

**CENTRE OF RESEARCH FOR DEVELOPMENT  
UNIVERSITY OF KASHMIR  
SRINAGAR-190006, J & K, INDIA**



**M. SC. MICROBIOLOGY**

**CHOICE BASED CREDIT SYSTEM**

**COURSE STRUCTURE FOR THIRD AND FOURT  
SEMESTERS MICROBIOLOGY 2017 BATCH**

  
Prof. Azra N. Kamili

Microbiology- the study of microorganisms, as a subject of study has immense importance as microorganism are the first inhabitant of the planet and in fact have over the years made this planet habitable for other life forms. Microorganism are associated with our day to day life and affect us directly or indirectly in a number of ways. Microbiology as a subject has immense applications in the fields of public health, agriculture, environment, food and dairy industry as well as in biotechnology. This course content is designed in such a way as to impart quality education and training in both the basic and applied aspects of microbiology. Therefore, we intended to produce highly trained professionals who besides serving various public and private organizations in the area of public health, environment, agriculture, food and dairy industry and biotechnology will also become entrepreneurs, who can exploit the services of microorganisms for the benefit of mankind besides creating self-employability opportunities.

The revised syllabi and courses of study for Post-graduate programme in Microbiology will be based on 96 credits (average of 24 in each semester). All the 96 credits will spread over 5 different components viz. - (i) teaching, (ii) tutorial, (iii) seminar, (iv) three laboratory courses (one each in the first, second and third semester), and (v) project work /Internship in fourth semester. Each semester will consist of at least 24 credits including 12 core credits (compulsory), 12 discipline centric elective (maximum of 8 credits to be opted) and 2 generic and 2 open elective credits for the students of other departments of the university.

**Course Structure:** There will be 12 core courses (theory and lab.) in all with each semester covering 3 core courses referred to as **MIC-CR**. Each core course will be worth 4 credits with theory covering 8 credits and practical component 4 credits. There will be Discipline Centric Elective (DCE) courses (mainly for Department's own students) worth 4 credits referred to as **MIC-DCE**. Students can opt for 2 courses to earn 8 credits or at least one course each to earn minimum of 4 credits. Further, in addition to **CR** and **DCE** courses there will be Generic Elective courses referred to as **MIC-GE** which will be open to the students of Biological sciences and Open Elective courses referred to as **MIC-OE** that will be open to students from all other faculties (Science, Social Science, Arts, Commerce etc) so that they may seek knowledge from unrelated subject which will nurture student's proficiency and /skill. The total course of M. Sc. Microbiology will comprises of **96 credits out of which 48 are core while other credit combinations would be as under.**

Credits	Core	DCE	GE	OE	Total
Minimum Credits	12	8	2	2	24
Average Credits	12	8	2-4	2-4	24

Each **CR** course will be worth of 100 marks and 4 credits comprising of **continuous assessment of 50 marks** and **end semester examination of 50 marks**. Internal assessment of theory papers will be based on quiz tests/assignments/seminars, etc. The practical component will also be of **continuous assessment** comprising 25 marks based on student's performance during practical periods and **end semester examination** of 75 marks through conduct of common test at the end of each semester to finalize awards for the same. The students will be required to submit their lab work records at the end of each semester examination for evaluation by the examiner/teacher(s) concerned.

**MIC-DCE** course is a choice based credit course where a student has to acquire 8 credits in total out of 10 DCE credits courses. One paper among **DCE course** will be worth of **4 credits carrying 100 marks** and comprising of **continuous assessment of 50 marks** and **end semester examination of 50 marks**. Two courses will be worth of 2 credits each carrying 50 marks,

**Industrial/ Educational Tours:** To make an on-field observations and impart on-site training in the subject, the students are required to go for tour organized during **2<sup>nd</sup> semester** (outside state) carrying **2 credits** will form a component of **DCE**.

Each **GE and OE course** will be worth of **50 marks (2 credits)**. **MIC-DCE, MIC-GE and MIC-OE** will be floated as semester courses wherein the selection will be based on the choice of the teacher concerned in terms of feasibility/availability as well as the number of vacancies available based on the choice of the concerned teacher. However, on the basis of the recommendations of Departmental Committee minimum number of seats under these courses should not be less than 4 for DCE, GE and OE respectively in any such course.

**Project work/ Internship:** Project work (**MIC-CR**) worth **8 credits** is compulsory for the students and will be assigned in **4th semester** based on choice of the student and space availability in relation to his/her choice. The project has to be submitted prior to the conduct of 4th semester examination so that it can be evaluated and *viva voce* be conducted prior to declaration of the results. The students for project work will be evenly distributed among faculty members of the Department.

