

MASTER OF SCIENCE

IN

MICROBIOLOGY

(Choice Based Credit System- semester system)

COURSE STRUCTURE & REVISED SYLLABUS

Syllabus of (M.Sc. Microbiology)

(For Fourth and Fifth Years of Higher Education (PG))

As per Guidelines of U.P. Government, according to the National Education Policy- 2020

(Effective from academic year 2025-26 onwards)

(For both University Campus and Colleges)



DEPARTMENT OF MICROBIOLOGY

DR. SHAKUNTALA MISRA NATIONAL REHABILITATION UNIVERSITY,

MOHAAN ROAD, LUCKNOW

INDIA-226017

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DEPARTMENT OF MICROBIOLOGY

The Department of Microbiology, Dr. Shakuntala Misra National Rehabilitation University, Lucknow, is a premier centre for the study of basic and advance concepts of microbiology. The Department was established in 2015 with an intake of 40 students in M.Sc. Microbiology (50% of seats are reserved for physically challenged students). The university campus has established a world-class infrastructure to encourage research-based teaching and applied learning. The department has a contemporary infrastructure with a team of highly motivated faculty members in microbiology. In M.Sc. Microbiology students get acquainted with various fields of microbiology, such as industrial, agricultural, molecular, environmental, medical, food and dairy microbiology. The Lab of the department is equipped with classical and modern instruments, including Autoclaves, Laminar air flow, BOD incubators, orbital shakers, bright field, phase contrast and dark field microscopes, horizontal and vertical electrophoresis apparatus, gel documentation system, pH meter, stagnant and shaking water baths, etc. Students receive hands-on training on all instruments during their class practicals and in the fourth semester to complete their dissertations. The department alumni are pursuing higher education in various reputed institutes in India and abroad.

Vision

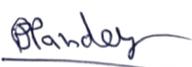
The department's vision is to find solutions to global challenges with one of the most efficient consortia of microbiologists worldwide.

Mission

The mission of the Department is to provide avant-garde research and teaching in Microbiology.

CHOICE-BASED CREDIT SYSTEM (CBCS)

The CBCS allows the students to choose courses from the prescribed courses, which are core, elective/minor, or skill-based. The courses can be evaluated by a grading system, which is considered better than the conventional marks system. The grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on a student's performance in examinations, which enables the student to move across institutions of higher learning. The uniformity in the evaluation system also allows potential employers to assess the performance of the candidates.


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DEPARTMENT OBJECTIVES

1. To offer courses within the National Education Policy (NEP-2020) to enhance the intellectual foundation and help students survive and lead life in a complex, dynamic, competitive world.
2. To preserve, add to, evaluate and transmit knowledge in Microbiology.
3. To help students prepare for their careers in various fields of microbiology and serve society by promoting awareness about different aspects of microbiology.
4. To prepare students with in-depth knowledge and research skills for professional careers in Microbiology and to serve society.

PROGRAM EDUCATIONAL OBJECTIVES

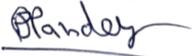
The Program Educational Objectives (PEOs) for M.Sc. Microbiology describes accomplishments that students are expected to attain after completion of their course:

- PEO-1:** To exhibit the ability to pursue careers in the industries of agriculture and applied research where microbial systems are increasingly employed.
- PEO-2:** To address the increasing need for skilled scientific human resources in microbiology for the advancement and implementation of knowledge in interdisciplinary areas.
- PEO-3:** To exhibit excellent professional, communication and ethical attributes as an effective team member in a competitive global environment.
- PEO-4:** To demonstrate the right mix of innovative ability, equipped with self-start-up skills, contributing to self and national development.
- PEO-5:** The students will be cognizant and responsive to societal needs and possess the initiative and critical acumen to improve their knowledge through lifelong learning.

PROGRAM OUTCOMES

This program will help postgraduates to:

- PO1:** Knowledge and technical skills related to the microbiology laboratory for quality clinical investigations for community welfare.
- PO2:** To conduct independent research, safely and efficiently use basic laboratory techniques and equipment.
- PO3:** Perform advanced molecular microbial methods including polymerase chain reaction, SDS-PAGE, agarose gel electrophoresis, western blotting, Southern blotting, transformation and transduction, etc.


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2





- P04:** Conduct routine clinical laboratory procedures within acceptable quality control parameters in bacteriology, virology, mycology, parasitology and immunology.
- P05:** Evolve problem-solving skills in identifying and correcting pre-analytical, post-analytical & analytical variables.
- P06:** Demonstrate technical skills, social behaviour and functioning effectively as a microbiology specialist.
- P07:** Maintain and operate laboratory equipment utilising appropriate quality control and safety procedures.
- P08:** Identify the impact of laboratory tests in a global and environmental context.
- P09:** Perform as a leader/team member in diverse professional and industrial research areas.
- P010:** Use the fundamentals of the research process to complete and present research studies that enrich all areas of advanced research.
- P011:** Gain practical knowledge through dissertations at various institutes and industries.
- P012:** Ability to inculcate an attitude of inquiry towards developing innovative ability and enhancing entrepreneurship skills.

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Dr. Anurag K. Singh

DEPARTMENT OF MICROBIOLOGY
M.Sc. Microbiology

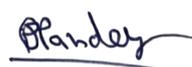
First Year

{First Year of Two-Year Master of Science (Course /Research) in Microbiology}

{Fourth Year of Bachelor of Science (Course /Research) in Microbiology}

Semester I						
Paper Code	Paper Title	Type	Credits	Marks		Total Marks
				Internal Assessment	External Assessment	
MB101	General Microbiology	Core Paper	4	25	75	100
MB102	Instrumentation and Modern Analytical Techniques	Core Paper	4	25	75	100
MB103	Bioinformatics, Biostatistics and IPR	Core Paper	4	25	75	100
MB104	Immunology	Core Paper	4	25	75	100
MB105	Practical	Core Paper	4	25	75	100
Total			20	125	375	500

Semester II						
Paper Code	Paper Title	Type	Credits	Marks		Total Marks
				Internal Assessment	External Assessment	
MB201	Medical Microbiology	Core Paper	4	25	75	100
MB202	Microbial Physiology and Biochemistry	Core Paper	4	25	75	100
MB203	Industrial Microbiology	Core Paper	4	25	75	100
MB204A	Nutritional Therapy	Core Paper (optional)	4	25	75	100
MB204B	Agricultural Microbiology					
MB205	Practical	Core Paper	4	25	75	100
Total			20	125	375	500


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DEPARTMENT OF MICROBIOLOGY
M.Sc. Microbiology

Second Year

{Second Year of Two-Year Master of Science (Course) in Microbiology}

{One-year Master of Science (Course) in Microbiology}

Semester III						
Paper Code	Paper Title	Type	Credits	Marks		Total Marks
				Internal Assessment	External Assessment	
MB301A	Food Microbiology and Toxicology	Core Paper (optional)	4	25	75	100
MB301B	Pharmaceutical Microbiology					
MB302	Molecular Microbiology	Core Paper	4	25	75	100
MB303	Recombinant DNA Technology	Core Paper	4	25	75	100
MB304A	Epidemiology	Core Paper (optional)	4	25	75	100
MB304B	Food and Water-Borne Diseases					
MB305	Practical	Core Paper	4	25	75	100
Total			20	125	375	500

Semester IV						
Paper Code	Paper Title	Type	Credits	Marks		Total Marks
				Internal Assessment	External Assessment	
MB401	Microbial Genetics	Core Paper	4	25	75	100
MB402A	Environmental Microbiology	Core Paper (optional)	4	25	75	100
MB402B	Modern Immunological Techniques					
MB403A	Lab Diagnosis	Core Paper (optional)	4	25	75	100
MB403B	Food Safety					
MB404A	Virology	Core Paper (optional)	4	25	75	100
MB404B	Food Processing, Preservation and Packaging					
MB405	Practical	Core Paper	4	25	75	100
Total			20	125	375	500

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DEPARTMENT OF MICROBIOLOGY
M.Sc. Microbiology

{Second Year of Two-Year Master of Science (Research) in Microbiology}

{One-year Master of Science (Research) in Microbiology}

Semester III						
Paper Code	Paper Title	Type	Credits	Marks		Total Marks
				Internal Assessment	External Assessment	
MB301R	Molecular Microbiology	Core Paper	5	25	75	100
MB302R	Recombinant DNA Technology	Core Paper	5	25	75	100
MB303R	Research Project	Core Paper	10*	_*	_*	_*
Total			20	50	150	200

*Credits and marks will be awarded in fourth semester

Semester IV						
Paper Code	Paper Title	Type	Credits	Marks		Total Marks
				Internal Assessment	External Assessment	
MB401R	Microbial Genetics	Core Paper	5	25	75	100
MB402R	Virology	Core Paper	5	25	75	100
MB403R	Research Project	Core Paper	10+10*	50*	150*	200*
Total			30	100	300	400

*Credits and marks of the third semester, awarded in fourth semester

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Internal Assessment Scheme

Internal Assessment	Marks
Class Interaction/Test	10
Quiz	5
Seminar	5
Assignment (Charts/Rural Service/Technology Dissemination/field visits with report)	5
Total	25

For practical purposes, the distribution of marks will be as follows

Internal Assessment	Marks
Practical class interaction	4
Viva voce	5
Two practical-based exercises	8 (4+4)
Charts/model/ collection	8
Total	25

For the external practical examination, the marks distribution will be as follows.

External Assessment	Marks
Viva voce on practicals	10
Report of field visit/lab visits/industrial visit/survey/collection/models with reports	10
Table work/experiments	45
Practical record file	10
Total	75

All rules for examination pattern, pass credit and admissions shall be the same as for the other post-graduate courses in the Faculty of Science, DSMNRU Campus. Minimum eligibility for admission in a two-year M.Sc. (Microbiology) course shall be B.Sc. (Biology group / Medical / Paramedical) / M.B.B.S. / B.V.Sc. / B. Pharma / B.M.L.T. and allied subjects. The Coordinator, Department of Microbiology, is authorised to decide the eligibility criterion further and add/delete any reading material in the course(s). There shall be 25% internal and 75% external assessment in all the aforesaid courses. The Department shall decide the pattern of internal assessment; however, it will mainly be based on tests, quizzes, seminars, term papers, group discussions, industrial visits and home assignments. The candidates who opted research mode will have to complete a dissertation/project in third and fourth semesters. At the end of the fourth semester, the dissertation/project report shall be submitted. The Board of Examiners will jointly evaluate it. The candidate will make an open short presentation and defend their experimental design, results and conclusions. The Department shall be free to alter the sequence of the courses in any semester, depending upon the resources available.

