Dolphin (PG) Institute
Of Biomedical & Natural Sciences
Dehradun, Uttarakhand-248007
(An Autonomous Institute)

Ordinance & Syllabus
of
M.Sc. MICROBIOLOGY

Duration: 2 Years

Overview: Studying microbiology involves exploring microorganisms like bacteria, viruses, fungi, and algae, focusing on their structure, behavior, and applications. The field covers areas such as medical microbiology, immunology, and environmental microbiology, offering diverse career opportunities in research, healthcare, and industry. Students gain practical skills through laboratory work and research. It's a rapidly evolving field with significant impact on medicine, biotechnology, agriculture and environmental science.

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Career Path: Master's degree in Microbiology opens up a wide range of career opportunities across various sectors. Graduates can work in medical and clinical microbiology, focusing on disease diagnosis, research, and treatment in hospitals or diagnostic labs. They can also enter the biotechnology and pharmaceutical industries, engaging in drug development, vaccine production, and microbial quality control. Environmental microbiologists may work in waste management, water treatment, and ecological conservation. Additionally, research roles in academia, government research organizations, or private R&D labs allow graduates to contribute to advancements in genomics, microbiome research, and biotechnology. Teaching and regulatory affairs are other viable career options. The field promises a dynamic and rewarding career, with the chance to impact public health, sustainability, and innovation

Higher Studies and Certifications:

Ph.D. in Microbiology or Related Fields: After completing an M.Sc. in Microbiology, pursuing a Ph.D. allows individuals to specialize in areas like microbial genetics, immunology, or environmental microbiology. This opens up opportunities for advanced research positions in academia, industry, or government research organizations.

Postgraduate Diplomas and Certifications: Specialized diplomas or certifications in fields such as clinical microbiology, industrial microbiology, or bioinformatics can enhance expertise. Certifications like Good Manufacturing Practices (GMP), Clinical Research, or Bioinformatics can make you more competitive in specific industries like pharmaceuticals or healthcare.

Career Opportunities:

Microbiology offers diverse career opportunities and has a broad scope, with the field constantly evolving and expanding. Here are some future prospects, job availability, and the scope of microbiology.

1. **Pharmaceutical Industry:** Microbiologists are in demand in Pharmaceutical industries - in formulation, API and fermentation for research and development of new drugs, Managing Quality control and Quality assurance as a critical and vital part in all drug manufacturing process like tablets, capsules, ointments, Sterile products, active

pharmaceutical ingredients. Few pharmaceutical industries: Pfizer, Glaxo-smithKlin, Novartis, Jhonson and Jhonson, Sun Pharmaceuticals, Merck and Co, Inc, AstraZneca, Baxter Pharmaceuticals, Mankind Pharma,

2. **Cosmetics Industry:**microbiologists play a critical role in ensuring the microbiological safety, quality, and compliance of cosmetic products, thereby safeguarding consumer health and confidence in the industry. Their expertise in microbiology, quality assurance, and regulatory affairs contributes to the success and integrity of cosmetic companies and brands. Few cosmetics industries:Avon Products Inc. LOreal, Procter and Gamble, Emami, Revlon, Inc. VLCC, Unilever, etc .

3. **Alcohol Industry:** Microbiologist play several important roles in the alcohol industry, particularly in the production of alcoholic beverages such as beer, wine, and spirits in fermentation process, yeast management, quality control, contamination prevention, sensory analysis, research and innovation and regulatory compliance. Few alcohol industries: United Spirits Ltd., South Asian Breweries, Kingfisher, Pernord Richard SA, Carlsberg group, Bacardi Ltd. Etc.

4. **Food and Beverage Industry:** Microbiologists are employed in the food and beverage industry to ensure food safety, quality control, and develop new products. They work in food testing laboratories, food processing plants, and regulatory agencies. ITC Ltd., Pepsico, Inc, The Coca – Cola Company, Kellogg company

5. **Diagnostic kits Manufacturing industry:** Microbiologist play several crucial roles in the manufacturing of diagnostic kits, which are essential tools for the detection and diagnosis of various infectious diseases, genetic disorders, and other medical condition in assay development, quality control and assurance, validation studies, technology transfer and scale up and stability testing's. Few names: Bacten – Dickenson and Company, Roche Diagnostics, Abbott Laboratories, Thermo Fisher Scientific, Bio -Rad Laboratories Inc etc.

6. **Dairy Industry:** Microbiologist play several key roles in the dairy industry, where their expertise in microbiology is essential for ensuring the safety, quality, and efficiency of dairy products in fermentation process, starter culture development, hygiene and sanitation practices, product development, quality control and regulatory compliance. Few names are: Nestle SA, Amul, Mother Dairy etc.

7. **Hotel Industry:** Microbiologist play a significant role in the hotel industry, primarily in ensuring the safety and hygiene of food, water, and environmental surfaces to prevent the spread of infections and maintain high standards of cleanliness by ensuring food safety and hygiene, HACCP implementation, water quality management, environment monitoring, Few names are: Taj group of Hotels, Hayatt Hotels, Marriot Hotels, Radisson Hotels, Hilton Hotels etc.

8. **Space Microbiology:**Microbiologists play several important roles in space exploration and research, contributing to the understanding of microbial life in space environments, ensuring the safety of astronauts by spacecraft contamination control, crew health monitoring, microgravity research and planetary protection.

9. **Culture media manufacturing Industry:** play a crucial role in the culture media

manufacturing industry, where they are responsible for developing, producing, and ensuring the quality of culture media used for cultivating and identifying microorganisms in laboratory settings by formulation development, media optimization, quality control, sterilization processes, media packaging and storage and research and innovation. Few names are Merck Millipore, Hi Media Laboratories,, Sigma Aldrich, BD Difco etc.

10. **Petroleum Industry**: Microbiologist play a crucial role in the petroleum industry, particularly in addressing microbiologically influenced corrosion (MIC) and microbial enhanced oil recovery (MEOR) by microbiologically influenced corrosion (MIC) prevention, biocide evaluation and management, microbial souring control, microbial enhanced oil recovery, microbial reservoir characterization, bioremediation of petroleum contamination. Expertise in microbiology is essential for optimizing oilfield operations, reducing operational risks, and advancing sustainable practices in the petroleum sector. ONGC Ltd, Reliance Industries Ltd. ESSAR Oil Ltd. (now Rosneft) etc.

11. **Swimming pools:** Microbiologist play a crucial role in ensuring the safety and hygiene of swimming pools by monitoring water quality, preventing the spread of waterborne illnesses, and implementing measures to control microbial contamination by water quality monitoring, pathogen detection and control, bioflim prevention and management, legionella management, disinfection and treatment technologies and public health education.

12. **Meat processing Industry:** play a critical role in the meat processing industry, ensuring the safety, quality, and compliance of meat products through microbiological testing, process control, and hygiene management. Few names are Tyson Food Inc, Maple Leaf food Inc. etc

13. **Agriculture Industry:** Microbiologists contribute to agricultural productivity by developing microbial fertilizers, biopesticides, and biocontrol agents. They also research plant-microbe interactions, soil microbiology, and sustainable agricultural practices. Few names: Bayer Crop Science, Corteva Agriscience, Wilmar International Ltd etc.

14. **Healthcare Industry:** Microbiology plays a crucial role in healthcare, including clinical microbiology (diagnosis and treatment of infectious diseases), epidemiology (study of disease patterns), and pharmaceuticals (development of antimicrobial drugs and vaccines). Microbiologists can work in hospitals, clinical laboratories, pharmaceutical companies, and public health agencies.

15. **Biotechnology Industry**: Microbiologists are in demand in biotechnology industries for research and development of new drugs, biologics, and biotechnological products. This includes genetic engineering, fermentation technology, and industrial microbiology. Biocon Ltd, Wockhardt Ltd. Biogen Inc. CRISPER Therapeutics AG etc.

16. **Environment CareIndustry:** With growing concerns about environmental pollution and climate change, environmental microbiologists are needed to study microbial communities in various ecosystems, public water supply purification, bioremediation

of pollutants, oil spills control and environmental monitoring. Few names: Waste Management Inc. SUEZ Groups, Tetratech Inc. Etc.

17. **Bioinformatics and Computational Biology:** With advancements in high-throughput sequencing and bioinformatics tools, there is a growing demand for microbiologists with skills in data analysis, computational modelling, and systems biology to study microbial communities and their interactions.