**In the Table below the terms refer to:**

**L – Lecture**

**T – Tutorial;**

**P – Practical Work**

**CR – Core Course**

**DCE -Discipline Centric Elective**

**GE – Generic Elective**

**OE - Open Elective**

M. SC. MICROBIOLOGY CORD KU

  
*Prof. Azra N. Kamili*

# General course outline for 2<sup>nd</sup> year program for two semesters

## 3<sup>rd</sup> Semester

Course	Course Code	Course Name	Paper Category	Hours/Week			Credits
				L	T	P	
CORE	MIC-18301CR	Molecular Biology and Microbial Genetics	Core	4			4
	MIC-18302CR	Immunology	Core	4			4
	MIC-18303CR	Laboratory Course	Core			8	4
DCE	MIC-18304DCE	Food Microbiology	DCE	3	2		4
	MIC-18305DCE	Agricultural Microbiology	DCE	3	2		4
GE	MIC-18306GE	Applied Food Microbiology	GE	1	2		2
	MIC-18307GE	Clinical Microbiology	GE	1	2		2

## 4<sup>th</sup> Semester

Course	Course Code	Course Name	Paper Category	Hours/Week			Credits
				L	T	P	
Core	MIC-18401CR	Genetic Engineering and Genomics	Core	4			4
	MIC-18402CR	Medical Microbiology	Core	4			4
	MIC-18403CR	Project Work	Core			8	8
DCE	MIC-18404DCE	Bioinformatics and Biostatistics	DCE	3	2		4
GE	MIC-18405GE	Fermentation Technology	GE	1	2		2
GE	MIC-18406GE	Applied agricultural Microbiology	GE	1	2		2

Note: GE and OE of the 4<sup>th</sup> semester be opted in 3<sup>rd</sup> semester itself

# Course Description 3<sup>rd</sup> Semester

## Core Courses

### MIC-18301CR: MOLECULAR BIOLOGY AND MICROBIAL GENETICS

(Credits 4)

**Objectives:** This course is introduced with the aim of teaching the students the basics of genome organization, it will also explore and compare the central dogma i-e replication, transcription and translation in prokaryotes and eukaryotes. Further, the concept of horizontal gene transfer important for the genome evolution and the concept of operons in prokaryotes shall help students understand the basics of microbial genetics.

#### Unit I

- 1.1 Historical perspective of DNA, structure and its forms
- 1.2 Genome organization in prokaryotes and eukaryotes, DNA supercoiling (Linking number, writhes and twists), gene concept and structure of gene
- 1.3 Prokaryotic and eukaryotic DNA replication
- 1.4 Experimental evidence for DNA replication in prokaryotes and eukaryotes, reverse transcription
- 1.5 DNA damage and repair mechanisms

#### Unit II

- 2.1 RNA and its types, concept of micro RNA, snRNAs, siRNA, scRNA, snoRNA, hnRNA, lncRNA and their functions. Structure of tRNA
- 2.2 Transcription: mechanism of transcription in prokaryotes and eukaryotes
- 2.3 Post-transcriptional modifications and regulation of transcription in eukaryotes
- 2.4 Genetic code, protein biosynthesis and its mechanism
- 2.5 Post translational modifications

#### Unit III

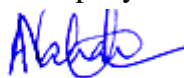
- 3.1 Gene families: split genes, pseudogenes, non-coding genes, overlapping genes and multi-gene families
- 3.2 Regulation of gene expression in prokaryotes-operon concept, regulatory elements of operon-inducers, apo-repressors and co-repressors. Positive and negative regulations
- 3.3 Catabolite repression. Detailed account of structure, function and regulation of *lac* operon, *trp* operon and lambda operon
- 3.4 Mutations: types of mutagens (physical, chemical), types of mutations site directed mutagenesis
- 3.5 Mutation screening in microorganisms: evaluation of mutagens using microbial systems- Ames test, detection of mutations

#### Unit IV

- 4.1 Gene transfer in bacteria: transformation, transduction, conjugation and sexduction
- 4.2 Molecular basis of recombination- models of homologous recombination, the Holliday model, double strand break repair model, site specific recombination
- 4.3 Gene mapping in prokaryotes: deletion mapping, complementation, DNA foot printing, chromosome walking and jumping
- 4.4 A general account of plasmids: Characteristics, functions, genes of plasmids, F plasmids, R-plasmids, Colicinogenic plasmids, Ti-plasmid, broad host range plasmids
- 4.5 Transposable elements: IS elements, bacterial transposons, mechanism and types of transposition. Genetic phenomena mediated by transposons, transposons as genetic tools

#### Recommended Books

1. Molecular Biology of the Gene by Watson et. al., Benjamin Cummings.
2. Genomes 3 by T.A. Brown, Garland Science.
3. Microbial Genetics by Freifelder D, Narosa Publishing House.
4. Principal of Genetics by E.J Gardner, M.J.Simmons and DP Snustad, John Wiley and Sons
5. Biochemistry by Stryer WH et al., W.H Freeman and company.
6. Genetics: A Conceptual Approach by Benjamin A. Pierce, W.H Freeman and company

  
Prof. Azra N. Kamili

## MIC-18302CR: IMMUNOLOGY (Credits 4)

**Objectives:** This course introduces the concept of host defense, the cells and organs involved in immune response, immunoglobulins their structure and interaction with antigens. It further explores the advances in immunological diagnostic of infections and the techniques involved therein.

