

Annamalai  **University**

Syllabi-2023-24

Ph.DMICROBIOLOGY
Programme Code:SMIC81



DEPARTMENT OF MICROBIOLOGY

Faculty of Science

COURSE I: RESEARCH METHODOLOGY

Learning Objective (LO):

LO	To understand and learn the basic concepts of the research methods, statistical and bioinformatics tools essential for biological research.
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Unit 1: Scientific Research And Scientific Writing

Purpose of research, Classification of research, Fundamentals of research methods, Writing a research proposal, Problem Identification: Review of literature, broadening knowledge base in the specific research area, bringing clarity and focus to the research problem, Writing a research proposal, Writing a research report, Writing thesis, Research article and publishing. Publication indices. Clinical research: Informed Consent Process, Types and Designs used in Clinical Research, Clinical Trial Study team, Quality Assurance and Quality Control in Clinical Trials, Clinical Trial Data Management .

Unit 2: Biostatistics

Types of data distribution, Measures describing the central tendency distributions- average, median, mode, Construction and labeling of graphs, histogram, piecharts, scatter plots, semi algorithmic plots, Measurement of the spread of data-range, variation of mean, standard deviation, variance, coefficient of variation, standard error of mean. Incidence and prevalence, relative risk, attributable risk, Null hypothesis, level of significance, power of test, P value, statistical estimation of confidence intervals, SPSS, Epi Info, SAS, Mathematica

Unit 3: Computer Applications In Biology

Spreadsheet tools: Introduction to spreadsheet applications, features, using formulae and functions, data storing, features for statistical data analysis. Generating charts/graph and other features. Tools -Microsoft excel or similar presentation tools: Introduction features and functions. Power point Presentation, customizing and showing presentation. Introduction to internet, use of internet and WWW. Use of search engines.

Unit 4: Bioinformatics

Genomics: Genes, Genomes, Human Genome Project. Genome Databases: Sequence databases: GeneBank, EMBL, DDBJ Proteomics: Proteomics classification; tools and techniques in proteomics, Protein Databases, Sequence alignments: physicochemical properties based on sequence, sequence comparison. Pair-wise sequence alignment. ClustalW, BioEDIT, BLASTp, Phylogenetic analysis tools- Phylip, ClustalW, Online phylogenetic analysis. Nucleotide sequencing: Sanger's sequencing, various NGS platforms.

Unit 5: Bioethics and Biosafety

Bioethics - Definition – Principles of Bio ethics – ethics in animal experimentation, ethical issues related to the use of animal as models for microbial disease. Animal ethical norms in India. Ethical clearance norms for conducting studies on human subjects. Ethical issues related to research in embryonic stem cell cloning. Biosafety – Introduction. Different levels of biosafety. Guidelines for recombinant DNA research activities in microorganisms. Good Laboratory Practices (GLP). Containments – BSL Types. Basic Laboratory and Maximum Containment microbiology Laboratory research. Patenting and Fundamental research.

Text Books:

1. Kothari, C.R.(2013). *Research methodology Methods and Techniques*, New Age International Pvt. Ltd Publishers, New Delhi.
2. Anderson, J., Duros, B.H. and Poole, M. (2011). *Thesis and assignment writing*, Wiley Eastern Ltd., New Delhi.
3. Lesk, A.M. (2009). *Introduction to Bioinformatics*. Oxford.
4. Krane, D.E. Raymer M.L. and Marieb, E.N. (2002). *Fundamental concepts of bioinformatics*. Benjamin Cummings. San Francisco.

Supplementary Books:

1. Lenk, C.Hoppe.L.C, N. and Andorno, R. (2007). *Ethics and Law of Intellectual Property: Current Problems in Politics, Science and Technology*, Ashgate Publisher (P) Ltd.Surrey.
2. Thiele, F. and Ashcroft. R.E. (2005). *Bioethics in a Small World*. Springer. Berlin.