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7

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Research Project:

At the end of the 5th year/10th semester (M.Sc.), the candidate will submit a research project, which an external examiner and internal supervisor will evaluate along with a presentation and viva-voce examination.

In the M.Sc., second year/fifth year of the B.Sc. programme, or at the start of the M.Sc. final, the research project topic will be chosen along with the core compulsory courses/core elective courses of that year.

In the third and fourth semesters, students choosing the research mode will work 10 hours/week/semester for 10 credits each. In this way, a project will have 10 credits (i.e. 20 credits for two years).

The research dissertation/project may be interdisciplinary/ multidisciplinary. It may be industrial training, internship, or survey work. **The research project will be done under the guidance of the faculty member (s), preferably having a Ph.D. degree.** For this, a co-supervisor may be chosen from a university, college, industry or research institute, etc.

The research project will be worth 200 marks. If any student publishes a research paper from his/her research project in a UGC care-listed/Scopus-indexed or Web of Science, he/she will get 50 extra marks (although the maximum marks will not exceed 200). The marks obtained in the research project will be coded in grades and counted in the CGPA calculation.

Credits:

The MSc programme will be run semester-wise and on a choice-based credit system.

M.Sc. 1st year or B.Sc. 4th year will be of 40 credits, whereas M.Sc. 2nd year will be of 40 credits. Each semester will be of 20 credits of courses for course-based mode (4 theory+1 practical, each will be of 4 credits) for Research mode {4 theory+1 practical, each will be of 4 credits (first year) 2 theory (10 credit) + 1 research project (10 credit) (second year/both semester)} and thus the credits of two years (4 semesters) will be 80 credits. Therefore, the M.Sc. programme will be 80 credits.

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FIRST YEAR

FIRST SEMESTER

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9

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Semester -1

Course MB101: General Microbiology

Course Learning Objectives

- To provide information on the history, relevance and scope of microbiology.
- To provide deep knowledge on Bergey's Manual of Determinative Bacteriology.
- To provide in-depth knowledge about the classification and taxonomy of microorganisms.
- To provide detailed knowledge on the morphology of microbes and their growth requirements.
- To provide a broad knowledge of the different types of culture media and isolation, cultivation and enumeration of microorganisms.
- Provide in-depth knowledge of microbial preservation techniques.
- To provide information on viruses, their life cycle and cultivation techniques.

Unit I: History and scope of microbiology:

History of microbiology, scope and relevance of microbiology in current scenario.

Unit II: Classification and morphology of bacteria:

Classification of microbes (three kingdom, five kingdom, eight kingdom and three domain concept), numerical and molecular taxonomy, introduction to the Bergey's manual of determinative bacteriology; general characters of major groups of eubacteria. Morphology of bacteria (cell, size, shape, cell membrane, flagella, pili and capsule), structure, function and chemical composition of bacterial cell wall.

Unit III: Classification and morphology of Archaea:

Classification of Archaea, general characteristics of *Methanobacterium*, *Methanococcus*, *Methanomicrobium*, *Methanosarcina*, *Halobacterium* and *Thermococcus*; adaptations and role of Archaea in the evolution of microbial world and its cell wall structure.

Unit IV: Cultivation techniques of bacteria:

Concept of Microbial Growth and Nutritional Requirements. Preparation and types of culture media (synthetic, enriched, selective, differential, indicator media), preservation and maintenance techniques of pure culture. Physical and chemical factors affecting microbial growth.

Unit V: Classification, structure and life cycle of viruses:

General characters of viruses: morphology, capsid and their arrangement, nomenclature and classification. Cultivation of viruses: animal inoculation, embryonated eggs, cell culture. Bacteriophages: structure and life cycle patterns of lytic phages-T7 and T4, lysogenic phages- & P1, M13 & ϕ X174, structure of cyanophages and mycobacteriophages. Recombination and genome mapping in viruses

Courses Learning Outcomes

- Will be able to know the microbial structure, metabolism and their existence in nature.
- Will know isolation, maintenance and preservation of microbial culture.
- Will know nomenclature, taxonomic trends and major characteristics used in taxonomy.
- Will know the discovery, classification, structure and importance of viruses.

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Course MB102: Instrumentation and Modern Analytical Techniques

Course Learning Objectives

- To provide information on microscopy and staining methods that help to observe microorganisms.
- Gives insights into electrochemical and spectroscopy concepts to analyse biomolecules.
- Provide in-depth knowledge of separation techniques such as centrifugation, electrophoresis and chromatography commonly used to purify biomolecules.

Unit I: Microscopy:

Microscopy: light, dark field, phase-contrast, epifluorescence, confocal and Electron Microscopy (TEM and SEM), fixation techniques for EM. Micrometry.

Unit II: Staining and sterilization procedures:

Basic principles and applications of staining: specimen preparation, simple, gram, capsule, flagella, endospore, acid-fast, fluorochrome and nucleic acid staining. Principles of sterilization techniques (physical and chemical methods), evaluation of antimicrobial agent effectiveness. Principle and method of sterilization by instruments (Hot air oven, Autoclave), BOD incubator, Laminar Air Flow and Biosafety cabinets.

Unit III: Chromatography:

Principles and applications of chromatography (partition and adsorption), paper, thin-layer, column, size exclusion, ion exchange, affinity chromatography, GLC, HPLC and FPLC.

Unit IV: Spectrophotometry:

Interaction of radiation with matter, α , β , γ -rays; absorption (Beer-Lambert's law) and emission. Principles and applications of spectrophotometry: UV-visible, IR, fluorescence, NMR, ORD/CD, flow cytometry, X-ray crystallography.

Unit V: Miscellaneous techniques:

Principles and applications of electrophoresis: agarose gel electrophoresis, SDS- and native PAGE, isoelectric focusing, 2D-gel electrophoresis. Centrifugation, ultracentrifugation, differential centrifugation. Dialysis, ultrafiltration.

Courses Learning Outcomes

- Will know the principles, instrumentation and applications of Microscopy.
- Will be able to know the principles, instrumentation and applications of spectroscopy and other analytical techniques to purify and characterise biological macromolecules.
- Will know the principles, methods and applications of separation techniques.

Course MB103: Bioinformatics, Biostatistics and IPR

Course Learning Objectives

- To provide basic knowledge of computer systems and the Internet.
- To provide basic knowledge of bioinformatic networks such as NCBI and GenBank.
- To provide a basic understanding of statistical data, its analysis and its utilisation in biological science.
- To provide knowledge on statistical test methods and research methodology.
- To provide a basic understanding of the intellectual property concept.
- To provide knowledge of thesis writing.

Unit I: Basic concept of bioinformatics:

Generations of computer hardware and software; number system, translators (compiler & interpreter), Introduction of Bioinformatics and applications. Information network: web browser and address (GeneBank and Biological databases; NCBI, DDBJ, EMBL, TIGR and PDB, etc), BLAST, FASTA file format, sequence alignment

Unit II: Application of bioinformatics in microbiology:

Databases: information resources for protein and genomics, alignment, phylogenetic analysis; phylogenetic software (MEGA 11.0), fundamentals of phylogenetic tree building and evaluation, interpretation of paralogues and orthologues.

Unit III: Introduction to statistics:

Range, Mean, median, mode, standard deviation, Probability distribution, Chi-square test, 't' and 'f' test, analysis of variance, standard error, linear regression, Sample, Population and sampling methods.

Unit IV: Intellectual Property Concept:

Intellectual Property Rights (IPR), Patents, Trademarks, Copyrights. Introduction to Patenting of Microbiological Materials and GMOs, Implications of Patenting, Current Issues, Patenting of Genes and DNA Sequences.

Unit V: Project and research article drafting:

Concept of plagiarism, project report structure (Introduction, literature review, Materials and Methods, Results, Discussion, Summary, Conclusion and Reference).

Course Learning Outcomes

- Will be able to know the computer system and its functions.
- Will be able to know bioinformatics and its uses in microbiology.
- Will be able to know biological databases and their usage.
- Will be able to know the importance of the patent process and ethics of research reports.
- Will be able to write their project report and thesis.

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Course MB104: Immunology

Course Learning Objective

- To provide detailed information about cells and organs of the immune system.
- To provide in-depth knowledge about antigen-antibody interaction.
- To provide detailed knowledge about immunopathology.
- To provide core concepts in transplantation and transfusion immunology.

Unit I: Basics of the immune system:

Overview of the immune system, innate and adaptive immune system, humoral and cell-mediated immune responses, cells and organs of immune system involved in innate and adaptive immunity, primary and secondary lymphoid organs, antigens, structure and function of antibody molecules, antibody classes and biological activities, heptanes, adjuvants, antigenicity and immunogenicity, factors that influence immunogenicity, antigenic determinants on immunoglobulin (isotype, allotype and idiotype).

Unit II: Antibody diversity and engineering:

B and T cell epitopes, generation of antibody diversity, monoclonal antibodies and antibody engineering.

Unit III: Antigen processing and presentation:

Antigen-antibody interactions, antigen processing and presentation, maturation, activation and differentiation of B and T cells, B and T cell receptors, toll-like receptors, natural killer cells, antigen-presenting cells, cytokines, interleukins, interferons.

Unit IV: MHC, complement system and hypersensitivity:

Major histocompatibility complex (MHC), complement system, hypersensitivity (IgE mediated, antibody mediated, immune complex mediated and delayed type).

Unit V: Principles of Immuno-techniques:

Strength of antigen-antibody interaction; precipitation reaction, agglutination reactions, radioimmunoassay, enzyme-linked immunosorbent assay, western blot, autoimmunity, vaccines, AIDS and HIV.

Course Learning Outcomes

- Will be able to describe immunology basics.
- Will understand the theoretical principles of immunology and in vitro serological tests.
- Will be able to understand allergic reactions.
- Will be able to explain immune cells and the immune organ developmental processes.

MB105A: Food Quality Testing

Course Learning Objectives

- To provide information for qualitative assessment of various food products
- To provide information to preserve the milk products, fruits and vegetables

Unit I: Food adulterants:

Microbiological and chemical examination of typical food adulterants in wheat, flour, sugar, turmeric, ground coriander, salt, vegetable oils, ghee, honey, etc.

Unit II: Microbial analysis of fruits and vegetables:

Microbiological examination of seasonal fruits and vegetables for the occurrence of common disease-causing pathogens.

Unit III: Microbial analysis of milk and milk products:

Milk and milk products- quality testing, chemical and microbiological analysis, common diseases caused by infected milk and milk products- their prevention and cure.

Unit IV: Microbial analysis of stored and frozen food and beverages:

Microbiological and chemical examination of low temperature stored food and beverages, frozen vegetables, pizza, soya cheese, ice cream, frozen yoghurt, frozen soup, soft drinks.