18. **Research and Academics**: Microbiology research is fundamental for understanding microbial physiology, genetics, ecology, and evolution. Microbiologists work in academic institutions, research laboratories, and government agencies to advance scientific knowledge and address global challenges such as antimicrobial resistance and emerging infectious diseases.

19. **Scope in Indian Government Services:** In the Indian government, microbiology-related activities and initiatives are often overseen by various departments and agencies, depending on the specific focus areas and applications. Here are some key departments and organizations in the Indian government that may have involvement with microbiology: Department of Health and Family Welfare, Indian Council of Medical Research (ICMR), Food Safety and Standards Authority of India (FSSAI), Indian Veterinary Research Institute (IVRI), Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Forest and Climate Change and National Dairy Research Institute, Defence Research Organisation (DRDO) etc.

20. **Microbiologist as Entrepreneurs**: Microbiologist can become entrepreneurs in various fields, leveraging their expertise in microbiology to create innovative products, services, and solutions. Some fields in which microbiologists can become entrepreneurs are:

    Agri-biotech start-ups: specializing in microbial solutions for agriculture, such as Composting, biofertilizers, biopesticides, and microbial inoculants for crop enhancement, soil health improvement, and sustainable agriculture practices., can also develop precision agriculture technologies, microbial soil testing services, and agritech platforms for farm management and decision-making.

    Start up for Producing Probiotics foods, functional foods, and fermented foods leveraging beneficial microorganisms for health and nutrition benefits.

    Environmental biotech start-ups: Microbiologist can establish environmental biotech startups offering microbial solutions for wastewater treatment, bioremediation of contaminated sites, and waste valorization. They can develop microbial-based technologies for pollutant degradation, bioenergy production, and sustainable waste management practices.

    Microbiome Research and Personalized Medicine related Start –ups: Microbiologist can launch startups focused on microbiome research, analysis, and therapeutics for personalized medicine applications. They can offer microbiome testing services, microbiome-based diagnostics, and microbiome modulation therapies for improving human health and wellness.

Microbial Bioinformatics and Data Analysis Start ups. Microbiologist with expertise in bioinformatics and computational biology can start companies focused on microbial genomics, metagenomics, and bioinformatics analysis services. They can offer microbial genome sequencing, microbiome data analysis, and bioinformatics software solutions for research and clinical applications.

Overall the scope of microbiology is vast and interdisciplinary, offering numerous career opportunities in diverse sectors including healthcare, agriculture, pharmaceuticals, environmental science, food, dairy, cosmetics, alcohol, petroleum, beverages, waste water treatment, municipalities, space microbiology, pollution control, biowepons, biodegradation, hotel industry (swimming pools sanitization and food testing's) and their threats to guard human and animal welfare. and research. As society faces new challenges and technological advancements continue, the demand for skilled microbiologists is expected to remain strong in the future.

Fee Structure

M.Sc. Microbiology - 2 year (Sem. system)

Tuition Fee	**M.Sc Microbiology**
1st Year	**90000/-**
2nd Year	**90000/-**

Other Charges

Processing fee	**5000/-**
Registration fee	**10000/-**
Examination fee per sem	**6000/-**
Security fee	**2500/-**
Library fee	**500/-**
Sports fee	**250/-**
Dolphin students Welfare council	**500/-**
Accidental Insurance per year	**200/-**
Project Fee(Dissertation fee for M.Sc)	**7000/-**
Hostel fee Per year	**85000/-**

Note:

- Uniform fees are charged separately.
- The fee structure is subject to revision at any time. The institution reserves the right to modify or update details without prior notice.

Fee Payment Schedule:

- **1st Installment:** Payable at the time of admission
- **2nd, 4th, 6th, and 8th Installments (if applicable):** Deadline - January 15 of each academic year
- **3rd, 5th, and 7th Installments (if applicable):** Deadline - July 15 of each academic year

FAQ:

1. **What qualifications do I need to apply for an M.Sc. in Microbiology?**

Answer: To apply for an M.Sc. in Microbiology, you generally need a Bachelor's degree (B.Sc.) inMicrobiology, Life Sciences, Biotechnology, Biochemistry, or a related field. Some institutions may accept students with a background in other science disciplines as long as they have studied subjects like Biology and Chemistry.

2. **What is the typical duration of the M.Sc. Microbiology program?**

   Answer: The M.Sc. in Microbiology typically lasts 2 years, divided into 4 semesters. The program involves both theoretical coursework and practical laboratory work, with opportunities for research projects or internships.

3. **What are the eligibility criteria for M.Sc. Microbiology?**

   Answer: Eligibility criteria vary by university, but common requirements include:

   - A B.Sc. degree in Microbiology, Biotechnology, or related fields (with a minimum aggregate percentage, usually between 50-60% depending on the institution).
   - Some universities may require an entrance exam or interview.
   - A basic understanding of subjects like microbiology, biochemistry, and molecular biology from undergraduate studies.

4. **What topics are covered in the M.Sc. Microbiology syllabus?**

Answer: The M.Sc. Microbiology program includes both theoretical and practical subjects. Some key topics are:

- Advanced Microbiology
- Microbial Physiology
- Molecular Genetics and Biotechnology
- Immunology and Serology
- Virology
- Environmental Microbiology
- Agriculture Microbiology
- Medical Microbiology
- Industrial Microbiology
- Bioinformatics and Data Analysis
- Research Methodology and Statistic

5. **Can I pursue an M.Sc. in Microbiology if my undergraduate degree is in a related field (e.g., Biotechnology or Biochemistry)?**

   Answer: Yes, students with a background in Biotechnology, Biochemistry, Life Sciences, or similar fields can generally apply for the M.Sc. in Microbiology, provided they meet the required eligibility criteria. You may need to have studied subjects like biology, chemistry, or microbiology during your undergraduate course.

6. **What career opportunities are available after completing an M.Sc. in Microbiology?**

   Answer: Graduates of M.Sc. Microbiology have various career opportunities in:

   - Medical and Clinical Laboratories
   - Pharmaceutical and Biotech Industries
   - Research and Development (R&D)
   - Environmental Microbiology (waste management, water treatment, etc.)
   - Food and Beverage Industries (quality control, safety)
   - Academia and Teaching
   - Government Research Organizations (e.g., CSIR, ICMR)
   - Public Health Microbiologist
   - Regulatory Affairs and Quality Control

7. **Is it possible to pursue M.Sc. Microbiology through distance education or online courses?**

   Answer: Yes, some universities offer distance learning or part-time M.Sc. Microbiology programs. These programs are designed for working professionals or those unable to attend regular classes. However, practical laboratory sessions and internships might still be required. Be sure to check if the course is accredited and offers sufficient hands-on training.

Programme:

M.Sc. Microbiology

Introduction

The MSc in Microbiology is an intensive two-year postgraduate program designed to immerse students in the world of microorganisms, encompassing bacteria, viruses, fungi, and protozoa. The course aims to provide a comprehensive understanding of microbial physiology, genetics, and taxonomy, integrating theoretical knowledge with practical skills essential for careers in research, healthcare, and industry. The first year focuses on core subjects such as general microbiology, biological techniques, biochemistry ,cell biology ,molecular biology ,agriculture microbiology, environment microbiology and immunology, laying a solid foundation in both fundamental and applied microbiological sciences. In the second year, students delve into advanced topics including industrial microbiology,medical microbiology , Microbial Product Formulation ,Sales, marketing & distribution of Microbial Products and research methods, alongside elective modules tailored to specific interests. A significant component of the program is the research project, where students conduct original research under supervision, culminating in a dissertation that demonstrates their ability to apply their knowledge and skills. Assessment is multifaceted, incorporating examinations, laboratory reports, assignments, seminars, and the final dissertation, all aimed at evaluating students' mastery of microbiological concepts and techniques. Students are equipped for diverse career opportunities in research and development, healthcare, industry, and education, making substantial contributions to fields such as biotechnology, pharmaceuticals, and environmental science.

Eligibility:

B Sc with CBZ or any other equivalent degree like Biotechnology /Microbiology / Biochemistry /Genetics / Industrial Microbiology / Medical Lab Technology with minimum 50% marks in aggregate.