3. Bryant, J. (2005) *Bioethics for Scientists*. John Wiley and Sons. Newton, Massachusetts.
4. *Recombinant DNA safety guidelines*(1990), Department of Biotechnology, Ministry of Science & Technology, Government of India, New Delhi.
5. Sanna, P. and Wright, A.(2013).*Windows 8.1 Absolute Beginner's Guide*. How Que Publishing.Indianapolis
6. *The Internet for Beginners*.(2005). Web Wise Seniors. Inc. Ohio

Course Outcomes (CO)

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

CO1:	Understand the basic concepts of scientific research formulate a hypothesis and design an experiment.
CO2:	Expertise in scientific reading and writing.
CO3:	Understand the basic concepts in bioinformatics.
CO4:	Understand the statistical tools and apply the appropriate tools for data analysis.
CO5:	Gain knowledge about the rules of bioethics and biosafety.

COURSE II: ADVANCES IN MICROBIOLOGY

Learning Objective (LO):

LO	To gain knowledge about microbial physiology and Genetics of microbes, recombinant DNA technology, immunology, immunological techniques and Instruments used in biology.
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UNIT 1: Microbial Physiology

Microbial enzymes: Structure of enzymes. Nomenclature and classification of enzymes. Mechanism of enzyme action, Factors affecting enzyme activity, Inhibition of enzyme activity: Competitive and non-competitive. Biomolecules and their properties carbohydrates, proteins, lipids and nucleic acids. Anaerobic respiration and fermentation. Oxidation and Reduction Processes. Autotrophic Mechanisms in Bacteria. Microbial Stress Responses to different conditions. Methanogenesis. Reproductive physiology of Microorganisms.

UNIT 2: Molecular Biology and Genetic Engineering

DNA as Genetic material, DNA replication, Differences in prokaryotic and eukaryotic DNA replication, Gene expression, Regulation of gene expression, Eukaryotic translational control; Isolation of DNA and RNA – Gene cloning, Molecular diagnostics of genetic disease using PCR . Applications of Genetic Engineering, production of recombinant Hormones , Antisense technology, Safety of rDNA technology, Ethical, Legal, Social and Environmental Issues related to rDNA technology.

UNIT 3: Bioinstrumentation

Microscopy- Bright field, Dark field, phase contrast, Florescence, Polarising Microscope, Electron Microscope – TEM, SEM, Confocal Microscope and Atomic Force Microscope (AFM). Centrifugation - preparative and analytical, ultracentrifugation, density gradient centrifugation. Calorimetry. Biophysical techniques: Principle & application of gel filtration, Ion exchange & hydrophobic interaction chromatography, GC, HPLC, FPLC, Isoelectric-focussing (IEF), 2-D gels, Spectrophotometry, GC-MS, LCMS, NMR, MALDITOF, X-ray crystallography.

UNIT 4: Molecular Techniques

Gel Electrophoresis – Principle, types and applications – Amplified Ribosomal DNA and Restriction Analysis (ARDRA), T-RFLP. Blotting techniques - PCR and its types, applications . Library preparation: Genomic DNA, cDNA, EST and reduced representation

libraries. DNA microarray, DNA sequencing techniques.-Chemical and enzymatic Methods(Sanger Sequencing, NGS,Pyrosequencing).

UNIT 5: Immunology and Immunotechnology

Antigens – Properties . Antigen processing and presentation, MHC Molecules. Antibodies – structure and function, antibody diversity, Monoclonal antibody technology. Antibody engineering. Complement systems. T and B lymphocytes activation and role in humoral and cell-mediated immunity. Immuno prophylaxis and Immunotherapy .Regulation of Immune response. Interleukins, Interferon and Lymphokines. Vaccines - .multiepitope vaccines. Reverse vaccinology. Hypersensitivity and autoimmune diseases. Immunological techniques: ELISA, RIA, Immunofluorescence, RAST, RIST, MLR, Flow cytometry and Fluorescence, FACS and Immunoelectron microscopy.

Text Books:

1. White, D.(2006).*The Physiology and Biochemistry of Prokaryotes*, Oxford University Press.
2. Waksman, S.A.(2011).*Soil Microbiology*. Nabu Press.
3. Kindt, T.J. Goldsby, R.A.. Osborne, B.A. Kuby, J.W.H. (2007). *Immunology*. Freeman.
4. Wilson and Walker. (2000).*Principles and Techniques in Practical Biochemistry*, 5th ed. Cambridge Univ. Press.

