

## The New National Education Policy (NEP), 2020

**Syllabus B. Sc. Microbiology**  
(Pursuant to inclusion as major subjects/ disciplines)

## GENERAL COURSE OUTLINE

Semester	Course Type 1	Course Type 2	Course Type 3	Total
I.	4 + 2 Credits Fundamentals of Microbiology			6 Credits
II.	4 + 2 Credits Microbiological Techniques			6 Credits
III.	4 + 2 Credits Cell Biology and Biochemistry			6 Credits
IV.	3 + 1 Credits Microbial Diversity and Ecology	4 + 2 Credits Immunology	4 + 2 Credits Instrumentation and Bio-techniques	16 Credits
V.	3 + 1 Credits Bacteriology	4 + 2 Credits Microbial Genetics and Genomics	4 + 2 Credits Mycology and Phycology	16 Credits
VI.	3 + 1 Credits Virology	4 + 2 Credits Microbial Physiology and Metabolism	4 + 2 Credits Molecular Microbiology And Recombinant DNA Technology	16 Credits
VII.	3 + 1 Credits Industrial and Pharmaceutical Microbiology	4 + 2 Credits Food and Dairy Microbiology	4 + 2 Credits Biostatistics and Bioinformatics	16 Credits
VIII.	3 + 1 Credits Environmental and Agricultural Microbiology	4 + 2 Credits Medical Microbiology	4 + 2 Credits Microorganisms and IPR	16 Credits
<b>Total</b>	<b>38 Credits</b>	<b>30 Credits</b>	<b>30 Credits</b>	<b>98 Credits</b>

## Research mode

VII	3 + 1 Credits Industrial and Pharmaceutical Microbiology	6 Credits Research Methodology	4 + 2 Credits Biostatistics and Bioinformatics	16 Credits
VIII	3 + 1 Credits Environmental and Agricultural Microbiology	12 Credits Research project		16 Credits
<b>Total</b>	<b>8 Credits</b>	<b>24 Credits</b>		<b>32 Credits</b>

**Course Description: Seventh Semester****Course Type: 1****Course Type: Major/Minor****Course Title: Industrial and Pharmaceutical Microbiology****Course credits: 3 + 1****Course code: MIC-24-701-CT1****Course Objectives:**

- To acquaint students with the various aspects of industrial microbiology, different types of fermentation processes, fermenters designs and operations
- To familiar with mass scale culturing of microorganisms for industrial production of various biomolecules and /metabolites of industrial interest and different recovery methods in detail

**Credit-I: Industrial Microbiology**

- 1.1 Brief history and developments in industrial microbiology
- 1.2 Overview of industrially important microorganisms and their characteristics
- 1.3 Fermenter-design, Types of fermenters
- 1.4 Media formation, sterilization, inoculum development for industrial fermentation.
- 1.5 Types of fermentation Process –solid state and liquid fermentation –batch, fed batch and continuous fermentation

**Credit-II: Microbial Production of Industrial Products**

- 2.1 Industrial production of Antibiotics (Penicillin and Streptomycin)
- 2.2 Industrial production of Alcoholic beverages (Beer and Wine)
- 2.3 Industrial production of Enzymes (Amylase and Cellulase)
- 2.4 Industrial production of Organic acids (Citric acid and Acetic acid)
- 2.5 Downstream processing: Cell disruption, Filtration, Centrifugation, Solvent extraction, Precipitation and Ultrafiltration

**Credit III: Pharmaceutical Microbiology**

- 3.1 History and scope of pharmaceutical microbiology
- 3.2 Classification and mode of action of disinfectants; factors influencing disinfection
- 3.3 Sterility testing pharmaceutical of products, Designing of aseptic areas.
- 3.4 Microbial limit testing of pharmaceutical products
- 3.5 Methods for standardization of antibiotics, vitamins and amino acids

**Credit-IV: Practical**

- 4.1 Microbial fermentation for the production of Enzyme (Amylase)
- 4.2 Microbial fermentation for the production of Organic acid (Citric acid)
- 4.3 Microbial fermentation for the production of Antibiotic (Penicillin)
- 4.4 Microbial limit testing of syrup and capsules
- 4.5 Microbiological assay of antibiotics by cup plate method

**Note: Those experiments which can't be performed in laboratory, should be conducted via Virtual lab**

**Learning outcome**

- Students will learn about the different types of fermentation processes, equipments used and microbiological processes involved.
- Students will have gained in-depth knowledge of the principles of microbial production and recovery of industrial products at large scale.

