

**Shiksha Mandal's  
Bajaj College of Science, Wardha (Autonomous)  
B.Sc. Microbiology  
Semester V**

**Syllabus**

**DSC V: MEDICAL MICROBIOLOGY**

(UMB350T)

**Credits: 06**

**Course Objectives**

- To enrich students with knowledge and understanding of the different concepts of medical microbiology.
- To understand relationship between human host and pathogens.
- To understand the ability of pathogens to cause disease.

**Learning Outcomes:** After successful completion of this course, students are expected to:

- Get acquired with sufficient knowledge of relationship between host and pathogens.
- Know the concepts related to infection, its stages & types.
- Correlate disease symptoms with causative agents.
- Gain the knowledge of mechanism of action of antimicrobial drugs and prophylaxis.
- Gain knowledge on significance of normal flora in human life.
- Understand the laboratory diagnosis methods for various infectious diseases.

**UNIT I: Epidemiology and host–parasite relationship.**

1. Definitions:

i. Signs, symptoms and syndrome of disease, stages of infectious diseases-incubation period, prodromal phase, Invasive phase, decline phase and the period of convalescence, ii. Bacteremia, septicaemia, pyamia, toxemia, Viremia.

iii. Epidemic, Endemic, Pandemic, Zoonotic, Exotic, prosodemic sporadic deisease.

2. Dynamics of disease transmission:

i. Causative or etiological agents [list]

ii. Sources of reservoir of infection.

Exogenous Human (case and carrier)

Non-living reservoir.

Endogenous infections

iii. Portal of exit

iv. Mode of transmission-Contact, Vehicle, Vector, Air-borne, transplacental and laboratory/hospital infections.

v. Portal of entry.

vi. Susceptibility of host.

Control of communicable diseases: Control of sources, blocking the channels of transmission, protecting the susceptible host.

## **UNIT II: Pathogenicity & Normal flora**

Microbial mechanism of Pathogenicity: pathogenicity and virulence, exaltation and attenuation, MID, MLD, ID 50, LD50.

- i. Invasiveness:-adherence,capsule,enzymes.
  - ii. Toxigenicity:- Exotoxins and Endotoxins.
2. Normal flora of healthy human host:
- i. Definition, origin, significance, Germ free and Gnotobiotic life.
  - ii. Characteristics of normal flora
- Normal flora of skin, eye, gastrointestinal tract, respiratory tract, urinogenital tract etc.

## **Unit III: Infectious Microbiology**

Concept of infection, Types: primary infection, secondary infection, acute infection, chronic infection local and systemic infection, iatrogenic infection, nosocomial infection, congenital infection, teratogenic infection, fulminating infection, atypical infection, latent infection

Microbial diseases of skin, eye, digestive, respiratory, cardiovascular, lymphatic, urinary, reproductive and nervous systems. (Detail structure of each system and its etiological agents, lists of infectious diseases affecting the particular system).

## **UNIT IV Study of pathogenic organisms:**

Study of pathogenic organisms, Morphology, cultural characteristics, biochemical characteristics, pathogenesis, serology, lab diagnosis and disease control

### **1. Bacteria**

- i. Salmonella typhi and paratyphi A&B.
- ii. Spirochetes-*Treponema pallidum*

### **2. Viruses**

- i. HIV

### **3. Protozoa**

- i. Plasmodium

## **UNIT V Disease control**

1. Basic mechanism of action of drugs.
  - i. Bacterial cell wall synthesis inhibitor; Penicillin
  - ii. Bacterial protein synthesis inhibitor: Chloramphenicol
  - iii. Bacterial DNA synthesis inhibitor: Nalidixic acid, Floxacin
  - iv. Anti metabolites: Trimethoprim, sulfamethoxazole.

## **UNIT VI Drug resistance**

Drug resistance: Definition & Concept

Consequences & challenges of drug resistance

Concept & example of MDR

Various mechanisms of development of drug resistance

Non automated and automated in vitro drug susceptibility testing- Kirby-Bauer disc diffusion method, E-strip method, Agar well diffusion method

**SEM V**  
**Practical Course in Medical Microbiology**  
(UMB350P)

**Course Objectives**

- The objective of this laboratory course is to provide the students practical skills in Medical microbiology

**Course Outcomes**

- Students are expected to demonstrate practical skills in identification of bacteria
- To demonstrate practical skill in Antibiotic sensitivity testing
- To learn how to determine the minimum inhibitory concentration of antibiotics

**Practicals:**

1. Identification of bacteria: *E.coli*,
2. Identification of bacteria: *S.aureus*,
3. Identification of bacteria: *Salmonella*
4. Identification of bacteria: *Proteus vulgaris*
5. Isolation and identification of candida from mouth
6. Antibiotic sensitivity test by Kirby-Bauer disc diffusion method
7. Determination of MIC of antibiotic by e -strip method
8. Estimation of creatinine by spectrophotometric method
9. Pregnancy Test
10. Blood urea estimation