Unit V: Food preservatives:

Common food preservatives and their effect on human health.

Courses Learning Outcomes

- Will be able to know about the basics of food microbiology, contamination and spoilage of different food items.
- Will be able to understand the adverse effects of adulterants on human health and their prevention

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MB105B: Health and Hygiene

Course Learning Objectives

- To provide information about key health indicators and future challenges in public health.
- To provide information about role of Public, Private and NGO in health sector
- To provide information about epidemiological diseases

Unit I: Introduction to health and hygiene:

Individual health parameters, Determinants of Health, Key health indicators, Burden of diseases, Importance and Source of Public-health Data Health status in India: Standards, Relevance to social aspects, Future challenges in public health.

Unit II: Public health and nutrition:

Personal health, Food safety, quality control and hygiene: Personal and domestic Hygiene. Classification of nutritional profiles of various foods and drinks, Balanced Diet, Nutritional Problems, Demography and Family Planning.

Unit III: Role of Public, Private and NGO in health sector:

Expenditure in Healthcare, Government Plans and Policies in India, The Global Health Council, The International AIDS Vaccine Initiative, Malaria Vaccine Initiative, World Health Organisation (WHO).

Unit IV: Community diseases, prevention and control:

Common Community Diseases like: Chikungunya, Dengue, Malaria, Cholera, T.B., HIV/AIDS, Hepatitis: Their prevention and control.

Unit V: Epidemic diseases:

Epidemiology and history of epidemiological diseases in India with special reference to COVID-19, Route of Transmission of Disease, Communicable and Noncommunicable diseases.

Courses Learning Outcomes

- Will be able to know about the hygienic cleaning processes and their effect on human health.
- Will be able to know concepts of housing hygiene and health.
- Will be able to understand the role of the public and government in Health promotion.

Course MB106: Practicals* based on course MB101 to MB104

- Determination of growth of bacteria by measuring wet and dry weight.
- Media preparation, sterilization, inoculation and incubation methods.
- Demonstrate the pour plate, spread plate and streaking methods.
- Studying the effect of pH on bacterial growth.
- Studying the oxygen requirement of the given sample.
- Demonstration of specific growth rate and generation time.
- Isolation of fungus from soil using serial dilution.
- Isolation of bacteriophages from sewage sample.
- Estimation of infectivity titre of virus sample using plaque assay.
- To separate plant pigments using paper chromatography.
- To evaluate the effectiveness of alcohol.
- Study of compound Microscope.
- To calibrate objective of microscope using stage micrometre.
- To perform staining techniques on given sample.
- To study protein purification using various column chromatography methods.
- To perform SDS-PAGE and native PAGE on given protein sample.
- Usage of NCBI, PUBMED resources.
- Construction of phylogenetic tree.
- Exercise based on BLAST.
- To study various software for gene identification.
- To identify your blood group and Rh factor.
- Counts blood cells in the given sample.
- To study the morphology and staining characteristics of lymphocytes, neutrophils, monocytes, eosinophils and basophils from your blood sample.

**Number and type of practicals may vary depending on the availability of resources*

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16

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Semester Outcomes: First Semester

After completing the first semester, students will gain comprehensive knowledge of microbiology from history to modern applications. They will develop an in-depth understanding of microbial classification and taxonomy. They will also learn essential techniques for isolation, characterisation, maintenance and preservation of microbial cultures. Additionally, the students will become proficient in using advanced methods and equipment, enhancing their research and experimental skills. They will also learn how to apply these advanced techniques in their studies. Furthermore, students will gain basic knowledge in bio-statistics, which is essential for designing experiments, analysing data and interpreting results accurately. Knowledge of Intellectual Property Rights (IPR) will help students to understand how to protect their research findings and innovations. The students will also learn to write projects and research articles effectively, enabling them to communicate their research findings clearly and professionally. These outcomes will give students a solid foundation for advanced studies and successful careers in microbiology and related fields.

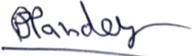
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Dr. Anurag Kumar

Recommended Books:

1. Michael, T. M., and John, M. M., David, S. Brock Biology of Microorganisms. Benjamin Cummings.
 2. Willey, J., Sherwood, L., and Woolverton, C. Prescott's Microbiology. McGraw-Hill Education.
 3. Pelczar, M. J., Chan, E. C. S., and Krieg, N. R. Microbiology. McGraw-Hill Education (India) Private Limited.
 4. Talaro, K. P., and Talaro, A. Foundations in Microbiology. McGraw-Hill.
 5. Wilson, K., and Walker, J. Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.
 6. Mount, D. Bioinformatics Sequence and Genome Analysis. Cold Spring Harbour Laboratory Press.
 7. Kindt, T. J., Barbara, A.O., and Goldsby, R. A. Kuby Immunology. W. H. Freeman & Company.
 8. Peter, J. D., Seamus J. M., Dennis, R. B. and Ivan, M. R. Roitt's Essential Immunology. Wiley-Blackwell.
 9. Banwart, G.T. Basic Food Microbiology. CBS Publishers.
 10. Frazier, W. C. Food Microbiology. Mc. Graw Hill.
 11. Hobbs, B. C., and Roberts, D. Food poisoning and hygiene. Arnold Publisher.
 12. Mountney, G. Practical Food Microbiology & Technology. Krieger Publishing Company.
 13. Brooks, G. F., Karen, C. C., Janet, S. B., Stephen, A. M., and Timothy, A. M. Jawetz, Melnick and Adelberg's Medical Microbiology. McGraw-Hill Education.
 14. Gordon, E., and Golanty, E. Health & Wellness. Jones & Bartlett Publisher.
 15. Robert, S. B. Principles of Public Health Microbiology. Jones & Bartlett Publishers.
 16. Richard, S. Global Health 101. Jones & Bartlett Learning.
 17. Schneider, M. J., Introduction to Public Health. Jones & Barlett.
 18. De la Maza, L. M., and Pezzlo, M. T. Colour Atlas of Diagnostic Microbiology. Jones & Bartlett Learning.
 19. Pommerville, J. C. Alcamo's Laboratory Fundamentals of Microbiology. Jones & Bartlett Learning.
 20. Cappuccino, J., and Sherman, N. Microbiology: A Laboratory Manual. Pearson Benjamin Cummings.
 21. Brown, A. E., and Benson, H. J. Benson's Microbiological Applications: Laboratory Manual in General Microbiology. McGraw-Hill Higher Education.
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FIRST YEAR

SECOND SEMESTER

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19

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Semester- 2

Course MB201: Medical Microbiology

Course Learning Objective

- To provide knowledge on microbial infections and pathogenesis.
- To provide detailed knowledge on the principles of chemotherapy.
- To provide detailed knowledge of symptoms and methods of diagnosing a microbial infection.
- To provide detailed knowledge of symptoms of viral, fungal and parasitic diseases.

Unit I: Introduction to medical microbiology:

Normal flora of human body (skin, oral and gut), clinical sample collection and serological testing for important pathogens (bacterial, viral and fungal),

Unit II: Bacterial diseases:

Important human bacterial diseases caused by *Staphylococcus*, *Pneumococcus*, *Neisseria*, *Bacillus*, *Corynebacterium*, *Clostridium*, *Pseudomonas*, *Yersinia*, *Haemophilus*, *Mycobacterium*, *Nocardia*, *Klebsiella*, *Salmonella*, *Shigella*.

Unit III: Fungal diseases:

Phycomycosis; Candidiasis, *Fusarium*, *Cryptococcus*, *Pneumocystis*, Dermatophytosis; Aspergillosis; Otomycosis, Cutaneous and subcutaneous mycoses; Zygomycoses, *Histoplasma*, *Blastomyces*, *Coccidioides*, *Systemic mycoses*; *Trichophyton*, *Microsporum*, *Epidermophyton*, Opportunistic mycoses; *Rhizopus*, *Rhizomucor*, *Absidia*. Antifungal agents and susceptibility test.

Unit IV: Protozoan diseases:

Malaria, sleeping sickness, amoebiasis, leishmaniasis, Giardiasis.

Unit V: Viral diseases:

Algorithms for detection and identification of viruses: Mumps, Measles, Influenza, Adenovirus, Enterovirus, Rhinovirus, Poxvirus, Hepatitis A, B, C, D and G virus, rabies virus, polyoma viruses, Epstein-Barr virus, Herpes virus, HIV, Varicella zoster virus, tumour viruses and Japanese encephalitis virus (JEV). Antiviral agents and susceptibility test.

Course Learning Outcomes

- Will be able to understand various microbial infections, their causative agents and protection methods.
- Will be able to understand the diagnostic methods.
- Will be able to understand the symptoms of bacterial infections.
- Will be able to explain the symptoms of viral, fungal and parasitic diseases.

Course MB202: Microbial Physiology and Biochemistry

Course learning Objectives

- To provide basic concepts of chemistry of microbial physiology.
- To provide in-depth information on lipids and amino acids.
- To provide in-depth information on proteins and catalytic proteins.
- To provide in-depth information on nucleic acids, hormones and vitamins

Unit I: Basics of biochemistry and function of bio membrane:

Stabilising interactions: Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc. Structure of model membrane (lipid bilayer and membrane protein diffusion, osmosis, ion channels, facilitated diffusion, primary and secondary active and passive transport, membrane pumps). pH and buffers.

Unit II: Structural composition, function and metabolism of amino acids and proteins:

Proteins (amino acid, peptide bond, pathway of amino acid biosynthesis and degradation, human genetic disorder affecting amino acid catabolism, primary, secondary, tertiary and quaternary structure, Ramchandran plot, protein folding).

Unit III: Structural composition, function and metabolism of carbohydrates and lipids:

Carbohydrates (mono, di and polysaccharides), glycogenolysis, gluconeogenesis; lipid (lipid transport, cholesterol synthesis, fatty acid synthesis, β -oxidation, Ketogenesis).

Unit IV: Structural composition, function and metabolism of nucleic acids and vitamins:

Nucleic acids (different forms of DNA, biosynthesis and degradation of nucleotides) and vitamins.

Unit V: Enzyme kinetics and bioenergetics:

Classification, Michaelis-Menton kinetics, enzyme inhibition (competitive, uncompetitive, non-competitive and mixed); enzyme regulation, mechanism of enzyme catalysis, isozymes, ribozyme, energy production in the cell, ATP generation, glycolysis, shuttle system. TCA cycle, pentose phosphate pathway, urea cycle, glyoxylate cycle, electron transport chain (respiratory chain), oxidative and substrate-level phosphorylation, bacterial photosynthesis.

