ಡಾ. ಮನಮೋಹನ ಸಿಂಗ್
ಬೆಂಗಳೂರು ನಗರ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ

Dr. MANMOHAN SINGH
BENGALURU CITY UNIVERSITY

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No.MSBCU/BoS/Syllabus/Science/ 109 /2026-27 Date: 29.06.2026

NOTIFICATION

Sub: Syllabus for the V & VI Semester Under Graduate Courses in the Faculty of Science -reg

Ref: 1. Government Order No. ED 166 UNE 2023 Bengaluru dated. 08.05.2024
2. Recommendations of the Boards of Studies in the Faculty of Science
3. Approval of the Academic Council in its meeting held on 08.06.2026
4. Orders of Vice-Chancellor dated.29.06.2026

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The Syllabus prepared by the Boards of Studies for the different Subjects of V & VI semester Under Graduate Courses, in the faculty of Science based on the Guidelines and Curriculum Structure issued by the Government under ref(1) have been approved by Academic Council meeting held on 08.06.2026.

Accordingly, the CBCS Syllabus for the V & VI Semester UG Courses of Science Faculty in respect of following subjects are hereby notified for implementation from the academic year 2026-27.

Sl. No.	Subjects
1.	Botany– V & VI Semester
2.	Chemistry– V & VI Semester
3.	Zoology and Genetics– V & VI Semester
4.	BoS in Fashion and Apparel Design i. FAD – V & VI Semester ii. IDD– V & VI Semester
5.	Geography– V & VI Semester
6.	Mathematics– V & VI Semester
7.	Physics – V & VI
8.	BoS in Home Science i) Home Science – V & VI ii)Nutrition & Dietetics – V & VI iii)Clinical Nutrition & Dietetics – V & VI iv)Food Technology – I & II Sem

p.t.o

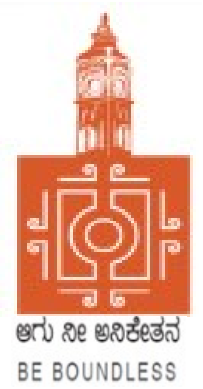
9.	Criminology and Forensic Science– V & VI
10.	Psychology– V & VI Semester
11.	Electronics – V & VI
12.	Statistics – V & VI
13.	Microbiology– V & VI
14.	Biotechnology– V & VI
15.	Environmental Science– V & VI

The detailed Syllabi for above subjects are notified in the University Website: www.bcu.ac.in for information of the concerned.

REGISTRAR

Copy to;

1. The Registrar(Evaluation), Dr. Manmohan Singh Bengaluru City University
2. The Dean, Faculty of Science, MSBCU.
3. The Principals of the concerned affiliated Colleges of MSBCU- through email.
4. The P.S. to Vice-Chancellor/Registrar/Registrar (Evaluation), MSBCU.
5. Office copy / Guard file / University Website: www.bcu.ac.in



Dr. MANMOHAN SINGH BENGALURU CITY UNIVERSITY

CHOICE BASED CREDIT SYSTEM
[As per SEP]

Syllabus for B.Sc.
Microbiology

2026-27 onwards

BENGALURU CITY UNIVERSITY
REGULATIONS & SYLLABUS FOR MICROBIOLOGY
in
Three-Year B.Sc. Course (SEP 2024)

Scheme of Instruction/ Examination:

1. The theory question paper for each paper shall cover all the topics in the pertaining syllabus with proportional weightage to the number of hours of instruction prescribed.
2. The practical Classes are to be conducted in batches of 10 students per batch (maximum 12) per teacher as per the University norms for the faculty of science for giving instructions, explaining the principles of experiments, supervising the conduct of experiments and correction of Records.
3. It is expected that each student conducts and learns the experiments in the practical classes.
4. Students are required to use microbiology instruments and tools to run the experiments and record the outputs to the practical records in each practical class.
5. Maximum marks for practical records in the examinations is 5.
6. A study tour or visit to industries and research institutes for the students is strongly recommended to gain practical knowledge of applications of Microbiology in Industries/Agriculture/Medical field and research.

B.Sc. CREDIT BASED SEMESTER SCHEME

MICROBIOLOGY

SCHEME OF INSTRUCTIONS AND CREDITS

Paper No.	Title of the paper	Type of paper	Hours/ Week	Duration of Exam (Hours)	IA	Exam	Total Marks	Credits
V SEMESTER								
MBT -501	Medical Microbiology and Immunology	T	4	3	20	80	100	3
MBT -502	Recombinant DNA Technology	T	4	3	20	80	100	3
MBP - 503	Medical Microbiology and Immunology And Genetic Engineering	P	3	3	10	40	50	2
Compulsory Practical/Skill2*	Advanced Microbiological Techniques	SK2	2	3	10	40	50	2
							300	**10**

VI SEMESTER								
MBT -601	Agricultural and Food Microbiology	T	4	3	20	80	100	3
MBT -602	Environmental and Industrial Microbiology	T	4	3	20	80	100	3
MBP -603	Agricultural and Food Microbiology Environmental and Industrial Microbiology	P	3	3	10	40	50	2
Compulsory Practical/Skill-3*	Internship/ Project	SK3	2	3	10	40	50	2
							300	**10**

The compulsory skill may involve practical experience in an industrial set up/Laboratory/ dissertation/ minor Project providing hands on experience other than the regular practical of the course. Skill-3- Report to be submitted (Manuscript) -40 Marks and Viva Voce -10 Marks)

Internal assessment:

Theory: (20)

(a) Tests and assignments – 15

(b) Attendance - 05

Practical: (10)

(a) Tests – 10

B.Sc. SEMESTER SCHEME (SEP 2024)
MICROBIOLOGY
SCHEME OF THEORY EXAMINATION

Duration: 3 Hours **Max. Marks: 80**

I.	Answer any 10 of the following: (out of 12) Questions 1 to 12	10 x 2 marks = 20 Marks
II.	Answer any 6 of the following: (out of 8) Questions 13 to 20	6 x 5 marks = 30Marks
III.	Answer any 3 of the following: (out of 5) Questions 21 to 25.	3 x 10 marks = 30 Marks