**Reference Books:**

1. Jawetz, Melnick and Adelberg's Medical Microbiology, 26<sup>th</sup> Edition, Lange publication
2. Bacterial Pathogenesis –A molecular approach Abigail Salyer And Dixie Whitt 2nd Ed ASM press
3. Ananthanarayan and Panicker's, Textbook of Microbiology, 9 edition
4. Baron Samuel, Medical Microbiology, 4 edition
5. Tortora, G.J., Funke, B.R., Case, C.L, 1992.
6. Chakraborty, P., 2003 A textbook of Microbiology, 2nd Edition New Central Book Agency, India.
7. Medical Microbiology edited by Samuel Baron. Fourth edition (University of Texas Medical Branch of Galvesion)
8. Virulence mechanisms of bacterial pathogens (Second edition) by Roth, Bolin, Brogden Minion and Michael.
9. Ganti, A. Sastry.1975. Veterinary Pathology. Seventh Edition. Revised by P. Rama Rao.
10. Davis B.D., Delbacco, 1990 Microbiology 4th edition, J.B. Lippincott Co. NY
11. Wolfgang K. Joklik, 1992, Zinsser Microbiology 20<sup>th</sup> Edition, McGraw-Hill Professional Publishing.
12. Dey, N.C and Dey, TK. 1988, Medical Bacteriology, Allied Agency, Calcutta, 17<sup>th</sup> Edition
13. Ananthnarayana, R. and C.E, JayaramPanikar, 1996 Text book of microbiology, 5<sup>th</sup> edition, Orient Longman.
14. David Greenwood, 1995, Antimicrobial Chemotherapy, 3<sup>rd</sup> Edition, Oxford University Press.
15. Franklin, T.J and Snow, G. A. 2012, Biochemistry of Antimicrobial Action. Springer Science & Business Media
16. Mukherjee, K.L 1988 Medical Laboratory Technology, Vol III, 10<sup>th</sup> Edition, Tata Mc. Graw-Hill Pub Co.
17. Atlas, R. M. (1995), Microorganisms in our world, Mosby Year Book Inc.
18. Prescott, L. M., Hartley, J. P. and Klein, D. A., (1993), Microbiology, 2<sup>nd</sup> Ed., W. M. C. Brown Publ, England
19. Vyas, S. P. and Dixit, V. K. (1998), Pharmaceutical Biotechnology, CBS Publisher, New Delhi.

## SEM V

### DSC VI: Immunology

(UMB355T)

**Credits: 06**

#### **Course Objectives**

- To enrich students' knowledge and train them in Immunology.
- To complement the students with various aspects of immunology
- To inculcate sense of scientific responsibilities & social awareness with respect to immunity..

**Learning Outcomes:** After successful completion of this course, students are expected to:

- Students will be acquainted with the various principles of Immunology
- Students will become aware about the role of microbiologist in various fields of disease epidemiology and immunology
- Comprehend knowledge regarding host defense mechanisms against pathogen.
- Understand diverse cells and organs involved in immune system.
- Gain knowledge on antigens & antibodies
- Understand the importance of vaccines in immunity.

#### **UNIT I: Immunity & cells of immune system**

1. Immunity: Definition and general concept

2. Haematopoiesis

a) Diagram of Haematopoiesis

b) General characteristics and functions of cells of immune system

i. B and T cells,

ii. Monocytes and macrophages,

iii. Neutrophils, Eosinophils and basophiles.

iv. Mast cells

v. Dendritic cells

vi. Natural Killer cells

#### **UNIT II Nonspecific defenses**

3. Non specific defenses of the host:

a) Species, race and individual resistance.

b) Age, sex, hormonal and nutritional influences.

4. Mechanism of non-specific defenses:

a) First line of defense – Physical, chemical and biological barriers

b) Second line of defense:

i. Humoral components: Defensins, pattern recognition proteins (PRP) and pathogen associated molecular patterns (PAMPs), complement, kinins, acute phase reactants.

ii. Cellular components: Phagocytic cells – PMNL, macrophages (reticulo-endothelial cell system) and dendritic cells

5. Functions: Phagocytosis (oxygen dependent and independent systems), Complement activation (General concept), Coagulation system, Inflammation (cardinal signs, mediators, vascular and cellular changes, role of Toll-like receptors)

### **UNIT III: Antigen & Antibody**

#### **1. Antigen:**

- a) Concepts and factors affecting immunogenicity
- b) Antigenic determinants, haptens and cross-reactivity, Carriers, Adjuvants
- c) Types of antigens: Thymus-dependent and thymus-independent antigens, Synthetic antigens, Soluble and particulate antigens, Autoantigens, Isoantigens, Species specific antigens, Organ specific antigens, Heterophile antigens

#### **2. Immunoglobulins:**

- a) Structure of basic unit, chemical and biological properties
- b) Characteristic of domain structure, functions of light and heavy chain domains
- c) Molecular basis of antibody diversity (kappa chain, lambda chain and heavy chain diversity)
- d) Classes of Immunoglobulins and their functions.