Program Objectives of MSc. Microbiology

i. The students will get exposure to theoretical and practical aspects of Microbiology.
ii. The programme includes details of microorganisms which are important for the fields of agriculture, medicine and industrial importance.
iii. The students will learn the concepts of biomolecules, enzymes, immunology, cell biology,molecular biology, genetic engineering. They will apply these concepts to make the study of microbiology for sustainable development of human society.
iv. The practical courses have been designed to equip the students with the laboratory skills in microbiology and allied subjects (biochemistry, biotechnology) .

v. The programme will provide students with the knowledge and skills that would enable them to undertake further studies in microbiology and related areas or in multidisciplinary areas.
vi. The programme will help the students to develop arange of generic skills that are relevant in enhancing entrepreneurship skills.
vii. The students will learn about the impact of microbes on the health of the planet and its inhabitants, as well as the significance of microbiology in the study of all life forms.

Programme outcomes

Type of learning outcomes	The Learning outcomes descriptors
Generic learning outcomes:	***Complex problem-solving***: Microbiology students will be able to analyze and interpret results from a variety of microbiological methods, and apply these methods to analogous situations. Use mathematical and graphing skills and reasoning to solve problems in microbiology.Understand that microbiology is a complex field with real-world implications, and commit to mastering the material.
	Critical Thinking-Microbiology students will be demonstrate the capacity to cultivates independent thinking and is able to integrate knowledgefrom other disciplines of chemistry , biochemistry, biotechnology andbioinformatics. and fit that knowledge into the context of microbiology. Understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevancies in the day-to-day life.
	Creativity:Microbiology students will be able to create experiments to investigate microbial processes, interactions, and functions. such as creative approch for discovering new antibiotics to combat drug-resistant pathogens. Ability to place scientific statements and themes in contexts and also evaluate them interms of generic conventions
	Communication Skills:Communicate and collaborate with other disciplines by effectively communicating the fundamental concepts of microbiology in written and oral format which will help in expressing ideas and views clearly and effectively.Ability to listen and follow scientific viewpoints and engage with them. Ability to participate constructively in class room discussions.
	Analytical reasoning/thinking Analyze and interpret results from a variety of microbiological methods and quantitative reasoning by using mathematical calculations and graphing skills tosolve problems in microbiology.

	Research-related skills: Able to analyze, design standards, resolve and troubleshoot problems in implementation or standardization of Life sciences protocols coping up to suit in a position in academia or industry or Institutions and to pursue a career in research.Enhancement of ability to read, assimilate and discuss scholarly articles and research papers showcasing microbiology as well as interdisciplinary areas of life sciences. Systematically collect, record, and analyze data, identify sources of error,interpret the results, and reach logical conclusions.
	Coordinating/collaborating with others: Communicate and collaborate with other disciplines by effectively communicating the fundamental concepts of microbiology in written and oral format.
	Leadership readiness/qualities: Taking on responsibilities such as organizing events, leading discussions, or managing projects can help develop leadership skills.Engaging in internships or research project in microbiology-related fields can offer practical experiences where students can take on leadership roles such as initiative, problem-solving, and teamwork.
	Learning how to learn skills:Learning how to learn enables students to adapt to new information and advancements in the field of microbiology.Efficient learning strategies enable students to manage their time effectively, allowing them to balance their workload and responsibilities more efficiently.
	Digital and technological skills: Incorporate advanced digital skills in designing, developing, managing and deploying in media and technical field.
	Multicultural competence*:* as a member in diverse team in multidisciplinary settings where specialties of diverse field work for common goal student develops a sense of multiculturalism
	Value inculcation: Microbiologists must uphold the highest standards of integrity in their research, including honesty, transparency, and adherence to ethical guidelines. This includes accurately reporting data, acknowledging sources, and avoiding conflicts of interest. Microbiologists should consider the ethical implications of their research, including the potential impact on human health, the environment, and society as a whole. Ethical considerations may include issues such as the use of genetically modified organisms, animal testing, and informed consent in clinical research.
	Autonomy, responsibility and accountability*:* Autonomy and responsibility in learning cultivate leadership qualities and effective collaboration skills. Microbiology professionals often work in

	interdisciplinary teams, where taking initiative and assuming accountability contribute to successful teamwork and project outcomes. in scientific investigation
	Environmental awareness and action: develops a basic understanding of the microbiological principles that have environmental implications such as bioremediation of polluted sites, microbial ecology in extreme environments, and climate change mitigation strategies involving microbial communities.and gains an awareness of regulatory requirements and their compliance in microbiological research.
	Community engagement and service: Understand the relationship between science and society by recognizing and discussing logical, scientific and ethical issues in microbiology. Creative educational resources, outreach programs, and multimedia tools help engage and inspire interest in microbiology.
	Empathy: Incorporating empathy into microbiology education can therefore lead to more holistic and compassionate healthcare practices, benefiting both patients and healthcare professionals alike. It encourages students to consider the human aspects of microbiological research and practice, ultimately contributing to a more humane and ethical approach to healthcare .

M.Sc. MICROBIOLOGY
CURRICULUM AND SYLLABUS

Minimum credit requirement = 80

	Title of Course	**code**	**Credits**
	I Semester		
	Theory Courses		
1.	General Microbiology	MIC001	**4**
2.	Biochemistry	MIC002	**4**
3.	Cell Biology	MIC003	**4**
4.	Biological Techniques	MIC004	**4**
	Practicals Courses		
5.	Laboratory Course-I	MIC005	**2**
6.	Laboratory Course-II	MIC006	**2**
	Total Credits		**20**
	II Semester		
	Theory Courses		
1.	Molecular Biology	MIC007	**4**
2.	Immunology	MIC008	**4**
3.	Environment and Agriculture Microbiology	MIC009	**4**
4.	Food & Dairy Microbiology	MIC010	**4**
	On-line Course From MOOCS/NPTEL*		**2**
	Practicals Courses		
5.	Laboratory Course-I	MIC011	**2**
6.	Laboratory Course-II	MIC012	**2**
	Total Credits		**22**
	III Semester		
	Theory Courses		
1.	Applied & Industrial Microbiology	MIC013	**3**
2.	Medical Microbiology	MIC014	**3**
3.	Biostatistics and Research Methodology	MIC015	**3**
4.	Recombinant DNA Technology	MIC016	**3**
	On-line Course From MOOCS/NPTEL*		**2**
	Practicals Courses		
5.	Laboratory Course-I	MIC017	**2**
6.	Laboratory Course-II	MIC018	**2**
	Total Credits		**22**
	IV Semester		
	Dissertation	MICE001	**20**
	OR		
1	Microbial Product Formulation	MICE002	**4**
2	Sales, marketing & distribution of Microbial Products	MICE003	**4**
3	Laboratory Course-I	MICE004	**2**
4.	AI in Microbiology-Pharma,cosmetic and food industry	MICE005	**4**
5.	Research presentation	MICE006	**6**
	Total Credits		**20**

M.Sc. I Semester

S.No.	Subjects	**Subject Code**	**Credit**	**MARKS**		
				Internal Assessment	External Assessment	Maximum Marks
1.	General Microbiology	MIC001	**4**	40	60	100
2.	Biochemistry	MIC002	**4**	40	60	100
3.	Cell Biology	MIC003	**4**	40	60	100
4.	BiologicalTechniques	MIC004	**4**	40	60	100
5.	Laboratory Course-I	MIC005	**2**	40	60	100
6.	Laboratory Course-II	MIC006	**2**	40	60	100
		Credits	**20**			600

M.Sc. II Semester

S.No.	Subjects	**Subject Code**	**Credit**	**MARKS**		
				Internal Assessment	External Assessment	Maximum Marks
1.	Molecular Biology	MIC007	**4**	40	60	100
2.	Immunology	MIC008	**4**	40	60	100
3.	Environment and Agriculture Microbiology	MIC009	**4**	40	60	100
4.	Food & Dairy Microbiology	MIC010	**4**	40	60	100
5.	Laboratory Course-I	MIC011	**2**	40	60	100
6.	Laboratory Course-II	MIC012	**2**	40	60	100
	On-line Course From MOOCS/NPTEL*		**2**			
		Credits	**20+02**			600

Core Credits= 20 with additional 02 Credits of On-line Course From

MOOCS/NPTEL*

SYLLABUS OF M.Sc. MICROBIOLOGY

I& II SEMESTERS

I SEMESTER
General Microbiology
MIC001

Total Number of Credits: 4
TOTAL HOURS: 60h

Course Description: This subject gives a general insight into the history, basics of microbiology and imparts knowledge about culture media and cultivation techniques used in microbiology and to learn about the basic structure a, classification,cultivation techniques and assay of animal viruses.