### Unit I

- 1.1 General principles of immunology: history of immunology (contributions of Edward Jenner, Karl Landsteiner, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa)
- 1.2 Structure, composition and function of cells and organs involved in immune system
- 1.3 Mechanism of immune response
- 1.4 Antigens, nature and source of antigens, haptens, adjuvants, immunogenicity versus antigenicity
- 1.5 Antibody-structure and functions-subtypes; structural basis of antibody diversity; theories of antibody formation

### Unit II

- 2.1 Antigen and antibody interactions: *In vitro* methods-agglutination, precipitation, complement fixation
- 2.2 Phagocytosis, opsonization, neutralization
- 2.3 Complement system: complement components and complement activation, pathways, regulation of complement system, biological consequences of complement activation, complement deficiencies
- 2.4 Structure, distribution and functions of histocompatibility antigens
- 2.5 Major histocompatibility gene complex (MHC), structure and its types

### Unit III

- 3.1 Gene regulation and immune response (IR) genes
- 3.2 HL-A and tissue transplantation-tissue typing, methods for organ and tissue transplantations in humans; graft versus host reaction and rejection
- 3.3 Tumor immunology: tumor antigens, host immune response to tumors
- 3.4 Antibody dependent cell cytotoxicity (ADCC), tumor escape mechanisms, immuno diagnosis and therapy
- 3.5 Hybridoma technology, myeloma cell lines used as fusion partner, fusion method, detection and application of monoclonal antibodies, recombinant antibodies

### Unit IV

- 4.1 Immunodeficiencies-animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak-Higashi syndrome, leukocyte adhesion deficiency, Chronic Granulomatous Disease (CGD); characteristics of tumor antigens
- 4.2 Hypersensitivity reactions: type I, II, III and IV the respective diseases, immunological methods of their diagnosis
- 4.3 Autoimmunity mechanism and diseases. General account of interferons, Lymphokines and cytokines
- 4.4 Immunotechniques: Immunodiffusion, Immunoelectrophoresis, RIA, ELISA, ELISPOT, Western blotting
- 4.5 Immunofluorescence, Flow cytometry, Immunoelectronmicroscopy, RIST, RAST and MLR

### Recommended Books

1. Kuby Immunology by Kindt T.J et al., W.H. Freeman and Company.
2. Immunology- A Short Course by Eli Benjamini, Richard Coico and G. Sunshine. Wiley's Publication.
3. Cellular and Molecular Immunology by Abbas AK, Lichtman AH and Pillai S: Saunders Elsevier.
4. Fundamental Immunology by William E. Paul, Lippincott Williams and Wilkins.
5. Roitt's Essential Immunology by Delves PJ et al., Blackwell Publishing/Oxford Univ. Press.
6. Immunology: An Introduction by Tizard IR, Saunders College Publishing.

**Objectives:** This course shall deal with the practical aspects of detection of infection in clinical specimen, the microscopic examination of the pathogens and serological diagnosis. Isolation of microorganisms from agricultural soils and root nodule shall be carried out. Further, hands on training on basic molecular techniques like extraction of genomic and plasmid DNA, polymerase chain reaction, agarose gel electrophoresis and TA cloning shall be provided.

1. Examination of urine samples for urinary tract infections
2. Isolation and microscopic examination of human fungal pathogen
3. Latex agglutination test (Antistreptolysin O test, Widal slide test for typhoid fever and Rheumatoid arthritis test)
4. Blood grouping and Rh Typing
5. Isolation of lactic acid bacteria from curd
6. Isolation of bacteria and fungi causing food spoilage
7. Isolation of bacteria and fungi from rhizosphere and non-rhizosphere soil samples
8. Isolation of bacteria from root nodule
9. Isolation of genomic DNA from *E. coli*
10. Agarose gel electrophoresis of isolated gDNA
11. Polymerase Chain Reaction (PCR) (amplification of 16S rRNA fragment using *E. coli* gDNA).  
Visualization of PCR products
12. Isolation of plasmid DNA from *E. coli*
13. T/A cloning (ligation, transformation, blue/white selection and restriction digestion)

**Recommended Books**

1. Microbiology: A Laboratory Manual by James G. Cappuccino and Natalie Sherman, Pearson Benjamin Cummings Publishers.
2. Practical Microbiology by D K Maheshwari & R C Dubey, S Chand & Company Publishers.
3. Alcamo's Laboratory Fundamentals of Microbiology by Pommerville J.C., Jones and Bartlett Publishers, Inc.
4. Gene Cloning and DNA analysis by T.A Brown, Wiley-Blackwell.
5. Molecular Cloning: A laboratory manual by Joseph Sambrook & David Russell CSHL press.