### **UNIT IV: Organs of immune system:**

- a) Primary lymphoid organs (Thymus and Bursa): Thymus – structure, thymic education (positive and negative selection), Bone marrow
- b) Secondary lymphoid organs – Structure and function of spleen and lymph node, mucous associated lymphoid tissue and lymphatic system and lymph circulation

### **UNIT V: Adaptive / Acquired Immunity (Third line of defense):**

- a) Acquired immunity: Active and Passive immunity.
- b) Primary and secondary response and its significance in vaccination programs
- c) Clonal selection and clonal deletion (immunotolerance)
- d) B cell biology, role of cytokines in activation and differentiation of B-cells

#### **Cell Mediated Immune Response:**

- a) Activation and differentiation of T cells
- b) Mechanism of CTL mediated cytotoxicity, ADCC
- c) Applications of CMI

#### **T-cellbiology:**

- a) T-cell dependent antibody response. outline
- b) T-cell independent antibody response. outline
- c) Types of T-cells and Cluster of differentiation (CD)
- d) T-cell receptor (TCR)

### **VI. MHC molecule, Cytokines & Hypersensitivity**

#### **Major Histocompatibility Complex:**

- a) Definition, Structure and functions of MHC class-I and class-II molecules
- b) Antigen presentation, endogenous and exogenous pathways (diagrammatic)

#### **Cytokines**

- a) Definition and general characteristics
- b) Types- colony stimulating factor, Interleukins, Tumor necrosis factor

#### **Hypersensitivity: Concept & its types**

**SEM V**  
**Practical Course in Immunology**  
(UMB355P)

**Course Objectives**

- The objective of this laboratory course is to provide the students practical skills diagnostic immunology

**Course Outcomes**

- Students are expected to demonstrate widal test
- To demonstrate practical skill in blood grouping
- To learn the technique of immunodiffusion

**Practicals:**

1. Study of permanent slides- T.S. of spleen, thymus, bursa of fabricius and lymph node
2. Qualitative widal test
3. Perform Quantitative WIDAL test
4. Rapid plasma reagin (RPR) Test
5. Blood Group Detection (Direct and Reverse typing)
6. Perform Immunodiffusion
7. ELISA Test
8. Coomb's Direct test
9. Perform VDRL test

**Reference Books:**

1. Kuby Immunology, 6<sup>th</sup> Edition, W H Freeman and Company
2. Pathak & Palan, Immunology: Essential & Fundamental, 1<sup>st</sup> & 3<sup>rd</sup> Edition, Capital Publishing Company
3. Fahim Khan, Elements of Immunology, Pearson Education
4. Microbiology: An introduction 5th Edition, Benjamin Pub. Co. NY
5. Banker, D (1980), Modern Practice in Immunization, 3rd Ed., Popular Prakashan Pvt. Ltd., Bombay.
6. Coleman, R. M, Lombard M F, Sicard, R. E., (1989), Fundamental Immunology, 2nd Ed., W. C. Brown Publishers, USA.
7. Kimball, J. W, (1990), Introduction to Immunology, MacMillan Publishing Company, New York.
8. Weir, D. M., (1991), Immunology, Livingstone, ELBS and Churchill.
9. Roitt's essential Immunology

## SEM V

### DSE I

#### Food Microbiology

(UMB354T)

**Credits: 4**

#### **Course Objectives**

- To understand concepts in milk microbiology.
- To complement the students with the basic knowledge of food microbiology.
- To acquaint the students with food preservation techniques.

**Learning Outcomes:** After successful completion of this course, students are expected to:

- Get acquired with sufficient knowledge of relationship between food and microbes and fermented food products
- Know the concepts related to popular milk products, milk examination and spoilage.
- Comprehend knowledge regarding fermented food products, food spoilage and infection.
- Understand diverse strategies for food preservation.
- Gain knowledge on Foodborne diseases and their control
- Understand the importance of food safety, food quality, food plant sanitation, food laws and regulations, food engineering and packaging in food industry

#### **UNIT I- Introduction to food microbiology:**

Concept of fermented food, History of food microbiology & fermented food.

Scope of food microbiology, Inter-relationship of food science, nutrition & food microbiology.

Types of microbes associated with food: Bacteria, mould, fungi, yeast & virus.

Intrinsic and extrinsic factors affecting growth of microorganisms in food.

#### **UNIT-II Milk Microbiology**

Milk - Definition, composition and types, Pasteurization of milk, Grades of milk

Microbiological examination of milk: Test for mastitis, MBRT test, Resazurin test & Brucella ring test.

Milk products: Fermented milk (Dahi / Yoghurt, buttermilk )

Cheese: Types, general production process, microbiological changes during ripening, defects and spoilage.

Microbial quality of milk

Milk microorganisms: acid/ gas producers, proteolytic, lipolytic, pathogenic etc.

Defects: Colour and Flavour, Sweet curdling, Stormy fermentation & Ropiness.

Concept of prebiotics and probiotics and their significance.

#### **UNIT III Food Microbiology**

Food and microbes: Food as substrate for microbial growth, Sources for food Contamination.

