

Department of Microbiology

School of Biological Sciences



Curriculum Framework- 2022

Based on National Education Policy-2020

Date of BoS: 13 August 2022

**Doctor Harisingh Gour Vishwavidyalaya
(A Central University)
Sagar-Madhya Pradesh
470003**

About the Department



A full-fledged Post Graduate curriculum in Microbiology at Dr. Harisingh Gour Vishwavidyalaya, Sagar was started under the headship of Prof. S. C. Agrawal (Head:1996-2004). The department further progressed to new heights by the untiring efforts of Late Prof. P.C. Jain (Head: 2004-2012). Since inception, the department has stood among the front runners in teaching and research in Microbiology and occupies a place of prominence in the field. With the establishment of Central University in 2009, the Department of Microbiology became a part of School of Biological Sciences (SBS). The department has been publishing a number of high impact publications in the leading national and international peer reviewed scientific journals with focus on inter disciplinary research. In the past, the department has also organized several hand's on workshops, GIAN programs and international conferences. The major thrust areas of the department encompass production and application of microbial enzymes (mannanase, xylanase, keratinase, inulinase, L-asparaginase, thermophilic fungi, host-pathogen interaction, vertebrate animal models, bioimaging, biofilm and cancer biology.

Curriculum Framework based on National Education Policy 2020

NEP-2020 has conceptualized the idea to develop wellrounded competent individuals for making the nation a self-reliant and global leader. In the same spirit, we at Department of Microbiology have developed a curriculum framework to encompass the goals of NEP 2020. To this end, we have incorporated choice of subject/disciplines of study, creating academic pathways having constructive combinations of disciplines for study with multiple entry and exit points as well as focus on **experiential learning** for students by introducing **multidisciplinary and skill enhancement courses** and actual Hand's on training in the recent and trending aspects of Microbiology and applied areas.

Programs offered

SN	Course	Intake
1	M.Sc. Microbiology	19
2	Ph.D. Microbiology	12*

*Subject to availability of seats under supervisor

Post Graduate Curriculum Framework

M.Sc. Microbiology

Level: L8

Semester I

Nature of Course	Course Code	Course Title	Credits
Discipline Specific Major-1	MIC-DSM-121	General Microbiology and Microbial Diversity (T)	4
	MIC-DSM-122	General Microbiology and Microbial Diversity (P)	2
Discipline Specific Major-2	MIC-DSM-123	Medical Microbiology and Immunology (T)	4
	MIC-DSM-124	Medical Microbiology and Immunology (P)	2
Multi-Disciplinary Major-3	MIC-MDM-121	Principles of Biochemistry (T)	4
	MIC-MDM-122	Principles of Biochemistry (P)	2
Skill Enhancement Course (SEC)	MIC-SEC-121	Bioinstrumentation and Bioinformatics (T)	3
	MIC-SEC-122	Bioinstrumentation and Bioinformatics (P)	1

Semester II

Nature of Course	Course Code	Course Title	Credits
Discipline Specific Major-1	MIC-DSM-221	Microbial Physiology (T)	4
	MIC-DSM-222	Microbial Physiology (P)	2
Discipline Specific Major-2	MIC-DSM-223	Environmental Microbiology (T)	4
	MIC-DSM-224	Environmental Microbiology (P)	2
Multi-Disciplinary Major-3	MIC-MDM-221	Pharmaceutical Microbiology and IPR (T)	4
	MIC-MDM-222	Pharmaceutical Microbiology and IPR (P)	2
Skill Enhancement Course (SEC)	MIC-SEC-221	Methods in Molecular Biology and Biocatalysis (T)	3
	MIC-SEC-222	Methods in Molecular Biology and Biocatalysis (P)	1
Exit: PG Diploma in Applied Microbiology			

Level: L9**Semester III**

Nature of Course	Course Code	Course Title	Credits
Discipline Specific: Major-1	MIC-DSM-321	Agriculture and Food Microbiology (T)	4
	MIC-DSM-322	Agriculture and Food Microbiology(P)	2
Discipline Specific: Major-2	MIC-DSM-323	Industrial Microbiology and Bioprocess Engineering (T)	4
	MIC-DSM-324	Industrial Microbiology and Bioprocess Engineering (P)	2
Multi-Disciplinary: Major-3	MIC-MDM-321	Microbial Biotechnology (T)	4
	MIC-MDM-322	Microbial Biotechnology (P)	2
Skill Enhancement Course (SEC)	MIC-SEC-321	Advance Imaging and Microscopy (T)	3
	MIC-SEC-322	Advance Imaging and Microscopy (P)	1

Semester IV

Nature of Course	Course Code	Course Title	Credits
Discipline Specific: Major-1	MIC-DSM-421	Dissertation Project Work / Experiential learning on any Microbiology related aspect	14
Exit: Post Graduate Degree M.Sc. Microbiology			

DSM: Discipline Specific Major	MDM: Multi-Disciplinary Major	SEC: Skill Enhancement Course
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Level	Course Code	Course Title	Marks	Credits
L8 Sem I	MIC-DSM-121	General Microbiology and Microbial Diversity (Theory)	Mid Sem 40 End Sem 60	4

Objective

To build a strong foundation in the microbial diversity, general properties and the significance of relevant prokaryotic and eukaryotic microbes.

Learning Outcome

CO 1. Learn and appreciate the major discoveries and contribution of leading microbiologists.

CO 2. Learn about the diversity and physiological adaptations present in microbes.

CO 3. Learn about the importance of representative bacterial genera.

CO 4. Learn about the fungal diversity and representative genera.

CO 5. Learn about the classification of virus and their mechanism of replication.

Unit 1

Timeline, major discoveries and contribution of important scientists: From 1800 - 1900: Leeuwenhoek, Jenner, Pasteur, Koch, Gram, Mechnikoff and Ehrlich; Ivanovsky; Winogradsky. From 1900 - 1950: Bergey, Griffith; Fleming; Luria Delbruck; Waksman; Lederberg and Tatum; From 1950 to 2000: Lederberg and Zinder, Benzer; Jacob and Monod, Ames, Temin and Baltimore; Carl Woese and Craig Venter. Microbiological growth techniques: Pure culture techniques, Enrichment, Anaerobic culturing. Staining techniques: Gram's staining, Endospore, Capsule, Acid fast staining.

Unit 2

Bacterial Diversity: Habitat, structure, physiology & significance of Photoautotrophic bacteria (Cyanobacteria, Green and Purple bacteria), Photoheterotrophic bacteria (Green Non-sulfur and Purple Non-sulfur bacteria) and Chemoautotrophic bacteria (sulfur oxidizers, iron bacteria, hydrogen bacteria). Extremophiles physiological characteristics and significance of (Methanogenic bacteria, Methylotrophs, Halobacteria).