# Discipline Centric Elective

## MIC-18304DCE: FOOD MICROBIOLOGY

(Credits 4)

**Objectives:** This course shall impart knowledge and skill about the microbiological examination of food, production of food using microorganisms, food preservation methods and microbial spoilage of food. The detection and control of food borne pathogens and toxins using classical and advanced methods following national and international guidelines are also included.

### Unit I

- 1.1 History and development of food microbiology, sources and factors influencing microbial growth in foods: intrinsic factors or food environment and extrinsic factors
- 1.2 Biochemical changes caused by microorganisms in foods-degradation of carbohydrates, lipids, proteins and amino acids; putrefaction
- 1.3 Microbial spoilage of plant (Fruits, vegetables, cereals, oil seeds) and their products
- 1.4 Microbial spoilage of animal (milk, meat, egg) based foods
- 1.5 Spoilage of processed foods– canned products, causes of spoilage, appearance of spoiled cans

### Unit II

- 2.1 Control of microorganisms in foods: asepsis, use of heat, low temperature, drying, methods of food preservation (chemical preservatives, bio preservatives and irradiation)
- 2.2 Microbiology of fermented products: bread, wine, vinegar and fermented vegetables
- 2.3 Microbial examination of milk, meat, egg, fruits, vegetables and their products
- 2.4 Probiotics and prebiotics and their significance in human health.
- 2.5 Production of yoghurt, kefir and ice-cream and their health benefits

### Unit III

- 3.1 Bacterial food borne pathogens (Staphylococcus, Clostridium spp, *Bacillus cereus*, *Salmonella*, *E.coli*, *Shigella*, *Listeria*, *Brucella*)
- 3.2 Fungal intoxications ( mycotoxicosis- aflatoxins, ochratoxins and patulin)
- 3.3 Food borne viral pathogens: Norwalk virus, hepatitis A virus, hepatitis E virus, and rotavirus
- 3.4 Detection and enumeration of microorganisms and their products in food. Molecular detection: PCR, Q-PCR
- 3.5 Emergence and health risk of antibiotic resistance from processed foods and emerging foodborne pathogens

### Unit IV

- 4.1 Safety aspects of food products with reference to mycotoxins, antibiotics, pesticides, weedicides and heavy metals
- 4.2 General principles of food safety risk management, recent concerns on food safety- safe food alternatives (Organic foods)
- 4.3 Safety concerns of biofilm formation on equipment surfaces and their control measures, quality control of food at all stages from production to packaging materials
- 4.4 Good agricultural practices (GAP), HACCP and ISO systems for food safety. International and national food laws. USFDA/ ISO-9000 and FSSAI
- 4.5 Biosafety of genetically modified foods: benefits and future challenges

### Recommended Books

1. Food Microbiology by Frazier and Westhoff, TaTa McGraw Hill.
2. Food Microbiology: Fundamentals and Frontiers by Doyel et.al. ASM Press.
3. Basic Food Microbiology by Banwart G.J., CBS Publishers & Distributors.
4. Modern Food Microbiology by Jay et.al. Springer India Ltd.

  
Prof. Azra N. Kamili



## MIC-18305DCE: AGRICULTURAL MICROBIOLOGY (Credits 4)

**Objectives:** This course aims at imparting knowledge about the role of microorganism in agriculture. Importance of soil microbiota in relation to the formation of soil, biogeochemical cycling of important nutrients, as biofertilizers and biopesticides are also described. Further, major plant diseases caused by microorganisms and the importance of tissue culture in enhancing plant productivity are also covered.

### Unit I

- 1.1 Introduction and scope of agricultural microbiology. Contributions of M. Beijerinck, S. Winogradsky, B. Frank and S. Waksman
- 1.2 Soil as substrate for growth of microorganisms, soil microflora, culture dependent and independent methods of studying soil microflora
- 1.3 Rhizosphere, phyllosphere and endophytic microorganisms and their interactions with plants
- 1.4 Nitrogen cycle: ammonification, nitrification and denitrification. Biological nitrogen fixation (symbiotic and asymbiotic), biochemistry and molecular genetics of nitrogen fixation
- 1.5 Microbial transformations of phosphorus, sulphur and minor nutrients

### Unit II

- 2.1 Mycorrhizae, Frankia, biology and their applications
- 2.2 Biofertilizers: production and application of *Rhizobium*, *Azospirillum*, *Azotobacter*, phosphobacteria and Cyanobacteria and their quality control
- 2.3 Concept of biopesticides: *Bacillus thuringiensis* (Bt), mode of action of Bt toxins and production of Bt biopesticides, Bt transgenics and their issues
- 2.4 Fungal and viral biopesticides: production and genetic improvement of Baculoviruses, advantages and disadvantages of fungal and viral biopesticides.
- 2.5 Role of beneficial microbes for combating abiotic stress in economically important crops