Fermented Foods: Bread, Malt beverages, Wine, Tempeh and Idli

Fermented vegetables: Sauerkraut and Soy Sauce

Microbiological examination of food: Standard plate count, Breed count, Direct Microscopic Count

## **UNIT-IV Food spoilage & Food borne diseases**

Concept of food spoilage, Factors affecting food spoilage, types of food (Perishable, Non perishable, Semi perishable)

Food infection: sources, mechanism of infection and prevention.

Microbial food poisoning with respect to toxins, their effects, properties of toxins and treatment: Staphylococcus aureus, Bacillus cereus, Clostridium botulinum, Salmonella and Vibrio parahaemolyticus.

Aflatoxins: Structure, detection, mode of action and detoxification.

## **UNIT V Food Preservation Techniques**

Factors influencing on food preservation. Temperature dependent control: Low temperature: Chilling and freezing, High temperature

Chemical preservatives: Sulphur dioxide, Nitrites and nitrates& Organic acids (Acetic and Lactic acids)

Antibiotics (Natamycin)

Canning: Concept and Method.

Control of Water activity: Dehydration

Use of radiations: Microwave, UV and Ionizing

Food preservation & Quality Control

## **Unit VI: Food Safety**

Introduction to food safety, Food safety laws & GMP

Importance of food safety

Basic knowledge of food sanitation and hygiene

Food safety indicator organisms

HACCP system

## **Reference Books:**

1. Adams, M. R., Moss, M. O, (1995), Food Microbiology, New Age International, New Delhi.
2. Singh B. D. (2014), Biotechnology: exploring horizons, Kalyani publishers, Ludhiana.
3. Banwart, G. J., (1987), Basic Food Microbiology, CBS Publ., New Delhi.
4. Bilgrami, K. S, Dube, H. G., (1994), Textbook of Modern Plant pathology, Vikas Publ., New Delhi.
5. Frazier, W. C, Westhoff, D C., (1988), Food Microbiology, Tata McGraw Hill, New Delhi.
6. James M. Jay, Martin J. Loessner, David A. (2012), Modern Food Microbiology, 7th Edition(Food Science Texts Series).
7. Winton, A. L, Winton, K. B, (1998), Milk and Milk Products, Agro-botanical Publ, Bikaner. 8. Ray B (2005), Fundamental Food Microbiology, CRC press, London.

## SEM V

### DSE I

#### Agricultural Microbiology & Plant Pathology

(UMB354T)

**Credits: 4**

#### **Course Objectives**

- To understand concepts in plant pathology.
- To acquaint the students with basic knowledge of plant disease control.
- To complement the students with the concepts in Agricultural Microbiology.

#### **Learning Outcomes**

After successful completion of this course, students are expected to:

- Understand classification of plant pathology with regional plant diseases.
- Know the concepts related to methods of plant disease control.
- Comprehend knowledge regarding Agricultural Microbiology.
- Get acquainted with Soil and Microbe relation
- Become aware of the important role microbes play in bio-geochemical cycling of essential elements occurring within an ecosystem and its significance

#### **Unit I: Soil Microbial ecology**

Soil: concept, composition, soil formation, soil as an ecosystem, types of soil in India, Crop Rotation and production. Biogeochemical Cycles (N, P, S, C), Effect of modern agro technology and pesticides on soil.

#### **Unit II Bio fertilizers**

Rhizosphere: concept, microorganisms, significance, concept & significance of PGPR, Characteristics and role of PGPR, Rhizosphere engineering  
Methods of Biofertilizer production, methods of application, Organic Farming, manure production and types (compost, vermicompost & green manure)

#### **UNIT-III Plant pathology**

Classification of plant diseases based on symptoms, crop and parts affected  
Terminology: Host, Alternate and Collateral host, Resistance, Susceptibility and Tolerance  
Disease Triangle (Host, environment and pathogen), concept of Disease cycle  
Study of plant diseases with respect to causative agent, host, symptoms and control:

- Wilt of cotton
- Citrus canker

#### **UNIT -IV Methods of plant disease control**

Mechanism: Exclusion, Eradication, Reduction of inoculum, Protection and Resistant varieties  
Chemical control: fungicides, bactericides etc.  
Biological control: microbial herbicides& insecticides  
Cultural methods: Tillage, Deep ploughing and Spacing

## **Unit V Integrated pest management:**

Concept of IPM, Components of IPM: legal approach, ecological management, diverting pest population away from the crop.