Unit 3

Ultra-structure of bacterial cell A) Cell wall; B) Surface adherents: capsule and slime layer; C) Surface appendages: Flagella and Pili; D) Endospores. Bacteriology: Classification, habitat, structure, reproduction & significance of Chemoheterotrophic bacteria (filamentous & gliding bacteria, Gram-Positive (*Bacillus*, *Actinomyces*) and Gram-negative bacteria *Spirochetes*, *Chlamydia*, *Rickettsia* and *Mycoplasma*).

Unit 4

Mycology: Thallus morphology and modifications in fungi. Nutrition and physiology of fungi. Reproduction (asexual, sexual and parasexual) characteristics of fungi. Major taxonomic group of fungi with focus on structure, reproduction, life cycle and significance of the following: representatives: i) Gymnomycota (Cellular slime moulds), ii) Mastigomycota (*Phytophthora*), iii) Amastigomycota: a) Zygomycotina (*Mucor/Rhizopus*), b) Ascomycotina (*Saccharomyces*), c) Basidiomycotina (*Agaricus*), d) Deuteromycotina (*Fusarium*). Characteristics and importance of Deuteromycetes.

Unit 5

Baltimore classification of virus. General methods for isolation and cultivation of virus. One-step growth curve, burst size and determination of titre value of virus. Concept of Viroids & Prions. General characteristics and life cycle of Bacterial virus (T4 bacteriophage), Plant virus (TMV), Animal virus (e.g. Herpes Simplex).

Level	Course Code	Course Title	Marks	Credits
L8 Sem I	MIC-DSM-122	General Microbiology and Microbial Diversity(Practical)	Mid Sem 40 End Sem 60	2

List of Practical

1. Preparation of A) Nutrient agar (NA) for bacterial isolation and B) Potato/Sabouraud Dextrose Agar (PDA/SDA) for fungal/yeast growth.
2. Isolation and growth of rhizosphere bacteria on NA plate using serial dilution and spread plate method.
3. Isolation and growth of fungal colony on PDA/SDA plate.
4. Preparation of single bacterial colony using streak plate method.
5. Bacterial identification: Morphological staining and biochemical tests on isolated bacteria.
6. Fungal identification: Spore and hyphal staining and their characteristics.
7. General characteristics and microscopic identification of Bacteria & Fungi.
8. Isolation of plaques from sewage water.

Essential Readings

1. The Microbial World by Stainier R.V., Ingraham, J.L., Wheelis, M.L. and Painter P.R., Prentice-Hallof India (Pvt.) Ltd., New Delhi.
2. Microbiology By Pelczar M.J, Chan E.C.S. and Krieg, N.R. Tata McGraw Hill
3. Brock-Biology of Microorganisms by Madigan M., Bender K., Buckley D., Sattley W., Stahl D. 15th edition, Pearson.
4. An Introduction to Mycology, by Mehrotra, R.S. and K.R. Aneja, New Age International Press, New Delhi.
5. Webster, J. 1985. Introduction to fungi. Cambridge University Press. Cambridge, U.K.

Suggested Readings

1. Bergey's Manual of Determinative Bacteriology (8 Edition) Buchanan, R.E. and Giboson, N.E., Williams and Wilkinson company, Baltimore
2. Morphology and Taxonomy of fungi, by Bessey E.A., Vikas Publishing House Pvt. Ltd., New Delhi.

Year/ Semester	Course Code	Course Title	Marks	Credits
L8 Sem I	MIC-DSM-123	Medical Microbiology and Immunology(T)	Mid Sem 40 End Sem 60	4

Course Objectives

The objective of this course is to understand the epidemiology, pathogenicity, diagnosis & control of important bacterial, fungal, viral and diseases related to medical microbiology.

Course Learning Outcomes

CO1. Will be able to gather information about immune system and antigens.

CO2. Will have gained insight on humoral and cell mediated immune response.

CO3. Will gain insight on immunodiagnostics and immunotherapy.

CO4. Will be able to apply the knowledge gained to understand serological methods.

CO5. Will be able to gain insight about different viral diseases and their control.

Unit 1

Organs and cells involved in immune system and immune response. Concept of haptens, determinants, conditions of antigenicity, antigens and immunogenicity, superantigen. Freund's adjuvants and its significance. Immunoglobulins: Structure and properties of immunoglobulin classes. Antigen-Antibody reaction by precipitation, agglutination and complement fixation. Hybridoma technology for monoclonal antibodies.

Unit 2

Antigen processing and presentation, generation of humoral and cell mediated immune response, activation of B and T lymphocytes, cytokines and their role in immune regulation, T cell regulation, MHC restriction, immunological tolerance. Cell mediated cytotoxicity: Mechanism of T cells and NK mediated lysis, antibody dependent cell mediated cytotoxicity, and macrophage mediated cytotoxicity. Complement system: Classical, alternate, lectin pathway of complement activation. Regulation of complement activation.

Unit 3

Immunodiagnostics and immunotherapy in virology – Serological methods for detection and quantitation of viruses including Hepatitis, Influenza, HIV and others. Immuno-assays: SRID, ELISA, ELISA-PCR, RIA, Western Blotting, Immunofluorescence and their application. Immune deficiencies and autoimmunity.

Unit 4

Epidemiology, pathogenicity, diagnosis & Control of important bacterial diseases: Tuberculosis, Anthrax, Typhoid, Diphtheria, Leprosy. Antibiotics, Vaccines and their use in diseases control. Drug resistance in bacteria. Epidemiology, diagnosis and treatment of the Fungal diseases: Important human diseases caused by fungi (Mycoses); Fungal Dermatitis, Allergies, Aspergillosis. Host defences & control against fungi.

Unit 5

General account of viral diseases- Herpes, Adeno, Picorna (Polio), Orthomyxo (Influenza), Paramyxo (Mumps & Measles), Oncoviruses, HIV-AIDS, Rhabdo (Rabies), Hepatitis, SARS and Swine flu Viruses. Identification and Serological assay of viruses. Control of viral infections.

Year/ Semester	Course Code	Course Title	Marks	Credits
L8 Sem I	MIC-DSM-124	Medical Microbiology and Immunology (Practical)	Mid Sem 40 End Sem 60	2

List of Practical

1. Experiment to show normal body flora and understanding the disease pathogenesis
2. Simple and differential staining to show bacterial colony from blood/stool samples.
3. Screening of Antibiotics.
4. MIC & Drug resistant calculation by Disc diffusion
5. Culture of Virus
6. Experiments to define immunodiagnostics of important diseases.

Essential Readings

1. Microbiology: Principles and Explorations, 9th Edition (2015) by Black J.G., Black L.J., Wiley
2. Brock Biology of Microorganisms, 14th Edition by Michael TM., John M, Kelly S.B., Daniel H.B., (2017)
3. Kuby Immunology, 8th Edition, by Punt J., Stranford S., Jones P., Owen J.A
4. Roitt's Essential Immunology, 13th Edition (2017) by Delves P.J., Martin S.J., Burton D.R. and Roitt I.M. Wiley-Blackwell.
5. Cellular and Molecular Immunology 10th Edition by Abbas A, Lichtman A., Pillai S. - February 19, 2021
6. Text book of Microbiology by Ananthanarayan. R. and. Paniker C.K.J. 12th Edition (2022)
7. Text Book of Medical Microbiology by Chaapra. H.L.
8. Mackis and Mccontney Practical Medical Microbiology Edited by Coffee, Dugmiol, Fraser and Marmion.