BANGALORE UNIVERSITY, BANGALORE
Syllabus for B.Sc., Microbiology
CBCS, SEMESTER V

MBT-501 – Medical Microbiology and Immunology

Course Title : Medical Microbiology and Immunology	
Course Code : MBT-501	L-T-P per week: 4-0-0
Total Hours: 56	Course Credits: 03
Formative Assessment(IA) Marks: 20	Duration of ESA/ Exam: 3 Hrs
Summative Assessment Marks: 80	

Course Objectives:

The objectives of this course are to enable students to:

1. Understand the history, scope, and significance of medical microbiology in human health and infectious diseases.
2. Explain host–microbe interactions, normal microflora, pathogenicity, virulence factors, and disease transmission mechanisms.
3. Study important bacterial, viral, fungal, and protozoan diseases, including their diagnosis and control.
4. Understand basic immunology concepts such as immunity, immune cells, lymphoid organs, antigens, and antibodies.
5. Gain knowledge of antigen–antibody reactions and their diagnostic applications in medical microbiology.
6. Understand hypersensitivity, autoimmunity, immunodeficiency, transplantation immunity, vaccines, and immunization programmes.

Sessions Per Week	Total Contact Hours	Marks		Duration of Examination	Total Marks
		Internal Assessment	End Semester Exam		100 Marks
4	56	20 marks	80 marks	3 hours	
Unit 1: Introduction to Medical Microbiology & Bacterial Diseases					14 hours
Introduction to Medical Microbiology History and scope of medical microbiology, normal microflora of the human body, host–microbe interactions.					2
Pathogenicity and Virulence Factors Pathogenic microorganisms, virulence factors, exotoxins, endotoxins, opportunistic pathogens, nosocomial infections.					3
Transmission of Infectious Diseases Sources and modes of transmission, portals of entry and exit, epidemiology of infectious diseases.					2
Gram Positive Bacterial Diseases Etiology, symptoms, laboratory diagnosis, prevention and control of Tuberculosis, Tetanus and Diphtheria.					3

Gram Negative Bacterial Diseases Etiology, symptoms, laboratory diagnosis, prevention and control of Typhoid, Cholera, Gonorrhea and Syphilis.	**4**
Unit 2: Viral, Fungal & Protozoan Diseases	**14 hours**
General Properties of Viruses Structure, classification, cultivation and diagnosis of medically important viruses.	**2**
Viral Diseases Etiology, symptoms, laboratory diagnosis, prevention and control of HIV/AIDS, Hepatitis, Rabies, Influenza, Dengue and Poliomyelitis.	**4**
Fungal Diseases (Mycoses) Superficial, subcutaneous and systemic mycoses, pathogenic fungi and laboratory diagnosis.	**3**
Medically Important Fungi Diseases caused by Candida, Aspergillus and Dermatophytes.	**2**
Protozoan Diseases Life cycle, pathogenicity, diagnosis, prevention and control of Malaria, Amoebiasis, Giardiasis and Leishmaniasis.	**3**
Unit 3: Immunology – Immune System & Immunity	**14 hours**
Introduction to Immunology Concept of immunity, innate and acquired immunity, active and passive immunity.	**2**
Cells of the Immune System Structure and functions of B-cells, T-cells, macrophages, dendritic cells and natural killer cells.	**3**
Organs of the Immune System Primary and secondary lymphoid organs, thymus, spleen, lymph nodes and bone marrow.	**3**
Antigens and Immunogens Properties of antigens, haptens, epitopes, adjuvants and antigen specificity.	**3**
Antibodies and Immunoglobulins Structure, classes and functions of immunoglobulins, monoclonal antibodies.	**3**
Unit 4: Immunological Reactions & Applied Immunology	**14 hours**
Antigen–Antibody Reactions Precipitation, agglutination, complement fixation, neutralization reactions.	**3**
Immunological Techniques ELISA, immunofluorescence, Western blotting, rapid diagnostic tests and applications.	**3**
Hypersensitivity Reactions Types I, II, III and IV hypersensitivity reactions and their clinical significance.	**3**
Autoimmunity and Immunodeficiency Autoimmune disorders, immunodeficiency diseases, transplantation immunity.	**2**
Vaccines and Immunization Types of vaccines, immunization schedules, recombinant and DNA vaccines, national immunization programme.	**3**

Course Outcomes (COs):
After the successful completion of the course, the student will be able to:

CO1: Describe the scope of medical microbiology and its relevance to infectious diseases.

CO2: Explain host–pathogen interactions, pathogenicity, virulence factors, and routes of disease transmission.

CO3: Discuss major bacterial diseases with reference to symptoms, diagnosis, prevention, and control.

CO4: Identify important viral, fungal, and protozoan diseases and their diagnostic approaches.

CO5: Explain immune mechanisms, immune cells, lymphoid organs, antigens, antibodies, and immunoglobulins.

CO6: Apply antigen–antibody reactions and serological techniques for infectious disease diagnosis.

CO7: Describe hypersensitivity, autoimmunity, immunodeficiency, transplantation immunity, vaccines, and immunization programmes.

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 80 Marks	
Formative Assessment / type	**Weightage in Marks**
Attendance	5
Seminar Assignment	5
Debates and Quiz	5
Test	5
Total FA	**20**
Total (FA + SA)	**100 marks**

Text Books/References

1. Ananthanarayan, R. and Paniker, C.K.J., *Textbook of Microbiology*, 11th Edition, 2021, Universities Press (India) Pvt. Ltd., Hyderabad, India.
2. Prescott, L.M., Harley, J.P. and Klein, D.A., *Microbiology*, 10th Edition, 2017, McGraw-Hill Education, New York, USA.
3. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R., *Microbiology*, 5th Edition, 2001, Tata McGraw-Hill Publishing Company Ltd., New Delhi, India.
4. Jawetz, Melnick and Adelberg, *Medical Microbiology*, 28th Edition, 2019, McGraw-Hill Education, New York, USA.
5. Brooks, G.F., Carroll, K.C., Butel, J.S. and Morse, S.A., *Jawetz, Melnick & Adelberg's Medical Microbiology*, 27th Edition, 2016, McGraw-Hill Education, USA.

