Enclosure – IA

B. Sc. Microbiology
Semester III

16UMBCC08	Core 6: Microbial Ecology	5hrs/wk	5 Credits

Course objectives:

• To introduce the field of microbial ecology and environmental microbiology

• To explore the functional ubiquity and diversity of microorganisms

Unit 1: Introduction to Microbial Ecology **10hrs**

- History, Significance, Developments in the field of Microbial Ecology, Ecological niche
- Major Contributions
- Microorganisms and their Habitat:
  - ❖ Terrestrial Environment: Brief account of Soil characteristics, Soil profile, Soil formation, Soil as a natural habitat of microbes, Soil microflora
  - ❖ Aquatic Environment: Stratification & Microflora of Freshwater & Marine habitats
  - ❖ Atmosphere: Stratification of the Atmosphere, Aeromicroflora, Dispersal of Microbes
  - ❖ Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body.
  - ❖ Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.

Unit 2: Successions and Interactions **10hrs**

- Succession of microbial communities in the decomposition of plant organic matter
- Biological Interactions
  - ❖ Microbe–Microbe Interactions
    - ▪ Mutualism, Synergism, Commensalism, Competition, Amensalism, Parasitism,
    - ▪ Predation, Biocontrol agents
  - ❖ Microbe–Plant Interactions
    - ▪ Roots, Aerial Plant surfaces, Biological Nitrogen fixation- (symbiotic / nonsymbiotic - biofertilizers)
  - ❖ Microbe–Animal Interactions (2 periods)
    - Role of Microbes in Ruminants, Nematophagus fungi, Luminescent bacteria as symbiont

Unit 3: Biogeochemical Cycles **10hrs**

- Carbon cycle: Microbial degradation of polysaccharide (cellulose, hemicellulose, lignin, chitin)
- Nitrogen cycle: Ammonification, nitrification, denitrification & nitrate reduction. Nitrate pollution.
- Phosphorous cycle: Phosphate immobilization and phosphate solubilization
- Sulphur Cycle: Microbes involved in sulphur cycle

Unit 4: Waste Management **10hrs**

- Sources and types of waste,
- Methods of disposal of solid waste (incineration, composting, sanitary landfill)
- Liquid Waste Management:
  a. Composition of sewage;
  b. strength of sewage (BOD and COD);
  c. Primary, secondary (aerobic – oxidation pond, trickling filter, rotating biological contractor/biodisc system, activated sludge process and anaerobic – septic tank, imhoff tank, anaerobic digestor) and tertiary sewage treatment

Unit 5: Applications of Microbial processes **10hrs**

- Bioleaching
- Biodeterioration
- Microbial deterioration of metals (corrosion), textile and paper

Text Books:

- Atlas, R.M., Bertha, R. (1997). Microbial Ecology, 4th Edition: Benjamin Cummings publication
- Madigan, M.T., Martinko, J.M., Stahl, D.A., Clark, D.P. (2011). Brock Biology of Microorganisms, 13th ed.: Benjamin-Cummings publication
- Barton, L.L., Northup, D.E. (2011). Microbial Ecology: Wiley-Blackwell publication

Reference Book:

- Begon, M., Townsend, C.R., Harper, J.L. (2006). Ecology – From Individuals to Ecosystems, 4th ed.: Wiley-Blackwell publication.
- Kirchman, D.L. (2008). Microbial Ecology of the Oceans: Wiley-Blackwell publication.
- Madsen, E.L. (2008). Environmental Microbiology - From Genomes to Biogeochemistry: Wiley-Blackwell publication.
- Rochelle, P.A. (2001). Environmental Molecular Microbiology: Protocols and Applications: Horizon Scientific Press

16UMBCC09	Core 7: Agriculture 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 **9hrs**

- Introduction to soil
- Formation of soil- weathering of rocks, pedogenesis
- Soil profile
- Edephic factors-Physical and chemical properties of soil

UNIT 2: Microbial Interactions in soil **9hrs**

- Rhizosphere
- Microbial diversity of soil
- Microbial Interactions in soil
  1. Microbe – microbe interaction
  2. Plant – microbe interactions

UNIT 3: Biofertilizers and Biopesticides **12hrs**

- Overview of organic farming
- Biofertilizers
- Biopesticides
- PGPR –Plant growth promoting rhizobecteria
- Introduction to mycorhiza
- IPM