Suggested Readings

1. Microbiology Including Immunology and Molecular Genetics. III Ed. By Davis.. Dulbecco, Eisen and Ginsberg.
2. Medical Laboratory Manual for Tropical Countries. Vol. II by Cheesbrough, M.
3. Essentials of Clinical Immunology 7th Edition by Misbah S.A., Spickett G.P., Dalm V.A.S.H. Wiley-Blackwell (2006).
4. Immunobiology: The Immune System in Health and Disease, 6th Revised edition by Charles A. Janeway, Paul Travers, Mark Walport and Mark J. Shlomchik, Churchill Livingstone; (2004).

Level	Course Code	Course Title	Marks	Credits
L8 Sem I	MIC-MDM-121	Principles of Biochemistry (Theory)	Mid Sem 40 End Sem 60	4

Objective

To build a strong foundation in the structure and function of biomolecules which results in life.

Learning Outcome

CO 1. Learn about the concept of chemistry and biology interface.

CO 2. Learn about the types and biosynthesis of nucleic acids.

CO 3. Learn about the types and significance of carbohydrates.

CO 4. Learn about the structure-function of proteins.

CO 5. Learn about the biosynthesis and function of lipids.

Unit1

Properties of water (Hydrogen bonding, Van der Waals interaction, colligative properties). Ionization of water, concept of acid-base, pH scale, equilibrium constant (K_a), pK_a , buffers and Henderson-Hasselbalch equation. Numerical problems related to acid base. Types of isomers (constitutional, stereoisomers, enantiomers, diastereomers). Laws of thermodynamics (Zeroth, First, Second and Third), concept of Enthalpy, Entropy, Free energy changes.

Unit2

Nucleic Acids: Classification (DNA and RNA) and properties (Watson and Crick model for DNA and Clover leaf model of tRNA), phosphodiester bond. Special structures of DNA (A, B and Z form). Ultrastructure of chromatin. Spectral shifts in nucleic acid absorption (Hypo, Hyper, Hypo and Bathochromic). Concept of Central Dogma. Numerical problems related to DNA structure. Biosynthesis of Purine and Pyrimidine bases of DNA and RNA.

Unit3

Carbohydrates: Families of Monosaccharides (Aldose and Ketose), their structure (asymmetric center and cyclic), Reducing and non-reducing sugars. Disaccharides and glycosidic bond and their modifications (N-linked, O-linked, Phospho-linked). Homo and Heteropolysaccharides. Significance of Glycoconjugates (Proteoglycans, glycoproteins and glycolipids). Lectins and their importance.

Unit4

Protein: Classification of amino acids (essential/non-essential, polarity) and proteins (Soluble and Membrane). General structure of amino acids and protein (primary, secondary and tertiary). Numerical problems related to protein structure. Ramachandran plot and peptide bonds. Concept of Isoelectric point, Zwitter ions. Introduction to amino acid families (Serine, Pyruvate, Glutamate, Aspartate, Aromatic and Histidine family).

Unit5

Lipid: Fluid mosaic model of phospholipid bio-membrane. Ether and ester-linkage. Structure and biological functions of oils, fats, waxes, fatty acids, sphingolipids, galactolipids, sulpholipids, steroids and phospholipids. Fatty acid biosynthesis and beta-oxidation. Biosynthesis of glycerol, glycerides (mono, di and tri) and phospholipids (PE, PG, PC, Cardiolipin).

Level	Course Code	Course Title	Marks	Credits
L8 Sem I	MIC-MDM-122	Principles of Biochemistry (Practical)	Mid Sem 40 End Sem 60	2

List of Practical

1. Fehling's test and Molisch's test for detection of carbohydrates.
2. Demonstration of light absorption by Nucleic acid.
3. Detection of proteins using spectrophotometry
4. Quantification of proteins.
5. Quantification of Nucleic Acids
6. Agarose gel electrophoresis for nucleic acid visualization.
7. Analysis of quality of DNA/RNA by spectrophotometer.
8. Demonstration of phenomena of hypochromic shift and hyperchromic shift.

Essential Readings

1. Harper's Biochemistry, 31st Edition, by Murray et al., McGraw Hill
2. Lehninger Principles of Biochemistry, Edition 2021 by Nelson D.L., Cox M., Freeman, W.H.
3. Textbook of Microbiology, by Naveen Kango, I.K. Inter Publishing House
4. Zubay's Principles of Biochemistry by Rastogi V.B. and Aneja KR
5. Physical Biochemistry: Applications to Biochemistry and Molecular Biology W.H. Freeman & Company.
6. Color Atlas of Biochemistry, 3rd Edition by Koolman J. and Rohm KH.

Suggested Readings

1. Biochemistry, Stryer 5th edition W.H. Freeman 2001
2. Textbook of Medical Biochemistry: 8th Edition by Chatterji M.N. and Shinde R.

Year/ Semester	Course Code	Course Title	Marks	Credits
L8 Sem I	MIC-SEC-121	Bioinstrumentation and Bioinformatics (Theory)	Mid Sem 40 End Sem 60	3

Course Objectives

The major objective of this course is to provide training in sophisticated instrumentation and bioinformatics and biostatistics techniques. Students will be trained in instrumentation, bioinformatics tools as well as use of bioinformatics in biological studies.

Course Learning Outcomes

- CO1. Will be able to understand sterilization principles and handling of microbiological goods.
 - CO2. Will be able to describe applications of bioinstrumentation used in microbiological field.
 - CO3. Understands the concept of fermenter design and applications.
 - CO4. Acquires knowledge about chromatography and characterization of proteins and enzymes.
 - CO 5. Know about variety of databases information and role of bioinformatic tools.
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Unit 1

Principles and applications of sterilization: Heat, filtration and radiation. Use of Autoclave, Laminar flow, Bacteriological filters. Use of halogens, and phenolic compounds, heavy metals, alcohols, ethylene oxide, aldehydes and hydrogen peroxide for sterilization.

Unit 2

Principle and applications of spectrophotometry, microplate reader, flow-cytometer, DNA sequencer and thermocycler (PCR). Principle, applications and types of centrifuges. Cellular fractionation

Unit 3

Fermentation equipments: Design and construction of fermenters, Shaking device, aeration device, Monitoring of fermentation process; Solid state fermentation; Methods used in Downstream processing of microbial fermentation.

Unit 4

Chromatographic techniques: Types and uses of paper chromatography, thin layer chromatography, column chromatography, high performance liquid chromatography (HPLC). Electrophoresis: principle and applications in characterization of proteins and enzymes.