6. Murray, P.R., Rosenthal, K.S. and Pfaller, M.A., *Medical Microbiology*, 9th Edition, 2020, Elsevier Health Sciences, Philadelphia, USA.
7. Cheesbrough, M., *District Laboratory Practice in Tropical Countries, Part 2*, 2nd Edition, 2006, Cambridge University Press, Cambridge, UK.
8. Tortora, G.J., Funke, B.R. and Case, C.L., *Microbiology: An Introduction*, 13th Edition, 2019, Pearson Education, London, UK.
9. Kuby, J., Kindt, T.J., Goldsby, R.A. and Osborne, B.A., *Kuby Immunology*, 8th Edition, 2018, W.H. Freeman and Company, New York, USA.
10. Abbas, A.K., Lichtman, A.H. and Pillai, S., *Cellular and Molecular Immunology*, 10th Edition, 2021, Elsevier, Philadelphia, USA.
11. Roitt, I., Brostoff, J. and Male, D., *Roitt's Essential Immunology*, 13th Edition, 2017, Wiley-Blackwell Publications, Oxford, UK.
12. Delves, P.J., Martin, S.J., Burton, D.R. and Roitt, I.M., *Roitt's Essential Immunology*, 14th Edition, 2021, Wiley-Blackwell, Hoboken, USA.
13. Janeway, C.A., Travers, P., Walport, M. and Shlomchik, M.J., *Janeway's Immunobiology*, 9th Edition, 2017, Garland Science, Taylor & Francis Group, New York, USA.
14. Subhash Chandra Parija, *Textbook of Medical Parasitology*, 5th Edition, 2023, Springer Nature India Pvt. Ltd., New Delhi, India.
15. Apurba Sankar Sastry and Sandhya Bhat K., *Essentials of Medical Microbiology*, 3rd Edition, 2021, Jaypee Brothers Medical Publishers, New Delhi, India.

BANGALORE UNIVERSITY, BANGALORE
Syllabus for B.Sc., Microbiology
CBCS, SEMESTER V

MBT-502– Recombinant DNA Technology

Course Title : Recombinant DNA Technology	
Course Code : MBT-502	L-T-P per week: 4-0-0
Total Hours: 56	Course Credits: 03
Formative Assessment(IA) Marks: 20	Duration of ESA/ Exam: 3 Hrs
Summative Assessment Marks: 80	

Course Objectives:

The objectives of this course are to enable students to:

1. Understand the history, scope, principles, and applications of genetic engineering, recombinant DNA technology, and biotechnology.
2. Explain the role of important enzymes, vectors, and cloning hosts used in recombinant DNA technology.
3. Develop knowledge of gene cloning strategies, recombinant DNA construction, gene transfer methods, and screening of recombinants.

4. Understand molecular biology techniques such as PCR, DNA sequencing, blotting, hybridization, DNA fingerprinting, genomics, and proteomics.
5. Explain the principle and applications of CRISPR-Cas genome editing and other modern genomic analysis tools.
6. Analyse the applications of genetic engineering in agriculture, medicine, industry, and environment, along with ethical, legal, and biosafety issues.

Sessions Per Week	Total Contact Hours	Marks		Duration of Examination	Total Marks
		Internal Assessment	End Semester Exam		100 Marks
4	56	20 marks	80 marks	3 hours	
Unit 1: Introduction to Tools of Recombinant DNA Technology					**14 hours**
Introduction to Recombinant DNA Technology History, scope and applications of genetic engineering, recombinant DNA technology and biotechnology.					**2**
Enzymes Used in Recombinant DNA Technology Restriction endonucleases, exonucleases, DNA ligase, alkaline phosphatase, reverse transcriptase and DNA polymerases.					**4**
Vectors in Recombinant DNA Technology Characteristics of ideal vectors, plasmid vectors, bacteriophage vectors, cosmids and shuttle vectors.					**3**
Cloning Hosts Characteristics of cloning hosts, E. coli strains, yeast and other microbial hosts.					**2**
Gene Cloning Strategies Preparation of foreign DNA, ligation, transformation, selection and screening of recombinants.					**3**
Unit 2: Gene Transfer Methods					**14 hours**
Construction of Recombinant DNA Isolation and purification of DNA, genomic and cDNA libraries, ligation techniques.					**3**
Gene Transfer Methods Transformation, transduction, electroporation, microinjection, lipofection and biolistic method.					**3**
Screening and Selection of Recombinants Selectable markers, reporter genes, blue-white screening and colony hybridization techniques.					**3**
Polymerase Chain Reaction (PCR) Principle, types, steps and applications of PCR, RT-PCR and real-time PCR.					**3**
DNA Sequencing Techniques Maxam–Gilbert method, Sanger's dideoxy sequencing method and automated DNA sequencing.					**2**
Unit 3: Molecular Techniques & Genomic Analysis					**14 hours**
Blotting Techniques Southern, Northern and Western blotting techniques and applications.					**3**
Hybridization Techniques DNA probes, nucleic acid hybridization, fluorescence in situ hybridization (FISH).					**3**

DNA Fingerprinting Principle, methodology and applications in forensic science and paternity testing.	**2**
Genomics and Proteomics Introduction to genomics, proteomics and bioinformatics, genome mapping and Human Genome Project.	**3**
CRISPR and Genome Editing Principle of CRISPR-Cas system, genome editing and applications in biotechnology and medicine.	**3**
Unit 4: Applications of Recombinant DNA Technology	**14 hours**
Genetically Modified Organisms (GMOs) Transgenic plants and animals, Bt cotton, Golden Rice and genetically modified microbes.	**3**
Genetic Engineering in Medicine Recombinant vaccines, insulin production, gene therapy and monoclonal antibodies.	**3**
Industrial Applications Production of enzymes, antibiotics, biofuels and recombinant proteins.	**3**
Environmental Applications Bioremediation, biosensors and waste management using genetically engineered microorganisms.	**2**
Ethical, Legal and Biosafety Issues Bioethics, biosafety guidelines, intellectual property rights and regulations related to recombinant DNA technology.	**3**

Course Outcomes (COs):
After the successful completion of the course, the student will be able to:

CO1: Describe the basic concepts, history, scope, and applications of Recombinant DNA Technology.