Modern approaches in IPM: Application of viral proteins in controlling plant viral diseases, Antisense RNA technology in plant disease control, Mycoviruses for controlling fungal pathogens

## **UNIT-VI Agricultural waste management**

Transgenic plants:

Method: Gene construction, vector (Ti/Ri plasmid), mechanism & importance

Examples: Development of insect resistant plants (Bt cotton), Biochemical production of Hirudin-A polypeptide & Phytase enzyme

Agricultural waste: source, types and management

Solid waste: Composting: necessity, microbiology, methods, advantages and disadvantages

## **Reference Books:**

1. Dubey R. C. and Maheshwari D. K. (2006), A textbook of microbiology, S Chand, New Delhi.
2. Das H. K. (2005), Textbook of biotechnology, Wiley Dream tech India Pvt. Ltd.
3. Kuderia, V. P., (1998), Water Pollution, Pragati Prakashan, Meerut.
4. Martin Alexander (1977), Introduction to Soil Microbiology, 2nd Ed., John Wiley & Sons.
5. Mitchell, R. (1974), Introduction to Environmental Microbiology Prentice Hall, New Jersey.
6. Pathak, V. N, Khatri, N.K., Pathak, M., (1996), Fundamentals of Plant Pathology, Agro - botanical Publ., Bikaner.
7. Powar, C. B., Dagainwalla, H. F., (1990), General Microbiology Vol. I & II, Himalaya Publishing House, Mumbai.
8. Rao, M. N. and Rao, H. V N, (1989), Air Pollution, Tata McGraw Hill Publ, Company, Ltd., New Delhi.
9. Salle, A. J., (1990), Fundamentals of Microbiology, Tata McGraw Hill, New Delhi.
10. Satyanarayana U. (2005), Biotechnology, Books and Allied (P) Ltd. Kolkata.
11. Thakur I S (2011), Environmental Biotechnology: Basic concepts and applications, IK International, New Delhi.

**Sem V VSEC**  
**Practical Course in Soil and Agricultural Microbiology**  
(UMB352P)

**Credit: 02**

**Course Objectives**

To acquaint students with various micro-organisms, its harmful or beneficial effects on Agriculture, how to use them in a safer way for creating a better agriculture system

**Course Outcomes**

- To gain knowledge on several beneficial and harmful micro-organisms
- To know the complex interaction between agriculture system and micro-organism.
- To introduce micro-organism in agricultural system for building a pathway for sustainable agriculture
- To be able to isolate organisms that have potential as biofertilizers

**Practicals:**

1. Enumeration of microbial population in soil- bacteria, fungi, actinomycetes.
2. Isolation of Azotobacter from soil
3. Isolation of phosphate solubilizing bacteria from soil
4. Isolation IAA producing bacteria from soil
5. Isolation of antagonistic Pseudomonas from soil.
6. Isolation of Azospirillum sp. from the roots of grasses
7. Isolation of phyllosphere microflora
8. Demonstration on different biofertilizers types, formulation and application methods.

**Reference Books:**

- Aneja K.R. (2001) Experiments in Microbiology, Plant Pathology, Tissue culture and Mushroom production technology, 3rd Edition, New Age International Publishers, (ISBN: 978-9386418302)
- Amaresan N., Patel P. and Amin D. (Eds.) (2022) Springer Protocols: Practical Handbook on Agricultural Microbiology. Springer. p.391
- R C Dubey and D.K.Maheshwari (2010) Practical Microbiology. S Chand Publisher. ISBN 9788121921534
- Harley, J. P. and Prescott L. M. (2002) Laboratory Exercises in Microbiology, 5 th edition, The McGraw-Hill Co., New York
- Kapoor K K and Shashi Paloda (2007) Experimental Soil Microbiology. CBS Publishers. ISBN 9788123914305
- Microbiology A Laboratory Manual: James, C and Natile, S.(10th Ed.) 2014. Pearson India Education Services Pvt. Ltd., South Asia.

**B.Sc Semester VI**  
**DSC VII**  
**Molecular Biology and Genetics**

(UMB360T)

**Credit: 06**

**Course Objectives**

- To enrich students' knowledge in molecular biology.
- To complement the students with various aspects of genetics
- To inculcate sense of scientific responsibilities with respect to molecular biology

**Learning Outcomes:** After successful completion of this course, students are expected to:

- Students will be acquainted with the various principles of molecular biology
- Students will become aware about the role of molecular biology in research
- Comprehend knowledge regarding microbial genetics
- Understand gene mutation, gene regulation
- Gain knowledge on genetic recombination
- Understand DNA repair mechanisms.

**Unit 1 Concept of Gene mutation and regulation.**

- Concept of gene, muton, recon, cistron, monocistronic and polycistronic gene, gene within gene, split gene.
- Mutation: Definition, random vs directed mutation, type of mutation, base pair substitution, frameshift, point, nonsense, missense, and silent mutation.
- Genetic suppression: Intergenic and Intragenic.
- Molecular basis of mutation: Mechanism of spontaneous and induced mutation.