Courses Learning Outcomes

- Will be able to identify and analyse biological molecules such as carbohydrates, proteins and lipids.
- Will be familiar with behaviour of amino acids structure functional relationship of protein and their profiling.
- Will be able to know about various separation techniques such as centrifugation and electrophoresis.

Course MB203: Industrial Microbiology

Course Learning Objectives

- To give insight into isolating industrially viable microbes, the screening methods and industrial applications of microorganisms.
- To know about the critical parameters of industrial production of various value-added products in a fermentor.
- To provide insight into microbial transformation and key insights into antibiotic production.
- To provide detailed knowledge on producing malt beverages, distilled beverages and wine.

Unit I: Sources and characteristics of industrially potent microbes:

Isolation, purification and maintenance of industrially potent microbes. Screening of beneficial strains: primary and secondary screening. Strain improvement through random mutation, genetic recombination and genetic engineering. Microbial growth kinetics in batch, continuous and fed-batch fermentation.

Unit II: Bioreactor:

Basic principles, architecture and design of bioreactors (stirred tank, trickling filter, packed, air lift and photo bioreactor) and raw materials used in fermentation media. Solid state fermentation and submerged fermentation: their advantages and disadvantages.

Unit III: Commercial production of antibiotics:

Microbial transformations with special reference to steroids and alkaloids. Primary and secondary metabolites. Upstream and downstream processing of microbial products, commercial production of antibiotics with special reference to penicillin, streptomycin and their derivatives.

Unit IV: Microbial production of beverages and acids:

Malt beverages, distilled beverages, wine and champagne. Commercial production of organic acids (acetic, lactic, citric and gluconic acids).

Unit V: Commercial production of amino acid, insulin and vitamins:

Commercial production of critical amino acids (glutamic acid, lysine and tryptophan), production of recombinant products (insulin) and vitamins (vitamin B12, riboflavin and vitamin A).

Course Learning Outcomes

- Will be able to understand the difference and needs of both the fermenter and the fermentor.
- Will be able to understand the process economics of upstream and downstream processing
- Will be able to gain detailed knowledge about the production of therapeutic molecules and alcoholic beverages.

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MB204A: Nutritional Therapy

Course Learning Objectives

- To provide information on sources of nutrition, nutritional requirements of a healthy person
- To provide information on disease-causing agents present in food
- To give an insight into the diet management in health as well as in disease conditions
- To help reduce malnutrition and improve quality of life,

Unit I: Basics of nutritional requirements:

Nutrition and Nutritional requirements in humans, Artificial nutrition & types, Functional foods & types, Therapeutic nutrition, Nutritional supplements, Prebiotics & Probiotics, Nutraceuticals.

Unit II: Importance of microbes in food:

Food for humans: Use of microbes and microbial enzymes in improving the nutritional quality of food, Microbiological criteria for food, Fruit juices, Food control.

Unit III: Therapeutic nutrition and management for allergies:

Therapeutic nutrition in Nausea, constipation, Weight loss & Swallowing problems, Allergies, Food born allergies, Diagnosis and intolerance, Dietary management of food allergies, Pea nut allergy, Cow milk allergy.

Unit IV: Therapeutic nutrition and management for cancer, digestive and metabolic disorders:

Cancer, Cancer-causing dietary factors, Therapeutic nutrition and dietary management, Diets and Digestive disorders, Metabolic conditions of liver & Gallbladder; Hepatitis, Cirrhosis.

Unit V: Therapeutic nutrition and management for diabetes, obesity and renal dysfunction:

Diabetes & Diabetes types, complications, Therapeutic nutrition & management of diabetes, Fat and Cholesterol, Renal dysfunction, stones, Therapeutic nutrition & treatment.

Courses Learning Outcomes

- Will know the improved nutritional status, early recovery, improved immune status and quality of life following critical illness.
- We will understand that the overall use of resources can be reduced through nutrition counselling, oral diet, oral supplements, etc.

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Depace

MB 204B: Agricultural Microbiology

Course Learning Objective

- To provide detailed information about plant-microbe interactions.
- To give information on the principles of plant pathology.
- To provide knowledge on plant disease symptoms and epidemiology/disease cycles.
- To provide detailed knowledge about microbial toxins and their natures.

Unit I: Development and scope of agricultural microbiology:

History, development and scope of agricultural microbiology.

Unit II: Introduction to soil microbiology:

Formation and composition of soil organic matter; physicochemical properties of soil. Microbiota in different soil profiles, microbiological methods of evaluation of soil fertility.

Unit III: Biofertilizers and soil:

Biocontrol agents/biopesticides (bacteria, fungi, viruses and nematodes), biofertilizer; production, formulation and application, composting, vermicomposting, Mycorrhiza (VAM), Actinorhiza, Entomopathogenic Nematodes (EPN).

Unit IV: PGPR and mushroom cultivation:

Rhizosphere, biofertilizers, plant growth-promoting rhizobacteria (PGPR) concept and their mode of action, single-cell protein and mushroom cultivation.

Unit V: Plant diseases:

Late blight of potato, downy mildew of pea, stem gall of coriander, powdery mildew/ smut/ rust of linseed, ergot of pearl millet, anthracnose of soybean, tikka disease of groundnut, wilt of pigeon pea, blight (fungal and bacterial), citrus canker, leaf curl of papaya, little leaf of brinjal, nematode disease of agri-crops (root-knot nematode, root lesion nematode, reniform nematode).

Course Learning Outcomes

- Will be able to acquaint themselves with plant-microbe interaction.
- Will be able to understand microbial-plant pathogens and biological controls.
- Will be able to learn about various viral, bacterial and fungal diseases on plants.
- Will be able to know about diseases caused by microbial toxins.

Course MB205: Practicals* based on course MB201 to MB204

- To study the normal microflora of the skin.
- To study the resident microflora of the oral cavity.
- Perform IMViC test for the identification given bacterial sample.
- To study the antimicrobial susceptibility test using an antibiotic disc.
- To determine the minimal inhibitory concentration (MIC) of the antibiotic.
- To study enzyme kinetics.
- Preparation of biologically important buffers.
- Isolation of carbohydrates, proteins and fats.
- Estimation of protein by the Bradford method.
- Estimation of protein by Lowry's method.
- Isolation of the amylase producer from the soil sample.
- Isolation of the amylase producer from spoiled potato.
- Isolation of the protease producer from the soil sample.
- Quantitative assay of amylase.
- Amylase production in SSF.
- Isolation of the antibiotic producer from the soil sample using the crowded plate method.
- Production of malt beverages in the lab.
- Production of wine in the lab.
- Isolation of free-living nitrogen-fixing bacteria (*Azotobacter*) from agricultural soil.
- Isolation of nitrogen-fixing (*Rhizobium*) from the root nodules of legume plants.
- Isolation of *Bacillus thuringiensis* from agricultural soil.
- Isolation of bio-fungicidal microbes *Trichoderma* from agricultural soil.
- Demonstration of laboratory-scale mass production of bio fungicides (*Trichoderma*).
- Mushroom cultivation using locally available substrates and evaluation of total protein content.
- Isolation and identification of plant-parasitic nematodes from soil samples.
- Isolation and identification of plant-parasitic nematodes from plant roots.

***Number and type of practicals may vary depending on the availability of resources**

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25

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Semester Outcomes: Second Semester

After completing the second semester, students will not only get the degree but also understand the role of microbiology in different areas such as medical, industrial and microbial physiology, along with nutritional therapy or lab diagnosis. They will learn to identify, diagnose and prevent diseases caused by bacteria, fungi, viruses and protozoa. Additionally, students will understand the structure, function and metabolism of important biological molecules like carbohydrates, lipids, amino acids, proteins, nucleic acids and vitamins, as well as how enzymes work. They will also learn about different types of industrial foods, enzymes and how antibiotics are produced. Moreover, students will gain knowledge about bioreactors and their use in making antibiotics, organic acids (like acetic, lactic, citric and gluconic acids) and alcoholic beverages. These outcomes will give students a strong foundation in microbiology, preparing them for further studies and careers in various fields. The students will also understand the diversity and functions of microorganisms in agriculture. They will acquire practical skills in soil microbiology, biofertilizer production, biocontrol methods, and plant disease diagnostics, enabling them to apply microbial solutions for sustainable farming and enhanced crop productivity.

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Recommended Books:

22. Black, J. G. Microbiology: Principles and Explorations. John Wiley & Sons.
23. Brown, A. E., and Benson, H. J. Benson's Microbiological Applications: Laboratory Manual in General Microbiology. McGraw-Hill Higher Education.
24. Pelczar, M. J., Chan, E. C. S., and Krieg, N. R. Microbiology. McGraw-Hill Education (India) Private Limited.
25. Nelson, D. L., and Cox, M. M. Lehninger Principles of Biochemistry. W. H. Freeman.
26. Voet, D., and Voet, J. G. Textbook Biochemistry. John Wiley & Sons Inc.
27. Casida, L. E. Industrial Microbiology. John Wiley & Sons Inc.
28. Pommerville, J. C. Alcamo's Laboratory Fundamentals of Microbiology. Jones & Bartlett Learning.
29. Cappuccino, J. and Sherman, N. Microbiology: A Laboratory Manual. Pearson Benjamin Cummings.
30. Sharma, S. Medical Laboratories Management. Viva Publications.
31. Murray, P. R., Baron, E. J., Pfaller, M. A., Tenover, F. C., and Tenover, R. H. Manual of Clinical Microbiology. American Society for Microbiology, ASM Press.
32. Bansal, A. Basic of body fluids analysis of undergraduate and post graduate students. Abhishek Publication.
33. Ryan, K. J. Sherris's Medical Microbiology. Mc Graw Hill.
34. Barrow, G. I., and Feltham, R. K. A. Cowan and Steel's Manual for the Identification of Medical Bacteria. Cambridge University Press.
35. Greenwood, D. Medical Microbiology. Elsevier.
36. Murray, P. R., Pfaller, M. A., Tenover, F. C., and Tenover, R. H. Clinical Microbiology. ASM Press.
37. Brooks, G. F., Karen, C. C., Janet, S. B., Stephen, A. M., and Timothy, A. M. Jawetz, Melnick and Adelberg's Medical Microbiology. McGraw-Hill Education.
38. Fleming, D. O., Richardson, J. H., Tulis, J. J. and Vesley, D. Laboratory Safety: Principles and Practices. ASM Press, Washington, D.C.
39. Truant, A. L. Manual of Commercial Methods in Clinical Microbiology. ASM Press, Washington, D.C.
40. Wright, J. V. Dr Wright's book of nutritional therapy. St Martin's Press.
41. Lazarides, L. Principles of Nutritional Therapy. HarperCollins Publishers Limited.
42. Schlenker, E. D., and Gilbert, J. Williams' Essentials of Nutrition and Diet Therapy. Elsevier Health Sciences.
43. Todd, J. C., and Henry, J. B. Clinical diagnosis and management by laboratory methods. Saunders

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SECOND YEAR

THIRD SEMESTER

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28

Depace

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Semester - 3

Course MB301A: Food Microbiology and Toxicology

Course Learning Objective

- To provide knowledge on the analysis and quality control of food products.
- To provide in-depth knowledge about microbial toxins and fermented food products.
- To understand the concepts of fermentation technology.
- To give knowledge on microbial applications and modern technology in dairy microbiology.