### Unit III

- 3.1 Introduction to plant pathology: history, significance, symptoms and types of plant diseases
- 3.2 Defense mechanisms of plant disease: Pre-existing, structural and chemical defenses, induced defense mechanisms.
- 3.3 Bacterial diseases of economically important crops (canker, fire blight, angular leaf spot and wilt)
- 3.4 Fungal diseases of economically important crops (blast, rot, blight, smut rust and powdery mildew)
- 3.5 Viral diseases of economically important crops (mosaic diseases, tomato leaf curl, potato leaf roll)

### Unit IV

- 4.1 Basic concepts of plant tissue culture, culture-media, plant hormones and growth parameters
- 4.2 Embryogenesis and organogenesis
- 4.3 Organ culture: meristematic and non-meristematic methods, somaclonal variations (brief account)
- 4.4 Micropropagation and its applications
- 4.5 Applications of plant tissue culture for plant improvement and germplasm conservation.

### Recommended Books

1. Soil microbiology and Biochemistry by EA Paul and F.E. Clark, Academic press.
2. Soil Microbiology by Subba Rao, Science Publishers.
3. Agricultural Microbiology by G.Rangaswamy and Bagyaraj, Prentice Hall India.
4. Soil Microorganisms and Plant Growth by N.S Subba Rao, Science Publishers.
5. P. D. Sharma (2006), Plant Pathology. Alpha Science International Publishers.
6. An introduction to plant Tissue Culture by M.K. Razdan, Oxford & IBH publishing.
7. Plant cell tissue & organ culture- Fundamental methods by O. L. Gamborg, & G. C. Philips, Springer publications.
8. Plant Tissue Culture: An Introductory Text by [Sant Saran Bhojwani](#) and [Prem Kumar Dantu](#), Springer Science & Business Media.

  
Prof. Azra N. Kamili

# Generic Electives

## MIC-18306GE: APPLIED FOOD MICROBIOLOGY

(Credits 2)

**Objectives:** This course shall deal with the fundamental and applied aspects of food spoilage and food production by microorganisms. Further, foodborne infections/intoxications and methods to control them shall be taught in detail.

### Unit I

- 1.1 Historical developments in food microbiology
- 1.2 Factors influencing microbial growth in foods: intrinsic and extrinsic factors
- 1.3 Food spoilage, causes of spoilage and spoilage of canned foods
- 1.4 Food preservation
- 1.5 Microbial examination of milk, meat, egg, fruits and vegetables

### Unit II

- 2.1 Microorganisms as single cell protein (SCP)
- 2.2 Probiotics and prebiotics, production of fermented milk (yoghurt, cheese and kefir)
- 2.3 Fermented vegetable (sauerkraut and kimchi) products
- 2.4 Foodborne intoxications: Staphylococcal intoxication, botulism, mycotoxicosis
- 2.5 Foodborne infections: Salmonellosis, Listeriosis, pathogenic *Escherichia coli*, gastroenteritis, shigellosis and brucellosis

### Recommended Books

1. Food Microbiology by Frazier and Westhoff, TaTa McGraw Hill.
2. Food Microbiology: Fundamentals and Frontiers by Doyel et.al. ASM Press.
3. Basic Food Microbiology by Banwart G.J., CBS Publishers & Distributors.
4. Modern Food Microbiology by Jay et.al. Springer India Ltd.

## MIC-18307GE: CLINICAL MICROBIOLOGY (Credits 2)

**Objectives:** This course deals with the basic biology, laboratory diagnosis and control measures of important human bacterial, fungal and viral pathogens.

### Unit I

- 1.1 Introduction to clinical microbiology, types of infections
- 1.2 Brief description of medically important bacteria (*Mycobacterium tuberculosis*, *Vibrio Cholera*, *Salmonella typhi*, *Clostridium tetani*)
- 1.3 Introductions to medical virology; basic features of HIV, Influenza, Rabies, Hepatitis, Small pox
- 1.4 Introduction to medically important fungi (*Piedraia hortae*, *Trichophyton rubrum*, *Cryptococcus neoformans*, *Candida albicans*)
- 1.5 Antibiotics and mode of action

### Unit II

- 2.1 Basic techniques in microbiology, sterilization, preparation of media, culture techniques
- 2.2 Gram staining and acid fast staining
- 2.3 Collection, transportation and identification of specimen from blood and urine samples
- 2.4 Lab diagnosis of bacterial and fungal infections using culture and non-culture methods (Microscopy, PCR and serological tests)
- 2.5 Isolation and cultivation of viruses

### Recommended Books

1. Ananthanarayan & Paniker's text book of Microbiology by Reba Kanungo, Universities Press.
2. Jawetz, Melnick & Adelbergs Medical Microbiology by Brooks et al., McGraw-Hill Medical.
3. Prescott's Microbiology by Joanne Willey, Linda Sherwood and Christopher J. Woolverton, McGraw Hill Publisher Companies, Inc.

