Enclosure – III

B.Sc. MICROBIOLOGY
SEMESTER – I

19UMBCC101	Core I: Fundamentals of Microbiology	4hrs/wk	4 Credits

Course Objectives:
After successfully completing this course the student should be able to:

1. Identify major contributions of the early scientists and the historical milestones that laid the groundwork for modern microbiology
2. Understand the characteristics of major groups of microorganisms
3. Explain the fundamentals of microscopy and staining technique
4. Understand the characteristics of prokaryotic cells and eukaryotic cells
5. Identify, discuss and illustrate morphological features of bacterial cell and its organelles.

Unit 1: Scope and History of Microbiology **(12hrs)**

- Microbiology as a field of Biology
- History and Development of Microbiology
- The Place of Microorganisms in the living world; Distribution of Microorganisms in Nature
- Spontaneous generation versus Biogenesis; Germ Theory of disease
- Applied areas of Microbiology

Unit 2: Microscopy **(12hrs)**

- Microscopy: Introduction and Types
- Principle, Construction and working of : Bright field Microscopy, Dark field Microscopy, Fluorescent Microscopy, Phase Contrast Microscopy
- Introduction to Advanced Microscopic techniques: Confocal microscopy
- Electron Microscopy – Types, working and Limitations
- Preparation of sample for Electron Microscopy

Unit 3: Staining **(12hrs)**

- Stains and staining solutions
- Types of Stains: Natural, Acidic & Basic Stains
- Chromophore & Auxochrome groups, Leuco compounds
- Theories and types of Staining
- Non Biological uses of stains

Unit 4: Major Groups of Microorganisms **(12hrs)**

- Difference between Eukaryotes, Prokaryotes and Archaea
- Major groups of Microorganisms
- Bacteria: General characteristics

- Eukaryotic Microorganisms: Fungi, Algae, Protozoa
- Viruses: Plant, Animal Viruses, Bacteriophages

Unit 5: Morphology of Bacteria (12hrs)

- Size, Shape and Arrangement of Bacteria
- The cell wall of Bacteria – Structure and chemical composition of Gram negative and Gram positive Bacteria
- Bacterial Structures – Internal to Cell Wall – Cell Membrane, Protoplast, Spheroplast, Membranous intrusions and intracellular membrane system, Cytoplasm, Cytoplasmic inclusions and Vacuoles, Nuclear Material
- Bacterial Structures – External to Cell Wall – Capsule, Flagella, Pilli, Prostheca, Shealth & Stalk
- Bacterial Spores & Cyst – Types of Spore, Structure and formation of Endospores (Sporogenesis) , Occurrence & Functions of Akinetes & Heterocyst

Text Books:

- Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. (2002) Microbiology. 5th Edition, Tata McGraw-Hill, New Delhi. (UNIT: 1 – 5)
- Presscott, M.J., Harley, J.P., Klein, D.A. (2008). Microbiology, 7th Edition, New York: WCB McGraw Hill publication (UNIT: 1 – 5).

Reference Books:

1. Pommerville, J.C. (2013). Alcamo's Fundamentals of Microbiology, 10th Edition: Jones and Barlett learning LLC.
2. Black, J.G. (2005). Microbiology: Principles and Explorations. New York: Wiley publication
3. Tortora, G.J., Funke, B.R., Case, C.L. (2004). Microbiology: An Introduction. Singapore: Pearson Education.
4. Singh, R.P. (2007). General Microbiology. New Delhi: Kalyani Publishers.

19UMBCC102	Core 2: Bacteriology	4hrs/wk	4 Credits

Objectives:

At the end of the course, the student shall be able to

1. Understand the nutritional requirements of microbes
2. Explain the principle and the techniques of microbial cultivation
3. Comprehend various phases of bacterial lifecycle and the techniques of its measurement
4. Know the methods of pure culture
5. Understand the methods of microbial control

Unit 1: Microbial Growth and Nutrition (12hrs)

- Introduction and Definition of Growth, Modes of Cell division in procaryotes
- Septum Formation
- Bacterial Growth Curve
- Synchronous culture & Continuous Growth of Bacteria
- Measurement of Bacterial Growth

Unit 2: Cultivation of Bacteria and Pure Culture Techniques (12hrs)

- Nutritional requirements and types of Bacteria,
- Chemical and Physical requirement of Growth – Bacteriological Media & their Types, Air, pH & Temperature, Cultivation of Anaerobes
- Natural Microbial Population (Mixed Cultures), Selective methods to obtain Pure Cultures
- Isolation and Preservation of pure cultures
- Cultural Characteristics

Unit 3: Control of Microbes by Physical methods (12hrs)

- Definitions: Sterilization, Disinfection, Sanitization, Antisepsis, Microbiocidal & Microbiostasis, Thermal Death Time, Thermal Death Point, D-Value, z-Value & F-value
- Control by Temperature:
    - High Temperature
        - Moist Heat – Autoclave, Fractional Sterilization, Boiling, Pasteurization;
        - Dry Heat – Hot Air Oven, Incineration,
    - Control by Low Temperature,
    - Control by Desiccation
- Control by Radiation – UV radiation, x-rays, Gamma rays and Cathode rays
- Control by Surface tension & Interfacial tension
- Control by Filtration

Unit 4: Control of Microbes by Chemical methods (12hrs)

- Characteristics of an Ideal Antimicrobial agent
- Phenol & Phenolic compounds, Alcohols
- Halogens – Iodine & Chlorine, Heavy Metals & Dyes
- Detergents & Quaternary Ammonium Compounds, Aldehydes & Gaseous agents
- Phenol coefficient method

Unit 5: Control of Microbes by Antibiotics (12hrs)

- Chemotherapeutic agents and Chemotherapy, Characteristics of ideal chemotherapeutic agent
- Antibiotics and their mode of action : Inhibition of cell wall synthesis, Damage to cytoplasmic membrane, Inhibition of nucleic acid and protein synthesis, Inhibition of specific enzyme system
- Antifungal, antiviral and antitumor chemotherapeutic agents
- Microbiological assay of antibiotics
- Nonmedical uses of antibiotics

Text Books:

1. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. (2002) Microbiology. 5th Edition, Tata McGraw-Hill, New Delhi. (UNIT: 1 & 2)
2. Powar, C.B., Daginawala, J.F. (2010). General Microbiology Vol-I. Mumbai: Himalaya Publishing House. (UNIT: 3,4 &5)

Reference Book:

1. Stanier, R.Y. (1987). General Microbiology, 5th Edition: Macmillan publication.

19UMBCC103	Core Practical – 1- Fundamentals of Microbiology and Bacteriology	6hrs/wk	2 Credits

Objectives:

The course will impart

1. Operational skills for basic instruments used in Microbiology Laboratory
2. Understanding about the staining process and reagent preparation
3. Knowledge about the morphological properties of Microbial cell structure
4. To develop skills, through lab experiments, in some of the specific methodologies used in the study of bacterial growth

List of Practicals:

1) Good microbiological Laboratory Practices
2) Principles of Laboratory Sanitation
3) Principles, working and uses of the following laboratory instruments :
    a) Microscope
    b) Incubator
    c) pH meter
    d) Refrigerator
    e) Colorimeter
4) Principles, working and uses of the following sterilizers:
    a) Autoclave
    b) Hot air oven
    c) Bacteriological filters.
5) Preparation of glassware for sterilization and disposal of laboratory media & cultures.
6) Preparation of Stains and Staining Reagents.
7) Preparation of Culture media used in Microbiology Laboratory
8) Study of Permanent Slides: Bacteria, Fungi, Algae, Protozoa,
9) Study of bacterial motility by hanging drop method.
10) Monochrome Staining:
    a) Negative Staining
    b) Positive Staining
11) Gram's Staining
12) Special staining of bacteria:
    a) Capsule staining – Hiss's method
    b) Cell wall staining – Webb's method
    c) Spore staining – Schaeffer's method
    d) Metachromatic granule staining – Albert's method
    e) Spirochete staining – Harrie's method
13) Measurement of size of microorganisms by Micrometry (Demonstration)
14) Calibrations of microscopic measurements (Ocular & stage micrometers)
15) Isolation of microorganisms by various methods
16) Turbidometric study of growth curve of *E.coli* and derivation of Growth rate & Generation time.
17) Enumeration of bacteria by viable count technique.
18) Enumeration of bacteria by Total Count Technique.
19) Effect of various chemicals on microbial growth
20) Effect of antibiotics on microbial growth

Reference Books:

1. Patel. R.J., Patel. K.R. (2009). Experimental Microbiology, Vol-I, Ahmedabad: Aditya Publications.
2. Patel. R.J., Patel. K.R. (2009). Experimental Microbiology, Vol-II, Ahmedabad: Aditya Publications.
3. Dubey, R.C., Maheshwari, D.K. (2005). Practical Microbiology. New Delhi: S. Chand & Company Limited.
4. Sharma, K. (2005). Manual of Microbiology – Tools and Techniques. New Delhi: Ane books.
5. Benson, H.J. (2002). Microbiological Applications – Laboratory Manual in General Microbiology – 8th edition: MacGrow Hill Company.