UNIT 4: Beneficial role of microbes in Agriculture **10hrs**

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

Unit 5: Harmful effect of microbes in Agriculture **10hrs**

- General Mechanism, Propagation and control of:
  - Plant diseases by Bacteria-Xanthomonas citrii
  - Plant diseases by viruses - TMV
  - Plant diseases by fungi – Types and one example of each
  - Plant pathogenic Nematods

Text Books:

- Alexander, M. (1991). Introduction to Soil Microbiology: Krieger Pubcation.
- 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.
- Subba Rao, N.S. (1999). Biofertilizers in Agriculture and Agro forestry. New Delhi: Oxford & IBH.
- Subba Rao, N.S. (1995). Soil Microorganisms and Plant Growth. New Delhi: Oxford & IBH.
- Waiter, M.J., Morgan, N.L., Rocky, J.S., Higton, G. (1999). Industrial Microbiology: An Introduction: Wiley-Blackwell publication.

Reference Books:

- Dirk, J., Elas, V., Trevors, J.T., Wellington, E.M.H. (1997). Modern Soil Microbiology. New York: Marcel Dekker INC.
- Ramanathan, N., Muthukaruppan, S.M. (2005). Environmental Microbiology. Annamalai Nagar: Om Sakthi Pathipagam.

16UMBCC10	Core 8: Food and Dairy Microbiology	4hrs/wk	4 Credits

Course objectives:

This course is designed to provide Instruction about

- General principles of food microbiology and dairy Microbiology.
- Food spoilage by microorganisms;
- The microbiology of food preservation and food commodities;
- Fermented and microbial foods;
- Principles and methods for the microbiological examination of foods; micro biological quality control, and quality schemes.
- Processing in dairy for milk and milk product is core part of dairy microbiology.

UNIT –1 Introduction to Food Microbiology and Food Preservation

- Microbial flora of fresh food
- Food as a substrate for micro organisms -. Micro organisms important in food microbiology;
- Preservation of foods: General principles & methods of food preservation
- Principles of food preservation - Asepsis - Removal of micro organisms, anaerobic conditions - High temperature - Low temperature - Drying - Food additives

UNIT –2 Food Spoilage, Food Intoxication and Food borne Infection

- Microbial spoilage of foods: Fresh foods & Canned foods
- Food Spoilage
- Food Borne infection & intoxication
- Role of *S.aureus,, C.botulinum* & *Salmonella Spp.*in food poisoning – Case Study
- Microbiological examination of food; Introduction to AGMark

UNIT – 3 – Milk Microbiology

- 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

UNIT-4 – Dairy Products and Preservation Of Milk

- Fermented milk Beverages
- Manufactured Dairy Products: Starter Culture, Cheese, Yogurt, Buttermilk, Acidophilus milk, Kefir
- Preservation of milk: Principles
- methods of preservation

UNIT –5 Fermented Foods

- Fermented Dairy Products.
- Brief introduction about fermented foods: Pickles, Sauerkraut, Silage, Sausages & Bread
- Microorganisms as food: Single Cell Protein, Mushrooms
- Functional foods

Text Books:

- Frobisher, M. (1974). Fundamentals of Microbiology. 9th Edition. Philadelphia, PA: W. B. Saunders Company.
- Frazier, W.C., Westhoff, D.C. (1978). Food Microbiology. Tata McGraw-Hill Publishing Company.
- Swaminathan, M. (1990). Food Science, Chemistry and Experimental Foods. Mysore: Bappco Book Publishing Company.
- Jay, J.J., Loessener, M.J., Golden, D.A. (2005). Modern Food Microbiology: Springer publication.
- Prajapati, J.B. (1995). Fundamentals of Dairy Microbiology: Ekta Publication.

Reference Book:

- Manay, S., Shadaksharaswami, M. (2008). Foods: Facts and Principles. New Delhi: New Age Publishers.
- Srilakshmi, B. (2002). Food Science. New Delhi: New Age Publishers.
- Meyer, L.H. (2004). Food Chemistry. New Delhi: New Age Publishers.
- Kenneth, F.K., Kriemhild, K.O. (2000). The Cambridge World History of Food. Cambridge: Cambridge University Press.