Unit I: History and scope of food microbiology:

Food microbiology: brief history, scope and microbial diversity of foods; microbes involved in the spoilage of food, meat, poultry, vegetables and dairy products; food preservation.

Unit II: Role of microbes in milk and dairy products:

Microbiological examination of milk, standard plate count, direct microscopic count and reductase test, composition of milk, sources of contamination of milk, type of microbes in milk, pasteurisation of milk, ability of milk to cause disease; manufacturing of cheeses, butter, yoghurt and fermented milk.

Unit III: Role of microbial enzymes in food:

Microbial enzymes in food; low calorie sweeteners, flavour modifiers, food additives, food quality monitoring.

Unit IV: Role of microbes in food spoilage:

Food spoilage, antimicrobial compounds of foods, lactose-peroxidase system, microbial deteriorations of cereals, pulses, fish and seafood during storage.

Unit V: Role of microbial toxin in food:

Introduction to toxins and toxoids, bacterial and mycotoxins, chemical nature of important toxins and their role in food poisoning, physiology and mechanism of action, modification and methods of detoxification, prevention and control of toxin contamination.

Course Learning Outcomes

- Will be able to understand the history and role of microbes in food processing.
- Will be able to understand the microbial toxins present in food and the producer microbes.
- To gain knowledge on dairy microbiology process.
- Will be able to know the advantages of microbes and food products.

MB301B: Pharmaceutical Microbiology

Course Learning Objectives

- To provide information about antimicrobial drugs and their mechanisms of action
- To provide information about microorganisms associated with the manufacture of pharmaceuticals
- To provide information about microbial contamination and its adverse effects
- To provide information about Good Manufacturing Practices (GMP) in pharmaceutical microbiology

Unit I: General characteristics and mode of action of antimicrobial drugs:

General characteristics and mechanism of action of antimicrobial drugs, Factors influencing antimicrobial drug effectiveness, Antibiotics and synthetic antimicrobial agents: Aminoglycosides, β - lactams, tetracyclines, annamycin's, antifungal antibiotics, antitumor substances; peptide antibiotics, Chloramphenicol, sulpha drugs.

Unit II: Action mechanism of antibiotics:

Penicillin, vancomycin (cell wall synthesis inhibition); aminoglycosides, tetracycline, chloramphenicol (protein synthesis inhibition); Rifampin, quinolones and fluoroquinolones (nucleic acid synthesis inhibition); polymyxin B (cell membrane disruption).

Unit III: Microbial contamination and spoilage of pharmaceuticals products:

Sterile injectables, noninjectable and their sterilization; Manufacturing procedures and in process control of pharmaceuticals. Use of microbial enzymes in pharmaceuticals, biosensors.

Unit IV: Drug delivery system in gene therapy

Molecular principles of drug targeting, drug delivery system in gene therapy, 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.

Unit V: Quality assurance and quality management:

Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP) are used in the pharmaceutical industry, regulatory aspects of quality control, Quality assurance and quality management in pharmaceuticals, ISO, WHO and US certification.

Courses Learning Out Comes

- Will be able to acquire knowledge and application ability in the pharmaceutical field.
- Will be able to identify the problems in the pharmaceutical field.

Course MB302: Molecular Microbiology

Course Learning Objectives

- To give information on the basic structure of microbial genetic material.
- To give knowledge about the DNA replication process and mutations.
- To give knowledge about transcription and translation mechanisms along with recombination.
- To give information about biosynthesis, gene regulation and gene transfer mechanisms.

Unit I: DNA replication and repair mechanisms:

DNA replication in prokaryotes and eukaryotes; enzymes involved, replication unit, origin of replication and replication mechanism. Types of DNA polymerase in prokaryotes and eukaryotes, inhibitors of DNA synthesis, DNA damage and repair mechanisms.

Unit II: Mechanism of RNA synthesis and processing:

Structure and function of different types of RNA, different types of RNA polymerases (I, II & III), RNA editing, splicing and polyadenylation, transcription in prokaryotes and eukaryotes, inhibitors of RNA synthesis, genetic code.,

Unit III: Mechanism of Protein synthesis and modification:

protein synthesis in prokaryotes and eukaryotes, aminoacylation of tRNA, formation of initiation complex, initiation factors, elongation factors, termination, translational inhibitors, post-translational modification of proteins.

Unit IV: Regulation of gene expression:

Control of gene expression at the transcription and translation levels, operon concept, negative and positive regulation, inducers and corepressors, catabolite repression.

Unit V: Molecular mechanism of signal transduction

Bio signalling: molecular mechanism of signal transduction, mode of cell-cell signalling, G protein-coupled receptor, protein tyrosine kinase receptor, second messengers, signalling in development and differentiation, apoptosis.

Course Learning outcomes

- To give information on the basic structure of microbial genetic material
- To give knowledge about the DNA replication process in microbes and the impact and mechanism of mutation.
- To give knowledge about transcription and translation mechanisms and significance and the mechanism of recombination
- To give information about biosynthesis, gene regulation and transfer mechanisms in microbes and their impact.

Course MB303: Recombinant DNA Technology

Course Learning objectives

- To give basic information about genetic tools and markers.
- To give knowledge about cloning vectors and the cloning process.
- To give knowledge about r-DNA technology and its applications.
- Mechanism of gene regulation with respect to foreign gene expression and problems associated.

Unit I: Basics of r-DNA technology:

Introduction and History of RDT, Enzymes used in r-DNA technology; DNA ligase, DNA polymerase, Klenow fragment, reverse transcriptase, exonuclease, endonuclease, terminal deoxynucleotidyl transferase, alkaline phosphatase, polynucleotide kinase and dephosphatases; restriction modification systems and their types; sticky and blunt end ligation, joining with linkers, adapters & homopolymer tailing.

Unit II: PCR and DNA fingerprinting technology:

PCR its various schemes and applications (Basic PCR, inverse-PCR, multiplex-PCR, RT-PCR, anchored-PCR, asymmetric-PCR, real time-PCR); DNA sequencing methods: dideoxy and chemical method, automated sequencing and pyrosequencing, strategies for sequencing large DNA fragments (Shotgun approach); non-radioactive & radioactive labelling of probes; RFLP, AFLP, RAPD, DGGE, ARDRA, microarray.

Unit III: Cloning vectors and host:

General properties, plasmids, fosmids, bacteriophages, cosmids, shuttle vectors, bacterial artificial chromosomes. Eukaryotic cloning vectors for yeast (YIp, YEp, YCp, YAC), higher plants (Ti-based vectors, binary and cointegrate, chloroplast-based vectors) & for animal cells (SV 40, vaccinia, retroviruses).

Unit IV: Cloning and hybridisation techniques:

Selection of recombinant clones: colony hybridisation, plaque hybridisation, immunochemical methods, southern blotting and northern blotting. Isolation and purification of genomic and plasmid DNA. Gene libraries: genomic library, screening of libraries, cDNA library (different methods for synthesising cDNA molecules).

Unit V: Expression vectors for expressing foreign genes in *E. coli*:

Problems associated with the production of r-proteins in *E. coli*, production of r-protein by eukaryotic cells. Applications of gene technology: production of pharmaceuticals- Humulin, somatotropin, somatostatin, recombinant vaccines. Bt-cotton, 'Flavr Savr' tomato and golden rice.

Course Learning Outcomes

- Will be able to understand the various molecular tools/markers and instruments used in gene cloning.
- Will be able to understand the type and use of various cloning vectors.
- Will be able to troubleshoot common problems associated with gene expression.
- Will be able to understand the concept behind the various recombinant products available in the market.

MB304A: Epidemiology

Course Learning Objectives

- To identify factors related to the occurrence of disease at the global level
- To learn the basic concepts of screening and outbreak investigations
- To improve health, lower the risk of death and increase the quality of life by refining preventive measures and treatments of diseases.

Unit I: History, development and scope:

History of epidemiology, basic vocabulary and processes used in the science of epidemiology, routes of transmission of disease, non-communicable and communicable infection, microorganism responsible for nosocomial infection, epidemiology of nosocomial infection.

Unit II: Health and disease:

Basic Concepts and Definition, Disease Control and Levels of Prevention, Determinants and Indicators of Health, Health Situation and Trends in India. Genesis and Development of the Concept, Healthcare versus Medical Care.

Unit III: Infectious notifiable diseases and prevention

Studies of infectious notifiable diseases as COVID-19, AIDS, Plague, anthrax, botulism, cholera, gonorrhoea, hepatitis, rabies, syphilis, tetanus, tuberculosis, typhoid, with their sign, symptoms, diagnostic tests, chemotherapy and vaccine availability.

Unit IV: Nutrition and health:

Classification and Nutritional profiles of various foods and drinks, Balanced diet, Diet survey, consumption unit, nutritional classification, Nutritional problems, e.g. LBW, PEM, Xerophthalmia, IDD, etc. Nutritional factors in selected/ major diseases (Cardiovascular, Diabetes, Obesity, Cancer)

Unit V: Environment and health:

Environmental degradation and human pathology, Examination of living/ working environment & its impact on human health; Industrial and Occupational Health: Industrial and Occupational hazards and accidents, Occupational diseases and their prevention. Right to a safe Biosphere.

Courses Learning Outcomes

- Will be able to understand the basic principles and methods of epidemiology and demonstrate their broad applicability to public health.
- Will be able to know the ethical issues in epidemiological research.
- Disease surveillance

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MB304B: Food and Waterborne Disease

Course Learning Objectives

- To provide information about foodborne diseases, prevention and control
- To provide information about waterborne diseases, prevention and control

Unit I: Foodborne diseases:

Classification of foodborne diseases, Food poisoning, Infection and intoxication, Nonbacterial toxins and mycotoxins, seafood toxins, Poisoning by chemicals.

Unit II: Food and waterborne bacterial and viral diseases:

Major food and waterborne bacteria *S. aureus*, *Pseudomonas*, *Clostridium*, *Bacillus*, *Vibrio*, *E. coli*, *Salmonella*, *Shigella*, Major food and waterborne Viruses- Polio virus, Rotavirus, SARS, Enterovirus.