CO2: Explain the role of enzymes, vectors, and cloning hosts in recombinant DNA technology.

CO3: Describe recombinant DNA construction, gene cloning strategies, transformation, selection, and screening methods.

CO4: Apply PCR, DNA sequencing, blotting, hybridization, FISH, and DNA fingerprinting techniques.

CO5: Explain genomics, proteomics, genome mapping, Human Genome Project, and CRISPR-Cas editing.

CO6: Evaluate applications, ethical concerns, biosafety guidelines, IPR, and GMO regulations.

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 80 Marks

Formative Assessment / type	Weightage in Marks
Attendance	5
Seminar Assignment	5
Debates and Quiz	5
Test	5
Total FA	**20**
Total (FA + SA)	**100 marks**

Text Books/References

1. Brown, T.A., *Gene Cloning and DNA Analysis: An Introduction*, 8th Edition, 2021, Wiley-Blackwell Publishing, Oxford, UK.
2. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., *Molecular Biology of the Gene*, 7th Edition, 2013, Pearson Education, Boston, USA.
3. Sambrook, J. and Russell, D.W., *Molecular Cloning: A Laboratory Manual*, 3rd Edition, 2001, Cold Spring Harbor Laboratory Press, New York, USA.
4. Primrose, S.B. and Twyman, R.M., *Principles of Gene Manipulation and Genomics*, 8th Edition, 2016, Wiley-Blackwell Publishing, UK.
5. Old, R.W. and Primrose, S.B., *Principles of Gene Manipulation: An Introduction to Genetic Engineering*, 6th Edition, 2001, Blackwell Scientific Publications, Oxford, UK.
6. Glick, B.R., Pasternak, J.J. and Patten, C.L., *Molecular Biotechnology: Principles and Applications of Recombinant DNA*, 5th Edition, 2010, ASM Press, Washington D.C., USA.
7. Snustad, D.P. and Simmons, M.J., *Principles of Genetics*, 7th Edition, 2015, John Wiley & Sons, New York, USA.
8. S. Ignacimuthu, *Basic Biotechnology*, 3rd Edition, 2020, Tata McGraw-Hill Education Pvt. Ltd., New Delhi, India.
9. P. K. Gupta, *Elements of Biotechnology*, 3rd Edition, 2015, Rastogi Publications, Meerut, India.
10. U. Satyanarayana, *Biotechnology*, 1st Edition, 2008, Books and Allied (P) Ltd., Kolkata, India.
11. Lewin, B., *Genes XII*, 12th Edition, 2017, Jones and Bartlett Learning, Burlington, USA.
12. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K. and Walter, P., *Molecular Biology of the Cell*, 6th Edition, 2014, Garland Science, New York, USA.
13. Green, M.R. and Sambrook, J., *Molecular Cloning: A Laboratory Manual*, 4th Edition, 2012, Cold Spring Harbor Laboratory Press, New York, USA.
14. Brown, C.M., *Introduction to Bioinformatics*, 1st Edition, 2005, Chapman and Hall/CRC Press, Boca Raton, USA.
15. Klug, W.S., Cummings, M.R., Spencer, C.A. and Palladino, M.A., *Concepts of Genetics*, 12th Edition, 2018, Pearson Education, London, UK.

SEMESTER V

MBP-503 – Medical Microbiology and Immunology and Recombinant DNA Technology

Course Title : Medical Microbiology and Immunology and Recombinant DNA Technology	
Course Code : MBP-503	L-T-P per week: 0-0-3
Total Hours: 36	Course Credits: 02
Formative Assessment(IA) Marks: 10	Duration of ESA/ Exam: 4 Hrs
Summative Assessment Marks: 40	

Course Objectives:

The objectives of this course are to enable students to:

1. Develop practical skills in using differential and selective media for identifying medically important bacteria.
2. Perform staining, biochemical, and cultural methods used for identification of pathogenic microorganisms.
3. Understand antimicrobial susceptibility testing methods, including disc diffusion and MIC determination.
4. Demonstrate immunological and serological techniques such as Widal test, agglutination, ELISA, blood grouping, Rh typing, and Ouchterlony double diffusion.
5. Acquire hands-on knowledge of genetic engineering techniques such as buffer preparation, genomic DNA isolation, plasmid DNA isolation, agarose gel electrophoresis, and DNA estimation.
6. Understand the practical principles of bacterial transformation, Southern blotting, PCR, replica plating, recombinant DNA technology, restriction enzymes, plasmid vectors, and CRISPR-Cas system.

Sessions Per Week	Total Contact Units	Marks		Duration of Examination	Total Marks
		Internal Assessment	End Semester Exam		50 Marks
3	18	10 marks	40 marks	3 hours	

No.	Experiments	Units
1	Study of composition and use of important differential media for identification of pathogenic bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS.	1
2	Gram staining of bacterial cultures. Acid-fast staining of Mycobacterium	1
3	Identify pathogenic bacteria (any three of *E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus*) on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease and catalase tests Study of bacterial flora of skin by swab method.	1
4	Antibiotic sensitivity test by paper disc diffusion method, Determination of MIC of antimicrobial agents	1
5	Widal test for typhoid diagnosis	1

6	Study of symptoms of the diseases with the help of photographs: Hepatitis, AIDS, Corona, Influenza, Pedis (Athlete's foot), Candidiasis.	1
7	Agglutination reaction using antigen–antibody interaction	1
8	ELISA technique (demonstration)	1
9	Blood grouping and Rh typing	1
10	Estimation of sugar from urine sample.	1
11	Ouchterlony double diffusion test	1
12	Preparation of buffers used in Genetic Engineering – TE, TAE and TBE buffers, Isolation of genomic DNA from bacteria, Isolation of plasmid DNA from bacteria	1
13	Agarose gel electrophoresis of DNA, Estimation of DNA by spectrophotometric method	1
14	Preparation of competent cells and demonstration of bacterial transformation.	1
15	Demonstration of southern blotting technique.	1
16	Preparation of master and replica plates.	1
17	Demonstration of PCR.	1
18	Charts on recombinant DNA technology: a) Plasmid vectors b) Restriction enzymes c) PCR amplification process d) CRISPR-Cas system	1

Course Outcomes (COs):
After the successful completion of the course, the student will be able to:

CO1: Prepare and use differential and selective media for identifying pathogenic bacteria.

