

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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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: Basic concepts of research

Definition of Research, Qualities of Researcher, Components of Research Problem, Various Steps in Scientific Research, Formulation of hypothesis - types and characteristics. Designing research work.

Unit – 2: Scientific writing

Scientific writing - characteristics. Logical format for writing thesis and papers. Essential features of abstract, introduction, Literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research database, development of working hypothesis. materials and methods and discussion. Effective illustration - tables and figures. Reference styles - Harvard and Vancouver systems.

Unit – 3: Bioinformatics

The scope of bioinformatics. Use of internet, World Wide Web. useful search engines – the Entrez system, file formats. Finding scientific articles - Pubmed – public biological databases. Biological database- Types, Sequence and structure, NCBI, data retrieval. Multiple sequence alignments, Genbank – sequence queries against biological databases. Searching sequence database: Database search – FASTA and BLAST, Phylogenetic alignment – profiles and motifs. Protein multiple sequence alignments. Classification of protein structures. Protein structure prediction – Secondary, Tertiary structure prediction. Molecular docking.

Unit – 4: 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 - Pubmed. Outline of SPSS and Mathematica.

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.

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 – 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.
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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 - Characteristic of soil Microorganisms – Enzymes of soil microorganisms – Microbial Biochemistry – Plant – Soil Microorganisms interactions – Factors affecting the activities of soil microorganisms – Microbial degradation in soil.

Unit – 2: Environmental Microbiology

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

Unit – 3: Food Microbiology

Food micro flora - spoilage organisms - Food poisoning - Intoxication and infection - Quality management in food industries - Fermented foods - SCP. Microbial enzymes - 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, Virus, Fungi and Parasites - Antimicrobials - General characters and drug resistance – MDR, XDR, MRSA, antiviral, antifungal and antiparasitic drugs. Molecular diagnostic technology.

Text Books:

1. Elsas, 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 Tenover, 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: ENVIRONMENTAL MICROBIOLOGY

Learning Objective (LO):

LO	To provide a fundamental knowledge about the various scopes in Environmental studies.
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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 trophic 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 – impingement 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 III: 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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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, Lyophilization. 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, cylindrical 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. Pepler, 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. Prescott 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 III: 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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Course Outcomes (CO)

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

CO1:	Gain Knowledge 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*, *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, 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 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 III: 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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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. Paracitical - 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.