Course Outcomes:
On completion of the course, the students will be able to :
CO1. Understand theories and concepts of microorganisms.
CO2. Describe the morphology of prokaryotic cells and different stains and staining techniques
CO3. Understanding composition and preparations of various liquids and solids Culture Media and growth of microorganisms.
CO4. Understand the concepts of microbial genetics, including gene transfer mechanisms (transformation, conjugation, and transduction)
CO5. Impart knowledge about the structure and cultivation techniques of animal viruses and bacteriophage.

Unit1 History and Classification (12 hours)

Scope and relevance of microbiology, Discovery of microorganisms; Conflicts over spontaneous generation; Golden era of microbiology; Microbial Classification: Two Kingdom system and its Drawbacks, Three domain concept, Five kingdom system, Six kingdom system, Eight kingdom system, Bergey's system of Bacterial classification , Phenotypic and Genotypic basis of classification.

Unit 2 General Bacteriology (12 hours)
Ultrastructure of bacterial cell their functions: Flagella, cilia, pili, s-layer, cytoplasmic inclusions, ribosomes and nucleoid; Morphology of bacteria: Shape, size and arrangements, structure and properties of cell wall and cell membrane, Capsule (Types, composition and function); Introduction and principles of staining, dye and stain, Staining methods such as Simple, Negative, Gram, Endospore, Acidfast, Fungal staining; Measurement of growth, (Cell no. and cell count). Microbial Preservation.

Unit 3 Nutrition, cultivation and Growth (12 hours)

Cultural Media: Classification, Liquid and solid Media, Simple, Complex, Synthetic media, Selective media, Enriched media, Enrichment media, Differential media, Sugar media, Transport media, culture media for fungi; Control of Microbial Growth; Microbial growth; Growth curve of batch and continuous cultivation, Diauxic growth curve, Asynchronous and synchronous growth, Factors affecting growth.

Unit 4 Microbial Genetics (12 hours)

Modes of genetic recombination in bacteria: Transformation- Mechanism of transformation, Competence, DNA uptake by competent cell, Conjugation: F-factor, Conjugal transfer process, High frequency recombination (Hfr) strains, Transduction: Generalized and specialized transduction.

Unit 5 General Virology (12 hours)

Discovery of viruses; Characteristic feature of viruses, viroids, virusoids and prions; Baltimore scheme of classification; Morphology and ultrastructure: Capsids and their arrangements, Types and composition of envelopes, Viral genome (Types and structures), Isolation and cultivation of viruses using embryonated eggs, experimental animals and cell culture; Bacteriophage: Structural organization, Cultivation, Replication.

Text books:

1. Tortora GJ, Funke BR and Case CL. Microbiology: An Introduction. Pearson EducationWiley JM, Sherwood LM and Woolverton CJ. Prescott's Microbiology.
2. McGrawHillInternational,Pelczar MJ, Chan ECS and Krieg NR. Microbiology. McGraw Hill Book Company. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. General Microbiology. McMillan Modi H.A,
3. Elementary Microbiology Vol I, Fundamentals of Microbiology Dubey R. C. and D. K. Maheshwari. A textbook of Microbiology. S Chandand Company. New Delhi, India

Reference books :

1. Madigan MT, Martinko JM, Dunlap PV and Clark DP. Brock Biology of Microorganisms.Pearson International Edition
2. Salle A.J. Fundamental Principles of Bacteriology. Tata McGraw-Hill Education
3. Powar C. B. and Daginawala H. I. General microbiology Volume I. Himalaya Publishing House Private Limited, Pune, India.
4. McDonnell G. E. Antisepsis, Disinfection, and Sterilization: Types, Actionand Resistance. United States: Wiley.
5. Bergey's Manual of Systematic Bacteriology.Volume Two: TheProteobacteria, Part A: Introductory Essays. Garrity G. editor. Springer.
6. Atlas R. M. Handbook of Microbiological Media. Ukraine:Taylor andFrancis.

FUNDAMENTALS OF BIOCHEMISTRY
MIC002

Total Number of Credits: 4+1
TOTAL HOURS: 60h

Course Description: It is an interdisciplinary course designed to introduce the essential fundamentals of biochemistry. This course focuses on the concepts of biochemistry and important microbial macromolecules and their metabolism.

Course outcomes:
CO1. Knowledge of Acid- base chemistry and concepts of bioenergetics.
CO2. Understand the structure, and function of Carbohydrates.
CO3. Knowledge about structure, function and classification of lipids
CO4. Illustrate the structure and function of proteins and nucleotides, as well regulation of nucleotide biosynthesis
CO5. Analyze the general characters, inhibitors and kinetics of enzymes.

Unit-I: Acid-base Chemistry and Bio-energetics (14h)
Acid-base chemistry: Bronsted concept of conjugate acid-conjugate base pairs, Ionization of solutions, pH, Important biological buffers, Henderson-Hasselbalch equation, Buffer capacity,Polyproteic acids, Amphoteric salt, Ionic strengths; Bioenergetics: Concept of free energy,Standard free energy, Enthalpy, Entropy, High energy phosphate compounds, Phosphate group transfer, Free energy of hydrolysis of ATP, Oxidation-reduction, Redox potential; Energy generation in biological systems: Phosphorylation and electron transport chain, Electron carriers,Artificial electron donors, Inhibitors and uncouplers of oxidative phosphorylation, Chemiosmotic theory of ATP synthesis.

Unit II: Carbohydrates (10h)
Classification, nomenclature, structure, general properties and functions of simple carbohydrates; Complex carbohydrates: Mucopolysaccharides, Amino sugars, Bacterial cell wall sugars, Sugar alcohols, Glycoconjugates.

Unit III: Lipids (12h)
General properties, nomenclature and classification of lipids; Lipid functions: Cell signals,cofactors, prostaglandins; Fatty acids; Saponification, acid value and iodine value of fats; Rancidity of fats; Storage and structural lipids; Special mention of sphingomyelins, cerebrosides and gangliosides; Vitamins: Structure and function of fat soluble vitamins; Metabolism:Biosynthesis of fatty acids, triacylglycerols, membrane phospholipids, cholesterol, steroids and isoprenoids, Beta oxidation and its regulation, LDL and HDL, Regulation of cholesterol biosynthesis.

Unit IV: Proteins and Nucleotides (12h)
Proteins: Structural features and classification of amino acids, General reactions of amino acid metabolism (Transamination, decarboxylation, oxidative and non-oxidative deamination of amino acids), Peptide bond, Properties and functions of primary, secondary, tertiary and quaternary structure of proteins, Ramachandran plot, Factors affecting secondary and tertiary structures, Hydropathy index, Protein domain and motifs; Nucleotides: Structure of purines and pyrimidines, Synthesis of purines and

pyrimidines, Regulation of nucleotide biosynthesis, Degradation of purines and pyrimidines.

Unit V: Enzymes (12h)

General characteristics of enzymes; Co-enzymes; Holoenzymes; Prosthetic groups; Enzyme nomenclature; Classification of enzymes; Active site; Transition state; Activation energy; Enzyme activity; Specific activity and turn over number; Isozymes; Mechanism of enzyme catalysis; Enzyme kinetics for single substrate and multi-substrate reactions; Reaction mechanisms of enzymes (Acid base and covalent catalysis); Reversible and irreversible inhibition of enzymes; Effect of pH and temperature on enzyme activity; Allosteric enzymes; Determination of active site and turn over number.

Text books

- Jain, J.L. Fundamentals of biochemistry. S. Chand and Company, New Delhi.
- Palmer, T. Enzymes: Biochemistry, biotechnology and clinical chemistry. Horwood Publishing Company, Chinchester.
- Robert, M., Bender, D., Botham, K.M., Kennelly, P.J., Rodwell, V. and Weil, P.A. Harper's illustrated biochemistry. McGraw-Hill, New York.