**Recommended Books:**

1. Principles of Fermentation Technology by P.F. Stanbury, W. Whitaker & S.J. Hall, Elsevier 3<sup>rd</sup> Edition 2016.
2. Modern Industrial Microbiology and Biotechnology by N. Okafor and B.C. Okeke 2<sup>nd</sup> Edition 2017.
3. Biotechnology: A Textbook of Industrial Microbiology by W. Crueger, A. Crueger and K.R. Aneja 3<sup>rd</sup> Edition 2017.
4. Russell and Ayliffe, G.A.J(1982) Principles and practice of Disinfection, preservation and sterilization 5<sup>th</sup> Edition 2013
5. Hugo, W.B., Russell, A.D, pharmaceutical Microbiology 4<sup>th</sup> edition. Blackwell scientific publications 8<sup>th</sup> Edition 2013

**Course Description: Seventh Semester****Course Type: 2****Course Type: Major/Minor****Course Title: Food and Dairy Microbiology****Course Credits: 4 + 2****Course Code: MIC-24-701-CT2****Course Objectives:**

- To impart knowledge about the microbiological examination of food, food products and methods of food preservation
- to familiarize the students about diseases caused by different types of microorganisms in foods, production of different types of fermented foods, quality control and measurements of different types of quality standards

**Credit-I: Microbial Spoilage and Preservation**

- 1.1. Historical perspective of food microbiology
- 1.2. Intrinsic and extrinsic factors that affect growth and survival of microbes, source of contamination of foods
- 1.3. Normal Microflora of foods: Vegetables, fruits and meat
- 1.4. Microbial spoilage: Fruits, vegetables and canned foods
- 1.5. Methods of food preservation (Physical, chemical and Biological)

**Credit-II: Food borne Pathogens and Diseases**

- 2.1. General characteristics of Food borne bacterial pathogens: *Listeria*, *Brucella*, *Staphylococcus*, *Clostridium*
- 2.2. General characteristics of Food borne fungal pathogens: *Aspergillus*, *Penicillium*, *Rhizopus*
- 2.3. General characteristics of Food borne viral pathogens: Norwalk virus, hepatitis A virus, hepatitis E virus and rotavirus
- 2.4. Food borne infections and intoxications: Salmonellosis, Shigellosis, Mycotoxicosis
- 2.5. Quality check of food products: Microbial limit testing, PCR, q PCR

**Credit-III: Fermented Foods**

- 3.1. Dairy starter cultures
- 3.2. Production of Fermented dairy products: yogurt, cheese, kumiss, kefir and ice-cream
- 3.3. Production of Other fermented foods: dosa, sauerkraut and soy sauce
- 3.4. Probiotics and their health benefits
- 3.5. Types of microorganisms used in probiotics, probiotic foods available in market

**Credit-IV: Quality Control and Food Standards**

- 4.1. Indices of food sanitary quality and sanitizers
- 4.2. Quality control and quality assurance
- 4.3. Hazard Analysis and Critical Control point (HACCP): It principles and applications
- 4.4. United States Food and Drug Administration (USFDA) and Food Safety and Standards Authority of India (FSSAI): Objectives and applications; Concept of ISO-9000 and ISO-22000
- 4.5. Methods of microbiological quality examination of milk and milk products

**Credit-V: Practical-I**

- 5.1. Isolation of bacteria from spoiled vegetables
- 5.2. Isolation of fungi from spoiled vegetables
- 5.3. Standard plate count of spoiled vegetable samples
- 5.4. Isolation of lactic acid bacteria from curd
- 5.5. Morphological analysis of lactic acid bacteria (Simple stain and gram stain)

**Credit-VI: Practical-II**

- 6.1. Preparation of Yogurt/Dahi
- 6.2. Assessment of quality of raw milk by methylene blue dye reduction test
- 6.3. Standard plate count of raw milk
- 6.4. Determination of bacterial growth in milk by turbidity measurements
- 6.4. Alkaline phosphatase test to check the efficiency of pasteurization of milk