B.Sc. MICROBIOLOGY
SEMESTER – II

19UMBCC201	Core 3: Microbial Diversity	4hrs/wk	4 Credits

Course Objectives:
After completing the course, the student will become competent enough to:

1. Understand the need and the types of microbial classification
2. Identify diverse varieties of microorganisms from their natural surroundings
3. Acknowledge the economical role of microorganisms

Unit . 1: Introduction to Microbial Diversity (12hrs)

- Introduction to Biodiversity- Microbial evolution and diversity, Types of diversity
- Microbial Taxonomy: Introduction and overview, Taxonomic ranks of microorganisms , Classification systems
- Major characteristics used in taxonomy
- Assessing Microbial Phylogeny
- The Major Divisions of Life

Unit . 2: Prokaryotic Diversity (12hrs)

- Introduction to Eubacteria
- Gram negative bacteria – General features of:
  - Aerobic/Microaerophilic motile, helical vibroid
  - Non-motile curved bacteria
  - Aerobic/Microaerophilic rods and cocci
- Gram negative bacteria – General features of:
  - Facultative anaerobes – rods, curved and helical bacteria
  - Dissimilatory Sulfate reducers
- Gram negative bacteria – General features of:
  - Anaerobic cocci
  - Phototrophic bacteria
- Gram positive bacteria – General features of:
  - Endospore forming rods and cocci
  - Asporogenous rods
  - Mycobacteria and Actinomycetes

Unit 3: Diversity of some unusual Prokaryotes (12hrs)

- General Features of Bacteria with unusual morphology:
  - Budding and appendaged bacteria
  - Sheathed Bacteria
  - Mycoplasma
- Bacteria with gliding motility,
- Rickettsia and Chlamydia
- General Features of Bacteria of extreme environments:
- Introduction to Archaea
  - Thermophiles
  - Halophiles
  - Acidophiles

- Barophiles
- Methanogens
- Psychrophiles

Unit . 4: Eukaryotic Diversity (12hrs)

- Fungi: General characteristics – Definition, occurrence and structure of fungi
- Salient features and Economic importance of fungi
- Algae: General Characteristics – Definition, Occurrence, Ultra- Structure, Reproduction
- Economic importance of Algae
- General Characteristics – Definition, Occurrence, Ultra- Structure, Reproduction and Economic importance of Protozoa

Unit . 5: Akaryotic Diversity - Viruses (12hrs)

- Introduction to Viruses**:** Definition, Historical background of virology, General features of viruses: Size, Capsids symmetry, Chemical Nature, Life cycle
- Overview of Bacterial Virus: T4 and Lambda
- Overview of plant Virus: TMV
- Overview of Animal viruses; HIV

Text Books:

1. Presscott, M.J., Harley, J.P., Klein, D.A. (2008). Microbiology, 7th Edition, New York: WCB McGraw Hill publication (UNIT: 1 – 5).
2. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. (2002) Microbiology. 5th Edition, Tata McGraw-Hill, New Delhi. (UNIT: 1 – 5)

Reference Books:

1. Modi, H.A. Elementary Microbiology - Vol -I, Akta Prakashan, Nadiyad.
2. Modi, H.A. Elementary Microbiology – Vol-II, Akta Prakashan, Nadiyad.
3. Dubey, R.C.and Maheshwari, D.K., A Text Book of Microbiology, S. Chand Publications , New Delhi.
4. Tortora, Funke & Case. Microbiology-An Introduction, 8 Edition, Pearson Education, Delhi.
5. Powar and Daginawala, General Microbiology Vol-II. Himalaya Publishing House, Mumbai.
6. Atlas. R.M., Principles of Microbiology- 2nd Edition ,

19UMBCC202	Core 4: Basic Biochemistry	4hrs/wk	4 Credits

Course Objectives:

Upon completion of the course, the student should achieve an understanding of the following:

1. Basic cellular structure and the special properties of water
2. The structures of amino acids, their chemical properties and their organization into polypeptides and proteins.
3. Structure of fundamental monosaccharides and polysaccharides
4. Structure and basic function of nucleotides
5. Structure of different classes of lipids and their roles in biological systems

Unit 1: Basic Biochemistry (12hrs)

- Introduction to Atoms, Elements & Molecules
- Major Chemical bonds found in biological system: Ionic Bonds, Covalent Bonds, Hydrogen Bonds, Van der Waals interactions, Hydrophobic interactions
- Introduction to pH
- Major Chemical reactions: Acid Base, Redox, Condensation-Hydrolysis Reactions
- Water and its important properties

Unit 2: Carbohydrates (12hrs)

- Definition and Functions of Carbohydrates
- Classification of Carbohydrates
- Structure and properties of Monosaccharide
- Types and importance of Disaccharides
- Types of importance of Polysaccharides

Unit 3: Proteins (12hrs)

- Definition and Functions of Proteins
- Classification of Proteins
- Amino acids: Classification
- Physical & Chemical Properties of Amino acids
- Structure of Proteins: Primary, Secondary, Tertiary & Quaternary Levels

Unit 4: Lipids and Nucleic acids (12hrs)

- Definition, Functions and Classification of Lipids
- Fatty acids: Structure and types, Introduction to phospholipids: Examples and Significance
- Introduction and Significance of Steroids
- Introduction to Nitrogen Base, Nucleosides & Nucleotides, Structure of Deoxyribonucleic acid: A-DNA, B-DNA, Z-DNA
- Introduction to RNA & its types

Unit 5: Enzymes (12hrs)

- Definition of Enzymes, Apoenzyme, Core Enzyme, Holo enzyme, Coenzyme, Cofactors, Prosthetic Groups, and Classification
- Mechanism of enzyme action – Active Sites, Activation Energy, Lock & Key Model, Induced Fit model
- Factors affecting enzyme activity
- Enzyme inhibition
- Phenotypic and genotypic regulation of Enzymes

Text Book:

1. Atlas, R.M., Bartha, R. (1997). Microbial Ecology, 4th Edition: Benjamin Cummings publication (UNIT: 1)
2. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. (2002) Microbiology. 5th Edition, Tata McGraw-Hill, New Delhi. (UNIT: 2 – 5)
3. Powar, C.B., Daginawala, J.F. (2010). General Microbiology Vol-I. Mumbai: Himalaya Publishing House. (UNIT: 2 - 5)

Reference Book:

1. Conn E.E., Stumpf P.K. (1989). Outlines of Biochemistry. Wiley publication.
2. Stanier, R.Y. (1987). General Microbiology, 5th Edition: Macmillan publication.
3. Nelson, D.L., Cox, M.M. (2013). Lehninger: Principles of Biochemistry. W.H. Freeman publication.
4. Satyanarayan, U. (2008). Biotechnology. Kolkata, West Bengal: Books and allied (P) Ltd

19UMBCC203	Core 5: Cell Biology	4hrs/wk	4 Credits

Course Objectives:

By the end of the semester, a student should be able to:

1. Appreciate and understand the dynamic nature of the cell, including how it receives and responds to information from its environment.
2. Explain and compare different mechanisms for receptor activation and regulation.
3. Understand and explain how membrane chemistry and regulation are essential in cell communication.
4. Understand intracellular signalling cascades and their impact on cellular activities, including cytoskeleton rearrangements, motility and changes in gene expression.
5. Understand mechanisms of cell cycle regulation.
6. Appreciate the cellular organization of intracellular and extracellular organelles

Unit 1: Cell concept and Cytology (12hrs)

- Cell concept, principal levels of cellular organization
- Historical aspects of Cytology
- Basic differences in structural organization in Prokaryotes and Eukaryotes
- Structure of Animal and Plant cell
- Endosymbiosis Theory

Unit 2: Membrane organization, function and Cell cycle (12hrs)

- Models of cell membrane
- Structural organization of plasma membrane – Fluid Mosaic Model
- Transport of Small Molecules across cell membrane-Active and Passive Transport
- Transport of Macromolecules across cell membrane -Phenomenon of exocytosis and endocytosis
- Cell Cycle and Cell Division – Mitosis and Meiosis

Unit 3: Cell wall, intercellular and intracellular transport (12hrs)

- Plant cell wall: its ultra structure and function
- Intracelluar junction, tight junction, intermediate junction, spot desmosome, gap junctions, plasmodesmata
- Endoplasmic reticulum: structure, chemical nature and function
- Golgi apparatus: structure, chemical nature and function
- GERL system and its role in intra-cellular secretion

Unit 4: Cellular Organelles (12hrs)

- Chloroplast: Ultrastructure and function
- Mitochondria: structure, morphogenesis, chemical nature and functions
- Lysosomes, Peroxisomes and Glyoxisomes: Structure & functions
- Centrosomes, Centrioles, and Cytoskeletal elements
- Motility: Cilia and Flagella

Unit 5: Nucleus **(12hrs)**

- Light and electron microscopic structure of chromosome and types
- Polytene chromosome, Lampbrush chromosomes and their importance
- Nucleus and nucleolus : Ultra structure, chemical nature, nucleolar Chromosome
- Nuclear envelop: ultra structure, transport of material
- Functions of Nucleus and Nucleolus

Text Books:

1. De Robertis, EDP, De Robertis EMF. (2006). Cell and Molecular Biology, 8th edition. Philadelphia: Lipincott Williams and Wilkins. (UNIT: 1 – 5)
2. Verma, P.S., Agrawal, V.K. (2005). Ecology, Cell Biology, Molecular Biology, Genetics. New Delhi: S. Chand and Company Limited. (UNIT: 1 – 5)

Reference Books:

1. Presscott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology, 5th Edition. New York: WCB Mc GrawHill publication.
2. Stanier, R.Y. (1987). General Microbiology, 5th Edition: Macmillan publication.
3. Tortora, G.J., Funke, B.R., Case, C.L. (2008). Microbiology, 8th Edition: McGraw Hill Company.