CO2: Perform staining, cultural, and biochemical tests for bacterial identification.

CO3: Evaluate antimicrobial activity using disc diffusion and MIC determination methods.

CO4: Demonstrate serological and immunological tests used in disease diagnosis.

CO5: Isolate, estimate, and analyse genomic and plasmid DNA samples.

CO6: Explain bacterial transformation, PCR, Southern blotting, replica plating, and recombinant DNA methods.

CO7: Interpret plasmid vectors, restriction enzymes, PCR amplification, and CRISPR-Cas system charts.

Formative Assessment/ Internal	**Total Marks-10**	**Summative Assessment Marks**

Assessment Occasion/ type	Weightage in Marks	Practical Exam
House Examination/Test	05	40 Marks
Class Performance/Attendance	05	

Text Books/References

1. Cappuccino, J.G. and Sherman, N., *Microbiology: A Laboratory Manual*, 12th Edition, 2020, Pearson Education, New York, USA.
2. Aneja, K.R., *Experiments in Microbiology, Plant Pathology and Biotechnology*, 4th Edition, 2003, New Age International Publishers, New Delhi, India.
3. R. C. Dubey and Maheshwari, D.K., *Practical Microbiology*, Revised Edition, 2012, S. Chand & Company Ltd., New Delhi, India.
4. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R., *Microbiology Laboratory Manual*, 5th Edition, 2001, Tata McGraw-Hill Publishing Company Ltd., New Delhi, India.
5. Harley, J.P. and Prescott, L.M., *Laboratory Exercises in Microbiology*, 10th Edition, 2016, McGraw-Hill Education, New York, USA.
6. S. Ignacimuthu, *Applied Plant Biotechnology and Molecular Biology: A Practical Manual*, 2nd Edition, 2009, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India.
7. Sambrook, J. and Russell, D.W., *Molecular Cloning: A Laboratory Manual*, 3rd Edition, 2001, Cold Spring Harbor Laboratory Press, New York, USA.
8. Green, M.R. and Sambrook, J., *Molecular Cloning: A Laboratory Manual*, 4th Edition, 2012, Cold Spring Harbor Laboratory Press, New York, USA.
9. Brown, T.A., *Gene Cloning and DNA Analysis: An Introduction*, 8th Edition, 2021, Wiley-Blackwell Publishing, Oxford, UK.
10. P. Gunasekaran, *Laboratory Manual in Microbiology*, 1st Edition, 1996, New Age International Publishers, New Delhi, India.
11. Wilson, K. and Walker, J., *Principles and Techniques of Biochemistry and Molecular Biology*, 8th Edition, 2018, Cambridge University Press, Cambridge, UK.
12. Ausubel, F.M., Brent, R., Kingston, R.E., Moore, D.D., Seidman, J.G., Smith, J.A. and Struhl, K., *Current Protocols in Molecular Biology*, Latest Edition, Wiley Interscience, New York, USA.
13. Collee, J.G., Fraser, A.G., Marmion, B.P. and Simmons, A., *Mackie and McCartney Practical Medical Microbiology*, 14th Edition, 2007, Churchill Livingstone, Elsevier, London, UK.
14. Subhash Chandra Parija, *Textbook of Practical Microbiology*, 2nd Edition, 2012, Ahuja Publishing House, New Delhi, India.
15. Singh, B.D., *Biotechnology: Expanding Horizons*, 4th Edition, 2012, Kalyani Publishers, New Delhi, India.

B.Sc. Microbiology, V Semester
Practical Exam Question Paper
Practical: MBP-503 Medical Microbiology and Immunology,

and Recombinant DNA Technology

Time: 3hours **Marks: 40M**

Q.no	Experiment	Marks
1	Isolate the genomic DNA from sample 'A' (Plant / Animal tissue). (Principle – 2M, Performance – 4M, Result – 1M)	6 marks
2	Perform the Blood Grouping / Differential count of WBC from the given sample 'A'. Comment on the results (Principle – 2M, Performance – 3M, Result – 2M)	6 marks
3	Write the Principle and Procedure for 'B' Restriction Digestion, Ouchterlony double diffusion/ ELISA/ DNA fingerprinting (Principle – 2M, Procedure – 3M)	4 marks
4	Perform RPR / Widal test with the given sample 'B'/ Electrophoresis- Agarose Gel loading. (Principle – 2M, Performance – 2M, Result – 1M)	5marks
5	Identify and Comment on 'C' & 'D'	2x3=6 marks
6	Class Records and Industrial Visit	8 marks
7	Viva- voce	5 marks

Course Title **:** Advanced Microbiological Techniques	
Course Code : MBSkill-2	L-T-P per week: 0-0-3
Total Hours: 36	Course Credits: 02
Formative Assessment(IA) Marks: 10	Duration of ESA/ Exam: 4 Hrs
Summative Assessment Marks: 40	

Course Objectives:

The objectives of this course are to enable students to:

1. Develop advanced practical skills in microscopy, sterilization, aseptic handling, pure culture preparation, anaerobic culturing, and microbial culture preservation.
2. Understand differential, special staining, biochemical, diagnostic, and antimicrobial susceptibility testing techniques used in microbiology laboratories.
3. Acquire hands-on knowledge of molecular microbiology techniques such as DNA isolation, DNA estimation, agarose gel electrophoresis, PCR, blotting techniques, and nucleic acid analysis.
4. Demonstrate basic immunological techniques such as ELISA, immunofluorescence, and monoclonal antibody-based diagnostic methods.
5. Develop skill-based understanding of applied techniques used in food, agricultural, environmental, industrial, and healthcare microbiology.
6. Introduce emerging areas such as biosensors, nanotechnology, microbiome analysis, metagenomics, bioinformatics, artificial intelligence, CRISPR-Cas technology, and genome editing.