Unit 5

Biological databases for nucleic acid and proteins. Data mining, Database searching, Sequence alignment (pairwise and multiple alignments), BLAST, FASTA, CLUSTAL W. Application of bioinformatic tools in microbiology. Search and retrieval of biological information and databases sequence, databank (PDB and gene bank), accessing information. Modelling and Simulation.

Year/ Semester	Course Code	Course Title	Marks	Credits
L8 Sem I	MIC-SEC-122	Bioinstrumentation and Bioinformatics (Practical)	Mid Sem 40 End Sem 60	1

List of Practical

1. Application of various methods/apparatus for sterilization of liquids/solids
2. Visualization of various microorganisms by using different microscopic techniques
3. To decipher the principle of Beer-Lambert's law using spectrophotometer.
4. To amplify a single gene of interest by PCR
5. To perform Paper/TLC chromatography of compounds
6. Separation of DNA fragments by Electrophoresis
7. Bioinformatics data mining/primer designing/BLAST

Essential Readings

1. Bioinformatics and Systems Biology by Marcus F., Springer Nature
2. Introduction to Bioinformatics by Lesk A.M. Oxford University Press
3. Applied Bioinformatics: An Introduction by Selzer P.M., Marhofer R.J., Koch O., Springer,
4. Bioinstrumentation by Webster JG, Wiley
5. Principles of Instrumental Analysis, by Skoog D.A., Holler F.J., Crouch S.R. 7th Edition
6. Fundamentals of Information Technology by Leon, A. and Leon, M. Vikas Publishing House and Leon Press Chennai.
7. Biochemistry Laboratory Techniques by Chaykin, S.
8. Statistical Analysis in Biology by Mathur, K.
9. Introductory Practical Biostatistics by Mishra and Mishra.
10. Instrumental Methods of Chemical Analysis by Sharma, B.K.
11. Statistical Methods in Biology by Bailey, N.T.J. (3rd Ed.).

Suggested Readings

1. Fundamentals of Computers by C. Xavier, New Age Publishers, New Delhi.
2. Introduction to Bioinformatics by Parrysmith and Attwood.

Level	Course Code	Course Title	Marks	Credits
L8 Sem II	MIC-DSM-221	Microbial Physiology (Theory)	Mid Sem 40 End Sem 60	4

Objective

To build a strong foundation in the dynamics and bioenergetics of biochemical pathways.

Learning Outcome

- CO 1. Learn about the concept of cell growth and its regulations.
 - CO 2. Learn about the transport of biomolecules across the membrane and cellular locomotion.
 - CO 3. Learn about the metabolism of carbohydrates.
 - CO 4. Learn about the photosynthesis and carbon fixation pathways.
 - CO 5. Learn about the nitrogen fixation and molecular adaptations by bacteria.
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Unit 1

Growth curve and its properties. Binary expression of cell division, generation time. Stages in mitosis and meiosis cell cycle and its regulations. Synchronous and asynchronous growth. Methods to produce synchronous growth. Growth in batch and continuous culture (Chemostat and Turbidostat).

Unit 2

Movement of biomolecules: Facilitated diffusion, aquaporins, mechanosensitive/ion-channels, ABC transporters, Chemiosmotic driven transport (symport, antiport and uniport), Group translocation/Phosphotransferase system (PTS), transport of Iron (Gram +Ve and Gram -Ve bacteria). Movement of whole cell: Chemotaxis, Quorum sensing and regulation of biofilm formation.

Unit 3

Carbohydrate metabolism: Glucose catabolism (Embden-Meyerhof pathway (EMP) /glycolytic pathways, Entner-Doudoroff pathway and Pentose phosphate pathway (PPP) /hexose monophosphate shunt) and Glucose anabolism (Gluconeogenesis). Pyruvate decarboxylation. Pyruvate utilization pathways (TCA cycle, glyoxylate cycle). Fermentation pathways: Yeast fermentation, Fermentation to produce short-chain fatty acids and mixed acid types.

Unit 4

Principles and components of photosynthesis (light absorption, light driven electron flow). Carbon dioxide fixation pathways (dark reaction). Photophosphorylation (cyclic and non-cyclic (z-scheme)). Generation of reducing power. Oxygenic and non-oxygenic photosynthesis. Oxidative phosphorylation (PMF and Electron Transport System). Chemiosmotic theory of ATP synthesis.

Unit 5

Nitrogen metabolism: Biological nitrogen fixation, Component of Nitrogenase system, Inorganic nitrogen metabolism (denitrification and nitrification), Assimilation of inorganic nitrogen (ammonia), Molecular adaptations in microbes for nitrogen fixation (free living aerobic, free living anaerobic and symbiotic microbes). General reactions of amino acids and the Stickland Reaction.

Level	Course Code	Course Title	Marks	Credits
L8 Sem II	MIC-DSM-222	Microbial Physiology (Practical)	Mid Sem 40 End Sem 60	2

List of Practical

1. Demonstration of bacterial growth curve using spectrophotometer/plate-reader (OD_{600}).
2. Effect of antibiotics or radiation on bacterial growth rate as demonstrated by spread plate method.
3. Demonstration of Bacterial chemotaxis/motility in bacteria.
4. Demonstration of bacterial biofilms as a product of its metabolism.
5. Demonstration of metabolically active cells using colour dyes e.g. SYBRGreen or tetrazolium salt 5-cyano-2,3-ditolyltetrazolium chloride (CTC) or other chemicals.

Essential Readings

1. "The Microbial world" by Stanier, Ingraham, Wheelis and Painter. Mc Millan Ltd., London.
2. Microbial Physiology by Moat, Foster and Spector, Wiley.
3. Essentials of Bacterial Physiology by Umbreit.
4. Bacterial Physiology and Metabolism by Skokatch.
5. Microbial life in Extreme Environments by Kushner, D.J. Academic Press.
6. Cell Biology by Powar, C.B.
7. The control of Antibiotic Resistance in Bacteria by Harris C.H.S, Harris DM.
8. Biochemistry of Antimicrobial Action by Franklin and Snow, Chapman and Hall, New York.

Suggested Readings

1. Manual of Methods for General Bacteriology by Philipp. G.
2. An Introduction to Practical Biochemistry by David T. Plummer.
3. Soil Microorganisms and Plant Growth by Subbarao N.S.Science Publishers.

Year/ Semester	Course Code	Course Title	Marks	Credits
L8 Sem II	MIC-DSM-223	Environmental Microbiology (Theory)	Mid Sem 40 End Sem 60	4

Course Objectives

The major objective of this paper is to introduce the role of microbes in regulating our environment. This will be covered through the knowledge about the fundamental methods used for sampling air, water and soil microflora. To give an account on the microbial interactions and scope of environmental biotechnology.

Course Learning Outcomes

CO1. Will get an in-depth understanding about the importance of indoor and outdoor air quality in terms of microbial load and their types.