**Note: Those experiments which can't be performed in laboratory, should be conducted via Virtual lab**

**Learning outcome:**

- Students will know the causes of food spoilage and mechanism of food preservation
- Students will learn about diseases caused by different types of microorganisms, fermented foods and different types of quality measurements

**Recommended Books**

1. Food Microbiology 5<sup>th</sup> Edition by Frazier and Westhoff, TaTa McGraw Hill, 2017
2. Food Microbiology: Fundamentals and Frontiers 5<sup>th</sup> Edition by Doyel et.al. ASM Press, 2019
3. Basic Food Microbiology by Banwart G.J., CBS Publishers & Distributors, 2004
4. Modern Food Microbiology by Jay et.al. Springer India Ltd, 2004
5. Tortora GJ, Funke BR, and Case CL. Microbiology: An Introduction. 13<sup>th</sup> edition. Pearson Education, 2018

**Course Description: Seventh Semester**

**Course Type: 3**

**Course Type: Major/Minor**

**Course Title: Biostatistics and Bioinformatics**

**Course Credits: 4+2**

**Course Code: MIC-24-701-CT3**

**Course Objectives**

- To teach the basic principles of statistics, tools and techniques
- To Identify and discuss the concepts and procedures of sampling, data collection, analysis.
- To familiarize the student's comprehensive information about various bioinformatics tools
- To familiarize the student's comprehensive information about the applications of bioinformatics tools

**Credit-I: Biostatistics-I**

- 1.1 Biostatistics- scope and significance
- 1.2 Collection of data, sampling and sampling types
- 1.3 Classification of data.
- 1.4 Diagrammatic and graphical representation of data; bar diagrams, pie diagrams
- 1.5 frequency distributions curves

**Credit II: Biostatistics-II**

- 2.1. Measures of central tendency, mean, median, mode
- 2.2. Basic idea about regression and correlation analysis, correlation coefficient
- 2.3. Deviations-Mean Deviation, Standard Deviation
- 2.4. Tests of statistical significance - t-test, z-test, F-test
- 2.5. ANOVA

**Credit-III: Computer fundamentals and databases**

- 3.1. Introduction to Computer Fundamentals
- 3.2. RDBMS-Definition of relational databases.
- 3.3. Mode of data transfer (FTP, SFTP, SCP)
- 3.4. Advantage of encrypted data transfer.
- 3.5. Biological databases - nucleic acid, genome, protein sequence and structure,

**Credit- IV: File Formats and Data submission and retrieval**

- 4.1. File formats -FASTA.
- 4.2. Genbank and Uniprot.
- 4.3. Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB.
- 4.4. Local and Global Sequence alignment, pairwise and multiple sequence alignment.
- 4.5. Phylogenetic trees- construction and their significance

#### **Credit-V: Practical- I**

- 5.1 Collection of data, sampling designs, tabulation and graphic representation using biological data.
- 5.2 To calculate Mean, Mode, Median, Co-efficient of variance using biological materials.
- 5.3 Standard error and standard deviation.
- 5.4 Data Analysis using Excel, SPSS
- 5.5. 't' Test, chi square, statistical error, standard deviation also, to be practically done through SPSS Programme (Statistical Package for Social Sciences)

#### **Credit-VI: Practical- II**

- 6.1. Introduction to different operating systems - UNIX, LINUX and Windows
- 6.2. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot
- 6.3. Sequence retrieval using BLAST.
- 6.4. Sequence alignment & phylogenetic analysis using clustal W & phylip
- 6.5. Primer designing

**Note: Those experiments which can't be performed in laboratory, should be conducted via Virtual lab.**

#### **Learning outcome:**

- Students learn basics of statistics.
- Make the students capable of designing their experiments, predict, interpret and conclude on the basis of statistical analysis.
- Students will get knowledge about bioinformatics tools and their utility in biological science
- They will acquire knowledge about the significance of various bioinformatics topics

#### **Recommended Books**

1. Balaji, K. Raghavaiaha A.V.S. and Jayaveera, K.N. 2020. Biostatistics, Wiley Publication, Hoboken, New Jersey, United States
2. Bernard Rosner. 2010. Fundamentals of Biostatistics, 7<sup>th</sup> edition, Cengage Learning, USA.
3. Beth Dawson Robert G. Trapp Beth Dawson Robert Trapp, 2004. Basic and Clinical Biostatistics (LANGE Basic Science), McGraw-Hill, New York.
4. Pradeep and Sinha Preeti (2007) Foundations of Computing, 4th ed., BPB Publications.
5. Lesk M.A. (2008) Introduction to Bioinformatics. Oxford Publication, 3rd International Student Edition.

