Annamalai University

Syllabi-2020-21

Ph.D MICROBIOLOGY

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.

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.

Unit – 1: Scientific Research And Scientific Writing

Research Methodology – Introduction, importance, identification of research areas, Hypotheses, Review of Literature - primary and secondary sources (Library, research databases, web as a source) - Review and synopsis presentation. Research process, Research design and experimentation - Preparation of research report. Scientific documents – research paper, review paper, book reviews, theses (Abstract, Literature review, materials and methods, Discussion, Effective illustration - tables and figures. Reference styles - Harvard and Vancouver systems), references/ bibliography, project reports. Guidelines for preparing an article - ISSN, ISBN, impact factor, citation index, downloading index, h-index, i-index, Google scholar, Scopus, Thomson & Reuters, Web of Science and Science Citation Index (SCI) of Web of Science (WOS). Plagiarism and its software's.

Unit – 2: Biostatistics

Collection and classification of data - diagrammatic and graphic representation of data. Measurement of central tendency - Mean, Median, Mode, standard deviation - normal distribution - test of significance based on large samples. Student *t* test. Correlation and regression - *Chi* square test for independence of attributes - ANOVA. Finding scientific articles – Pub med. Outline of SPSS and 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

The scope of bioinformatics. Use of internet, useful search engines – the entrez system, file formats. Biological database Sequence and structure, NCBI, data retrieval. Searching sequence database. Sequence similarity searches. Database search – FASTA and BLAST, protein multiple sequence alignments. Molecular phylogenetics – Phylogenetic tree construction methods, software programmes and analysis.

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 – 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., Durosn, 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 II: ADVANCES IN MICROBIOLOGY - I

Learning Objective (LO):

LO	To gain in depth knowledge about the applied areas of microbiology and role of microorganisms in the respective fields.

Course Outcomes (CO)

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

CO1:	Understand the Soil microorganisms involved in bio geochemical cycles, ecosystem and biodegradation process.
CO2:	Know about the Environmental pollutions and control measures.
CO3:	Acquire knowledge about fermented food production.
CO4:	Know about medically important organisms and their Diagnosis.

Unit – 1: Soil Microbiology

Broad significance of soil Microorganisms – Characteristics and role of soil Microorganisms in soil fertility – Enzymes of soil microorganisms – Microbial Biochemistry – Plant – Soil Microorganisms interactions – Factors affecting the activities of soil microorganisms. Rhizosphere and Rhizosphere Engineering. Organic farming. Contribution of Microbial ecosystems in Biogeochemical cycles: transformation, fixation and mobilization of soil nutrients. Strengthening of below ground diversity - R:S ratio. Microbial degradation in soil.

Unit – 2: Environmental Microbiology

Concept & Scope of Environmental Microbiology – soil pollution – water pollution – Air pollution & assessment of air quality – Oil pollution- Biomining of metals – Solid wastes Management. Microbial control of environmental pollution and Bio remediation– Microbial degradation of Xenobiotics. Bioleaching. Environmental laws, Biological warfare.

Unit – 3: Food Microbiology

Food micro flora - spoilage organisms - Food poisoning (Bacterial, viral, Fungal, Parasitical) Non microbial - Intoxication and infection – Sea food toxicants - Food Hygiene, Sanitation and control, Quality management in food industries, Food control agencies, Trade and its regulations - Fermented foods and dairy products – SCP - Beverages. Microbial enzymes for food production. Genetically modified foods.

Unit – 4: Industrial Microbiology:

Concept and scope of industrial Microbiology – Strain improvement; Bioreactors – types, design and functional characteristics. Scale up of fermentations. Production of microbial inoculants, Principles of immobilization – different kinds of immobilization techniques and their uses in industries. Intellectual Property Rights (IPR) Patents, Trademark, copyright, Design registration and know- how – patent system India – patenting microorganisms and microbial products.

Unit – 5: Medical Microbiology:

Diagnostic Microbiology - General methods for isolation and identification of bacteria - typing of bacterial isolates – Lab diagnosis of viral diseases – Cytology, EM, viral Isolation and growth (Cell culture) - Viral serology. Diagnosis of Fungal infections. Laboratory diagnosis of parasitic and Helminthic infections. Antimicrobials – General characters and drug resistance – antiviral, antifungal and anti- parasitic drugs. Molecular diagnostic technology.