Unit III: Detection and prevention of food contaminants:

Rapid methods for detecting microbial contaminants in foods, Interpretation and application of results and preventive measures.

Unit IV: Disease management of foodborne disease:

Irradiation replaces other foodborne diseases, the microbiological aspects of food, transmission, symptoms, diagnosis, treatment, prevention of disease and Surveillance systems for tracking foodborne diseases.

Unit V: Water contaminants and quality analysis:

Natural waters: Sources of contamination, Microbial indicators of faecal pollution and other pollution, IMViC test and Water quality test.

Courses Learning Out Comes

- Will be able to identify potential sources of contamination in the food and water systems.
- Will be able to understand how foodborne pathogens and chemical contamination of food can impact health.
- Will be able to describe the steps involved in a foodborne illness outbreak investigation and the rationale for each.
- Will be able to describe ways to prevent foodborne and waterborne illness.

Course MB305: Practicals* based on courses MB301-MB304

- Isolation of post-harvest spoilage fungi from food commodities (fruit).
- Demonstration of pathogenicity of a fungal pathogen (Koch's postulates).
- MBRT test to evaluate milk quality.
- Isolation of probiotic bacteria from milk and curd.
- Microbial examination of food and milk.
- Extraction of genomic DNA from Gram-positive and Gram-negative bacteria.
- Extraction of genomic DNA from the fungus.
- Method of RNA isolation.
- Electrophoresis of DNA/RNA/Protein.
- Quantification of genomic DNA by spectrophotometer.
- Perform agarose gel electrophoresis to determine the molecular weight of DNA.
- Amplify the 16S rDNA by PCR.
- Randomly Amplified Polymorphic DNA (RAPD) analysis in bacteria.

**Number and type of practicals may vary depending on the availability of resources*

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35

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Semester Outcomes: Third Semester

After completing the third semester, students will gain valuable insights into assessing the quality of food products and understanding the diversity of microbes present in food. They will learn about the mechanisms by which microbes cause food spoilage, providing a strong foundation in food microbiology. Additionally, students will explore the processes of replication, transcription and translation in both prokaryotic and eukaryotic organisms, deepening their understanding of genetic processes and the mechanisms of transferring traits. They will also become familiar with gene regulation and advanced molecular tools and markers used in gene cloning. Moreover, students will grasp the concepts behind various recombinant products available in the market, enhancing their knowledge in 'Gene Technology'. In addition to that, students will also learn the microbiology of epidemics and the microbiology involved in the pharmaceutical industry. These comprehensive outcomes will equip students with essential skills and knowledge in food quality assessment, genetic mechanisms and modern biotechnological applications, preparing them for advanced studies and diverse career opportunities in microbiology and related fields.

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Recommended Books:

1. Campbell-Platt, G. Food Science and Technology. Willey and Blackwell Publication, UK.
 2. Lightfoot, N. F., and Maier, E. A. Microbiological analysis of food and water. Elsevier Publication, Netherlands.
 3. Hobbs, B. C., and Roberts, D. Food poisoning and Food Hygiene. Edward Arnold (A division of Hodder and Stoughton, London).
 4. Jones, S., and Quinn, S. Textbook of Functional Medicine. Institute for Functional Medicine.
 5. Frazier, W., and Westhoff, D. Food Microbiology. McGraw-Hill Inc.
 6. Adams, M. R., and Moss, M. O. Food Microbiology. Royal Society of Chemistry.
 7. Reece, R. J. Analysis of Genes and Genomes. Willey Blackwell.
 8. Primrose, S. B., Twyman, R., and Old, B. Principles of Gene Manipulation. Wiley-Blackwell.
 9. Watson, J. D. Molecular Biology of the Gene. Cold Spring Harbour Laboratory Press.
 10. Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D., and Darnell, J. Molecular Cell Biology. W. H. Freeman.
 11. Barrow, G. I. and Feltham, R. K. A. Cowan and Steel's Manual for the Identification of Medical Bacteria. Cambridge University Press.
 12. Pommerville J. C. Alcamo's Laboratory Fundamentals of Microbiology. Jones & Bartlett Learning.
 13. Cappuccino, J., and Sherman, N. Microbiology: A Laboratory Manual. Pearson Benjamin Cummings.
 14. Glick, B. R., and Pasternak, J. J. Molecular Biotechnology. ASM Press.
 15. Brown, T. A. Gene Cloning. Blackwell Publishing.
 16. Merchant, K. Pharmacological regulation of Genes. CRC Press.
 17. Ghosh, T. K., Fiechter, A., and Blakebrough, N. Advances in Biochemical Engineering. Springer Berlin Heidelberg.
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SECOND YEAR

FOURTH SEMESTER

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38

Depace

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Course MB401: Microbial Genetics

Course Learning Objectives

- To give information on the basic structure of microbial genetic material.
- To give knowledge about mutations.
- To give knowledge about the mechanism of recombination along with gene mapping.
- To give information about the gene transfer mechanism.
- To give information about plasmids.

Unit I: Prokaryotic gene structure:

The rII locus, complementation test, cistron, recon, muton, diversity of phage genomes, Life cycle of Bacteriophages (Lytic and Lysogenic), linkage and crossing over.

Unit II: Mutation and mutagens:

Spontaneous, induced, intragenic and intergenic mutation, mutagenesis, mutagens (physical and chemical mutagens; non-ionising radiation; base analogues, alkylating agents, deaminating agents, intercalating agents & others), molecular mechanism of mutagens. Detection and isolation of mutants. DNA damage and repair mechanisms.

Unit III: Recombination and Gene Mapping:

Reciprocal and non-reciprocal mechanisms of recombination; Holiday model, Fox model, enzymatic mechanism of recombination, transposable element (classes and nomenclature), IS elements, transposons (composite structure and complex transposon's structure), mechanism of transposition, gene mapping.

Unit IV: Gene transfer mechanism:

Bacterial transformation (mechanism of transformation, transfection, competence), transduction; generalized transduction, specialized transduction, abortive transduction, conjugation; effective contact and Pilli in conjugation, the role of F- plasmid 'F' factor, the conjugal transfer process, high frequency recombination (Hfr) strains, the order of chromosome transfer, formation of F prime (F'). Methods of gene mapping in microbes.

Unit V: Plasmids:

F-, R-, Col- and Ti plasmid; control of copy number and incompatibility. Bacteriophages; lytic phages-T7 and T4, lysogenic phage- λ and P1; M13 and $\phi\times 174$; recombination and gene mapping in viruses.

Course Learning Outcomes

- Be able to know about mutagens and the mechanism of mutation.
- Be able to understand about basic structure of microbial genetic material
- Be able to know about the mechanism of recombination and its significance in gene mapping.
- Be able to understand plasmids.

Course MB402A: Environmental Microbiology

Course Learning Objectives

- To provide an overview of microbial ecology
- To give in-depth knowledge about soil microbiology
- To give knowledge about aquatic microbiology
- To provide information about waste management and treatment methods

Unit I: Microbes in extreme environments:

Environment-induced genetic and physiological adaptations in microbes; characteristic features of thermophiles, psychrophiles, methanogens, methylotrophs, acidophiles, alkaliphiles, halophiles and their survival strategies.

Unit II: Biogeochemical cycling:

Microbes in nutrient cycling with special reference to carbon, phosphorous, sulphur and nitrogen cycles.

Unit III: Biodeterioration:

Biodeterioration of properties & cultural heritage; microbial deterioration of paper, textile, wood, paint and metal corrosion. Methods for their protection.

Unit IV: Biodegradation and Bioremediation:

Microbial degradation of lignocellulosic substances, keratin and chitin and xenobiotics; microbial degradation of pesticides; hydrocarbons; clean-up of sites polluted with oil spills, heavy metals and chlorinated solvents; biological treatment of effluents of the sugar, pulp and paper industry. Recovery of minerals and metals from ores.

Unit V: a. Techniques in environmental microbiology:

Methods for the determination of numbers, biomass and activities of microbes in soil, water, air and on plant surfaces and dead organic materials.

b. Microbes in waste disposal:

Microbes in solid waste and sewage treatment systems. Disinfection of potable water supplies; bacterial indicators of water safety; microbial assessment of water quality; standards for tolerable levels of faecal contamination.

Course Learning Outcomes

- Will be able to become acquainted with microbial communities and their interaction
- Will be able to know about the biogeochemical cycle and the roles of microbes in its control.
- Will be able to understand the waterborne diseases and their control measure.
- Will be able to understand thus solid waste management.

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Course MB402B: Modern Immunological Techniques

Course Learning Objective

- To provide detailed information about immunity, cells and organs of the immune system and antigen-antibody interaction.
- To acquire knowledge on antigens and antibody preparation.
- To gain insights into Techniques used in immunology
- To provide detailed knowledge about the use of antisera in immunopathology.
- To provide core concepts in transplantation and transfusion immunology.

Unit I: History and principles of Immuno-techniques:

History and principles of immuno-techniques: agglutination, direct and indirect, immuno-electrophoresis, RIA, ELISA, immuno-fluorescence.

Unit II: Methods used in immunology:

Preparation of antigens and antibodies, purification of antibodies, analysis of antibodies and antigens, preparation and uses of various types of vaccines.

Unit III: Techniques used in immunology:

Types of immunodiffusion methods, ELISA, RIA, Western blot analysis, Electrophoresis and Hybridisation techniques, immunohistochemistry, flowcytometry, Immunofluorescence, Lateral flow immune assay, Heterologous and homologous immunoassay.

Unit IV: Clinical immunotechniques:

Applications of antisera in the detection of various diseases, like syphilis and lyme, typhoid, streptococci infections, HIV, various types of Hepatitis.

Unit V: Antibody engineering and immunotherapy:

Antibody engineering, Catalytic antibodies, antibody immunotherapy, production of drugs for allergies.

Course Learning Outcomes

- Will be able to understand the theoretical principles of immunology and in vitro serological tests.
- Will be able to understand and detect various diseases by the application of antisera.
- Will be able to explain engineered antibodies and catalytic antibodies and produce drugs for allergies.

Course MB403A: Lab Diagnosis

Course Learning Objectives

- To provide information about the collection, transport and storage of clinical samples
- To provide information about the laboratory diagnosis of various diseases

Unit I: Clinical sampling, identification and staining of microbes:

Collection, transport and storage of clinical specimens; Prevention and control of laboratory-acquired infections; Identification of Microorganisms; Different staining techniques: Gram's staining, Ziehl-Neelsen method for AFB, Fluorescent staining, Giemsa's staining and special staining methods to demonstrate granules, capsule and endospores.

Unit II: Clinical pathology:

Physical, chemical and microbiological examination of urine, stool, CSF and blood culture; Semen analysis; Pregnancy test.