CO2. Will get an in-depth knowledge about water microbiology and methods to get knowledge about large scale water purification and sewage treatment

CO3. Will be introduced to various biogeochemical cycles and the role of microbes in them.

CO4. Will have gathered detailed information about the social interactions of microbes in environmental field and production of bioactive molecules enzymes and antibiotics.

CO 5. Will get understanding about the concept and scope of environmental biotechnology.

Unit 1

Air Microbiology: Air borne microorganisms and their significance in human health and plant disease development. Microorganisms in indoor and outdoor environment. Techniques for analysis of air borne microorganisms – The settling plate technique, slit type sampler, liquid impinger, sieve sampler (Anderson's sampler and cascade sampler); Filtration methods

Unit 2

Water Microbiology: General distribution and factor affecting water microbes. Methods of purification of water (Small- and Large-scale purification), Bacterial contaminants in water: The coli form group and non-coliform groups.

Sewage: Composition and its disposal, major groups of microorganisms in sewage, BOD, treatment of domestic and municipal sewage.

Unit 3

Soil as environment for microbial growth: Rhizosphere soil microorganisms. Rhizosphere effect. Role of microorganisms in mineral cycling (Nitrogen, Carbon, Phosphorus).

Solid waste & its management using microbes as tool.

Unit 4

Microbial interactions: commensalisms, neutralism, synergism and antagonism, symbiosis. Soil as source of industrially important microorganisms. Screening of soil microorganisms for bioactive molecules: enzymes and antibiotics

Unit 5

Concept and scope of environmental biotechnology: Role of microorganisms in Bioremediation. Nature of industrial effluents of leather and pharmaceutical industries.

Year/ Semester	Course Code	Course Title	Marks	Credits
L8Sem II	MIC-DSM-224	Environmental Microbiology (Practical)	Mid Sem 40 End Sem 60	2

List of Practical

1. Analysis of microorganisms present in different type of environment/air by settling plate/different Air sampler.
2. MPN analysis of sewage and tap water.
3. Screening of microbes from environment to show their economic potential e.g., enzyme secretion or antibiotic producers.
4. Demonstrating rhizosphere effect.
5. Isolation & identification of microorganism from different biomass.

Essential Readings

1. Brock-Biology of Microorganisms Madigan M.T., Martinko J.M. and Parker J., Prentice Hall Int. Inc.
2. Environmental Microbiology, by Pepper I.L., Gerba C.P., Gentry T.J. Academic Press
3. Sewage treatment in hot climates by Mara, D.
4. Biotechnology and waste water treatment by Fields, M.L.
5. Tilak, S.T. (1989). Environmental ecology and aerobiology. Today & Tomorrow's Printers & Publishers. p222
6. Tilak S.T. 1987 "Air monitoring practical Manual", VijantiPrakashan, Aurangabad.

Suggested Readings

1. Introduction to soil microbiology by Alexander, Martin. John. Wiley & Sons Inc., NY.
2. Bioremediation by Barker, KH, & Herson, D.S. Mc Craw Hill Inc., New York.
3. Andersen, A. A. (1958) New sampler for the collection, sizing and enumeration of viable airborne particles. Journal of Bacteriology 5: 470-484
4. May, K.R. (1966) Multistage liquid impinger. Bacteriological Reviews 30(3): 559-570
5. Chemistry of the Environment, 2 Edition, by Ronald A. Bailey, Herbert M. Clark, James P. Ferris and Sonja Krause, Academic Press; (2002)
6. Environmental Science and Technology-A Sustainable Approach to Green Science and Technology, CRC Press; 2 edition (2006) Stanley E. Manahan.

Year/ Semester	Course Code	Course Title	Marks	Credits
L8 Sem II	MIC-MDM-221	Pharmaceutical Microbiology and IPR (Theory)	Mid Sem 40 End Sem 60	4

Course Objectives

The major objective of this course is to provide training in Pharmaceutical Microbiology and IPR.

Course Learning Outcomes

CO1. Will be able to understand fundamentals of Antibiotics and synthetic antimicrobial agents

CO2. Be familiar with the Molecular principles of drug targeting

CO3. Will be able to describe the various microbial contamination and spoilage of pharmaceutical products.

CO4. Acquires knowledge about Good Manufacturing Practices (GMP) and Good Laboratory Practices

(GLP) in pharmaceutical industry.

CO5. Know about Intellectual Property Rights (IPR) and Patents.

Unit 1

Antibiotics and synthetic antimicrobial agents (Aminoglycosides, Beta-lactams, Tetracyclines, Kanamycins, Macrolides antibiotics), Antifungal antibiotics, antitumor substances. Peptide antibiotics, Chloramphenicol, Sulphonamides and Quinolone antimicrobial agents. Chemical disinfectants, antiseptics and preservatives.

Unit 2

Molecular principles of drug targeting. Bacterial resistance to antibiotics. Mechanism of action of antibiotics. Mode of action of non – antibiotic antimicrobial agents. Penetrating defenses – How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion). Immobilization procedures for pharmaceutical applications (liposomes). Macromolecular, cellular and synthetic drug carriers.

Unit 3

Microbial contamination and spoilage of pharmaceutical products (sterile injectables, non injectables, ophthalmic preparations and implants) and their sterilization. Manufacturing procedures and in process control of pharmaceuticals. Other pharmaceuticals produced by microbial fermentations (streptokinase, streptodornase). New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines. Vaccine clinical trials. Drug delivery system in gene therapy.

Unit 4

Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry. Regulatory aspects of quality control. Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization), Chemical and biological indicators. Design and layout of sterile product manufacturing unit i.e., Designing of Microbiology laboratory and Safety in microbiology laboratory.

Unit 5

Intellectual Property Rights (IPR), Patents, Trademarks, Copyrights, Secrets, Patenting of biological materials, international co-operation, obligations with patent applications, implication of patenting, current issues. Patenting of higher plants and animals, transgenic organisms and isolated genes, patenting of genes and DNA sequences, plant breeders right and farmers rights.

Year/ Semester	Course Code	Course Title	Marks	Credits
Year/ Semester	Course Code	Course Title	Marks	Credits
L8 Sem II	MIC-MDM-222	Pharmaceutical Microbiology and IPR (Practical)	Mid Sem 40 End Sem 60	2

List of Practical

1. Introduction and study of different equipment and processing, e.g., B.O.D. incubator, laminar flow, aseptic hood, autoclave, hot air sterilizer, deep freezer, refrigerator, microscopes used in experimental microbiology.
2. Sterilization of glassware, preparation and sterilization of media.
3. Sub culturing of bacteria and fungus. Nutrient stabs and slants preparations.
4. Microbiological assay of antibiotics by cup plate method and other methods.
5. Sterility testing of pharmaceuticals.