Supplementary Books:

1. Moat A.G. Foster J.W. Spector, M.P. (2009). *Microbial Physiology* (4th ed). Wiley.
2. Friedberg, E.C, Walker, G.C. Siede, W. (2006). *DNA repair and mutagenesis*. ASM press.
3. Malavinski, G.M and Freifelder, D. (1998).*Essentials of Molecular biology* 3rd ed. John & Bartlett Publisher.
4. Webster, J.G.(2008). *Bioinstrumentation*, University of Wisconsin, John Wiley & Sons, Inc.
5. Atlas, R. Bartha, M and Richard (1997). *Microbial Ecology*. 4thed. Benjamin Cummings Publishing Company, California.

Course Outcomes (CO)

At the end of this course, students will be able to,

CO1:	Understand the microbial metabolism and mechanism behind the microbial fermentation, respiration, reproduction process.
CO2:	Know about the applications in molecular biology and recombinant DNA technology.
CO3:	Evaluate the various types and applications of Instruments.
CO4:	Understand about applications of Molecular techniques.
CO5:	Get knowledge about the Immunology and Immunotechnology.

COURSE IV: ENVIRONMENTAL MICROBIOLOGY

Learning Objective (LO):

LO	To provide a fundamental knowledge about the various scopes in Environmental studies.
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Unit1: Environment & Ecosystem

Microbial services in greenhouse gases mitigation, natural resource management and restoration ecology. Microbial ecology of greenhouse gas (methane) producing and consuming bacteria from different ecosystems. Impact of different environmental drivers on ecologically beneficial microbial community and their biomass. Beneficial microbial services in wasteland reclamation and restoration of marginal lands. Microbial biomass as soil fertility index of different agriculture and forest ecosystems.

Unit 2: Nitrogen Fixation

Plant Growth Promotory Rhizobacteria and their metabolites. Mechanism of action for biotic and abiotic stress management. Biological Nitrogen Fixation, Biochemistry of nitrogen fixation - nitrogenase, ammonia assimilation and transport, physiological aspects of nitrogen fixation, nodulation - early and late events, molecular biology of nitrogenase activity.

Unit3: Biofertilizers

Biofertilizers - history of biofertilizers, sources of nitrogen and the importance of biofertilizers, description and characteristics of biofertilizers - Rhizobium, Azotobacter, Azospirillum, Blue Green Algae, Azolla, Phosphate solubilizing microorganisms, VAM) Biofertilizer production technology - strain selection, sterilization, growth and fermentation, standards and quality control, biofertilizer application technology, constraints in the commercialization of biofertilizer technology.

Unit 4: Bioremediation & Global Environmental Problems

Microbiology of degradation of xenobiotics in the environment, biomagnifications and degradative plasmids, heavy metals and petroleum compounds, hydrocarbons, Bioremediation of dyes and paper & paper pulp, Oil pollution, surfactants and pesticides.

Ozone depletion, UV-B and acid rain, their impact and biotechnological approaches for management. Microbial leaching. Bio degradable Plastics and super bug. Phycoremediation, Algal technology.

Unit 5 :Sustainable Environment:

Influence of land use change (LUC) on ecosystems services and agro environmental sustainability. Microbial responses to landscape dynamics. Landscape changes on soil N status, climate system, carbon sequestration and GHG problems
 Impact of LU on dynamics of important soil microbiomes. Impact of crop residues burning on soil fertility and agriculturally important microbes.

Text Books:

1. Crawford, R L. and Crawford, D L. (2005). *Bioremediation: Principles and Applications* (Biotechnology Research). Cambridge University Press.
2. Glymph, T. (2005). *Wastewater Microbiology: A Handbook for Operators*. Amer Water Works Assn.
3. Bhattacharyya, B.C. and Banerjee, R.. (2007). *Environmental Biotechnology*. Oxford University Press.
4. Daniel, C.J. (1996) *Environmental Aspects of Microbiology*. Brightsun Publications.

Supplementary Books:

1. Eldowney, Ec. S. Hardman D.J. and Waite S. (2000). *Pollution: Ecology and Biotreatment*. Longman Scientific Technical.
2. Lawrence, P. Wacekett, C. and Hershberger, D. (2001). *Biocatalysis and Biodegradation: Microbial transformation of organic compounds*. ASM Publications.
3. Hurst, C.J. (2007). *A Manual of Environmental Microbiology*. 2nd ed. ASM Publications.