16UMBCC11	Core Practical – 3- Agriculture, Food and Dairy 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

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 phosphobacteria –
5. Observation of mycorrhiza roots.
6. Food spoilage - microorganisms involved in dairy products - Identification of bio control agents.
7. Isolation and identification of microorganisms involved in food spoilage
8. Enumeration and identification of food poisoning organisms
9. Study of food spoilage (Characters that shows food is spoiled)
10. Isolation of microorganisms from milk and milk products and their identification • Microbiological grading of milk and milk products
11. Production and estimation of lactic acid by Lactobacillus Sp. Or Streptococcus Sp.
12. Production of fermented milk by Lactobacillus acidophilus. - Yogurt
13. Rapid analytical techniques in food quality control using microbial Biosensors.
14. Standard qualitative analysis of milk
15. Methylene Blue Reduction Time test for milk
16. To preserve food with high salt/vinegar/high sugar for long time
17. Isolation of probiotics.

Reference Books:

- Adams M.R., Moss, M.O. (2008). Food Microbiology. 2nd Edition: Royal Society of Chemistry.
- Banwart, G.J. (1989). Basic Food Microbiology: Springer publications.
- Doyle, M.P., Buchanan, R.L. (1997). Food Microbiology: Fundamentals and Frontiers: ASM publication.
- Joshi, V.K., Pandey, A. (1999). Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2. Emakulam: Educational Publishers & Distributors.
- Prajapati, J.B. (1995). Fundamentals of Dairy Microbiology: Ekta Publication.
- Garbult, J. (1997). Essentials of Food Microbiology: Hodder Arnold publication.
- Wood, B.J. (2012). Microbiology of Fermented Foods. Volume I and II: Elsiever Applied Science Publication.
- Robinson, R.K. (2002). Dairy Microbiology Handbook: Wiley-Blackwell publication.

16UMBDA05	DSE Allied - 3: Sustainable Management	4hrs/wk	4 Credits

Course objectives:

This course is designed to provide Instruction about

- General principles of food microbiology and dairy Microbiology.
- Food spoilage by microorganisms;
- The microbiology of food preservation and food commodities;
- Fermented and microbial foods;
- Principles and methods for the microbiological examination of foods; micro biological quality control, and quality schemes.
- Processing in dairy for milk and milk product is core part of dairy microbiology.

UNIT –1 Introduction to Sustainable Management 10hrs

- What is Sustainable Management?
- Sustainable development and Green Climate Fund
- Introduction to Corporate Social Responsibility and ISO 14001
- Brief account on SDGs (Sustainable Development Goals), Agenda 21, MDGs (Millennium Development Goals), UNDP

UNIT –2 Biodiversity and its importance with respect to Environment and Economy10hrs

- Basic Concept of Biodiversity – Definition, Types of Biodiversity, Keystone Species, Importance of Biodiversity
- Global Distribution of Biodiversity and Biodiversity Hotspots
- Biodiversity in India – Wetlands, Marine Environment, Endemism, Biodiversity and People's Livelihood
- Forest Biological Diversity- Status of forest in India, Genetic Diversity of Indian Trees

UNIT –3 Biodiversity in sustainable Agriculture 10hrs

- Agrobiodiversity and Local Knowledge and its importance
- Plant Agrobiodiversity – Centres and origin, Value of Plant genetic resources
- Animal Genetic Resources – Five Major Species, Species with a Narrower Distribution, Breed Diversity
- Agrobiodiversity and Food Security

UNIT – 4 Threats to Biodiversity and impact of Biodiversity loss on sustainability 10hrs

- Extent of Biodiversity Loss
- Biodiversity Threats
- The Indian Scenario
- Protected Areas and Countering Biodiversity Loss

UNIT- 5 Sustainable Use of Biodiversity **10hrs**

- Sustainable Use of Biodiversity
- International and National Instruments Relating to Biodiversity Management
- Gender and Biodiversity in India
- Conservation Measures of Biodiversity

Reference Book:

- IGNOU Study Materials
- Verma, P.S., Agrawal, V.K. (2005). Ecology, Cell Biology, Molecular Biology, Genetics. New Delhi: S. Chand and Company Limited.