Essential Readings

1. A Textbook of Pharmaceutical Microbiology For Pharmacy, Medical Sciences, and Life Sciences by Dr. Rohit Shankar Mane. Publisher: IP Innovative Publication Pvt. Ltd.
2. Pharmaceutical Microbiology by Patel Kantilal Y.K., Manivannan R., Singh B.. Publisher: Thakur Publication. ISBN: 9789387880726, 9789387880726.
3. Pharmaceutical Microbiology (PCI) Sem-III, by Ashutosh Kar, 1e. Publisher: New Age International (P) Ltd. ISBN-13: 9789387788855
4. Pharmaceutical Microbiology: Essentials for Quality Assurance and Quality Control, by Sandle T. 2015, Elsevier Science.
5. Hugo and Russell's Pharmaceutical Microbiology, by Hodges N.A., Gorman, S.P., Denyer S.P., Wiley.

Suggested Readings

1. Pharmaceutical Microbiology A Lab Manual by Shyam Prasad G. Publisher: Pharma Med Press.

L8 Sem II	MIC-SEC-221	Methods in Molecular Biology and Biocatalysis (Theory)	Mid Sem 40 End Sem 60	3
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Year/ Semester	Course Code	Course Title	Marks	Credits
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Course Objectives

The course will provide a detailed understanding of methods used in molecular biology. The purpose of this study is to introduce the student to the advanced concepts in electrophoresis, proteomics, cloning strategies and various detection methods.

Course Learning Outcomes

- CO1. Is able to describe types and applications of electrophoresis.
- CO2. Will be able to describe applications of PCR, DNA fingerprinting, foot printing etc.
- CO3. Will be able to explain basics of cloning and application of genomics.
- CO4. Will gain an account of principle of biocatalysis and enzymology.
- CO5. Will be able to learn qualitative and quantitative enzyme assays (amylase, protease, cellulase)

Unit 1

Electrophoresis- Basic concept of electrophoresis, types of electrophoresis, factors affecting electrophoretic mobility of charged particle, Gel electrophoresis, Isoelectric point, Isoelectric focusing, applications of electrophoresis. Native and SDS- PAGE, Western blotting, Immunoprecipitation, Pull down Assay, proteomics as a tool for identification of proteins involved in disease conditions, applications of proteomics, Studying intracellular localization of proteins.

Unit 2

Isolation of plasmid DNA, genomic DNA and RNA, cDNA synthesis, PCR & real time PCR, Southern and Northern blotting, DNA fingerprinting, DNA foot printing, CRISPR-Cas 9.

Unit 3

Basics of cloning, Restriction Enzymes, Vectors, Transformation, Transfection, Selectable Markers, Reporter Genes, applications of genomics.

Unit 4

Introduction to enzymes: classification and nomenclature, Characteristics of enzymes. Mode of action and kinetics of enzyme catalyzed reactions (K_m , V_{max}). Types and Mechanism of enzyme inhibition, Biotechnological importance of enzymes. Microbial sources of enzymes. Primary and secondary screening of microorganisms for enzyme production.

Unit 5

Qualitative and quantitative assay of enzyme activity; Enzymes units Amylases, Cellulases, Hemicellulases, Proteases. Natural and synthetic substrates for enzyme assay. Enzyme purification Techniques- Precipitation, chromatographic separation-gel filtration, anion and cation exchange, zymography.

L8 Sem II	MIC-SEC-222	Methods in Molecular Biology and Biocatalysis (Practical)	Mid Sem 40 End Sem 60	1
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List of Practical

1. Transformation of *E. coli* cells.
2. Restriction digestion of Plasmid DNA.
3. Isolation of Plasmid DNA from *E. coli* cells.
4. Restriction analysis of DNA.
5. Measurement of DNA quantity by Spectrophotometer.
6. PCR amplification of DNA
7. Isolation of genomic DNA.
8. Visualization of DNA on agarose gel.
9. Separation of proteins by PAGE.
10. Estimation of enzyme activity (mannanase, xylanase, β -galactosidase).
11. Detection of enzymes on gels (Zymography).

Essential Readings

1. Wilson and Walkers Principles and Techniques of Biochemistry and Molecular Biology, 8th Edition, by Hofmann, A. and Clokie S. Cambridge University Press
2. Molecular Biology Techniques: A Classroom Laboratory Manual, by Miller H.B., Carson S., Witherow D.S., Elsevier Science
3. Biochemistry, by J.M. Berg, Stryer L., Tymoczko J., Gatto G., 9th Edition, W.H. Freeman.
4. Lehninger Principles of Biochemistry, by Nelson D.L., Cox M., Freeman, W.H.
5. Principles of Genetics by Gardner, Simmons, Snustad, 8th edition, Wiley
6. Freifelders, Essentials of Molecular Biology, by Malacinski G.M., 4th Edition Jones and Bartlett

Suggested Readings

1. Molecular Cloning: A Laboratory Manual (Vol III) by Green and Sambrook
2. Biophysical Chemistry, Principles and Techniques by Upadhyay, Upadhyay, and Nath.

Year/ Semester	Course Code	Course Title	Marks	Credits
L9 Sem III	MIC-DSM-321	Agriculture and Food Microbiology (Theory)	Mid Sem 40 End Sem 60	4

Course Objectives

The major objective of this paper is to introduce the role of microbes in the agriculture and food microbiology. Also, to introduce the role of microbes in food preservation, dairy and their applications in Industrial level. Finally, to impart knowledge about the dairy products.

Course Learning Outcomes

CO1. Will get an in-depth knowledge about the importance of microbes in soil fertility and crop production.

CO2. Will get an in-depth understanding about the Microbial diseases and control of crop plants.

CO3. Will have gathered detailed information about the principles of food preservation such techniques

for the identification of microbes especially in the food industry.

CO4. Will get detailed understanding about the distinction of preparation of fermented non-dairy food products like Rice, Fruits and Soybean based foods.

CO5. Will be introduced to the microbiology, of LAB and its importance.

Unit 1

Microbial groups in soil. Role of microbes in soil fertility and crop production, Microflora in Rhizosphere and Phyllosphere, Biogeochemical cycling of nutrients: Carbon, Nitrogen and Sulfur and Phosphorus cycle.

Unit 2

Microbial diseases and control of crop plants with special reference to Wheat, Rice, Groundnut, and Potato (Rust, Smut and Wilt and Blight disease). Control of plant diseases using integrated pest management. Bacterial insecticides. Concept of biofertilizers (e.g. *Rhizobium* and *Azotobacter*) and their application in agriculture.

Unit 3

Fundamentals of Food Microbiology: Important genera of bacteria, fungi and yeast in food microbiology. Principles of food spoilage: role of pH, water activity, redox potential, nutritional content of food. Mechanism of food spoilage: Olfactory changes, texture changes and visual changes in food.

Unit 4

Principles of food preservation: Asepsis, Physical methods (anaerobic condition, high and low temperature, drying), Chemical preservation, food additives, canning. Preventive methods applied in toxic foods.