Unit III: Laboratory diagnosis of diseases:

Laboratory diagnosis of Diarrhoea, sore throat, pyrexia, sexually transmitted disease, Urinary tract infection and Respiratory tract infection.

Unit IV: Haematological diagnosis:

Blood collection: venipuncture; White blood cells (WBC), Red blood cells (RBC) count and Platelet count; Haemoglobin estimation; Staining and Differential Leucocyte Count (DLC); Erythrocyte Sedimentation Rate (ESR), Haematocrit and Absolute values; Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC); Blood grouping.

Unit V: Infection in clinical practices:

Infections of the Skin and Tissues, Central nervous system, Eye and surrounding structure, Bone and Joints, Congenital and Neonatal infections, Hospital patient's infections, Immunocompromised patient's infections.

Courses Learning Outcomes

- Will be able to know about the collection of clinical samples with aseptic techniques.
- Will be able to know about the different haematological diagnostic techniques.
- Will be able to know about the different human disease diagnoses, prevention and control.

MB 403B: Food Safety

Course Learning Objectives

- To provide information on the detection of food quality, safety and various hazards present in food
- To provide basic information on HACCP
- To provide good food safety practices

Unit I: Introduction to food safety:

Hazards to safe food (chemical, biological, physical hazards), contamination and spoilage, food hygiene, food itself, safety of food, sources of contamination, food quality, food safety challenges, reducing the effect of contamination, Role of food processing industries and sector.

Unit II: History of HACCP, health and hygiene:

History, background and structure of HACCP, Food chain steps, benefits and barriers in implementing HACCP, HACCP prerequisites and good hygiene practice, Environmental hygiene, design and facilities in the establishment, equipment, utilities, personal health and hygiene, pest control.

Unit III: HACCP principles and application guidelines:

Determination of critical control points, establishing the critical limits, Establishment of corrective action, establishment of verification procedure, establishment of documentation and record keeping, validation, general errors in HACCP plan, Quantitative approach in HACCP, implementation of HACCP Plan, case studies of HACCP.

Unit IV: Risk analysis and management:

Introduction to risk analysis, risk management, Risk assessment and Risk communication. Detection of various methods of food toxicity, Hazard analysis and criteria control points (HACCP) system for food safety, Food Safety and Standards Authority of India (FSSAI), Food Quality Protection Act (FQPA)

Unit V: Other food safety practices:

Good Agriculture practices, good animal husbandry practices, good manufacturing practices, good retail practices, good transport practices, nutritional labelling and Traceability studies.

Courses Learning Outcomes

- Will be able to explain how contamination of food can occur in a food service establishment.
- Will be able to describe the effects and consequences of foodborne illness.
- Will be able to display sound practices to prevent the possibility of food poisoning
- Will be able to identify measures/procedures that will reduce or eliminate accidents in food preparation and service areas

MB 404A: Virology

Course Learning Objectives

- To provide basic and advanced information about viruses and the functioning of the immune system.
- To provide information about human, animal and plant diseases caused by viruses
- To provide information about diagnostic techniques for viral diseases.

Unit I: Origin and development of the concept of virology:

Collection of clinical samples; Cultivation of Viruses, Diagnostic techniques for viral diseases. Virus identification: Immunofluorescence, Immunoperoxidase test, Neutralisation, Light microscopy and Electron microscopy, replication strategies of representative viruses from the seven Baltimore classes

Unit II: Nature of viral zoonoses:

Rabies, Haemorrhagic fevers, yellow fever, Colorado tick fever, Viral Encephalitis (Japanese encephalitis, Venezuelan equine encephalitis, Eastern and Western equine encephalitis, St. Louis encephalitis, Murray valley encephalitis).

Unit III: Human diseases caused by viruses:

Diseases caused by Coronaviruses (COVID-19), Orthomyxoviruses (Influenza), Paramyxoviruses (Mumps, Measles, Respiratory Syncytial Virus), Picornaviruses (Enteroviruses, Rhinoviruses), Poxviruses, Herpesviruses, Human Retroviruses, Adenovirus, Hepatitis.

Unit IV: Characteristics, classification and diversity of plant viruses:

Plant Viruses with special reference to: Cucumber mosaic virus (CMV), Tobacco mosaic virus (TMV), Papaya ring spot mosaic virus (PMV), Tomato yellow leaf curl virus (TYLCV), Bhindi yellow mosaic vein virus (BYMVV).

Unit V: Prions and Viroids:

Structure, replication and diseases caused by them, Viroid; Emerging and re-emerging diseases.

Courses Learning Outcomes

- Will be able to know how viruses are classified
- Will be able to know the methods used in studying viruses
- Will be able to know the methods used in studying viruses
- Will be able to understand the replication strategies of representative viruses from the seven Baltimore classes
- Will be able to comprehend the intricate interaction between viruses and host cells

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MB404B: Food Processing, Preservation and Packaging

Course Learning Objectives

- To provide information about different food processes used in industries and in the research field
- To provide information about the importance of food safety and food quality
- To develop skills required in various industries, research labs and in the field of agriculture, food and human health.

Unit I: Common food processing:

Introduction, Classification & Method of Cooking, Baking, Frying, Roasting, Toasting, Grilling, Blanching and Extrusion

Unit II: Primary processing:

Introduction, Classification & Method of Cleaning, Sorting, Grading, Cutting, Seeding, Chilling and Freezing.

Unit III: Secondary processing:

Introduction, Classification & Method of Slicing, Pulping, Paste, Frying, Chilling and freezing, Milling.

Unit IV: Introduction to preservation:

Preservation, types and methods of preservation, natural and artificial preservative agent, class I, II and III preservative agents.

Unit V: Introduction to Food Packaging:

Objectives and functions of food packaging, Requirements for effective food packaging, Types of packaging Materials, General properties of packaging material

Courses Learning Outcomes

- Will be able to understand food composition and its physical, chemical, nutritional, microbiological and sensory aspects.
- Will be able to familiarise the students with the processing and preservation techniques of a variety of foods.
- Will be able to prepare the students to accept the challenges in life sciences.
- Will be able to enable the students to understand packaging materials and effective packaging processes.

Course MB405: Practicals* based on course MB401 to MB404

- Demonstration of mutagenesis by UV.
- Demonstration of transformation.
- Study of coli forms in surface water samples.
- To study soil-borne diseases.
- Isolation of food-spoiling microbes from spoiled food samples.
- To study microbial load in air, water and soil samples.
- Study of immuno-diffusion.
- Study of immuno-electrophoresis, DOT ELISA and sandwich ELISA.
- Study of Ouchterlony double diffusion, agglutination test.
- Isolation and identification of bacterial indicators from drinking water.
- Water quality analysis for microbiological indicators.
- Isolation and identification of microbial indicators from samples.

**Number and type of practicals may vary depending on the availability of resources*

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46

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Semester Outcomes: Fourth Semester

After completing the fourth semester, students will understand the practical aspects of water and wastewater treatment technologies, learning how these processes help in keeping the environment clean and safe. They will also gain knowledge about how microbes naturally cause deterioration and how to control this, which is important for preserving the quality and safety of various materials and historic valuables. Additionally, students will become familiar with the analytical techniques used to study and control microbial deterioration. They will learn about mutagens and understand the mechanisms behind it. Furthermore, students will also learn about food safety, virology and food processing and packaging. Understanding these areas is vital for ensuring the safety and quality of food products. Knowledge of virology helps in preventing viral outbreaks, while food processing and packaging techniques are essential for extending shelf life and maintaining nutritional values. These outcomes will provide students with a comprehensive foundation in environmental microbiology, genetics, food safety and biotechnology, preparing them for advanced studies and careers in these fields.

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Recommended Books:

1. Willey, J., Sherwood, L., and Woolverton, C. *Prescott's Microbiology*. McGraw Hill Education.
 2. Freifelder, O. M., *Genetics*. Narosa Publishing House.
 3. Pepper, I. L., Gerba, C. P., and Brusseau, M.L. *Environmental and Pollution Science*. Academic Press, USA.
 4. Johri, B. N., *Extremophiles*. Springer Verlag, New York.
 5. Colwd, D. *Microbial Diversity*. Academic Press, USA.
 6. Maier, R. M., Pepper, I. L., and Gerba, C. P. *Environmental Microbiology*. Academic Press, USA.
 7. Forster, C.F., and John, D. A. *Environmental Biotechnology*. Ellis Horwood Ltd. Publication.
 8. Christon, J. H. *A Manual of Environmental Microbiology*. ASM Publications.
 9. Singh, A., Kuhad, R. C., and Ward, O. P. *Advances in Applied Bioremediation*. Springer, USA.
 10. Kindt, T. J., Barbara, A. O., and Goldsby, R. A. *Kuby Immunology*. W. H. Freeman & Company.
 11. Wilson, K., and Walker, J. *Principles and Techniques of Biochemistry and Molecular Biology*. Cambridge University Press.
 12. Subba Rao, N. S. *Soil microbiology*. Oxford & IBH Publishing Co.
 13. Greenwood, D., Barer, M., Slack, R., and Irving, W. *Medical Microbiology*, Elsevier.
 14. Black, J. G. *Microbiology*, Wiley publication.
 15. Jawetz, M., and Adelberg. *Medical Microbiology*, McGraw-Hill Publishers.
 16. Raddy, S. R. *Essential of Virology*. Scientific Publishers.
 17. Jane, F., Vincent, R., Racaniello, Glenn, F. R., Theodora, H., and Anna, M. S. *Principles of Virology*. John Wiley & Sons.
 18. James, G. B., and Alistair, S. G. *Food Processing Handbook*. Wiley.
 19. Varzakas, T., and Tzia, C. *Handbook of Food Processing, Food Preservation*. Routledge, Taylor & Francis Group.
 20. Book series on *Food Microbiology and Food Safety*. Springer.
 21. Pommerville, J. C. *Alcamo's Laboratory Fundamentals of Microbiology*. Jones & Bartlett Learning.
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Second Year of Two-Year Master of Science (Research) in Microbiology
One-year Master of Science (Research) in Microbiology

Semester - 3

Course MB301R: Molecular Microbiology

Course Learning Objectives

- To give information on the basic structure of microbial genetic material.
- To give knowledge about the DNA replication process and mutations.
- To give knowledge about transcription and translation mechanisms along with recombination.
- To give information about biosynthesis, gene regulation and gene transfer mechanisms.

Unit I: DNA replication and repair mechanisms:

DNA replication in prokaryotes and eukaryotes; enzymes involved, replication unit, origin of replication and replication mechanism. Types of DNA polymerase in prokaryotes and eukaryotes, inhibitors of DNA synthesis, DNA damage and repair mechanisms.