19UMBCC204	Core Practical – 2 - Microbial Diversity, Biochemistry & Cell Biology	6hrs/wk	3 Credits

Objective: The course is designed to impart practical skills and the fundamental understanding about;

1. Techniques to isolate and study different microorganisms from natural samples
2. Qualitative and quantitative analysis of Biomolecules
3. Determination of enzymatic activity
4. Understand the structure, components and physiological processes of various types of cells and its organelles

List of Practicals:

1) Isolation of Gram negative bacteria from the given sample.
2) Identification of Gram negative bacteria from the given pure culture using biochemical media (*E.coli, Enterobacter aerogens, Proteus, Salmonella*)
3) Isolation of Gram positive bacteria from the given sample.
4) Identification of Gram positive bacteria from the given pure culture using biochemical media (*Bacillus megaterium, Bacillus subtilis, Staphylococcus aureus*)
5) Identification of Fungi on the basis of Morphological Characteristics.
6) Cultivation of yeast from different natural samples and its morphological characterization using microscopic observation.
7) Microscopic observation of different algae from the given samples.
8) Microscopic observation of different protozoa from the given sample.
9) Isolation and cultivation of bacteriophage of *E.coli* from the given sewage sample.
10) Estimation of Protein by Foiln-Lowry's Method.
11) Estimation of Sugar by Cole's Method.
12) Estimation of Reducing sugar by DNSA method
13) Estimation of DNA by DPA Method.
14) Qualitative Analysis of Carbohydrates.
15) Qualitative Analysis of Proteins & Amino acids.
16) Determination of alpha amylase activity by iodometric method.
17) Demonstration and study of various phases of mitosis and meiosis
18) Microscopic observation of plant cells from onion
19) Microscopic observation of Barr bodies and Drum stick
20) Mitochondrial staining

Reference Books:

1. Jayaraman, J. (2011). Laboratory Manual in Biochemistry: New Age International Private Limited. India
2. Sawhney S.K., Singh, R. (2005). Introductory Practical Biochemistry: Alpha Science International.
3. Cappuccino, J.G., Sherman, N. (2004). International student edition: Microbiology- A laboratory Manual 4th edition: Benjamin Cummings publications

B.Sc. MICROBIOLOGY
SEMESTER - III

19UMBCC301	Core 6: Biostatistics and Bioinformatics	5hrs/wk	5 Credits

Course objectives:
The goal for the Biostatistics and Bioinformatics for Basic Scientists course is to

1. Provide an introduction to statistics and informatics methods for the analysis of data generated in biomedical research.
2. Teach through Practical examples covering both small-scale lab experiments and highthroughput assays.
3. Emphasis on the basic concepts of biostatistics and bioinformatics

Unit 1 Introduction to Biostatistics (12hrs)

- Data Collection and presentation
- Origin of the word, Applications of biostatistics
- Sampling methods, Random and non random sampling
- Data: Types, Graphical presentation of data

Unit 2 Measures of Biostatistics, Probability Distributions (12hrs)

- Measures of central tendency Mean, median and mode
- Measures of dispersion- Range, mean deviation, standard deviation, variance
- Laws of probability
- Normal distribution
- Binomial distribution, Poisson distribution

Unit 3 Hypothesis Testing, Correlation and Regression Analysis (12hrs)

- Types of hypothesis
- Tests of significance-student's t test, F test
- Chi-square test, ANOVA test
- Types of correlation, Methods to study correlation analysis
- Methods of regression analysis

Unit 4 Computer Science : Components and Applications (12hrs)

- Structure of computer: Components, peripherals, uses and types
- The window screen and parts of window, the control panel
- MS Office: MS Word, MS Powerpoint, MS Excel
- Internet: History, Basic Concepts, Connection Types, Applications, Search Engines and E mail, Multimedia Usage in biological studies
- Basics of HTML, Page creation and design using HTML

Unit 5 Bioinformatics (12hrs)

- Introduction and importance of Bioinformatics
- Database: Introduction, Types, File formats,
- Primary and Secondary Biological databases, Structure databases, miscellaneous databases, Information retrieval from Biological database : ENTREZ, SRS and DBGET
- Sequence Alignment : FASTA, BLAST and Gap penalties
- Introduction to Drug discovery and Chemi informatics

Text Books:

1. Banerjee P.K. (2007) Introduction to Biostatistics: S Chand Publication, New Delhi, India (UNIT: 1 ,2,3)
2. Attwood, T.K., Parry. D.J. (2001). Introduction to Bioinformatics: Benjamin Cummings (UNIT: 4 & 5)

Reference Books:

1. Andreas, D. B., Ouellette, B.F.F. (2004). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition: Wiley publication.
2. Misener, S. (2000). Bioinformatics – Methods and Protocols: Humana Press.
3. Westhead D.R., Parish J.H., Twyman, R.A. (2002). Instant notes in Bioinformatics. Taylor and Francis publications.
4. Satyanarayan, U. (2008). Biotechnology. Kolkata, West Bengal: Books and allied (P) Ltd.

19UMBCC302	Core 7: Agricultural Microbiology	4hrs/wk	4 Credits

Course objectives:
After successfully completing this course the student should be able to:

1. Identify the role of soil in the sustenance of microbial life
2. Understand the characteristics of major groups of microorganisms in soil
3. Explain the fundamentals of various geochemical cycles in the soil and the role of microbes in each
4. Understand the beneficial as well as harmful role of microbes in Agriculture.

Unit 1: Soil as a culture media **(12hrs)**

- Introduction to soil
- Formation of soil- weathering of rocks, pedogenesis
- Soil profile and microbial diversity of soil
- Rhizosphere and Rhizoplane
- Edaphic factors-Physical and chemical properties of soil

Unit 2: Biofertilizers and Biopesticides **(12hrs)**

- Overview of organic farming
- Biofertilizers and Biopesticides
- Plant Growth Promoting Rhizobacteria
- Introduction to Mycorrhizae
- Integrated Pest Management

Unit 3: Beneficial role of microbes in Agriculture **(12hrs)**

- GMO – Definition, history and Current status
- Microbial Techniques in Crop improvement
- Phytoremediation
- Beneficial Sea weeds
- Edible microbes

Unit 4: Harmful effects of microbes in Agriculture **(12hrs)**

- General Mechanism, Propagation and control of plant diseases
- Plant diseases by Bacteria-*Xanthomonas citrii*
- Plant diseases by viruses - TMV
- Plant diseases by fungi – *Fusarium oxysporum*
- Plant pathogenic Nematods

Unit 5: Veterinary Microbiology **(12 hrs)**

- Introduction to veterinary microbiology
- Microbial diseases of farm Animals: Anthrax, CJD, FMD, Mastitis
- Zoonotic diseases and its management
- Vaccines for farm animals: vaccination schedule, modes of administration and side effects
- Poultry disease Management

Text Books:

1. Alexander, M. (1991). Introduction to Soil Microbiology: Krieger Publication. (UNIT:1)
2. Motsara, M.R. Bhattacharyya, P., Srivastava, B. (1995). Biofertilizer- Technology, Marketing and Usage. New Delhi: Fertilizer Development & Consultant Organization. Rangaswami, G., Bagyaraj, D.J. (1992). Agricultural Microbiology. New Delhi: Asia Publishing House.(UNIT: 2)
3. Subba Rao, N.S. (1999). Biofertilizers in Agriculture and Agro forestry. New Delhi: Oxford & IBH. (UNIT: 2,3)
4. Subba Rao, N.S. (1995). Soil Microorganisms and Plant Growth. New Delhi: Oxford & IBH.(UNIT:4)
5. Sharma S.N. Adlakha S.C (1996) Textbook of Veterinary Microbiology. Vikas Publications.(UNIT:5)

Reference Books:

1. Dirk, J., Elas, V., Trevors, J.T., Wellington, E.M.H. (1997). Modern Soil Microbiology. New York: Marcel Dekker INC.
2. Ramanathan, N., Muthukaruppan, S.M. (2005). Environmental Microbiology. Annamalai Nagar: Om Sakthi Pathipagam.
3. Waiter, M.J., Morgan, N.L., Rocky, J.S., Higton, G. (1999). Industrial Microbiology: An Introduction: Wiley-Blackwell publication.