Unit 5

Microbiology of Dairy Products: Concept of dairy fermentation: Starter and non-starter culture. Metabolic properties of lactic acid bacteria (LAB). Molecular organization of LABs for texture production in Cheese. Antibiosis activity of LABs.

Year/ Semester	Course Code	Course Title	Marks	Credits
L9 Sem III	MIC-DSM-322	Agriculture and Food Microbiology (Practical)	Mid Sem 40 End Sem 60	2

List of Practical

1. Isolation, identification and standard plate count of various microorganisms from raw, processed or spoiled foods: Milk (raw/spoiled); Bread (bread mould); Vegetables (raw/spoiled).
2. Biochemical characteristics of spoilage bacteria.
3. Methylene blue reductase test (MBRT) for determination of quality of milk samples.
4. Effect of commercial chemical preservatives on survival of microorganisms (sodium benzoate, sodium glutamate, vinegar etc.).
5. Finding thermal death time for untreated milk and different water samples at various temperatures (60°C, 70°C and 80°C).

Essential Readings

1. Food microbiology by Frazier and Westhoff
2. Fundamentals of food microbiology by Fields, M.L.
3. Food microbiology: An Introduction, by Matthews K.R; Kniel K.E; Montville T.J., ASM Press, (2017)
4. Modern Food Microbiology by Jay J.M., Loessner M.J., Golden D.A. (7th Edition)
5. Food Microbiology by Adams M.R. and Moss, M.O. Royal Society of Chemistry Publication, Cambridge.
6. Basic Food Microbiology by Banwart, GJ (1989) CBS Publishers and Distributors, Delhi.
7. Agricultural Microbiology by N.S. Subbarao, Medtech Publishers
8. Plant Disease Management by R. S. Singh (2001) Science Pub Inc.

Suggested Readings:

1. Principles of Fermentation Technology. Stanbury, P.F., Whittaker, A and Hall, S.J (1995) 2nd Edition. Pergamon Press
2. Agricultural Biotechnology by Altman Arie (1997), CRC Press

Year/ Semester	Course Code	Course Title	Marks	Credits
L9 Sem III	MIC-DSM-323	Industrial Microbiology and Bioprocess Engineering (Theory)	Mid Sem 40 End Sem 60	4

Course Objectives

The course will enthuse students to apply the learning of industrial microbiology concepts toward the development and scope of economically important products of human benefits.

Course Learning Outcomes

CO1. Will have gained knowledge about industrially important microbial strains screening, detection and assay of fermentation products.

CO2. Understands the concept of fermenter design and process. Critical components of fermentation process and product recovery methods.

CO3. Attains knowledge about production of antibiotics, vaccines. microbial enzymes their application strategies.

CO4. Learns about the production of beverages and organic acids

CO5. Acquires knowledge about various industrially relevant microbial products (amino acids, vitamins and steroids) and their production process.

Unit1

Design of a basic fermenter, bioreactor configuration, design features, individual parts, baffles, impellers, foam separators, sparger, culture vessel, cooling and heating devices, probes for online monitoring, computer control of fermentation process, measurement and control of process. Reactors for specialized applications: Tube reactors, packed bed reactors, fluidized bed reactors, cyclone reactors, trickle flow reactors, their basic construction and types for distribution of gases.

Unit 2

Transport phenomena in fermentation: Gas- liquid exchange and mass transfer, oxygen transfer, critical oxygen concentration, determination of $K_L a$, heat transfer, aeration/agitation, its importance. Sterilization of Bioreactors, nutrients, air supply, products and effluents, process variables and control, scale-up of bioreactors.

Unit 3

Growth of cultures in the fermenter Importance of media in fermentation, media formulation and modification. Kinetics of growth in batch culture, continuous culture with respect to substrate utilization, specific growth rate, steady state in a chemostat, fed-batch fermentation, yield of biomass, product, calculation for productivity, substrate utilization kinetics. Fermentation process: Inoculum development. Storage of cultures for repeated fermentations, scaling up of process from shake flask to industrial fermentation.

Unit 4

Biomass separation by centrifugation, filtration, flocculation and other recent developments.

Cell disintegration: Physical, chemical and enzymatic methods. Extraction: Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purification by different methods. Concentration by precipitation, ultra-filtration, reverse osmosis. Drying and crystallization.

Unit 5

Modern trends in microbial production of bioplastics (PHB, PHA), bioinsecticides (thuricide), biopolymer (dextran, alginate, xanthan, pullulan), Biofertilizers (nitrogen fixer

Azotobacter, Phosphate solubilizing microorganisms), Single Cell Protein (SCP) and production of biological weapons with reference to anthrax.

Year/ Semester	Course Code	Course Title	Marks	Credits
L9 Sem III	MIC-DSM-324	Industrial Microbiology and Bioprocess Engineering (Practical)	Mid Sem 40 End Sem 60	4

List of Practical

1. Screening of microbial population for bioactive molecules- enzymes, antibiotics etc.
2. Production of bioactive molecules in shake flasks and lab scale fermenter.
3. Downstream processing of a bioprocess- separation (filtration, centrifugation, precipitation), chromatographic methods etc.
4. Quantification of biological activity (enzyme assay, bioassay)
5. Studies on effect of process parameters on growth and production of microorganism and product.
6. Production of alcoholic beverages using native yeasts and estimation of yield using distillation.
7. Application of industrial enzymes in production of platform sugars, oligosaccharides etc.
8. Application of alkalistable protease in detergents – distaining of clothes, dehairing of hides etc.

Essential Readings

1. Industrial Microbiology by Casida, L.E.
2. Industrial Microbiology by Patel, A.H.
3. Industrial Microbiology by Miller and Litsky.
4. Industrial Microbiology by Prescott and Dunn.
5. Industrial Microbiology by Onions, Allsopp and Eggins.
6. Microbial Enzyme and Biotechnology by Fogarty and Kelly.
7. Biotechnology: A Text Book of Industrial Microbiology by Cruger, Wulf and Anneliese Crueger, Panima Publishing Corporation, New Delhi.
8. Principles of Fermentation Technology by Stanbury, P.F., ABP, New Delhi.

Suggested Readings

1. Comprehensive Biotechnology by Murray Moo-Young (Ed.). Vol. I, Elsevier
2. Process development of Antibiotics fermentation by Calam, C.T.,
3. Economic aspects of Biotechnology by Andrew J. Macking.

Year/ Semester	Course Code	Course Title	Marks	Credits
L9 Sem III	MIC-MDM-321	Microbial Biotechnology (Theory)	Mid Sem 40 End Sem 60	4

Course Objectives

The course is aimed to introduce various facets of Microbial Biotechnology to the students.