  
Prof. Azra N. Kamili

# Course Description 4<sup>th</sup> Semester

## Core Courses

### **MIC-18401CR: GENETIC ENGINEERING AND GENOMICS (Credits 4)**

**Objectives:** This course is designed to provide advancements in the area of recombinant DNA (rDNA) technology and genomics. The course deals with the methods involved in the development of recombinant vector(s), transformation, screening of recombinants and expression of proteins. The novel approaches in exploring microbiomes using omics technology and their applications in agriculture, environment and healthcare shall be described. The ethical and legal aspects associated with the release of genetically engineered organisms shall also be covered.

#### **Unit I**

- 1.1 Essentials of recombinant DNA technology: cloning vectors-plasmids, cosmids, phagemids, BAC, YAC and expression vectors
- 1.2 Enzymes in recombinant DNA technology: DNA polymerase, reverse transcriptase, restriction endonucleases, polynucleotide kinase, terminal deoxynucleotidyl transferase, DNase, Methylase, phosphatases, ligases, RNase and their mode of action
- 1.3 Transformation and selection of recombinants: (Antibiotic, blue/white selection, colony PCR, restriction digestion and colony hybridization)
- 1.4 *Agrobacterium* based gene transfer in plants; Ti plasmid, structure and functions; chloroplast transformation
- 1.5 Promoters, reporters and markers used in genetic engineering

#### **Unit II**

- 2.1 Polymerase chain reaction (PCR) and its variants. Quantitative real time PCR (qRT-PCR) their applications
- 2.2 Construction and screening of genomic and cDNA libraries
- 2.3 Applications of rDNA technology in medicine (insulin, monoclonal antibodies, antibiotics, vaccine production) and agriculture (growth hormones, biotic and abiotic stress tolerant varieties)
- 2.4 Gene therapy: Inherited disorders, detection of gene defects, strategies for gene therapy-*in vivo* and *ex vivo* therapies, gene delivery strategies- viral vectors, liposomes their advantages and disadvantages; future prospects of gene therapy
- 2.5 Genetically engineered organisms (GEOs): microbes, plants, animals and their ethical issues

#### **Unit III**

- 3.1 History of genomics, introduction to model prokaryotic genomes (*Escherichia* and Lambda phage) in detail
- 3.2 Elementary idea of eukaryotic genomes (*Saccharomyces*, *Arabidopsis*, *Caenorhabditis*)
- 3.3 DNA sequencing, whole genome shotgun sequencing: next-generation sequencing and full genome sequencing platforms
- 3.4 Analysis of structural, functional and comparative genomics with reference to *E. coli*
- 3.5 From genomics to synthetic biology and bioengineering (*Mycoplasma laboratorium*, synthetic bacteriophage)

#### **Unit IV**

- 4.1 General idea of human microbiome project, Earth microbiome project, hologenome theory. Human genome project
- 4.2 Metagenomics: definition, principles, methods, library production, high throughput screening, metagenomics of archaeological samples; Sargasso sea project
- 4.3 Transcriptomics, proteomics, metabolomics, ionomics, culturomics and their applications (Brief account)
- 4.4 Genome editing and its application
- 4.5 Application of genomics in medicine, agriculture and environment

#### **Recommended Books**

1. Principles of Gene Manipulation and Genomics by Sandy B. Primrose and Richard Twyman, Blackwell Publishers.
2. Gene Cloning and DNA analysis by T.A Brown, Wiley-Blackwell.
3. Biotechnology: Expanding Horizons by B.D. Singh, Kalyani Publishers.
4. Molecular Cloning: A laboratory manual by Joseph Sambrook & David Russell CSHL press.
5. Molecular Biotechnology: Principles and Applications of Recombinant DNA by Glick B.R and Pasternak J.J, ASM Press.

## MIC-18402CR: MEDICAL MICROBIOLOGY (Credits 4)

**Objectives:** This course describes the impact of microorganism on human health, the role of normal microbiota in human health. The etiology of various bacterial, viral, fungal and protozoan diseases, their lab diagnosis and prophylactic measures shall be taught in detail.

### Unit I

- 1.1 Normal microbial flora of human body and its importance
- 1.2 Mechanism of microbial pathogenesis: entry, colonization, growth, mechanism of damage host cell, host-pathogen interactions
- 1.3 Bacterial virulence factors
- 1.4 Epidemiology of infectious diseases and current pandemics
- 1.5 Pathogenicity vs virulence; quantitative measures of virulence: minimal lethal dose (MLD), LD<sub>50</sub>, ID<sub>50</sub>, TCID<sub>50</sub>. Facultative / obligate intracellular pathogens