**Unit 2 Gene Transfer and Genetic recombination**

Gene Transfer by Transformation:

- Development of Competence (Gram Positive & Gram Negative)
- Mechanism in Gram Positive and Gram-Negative bacteria

Gene Transfer by Conjugation:

- F<sup>+</sup>, Hfr and F1 strains • F plasmid • Conjugation in F<sup>+</sup> and Hfr cells

Gene Transfer by Transduction:

- Generalized Transduction • Specialized Transduction • Abortive Transduction

Transposition:

- Transposable elements that move via DNA intermediates: IS Composite & TnA family of transposons • Mechanism of DNA mediated transposition

### **Unit 3 Genetic code and protein synthesis**

1. Characteristics of genetic code: triplet code, nonoverlapping code, comma less, codons, anticodons, deciphering of code, wobble hypothesis, colinearity of gene structure & its polypeptide products.
2. Transcription: Central dogma of molecular biology. Components of transcription, process of transcription (prokaryotes), RNA Polymerases.
3. Protein synthesis: Outline, process of translation (Prokaryotes)

### **Unit 4 DNA Repair Mechanisms**

DNA Repair mechanisms:

- DNA damage
- Direct Reversal of DNA damage
- Base Excision Repair by base flipping
  - Nucleotide Excision Repair
- Recombination repair
- Translesion DNA synthesis (TLS)
- SOS Repair

### **Unit 5 Molecular Mechanism of gene regulation in prokaryotes**

Transcriptional regulation in prokaryotes (inducible and repressible system, positive regulation and negative regulation); Operon concept – lac, trp, Ara operons.

### **Unit 6 Bacteriophage Genetics**

Stages in the Lytic Life Cycle of a typical phage, Properties of a phage infected bacterial culture, Specificity in phage infection, Benzer's fine structure of gene in bacteriophage T4: Plaque Formation and Phage Mutants, Genetic recombination in the lytic cycle, (concept of recon, muton, cistron).

**SEM VI**  
**Practical Course in Molecular Biology and Genetics**

(UMB360P)

**Course Objectives**

- The objective of this laboratory course is to provide the students practical skills in basic molecular biology and genetics

**Course Outcomes**

- Students are expected to demonstrate practical skills in characterizing DNA and changes in it
- To learn the basic recombination techniques and amplification of DNA
- To learn the isolation of mutants by plate assay

**Practical's:**

1. Determination of absorption spectra of DNA for confirmation of purity
2. Determination of melting temperature ( $T_m$ ) of DNA
3. Isolation of genomic DNA
4. Isolation of plasmid DNA from bacteria
5. Demonstration of Restriction digestion Technique
6. Demonstration of genetic recombination in bacteria by conjugation
7. Ames test for detecting potential mutagens
8. Preparation of Competent Cells by  $CaCl_2$  method
9. Perform genetic recombination by transformation technique

**Reference Books:**

- Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. Molecular Biology of the Cell Garland Press 1999
- Brown, T.A Genomes: Wiley 1999
- Lewin, B. Genes VII Oxford 1997
- Lodish, H., Baltimore, D., Berk, A., Zipursky, S.L., Matsudaira, P. and Daniell, J. Molecular Cell Biology Freeman and Co 2000
- Singer, M. and Berg, P Genes and Genomes Blackwell Scientific 1991
- Weaver, R.F. Molecular Biology McGraw Hill 2002.

**SEM VI**

**DSC VIII**

**BIOINSTRUMENTATION AND BIOTECHNOLOGY**

**(UMB365T)**

**Credit: 06**

**Course Objectives**

- To enrich students' knowledge in bioinstrumentation and biotechnology.
- To understand the applications of biotechnology
- To acquaint the students with various bioinstrumentation techniques.

**Learning Outcomes:** After successful completion of this course, students are expected to:

- Students will be acquainted with the various principles of biotechnology
- Students will become aware about the various bioinstrumentation techniques
- Comprehend knowledge regarding advanced techniques in genetics.
- Understand tracer techniques
- Gain knowledge on healthcare biotechnology
- Understand the importance of biotechnology.

**Unit -1 Bioinstrumentation-I (Principles and applications)**

- Spectroscopy: Laws of absorption, limitations of beer law, UV-Visible spectroscopy and its applications.
- Centrifugation: Types of centrifuges, analytical and differential centrifugation.
- Electrophoresis: Principle, agarose gel electrophoresis and SDS- PAGE. Factors affecting electrophoresis mobility
- Chromatography: Thin layer chromatography, ion exchange, gel filtration
- Detection and measurement of stable isotope: Mass spectrometry. Detection and measurement of radioactive isotope: GM counter, scintillation counter

**Unit- 2 Applications of Biotechnology**

- Protoplast fusion, application of *Agrobacterium tumifaciens* in gene transfer.
- Production of Biopesticides – Buculo virus
- Production of Biofertilizers – Rhizobium
- Oriental Fermented food: Definition and production of soya sauce
- Genetically modified foods- Definition and concept of golden rice
- Transgenic plants - Definition and concept of BT Cotton

**Unit 3 Health care Biotechnology**

- Production of hormones : Insulin, Production of Interferon
- Production of vaccines : Conventional vaccines – BCG, Salk, Diphtheria Toxoid , ATS, DNA Vaccine, Edible vaccines
- Hybridoma technology, monoclonal antibody production 5. Gene Therapy.

#### **Unit 4 Tracer techniques**

- Properties and units of radioactivity; half-life;
- Measurement of radioactivity by GM counter, liquid scintillation counter; autoradiography; radioimmunoassay;
- Safety rules in handling of radioisotopes and hazardous chemicals.