19UMBCC303	Core 8: Food and Environmental Microbiology	4hrs/wk	4 Credits

Course objectives:

This course is designed to provide Instruction about

1. General principles of food, dairy and water Microbiology.
2. Food spoilage, food preservation and food commodities;
3. Processing in dairy for milk and milk product;
4. Fundamentals of drinking water and waste water treatment;
5. Overview of air microbiology
6. Role of microbes in environmental processes

Unit –1 Food Microbiology **(12hrs)**

- Microbial flora of fresh food
- Microbial spoilage of foods: Fresh foods & Canned foods, Food Borne infection & intoxication: Role of *S.aureus,, C.botulinum & Salmonella* Spp.in food poisoning
- Preservation of foods: General principles & methods of food preservation
- Microbiological examination of food; Introduction to AGMark
- Brief introduction about fermented foods: Pickles, Sauerkraut, Silage, Sausages & Bread, Microorganisms as food: Single Cell Protein, Mushrooms and Functional foods

Unit –2 Dairy Microbiology **(12hrs)**

- Milk as a medium, normal flora of milk, Types of microorganisms in milk: Biochemical types, Pathogenic types, Temperature types
- Spoilage of milk & milk products
- Microbial analysis of milk: SPC, Direct count, MBRT, Resazurin test, Grading of milk
- Fermented milk Beverages & Manufactured Dairy Products: Starter Culture, Cheese, Yogurt, Buttermilk, Acidophilus milk, Kefir
- Preservation of milk: Principles & methods of preservation

Unit – 3 Air Microbiology **(12hrs)**

- Air flora - Concept of transient air flora, droplet, droplet nuclei, and aerosols
- Monitoring and control of air flora of
  - Hospitals
  - Aseptic filling areas
  - Research laboratories
  - Industries – Food and Pharmaceutical
- Air pollution: Chemical pollutants and their sources in air
- Methods of Air sampling
- Air sanitation, Air borne infections

Unit-4 –Water Microbiology **(12hrs)**

- Microbiology of drinking water: Sanitary survey, Bacteriological evidence of pollution, Bacteriological analysis & Sampling techniques of water, Microorganisms other than Coliforms as nuisance organisms
- Process of Water purification: Sedimentation, Filtration use of Sand filters, Disinfection
- Microbiology of Waste water: Chemical and Microbial Characteristics of waste water, B.O.D., C.O.D. as indicator of quality of waste water
- Waste water treatment & Disposal - Single Dwelling Process & Municipal Treatment - Primary Treatment, Secondary Treatment, Advanced & final treatment,
- Solid waste processing: Anaerobic Sludge digestion & Composting

Unit –5 Environmental Microbiology **(12hrs)**

- Types of Pollutants, Sources & Effect on ecology
- Pollution by pesticides, Biomagnifications of pesticide & their Biological control
- Brief account on Water pollution (by Oil, Detergent, Heavy metal & industrial effluent) & their Biological control
- Role of microorganisms in Biodeterioration of Paper, Textiles, paints, woods & metals and their control, Bioleaching, Microbial enhanced oil recovery
- Biofuels, Bioplastics

Text Books:

1. Frazier, W.C., Westhoff, D.C. (1978). Food Microbiology. Tata McGraw-Hill Publishing Company. (UNIT: 1)
2. Prajapati, J.B. (1995). Fundamentals of Dairy Microbiology: Ekta Publication, India (UNIT: 2)
3. Microbiology by Pelczar M.J. & Chain E.C.S. : 5th edition (UNIT:3 & 4)
4. Presscott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology, 5th Edition. New York: WCB Mc GrawHill publication. (UNIT: 5)

Reference Book:

1. Manay, S., Shadaksharaswami, M. (2008). Foods: Facts and Principles. New Delhi: New Age Publishers.
2. Meyer, L.H. (2004). Food Chemistry. New Delhi: New Age Publishers.
3. Frobisher, M. (1974). Fundamentals of Microbiology. 9th Edition. Philadelphia, PA: W. B. Saunders Company.
4. Swaminathan, M. (1990). Food Science, Chemistry and Experimental Foods. Mysore: Bappco Book Publishing Company.
5. Jay, J.J., Loessener, M.J., Golden, D.A. (2005). Modern Food Microbiology: Springer publication.

19UMBCC304	Core Practical –Applied and Analytical Microbiology	6hrs/wk	3 Credits

Course objectives:
The course will impart

1. Technical skill for enumeration of soil, food and milk microbes
2. Understanding about the role of microbes in agriculture and food
3. Knowledge about the properties of microbes which make them important in nature .
4. To develop skills, through lab experiments, in some of the specific methodologies used in the study of modern food and dairy microbiology
5. Statistical Skills and the basic experimental know how about biostatistics and bioinformatics

List of Practicals

1. Enumeration of different kinds of microorganisms in soil – qualitative and quantitative methods
2. Study of degradation of organic matter.
3. Isolation of rhizosphere microorganisms – Isolation of nitrogen fixing microorganisms. *Rhizobium, Azospirillum* and *Azotobacter*
4. Isolation of Phosphate solubilizing bacteria from soil
5. Observation of mycorrhiza roots.
6. Isolation and identification of microorganisms involved in food spoilage
7. Isolation of microorganisms from milk and milk products and their identification
8. Production of fermented milk by Lactobacillus acidophilus - Yogurt
9. Standard qualitative analysis of milk
10. Methylene Blue Reduction Time test for milk
11. Isolation of probiotics
12. Estimation of Dissolved oxygen
13. Isolation and identification of coli forms from Water by Presumptive, Confirmed & Completed test
14. Determination of air flora and air density from indoor & outdoor sources
15. Review of NCBI Portal
16. Review of Biological Data Bases
17. Demonstration on BLAST analysis
18. Comparison of Entrez, SRS, and DBGET retrieval
19. Basic use of Computer – Use of Excel, Power point and Internet
20. Mean, Median, Mode
21. Standard deviation
22. Student t-Test
23. Chi – square Test
24. ANOVA

Reference Books:

1. Adams M.R., Moss, M.O. (2008). Food Microbiology. 2nd Edition: Royal Society of Chemistry.
2. Banwart, G.J. (1989). Basic Food Microbiology: Springer publications.
3. Doyle, M.P., Buchanan, R.L. (1997). Food Microbiology: Fundamentals and Frontiers: ASM publication.
4. Joshi, V.K., Pandey, A. (1999). Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2. Emakulam: Educational Publishers & Distributors.
5. Prajapati, J.B. (1995). Fundamentals of Dairy Microbiology: Ekta Publication.
6. Garbult, J. (1997). Essentials of Food Microbiology: Hodder Arnold publication.
7. Wood, B.J. (2012). Microbiology of Fermented Foods. Volume I and II: Elsiever Applied Science Publication.
8. Robinson, R.K. (2002). Dairy Microbiology Handbook: Wiley-Blackwell publication.
9. Andreas, D. B., Ouellette, B.F.F. (2004). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition: Wiley publication.
10. Misener, S. (2000). Bioinformatics – Methods and Protocols: Humana Press.
11. Rao, C.R. (1973). Linear Statistical Inference and its Applications. New York: Wiley publication.

B. Sc. MICROBIOLOGY
SEMESTER - IV

19UMBCC401	Core 9: Bacterial Metabolism	4hrs/wk	4 Credits

Course objectives:
After successfully completing this course the student should be able to:

1. Understand the central metabolic reactions in a cell and an organism
2. Understand the mechanism of energy generation and its utilization during cellular activities
3. Explain the fundamentals of catabolism of different biomolecules, its mechanism and its importance
4. Identify the metabolic differences among various categories of bacteria.
5. Understand the process and mechanism of transport of molecules across the membrane for metabolic reactions

Unit 1: Introduction to Metabolism, Bioenergetics and Enzyme Kinetics (12hrs)

- General Overview of Metabolism, primary and Secondary Metabolism and their significance
- Thermodynamics –First law of thermodynamics, second law of thermodynamics
- Bioenergetics: The concept of free energy, Determination of ΔG & Energy rich compounds
- Energy metabolism: Introduction to metabolism, Role of ATP in metabolism, Role of reducing power in metabolism, Role of precursor metabolites in metabolism
- Kinetics of a single-substrate enzyme catalysed reaction, Michaelis-Menten Equation, Km, Vmax, Lineweaver–Burk plot, Turnover number, K_{cat}; Kinetics of Enzyme Inhibition; Kinetics Allosteric enzymes

Unit 2: Catabolism of Carbohydrates (12hrs)

- General overview of various metabolic pathways, regulations and their significance
- Glycolysis and its regulation
- Pentose phosphate pathway
- Entner-Doudrroff pathway
- Citric acid cycle and its regulation, Glyoxylate cycle

Unit 3: Metabolism of amino acids, Nucleic acids and Lipids (12hrs)

- Biodegradation of amino acids – deamination, transamination, decarboxylation; Stickland Reactions
- Urea cycle including its regulation
- Biosynthesis of amino acids
- Biologically active amines Recycling of Purine and Pyrimidine nucleotides by salvage pathways
- Oxidation of Fatty Acids, Beta-Oxidation of Fatty Acids

Unit 4: Bioenergetics and Membrane Transport (12hrs)

- Different modes of ATP generation and comparative study of ATP (energy budget)
- Electron transport chain: Introduction, Components of ETC and energy yield, Anaerobic Respiration
- Bacterial photosynthesis; Biosynthesis of peptidoglycan
- Transport of small molecules across membrane: Active and Passive transport
- Specific Transport Systems: Mechanosensitive channels, ATP-binding cassette Transport family, Chemiosmotic-driven transport, Establishing Ion gradients, Iron transport, The phosphotransferase system

Unit 5: Some selected aspects of metabolism in specific microbial systems (12hrs)

- Chemo-autotrophs: Nitrifying Bacteria, Sulfur Oxidizers, The Iron bacteria, The Hydrogen bacteria
- The lactic acid bacteria: Patterns of carbohydrate fermentation in lactic acid bacteria
- The Enteric group and related Eubacteria: Fermentative patterns of Gram negative Eubacteria
- Archaebacteria: Energy metabolism and Carbon - Assimilation in Methanogens, photophosphorylation in *Halobacterium*
- Quorum sensing

Text Books:

1. D.White 2nd Edition. The physiology and Biochemistry of Prokaryotes (UNIT 1 – 5)
2. Stanier, R.Y. (1987). General Microbiology, 5th Edition: Macmillan publication.