Text Books:

1. Elasas, D.J. Trevors,V.J.T., Wellington, E.M.H. (2006). *Modern Soil Microbiology*, Marcel Dekker INC, New York, Hong Kong.
2. Frazier, W.C and Westhoff D.C (2013). *Food Microbiology*. TATA McGraw Hill Publishing Company Ltd. New Delhi.
3. Cassida, J.E. (2007). *Industrial Microbiology*, New Age International.
4. Murray, P.R.. Rosenthal, K.S and Pfaller, M.A. (2016). *Medical Microbiology* 8th Edition Elsevier.

Supplementary Books:

1. Mishra R.R. (2004). *Soil Microbiology*. CBS Publishers & Distributors., New Delhi.
2. Stanbury, P.F., Whittaker, A. and Hall, S.J. (2009). *Principles of fermentation technology*, 2nd edition, Pergamon press.
3. Jay, J.M. (2013). *Modern Food Microbiology*. 7th Edn. CBS Publishers and Distributors, New Delhi.
4. Asthana D.K. and Asthana. M. (2005). *Environment: Problems and Solutions*, S.Chand and Company Ltd., New Delhi.
5. Collee, G. J and Simmons. A. (2000). *Practical Medical Microbiology*. Longman Singapore (P) Ltd, Singapore.
6. Greenwood, D. Slack R.B and Peutherer J.F (2012). *Medical Microbiology*, 18th Edn Churchill Livingstone, London.

COURSE III: ADVANCES IN MICROBIOLOGY – II

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.

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:	Get knowledge about the Immunology and Immunotechnology.

UNIT – 1: Microbial Physiology

Microbial Energetic, Microbial enzymes, Metabolism of Carbohydrate, Alternate pathways of Carbohydrate Metabolism, Gluconeogenesis, Utilization of sugars other than glucose, Lipid metabolism, Nitrogen metabolism, Nucleic acid metabolism, Photosynthetic bacteria, Anabolic and catabolic processes of Lipids, 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 in prokaryotes, eukaryotes and bacteriophages, Gene silencing, Importance of gene cloning and future perspectives, Enzymes in genetic engineering, Cloning vectors, Bacteriophages, Transposon. Applications of Genetic Engineering, production of recombinant Hormones (Insulin, HGH, and Factor VIII), Antisense technology, Safety of rDNA technology, Ethical, Legal, Social and Environmental Issues related to rDNA technology. Genetically engineered Microorganisms. Transgenic technology.

UNIT – 3: Bioinstrumentation - I

Volumetric analysis **–** Strength of Chemicals and its calculations related to usage. 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, ultra - centrifugation, density gradient centrifugation. Calorimetry.

UNIT – 4: Bioinstrumentation - II

Spectroscopy - Spectroscopic methods – UV - Visible spectrophotometer, Flame photometry, Biosensor. Atomic absorption spectrophotometer, NMR, Mass spectrometry, MALDI -TOF, Nano- LC, IR spectrum, X-ray crystallography, FTIR. Chromatography and its types, Electrophoresis – Principle, types and applications – PAGE, SDS-PAGE, Agarose, Pulsed Field Gel Electrophoresis (PFGE), Two dimensional electrophoresis, DGGE, TGGE and T-RFLP. Blotting techniques - Southern, Northern, Western and Dot blotting & hybridization. Polymerase Chain Reaction – principles, types and applications, Single locus and multilocus DNA fingerprinting, PCR based DNA fingerprinting - RAPD, AFLP, STRR and LTRR analysis.

UNIT – 5: Immunology And Immunotechnology

Antigens and Antibodies, Antigen processing and presentation, MHC molecules. Antibodies – structure and function, antibody diversity, Complement systems, Monoclonal antibodies and its clinical applications. Immunity - Innate immunity, Acquired immunity, Humoral or antibody mediated immunity and Cell mediated immunity. Transplantation immunity. Auto immune diseases, Immunological disorders: Hypersensitivity Type I to Type IV, AIDS. Tumor immunology.

Antigen and Antibody reactions - Agglutination, Immuno diffusion, Widal, VDRL, RPR, ASO, CRP test, Precipitation, Latex Agglutination Test, CFT, ELISA and its types, RIA, CLIA.

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.* 4th ed. Benjamin Cummings Publishing Company, California.

COURSE IV: ENVIRONMENTAL MICROBIOLOGY

Learning Objective (LO):

LO	To provide a fundamental knowledge about the various scopes in Environmental studies.