Sessions Per Week	**Total Contact Hours**	**Marks**		**Duration of Examination**	**Total Marks**
		Internal Assessment	**End Semester Exam**		**50 Marks**
3	**32**	**10 marks**	**40 marks**	**3 hours**	
Unit 1: Advanced Microscopy, Sterilization and Culture Techniques					**10 hours**
Practical/Skill-Based Experiments 1. Calibration and handling of compound microscope 2. Sterilization of media and glassware using autoclave and hot air oven 3. Isolation of pure cultures using streak plate and spread plate techniques 4. Observation of microorganisms using phase contrast microscopy (demonstration) 5. Preservation of microbial cultures by glycerol stock method					
Unit 2: Advanced Staining, Identification and Diagnostic Techniques					**10 hours**
Practical/Skill-Based Experiments 1. Gram staining and acid-fast staining 2. Endospore staining and capsule staining					

3. Biochemical tests: IMViC, catalase, oxidase and urease tests 4. Antibiotic sensitivity testing by Kirby–Bauer disc diffusion method 5. Determination of Minimum Inhibitory Concentration (MIC) of antibiotics 6. Observation of rapid diagnostic kits used in microbiology laboratories	
Unit 3: Molecular Microbiology and Immunological Techniques	**10 hours**
Practical/Skill-Based Experiments 1. Isolation of genomic DNA from bacteria 2. Estimation of DNA by spectrophotometric method 3. Agarose gel electrophoresis of DNA samples 4. Demonstration of PCR amplification process 5. Demonstration of ELISA technique 6. Demonstration of Southern blotting and CRISPR-Cas system using charts/videos/models	
Unit 4: Applied and Emerging Techniques in Microbiology	**14 hours**
Practical/Skill-Based Experiments 1. Detection of coliform bacteria in water by MPN method 2. Microbiological examination of milk by methylene blue reduction test 3. Alcohol fermentation using yeast 4. Isolation of phosphate solubilizing microorganisms from soil 5. Preparation of biofertilizer culture (demonstration) 6. Study of fermentor components and downstream processing using charts/models 7. Demonstration of biosensors and microbiome analysis tools through digital resources	

Course Outcomes (COs):

After the successful completion of the course, the student will be able to:

CO1: Operate microscopes and apply sterilization, aseptic handling, biosafety, and culture preservation techniques.

CO2: Perform differential and special staining methods for microbial observation and identification.

CO3: Conduct biochemical, diagnostic, antibiotic sensitivity, and MIC-based microbiological tests.

CO4: Isolate, estimate, and analyse microbial DNA using standard molecular techniques.

CO5: Demonstrate ELISA, immunofluorescence, monoclonal antibody, blotting, PCR, and CRISPR-based methods.

CO6: Apply microbiological techniques in food, agriculture, environment, industry, and healthcare sectors.

Formative Assessment/ Internal Assessment:	**Total-10**
Assessment Components	**Weightage**
House Examination/Test	05
Class performance/Participation/ Attendance	05

Text Books/References

1. Cappuccino, J.G. and Sherman, N., *Microbiology: A Laboratory Manual*, 12th Edition, 2020, Pearson Education, New York, USA.
2. Harley, J.P. and Prescott, L.M., *Laboratory Exercises in Microbiology*, 10th Edition, 2016, McGraw-Hill Education, New York, USA.
3. Aneja, K.R., *Experiments in Microbiology, Plant Pathology and Biotechnology*, 4th Edition, 2003, New Age International Publishers, New Delhi, India.
4. Dubey, R.C. and Maheshwari, D.K., *Practical Microbiology*, Revised Edition, 2012, S. Chand & Company Ltd., New Delhi, India.
5. Sambrook, J. and Russell, D.W., *Molecular Cloning: A Laboratory Manual*, 3rd Edition, 2001, Cold Spring Harbor Laboratory Press, New York, USA.
6. Green, M.R. and Sambrook, J., *Molecular Cloning: A Laboratory Manual*, 4th Edition, 2012, Cold Spring Harbor Laboratory Press, New York, USA.
7. Brown, T.A., *Gene Cloning and DNA Analysis: An Introduction*, 8th Edition, 2021, Wiley-Blackwell Publishing, Oxford, UK.
8. Wilson, K. and Walker, J., *Principles and Techniques of Biochemistry and Molecular Biology*, 8th Edition, 2018, Cambridge University Press, Cambridge, UK.
9. P. Gunasekaran, *Laboratory Manual in Microbiology*, 1st Edition, 1996, New Age International Publishers, New Delhi, India.
10. Collee, J.G., Fraser, A.G., Marmion, B.P. and Simmons, A., *Mackie and McCartney Practical Medical Microbiology*, 14th Edition, 2007, Churchill Livingstone, Elsevier, London, UK.
11. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R., *Microbiology*, 5th Edition, 2001, Tata McGraw-Hill Publishing Company Ltd., New Delhi, India.
12. Prescott, L.M., Harley, J.P. and Klein, D.A., *Microbiology*, 10th Edition, 2017, McGraw-Hill Education, New York, USA.
13. S. Ignacimuthu, *Basic Biotechnology*, 3rd Edition, 2020, Tata McGraw-Hill Education Pvt. Ltd., New Delhi, India.
14. Atlas, R.M. and Bartha, R., *Microbial Ecology: Fundamentals and Applications*, 4th Edition, 1998, Benjamin/Cummings Publishing Company, California, USA.
15. Madigan, M.T., Bender, K.S., Buckley, D.H., Sattley, W.M. and Stahl, D.A., *Brock Biology of Microorganisms*, 16th Edition, 2021, Pearson Education, London, UK.