Reference Books

- Atkins, P. and Paula, J.D. Atkins' physical chemistry. Oxford University Press, Oxford.2. Segel, I.H. Biochemical calculations. John Wiley and Sons, New York.
- Nelson D.L. and Cox, M.M. Lehninger principles of biochemistry. W.H. Freeman and Company, New York.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. Biochemistry. W.H. Freeman and Company, NewYork.
- Garrett, R.H. and Grisham, C.M. Biochemistry. Cole Publishing Company, California.
- Voet, D. and Voet, J.G. Biochemistry. John Wiley and Sons, New York.
- Conn, E.E., Stumpf, P.K., Bruening, G. and Doi, R.Y. Outlines of biochemistry. John Wiley and Sons, New York.
- White, A., Handler, P., Smith, E., Hill, R. and Lehman, J. Principles of biochemistry. Mc-Graw Hill, New York.

CELL BIOLOGY
MIC003

Total Number of Credits: 4
TOTAL HOURS: 60h

Course Description: In this course microbiology. Students will explore major concepts in cell biology including eukaryotic cell structure and function, the cellular use of biomolecules, membranes, signal transduction,cell cycle and cell death pathways.

Course Outcomes (COs)
Upon successful completion of the course the student will
CO1 Knowledge about structure and function of cell organelles, cytoskeleton and cell integration
CO2 Understanding various components of cell membrane and transport of metabolites across the membrane
CO3 Knowledge of different cell- cell communication mechanism
CO4 To understand the molecular mechanism of cell cycle control and cell division
CO5 Knowledge about different pathways of cell death

Unit I: Intracellular Compartmentalization of Cell (12 Hrs)
Structure, organization and functions of nucleus, mitochondria, chloroplast, endoplasmic reticulum, golgi body, peroxisome, lysosome and endosomes; Cytoskeleton: Actin filaments, microtubules and intermediate filaments; Cell motility; Integrating cell into tissue: Cell junctions, Cell- Cell adhesions, Cell – extracellular matrix adhesion; Molecular mechanism of vesicular trafficking.

Unit II: Architecture of Plasma Membrane and Solute Transport (12 Hrs)
Plasma membrane: Composition of membrane, Fluid mosaic model, Membrane fluidity, Membrane dynamics, Membrane fusion; Solute transport across membranes: Diffusion (Simple and facilitated), Active transport (Primary and secondary), Pumps and transporters, Ion channels (Ligand gated and voltage gated channels), Trans-epithelial transport, Mechanism of regulation of intracellular transport.

Unit III: Cell Signaling (12 Hrs)
Basic signaling mechanisms (Paracrine, endocrine and autocrine signaling); Mechanism of signal transduction: Signaling molecules, Ligand-receptors interaction, Transmembrane and intracellular signaling, Cell surface receptors (G protein-coupled, enzyme-linked and ion channel-linked receptors), Second messengers and their role in signal transduction, Signal integration, Signal amplification.

Unit IV: Cell Cycle and Cell Division (12 Hrs)
Cell cycle: Molecular events, Cyclin, CDKs, Checkpoints in cell cycle, Intracellular control of cell cycle events, Abnormalities in cell cycle: Oncogenesis (Causes, proto-oncogenes and tumor suppresser genes, Oncogenic mutations); Cell division: Molecular mechanism of mitosis and meiosis.

Unit V: Cell Death Pathways (12 Hrs)
Necrosis; Autophagy; Senescence; Apoptosis: Mechanisms of apoptosis, Signals

triggering apoptosis, Apoptosis inducing factors, Apoptosis in cancer, Role of immune system in organ transplantation.

Reference Books

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. Molecular biology of the cell. Garland Science, New York.
2. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Scott, M.P., Bretscher, A., Ploegh, H. and Matsudaira, P. Molecular cell biology. W.H. Freeman and Company, New York.
3. Cooper, G.M. and Hausman, R.E. Cell: Molecular approach. ASM Press, Washington, D.C.
4. de Robertis, E. D. P. and de Robertis, E.M.F. Cellular and molecular biology. Saunders, Philadelphia.
5. Pollard, T.D., Earnshaw, W.C. and Schwartz, J.L. Cell biology. Saunders, Philadelphia.
6. Karp, G. Cell and molecular biology- Concepts and experiments. John Wiley and Sons, New York

BIOLOGICAL TECHNIQUES
MIC004

Total Number of Credits: 4
TOTAL HOURS: 60h

Course Description: The course combines lectures and laboratory experiments with hands-on training in the use of analytical instrumentation and experimental design in microbiological research and applications

On completion of the course, the students will be able to:
CO1 Developed understanding of principles and applications of differentmicroscopes.
CO2. Enhancement of practical expertise for proper handling of various centrifugesin the field of microbiology.
CO3.Applying chromatographic techniques to different biological samples
CO4. Analyzing biomolecules on the basis of electrophoresis and its applications
CO5. Understanding the Principles andapplication ofSpectroscopic methods.

Unit I: Microscopy and pH meter (12 Hrs)
Microscopy (Principles and applications): Light, phase contrast, fluorescence and confocal microscopy, Scanning and transmission electron microscopy.Calibration of ocular micrometer and Size Measurement of microorganisms pH Meter- Basic Principle, working and application.

Unit II: Centrifugation (12 Hrs)
Basic principle and applications of centrifugation; Centrifugal force; Sedimentation rate;Sedimentation coefficient; Common centrifuges used in laboratory (Clinical, micro, high speed,ultra and industrial centrifuges); Types of rotors (Fixed- angle, swinging bucket and continuous tubular); Types of centrifugation (Principle and applications): Preparative (Differential and density gradient centrifugation) and analytical centrifugation.

Unit III: Chromatography (12 Hrs)
General principle and applications of chromatography; Types of chromatography (Principles and applications): Adsorption chromatography, Ion exchange chromatography, Affinity chromatography, Size exclusion chromatography, Thin layer chromatography, Gas chromatography, High pressure liquid chromatography (HPLC)

Unit IV: Electrophoretic Techniques (12 Hrs)
General principle and applications of electrophoresis; Types of electrophoresis (Principles and applications): Paper electrophoresis, Moving boundary electrophoresis, Isotachophoresis,Agarose gel electrophoresis, Polyacrylamide gel electrophoresis (SDS-PAGE, Native-PAGE,Denaturing-PAGE and Reducing-PAGE), Isoelectric focusing (IEF), Pulse field gel electrophoresis (PFGE), Disc gel electrophoresis.

Unit V: Spectroscopy and Radiotracer Techniques (12 Hrs)
Spectroscopic methods (Principle and applications): UV, Visible, IR, NMR, Fluorescence, ESR,Atomic absorption, CD, ORD and Raman Spectroscopy; Mass Spectrometry: Principles andapplication of MALDI-MS, Radiotracer techniques: Applications of radioisotopes in biology, Properties and units of radioactivity,

Radioactive isotopes and half-life,Safety rules in handling of radioisotopes, Measurement of radioactivity (GM counter, gamma counter, wilson cloud chamber and liquid scintillation counter), Autoradiography: Principle and its applications

Reference Books

1.Wilson K and Walker J. Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.
2. Nelson DL and Cox MM. Lehninger Principles of Biochemistry, W.H. Freeman and Company.
3. Willey MJ, Sherwood LM & Woolverton C J. Prescott, Harley and Klein's Microbiology. McGrawHill.
4. Karp G., Cell and Molecular Biology: Concepts and Experiments, John Wiley & Sons. Inc.
5. De Robertis EDP and D e Robertis EMF. Cell and Molecular Biology. Lipincott Williams and Wilkins, Philadelphia.
6. Cooper G.M. and Hausman R.E, The Cell: A Molecular Approach. ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA,
7. Nigam A and Ayyagari A. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

I SEMESTER
LAB COURSE-I (MIC005)

(Based on Theory Papers MIC001 and MIC002)

1. To study the common instruments used in microbiology laboratory.
2. To Prepare basic liquid media (Nutrient Broth) and Basic Solid Media (Nutrient Agar) for routine cultivation of microorganisms
3. To study the morphology of given bacteria by simple staining.
4. To perform gram staining of given bacteria for differentiation into gram positive and gram negative class.
5. To study various techniques for isolation of pure culture.
6. To prepare Mac-conkey agar and differentiate between lactose and non-lactose fermenters.
7. To identify hemolytic microorganisms by using Blood agar
8. To detect the presence of coliform in given water sample by
   Presumptive test
   Confirmed test
   Completed test
9. Safety rules of working in lab, hazard from chemicals, handling of chemicals, disposal of chemicals, recording of scientific experiments, calibration, validation and maintenance of instruments.
10. Calculation of moles, molarity, molality and normality of given solution.
11. Calculation of pH of given solution.
12. Preparation of solutions and buffers of different concentrations and pH.
13. Qualitative tests for sugars, amino acids, proteins and lipids in given sample.
14. Quantitative estimation of sugar in given sample.
15. Quantitative estimation of protein in given sample.
16. Estimation of lipid concentration in given sample.
17. Determination of acid value, saponification and iodine value of fats and oils.
18. Determination of activity of given enzyme.
19. Determination of K m and V max of given enzyme.
20. Determination of optimum pH and temperature of given enzyme.
21. Determination of temperature and pH stability of given enzyme.