Reference Books:

1. Nelson, D.L., Cox, M.M. (2013). Lehninger Principles of Biochemistry. W.H. Freeman publication.
2. Moat, A.G., Foster. J.W., Spector, M.P. (2009). Microbial Physiology, 4th Ed: Wiley India Pvt Ltd.
3. Principles of Biochemistry By Lehninger
4. Conn E. E. and Stumpf P. K. Outlines of biochemistry by Lehninger 4th Ed.
5. Powar and Daginawala General Microbiology by Vol-1

19UMBCC402	Core 10: Analytical Techniques	4hrs/wk	4 Credits

Course objectives:

After successfully completing this course the student should be able to:

1. Understand the working principle and application of various analytical techniques in the field of Bioscience
2. To comprehend theories and principles of various Chromatographic techniques
3. Understand General principles and applications of electrophoresis and Centrifugation techniques
4. Identify the role and the application of various molecular biology techniques in the field of Microbiology

Unit 1 Basic Analytical Technique in Biosciences (12hrs)

- Colorimetry and Spectrophotomerty
- Introduction to Flame Photometry and its applications
- Applications of Radioisotopes in biosciences
- Atomic spectroscopy: Principles and application of Atomic Absorption/Emission Spectrometer
- Microtomy – sectioning.

Unit 2 Chromatography (12hrs)

- Chromatography : Theories and Principles
- Paper and Thin layer Chromatography
- Affinity and Ion Exchange Chromatography
- Partition and Size Exclusion Chromatography
- Gas Chromatography and High Performance Liquid Chromatography, HPTLC

Unit 3 Electrophoresis (12hrs)

- Electrophoresis : General principles, Horizontal & Vertical Gel electrophoresis, Isoelectric focusing
- Paper Electrophoresis
- Gel Electrophoresis : PAGE and AGE and PFGE,
- Capillary Electrophoresis
- Immunoelectrophoresis. Immunoblotting.

Unit 4 Centrifugation (12hrs)

- Centrifugation techniques- Basic principles
- Different types of centrifuges: Analytical and Preparative
- Ultracentrifugation methods.
- Density gradient centrifugation.

Unit 5 Advanced techniques (12hrs)

- Nanobiotechnology: Development and applications of Bionanoparticles
- FTIR
- Spectroscopy
- Introduction to Biosensor Technology
- Targeted Drug Delivery system

Text Books:

1. Purohit, S.S. (2007). Microbiology-Fundamentals and Applications, 6th Edition. New Delhi: Agrobios Publications. (UNIT 1 – 5)
2. Chatwal R.G., Anand, S.K. (2012). Instrumental Methods of Chemical Analysis. Mumbai: Himalaya publication

Reference Books:

1. Westhead D.R., Parish J.H., Twyman, R.A. (2002). Instant notes in Bioinformatics. Taylor and Francis publications.
2. Andreas, D. B., Ouellette, B.F.F. (2004). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition: Wiley publication.
3. Wilson, K., Walker, J. (2010). Practical Biochemistry – Principle and Technique, 7th Edition. Cambridge: Cambridge University Press.
4. Freifelder, D. (1982). Physical Biochemistry: Application to Biochemistry and Molecular biology, 2nd edition. San Francisco: W.H. Freeman and company.
5. Sadashivam, S., Manickam, A. (2004). Biochemical methods, 2nd edition. New Delhi: New Age International (P) Limited.
6. Oser, B.L. (2006). Hawk's physiological chemistry. 14th Ed. New York, NY: McGraw-Hill Book Company.
7. Boyer, R.F. (2002). Modern Experimental Biochemistry. San Francisco: Benjamin Cummings Publ. Company.
8. Williams, B.D., Wilson, K. (1981). A Biologist's Guide to Principles and Techniques of Practical Biochemistry. London: Edward Arnold publications.
9. Upadhyay, A., Upadhyay, K., Nath, N. (2009). Biophysical Chemistry: Principles and techniques. Mumbai: Himalaya publication

19UMBCC403	Core 11: Industrial Microbiology	4hrs/wk	4 Credits

Course objectives:

The course is designed to provide to the students:

1. Knowledge of basic principle of fermentation process,
2. Insight in helping students to design, develop and operate industrial level fermentation process.
3. This fundamental knowledge is essential for the students to make their career in industry based on bioprocess.

Unit 1: Fermentation Technology & Industrially Important Microorganisms (12hrs)

- Basic concept: Industrial Microbiology
- Range of Fermentation Processes; Component parts a fermentation process
- Fermentation Economics; GLP and GMP
- Screening of industrially important microorganisms: Use of enrichment techniques in isolation methods; Primary & Secondary Screening; Culture Collection Centres in India and abroad
- Improvement of industrially important microbes: Application of Mutation, protoplast fusion and recombinant DNA technology

Unit 2: Formulation of Fermentation Media (12hrs)

- Introduction, Types of Media and Medium formulation
- Raw materials: Crude Carbon and Nitrogen sources
- Minerals, Precursors, Growth Regulators, Buffers, Antifoam agents
- Media Optimization
- Inoculum Medium

Unit 3: Design and aseptic operation (12hrs)

- Introduction and basic functions of fermenter
- Types of bioreactors: Continuous stirred tank bioreactor, air lift fermenter, tower fermenter, immobilized enzyme bioreactors
- Aeration and Agitation
- Fermentation process: Batch Fermentation, Continuous fermentation and their comparative advantages and disadvantages
- Sterilization process in fermentation industries: Fermentor sterilization; Medium sterilization; Sterilization of air and feed, Aseptic operation and Containment

Unit 4: Overview of Downstream Processes (12hrs)

- Methods of Cell separation: Broth conditioning, Precipitation, Sedimentation,
- Centrifugation, Filtration
- Techniques of Cell Disruption: Mechanical and Non mechanical methods
- Product Recovery: Liquid-Liquid extraction, Solvent recovery, Two Phase aqueous extraction, Super critical fluid extraction; Chromatography, Drying and crystallization
- Physical, Chemical and Biological assay of fermentation products

Unit 5: Studies of selective fermentation processes (12hrs)

- Production of organic solvents: Ethyl alcohol
- Production of enzymes and Vitamins : Amylases and Riboflavin
- Production of antibiotics: Penicillin
- Production of amino acids and organic acids: Lysine and Citric acid
- Introduction to methods to immobilize whole cell and/ or enzymes; Applications

Text books:

1. Stanbury, P.F., Whittaker, A. (1984). Principles of Fermentation Technology, 2nd Edition. Pergamon Press. (UNIT – 1-5)
2. Patel, A.H. (2011). Industrial Microbiology, 2nd Edition: Laxmi publication.

Reference Books:

1. Casida, L.E. (1968). Industrial Microbiology. New Delhi: New Age International Pub. (P) Limited.
2. Joshi, V.K., Pandey, A. (1999). Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2. Emakulam: Educational Publishers & Distributors.
3. Prescott, S.C., Dunn, C.G., Reed, G. (1982). Prescott & Dunn's Industrial Microbiology. Westport: AVI Publication.
4. Crueger, W., Crueger, A. (1990). A text book of Industrial Microbiology, 2nd edition: Sunderland, Mass.: Sinauer Associates

19UMBCC404	Core Practical - 4: Microbial Technology and Instrumentation	6hrs/wk	3 Credits

Course objectives:
The course will impart

1. Technical skill to the students perform various analytical methods for estimations
2. Hands on training on many sophisticated instruments
3. Understanding of upstream and downstream process in the fermentation process

List of Practical

1. Estimation of Protein by Bradford method
2. Circular paper Chromatography of Amino acids
3. Ascending paper chromatography of sugars
4. Thin Layer Chromatography of Amino acids
5. Agarose Gel Electrophoresis of DNA
6. SDS PAGE of Protein
7. Centrifugation techniques
8. Microtome usage, sectioning and staining
9. Primary screening of industrially important microorganisms capable of producing: Antibiotics, Organic acids, amylases
10. Bioassay of penicillin using *B. subtilis*
11. Laboratory fermentation of Ethyl Alcohol by *Saccharomyces cerevisiae* & its estimation
12. Laboratory fermentation of amylase by *B. subtilis* & its estimation
13. Sterility testing of fermentation products (Demo) – Use of Sterile products for testing Microbial contamination
14. Immobilization of yeast cells by Ca-alginate entrapment method & determination of viability of immobilized cells by invertase activity / Gluconic acid formation. (Demo)

Reference Books:

1. Jayaraman, J. (2011). Laboratory Manual in Biochemistry: New Age International Private Limited. India
2. Sawhney S.K., Singh, R. (2005). Introductory Practical Biochemistry: Alpha Science International.
3. Cuppuccino, J.G., Sherman, N. (2004). International student edition: Microbiology- A laboratory Manual 4th edition: Benjamin Cummings publications.
4. Baker, F.J., Breach, M.R. (1967). Handbook of Bacteriological Technique: Butterworth & Co Publishers Ltd.