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 water pollution.
CO3:	Understand the various assessment techniques of air quality.
CO4:	Describe about different sewage treatment methods employed in waste water treatment.
CO5:	Learn about the global environmental problems.

Unit – 1: Environment and Ecosystems

Definitions, biotic and abiotic environment. Environmental segments. Composition and structure of environment. Concept of biosphere, communities and ecosystems. Ecosystem characteristics structure and function. Food chains, food webs and tropic structures. Ecological pyramids.

Unit – 2: Eutrophication

Water pollution and its control: Need for water management. Sources of water pollution. Measurement of water pollution, Eutrophication: Definition, causes of eutrophication, and microbial changes in eutrophic bodies of water induced by various inorganic pollutants. Qualitative characteristics and properties of eutrophic lakes. Algae in eutrophication, algal blooms, their effects and toxicity, coloured waters, red tides, and cultural eutrophication. Physico- chemical and biological measures to control Eutrophication.

Unit – 3: Aerobiology

Droplet nuclei, aerosol, assessment of air quality, - solid – liquid – impingment methods – Brief account of air borne transmission of microbes – viruses – bacteria and fungi, their diseases and preventive measures.

Unit – 4: Waste Treatment Techniques

Wastes – types – solid and liquid wastes characterization – solid – liquid; treatments – physical, chemical, biological – aerobic – anaerobic – primary – secondary – tertiary; solid waste treatment – saccharification – gasification – composting, liquid waste treatment –

trickling – activated sludge – oxidation pond – oxidation ditch. Utilization of solid wastes – food (SCP, mushroom, yeast): fuel (ethanol, methane) fertilizer (composting).

Unit – 5: Bioremediation & Global Environmental Problems

Microbiology of degradation of xenobiotics in the environment, biomagnifications and degradative plasmids, heavy metals and petroleum compounds, hydrocarbons, Bio remediation of dyes and paper & paper pulp, Oil pollution, surfactants and pesticides. Ozone depletion, UV-B, green house effect and acid rain, their impact and biotechnological approaches for management. Microbial leaching. Bio degradable Plastics and super bug. Phycoremediation, Algal technology.

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 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.

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 of fermentor design and types of fermentation.
CO3:	Acquire knowledge about production of pharmaceutical products and their quality control.

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.

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. Downstream process – intracellular and extracellular product separation. Liquid extraction, Precipitation and floatation. Immobilization and its applications.

Unit – 3: Production Of Fermented Products

Fermentor design – body construction and types of fermentors (Tower, cylindro conical and airlift) – mass transfer – oxygen transfer – effect of viscosity – scale-up process. Production of beverages – beer and wine – vitamin B12, and Riboflavin – antibiotics – penicillin and streptomycin – production of enzymes – amylase and proteases and immobilization techniques.

Unit – 4: Pharmaceutical Microbiology

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

Role of precursors and steering agents in production of antibiotics, vitamins and enzymes. Antiseptics - disinfectants their standardization and Quality control of Pharmaceutical products – Injectables, IV fluids and pyrogen testing.

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*, 2nd ed. Sinavos association, Ino Sundeland.
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 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.

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 and fungal diseases.
CO3:	Know the medically important viral and parasitic diseases.

Unit – 1: 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.

Unit – 2: 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.*

Unit – 3: Fungal Diseases

Characteristics and Classification of fungi, Mycotic disease, pathogenesis and diagnosis of – Superficial mycosis: *Pityriasis versicolor*, *Tinea nigra*, Dermatophytoses. Subcutaneous mycosis: Mycetoma, Sporotrychosis. 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, Chickungunya 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 gondi*, *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 Livingston, 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 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.

Course Outcomes (CO)

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

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

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, 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, Study on spoilage organisms in dairy industry, probiotics. Fish and sea foods spoilage. Spoilage of heated and canned foods.

Unit – 4: Food Borne Diseases And Control Measures

Food borne 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

Fermented milk products – Butter, Butter milk, Sour cream, Youghurt, Cheese, Kefir, Kumis, Milk borne diseases, Quality Control of Milk – MBRT, Phosphotase 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*. 7th Edn. CBS Publishers and Distributors, New Delhi.
3. Robinson, R. K. (2002). *Dairy microbiology hand book*. 3rd ed. Chichester: Wiley. New York.