Practical books :

1. Cappucino, J. and Sherman, N. Microbiology: A laboratory manual. Benjamin/CummingsPublishing Company, San Francisco.
2. Prescott, L.M. and Harley, J.P. Laboratory exercises in microbiology. William C. Brown,Dubuque.
3. White, D. and Hegeman, G.D. Microbial physiology and biochemistry laboratory: Aquantitative approach. Oxford University Press, New York.
4. Aneja, K.R. Experiments in microbiology, plant pathology and biotechnology. New AgeInternational (P) Limited, New Delhi.
5. Atlas, R.M., Brown, A.E. and Parks, L.C. Laboratory manual of experimental microbiology.Mosby College Publishing Company, St. Louis.
7. Kannan, K. Laboratory manual in general microbiology. Panima, New Delhi.
8. Holt, J.G. and Krieg, N.R. Bergey's manual of determinative bacteriology. Lippincott Williams and Wilkin, Philadelphia.
9. Rose, N.R., Hamilton, R.G. and Detrick, B. Manual of clinical laboratory

immunology. ASMPress, Washington, D.C.
10. Weir, D.M. Handbook of experimental immunology. Blackwell Scientific Publications, NewJersey.
11. Rose, N.R., Hamilton, R.G. and Detrick, B. Manual of clinical laboratoryimmunology. ASMPress, Washington, D.C.
12. Weir, D.M. Handbook of experimental immunology. Blackwell Scientific Publications, NewJersey.
13. Stafseth, H.J., Stockton, J.J. and Newman, J.P. A laboratory manual for immunology.Burgess Publishing Company, Stockland

LAB COURSE-II (MIC006)

(Based on Theory Papers MIC003 and MIC004)

1.Study of different stages of mitosis.
2. Study of different stages of meiosis.
3. Study of mechanism of diffusion.
4. Study of mechanism of exosmosis and endosmosis.
5. Effect of isotonic, hypotonic and hypertonic solutions on cell.
6. .Study of microscope to visualize bacterial cells.
7. Separation and identification of sugars/amino acids/lipids by paper chromatography.
8. Separation and identification of sugars/amino acids/lipids by thin layer chromatography.
9. Measurement of pH of fruit juice/Soil.
10. Estimation of DNA.
11. Estimation of RNA.
12. Calibration of an ocular micrometer.
13. Measurement of size of a cell/conidium/spore.
14. Determination of molecular weight of DNA by agarose gel electrophoresis.
15. Separation and determination of molecular weight of proteins by SDS-PAGE.

Practical Books

1. Sambrook, J. and Russell, D.W. Molecular cloning: A laboratory manual. Cold Spring Harbor Lab Press, New York.
2. Miller, J.H. Experiments in molecular genetics. Cold Spring Harbor Lab Press, New York.
3. Murray, R.G.F., Wood, W.A. and Krieg, N.B. Methods for general and molecular bacteriology. ASM Press, Washington, D.C.
4. Chaitanya, K.V. Cell and molecular biology: A lab manual. PHI Learning, New Delhi.
5. Celis, J.E. Cell biology: A laboratory handbook. Elsevier, Am
6.'Jayaraman, J. Laboratory manual in biochemistry. New Age International (P) Limited, NewDelhi.
7. Sawhney, S.K. and Singh, R. Introductory practical biochemistry. Narosa Publishing House,New Delhi.
8.Segel, I.H. Biochemical calculations. John Wiley and Sons, New York.
9.Plummer, D.T. Introduction to practical biochemistry. Mc-Graw Hill, New York.
10. Boyer, R.F. Modern experimental biochemistry. Prentice Hall, New Jersey.

II SEMESTER

Molecular Biology
MIC007

Total Number of Credits: 4
TOTAL HOURS: 60h

Course Objective:
To provide an in-depth understanding of the molecular mechanisms underlying the storage, replication, and expression of genetic information, including the regulation of these processes and the implications for biotechnology.

Course Outcomes: On the completion of the course the students will be able to:
CO1: Describe key experiments that established nucleic acids as carriers of genetic information and discuss their significance in the context of molecular biology.
CO2: Explain the chemical and physical properties of DNA and RNA, their structural variations, and the organization of genetic material within chromosomes.
CO3: Compare and contrast DNA replication and transcription processes in prokaryotes and eukaryotes, including regulatory mechanisms and inhibitors.
CO4: Illustrate the process of translation, the genetic code, and regulatory mechanisms in both prokaryotic and eukaryotic systems, emphasizing the role of operons and DNA-binding motifs.
CO5: Identify different types of DNA damage and repair mechanisms, and assess the impact of various mutations on genetic stability and function.

Unit I
Historical overview; (12 Hrs)
Historical overview; Experimental evidences for nucleic acid as carrier of genetic information (Griffith's transformation, Avery-MacLeod-McCarty's experiment, Hershey-Chase experiment); Chemical and physical properties of genetic material; Structure and forms/types of DNA and RNA; Molecular structure of chromosome in eukaryotes: centromeres; structure of chromatin and packaging of DNA into chromosome; Basic concepts of epigenetic regulation, such as DNA methylation and histone modifications; Chromatin control: chromatin writers, readers and erasers; Polytene and Lampbrush chromosomes; DNA denaturation and renaturation.

Unit II
Central Dogma; (12 Hrs)

Central Dogma; DNA replication in prokaryotes and eukaryotes: Experimental evidence, Modes of replication, Mechanism of replication, Inhibitors of replication, the end-replication problem and telomerase; Transcription in prokaryotes and eukaryotes: Mechanism of transcription; regulatory elements such as enhancers and silencers; activators and repressors, Inhibitors of transcription; RNA processing: processing of heterogeneous nuclear RNA: capping, polyadenylation, splicing of mRNA; processing of tRNA and rRNA; Reverse transcription.

Unit III
Basic features of genetic code; (12 Hrs)
Basic features of genetic code; Translation in prokaryotes and eukaryotes: Mechanism of translation; Inhibitors of translation; Co- and post translational modifications, protein sorting and degradation; Gene expression and regulation in

prokaryotes; operon concept, inducible and repressible operons, lac operon and trp operon. Gene expression and regulation in eukaryotes; DNA binding motifs in regulatory proteins.

Unit IV

DNA Damage; DNA Repair (12 Hrs)

DNA Damage; DNA Repair (photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, SOS repair, homologous and non-homologous end joining); Mutations: nonsense, missense, frameshift and point mutations; intragenic and intergenic suppression;

Unit V

Recombination (12 Hrs)

Recombination: mechanism of homologous recombination, site specific recombination. Transposition: Insertion sequences and transposable elements in prokaryotes and eukaryotes, Mechanism of transposition; RNA interference and antisense RNA; Ribozymes.

Suggested Books

1. Principles of Genetics by D. Peter Snustad and Michael J. Simmons
2. Molecular Biology by David Friefelder
3. Molecular Biology by David P. Clark and Nanette J. Pazdernik
4. Molecular Biology of the Gene by James D. Watson et al.
5. Molecular Biology: Principles and Practice" by Michael M. Cox, Jennifer A. Doudna, and Michael O'Donnell
6. Genes XII by Benjamin Lewin
7. Lewin's Essential Genes by Jocelyn E. Krebs, Elliott S. Goldstein, and Stephen T. Kilpatrick
8. Molecular Cell Biology by Harvey Lodish et al.
9. Essential Molecular Biology: A Practical Approach by Terry Brown
10. Molecular Biology Techniques: An Intensive Laboratory Course" by Stefan Surzycki.