### Unit II

- 2.1 Historical perspective of medical bacteriology
- 2.2 General characteristics, mode of transmission, pathogenesis and diagnosis of medically important bacterial diseases like anthrax, tuberculosis, leprosy, cholera, typhoid, shigellosis, gastric ulcer, salmonellosis, tetanus, meningitis, pneumonia and syphilis
- 2.3 Etiology, pathogenesis and lab diagnosis of diarrhea, meningitis and pneumonia; Nosocomial infections and Zoonosis
- 2.4 General characteristics, mode of transmission, pathogenesis and diagnosis of diseases caused by *Staphylococcus*, *Streptococcus*, *Mycoplasma*, *Chlamydiae* and *Rickettesia*
- 2.5 Antibacterial drugs: classification and mode of action. Emergence of bacterial drug resistant strains

### Unit III

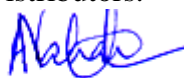
- 3.1 Introduction to medical virology
- 3.2 General characteristics, mode of transmission, pathogenesis and diagnosis of medically important viral pathogens: chicken pox, hepatitis, herpes, human papilloma virus (DNA viruses),
- 3.3 General characteristics, mode of transmission, pathogenesis and diagnosis of medically important viral pathogens: rabies, mumps, measles, AIDS, dengue (RNA viruses)
- 3.4 General characteristics, mode of transmission, pathogenesis and diagnosis of emergent viral diseases: influenza (swine flu), SARS, chikungunya, ebola, hanta, marburg, zika and rotavirus
- 3.5 Human prion diseases, novel approaches for viral detection; antiviral drugs, classification and mode of action

### Unit IV

- 4.1 Introduction to medical mycology. Mycoses (superficial, subcutaneous, systemic and opportunistic)
- 4.2 Isolation, characterization and identification of medically important fungal pathogens. Antifungal drugs, classification and mode of action
- 4.3 General characteristics, mode of transmission, pathogenesis and diagnosis of protozoan pathogens: *Entamoeba*, *Plasmodium*, *Leishmania*, *Giardia*, *Toxoplasma* and *Trypanosoma*
- 4.4 General characteristics, mode of transmission, pathogenesis and diagnosis of platyhelminthes; *Taenia*, *Schistosoma* and Nematelminthes; *Ascaris*, *Wuchereria*, . Antihelminthics drugs
- 4.5 Introduction to clinical microbiology (specimen collection. transport, handling, storage and laboratory analysis)

### Recommended Books

4. Ananthanarayan & Paniker's text book of Microbiology by Reba Kanungo, Universities Press.
5. Jawetz, Melnick & Adelbergs Medical Microbiology by Brooks et al., McGraw-Hill Medical.
6. Prescott's Microbiology by Joanne Willey, Linda Sherwood and Christopher J. Woolverton, McGraw Hill Publisher Companies, Inc.
7. Parasitology (Protozoology and Helminthology) by K.D.Chatterjee, CBS Publishers & Distributors.
8. Medical Parasitology by D. R. Arora and B. Arora, CBS Publishers & Distributors.

  
Prof. Azra N. Kamili

**Objectives:** This component shall inculcate in students the scientific temperament for finding solutions to the research problems. A student shall be required to select a research problem and perform experiments independently under the mentorship of a designated teacher. The methodology adopted and the findings of the study are to be compiled in a scientific manner and submitted to the department for evaluation in the form of a dissertation. A presentation of the methodology and finding should be made by the student in front of the scientific audience comprising of teachers, research scholars and the fellow students.

## Discipline Centric Elective

### MIC-18404DCE: BIOINFORMATICS and BIOSTATISTICS (Credits 4)

**Objectives:** This course is aimed at imparting the analytical and interpretative skills to the students so that they can analyze and interpret the data generated from the experiments in scientifically understandable form. Further, the students can make use of the statistical and bioinformatics tools learnt for the project work in upcoming semester and research career thereof.

#### Unit 1

- 1.1 History and scope of bioinformatics
- 1.2 Role of computers in bioinformatics: Operating systems (unix, linux), concept of networking
- 1.3 Biological database: literature (PubMed), nucleic acid NCBI, EMBL) protein (NBRF, PIR, Swiss-Prot) and structural database (PDB)
- 1.4 Sequence analysis and comparison; Similarity and homology between sequences; sequence alignment–local and global alignment (BLAST, FASTA), Multiple sequence alignment (Clustal W)
- 1.5 Phylogenetic analysis: types of phylogenetic trees, approaches of constructing phylogenetic trees (UPGMA, maximum parsimony, maximum likelihood, neighbor joining), phylogenetic analysis by MEGA software

#### UNIT II

- 2.1 Bioinformatic tools in microbial research: ORF finder, primer design, restriction mapping (NEBcutter), removal of vector contamination (VecScreen), domain finder.
- 2.2 Promoter analysis databases. (Virtual Foot print, PePPER, BPRM)
- 2.3 Prokaryotic and eukaryotic genome analysis software and databases: Microbial genomic database (MBGD), Virus data bank (ICTVdb), Cell line database (ATCC), Ribosomal database project-RDP, Genomes online database-GOLD, The Arabidopsis Information Resource (TAIR), TIGR Rice Genome Annotation)
- 2.4 Structure prediction: secondary structure of RNA, secondary and tertiary structure of proteins, In silico isoelectric point and molecular weight of proteins using Compute PI/MW, subcellular localization of prokaryotic protein PSORTb, PSLpred, TBPred
- 2.5 Protein modeling, comparative modeling, threading, molecular docking using AutoDock