Course Learning Outcomes

- CO1. Will gain knowledge about Scope and its applications of industrial biotechnology.
 - CO2. Understands the concept of various Recombinant microbial products e.g., Vaccines.
 - CO3. Learns about the production of Microbial transformation of steroids.
 - CO4. Learns about the downstream processing and purification of microbial products.
 - CO5. Acquires knowledge about large scale production of microbial products.
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Unit 1

Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology. Use of prokaryotic and eukaryotic microorganisms in biotechnological applications. Genetically engineered microbes for industrial application: Bacteria and yeasts.

Unit 2

Recombinant microbial production processes in pharmaceutical industries -recombinant vaccines (Hepatitis B vaccine, Corona Vaccines), Recombinant Hormones. Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics, microbial biosensors.

Unit 3

Microbial transformation of steroids and sterols. Bio-catalytic processes and their industrial applications: Production of High Fructose Syrup; Probiotics and Prebiotics.

Unit 4

Microbial product purification: filtration, ion exchange & affinity chromatography techniques; Immobilization methods and their application: Whole cell immobilization.

Unit 5

Large scale production of microbial products: Design and construction of fermenters, Shaking device, aeration device, Monitoring of fermentation process. Characteristics of fermentation media, Raw materials (substrates). Scale up of fermentation processes, Product recovery methods.

Year/ Semester	Course Code	Course Title	Marks	Credits
L9Sem III	MIC-MDM-322	Microbial Biotechnology (Practical)	Mid Sem 40 End Sem 60	2

List of Practical

1. Isolation of PGPRs from agricultural soils.
2. Production of prebiotics using microbial enzymes.
3. Isolation of probiotic bacteria from variety of milk samples.
4. Evaluation of production of SCFA, bacteriocins etc. from probiotics
5. Study and application of laboratory fermenter

Essential Readings

1. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press.
2. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press.
3. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.
4. Cruger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc.

Suggested reading

1. Swartz, J. R. (2001). Advances in *Escherichia coli* production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.
2. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.
3. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications,
4. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press.
5. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition., Elsevier Science.

Level	Course Code	Course Title	Marks	Credits
L9 Sem III	MIC-SEC-321	Advance Imaging and Microscopy (Theory)	Mid Sem 40 End Sem 60	3

Objective

To build a strong foundation in applied aspect of microscopy.

Learning Outcome

CO 1. Learn about the concept of different microscopies and laws governing magnification.

CO2. Learn about the aspect of optical aberrations and properties of light.

CO3. Learn about the principles of fluorescence and its application in microscopy.

CO4. Learn about the advance light microscopes with significant resolution.

CO5. Learn about the high-resolution microscopes based on electromagnetic waves.

Unit1

History and advents in Microscopy. Concept of magnification, resolution, Snell's law, numerical aperture, Raleigh's criteria. Microscopy: Different parts of light microscope. Principle, components and applications of Brightfield, Darkfield and Phase contrast Microscopy. Specimen preparation and development of contrast using dye-based staining.

Unit2

Properties of light, Light spectrum and its application. Microscopy lamps and their properties. Optical system of microscope and concept of magnification. Aberrations in microscope lens (Chromatic, spherical) and their corrections. Flat image (Plan) objectives. Types and properties of optical chambers for live cell imaging.

Unit3

Fluorescence Microscopy: Jablonski diagram and concept of absorption, non-radiative decay (vibrational relaxation, internal conversion and inter system crossing) and radiative decay (fluorescence and phosphorescence). Characteristics of fluorescence (photochemistry, fluorescence lifetime, Stokes shift, quantum yield and mirror image rule for absorption and emission spectra). Factor affecting fluorescence (intrinsic, physical and quenchers). Fluorescence Microscopy and Confocal Microscopy.

Unit4

High resolution light microscopes: Working principle, components and applications of Light sheet fluorescence microscopy and Stimulated emission depletion (STED) microscopy.

Unit5

Electron Microscopy (Scanning and Transmission Electron Microscopy): Optics and major components of SEM and TEM. Image formation in SEM and TEM. Biological sample preparation. Components of SEM and TEM. Secondary electron, backscattered electrons, resolution, Cryo-TEM. Advantages and limitations.

Level	Course Code	Course Title	Marks	Credits
L9 Sem III	MIC-SEC-322	Advance Imaging and Microscopy (Practical)	Mid Sem 40 End Sem 60	1

List of Practical

1. Demonstration of peak cut-off and effect of serial dilution on fluorophore spectra acquisition.
2. Demonstration of fluorescent image acquisition of yeast/bacterial cell labelled with fluorescein, Congo Red or GFP.
3. Quantitative imaging of microbes for motility, cell size, vacuole, cell death etc).
4. Quantitative imaging of higher animals e.g., Zebrafish/other small fishes, and data interpretation.
5. Tour to Electron microscopy/confocal microscopy facility for high resolution imaging.

Essential Readings

1. Luciferases—Advances in Research and Application, 2012 Edition, Scholarly Editions.
2. Principles of Fluorescence Spectroscopy, 2007, 3e, By Joseph R. Lakowicz, Springer Publication.
3. Green Fluorescent Protein, By Barry W. Hicks, Humana Press, 10-Nov-2010.
4. Methods of Biochemical Analysis, Green Fluorescent Protein: Properties, Applications and Protocols, By Martin Chalfie, Steven R. Kain, John Wiley & Sons, 18-Nov-2005.
5. New photolabeling and crosslinking methods. By Brunner J., Ann Rev Biochem. 1993; 62:483-514.

Suggested Readings

1. Improved genetically-encoded, FlincG-type fluorescent biosensors for neural cGMP imaging. By Bhargava Y, Hampden-Smith K, Chachlaki K, Wood KC, Vernon J, Allerston CK, Batchelor AM, Garthwaite J. Front Mol Neurosci. 2013 Sep 24;6:26. doi: 10.3389/fnmol.2013.00026. eCollection 2013.
2. Essential Ion Channel Methods, 2010, By P. Michael Conn, Academic Press Publication.

Year/ Semester	Course Code	Course Title	Marks	Credits
L9 SemIV	MIC-DSM-421	Dissertation Project Work / Experiential learning on any Microbiology related aspect	Mid Sem 40 End Sem 60	14

Course Outcomes

Student will undergo a semester long dissertation work in the subject/topic related to

- Microbial biotechnology
- Microbial enzymes
- Pathology
- Bioimaging
- Molecular biology

Student will submit hardbound copies of the dissertation/ project work in the departmental library.

The purpose of dissertation is to introduce few skills set like independent thinking, literature survey, data collection and interpretation, critical analytical reasoning, statistical understanding, hypothesis testing, project management and copy editing.

Evaluation of Project Work / Dissertation

It will be based on periodic assessment of the progress of the project and End Semester Examination as follows:

- | | | |
|-------|--|----------|
| (i) | First periodic assessment of the progress after 08 weeks : | 20 Marks |
| (ii) | Second periodic assessment after 04 weeks : | 20 Marks |
| (iii) | End Semester Examination will consist of: | |
| | (a) Evaluation of the project report : | 50 Marks |
| | (b) Viva-Voce of the project report : | 10 Marks |
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