Immunology
MIC008

Total Number of Credits: 4
TOTAL HOURS: 60h

Course Description: This course aims to provide Microbiology students with a comprehensive foundation in immunological principles, structure and function of the immune system, focusing on how it defends the body against pathogens and their applications in both research and clinical settings.

Course Outcomes:
On completion of the course, the students will be able to:
CO1.Understand the fundamental principles and components of the immune system.
CO2Gain insight on structure and functions of antigens and antibodies.
CO3.Gain a comprehensive understanding of the complement system's significance in health and disease.
CO4.Gain knowledge on hypersensitivity and cell mediated immune response.
CO5.Understand the different antigen-antibody reaction and apply immunological knowledge to clinical scenarios and therapeutic strategies.

Unit-I
Overview and historical aspects of Immunology: **(12Hrs)**
Historical background, general concepts of the immune system, innate and adaptive immunity; active and passive immunity.Cell and organs of immune systemHematopoiesis, cytokines, properties and functions of Band T Lymphocytes, Natural killer (NK) cells, Granulocytes (Neutrophils, Eosinophils andBasophils), Monocytes and macrophages, Dendritic cells and Mast cells. Primary lymphoidorgans; Bone marrow and Thymus. Secondary lymphoid organs; Spleen and Lymph nodes,

Unit-II
Antigens & Antibodies: (12Hrs)
Antigens and haptens: Properties, foreignness, molecular size, heterogeneity, B and T cell Epitopes, T dependent and T independent antigens.
Antibodies: structure, function and properties of the antibodies, different classes, subclasses and biological activities of antibodies, concepts of antibody diversity, isotype, allotype, Phagocytosis.

Unit-III
Complement system and Major Histo-compatibility Complex : (12Hrs)
Complement System: Structure, properties and functions of different components, Complementactivation pathways (Classical, alternate and lectin pathways)..Structure and function of various cytokines; Cytokine receptors; Antigen presenting cells; Structure and functions of MHC and HL-A system; Antigen processing and presentation.

Unit-IV
Hypersensitive reactions:: (12 Hrs)

Hypersensitive reactions: Classification, Humoral Immunity mediated hypersensitivity; Type I(IgE), Type II (IgG and IgM-ADCC), Type III (Antigen-antibody complex), and Cell mediated hypersensitivity Type IV (DTH).

Unit-V

Immunodiagnostic technique:(12Hrs)

Precipitation reactions .Single radial Immunodiffusion, Double Immunodiffusion,Immunoelectrophoresis, Rocket electrophoresis, Agglutination, Haemaggulitination, and agglutination inhibition. Enzyme linked immune-sorbent assay (ELISA): Direct, indirect, sandwich and competitive ELISA. Radio immunoassay (RIA). Immunofluorescence.

Text Books:

1. Abbas AK, Lichtman AH, Pillai S. Cellular and Molecular Immunology. 6th edition Saunders Publication,Philadelphia.
2. Murphy K, Travers P, Walport M. Janeway'sImmunobiology. 7th edition Garland Science Publishers, NewYork.
3.Kindt, T.J., Goldsby, R.A., Osborne, B.A. and Kuby, J. Kuby immunology. W.H. Freemanand Company, New York.
4.Pathak, S. and Palan, U. Immunology: Essential and fundamental. Science, New Hampshire.

Reference Books:

1.Chapel, H., Haeney, M., Misbah, S. and Snowden, N. Essentials of clinical immunology.Wiley, New Jersey.
2. PeakmanM, and Vergani D. (2009). Basicand Clinical Immunology. 2nd editionChurchill Livingstone Publishers,Edinberg.
3. Richard C and Geiffrey S. (2009). Immunology.6thedition. Wiley BlackwellPublication.
4. https://jcm.asm.org/content/43/1/49
5.https://www.publichealthontario.ca/en/laboratory-services/test-information-index/hepatitis-e-serology.
6.Delves, P.J., Martin, S.J., Burton, D.R. and Roitt, I.M. Roitt's essential immunology. Wiley-Blackwell, New Jersey.

Reference Books

1.Wilson K and Walker J. Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.
2. Nelson DL and Cox MM. Lehninger Principles of Biochemistry, W.H. Freeman and Company.
3. Willey MJ, Sherwood LM & Woolverton C J. Prescott, Harley and Klein's Microbiology. McGrawHill.
4. Karp G., Cell and Molecular Biology: Concepts and Experiments, John Wiley & Sons. Inc.
5. De Robertis EDP and D e Robertis EMF. Cell and Molecular Biology. Lipincott Williams and Wilkins, Philadelphia.
6. Cooper G.M. and Hausman R.E, The Cell: A Molecular Approach. ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA,
7. Nigam A and Ayyagari A. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY
MIC009

Total Number of Credits: 4
TOTAL HOURS: 60h

Course Description: Agricultural and Environmental microbiology is a dynamic field that bridges fundamental microbiological principles with real-world applications in environmental management and sustainability. This course equips Microbiology students with the knowledge and skills to understand and manipulate microbial communities for beneficial Agricultural and environmental outcomes.

On completion of the course, the students will be able to:
CO 1.Aware of the important role microbes play in bio-geochemical cycling of essential elementsoccurring within an ecosystem and its significance.
CO2 Understanding the abiotic and biotic components of Soil.
CO3 Demonstrate about the isolation, purification, mass multiplication and applications of biopesticides and biofertilizers
CO4 Knowledge about different microbial interactionsand Impact of Microbes on Environment
CO5 Gain in depth knowledge of different types of solid waste, liquid waste and their management.

Unit-I
Soil Microbes and Biogeochemical cycles (10 Hrs)
Soilmicrobes; Rhizosphere; Rhizoplane; Composition of root exudates; Factors affecting exudation; Plant growth promoting rhizobacteria, Mycorrhiza; Rhizosphere effect; Biogeochemical cycles; Carbon, Nitrogen, Phosphorous and Sulphur cycles.

Unit -II
Organic and Inorganic Matter Dynamics in Soil: (12 Hrs)
Microbial decomposition of cellulose, hemicellulose and lignin, Factors affecting organic matter decomposition. Mechanism of nitrogen fixation, Mechanism of phosphate solubilization and phosphate mobilization, Mechanism of iron chelation, Production of plant growth promoting hormones from bacteria and fungi, Production of antibiotics by plant growth promoting microorganisms.

Unit- III
Bio control Agents and Biofertilizers: (12 Hrs)
General account of microbes used as biopesticides and their advantages over syntheticpesticides; Bacillus thuringiensis: Mechanism of biocontrol; Production of bioinsecticide, Field applications, Viruses: Cultivation, Mechanism of biocontrol, Field applications. Biofertilizers; Isolation, purification, mass multiplication, inoculum production and method of application of biofertilizers: *Azospirillum*, *Azotobacter*, *Rhizobium*, Cyanobacteria, AM fungi, Phosphate solubilizer, Algal biofertilizers; Storage, shelflife, quality control and marketing of biofertilizers.

Unit-IV

Microbial Interactions and Impact of Microbes on Environment (13 Hrs)

Microbialinteractions:Mutualism,Synergism,Commensalism,Competition,Amensalism, Parasitism, Predation. Microbe-Plant interaction: Symbiotic and Non-symbiotic interactions. Microbe-animal interaction: Microbes in Ruminants,Nematophagus fungi and Symbiotic luminescent bacteria. Biodegradation of recalcitrant compounds: Pesticides and Petroleum; Bioremediation: *Insitu* and *Ex situ* remediation, Bioremediation of oil spills; Bioaugmentation; Biomagnification; Biomineralization; Microbial plastics; Biodiesel.

Unit –V

Waste Management and Water Potability (13 Hrs)

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (Composting and Sanitary landfill). Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (Oxidation ponds,Trickling filter, Activated Sludge process and Septic tank) and Tertiary Sewage treatments. Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique

Text Books:

1.Satyanarayana, T., Johri, B.N. and Prakash, A. Microorganisms in environmental management: Microbes and environment. Springer Verlag, New York.
2. Madigan, M.T., Martinko, J.M. and Parker, J. Brock biology of microorganisms. PrenticeHall, New Jersey.

