culture – Monolayer Cells
9. Primary cell culture – Suspension Cells
10. Sub culturing technique/Secondary cell culture method.
11. Lymphocytes response to mitogen
12. Cell counting and viability – Trypan blue dye exclusion test, MTT, DAPI staining
13. Visit to cell culture institutes

References:

1. Freshney RI. (2016). *Culture of Animal Cells. A Manual of Basic Techniques.* 2nd Ed. Alan R. Liss Inc, New York.
2. Harrison MA. & Rae IF. (1997). *General Techniques of Cell Culture*. Cambridge University Press.

MIM 5441 **Biostatistics and Bioinformatics** **4Hrs/4Cr**

This course provides a theoretical as well as practical approach towards learning bioinformatics and Biostatistics. It comprises the basics of molecular biology, evolution and genomic tools required to understand bioinformatics concepts better. It deals with the emergence of bioinformatics as a field, its datatypes, data retrieval, databases, sequence alignment, gene and protein structure prediction and molecular phylogeny tools. Biostatistics component is designed to impart a fundamental knowledge on data, scales of measurement, sources and acquisition; organization and presentation of data; descriptive statistics and inferential statistical procedures.

Specific Learning Outcome:

Upon successful completion of this course, student will be able to

- recollect the history and the evolution of bioinformatics as a field
- know basic concepts in storage, submission, retrieval of data and data formats
- apply the fundamental tools in the field of sequence analysis, and phylogeny
- understand the mechanisms of protein sequence, and structure analysis
- convey the fundamental concepts of molecular docking and drug design
- categorize the types of data, present them graphically
- apply biostatistics techniques like ANOVA to their data

I. **Introduction to bioinformatics:** - History: Margaret Dayhoff, Richard Eck, Robert Ledley; bioinformatics - definition, goals - technical toolbox; collecting and storing sequences - DNA sequencing, submission of sequences to the databases, computer storage of sequences, sequence formats; archives and information retrieval –databases indexing – format – search - retrieval systems, and genome browsers.

II. **Nucleotide analysis and Phylogeny:** Sequence Retrieval, Primer Designing, Editing Sequence Data, Sequence Assembly—CAP3 Program, Restriction Mapping Using NEBcutter, Gene Prediction Using ORF Finder, Gene Prediction Using FGENESB, Dot-Plot, Global and Local Sequence Alignment, BLAST - Interpreting Result; Multiple Sequence Alignment: T-Coffee, MUSCLE, MAFFT, Multiple Sequence Alignment and Phylogenetic Analysis Using MEGA; RNA Analysis - Predicting RNA Secondary Structure, Finding Repeats.

III. **Protein Sequence and structure analysis:** Protein Sequence Retrieval; Predicting Signal Peptides, Transmembrane Segments, Subcellular Location; Protein BLAST (blastp), (PSI)-BLAST, (PHI)-BLAST, (DELTA-BLAST); CASP; Protein Primary, Secondary, and Tertiary Structure Analysis—ProtParam, SOPMA, PSIPRED, Homology Modelling - SwissModel , Threading (Fold Recognition); ROSETTA, LINUS; Protein Tertiary Structure Analysis – RAMPAGE, SAVeS; Protein Structure Visualization – RasMol, PyMol, Protein Structure Alignment/Superimpose Using

SuperPose, Protein Cleft Analysis; Protein–Ligand Interactions - AutoDock4.1 and MGLTools, ClusPro2.0; Drug discovery and development.

IV. **Introduction to biostatistics**: understanding data, data types, sources, population, sample, sampling methods, scales of measurement – nominal, ordinal, interval and ratio scales - Organizing and presenting data – raw data, organizing – arranging, grouping; tabulation and graphical representation – pie charts, bar charts, column graphs, histograms, Ogive curves, stem-leaf diagram, box plot – properties.

V. **Descriptive statistics**: measures of dispersion/central tendency – mean, median and mode; measures of spread/dispersion – range, mean deviation, inter quartile range, variance, standard deviation and standard error, distribution. **Inferential statistics**: – chi-square test/goodness of fit; Spearman's rank correlation, Karl Pearson's correlation and regression, student's t-test paired & pooled; introduction to ANOVA (one way).

Textbooks:

1. Lesk, A. (2014). *Introduction to bioinformatics*. Oxford university press.
2. Paulson, D. S. (2008). *Biostatistics and microbiology: a survival manual*. Springer Science & Business Media.

References:

1. Choudhuri S. (2014). *Bioinformatics for beginners: genes, genomes, molecular evolution, databases and analytical tools*. Elsevier.
2. Ibrahim KS., Gurusubramanian G., Zothansanga YR., Yadav RP., Kumar NS., Pandian SK., & Mohan S. (2017). *Bioinformatics-a Student's Companion*. Springer.
3. Mount, D. W. Bioinformatics: sequence and genome analysis. (2004). *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor Laboratory Press
4. Singh, G. B. (2015). *Fundamentals of Bioinformatics and Computational Biology*. Springer International Publishing.
5. Rosner B. (2015). *Fundamentals of biostatistics*. Nelson Education.

MIC 1241 **INFECTIOUS DISEASES** **3Hrs/Wk - 2Cr**

This course aims to provide students with the understanding of positive and negative host microbe interaction. The students will also learn about the mechanism of pathogenesis for the establishment of infectious diseases, immune effector mechanism and control strategies for healthy life.

Specific Learning Outcomes (SLO):

Upon the completion of the course, the student will be able to

- Understand the stages of infectious diseases
- Learn about the significance of normal microbiota and its host interaction
- Understand the mechanism of infectious disease pathogenesis
- Explore the sources and impact of nosocomial infection
- Develop the control strategies for better health

UNIT-I Epidemiology: Infection – phases and stages, diseases and their types- list of infectious diseases, pathogenicity – morbidity and incubation, virulence – lethality and opportunistic pathogens.

UNIT-II Normal microbiota: Overview- distribution of normal microbiota in the body- type of interaction – positive and negative – commensalism, mutualism, parasitism – establishment and importance of normalmicrobiota.

UNIT-III Mechanism of pathogenesis: Reservoir-transmission- portal entry- adherence-invasion-colonization and pathogenesis of infectious diseases of human.

UNIT-IV Nosocomial infections: Definition-sources- mode of transmission-diagnosis-treatment-preventive measures-responsibilities of health care personals.

UNIT-V Control strategies: Good health practices - health awareness- prophylaxis - immunization – active and passive immunization - role of antibiotics.

TEXTBOOK

Ananthanarayanan and Jayaram Panikkar (1992) Text book of Medical Microbiology, 4thedn, Orient Longman Ltd. Madras.

REFERENCES

1. Cruickshank (1975) Medical Microbiology, Vol II ELBS, Churchill Livingstone Publication.
2. Patrick R. Murray, (2005) Medical Microbiology 4th edn, Library of Congress Publications, California.
3. Jawetz, E., Melnic, J. L. Adlberg, E. A. (2004) Medical Microbiology 19th edn, Lange Medical Publications, USA