**Course Description: Eighth Semester****Course Type: 1****Course Type: Major/Minor****Course Title: Environmental and Agricultural Microbiology****Course Credits: 3+1****Course Code: MIC-24-801-CT1****Course Objectives:**

- To familiarize the students with history and habitats of microbes.
- To familiarize the students with comprehensive information about bioremediation and bioleaching
- To familiarize the students with comprehensive information about the applications of microbes in organic agriculture.

**Credit-1: History and habitat of microbial world**

- 1.1. History and development of environmental microbiology.
- 1.2. Microorganisms of soil
- 1.3. Microorganisms of water
- 1.4. Microorganisms of air
- 1.5. Microorganisms of humans and ruminants

**Credit II: Microbial Interactions and biogeochemical cycles**

- 2.1. Microbial Interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation
- 2.2. Microbe-Plant interaction: Symbiotic and non-symbiotic interactions
- 2.3. Biogeochemical Cycling: Nitrogen, phosphorus, and sulfur cycle
- 2.4. Microbial degradation of cellulose, hemicelluloses, lignin and chitin
- 2.5. Concept of bioremediation, and bioleaching

**Credit III: Microbes in Agriculture**

- 3.1. History and scope of agricultural microbiology
- 3.2. Biological nitrogen fixation: Biochemistry and genetics, Nitrogen fixing bacteria with reference to *Rhizobium*, *Azotobacter*
- 3.3. Mycorrhizal biofertilizers-types, field application and ecological significance
- 3.4. Plant growth promoting rhizobacteria (PGPR)
- 3.5. Biological control agents with reference to *Pseudomonas* and *Trichoderma*

**Credit IV: Practical**

- 4.1. Demonstration of presence of microflora in the environment by exposing nutrient agar/PDA plates to air
- 4.2. Isolation of bacteria from industrial sites
- 4.3. Isolation of bacteria from earth worm gut.
- 4.4. Isolation of *Rhizobium* from root Nodules-Peas
- 4.5. To perform isolation of Phosphate solubilizing bacteria on Pikovskaya agar (on plate assay).

**Note: Those experiments which can't be performed in laboratory, should be conducted via Virtual lab.****Learning outcome:**

- Students will get knowledge about microbial ecology and their utility in environment
- They will acquire knowledge about the significance of microbial world in agriculture.

**Recommended Books**

1. Mitchell, R., & Gu, J. D. (Eds.). (2010). *Environmental microbiology*. John Wiley & Sons.
2. Bagyaraj, D. J., & Rangaswami, G. (2007). *Agricultural microbiology*. PHI Learning Pvt. Ltd.
3. Brock Biology of Microorganisms by Madigan and Martinko, 14th edition, Pearson Education International.
4. Prescott's Microbiology by Joanne Willey, Linda Sherwood and Christopher J. Woolverton, 11th edition, McGraw Hill Publisher Companies, Inc edition, Cambridge University Press.
5. Environmental Microbiology (3rd Edition). This book provides insights into microbial interactions in natural environments, including soil, water, and air.

**Course Description: Eighth Semester****Course Type: 2****Course type: Major/Minor****Course title: Medical Microbiology****Course credits: 4 + 2****Course code: MIC-24-801-CT2****Course Objectives:**

- To familiarize the students about impact of microorganisms on human health
- To familiarize the students about etiology of different bacterial, fungal, parasitic and viral human pathogens and diseases
- To familiarize the students about basic and advanced information on specimen collection and microbiological diagnostic methods of different pathogens

**Credit-I: Introduction to Medical Microbiology**

- 1.1. Introduction and historical perspective of medical microbiology
- 1.2. Human Normal microflora and its significance
- 1.3. Recommendation for collection, transportation and storage of clinical specimen
- 1.4. Host pathogen interactions, Virulence and Pathogenicity
- 1.5. Infection Prevention Control (IPC)