Unit II: Mechanism of RNA synthesis and processing:

Structure and function of different types of RNA, different types of RNA polymerases (I, II & III), RNA editing, splicing and polyadenylation, transcription in prokaryotes and eukaryotes, inhibitors of RNA synthesis, genetic code.,

Unit III: Mechanism of Protein synthesis and modification:

protein synthesis in prokaryotes and eukaryotes, aminoacylation of tRNA, formation of initiation complex, initiation factors, elongation factors, termination, translational inhibitors, post-translational modification of proteins.

Unit IV: Regulation of gene expression:

Control of gene expression at the transcription and translation levels, operon concept, negative and positive regulation, inducers and corepressors, catabolite repression.

Unit V: Molecular mechanism of signal transduction

Bio signalling: molecular mechanism of signal transduction, mode of cell-cell signalling, G protein-coupled receptor, protein tyrosine kinase receptor, second messengers, signalling in development and differentiation, apoptosis.

Course Learning outcomes

- To give information on the basic structure of microbial genetic material
- To give knowledge about the DNA replication process in microbes and the impact and mechanism of mutation.
- To give knowledge about transcription and translation mechanisms and significance and the mechanism of recombination
- To give information about biosynthesis, gene regulation and transfer mechanisms in microbes and their impact.

Course MB302R: Recombinant DNA Technology

Course Learning objectives

- To give basic information about genetic tools and markers.
- To give knowledge about cloning vectors and the cloning process.
- To give knowledge about r-DNA technology and its applications.
- Mechanism of gene regulation with respect to foreign gene expression and problems associated.

Unit I: Basics of r-DNA technology:

Introduction and History of RDT, Enzymes used in r-DNA technology; DNA ligase, DNA polymerase, Klenow fragment, reverse transcriptase, exonuclease, endonuclease, terminal deoxynucleotidyl transferase, alkaline phosphatase, polynucleotide kinase and dephosphatases; restriction modification systems and their types; sticky and blunt end ligation, joining with linkers, adapters & homopolymer tailing.

Unit II: PCR and DNA fingerprinting technology:

PCR its various schemes and applications (Basic PCR, inverse-PCR, multiplex-PCR, RT-PCR, anchored-PCR, asymmetric-PCR, real time-PCR); DNA sequencing methods: dideoxy and chemical method, automated sequencing and pyrosequencing, strategies for sequencing large DNA fragments (Shotgun approach); non-radioactive & radioactive labelling of probes; RFLP, AFLP, RAPD, DGGE, ARDRA, microarray.

Unit III: Cloning vectors and host:

General properties, plasmids, fosmids, bacteriophages, cosmids, shuttle vectors, bacterial artificial chromosomes. Eukaryotic cloning vectors for yeast (YIp, YEp, YCp, YAC), higher plants (Ti-based vectors, binary and cointegrate, chloroplast-based vectors) & for animal cells (SV 40, vaccinia, retroviruses).

Unit IV: Cloning and hybridisation techniques:

Selection of recombinant clones: colony hybridisation, plaque hybridisation, immunochemical methods, southern blotting and northern blotting. Isolation and purification of genomic and plasmid DNA. Gene libraries: genomic library, screening of libraries, cDNA library (different methods for synthesising cDNA molecules).

Unit V: Expression vectors for expressing foreign genes in *E. coli*:

Problems associated with the production of r-proteins in *E. coli*, production of r-protein by eukaryotic cells. Applications of gene technology: production of pharmaceuticals- Humulin, somatotropin, somatostatin, recombinant vaccines. Bt-cotton, 'Flavr Savr' tomato and golden rice.

Course Learning Outcomes

- Will be able to understand the various molecular tools/markers and instruments used in gene cloning.
- Will be able to understand the type and use of various cloning vectors.
- Will be able to troubleshoot common problems associated with gene expression.
- Will be able to understand the concept behind the various recombinant products available in the market.

MB303R: Research Project

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51

Prepar

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Semester Outcomes: Third Semester

After completing the third semester, students will gain valuable insights into the processes of replication, transcription and translation in both prokaryotic and eukaryotic organisms, deepening their understanding of genetic processes and the mechanisms of transferring traits. They will also become familiar with gene regulation and advanced molecular tools and markers used in gene cloning. Moreover, students will grasp the concepts behind various recombinant products available in the market, enhancing their knowledge in 'Gene Technology'. In addition to this, they will get insight into microbial research. These comprehensive outcomes will equip students with essential skills and knowledge in genetic mechanisms and modern biotechnological applications, preparing them for advanced studies and diverse career opportunities in microbiology and related fields.

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Recommended Books:

1. Reece, R. J. Analysis of Genes and Genomes. Willey Blackwell.
 2. Primrose, S. B., Twyman, R., and Old, B. Principles of Gene Manipulation. Wiley-Blackwell.
 3. Watson, J. D. Molecular Biology of the Gene. Cold Spring Harbour Laboratory Press.
 4. Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D., and Darnell, J. Molecular Cell Biology. W. H. Freeman.
 5. Glick, B. R., and Pasternak, J. J. Molecular Biotechnology. ASM Press.
 6. Brown, T. A. Gene Cloning. Blackwell Publishing.
 7. Merchant, K. Pharmacological regulation of Genes. CRC Press.
 8. Ghosh, T. K., Fiechter, A., and Blakebrough, N. Advances in Biochemical Engineering. Springer Berlin Heidelberg.
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53

Depace

Depace

SECOND YEAR

FOURTH SEMESTER

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54

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Course MB401R: Microbial Genetics

Course Learning Objectives

- To give information on the basic structure of microbial genetic material.
- To give knowledge about mutations.
- To give knowledge about the mechanism of recombination along with gene mapping.
- To give information about the gene transfer mechanism.
- To give information about plasmids.

Unit I: Prokaryotic gene structure:

The rII locus, complementation test, cistron, recon, muton, diversity of phage genomes, Life cycle of Bacteriophages (Lytic and Lysogenic), linkage and crossing over.

Unit II: Mutation and mutagens:

Spontaneous, induced, intragenic and intergenic mutation, mutagenesis, mutagens (physical and chemical mutagens; non-ionising radiation; base analogues, alkylating agents, deaminating agents, intercalating agents & others), molecular mechanism of mutagens. Detection and isolation of mutants. DNA damage and repair mechanisms.

Unit III: Recombination and Gene Mapping:

Reciprocal and non-reciprocal mechanisms of recombination; Holiday model, Fox model, enzymatic mechanism of recombination, transposable element (classes and nomenclature), IS elements, transposons (composite structure and complex transposon's structure), mechanism of transposition, gene mapping.

Unit IV: Gene transfer mechanism:

Bacterial transformation (mechanism of transformation, transfection, competence), transduction; generalized transduction, specialized transduction, abortive transduction, conjugation; effective contact and Pilli in conjugation, the role of F- plasmid 'F' factor, the conjugal transfer process, high frequency recombination (Hfr) strains, the order of chromosome transfer, formation of F prime (F'). Methods of gene mapping in microbes.

Unit V: Plasmids:

F-, R-, Col- and Ti plasmid; control of copy number and incompatibility. Bacteriophages; lytic phages-T7 and T4, lysogenic phage- λ and P1; M13 and $\phi\times 174$; recombination and gene mapping in viruses.

Course Learning Outcomes

- Be able to know about mutagens and the mechanism of mutation.
- Be able to understand about basic structure of microbial genetic material
- Be able to know about the mechanism of recombination and its significance in gene mapping.
- Be able to understand plasmids.

Course MB402R: Virology

Course Learning Objectives

- To provide basic and advanced information about viruses and the functioning of the immune system.
- To provide information about human, animal and plant diseases caused by viruses
- To provide information about diagnostic techniques for viral diseases.

Unit I: Origin and development of the concept of virology:

Collection of clinical samples; Cultivation of Viruses, Diagnostic techniques for viral diseases. Virus identification: Immunofluorescence, Immunoperoxidase test, Neutralisation, Light microscopy and Electron microscopy, replication strategies of representative viruses from the seven Baltimore classes

Unit II: Nature of viral zoonoses:

Rabies, Haemorrhagic fevers, yellow fever, Colorado tick fever, Viral Encephalitis (Japanese encephalitis, Venezuelan equine encephalitis, Eastern and Western equine encephalitis, St. Louis encephalitis, Murray valley encephalitis).

Unit III: Human diseases caused by viruses:

Diseases caused by Coronaviruses (COVID-19), Orthomyxoviruses (Influenza), Paramyxoviruses (Mumps, Measles, Respiratory Syncytial Virus), Picornaviruses (Enteroviruses, Rhinoviruses), Poxviruses, Herpesviruses, Human Retroviruses, Adenovirus, Hepatitis.

Unit IV: Characteristics, classification and diversity of plant viruses:

Plant Viruses with special reference to: Cucumber mosaic virus (CMV), Tobacco mosaic virus (TMV), Papaya ring spot mosaic virus (PMV), Tomato yellow leaf curl virus (TYLCV), Bhindi yellow mosaic vein virus (BYMVV).

Unit V: Prions and Viroids:

Structure, replication and diseases caused by them, Viroid; Emerging and re-emerging diseases.

Courses Learning Outcomes

- Will be able to know how viruses are classified
- Will be able to know the methods used in studying viruses
- Will be able to know the methods used in studying viruses
- Will be able to understand the replication strategies of representative viruses from the seven Baltimore classes
- Will be able to comprehend the intricate interaction between viruses and host cells

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MB403R: Research Project

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57

Prepar

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Semester Outcomes: Fourth Semester

After completing the fourth semester, students will understand the practical aspects of mutagens and the mechanisms behind them. Furthermore, students will also learn about virology. It will help in preventing viral outbreaks. These outcomes will provide students with a comprehensive foundation in genetics and virology, preparing them for advanced studies and careers in these fields. A microbiology research project offers numerous advantages, particularly in addressing real-world challenges related to health, agriculture and environment. It enhances critical thinking, technical skills and hands-on experience with microbial techniques such as culturing, molecular identification and antimicrobial assays. The projects can lead to discovery of novel microorganisms, enzymes, or bioactive compounds with industrial or therapeutic potential.

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Recommended Books:

1. Willey, J., Sherwood, L., and Woolverton, C. *Prescott's Microbiology*. McGraw Hill Education.
 2. Freifelder, O. M., *Genetics*. Narosa Publishing House.
 3. Raddy, S. R. *Essentials of Virology*. Scientific Publishers.
 4. Jane, F., Vincent, R., Racaniello, Glenn, F. R., Theodora, H., and Anna, M. S. *Principles of Virology*. John Wiley & Sons.
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59

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