B.Sc. Microbiology, V Semester :
Skill Exam Question Paper
Practical: MB Skill-2 **Advanced Microbiological Techniques**

Q 1.	Analyze the activity of enzyme in the given Milk sample./ Determine the Rf value of Plant pigments by Paper chromatography	10M (2.5M+2.5M+5 M)
Q 2.	Estimation of Vitamin C/ Protein from the given sample "A" (Principle, Procedure, Result and Observation).	10M (2.5M+2.5M+5 M)
Q 3.	Write the principle and procedure for "B" DNA fingerprinting / Peroxidase test	4M
Q 4.	Identify the spotter's "C" and "D" Cloning / PCR / / trypsinization / secondary metabolites	6M (3M+3M)
Q 5	Lab record	5M
Q 6.	Viva voce	5M

Summative Assessment - 40 Marks	
Formative Assessment Occasion/type	**Weightage in Marks**
Submission of a Case study	**05**
Test	**05**
Total	**40 + 10 Marks= 50 Marks**

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CBCS, SEMESTER VI

MBT-601– Agricultural and Food Microbiology

Course Title : Agricultural and Food Microbiology	
Course Code : MBT-601	L-T-P per week: 4-0-0
Total Hours: 56	Course Credits: 03
Formative Assessment(IA) Marks: 20	Duration of ESA/ Exam: 3 Hrs
Summative Assessment Marks: 80	

Course Objectives:

The objectives of this course are to enable students to:

1. Understand the scope, importance, and applications of agricultural microbiology in sustainable agriculture and soil fertility management.
2. Explain soil as a microbial habitat and describe the role of rhizosphere, phyllosphere, and soil microorganisms in plant growth and ecosystem functioning.
3. Understand microbial interactions, plant–microbe relationships, nutrient cycling, biofertilizers, biopesticides, and biological control methods in agriculture.
4. Develop knowledge of plant diseases caused by fungi, bacteria, and viruses, including their symptoms, transmission, diagnosis, prevention, and control.
5. Study the principles of food microbiology, food spoilage, food preservation, foodborne diseases, food hygiene, sanitation, HACCP, and food safety regulations.
6. Understand the role of microorganisms in fermented foods, dairy products, single cell protein, probiotics, industrial food applications, organic farming, biofortification, and genetically modified foods.

Sessions Per Week	Total Contact Hours	Marks		Duration of Examination	Total Marks
		Internal Assessment	End Semester Exam		100 Marks
4	56	20 marks	80 marks	3 hours	
Unit 1: Agricultural Microbiology & Soil Microorganisms					**14 hours**
Introduction to Agricultural Microbiology Scope, importance and applications of agricultural microbiology in sustainable agriculture.					**2**
Soil Microbiology Soil as a habitat for microorganisms, microbial flora of soil, rhizosphere and phyllosphere microorganisms.					**3**
Microbial Interactions in Soil Symbiosis, commensalism, mutualism, antagonism and plant–microbe interactions.					**2**
Microbial Role in Nutrient Cycling Carbon cycle, nitrogen cycle, phosphorus cycle and sulfur cycle in soil ecosystems.					**4**
Biofertilizers and Biopesticides Types, production and applications of Rhizobium, Azotobacter, Azospirillum, cyanobacteria, mycorrhizae and biopesticides.					**3**
Unit 2: Plant Pathology & Microbes in Agriculture					**14 hours**
Introduction to Plant Pathology Concept of plant diseases, symptoms, signs and classification of plant pathogens.					**2**
Fungal Plant Diseases Causal organisms, symptoms, transmission and control of rusts, smuts and wilts.					**3**
Bacterial Plant Diseases Causal organisms, symptoms, transmission and control of citrus canker, bacterial blight and crown gall disease.					**3**

Viral Plant Diseases Plant viruses, transmission and control of tobacco mosaic disease and leaf curl diseases.	**3**
Biological Control of Plant Diseases Biocontrol agents, mechanisms of biological control and integrated pest management (IPM).	**3**
Unit 3: Food Microbiology & Food Spoilage	**14 hours**
Introduction to Food Microbiology History, scope and importance of food microbiology, sources of microorganisms in food.	**2**
Food Spoilage Microbial spoilage of cereals, fruits, vegetables, meat, fish, eggs and dairy products.	**4**
Food Preservation Methods Physical and chemical methods of food preservation: temperature, drying, irradiation, preservatives and canning.	**3**
Foodborne Diseases Food infections and intoxications caused by Salmonella, Staphylococcus, Clostridium botulinum and E. coli.	**3**
Microbiological Standards of Food Hygiene, sanitation, HACCP, food quality control and food safety regulations.	**2**
Unit 4: Fermented Foods & Industrial Applications	**14 hours**
Fermented Foods and Beverages Microorganisms involved in fermentation of bread, curd, cheese, vinegar and alcoholic beverages.	**3**
Dairy Microbiology Microbiology of milk, pasteurization, fermented dairy products and spoilage of milk.	**3**
Single Cell Protein and Probiotics Production, advantages and applications of SCP and probiotics in food industries.	**3**
Industrial Applications of Food Microbiology Production of organic acids, enzymes, vitamins and fermented food products.	**2**
Recent Trends in Agricultural and Food Microbiology Organic farming, microbial biotechnology in agriculture, biofortification and genetically modified foods.	**3**

Course Outcomes (COs):

After the successful completion of the course, the student will be able to:

CO1: Describe agricultural microbiology, soil microbiology, rhizosphere, phyllosphere, and sustainable agriculture applications.

CO2: Explain soil microbial interactions, plant–microbe relationships, and major nutrient cycles.

CO3: Discuss biofertilizers, biopesticides, mycorrhizae, and microbial biocontrol agents in

agriculture.

CO4: Identify important fungal, bacterial, and viral plant diseases and their control methods.

CO5: Analyse food spoilage, preservation, foodborne diseases, hygiene, HACCP, and safety regulations.

CO6: Explain fermented foods, dairy microbiology, probiotics, single cell protein, and industrial food products.

CO7: Describe organic farming, microbial biotechnology, biofortification, and genetically modified food applications.

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments. Case studies highlight successful applications and challenges in transgenic crop development.