#### Unit III

- 3.1 A general account on biostatistics–samples and populations, types of variables, arithmetic mean, mode and median
- 3.2 Data interpretation: graphs, bar diagrams, average, range, standard deviation, standard error, coefficient of variation
- 3.3 General criteria for experimental design: latin square, block, completely randomized and split plot design
- 3.4 Regression and correlation analyses
- 3.5 Skewness and kurtosis and their measures, percentiles, quantiles, outliers

#### Unit IV

- 4.1 Tests of statistical significance - t-test, z-test, F-test
- 4.2 Analysis of variance, ANOVA, One way Anova (concept and calculation), SPSS and its applications
- 4.3 Probability: definition, conditional probability, addition and multiplication rules, normal, binomial and poisson distribution
- 4.4 Frameworks for statistical analysis: Bayesian, Parametric and Monte-carlo
- 4.5 Concept of isoclines, ecological diversity, incidences diversity (Simpson's index, ShannonWiener index)

#### Recommended Books

1. Bioinformatics and Functional Genomics by Jonathan Pevsner, Wiley-Blackwell.
2. Bioinformatics Sequence and Genome Analysis by Mount D.W., Cold Spring Harbor Laboratory Press.
3. Genome Analysis and Bioinformatics: A Practical Approach by T.R.Sharma, I K International Publishing House.
4. Biostatistics: A Foundation for Analysis in the Health Sciences (Wiley Series in Probability and Statistics) by Daniel W Wayne, John Wiley & Sons Inc.
5. Fundamentals of Biostatistics by Khan and Khanum, Ukaaz Publications.
6. Biostatistics by P.N Arora and P.K. Malhan, Himalaya Publishing House.
7. Statistics for Biologists by Campbell, R.C., Cambridge University Press.

## Generic Electives

### **MIC-18405GE: FERMENTATION TECHNOLOGY (Credits 2)**

*Objectives: This course shall impart knowledge about applications of microorganisms for the production of industrially important products. The basics of fermentation process and design of fermenters for the industrial production of antibiotics, enzymes, amino acids, vitamins and beverages shall be covered in this course.*

#### **Unit 1**

- 1.1 Introduction to industrial microbiology
- 1.2 Fermentor and its types
- 1.3 Microbial fermentation and types of fermentation
- 1.4 Carbon and nitrogen sources used for microbial fermentation
- 1.5 Factors effecting microbial growth during fermentation

#### **Unit 2**

- 1.2 Industrial production of antibiotics (penicillin, streptomycin)
- 1.3 Production of enzymes (protease, amylase and lipase)
- 1.3 Production of amino acids ( lysine and tryptophan)
- 1.4 Production of vitamins (riboflavin and cyanocobalamin)
- 1.5 Production of alcohol and organic acids (beer, wine and citric acid)

#### **Recommended Books**

1. Principles of Fermentation Technology by P.F. Stanbury, W. Whitaker & S.J. Hall, Elsevier.
2. Biotechnology: A Text Book of Industrial Microbiology by W. Crueger & A. Crueger, Sinauer Associates Inc.
3. Biotechnology: Expanding Horizons by B.D. Singh, Kalyani Publishers.
4. Biotechnology by U. Satyanarayana, Books & Allied Ltd.

### **MIC-18405GE: APPLIED AGRICULTURAL MICROBIOLOGY (Credits 2)**

*Objectives: This course is intended to deal with basics of agricultural microbiology, the plant microbe interactions, biological nitrogen fixation (BNF), use of microorganisms as biofertilizers and biopesticides shall be taught in detail.*

#### **Unit I**

- 1.1 Introduction to agricultural microbiology
- 1.2 Rhizosphere, phyllosphere and endophytic microorganisms and their interactions with plants
- 1.3 Biological nitrogen fixation (symbiotic and asymbiotic)
- 1.4 General account on plant-microbe interactions (beneficial and harmful)
- 1.5 Plant growth promoting bacteria and their uses

#### **Unit II**

- 2.1 Mycorrhizae and their applications
- 2.2 Biofertilizers, production and application of *Rhizobium* and *Azotobacter*
- 2.3 Cyanobacteria as biofuel and future prospectus
- 2.4 Biopesticides, production and uses
- 2.5 Bt transgenics their success and failures.

#### **Recommended Books**

1. Agricultural Microbiology by G.Rangaswamy and Bagyaraj, Prentice Hall India.
2. Soil Microbiology by Subba Rao, Science Publishers.
3. Soil Microorganisms and Plant Growth by N.S Subba Rao, Science Publishers.
4. P. D. Sharma (2006), Plant Pathology. Alpha Science International Publishers.

  
Prof. Azra N. Kamili