**Credit-II: Medical Bacteriology**

- 2.1. General characteristics, mode of transmission and diagnosis of medically important bacterial respiratory diseases:  
Tuberculosis and Staphylococcus-Pneumonia
- 2.2. General characteristics, mode of transmission and diagnosis of medically important bacterial gastrointestinal diseases:  
Gastric Ulcer (*H. Pylori*) and Cholera
- 2.3. General characteristics and clinical importance of medically important bacterial pathogens (skin and soft tissue):  
*Staphylococcus* and *Streptococcus*
- 2.4. General concept: Mycoplasma, Chlamydia, Nosocomial infections and Zoonosis
- 2.5. Antibacterial drugs, mechanism of action. Antibiotic resistance (General overview)

**Credit-III: Medical Mycology and Protozoology**

- 3.1. General characteristics, mode of transmission and diagnosis of Opportunistic mycoses: Aspergillosis and Cryptococcosis
- 3.2. General characteristics, mode of transmission and diagnosis of Systemic mycoses: Histoplasmosis and Blastomycosis
- 3.3. Fungal intoxication. Antifungal drugs and their classification
- 3.4. General characteristics and mode of transmission of important protozoan parasites: *Entamoeba*, *Leishmania* and *Giardia*
- 3.5. Antiprotozoal drugs

**Credit-IV: Medical Virology**

- 4.1. General characteristics, mode of transmission and diagnosis of medically important viral pathogens: Hepatitis B virus and Herpes simplex virus (DNA viruses)
- 4.2. General characteristics, mode of transmission and diagnosis of medically important viral pathogens: SARS-CoV-2 and AIDS (RNA viruses)
- 4.3. General characteristics, mode of transmission, pathogenesis and diagnosis of emergent viral diseases: Ebola *virus* disease (EVD), Zika virus disease
- 4.4. Antiviral drugs, classification and mode of action
- 4.5. Recent novel molecular and serological diagnostic approaches for virus detection

**Credit-V: Practical I**

- 5.1. Recommendation for collection, transportation and storage of clinical specimens
- 5.2. Study clinically important media their preparation and application: Eosin-methylene Blue Agar, Chocolate Agar, Blood Agar, Mannitol Salt Agar, Thiosulfate Citrate Bile Salts Sucrose Agar, XLD
- 5.3. Perform IMViC tests for biochemical characterization of bacterial pathogens

- 5.4. Study of bacterial flora of skin by swab method
- 5.5. Finger DAB test for hygiene testing

#### **Credit-VI: Practical II**

- 6.1. Demonstration of protozoan parasites *Entamoeba* and *Leishmania* with charts /audio-visuals
- 6.2. Perform anti-fungal sensitivity test by Kirby-Bauer method and determination of MIC
- 6.3. Microscopic examination of human fungal pathogen from skin sample (Nail/skin)
- 6.4. Demonstration of human viral pathogens Ebola and Zika with charts /audio-visuals
- 6.5. Perform rapid antigen tests (RAT) for detection of SARS-CoV-2 infection (COVID-19)

**Note: Those experiments which can't be performed in laboratory, should be conducted via Virtual lab.**

#### **Learning outcome:**

- Students will be familiarized with the important bacterial, fungal, parasital and viral human diseases and their pathogens
- Students will acquire knowledge about different pathogen diagnostic methods

#### **Recommended Books:**

1. Ananthanarayan & Paniker's text book of Microbiology by Reba Kanungo, Universities Press.
2. Jawetz, Melnick & Adelbergs Medical Microbiology by Brooks et al., McGraw-Hill Medical.
3. Brock Biology of Microorganisms by Madigan and Martinko, 14<sup>th</sup> edition, Pearson Education International.
4. Microbiology: A Laboratory Manual by James Cappuccino and Chad T. Welsh 11<sup>th</sup> Global Edition, Pearson Benjamin Cummings Publishers.
5. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology by Andreas Hofmann, 8<sup>th</sup> edition, Cambridge University Press.