16UMBDA05	**DSE Allied – 3 Practical : Sustainable Management**	**1hrs/wk**	**No Credit**

These are practice and observation exercises for the better understanding of the basic concepts like:

1. Microscopic Study of water from different sources to compare microbial and other biodiversity
2. Study of Agrodiversity
3. Case Study
4. Group Discussion

Semester - IV

16UMBCC12	Core 9: Bacterial Metabolism	4hrs/wk	4 Credits

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

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

UNIT – 1: Introduction to Metabolism, Bioenergetics and Enzyme Kinetics 10hrs

- 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, K_m, V_{max}, L.B. Plot, Turnover number, K_{cat}; Kinetics of Enzyme Inhibition; Kinetics Allosteric enzymes

UNIT – 2: Catabolism of Carbohydrates 10hrs

- 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 10hrs

- 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 10hrs

Bioenergetics:

- Different modes of ATP generation and comparative study of ATP (energy budget)
- Electron transport chain: Introduction, Components of ETC and energy yield

- Anaerobic Respiration
- Methods of studying biosynthesis: Strategy of Biosynthesis, Use of Biochemical Mutants, Use of Isotopic Labelling
- Bacterial photosynthesis; Biosynthesis of peptidoglycan

Membrane Transport:

- 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
- Quorum sensing

UNIT – 5: Some selected aspects of metabolism in specific microbial systems 10hrs

- 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*

Text Books:

- White, D. (2000). The physiology and Biochemistry of Prokaryotes, 2nd edition: Oxford University Press.
- Conn E.E., Stumpt P.K. (1989). Outlines of Biochemistry. Wiley publication.
- Stanier, R.Y. (1987). General Microbiology, 5th Edition: Macmillan publication.
- Nelson, D.L., Cox, M.M. (2013). Lehninger Principles of Biochemistry. W.H. Freeman publication.
- Moat, A.G., Foster. J.W., Spector, M.P. (2009). Microbial Physiology, 4th Ed: Wiley India Pvt Ltd.

Reference Books:

- Dirk, J., Elas, V., Trevors, J.T., Wellington, E.M.H. (1997). Modern Soil Microbiology. New York: Marcel Dekker INC.
- Ramanathan, N., Muthukaruppan, S.M. (2005). Environmental Microbiology. Annamalai Nagar: Om Sakthi Pathipagam.

16UMBCC13	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 10hrs

- 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 10hrs

- 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 10hrs

- 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 10hrs

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

UNIT 5 Molecular Biology Techniques 10hrs

- 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
- Introduction to Biosensor Technology

Text Books:

- Purohit, S.S. (2007). Microbiology-Fundamentals and Applications, 6th Edition. New Delhi: Agrobios Publications.
- Wilson, K., Walker, J. (2010). Practical Biochemistry – Principle and Technique, 7th Edition. Cambridge: Cambridge University Press.
- Attwood, T.K., Parry. D.J. (1999). Introduction to Bioinformatics: Longman publication

Reference Books:

- Westhead D.R., Parish J.H., Twyman, R.A. (2002). Instant notes in Bioinformatics. Taylor and Francis publications.
- Andreas, D. B., Ouellette, B.F.F. (2004). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition: Wiley publication.
- Chatwal R.G., Anand, S.K. (2012). Instrumental Methods of Chemical Analysis. Mumbai: Himalaya publication.
- Freifelder, D. (1982). Physical Biochemistry: Application to Biochemistry and Molecular biology, 2nd edition. San Francisco: W.H. Freeman and company.
- Sadashivam, S., Manickam, A. (2004). Biochemical methods, 2nd edition. New Delhi: New Age International (P) Limited.
- Upadhyay, A., Upadhyay, K., Nath, N. (2009). Biophysical Chemistry: Principles and techniques. Mumbai: Himalaya publication.
- Oser, B.L. (2006). Hawk's physiological chemistry. 14th Ed. New York, NY: McGraw-Hill Book Company.
- Boyer, R.F. (2002). Modern Experimental Biochemistry. San Francisco: Benjamin Cummings Publ. Company.
- Williams, B.D., Wilson, K. (1981). A Biologist's Guide to Principles and Techniques of Practical Biochemistry. London: Edward Arnold publications.

16UMBCC14	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 10hrs

- 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 10hrs

- 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 10hrs

- 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 10hrs

- 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 **10hrs**

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

Text books:

- Stanbury, P.F., Whittaker, A. (1984). Principles of Fermentation Technology, 2nd Edition. Pergamon Press.
- Casida, L.E. (1968). Industrial Microbiology. New Delhi: New Age International Pub. (P) Limited.