#### **Unit 5 Techniques in human gene and chromosome analysis**

- Human karyotype: banding, nomenclature of banding
- Fluorescence in situ hybridization (FISH), GISH, Flow Cytometry
- Comparative genomic hybridization
- DNA sequencing (Sanger, NGS): Types and application

#### **Unit 6 Advanced Techniques in Genetics**

- PCR: Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, PCR in molecular diagnostics; viral and bacterial detection.
- DNA Finger Printing: Principle, Methods & Applications.
- Gene Editing: Concept of CRISPR technology

## SEM VI

### Practical Course in Bioinstrumentation & Biotechnology

(UMB365P)

#### **Course Objectives**

- The objective of this laboratory course is to provide the students practical skills in bioinstrumentation and biotechnology

#### **Course Outcomes**

- To learn the basic principle of the instruments and techniques
- Students are expected to demonstrate practical skills in handling of equipment's
- To learn the advanced biotechnology techniques for studying mutant isolation

#### **Practicals**

1. Demonstration of Beers law
2. Perform gel filtration chromatography
3. Perform paper chromatography of amino acids and sugars
4. Perform TLC of amino acids and sugars
5. Isolation of antibiotic resistant mutant by gradient plate technique.
6. Isolation of streptomycin resistant mutant by replica plate technique.
7. UV induced auxotrophic mutant production
8. Demonstration of Polymerase Chain Reaction

#### **Reference Books:**

- Bajpai, P.K. 2006. Biological Instrumentation and methodology. S. Chand & Co. Ltd.
- K. Wilson and J. Walker Eds. 2005. Biochemistry and Molecular Biology. Cambridge University Press.
- K. Wilson andKHGoulding. 1986. Principles and techniques of Practical Biochemistry. (3 edn) Edward Arnold, London.
- Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley& Sons. Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
- Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell.7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

## **SEM VI**

### **DSE II**

## **GENETIC ENGINEERING**

(UMB364T)

**Credit: 04**

### **Course Objectives:**

1. To learn about the various enzymes involved in rDNA Technology
2. To know the principles of cDNA construction and amplification methods.
3. Making aware of synthesis of recombinant products

### **Course Outcome:**

1. Learn basic ideas on cloning vehicle
2. Know more about cDNA and amplification products
3. Understand the construction of recombinant DNA and molecular biology tools.

### **UNIT I**

Enzymes in genetic engineering: Restriction Endonucleases - classification, mode of action. Enzymes in modification - Polynucleotide phosphorylase, DNase, Methylases, phosphatases, polynucleotide Kinase, Ligases, S1 Nuclease, RNase and their mechanism of action.

### **UNIT II**

Vectors in recombinant DNA technology and its salient features, types of vectors – plasmids: pBR322, pUC18, pET21, cosmids, phages:  $\lambda$  and M13, SV40 Vector, Shuttle, Expression Vectors, YAC & BAC.

### **UNIT III**

Introduction of rDNA into host cell: - Electroporation, Microprojectile system, Liposome mediated transfer, gene gun, Calcium Phosphate method, DEAE dextran method.

### **UNIT – IV**

Gene Cloning, Cells for cloning: E.coli, S. cerevisiae, Direct screening & direct selection, indirect screening techniques: HAT (Hybrid Arrested Translation), HST (Hybrid Selected/released Translation), Colony hybridization, Dot Blot hybridization,

### **UNIT V**

Expression strategies for heterologous genes, Expression in plant, Bacteria and yeast, site- directed mutagenesis, genes targeting and protein engineering. Generation of Novel plants foods and GMOs, Gene Bank, Animal pharming.

### **UNIT VI**

Techniques and Application: Mapping of DNA, Gene Libraries: Genomic library, cDNA library. DNA foot Printing, DMS footprinting, DNase foot printing,

**Reference Books:**

1. Principles of gene manipulation (2006) by Sandy Primrose, Richard Twyman, Bob Old, Giuseppe Bertola (Black Well Publication).
2. Molecular cloning: A laboratory manual (2000) by J. Sambrook, E.F. Fritsch and T. Maniatis (Cold Spring Harbor).
3. Gene cloning and DNA analysis: An introduction (2006) by TA Brown (Blackwell Sci. Ltd).
4. Molecular biotechnology (1994) by S.B. Primrose (Blackwell, Scientific Publishers. Oxford).
5. PCR Strategies, M.A. Innis, D.H. Gelfant & J.J. Sninsky, 1995. IRL Press.
6. Genetic Engineering of Animals, A. Puhler, 1993. VCH Publishes, Weinheim FRG
7. Recombinant DNA (2nd Ed), J.D. Watson, M. Gillman, J. Witkowski and M. Zoller, 1992.

## SEM VI

### DSE II

### Environmental Microbiology

(UMB364T)

**Credit: 06**

**Course Objectives:**

1. To learn about environment and ecosystem
2. To understand the relationship of microbes and environment.
3. To learn about environmental pollution

**Course Outcome:**

1. Students will learn the interaction between environment and biota
2. Students will understand the importance of various biogeochemical cycles
3. Students will understand the concept of Plant growth promoting rhizobacteria

#### **Unit I Introduction to Environment & Ecosystem**

An Introduction: Definition of environment, Interaction between environment and biota, Concept of the habitat in biosphere, Food Chain, Ecosystem, Community, homeostasis and ecosystem management, Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.