#### **Course Description: Eighth Semester**

**Course Type: 3**

**Course type: Major/Minor**

**Course title: Microorganisms and IPR**

**Course credits: 4 + 2**

**Course code: MIC-24-801-CT3**

#### **Course Objectives:**

- To familiarize the students about IPR laws and their dimensions
- To familiarize the students about with real world IP issues and their management
- To familiarize the students about significant information on patent, patenting filling procedures and patenting microorganisms

#### **Credit-I: Intellectual Property Rights**

- 1.1. Introduction and significance of Intellectual Property Rights (IPR)
- 1.2. Introduction to World Intellectual Property Rights Organization (WIPO)
- 1.3. Definition, concept and types of Trademarks
- 1.4. Basic concept of Copyright; Patentable and non-patentable inventions
- 1.5. Rights and duties of patent owner

#### **Credit-II: Patenting microorganisms**

- 2.1. Patent: types and their applications
- 2.2. Patent form and its contents
- 2.3. Patenting microorganisms: rules and significance
- 2.4. Benefits of patenting microorganism or microbial products to patent owner



## 2.5. Patentability of microorganism in India and need of patenting microbes and their products

### **Credit-III: IP Treaties and Agreements**

- 3.1. Budapest Treaty on international recognition of the deposit of microorganisms
- 3.2. General Agreement on Tariffs and Trade (GATT), Trade Related Aspects of Intellectual Property Rights (TRIPS)
- 3.3. Introduction and importance: Madrid Agreement; Hague Agreement
- 3.4. UPOV & Brene conventions
- 3.5. Patent Co-operation Treaty (PCT)

### **Credit-IV: Patent infringement and legal protection**

- 4.1. The Patent Act 1970 and recent amendments
- 4.2. Patent infringement- meaning, scope, litigation and case studies
- 4.3. Doctrine of Equivalence and Doctrine of Colorable Variation
- 4.4. Legal protection of biotechnological and microbiological inventions
- 4.5. Geographical Indications and need for protection of industrial designs

### **Credit-V: Practical I**

- 5.1. Demonstration of IPR and its benefits with charts /audio-visuials
- 5.2. Demonstration of Trademark with charts /audio-visuials
- 5.3. Demonstration of Copyright with charts /audio-visuials
- 5.4. Mock patent form filling (Online/Offline)
- 5.5. Demonstration on patenting microorganisms with charts /audio-visuials

### **Credit-VI: Practical II**

- 6.1. Interaction with legal authority for IPR demonstration
- 6.2. Demonstration on claiming patent for microorganism and their products by patent attorneys
- 6.3. Demonstration on Indian Patent Act 1970 with charts /audio-visuials
- 6.4. Demonstration on different patent databases and cyber technology
- 6.5. Demonstration on patent infringement

**Note: Those experiments which can't be performed in laboratory, should be conducted via Virtual lab.**

### **Learning outcome:**

- Students will be familiarized with intellectual property rights and its socio-economic importance
- Students will acquire knowledge about claiming of patent for microorganism and their products, along with different patent laws and agreements

### **Recommended Books:**

1. Ahuja V K, 2017 Law Relating to Intellectual Property Rights, LexisNexis.
2. Ang Steven, 2013, The Moral Dimensions of Intellectual Property Rights, EE.
3. Copyrights, Patents and Trade Secrets, 2nd Ed., 2000 West Legal Studies, Canada
4. D. P. Mittal, 2002 Trade Marks, Passing Off & Geographical Indications of Goods: Law and Procedure, Taxmann Allied Services, New Delhi
5. N.S. Gopalakrishnan & T.G. Agitha, Principles of Intellectual Property (2009), Eastern Book Company, Lucknow

## Research Mode

**Course Description: Seventh Semester**

**Course Type: 2**

**Course type: Major/Minor**

**Course title: Research Methodology**

**Course credits: 6**

**Course code:**

### Course Objectives:

- To familiarize the students with biosafety guidelines for microbiology laboratory and different instruments and their working principles
- To familiarize the students with research ethics and manuscript writing
- To familiarize the students with biostatistic and bioinformatic tools

### Credit-I: Instrumentation-I

- 1.1. Biosafety guideline for Microbiology Laboratories. Good Laboratory Practices (GLP)
- 1.2. Specific procedure and precautions for sterilization of glassware and culture media
- 1.3. Working principle and design: autoclave, BOD incubator and biosafety cabinet
- 1.4. Construction and Working principle: pH Meter and ELISA reader
- 1.5. Working principle and design: NanoDrop, Atomic absorption spectrophotometer, UV-VIS-spectrophotometer