Reference Books:

- Crueger, W., Crueger, A. (1990). A text book of Industrial Microbiology, 2nd edition: Sunderland, Mass.: Sinauer Associates.
- Patel, A.H. (2011). Industrial Microbiology, 2nd Edition: Laxmi publication.
- Joshi, V.K., Pandey, A. (1999). Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2. Emakulam: Educational Publishers & Distributors.
- Prescott, S.C., Dunn, C.G., Reed, G. (1982). Prescott & Dunn's Industrial Microbiology. Westport: AVI Publication.

16UMBDA07	DSE – Allied – 4 – Biostatistics and Bioinformatics	4hrs/wk	4 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 **10hrs**

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

UNIT 2 Measures Of Biostatistics, Probability Distributions **10hrs**

- 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 **10hrs**

- 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 **10hrs**

- Structure of computer: Components, peripherals, uses and types
- The window screen and parts of window, the control panel
- MS Office: MS word, MS power point, MS Excel
- Internet: History, Basic Concepts, Connection Types, Applications, Search Engines and E mail
- Basics of HTML, page creation and design using HTML
- Multimedia Usage

UNIT 5 Bioinformatics **10hrs**

- Introduction and importance of Bioinformatics
- Database and DBMS : Introduction, File formats,

- Primary and Secondary Biological databases, Structure databases, Miscellaneous databases.
- Information retrieval from Biological database : ENTREZ, SRS and DBGET
- Sequence Alignment : Gap penalties, BLAST and FASTA
- Introduction to OMICS technology
- Introduction to Drug discovery and Chemi informatics

Reference Books:

- Andreas, D. B., Ouellette, B.F.F. (2004). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition: Wiley publication.
- Misener, S. (2000). Bioinformatics – Methods and Protocols: Humana Press.
- Attwood, T.K., Parry. D.J. (1999). Introduction to Bioinformatics: Longman publication
- Westhead D.R., Parish J.H., Twyman, R.A. (2002). Instant notes in Bioinformatics. Taylor and Francis publications.
- Satyanarayan, U. (2008). Biotechnology. Kolkata, West Bengal: Books and allied (P) Ltd.

16UMBCC15	Core Practical - 4: Metabolic analysis and Fermentation	6hrs/wk	3 Credits

Course objectives:

The course will impart

5. Technical skill to the students perform various analytical methods for estimations
6. Hands on training on many sophisticated instruments
7. Understanding of upstream and down stream process in the fermentation process

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* & itsestimation
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 for practical

- Chappuccino, J.G., Sherman, N. (2004). International student edition: Microbiology- A laboratory Manual 4th edition: Benjamin Cummings publications.
- Baker, F.J., Breach, M.R. (1967). Handbook of Bacteriological Technique: Butterworth & Co Publishers Ltd.

Reference Books:

- Jayaraman, J. (1981). Laboratory Manual in Biochemistry: Wiley publication.
- Sawhney S.K., Singh, R. (2005). Introductory Practical Biochemistry: Alpha Science International.
- Chappuccino, J.G., Sherman, N. (2004). International student edition: Microbiology- A laboratory Manual 4th edition: Benjamin Cummings publications.

16UMBDA08	DSE - Allied Practical - 4: Biostatistics and Bioinformatics	2hrs/wk	1 Credits

Course Objectives:

The course is designed to

1. Understand mathematic/physical principles of information retrieving and analyzing
2. build up the experience of utilizing website-based softwares and database
3. awareness about the accuracy, limitation and boundary of theoretical methods
4. develop the ability to perform basic computer programming

1. Review of NCBI Portal
2. Review of Biological Data Bases
3. Demonstration on BLAST analysis
4. Comparison of Entrez, SRS, and DBGET retrieval
5. Basic use of Computer – Use of Excel, Power point and Internet
6. Mean, Median, Mode
7. Standard deviation
8. Student t-Test
9. Chi – square Test
10. ANOVA

Reference Books:

- Andreas, D. B., Ouellette, B.F.F. (2004). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition: Wiley publication.
- Misener, S. (2000). Bioinformatics – Methods and Protocols: Humana Press.
- Rao, C.R. (1973). Linear Statistical Inference and its Applications. New York: Wiley publication.