#### **Unit-II Biogeochemical cycles**

Carbon cycle-significance and general aspects

Nitrogen cycle: Symbiotic and non-symbiotic 'N' fixation, Mechanism of nitrogenase, Biochemistry of Nitrate reduction.

Phosphorus cycle: Significance of 'P' element, role of phosphobacter and mycorrhizae in crop production.

Sulphur cycle - Significance of 'S' compound, sulphur oxidizing bacteria and mechanism.

#### **Unit III Plant Growth Promoting Microorganisms –**

Mycorrhizae, Rhizobia, Azospirillum, Azotobacter, Frankia, phosphate-solubilizers, fluorescent Pseudomonads. Significance of PGPR.

#### **UNIT-IV Air Microbiology**

Introduction, Significance of Air microflora, air pollution, air borne diseases, microbiological analysis of air, Different air sampling techniques, normal and beneficial air microflora

## **Unit V Emerging technologies in pollution management**

Role of microorganisms in controlling hazardous wastes pollution, indicators of biodiversity, Shannon-weaver index, algae dependent bioremediation, catabolic gene expression as indicator.

## **Unit VI Fresh water Microbiology**

Definition, Examples of fresh water i.e. ice sheets, ice caps, glaciers, icebergs, bogs, ponds, lakes, rivers, streams, and underground water and their outline, Water treatment using SSF and RSF, Methods of chlorination, Water Quality Standards (BIS and WHO).

### **Reference Books:**

1. Agarwal S.K. (2005) Advanced Environmental Biotechnology. APH Pub Co, New Delhi.
2. Alexander M. (1999) Biodegradation and Bioremediation. 2nd Edition, Academic Press, USA.
3. Asthana D.K. and Asthana M. (2001) Environment: Problems and Solutions. S. Chand & Co. Ltd., New Delhi.
4. Chatterji A.K. (2002) Introduction to Environmental Biotechnology. Prentice Hall of India Pvt Ltd., New Delhi.
5. Evans G.M. and Furlong J.C. (2003) Environmental Biotechnology: Theory and applications. John Wiley & Sons, England.
6. Huges W.W. (1996) Essentials of Environmental Toxicology. Taylor and Francis.
7. Krishnamurthy K.V. (2003) Textbook of Biodiversity. Science Publishers Inc, USA.
8. Mohapatra P.K. (2006) Textbook of Environmental Biotechnology. IK International, New Delhi.
9. Rana SVS (2009) Environmental Biotechnology. Rastogi Publications, Meerut.
10. Rittmann B.E. and McCarty P.L. (2001) Environmental Biotechnology: Principles and Applications. McGraw-Hill, USA.
11. Shaw I.C. and Chadwick J. (1998) Principles of Environmental Toxicology. Taylor & Francis Ltd., UK.
12. Thakur I. S. (2006) Environmental Biotechnology: Basic Concepts and Applications. IK International Pvt Ltd., New Delhi.
13. Yadav P.R. and Tyagi R. (2006) Environmental Biotechnology. Discovery Pub House, New Delhi.

**SEM VI VSEC**  
**Practical Course in Food Microbiology**

(UMB362P)

**Credit: 02**

**Course Objectives**

- The objective of this laboratory course is to provide the students practical skills in food microbiology

**Course Outcomes**

- To learn the basic principle of the food microbiology
- Students are expected to demonstrate practical skills in microbial analysis of milk
- To learn the role of various microbes in food

**Practical's Food Microbiology**

1. Analysis of milk sample by MBRT test
2. Analysis of milk sample by Resazurin test.
3. Isolation and characterization of food fermenting microorganisms from idli batter/Curd.
4. Isolation of probiotics/ lactic acid bacteria.
5. Determination of role of yeast as leavening agent in bread making
6. Production of Sauerkraut by lactic acid bacteria
7. Cultivation of edible mushrooms
8. Citric acid production by *A niger* by submerged fermentation

**Reference Books:**

1. Adams, M. R., Moss, M. O, (1995), Food Microbiology, New Age International, New Delhi.
2. Singh B. D. (2014), Biotechnology: exploring horizons, Kalyani publishers, Ludhiana.
3. Banwart, G. J., (1987), Basic Food Microbiology, CBS Publ., New Delhi.
4. Bilgrami, K. S, Dube, H. G., (1994), Textbook of Modern Plant pathology, Vikas Publ., New Delhi.
5. Frazier, W. C, Westhoff, D C., (1988), Food Microbiology, Tata McGraw Hill, New Delh i.
6. James M. Jay, Martin J. Loessner, David A. (2012), Modern Food Microbiology, 7th Edition(Food Science Texts Series).
7. Winton, A. L, Winton, K. B, (1998), Milk and Milk Products, Agro-botanical Publ, Bikan er. 8. Ray B (2005), Fundamental Food Microbiology, CRC press, London.