### Credit-II: Instrumentation-II

- 2.1. Principle and design: Light microscope and florescent microscope
- 2.2. Principle, design and application of Confocal Microscope
- 2.3. Principle, design and application of Scanning electron microscopy (SEM), Transmission electron microscopy (TEM)
- 2.4. Centrifugation: Basic principle and derivation of sedimentation coefficient
- 2.5. Ultracentrifugation and its applications

### Credit-III: Instrumentation-III

- 3.1. Principle and procedure: PAGE and SDS-PAGE
- 3.2. Chromatography: Ion exchange chromatography, Gel filtration chromatography
- 3.3. Chromatography: GC-MS and HPLC working principle and applications
- 3.4. Polymerase chain reaction (PCR) and its variants. Quantitative real time PCR (qRT-PCR) their applications
- 3.5. Principle and application; Northern, Southern and Western blotting techniques

### Credit-IV: Research Ethics

- 4.1. Research, meaning of research and objectives of the research
- 4.2. Types of Research, criteria of good research
- 4.3. Research process, Formulating the research problem, Selecting the problem
- 4.4. Ethics in research: Introduction to bioethics
- 4.5. Plagiarism and academic integrity

### Credit-V: Preparation of manuscript

- 5.1. Types of research documents: Research paper, review paper, Research Note, Book chapter, Edited book, Reference book
- 5.2. Generation or collection of data for manuscript preparation
- 5.3. How to prepare manuscript: Title, Authors name and affiliations, Abstract, Keywords, Manuscript body (Introduction, Materials and methods, Results, Discussion, Conclusion, Acknowledgement, Figures, Tables, graphs, and references).
- 5.4. Formatting and designing of manuscript

5.5. Types of journals (National, international, referred, peer reviewed etc.)

### **Credit-VI: Biostatistics and Bioinformatics**

6.1. Types of methods of collecting data and analysis of data

6.2. Correlation analysis, Chi-square test

6.3. ANOVA and Soft Statistical Package for Social Sciences (SPSS)

6.4. Biological database: literature (PubMed), nucleic acid (NCBI, EMBL), protein (NBRF, PIR, Swiss-Prot) and structural database (PDB)

6.5. Sequence analysis and comparison; Similarity and homology between sequences; sequence alignment–local and global alignment (BLAST, FASTA), Multiple sequence alignment (Clustal W)

### **Learning outcome:**

- Students will be familiarized with rules and regulations of microbiology laboratory
- Students will acquire knowledge about important instruments and methods of preparing manuscripts

### **Recommended Books:**

1. Brock Biology of Microorganisms by Madigan and Martinko, 14<sup>th</sup> edition, Pearson Education International.
2. Microbiology: A Laboratory Manual by James Cappuccino and Chad T. Welsh 11<sup>th</sup> Global Edition, Pearson Benjamin Cummings Publishers.
3. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology by Andreas Hofmann, 8<sup>th</sup> edition, Cambridge University Press.
4. Ahuja V K, 2017 Law Relating to Intellectual Property Rights, LexisNexis.
5. Biostatistics: A Foundation for Analysis in the Health Sciences (Wiley Series in Probability and Statistics) by Daniel W Wayne, John Wiley & Sons Inc.
6. Bioinformatics Sequence and Genome Analysis by Mount D.W., Cold Spring Harbor Laboratory Press.

**Course Description: Eighth Semester****Course Type: 2 & 3****Course type: Major/Minor****Course title: Research project****Course credits: 12****Course code:****Course Objectives:**

- This component shall inculcate in students the scientific temperament for finding solutions to the research problems.
- A student shall be required to select a research problem and perform experiments independently under the mentorship of a designated teacher.
- The methodology adopted and the findings of the study are to be compiled in a scientific manner and submitted to the department for evaluation in the form of a dissertation.
- A presentation of the methodology and finding should be made by the student in front of the scientific audience comprising of teachers, research scholars and the fellow students.

**Dissertation writing, Presentation and Viva-Voce****(Credits: 12)**

- Identification of research problem
- Review of literature
- Methodologies to be adapted
- Performance of experiments
- Collection of data
- Presentation of generated data
- Dissertation/Project writing
- Final presentation
- Viva-Voce

**Learning outcome:**

- Students will gain insight about local research problems
- Students will acquire knowledge about important instruments and methods of preparing manuscripts