Course Outcomes (CO)

After completion of course students will be able to

CO1:	Demonstrate an understanding of key concepts in ecosystems.
CO2:	Know the microorganisms responsible for Nitrogen fixation.
CO3:	Understand the various assessment techniques of air quality.
CO4:	Describe about different Biofertilizer production.
CO5:	Learn about the global environmental problems.

COURSE IV: INDUSTRIAL AND PHARMACEUTICAL MICROBIOLOGY

Learning Objective (LO):

LO	To know about the industrially important microbial strain development, fermentation process and fermentor used for the production of fermented products from industries and the role of quality control in industrial products.
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Unit 1 : Isolation, Preservation And Strain Development Of Bacteria

History and chronological development of industrial microbiology. Industrially important strains – Isolation, preservation, Lyophilisation. Inoculums development for various fermentation process. Strain development – mutation, recombinant DNA technology and plasmid fusion. Bioreactors-design and components of basic fermentor, specialized fermentors for specific purposes – continuous, anaerobic, for gaseous nutrients, for treatment of wastes, trickle flow reactors, cyclone reactors, submerged types, tube reactors, packed bed reactors, lab scale to pilot to industrial – scale up process, online monitoring.

Unit 2: Fermentation And Fermenting Process

Fermentation – submerged and solid state fermentation – Types of fermentation. Fermentation media – Formulation strategies - Components of CSTR — batch fermentation – continuous fermentation. Economics of a fermentation process, determination of cost and its recovery, costcutting strategies, hygiene and safety in fermentation industries. Downstream processing of industrial fermentation processes-product purification and recovery, -Physico-chemical basis of bio-separation processes, techniques for purification of end products – chromatography, electrophoresis, distillation, crystallization, filtration.

Unit 3: Production Of Fermented Products

Production of beverages – beer and wine – vitamin B12, and Riboflavin – Antibiotic fermentations – production of β lactams (penicillins), semi-synthetic penicillins and cephalosporins, amino-glycosides (streptomycin), macrolids (Erythromycin), quinines. – penicillin – Organic acids – production and applications of citric acid, fumaric acid, lactic acid, benzoic acid, gluconic acid, kojic acid, itaconic acid, and acetic acid. production of enzymes – amylase and proteases and immobilization techniques.

Unit 4: Pharmaceutical Microbiology

Overview of pharmaceutical microbiology - Ecology of microorganisms - Atmosphere, water, skin, respiratory flora of workers, raw materials, packaging, building equipment and their control measures .Clinical uses of antimicrobial drugs, Microbial spoilage and preservation of pharmaceutical products, Sterilization of pharmaceutical products, Applications of microorganism in the pharmaceutical Microbiology.

Unit 5: Quality Control of the Pharmaceutical products

Production of pharmaceutical products and quality assurance – Vaccines, immunodiagnostics, immuno-sera, immunoglobulin. Antibiotics - Penicillin, Griseofulvin, Metronidazole. Enzymes - Streptokinase, Streptodornase. Quality assurance and quality management in pharmaceuticals – In-Process, Final-Product Control and sterility tests. Regulatory aspects - BIS (IS), ISI, ISO, WHO and US certification.

Text Books:

1. Stanbury, P.F., Whittaker, A. and Hall, S.J.(2009). *Principles of fermentation technology*, 2nd ed. Pergamon press.
2. Cassida, J.E.(2007). *Industrial Microbiology*. New Age International.
3. Peppler, H. J. and Pearlman, D. (2009). *Microbial Technology*, Vol 1 and 2. Elsevier press.
4. Hugo and Russell's. (2011). *Pharmaceutical Microbiology* 8th ed. Wiley Blackwell publications.

Supplementary Books:

1. Waites, M.J, Morgan, N.L.Rockey, J.S. and Higton, G. A. (2001). *Industrial Microbiology: An Introduction*, 2nded.Sinavos association, InoSundeland.
2. Presscott and Dunn, S. (2009). *Industrial Microbiology*. Agrobios publishers.
3. Belter, P.A. Cussler, E.L. and Hu, W.S. (2011).*Bio separation.Downstream processing for Biotechnology*, John Wiley and Sons, New York.