Reference Books:

1.Alexander, M. Microbial ecology. John Wiley and Sons, New York.
2. Eldowney, S., and Waites, S. Pollution: Ecology and biotreatment. Longman, Harlow.
3. Baker, K.H. and Herson, D.S. Bioremediation. McGraw- Hill, New York.
4. Marshal, K.C. Advances of microbial ecology. Plenum Press, New York.5.
6. Chapman, J.L. and Reiss, M.J. Ecology: Principles and applications. Cambridge UniversityPress, Cambridge.
7. Heywood, V.H. and Watson, R.T. Global biodiversity assessment. Cambridge UniversityPress, Cambridge.
8. Kormondy, E.J. Concepts of ecology. Prentice-Hall, New Delhi.
9. Odum, E.P. Basic ecology. Saunders, Philadelphia.
10. Mitchell, R. and Gu, J.D. Environmental microbiology. Wiley-Blackwell, New Jersey.
11. Maier, R., Pepper, I. and Gerba, C. Environmental microbiology. Academic Press, SanDiego.
12. Evans, G.M. and John, J.C.F. Environmental biotechnology: Theory and applications. JohnWiley and Sons, New York.

FOOD AND DAIRY MICROBIOLOGY
MIC010

Total Number of Credits: 4
TOTAL HOURS: 60h

Course Description: The course provides Microbiology students with a comprehensive understanding of the role of microorganisms in food and dairy products, emphasizing both theoretical knowledge and practical skills essential for careers in food science.

Course Outcomes (COs)

Upon successful completion of the course the student will

CO1.Understand the factors affecting the growth of microorganisms in food.
CO2.Gain knowledge on the principles of food preservation.
CO3.Gain understanding on the spoilage of various foods.
CO4. Knowledge on Food Safety and Quality Assurance
CO5.Describing the manufacturing process of some fermented foods with the help of some microbes.

Unit – I

Food as a substrate for microorganisms (10 hours)

Food as a substrate for microorganisms – microorganisms important in food microbiology: molds, yeasts and bacteria – factors affecting the growth of microorganisms in food.

Unit- II

Principles of Food Preservation (12 hours)

Factors influencing microbial growth in food; Asepsis; Food preservation: Principles, Physical methods (Dehydration, freeze drying, heat and irradiation), Chemical methods (Chemical preservatives and food additives); Canning; Processing for heat treatment (D, Z and F values)and working out treatment parameters.

Unit- III

Foodborne Infections and Intoxications (12 hours)

Bacterial and nonbacterial infections and intoxications of Brucella, Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio, Yersinia, Listeria, nematodes, fungi and viruses; Laboratory testing procedures.

Unit- IV

Food Safety and Quality Assurance (12 hours)

Food sanitation in manufacture and retail trade; Microbiological quality standards of food; Food control agencies and their regulations: FDA, EPA, CDC and ISI; Good Manufacturing Practice; Plant sanitation (Employees health standards, waste treatment and disposal); Hazard Analysis and Critical Control Point (HACCP) system; Food Safety Act and Trade Regulations.

UNIT-V

Fermented Milk and food Products (14 hours)

Microbiology of Fermented Milk-Starter Lactic Culture; Industrial production and nutritional values of milk based fermented foods like Curd, Yoghurt, Kafir, Butter Milk

and Cheeses.Industrial production and nutritional values of Grain based Fermented foods like Soysauce, Bread, Idli, Dosa,Meat product s; Microorganisms and production process of Sausages and Sauces. Fermentation techniques and Importance of Sauerkraut, Kanji, Cucumber Pickle, Olives and Mixed vegetables pickles.

Text Books

1. Frazier W.C. and Westhoff D.C. (2008) Food Microbiology, 4th Edn. Tata McGrawHill Publishing Co., New Delhi.
2. Bamforth C.W. (2005) Food, Fermentation and Microorganisms, Blackwell Science.

Reference Books

1. Doyle M.P. and Buchanan R.L. (Ed.) (2013) Food Microbiology: Fundamentals andFrontiers, 4th Edn. ASM press.
2. Jay J.M., Loessner M.J. and Golden D.A. (2005) Modern Food Microbiology, 7th Edn.Springer Publishers.
3. Robinson R.K. (2002) Dairy Microbiology: Milk and Milk Products, 3rd Edn. Wiley Publishers.
4. Adams, M.R., and Moss, M.O. Food microbiology. Royal Society of Chemistry Publication,Cambridge.
5. James M.J. Modern food microbiology. CBS Publishers and Distributors, New Delhi.
6. Wood, B.J. Microbiology of fermented foods. Elsevier Applied Sciences, London.
7. Ayres, J.C., Mundt, O. and Sandinee, W.E. Microbiology of foods. W.H. Freeman andCompany, New York.
8. Jay, M.J., Loessner, M.J. and Golden, D.A. Modern food microbiology. Springer Science andBusiness Media, New York.

II SEMESTER
LAB COURSE-I (MIC011)

(Based on Theory Papers MIC007 AND MIC008)

1. Preparation of buffers for Molecular Biology experiments.
2. Visualization of DNA by Agarose Gel Electrophoresis.
3. Qualitative and Quantitative analyses of nucleic acid by Spectrophotometric method.
4. Estimation of concentration of DNA by Diphenylamine method.
5. Estimation of concentration of RNA by Orcinol method.
6. Estimation of G+C content of a given DNA sample by denaturation and plotting of melting curve
7. Separation and preservation of serum and plasma.
8. Determination of blood group and Rh factor.
9. To perform WIDAL test
10. To perform RPR test.
11. Determination of concentration of antigen by ELISA
12. Direct Coombs testing
13. Indirect Coombs testing
14. To perform antigen antibody reactions from samples of different blood groups

Practical Books

1. Cappucino, J. and Sherman, N. Microbiology: A laboratory manual. Benjamin/CummingsPublishing Company, San Francisco.
2. Prescott, L.M. and Harley, J.P. Laboratory exercises in microbiology. William C. Brown,Dubuque.
3. White, D. and Hegeman, G.D. Microbial physiology and biochemistry laboratory: Aquantitative approach. Oxford University Press, New York.
4. Aneja, K.R. Experiments in microbiology, plant pathology and biotechnology. New AgeInternational (P) Limited, New Delhi.
5. Atlas, R.M., Brown, A.E. and Parks, L.C. Laboratory manual of experimental microbiology.Mosby College Publishing Company, St. Louis.
6. Kannan, K. Laboratory manual in general microbiology. Panima, New Delhi.
7. Holt, J.G. and Krieg, N.R. Bergey's manual of determinative bacteriology. LippincottWilliams and Wilkin, Philadelphia.
8. Rose, N.R., Hamilton, R.G. and Detrick, B. Manual of clinical laboratory immunology. ASMPress, Washington, D.C.
9. Weir, D.M. Handbook of experimental immunology. Blackwell Scientific Publications, NewJersey.
10. Stafseth, H.J., Stockton, J.J. and Newman, J.P. A laboratory manual for immunology.Burgess Publishing Company, Stockland

II SEMESTER
LAB COURSE-II (MIC012)

(Based on Theory Papers MIC009 AND MIC0010)

1. Analysis of Soil- pH, moisture content, Water holding capacity.
2. Isolation of Microbes (Bacteria & Fungi) from Soil
3. Isolation of Rhizobium from Root nodules.
4. Assessment of Microbiological quality of Water.
5. Determination of BOD of waste water sample.
6. Study the presence of microbial activity by detecting (qualitatively) Enzymes (Amylase, Urease) in Soil.
7. Isolation of Microbes (Bacteria & Fungi) from Rhizosphere and Rhizoplane.
8. Quantitative analysis of milk by standard plate count method.
9. Test of quality of milk by methylene blue dye reduction test.
10. Isolation of lactobacillus from milk and curd .
11. Isolation of bacteria and fungi from spoiled food.
12. Microbial populations in fruit juices, soft drinks and ice cream.
13. Production of Sauerkraut and Estimation of lactic acid production in sauerkraut.

Practical Books

1.Cappucino, J. and Sherman, N. Microbiology: A laboratory manual. Benjamin/CummingsPublishing Company, San Francisco.

2.Prescott, L.M. and Harley, J.P. Laboratory exercises in microbiology. William C. Brown,Dubuque.

3. McLandsborough, L. Food microbiology laboratory. CRC Press, Boca Raton.

4.. Harrigan, W.F. Laboratory methods in food microbiology. Gulf Professional Publishing,Houston.