B. Sc. MICROBIOLOGY
SEMESTER - V

19UMBCC501	Core 12: Immunology	4hrs/week	4 Credits

Course Objectives:

After successfully completing this course the student should be able to:

1. Demonstrate a comprehensive and practical understanding of basic immunological principles involved in protection mechanism.
2. Differentiate between innate and adaptive immunity, primary and secondary responses and identify the role of antigen presenting cells, lymphocytes, and phagocytic cells in immune responses.
3. Differentiate between humoral and cell mediated immunity.
4. Discuss Dysfunctional immunity and its consequences, Process of infection and vaccination
5. Principle and applications of various immune reactions in research and diagnosis

Unit 1: Immunity and Immunogen (12hrs)

- Types of immunity: Natural, Acquired, herd, Innate, specific
- Cells and organs of immune system : An overview
- Primary response and generation of memory
- Antigen: Immunogenicity versus antigenicity, Factors influencing Immunogenicity, Adjuvant, Epitopes and Haptens
- Antigen processing and presentation (Endogenous and Exogenous Antigens)

Unit 2: Antibody (12hrs)

- Antibody: Basic structure of Antibody
- Immunoglobulin classes and their Biological activities
- Epitopes and Receptors on immunoglobulin molecule
- Antibody Diversity and Clonal Selection Theory
- Overview of Monoclonal Antibody

Unit 3: Dysfunctional Immunity (12hrs)

- Immunodeficiency Diseases
- Hypersensitivity
- Autoimmune diseases
- Overview of Tumor immunity
- Overview of Transplantation immunity

Unit 4: Infection and Prophylaxis (12hrs)

- Introduction to the normal flora of healthy human host
- Host –microbe interactions: Process of Infection, Pathogenicity, Virulence and infection
- Microbial adherence: Penetration of epithelial cell layers, Events in infection following penetration
- Microbial virulence factors
- Vaccines: Conventional and Modern

Unit - 5: Haematology and Serology (12hrs)

- Study of Blood and Blood groups: Discovery of human blood group system
- Principle, significance and procedure of blood transfusion, Blood coagulation
- Serology - In vitro antigen: antibody reaction: Strength of antigen – antibody reaction: Antibody affinity and avidity
- Precipitation and Agglutination Reactions: (in fluid and gel), immunoelectrophoresis, Haemagglutination, Bacterial Agglutination, Passive Agglutination and agglutination inhibition
- Other reactions: Radioimmunoassay, ELISA, Western Blot, Immunofluoroscence

Text Books:

- J. Kuby, R. A. Goldsby , T.J.Kindt , B.A. Osborne (2013). Immunology 7th edition. W.H. Freeman and Company , New York (UNIT – 1,2.4,5)
- P.M. Lyolyard , A. Whelan, M.W. Fanger. (2011) Instant Notes in Immunology. 3rd edition. Garland Science Taylor and Francis Group, Newyork (UNIT-3)

Reference Books:

- C.A.Janeway, P.Travers, M. Walport, M.J. Shlomchick. (2005). Immunology – the immune system in health and Diseases. 6th edition. Garland Science Taylor and Francis Group, Newyork
- K.Murphy, P.Travers, M. Walport. (2008). Janeway's Immunology. 7th edition. Garland Science Taylor and Francis Group, Newyork
- I.Roitt.(2017). Roitt's Essential Immunology, 13th edition Blackwell Science
- J.M.Cruse, R.E.Lewis. (2009). Illustrated Dictionary of Immunology. 3rd edition. CRC Press Taylor and Francis Group, New York.
- A. K. Abbas, A. H.H.Lichtman, S.Pillai. (2017).Molecular and Cellular Immunity. 9th edition. Elsevier
- R. M. Atlas (2015). Principles of Microbiology. 2nd edition. Wm.C.Brown Publishers
- Prescott , Harley , Klein (2007). Microbiology 5th edition. McGraw-Hill Publishers

19UMBCC502	Core 13: Medical Microbiology	1Hr/week	4 Credits

Course Objectives:

By the end of the semester, a student should be able to:

1. Appreciate and understand the concept of medical microbiology.
2. Understand and explain epidemiology of the diseases caused by the various pathogens
3. Understand causes, treatment, pathogenicity of viruses, bacteria fungi and parasites

Unit 1: Epidemiology and host –parasite relationship (12hrs)

- Definitions: Signs, symptoms and syndrome of disease, stages of infectious diseases- incubation period, prodromal phase, Invasive phase, decline phase
- Infection and their types
- Bacteraemia, septicaemia, pyamia, toxaemia and Viremia
- Epidemic, Endemic, Pandemic, Zoonotic and Exotic
- Dynamics of disease transmission: Causative or etiological agents, sources of reservoir of infection

Unit 2: Study of pathogenic organisms: Bacteria and Bacteria like organisms (12hrs)

Morphology, cultural characteristics, biochemical characteristics, serology, lab diagnosis and treatments of

- Enteric pathogens (Shigella and Salmonella)
- Pyogenic organisms – Staphylococcus and Streptococcus
- Mycobacterium tuberculosis and Mycobacterium leprae
- Rickettsia
- Chlamydia

Unit 3: Study of pathogenic organisms: (12hrs)

Morphology, cultural characteristics, serology & lab diagnosis of :

- Parasites : Plasmodium, Giardia and entamoba
- Fungus : Candida and Aspergillus
- Spirochetes – Treponema, Leptospira
- Metazoan diseases – Ascariasis and Filariasis
- Tuleremia

Unit 4: Viral diseases and their diagnosis with treatments (12hrs)

Symptoms, diagnosis and treatments of:

- Hepatitis: Hepatitis A & B viruses
- Influenza and Measles
- Chicken Pox
- Rabies
- AIDS and Ebola viruses

Unit 5: Advanced techniques **(12hrs)**

- Chemotherapeutic and antimicrobial agents
- Bioavailability of Drug
- Collection, transport and preliminary processing of Clinical pathogens
- Rapid methods of identification, Molecular methods of identification
- Gene Therapy

Text Book

1. C. K. J. Paniker, Anathanarayan and Paniker's text book of Microbiology (2013) 8th Edition, Orient Longman (UNIT-1-5)

Reference Book

1. Tortora, G.J., Funke, B.R., Case, C.L, 2010. Microbiology: An introduction 10th Edition, Benjamin Pub. Co. NY
2. Chakraborty, P., 2007 A textbook of Microbiology, 2nd Edition New Central Book Agency, India.
3. Samuel Baron, Medical Microbiology. Fourth edition (1996) University of Texas Medical Branch of Galvesion
4. K. Ryan and C. G. Ray, Sherri's Medical Microbiology: an Introduction to infectious diseases. (2004) McGraw hill Publication 4th edition

19UMBCC503	Core 14 Phycology (Self Study)	4hrs/week	4 Credits

Course Objectives:

The course entitled as above is designed to

1. Enlighten the students about general features of algae ; their distribution;
2. Acquire a consolidated overview on different major groups of algae
3. Recognize the importance of algae from economic values

Understand the major differences among varied range of thallus organization and pigment system

Unit 1: General account **(12hrs)**

- General characteristics & distribution
- Classification & range of thallus organization
- Cell components & Pigment system
- Motility & Mode of reproduction
- Economic importance

Unit 2 : Blue Green algae **(12hrs)**

- General features & distribution
- Major groups up to class
- Range of vegetative structure
- Cell structure & special features (heterocyst, hormogone, akinete)
- Mode of reproduction & Economic importance

- **Unit 3 : Diatoms** **(12hrs)**
- General characteristics
- Distribution
- Cell structure and its components
- Motility and mode of reproduction
- Economic importance of diatoms

Unit 4: Green algae **(12hrs)**

- General characteristics & distribution
- Classification & cell structure
- Pigment system & motility
- Mode of reproduction
- Economic importance

Unit 5 : Brown & Red algae **(12hrs)**

- General features
- Major groups upto class
- Cell structure and Pigment system
- Mode of reproduction
- Economic importance

Text Books:

- Sharma O.P. (2011). Textbook of Algae, 1st Edition, McGraw-Hill Education New Delhi (UNIT-1-5)

REFERENCE BOOKS:

- Dubey R.C. and Maheshwari, D.K. 2010. A Textbook of Microbiology. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620
.
- Pelczar, M.J., Chan, E.C.S., Kreig,N.R. (2002).Microbiology, 5th Edition, New Delhi; Tata Mc Graw Hill Publishing Co. Ltd.

- Sundara Rajan S (2003). College Microbiology. Volume 1 & 2. Revised Edition, Vardhana Publications, Bangalore

- Prescott, L.M., J.P. Harley and D.A .Klein (2015). Microbiology, 7th Edition, WM, C Brown Publishers.

19UMBDC501	DSE-Core 1 –Mycology and Virology	4hrs/week	4Credits

Course objectives:

This course is designed to provide Instruction about

1. **G**eneral features and characteristics of fungi and viruses
2. Different classes of fungi and viruses
3. Mode of fungal nutrition, reproduction and propagation
4. Cultivation and enumeration techniques for viruses..

Unit 1: General characteristics of Fungi (12 hrs))

- History, Definition and place in the living world
- Morphological features of fungi
- Special structural modifications
- Fungal nutrition and growth:
- Fungal associations

Unit 2: Fungal classification and reproduction (12 hrs)

- Types of classification: Natural and Artificial
- Fungal Classification: Four Class Classification of Fungi, Nine class Classification of Fungi
- Asexual reproduction
- Sexual reproduction
- Parasexual cycle

Unit 3: Introduction to Bacterial viruses (12 hrs)

- General morphology, occurrence and types
- LHT Classification system
- Viral Nomenclature system
- Lytic Cycle: T4 bacteriophage
- Lysogenic Cycle: Lambda phage, Mu Phage

Unit 4: Introduction to Animal and Plant viruses (12 hrs)

- General morphology, occurrence and types
- Animal virus classification and multiplication- Pox virus
- Viruses and Cancer
- Classification and Multiplication of Plant Viruses.- TMV
- Viroids and Prions

Unit 5: Cultivation & Enumeration of viruses (12 hrs)

- Animal virus cultivation: Direct Animal, Use of Organised Tissues, Animal tissue culture
- Plant virus cultivation: Plant tissue culture, Direct inoculation
- Bacterial virus Cultivation: Plaque method
- Enumeration of Viruses**:** Latex droplet method, Plaque assay, Acid end-point

determination assay, Haemagglutination assay, Particle count and infectivity

- Cytopathic effects

Text Books:

1. An Introduction to Fungi- (2^{nd} revised edition) H.C.Dubey, Vikas publishing House Pvt. Ltd (UNIT-1,2)
2. C.J.Alexopoulos, C.W.Mims, 2007 Introductory Mycology - 4^{rd} edition Wiley Eastern limited (UNIT-1-2)
3. Powar and Daginawala 2012 General Microbiology –Vol. 2, Himalaya Publishing House (UNIT-3,4)
4. S.B. Biswas & Amita Biswas An Introduction to Viruses – 4^{th} revised edition, ***Vikas*** Publishing House (P) Ltd., 2006. ISBN 10: 0706982207 / ISBN 13: 9780706982206. (UNIT-5)

Reference Book:

1. Microbiology – Fundamentals and Applications - 7^{th} edition - S.S.Purohit, Agrobios India Publishers
2. L.M. Prescott & Harley, Klein McGrow Hill *2015 Microbiology - 7^{th} Edition* International Edition
3. Microbiology (international student edition) - Michael Pelczar JR, E.C.S. Chan , Noel R. Krieg, McGraw-Hill publication

19UMBDC02	DSE-Core 1 Quality Assurance and Quality Control	4hrs/week	4Credits

Objectives:

1. For better perception in pharmaceutical microbiology standards
2. To understand industrial requirement of microbial technology
3. To get better opportunities in pharmaceutical industry/laboratories/ Research institutes
4. To be equipped with standard operating procedures as per regulatory authorities

Unit 1: Total Quality Management System **(12hrs)**

- Basic concept of Total quality management
- Importance of quality
- Components of TQM
- Advantages of quality
- Types of Quality measures

Unit 2: Quality Assurance **(12hrs)**

- Hazard and risk analysis in pharmaceutical products
- Personnel's in Quality assurance
- Functions of quality assurance
- Organizational setup in QA
- Importance of QA

Unit 3: Quality Control **(12hrs)**

- Definition : Quality Control and its types in various industries
- Principles of quality control
- Methods of quality control in food industry
- Methods of quality control in Pharma industry
- Corrective and Preventive actions

Unit 4: Quality Audits and inspections **(12hrs)**

- Self inspections and internal assessments
- Purpose of audits
- Types of Audit
- Methods to carry out audits
- Regulatory Compliance

Unit 5: Regulatory guidelines on Quality systems in industry **(12 hrs)**

- Regulatory bodies in industries
- FDA, USFDA, FSSAI and ISO
- Quality Standards in India : ISI, AGMARKS
- Commodity based standards
- Some case study

Text Book

1. Quality Assurance in Microbiology by Rajesh Bhatia, Rattan Lal Ihhpunjani. CBS publishers & distributors, New Delhi.(UNIT-1-5)
2. Good manufacturing practices for Pharmaceuticals By Sydney H. Willing, Murray M. Tuckerman, Willam S. Hitchings IV. Second edition Mercel Dekker NC New York (UNIT-1-5)

Reference Book

1. Vyas S. P., Dixit V. (2007) Pharmaceutical Biotechnology, CBS Publishers & Distributors
2. Stephen P. D., Norman A. H., Sean P. G., Brendan F. G. (2011) Hugo & Russell Pharmaceutical Microbiology 8th Ed. Wiley-Blackwell Publishing house
3. John S. Wolfson and David C. Hooper, (1989) Quinolone antimicrobial agents. American Society for Microbiology, Washington.
4. Cooper M. S. (1972) Quality control in the Pharmaceutical Industry Vol.2 Academic Press Inc.
5. Sidney H.W. Murray M. Tuckerman, W., S. Hitchings IV. Mercel D.,(2007) Good Manufacturing Practices for Pharmaceuticals, Second Edition, NC New York

19UMBCC505	Core Practical- 5 Clinical Microbiology	9hrs/week	3 Credits

Course Objectives:
After completing this course, Students will be able to:
1. Collect blood samples and other clinical samples
2. Perform various serological and haematological diagnostic tests
3. Understand the significance of blood count, various blood components and their analysis
4. Isolate pathogens from samples and identify them

List of Practicals

1. Study of serological and hematological reactions
   a. Agglutination (blood grouping, Serodiagnosis of enteric fever by Widal test)
   b. Serodiagnosis of syphilis by RPR Test
   c. Total count of RBC and WBC
   d. Differential count of WBC
   e. Haemoglobin estimation by Sahli's method
   f. Bleeding time by filter paper technique and clotting time by capillary method
   g. Erythrocyte Sedimentation Rate (ESR-demonstration)

2. Blood Chemistry
   a. Blood sugar estimation by GOD / POD method
   b. Blood urea by DAM method
   c. Serum bilirubin estimation
   d. Cholesterol estimation
   e. Ouchterlony Double Diffusion (Demonstration)

3. Physical, Chemical and Microscopic examination of Clinical samples – urine, stool, pus, Sputum

4. Isolation, identification of following pathogens from clinical Samples*: E. coli, Salmonella spp., Pseudomonas spp., Proteus spp., Shigella spp., Staphylococcus spp, Streptococcus spp*.(for identification use of keys as well as Bergey's Manual is recommended)
5. Study of growth characters of isolated pathogens on following media: Mannitol Salt Agar, Wilson Blair agar, Salmonella Shigella agar, Glucose azide medium, Cetrimide agar, TSI agar

Reference book

1. Broude AI: Medical Microbiology and Infectious Diseases, WB Saunders Co.
2. Jawetz, Melnick & Adelberg's: Medical Microbiology, 26th Edition, Mc Graw Hill Companies, a LANGE medical book.
3. Chapel and Haeney: Essentials of Clinical Immunology, Blackwell Scientific Publications.
4. Forbes BA, Sahm DF and Weissfeld AS: Bailey & Scott's Diagnostic Microbiology, Mosby

19UMBDC503	DSE-Core 1 –Practical: -Mycology and Virology	3hrs/week	1Credits

Course Objectives:

The course is designed to develop below mentioned skill in the student:

1. Identify various fungi on the basis of morphological characters
2. Distinguish different parts of fungal thallus
3. Cultivation techniques of fungi from various samples
4. Cultivation techniques for Coliphage

List of Practical

1. Microscopic observation of permanent slides of various fungi
2. Isolation and Cultivation of fungi from soil
3. Isolation of fungi from natural deteriorated samples
4. Study of antimicrobial effect of fungi on laboratory bacteria by plate method
5. Isolation of Bacteriaophage of *E.coli*

Reference Book:

1. Cappuccino, J.G., Sherman, N. (2004). International student edition: Microbiology- A laboratory Manual 4th edition: Benjamin Cummings publications

19UMBDC504	DSE-Core 1 –Practical: -Quality Assurance and Quality Control	3hrs/week	1Credits

Course Objectives:

The student shall be able to:

1. Acquire skills Quality management system
2. Understand the role of quality in human life and its role in betterment of society
3. Identify different domains of industry in quality systems like food, pharma etc.

List of Practicals

1. To check the quality of packed food products as per standard protocol of microbiology.
2. Testing for microbial contamination and sterility of the food products in packed food and packaged drinking water
3. Check regulatory guidelines on packaging materials and codes for assurance in quality
4. Study of various pharmaceutical packaged products

Reference Books

1. Quality Assurance in Microbiology by Rajesh Bhatia, Rattan Lal Ihhpunjani. CBS publishers & distributors, New Delhi.

B.Sc Microbiology
Semester - VI

19UMBCC601	Core 16: Molecular Biology	4hrs/week	4 Credits

Objectives

After completion of this course, student will be able to:

1. Understand the basic concept and scope of recombinant DNA technology
2. Understand the function of various Enzymes and Vectors used in Gene manipulation
3. Describe the methods used in selection, screening & analysis of recombinants
4. Develop knowledge of the genomic and cDNA cloning strategies
5. Understand the application and ethical aspects of using RDT in developing products.

Unit: 1 Molecular genetics and organization of genetic materials (12hrs)

- Concept of central dogma
- DNA as genetic material: experimental evidences
- Different forms of DNA
- Genomic organization of Eubacteria and Archaebacteria
- Mendelian Laws

Unit: 2 Replication and Recombination (12 hrs)

- Experimental evidences of Replication and enzymes involved in DNA Replication
- Process of Replication in Prokaryotes
- Regulation of Replication
- Process of Recombination- mechanism of gene transfer- Transformation, Conjugation, transduction
- Transposable elements

Unit: 3 Transcription (12 hrs)

- Enzymes involved in Transcription of Prokaryotes
- Process of Transcription in Prokaryotes and its inhibitors
- Types of RNA molecules and Post transcriptional modification
- Regulation of gene expression at transcriptional level in prokaryotes
-

Unit: 4 Translations (12 hrs)

- Genetic code
- Role of various RNA and Ribosome in Protein sysnthesis
- Process of Translation in Prokaryotes and its inhibitors
- Post translational modification
- Distinguishing features of prokaryotic translation

Unit: 5 Mutations and Repair **(12 hrs)**

- Occurrence, kinds of Mutation, spontaneous & induced Mutation
- Mutagens, detection of Mutation Lethal Mutations, Biochemical Mutations
- Phenotypic effects of Mutation and Molecular basis of Mutation
- Significance & Practical applications of Mutation
- DNA Repair-Types and mechanism

Text Books

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2014) Molecular Biology of the Gene, 7th edition, Cold Spring Harbour Lab. Press, Pearson Publication (UNIT-1-5)

2. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia

Reference books

1. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
2. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
3. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
4. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
5. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2016) The World of the Cell, 9th edition, Pearson Benjamin Cummings Publishing, San Francisco

19UMBCC602	Core 17: Genetic Engineering	4hrs/week	4 Credits

Objectives

After completion of this course, student will be able to:

1. Understand the basic concept and scope of recombinant DNA technology
2. Understand the function of various Enzymes and Vectors used in Gene manipulation
3. Describe the methods used in selection, screening & analysis of recombinants
4. Develop knowledge of the genomic and cDNA cloning strategies
5. Understand the application and ethical aspects of using RDT in developing products.