Course Outcomes (CO)

At the end of this course, students will be able to,

CO1:	Develop skills associated with screening of industrially important strains.
CO2:	Understand the principles and types of fermentation.
CO3	Describe the role of fermented products
CO4:	Acquire knowledge about production of pharmaceutical products and their quality control.
CO5	Acquire knowledge about quality control of pharmaceutical products

COURSE IV: MEDICAL MICROBIOLOGY

Learning Objective (LO):

LO	To impart a basic knowledge on bacterial, fungal, viral and parasitic infections caused by microorganisms and their preventive measures.
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Unit1: Introduction of Medical Microbiology

History, Koch & River's postulates, Role of Microbiology in Medicine, Normal Microbial flora, Infections and disease –Source, Mode of transmission, etiology & epidemiology of nosocomial infections, Prevention of medically important microbes. Host-microbe interactions. General characteristics, classification and mode of action of antibiotics, Anti fungal, Antiviral and Antiparasitic drugs.

Unit2: Bacterial Diseases

Morphology, cultural, biochemical characterization, pathogenicity, lab diagnosis and treatment of gram positive bacteria –*Staphylococcus aureus*, *Streptococcus pneumoniae*, *Bacillus sp*, *Corynebacterium diphtheriae*, *Clostridium sp*, *Mycobacterium sp*. Gram negative bacteria – *E. coli*, *Salmonella typhi*, *Enterobacteriaceae*, *Neisseria*, *Vibrio cholerae*, *Shigella dysenteriae*, *Proteus spp.*, *P. aeruginosa*, *Campylobacter* and *Helicobacter pylori*.

Unit3: Fungal Diseases

Characteristics and Classification of fungi, Mycotic disease, pathogenesis and diagnosis of – Superficial mycosis: *Pityriasis versicolor*, *Tinea nigra*, Dermatophytoses. Subcutaneous mycosis: Mycetoma, Sporotrichosis. Systemic mycosis: Histoplasmosis, Blastomycosis. Opportunistic mycosis: Candidiasis, Aspergillosis. Immunity to fungal diseases.

Unit 4: Viral Diseases

General characteristics, pathogenesis, lab diagnosis and treatment of viruses: Adenoviruses, Pox viruses, Hepatitis B & C viruses, HIV, Tumor viruses – *Polyoma*, Papilloma viruses, Rabies viruses, Polio virus, Herpes viruses, Influenza viruses (H1N1), Measles and mumps viruses. Emerging viral Diseases - Dengue, Chikungunya virus, Swine flu, Zika virus, Filo viruses (Ebola), Flavi viruses.

Unit 5: Parasitic Diseases

General characteristics and classification of parasites. Life cycle, mode of infection, pathogenesis, transmission, Laboratory diagnosis of Intestinal amoebae - *Entamoeba histolytica*, and *Balantidium coli*. Free living amoebae -*Naegleria fowleri*, *Acanthamoeba* spp. Intestinal and Genital flagellates - *Giardia*, *Trichomonas*. Blood and Tissue flagellates - *Leishmania donovani*, *Trypanosoma cruzi*. Haemosporina - Malarial parasites. Coccidian – *Toxoplasma gondii*, *Cryptosporidium parvum*.

Text Books:

1. Chander, J. (2009). *A text book of Medical mycology*. Interprint, New Delhi.
2. Parija, S.C. (2004). *Text Book of Medical Parasitology – Protozoology and Helminthology*. 2nd ed. All India Publishers and Distributors, Medical Book Publisher, New Delhi.
3. Ananthanarayan. R. and Paniker C.K. (2009). *Text Book of Microbiology*, Orient Longman.
4. Parija S.C. (2013). *Textbook of Medical Parasitology, Protozoology and Helminthology*. 4th ed. All India Publishers and distributors, Medical Book Publisher, New Delhi.

Supplementary Books:

1. Greenwood, D. Slack R.B and Peutherer J.F (2012). *Medical Microbiology*, 18th ed. Churchill Livingstone. London.
2. Norkin, L.C. (2010). *Virology: Molecular Biology and Pathogenesis*. American Society for Microbiology.
3. Morag, C. and Timbury, M.C. (1994). *Medical virology* 10th ed. Churchill Livingstone, London.
4. Prescott, L.M. Harley, J.P. and Klein, D.A. (2003). *Microbiology* 5th ed. McGraw Hill, New York.
5. Murray, P.R. Rosenthal, K.S and Pfaller, M.A. (2016). *Medical Microbiology*. 8th Edition. Elsevier.
6. Jawetz, Melnick, and Adelberg. (2015). *Medical Microbiology*, 23rd ed. Publisher: McGraw-Hill Education. Europe.

Course Outcomes (CO)

At the end of this course, students will be able to,

CO1:	Know about the Infection, Infectious diseases, sources, transmission and role of medicine.
CO2:	Know about a various bacterial diseases.
CO3:	Know about a various fungal diseases and their Diagnosis
CO4:	Know the medically important viral diseases.
CO5:	Understand the pathogenicity of parasitic diseases.

COURSE IV: FOOD & DAIRY MICROBIOLOGY

Learning Objective (LO):

LO	To emphasize the beneficial role of microorganisms in fermented food, contamination, spoilage, preservation of foods and to gain knowledge about food safety and food borne diseases.
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Unit 1: Microbiology Of Food

Food Microbiology - Introduction: Types of microorganisms in food – Sources of contamination (Primary sources) – Factors influencing microbial growth of food (Extrinsic and Intrinsic).

Unit 2: Food Preservation And Quality Control

Study of fermented and process of food: principles of food preservation- methods of preservation. Physical - (Irradiation, drying, heat processing, chilling and freezing, etc.). Chemical - sodium benzoate class I and II, bio preservatives. Food packaging & labeling. Food sanitation. Food laws and quality control – HACCP, Quality assessment, Codex alimentarius, PFA, FPO, MFPO, BIS, AGMARK.

Unit 3: Spoilage Of Foods

General principles underlying food spoilage and contamination. Spoilage and contamination of food – fruits, vegetables, cereals, Sugar products, meat and meat products, milk and milk products, Pasteurization techniques, Study on spoilage organisms in dairy industry, probiotics. Fish and sea foods spoilage. Spoilage of heated and canned foods. Prevention of Spoilage.

Unit 4: Food Borne Diseases And Control Measures

Food borne disease: Identification of Foodborne disease. Food poisoning – Food ingestion & Food intoxications. Microbial - (a) Bacterial: *Staphylococcus aureus*, *Brucella spp.*, *Bacillus spp.*, *Clostridium tetani*, *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*. (b) Non Bacterial - fungal: Mycotoxins, including aflatoxins. Viral – Hepatitis. Parasitical - Protozoa – Amoebiasis. (c) Non Microbial– Food toxins – Sea food toxicants. Culture and non-culture based detection of food pathogens and viruses. General methods for diagnosis of infections, intoxications and preventive measures.

Unit 5: Fermented Food Products

Fermentation- types, Fermentor types, Downstream processing, Fermented milk products – Butter, Butter milk, Sour cream, Yoghurt, Cheese, Kefir, Kumis, Milk borne diseases, Quality Control of Milk – MBRT, Phosphatase test, Rezasurin test, Starter cultures for fermented dairy products (*Streptococcus thermophilus*, *Lactobacillus bulgaricus*), Cheese

production. Fermented Vegetables. Production and applications of baker's yeast. Genetically modified foods. Biosensors in food. Application of microbial enzymes in food industry.

Text Books:

1. Frazier, W.C and Westhoff D.C.(2013). *Food Microbiology*. TATA McGraw Hill Publishing Company Ltd. New Delhi.
2. Adams, M.R. and M.O Moss. (2008). *Food Microbiology*. The Royal Society of Chemistry. Cambridge.

Supplementary Books

1. Doyle, M.P. (2005). *Handbook of Hygiene Control in the Food Industry*. 1st ed. Woodhead Publishing.
2. Jay, J.M. (2013). *Modern Food Microbiology*. 7thEdn. CBS Publishers and Distributors, New Delhi.
3. Robinson, R. K. (2002). *Dairy microbiology hand book*. 3rd ed. Chichester: Wiley. New York.

Course Outcomes (CO)

At the end of this course, students will be able to,

CO1:	Understand the types of microorganisms in food.
CO2:	Demonstrate food preservation methods.
CO3:	Acquire knowledge about contaminations and spoilage of various food products.
CO4:	Explain food borne diseases.
CO5:	Demonstrate food preservation methods. Gain knowledge about fermented food.