Unit 1: Introduction to Recombinant DNA Technology (12 hrs)

- Introduction to RDT
- History and relevant landmarks in the development of RDT
- Scope of RDT in biotechnology and human welfare: Transgenic plants: BT cotton, Genetically modified Food , Genetically Modified Organism, Scientific and ethical issues regarding GM food/organism, Gene Therapy
- Terminologies associated with RDT: Overview of cDNA, Clone, Gene, Genome, Vector, Recombinant, Genemap, Transgenics
- Future of RDT

Unit 2: Tools for RDT: Enzymes, Vector and Host (12 hrs)

- Restriction Endonuclease: Definition, nomenclature, mechanism, types and application
- Ligase: Definition, mechanism, application
- Other essential enzymes: DNA and RNA polymerase, Reverse Transcriptase.
- Vectors: Definition, properties, types.
  a) Plasmid vector
  b) Bacteriophage vector
  c) Shuttle Vector
  d) Cosmid Vector
  e) Yeast Vector: YAC
  f) Vector for Plant: Agrobacterium
  g) Vector for animal: SV40
- Selection of suitable host

Unit 3: Isolation of target DNA and Cloning Strategies (12 hrs)

- Isolation of DNA and selection of target gene.
- Construction of genomic Library
- Construction of cDNA Library
- Methods of Cloning
- PCR: As alternative to genomic DNA/ cDNA cloning

Unit 4: Expression, Screening and Selection of recombinants (12 hrs)

- Transformation of r-DNA to suitable host
- Expression of recombinant in suitable host: prokaryotic and eukaryotic.
- Basic techniques for screening and selection of the clones
- Sequence-dependent screening of recombinants: Hybridization and PCR
- Identification of DNA marker: RAPD, AFLP

Unit 5 Molecular Biology Techniques (12hrs)

- DNA sequencing: Principles and Methods, Automated DNA sequence Analyzer
- Blotting techniques and FISH
- RFLP, RAPD, VNTR, STR and SNP analysis, ARDRA
- Chemical synthesis of DNA
- PCR Technology: Principle, Methods and Applications

Text Book

1. R.C.Dubey (2010) A textbook of Biotechnology, S. Chand and Company, New Delhi (UNIT-1-5)

Reference book

1. S.B. Primrose, R.M. Twyman and R.W.Old.(2006) *Principles of Gene Manipulation. 7th Edition*, S.B.University Press,.
2. B.D. Singh (2010) Biotechnology Expanding Horizons. Kalyani Publishers.
3. J. Sambrook and D.W. Russel.(2001) Molecular Cloning: A Laboratory Manual, Volume
4. Chatwal R.G., Anand, S.K. (2012). Instrumental Methods of Chemical Analysis. Mumbai: Himalaya publication
5. Upadhyay, A., Upadhyay, K., Nath, N. (2009). Biophysical Chemistry: Principles and techniques. Mumbai: Himalaya publication

16UMBDC601	DSE-Core 2 Microbiology and Health Care	4hrs/week	4 Credits

Course objective

This course is designed to provide instruction about,

1. Microorganisms are beneficial for Human health care
2. Role of Microorganisms in different fields
3. Role of Microbes in day to day life

Unit: 1 History of Microbiology **(12 hrs)**

- History of microbiology and Health care
- Spontaneous generation verses Bio-generation
- Germ theory of disease
- Koch Postulate
- Antibiotics

Unit: 2 Microorganisms as probiotics **(12 hrs)**

- Probiotics
- Characteristics of probiotics
- Commercially available probiotic products
- Benefits of probiotic products
- Prebiotics

Unit: 3 Microorganisms as food **(12 hrs)**

- Microorganisms as a food source - Single cell protein
- Mushroom as a complete food and Nutritional level of mushroom
- Microorganisms in Dairy (Cheese, Yogurt, Buttermilk, Kefir)
- Microorganisms in fermented food (Pickles, Sauerkraut, Silage, Sausage, Bread)
- Functional Food

Unit: 4 Microorganisms as Bio-fertilizer and Bio-pesticides **(12 hrs)**

- Definition of Biofertilizer, history and milestones
- Types of Bio-fertilizer and mode of application
- Definition of Biopesticide, history and milestones
- Types of Bio-fertilizer and mode of application
- Advantages and limitations of Biofertilizer and Biopesticide

Unit: 5 Microorganisms as Vaccines **(12 hrs)**

- Definition and history of Vaccines and vaccination
- Traditional Vaccines: Live, attenuates vaccines, inactivated vaccines,
- New generartion vaccines: Toxid vaccines, Recombinant Vaccines, DNA Vaccines, sub unit vaccine
- Production of Vaccines
- Pros and cons of vaccination

Text book:

- Frazier .W.C Westhoff, D.C., (2003). Food Microbiology. 18th edition Tata McGraw-Hill Publication Company (UNIt-2,3)
- Subba Rao, N.S., (1999). Bio-fertilizers in Agriculture and Agro forestry. New Delhi:Oxford IBH (UNIT-4)
- Pelczar, M.J., Chan, E.C.S., Kreig, N.R. (2003). Microbiology 5th Edition, Tata McGraw-Hill Publication Company (UNIT-1,5)

Reference book:

- Tortora, G.J., Funke, B.R., Case, C.L., (2004). Microbiology Introduction .Singapore: Pearson Education.
- Presscott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology 5th edition, New York: WCB Mc GrawHill publication

16UMBDC602	Fundamentals of Research Methodology	2hrs/week	1 Credits

Objectives

After completion of this course, student will be able to:

1. Understand the concept of research and importance of studying research methodology
2. Gain knowledge regarding various components of research
3. Distinguish between various scientific documents
4. Understand the concept of thesis writing
5. Gain elementary knowledge regarding application of statistics in research

UNIT-1: Introduction to Research Methodology (12 hrs)

- Introduction to Research and Research Methodology
- Objective of Research
- Types of research
- Significance of research
- Process of Research

UNIT-2: Components of Research (12 hrs)

- Defining research problem
- Designing research
- Sample and sampling
- Data Collection
- Data Analysis

UNIT-3: Scientific documents and standards (12 hrs)

- Scientific Documents: Types
- Journals: types and properties.
- Publication: Types, Ethics and standards
- Quality of Journal: Impact Factor, Citation.
- Google sacholar

UNIT-4: Dissertation/Thesis Writing and Presentation (12 hrs)

- Modes of presenting scientific data
- Basics of Poster Presentation
- Thesis/Dissertation writing: overview, components and order of presentation.
- Ethics of Publication and Thesis writing

UNIT-5: Elementary statistics for Research **(12 hrs)**

- Hypothesis
- Hypothesis testing
- Measures of central tendency: Mean, Mode, Median
- ANOVA
- Chi Square test

Text Book

1. C.R. Kothari.(2004) Research Methodology. *2nd Edition*, New Age International Publisher. (UNIT-1-5)

16UMBCC603	Core Practical- 6 Molecular Biology	9hrs/week	3 Credits

Course Objectives:

After completing this course, Students will be able to:

2. Isolate genetic material from different types of cells
3. Quantify the nucleic acid material
4. Perform gene transfer in bacteria using various techniques
5. Perform mutation in bacteria

List of Practicals

1 Isolation of genomic DNA from bacteria
2 Isolation of plasmid DNA from bacteria
3 Agarose gel electrophoresis of isolated DNA
4 Isolation of RNA from yeast cells
5 Quantification of DNA and RNA by specrophotometry
6 Determination of Tm value of DNA
7 Bacterial Transformation
8 Bacterial Conjugation
9 U.V induced mutagenesis
10 Plasmid curing by Acridine orange

Reference books

1 T.A.Brown, Genome-2, 2nd edition
2 Verma and Agrawal, Cell biology, Genetics, Molecular biology
3 Karp, cell and Molecular biology

16UMBDC603	DSE-Core 2 Practical : Microbiology and Health Care	2hrs/week	1 Credits

Course Objectives:

After completing this course, Students will be able to:

1. Isolate microorganisms from different material and can study them
2. Can predict on the quality of the material

List of Practicals

1 Isolation and identification of microorganisms from butter milk
2 Isolation and identification of Probiotics from commercially available probiotic food
3 Isolation of Nitrogen fixing bacteria from root nodules
4 Isolation of non- symbiotic bacteria from Rhizospheric soil
5 Isolation and identification of fungus from fermented food (Bread)

Reference book:

1. Tortora, G.J., Funke, B.R., Case, C.L., (2004). Microbiology Introduction .Singapore: Pearson Education.

2. Presscott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology 5th edition, New York: WCB Mc GrawHill publication

16UMBDC604	**DSE-Core 2 Practical : Fundamentals of Research Methodology**	**2hrs/week**	**1 Credits**

List of Practicals

1. Writing research proposal
2. Protocol filling and submission
3. Making data analysis using statistics

Reference book:

1. C.R. Kothari.(2004) Research Methodology. *2nd Edition*, New Age International Publisher.