Summative Assessment = 80 Marks	
Formative Assessment Occasion/ type	**Weightage in Marks (20)**
House Examination/ Test	10
Written Assignment/ Presentation/ Project/ Term/Seminar	05
Class performance and Participation/ Attendance	05
Total	**80 marks + 20 marks = 100 marks**

Text Books/References

1. N. S. Subba Rao, *Soil Microbiology*, 4th Edition, 2017, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India.
2. N. S. Subba Rao, *Biofertilizers in Agriculture and Forestry*, 3rd Edition, 2001, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India.
3. Alexander, M., *Introduction to Soil Microbiology*, 2nd Edition, 1977, John Wiley & Sons, New York, USA.
4. Atlas, R.M. and Bartha, R., *Microbial Ecology: Fundamentals and Applications*, 4th Edition, 1998, Benjamin/Cummings Publishing Company, California, USA.
5. George N. Agrios, *Plant Pathology*, 5th Edition, 2005, Elsevier Academic Press, Burlington, USA.
6. Mehrotra, R.S. and Ashok Aggarwal, *Plant Pathology*, 2nd Edition, 2013, Tata McGraw-Hill Education Pvt. Ltd., New Delhi, India.
7. Rangaswami, G. and Bagyaraj, D.J., *Agricultural Microbiology*, 2nd Edition, 2006, PHI Learning Pvt. Ltd., New Delhi, India.
8. P. D. Sharma, *Microbiology and Plant Pathology*, 3rd Edition, 2011, Rastogi Publications, Meerut, India.
9. Frazier, W.C. and Westhoff, D.C., *Food Microbiology*, 4th Edition, 1988, Tata McGraw-Hill Publishing Company Ltd., New Delhi, India.
10. Jay, J.M., Loessner, M.J. and Golden, D.A., *Modern Food Microbiology*, 7th Edition, 2005, Springer Science & Business Media, New York, USA.

11. Adams, M.R. and Moss, M.O., *Food Microbiology*, 3rd Edition, 2008, Royal Society of Chemistry Publishing, Cambridge, UK.
12. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R., *Microbiology*, 5th Edition, 2001, Tata McGraw-Hill Publishing Company Ltd., New Delhi, India.
13. Prescott, L.M., Harley, J.P. and Klein, D.A., *Microbiology*, 10th Edition, 2017, McGraw-Hill Education, New York, USA.
14. Stanbury, P.F., Whitaker, A. and Hall, S.J., *Principles of Fermentation Technology*, 3rd Edition, 2016, Elsevier Ltd., Oxford, UK.
15. Subhash Chandra Parija, *Food Microbiology and Hygiene*, 1st Edition, 2012, Ahuja Publishing House, New Delhi, India.

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CBCS, SEMESTER VI

MBT-602– Environmental and Industrial Microbiology

Course Title : Environmental and Industrial Microbiology	
Course Code : MBT-602	L-T-P per week: 4-0-0
Total Hours: 56	Course Credits: 03
Formative Assessment(IA) Marks: 20	Duration of ESA/ Exam: 3 Hrs
Summative Assessment Marks: 80	

Course Objectives:

The objectives of this course are to enable students to:

1. Understand the scope, importance, and applications of environmental microbiology and microbial ecology.
2. Explain the role of microorganisms in microbial communities, ecosystem interactions, ecological relationships, and biogeochemical cycles.
3. Develop knowledge of water, air, sewage, solid waste, environmental pollution, microbial degradation, and environmental monitoring.
4. Understand the principles and applications of wastewater treatment, composting, vermicomposting, bioremediation, biofertilizers, biopesticides, renewable energy, biofuels, and microbial fuel cells.
5. Study the fundamentals of industrial microbiology, industrially important microorganisms, fermentation processes, fermentor design, operation, and downstream processing.
6. Understand the microbial production of industrial products such as alcohol, organic acids, enzymes, antibiotics, vitamins, vaccines, recombinant products, fermented foods, and recent trends in sustainable industrial microbiology.

Sessions Per Week	Total Contact Hours	Marks		Duration of Examination	Total Marks
		Internal Assessment	End Semester Exam		100 Marks
4	56	20 marks	80 marks	3 hours	
Unit 1: Environmental Microbiology & Microbial Ecology					**14 hours**
Introduction to Environmental Microbiology Scope, importance and applications of environmental microbiology.					**2**
Microbial Ecology Microbial communities, ecosystem interactions, microbial habitats and ecological relationships.					**3**
Microorganisms in Biogeochemical Cycles Role of microorganisms in carbon, nitrogen, sulfur and phosphorus cycles.					**3**
Water and Air Microbiology Microbiology of potable water, sewage water, air microflora and indicators of pollution.					**3**
Environmental Pollution and Microbial Control Sources and types of pollution, microbial degradation of pollutants and environmental monitoring.					**3**
Unit 2: Waste Management & Bioremediation					**14 hours**
Sewage and Wastewater Treatment Primary, secondary and tertiary sewage treatment processes and activated sludge process.					**3**
Solid Waste Management Microbial decomposition of solid waste, composting and vermicomposting.					**3**
Bioremediation Principles, types and applications of bioremediation in contaminated environments.					**3**
Biofertilizers and Biopesticides Production and applications of biofertilizers and biopesticides in environmental sustainability.					**2**
Renewable Energy and Environmental Biotechnology Biogas production, biofuels and microbial fuel cells.					**3**
Unit 3: Introduction to Industrial Microbiology & Fermentation					**14 hours**
Introduction to Industrial Microbiology History, scope and importance of industrial microbiology.					**2**
Industrially Important Microorganisms Characteristics and industrial applications of bacteria, fungi, yeast and actinomycetes.					**3**
Fermentation Technology Types of fermentation, batch, fed-batch and continuous fermentation processes.					**3**
Fermentor Design and Components Construction and operation of fermentors, sterilization, aeration and agitation systems.					**3**

Downstream Processing Recovery, extraction and purification of industrial products.	**3**
Unit 4: Industrial Production & Applications of Microorganisms	**14 hours**
Production of Industrial Products Microbial production of alcohol, organic acids, enzymes and antibiotics.	**4**
Production of Vaccines and Vitamins Microbial synthesis of vitamins, vaccines and recombinant products.	**2**
Food and Dairy Fermentation Industries Production of bread, cheese, curd, vinegar and fermented beverages.	**3**
Quality Control in Industrial Microbiology Good manufacturing practices (GMP), contamination control and biosafety in industries.	**2**
Recent Trends in Environmental and Industrial Microbiology Microbial biotechnology, nanobiotechnology, green technology and sustainable industrial processes.	**3**

Course Outcomes (COs):

After the successful completion of the course, the student will be able to:

CO1: Describe environmental microbiology, microbial ecology, microbial habitats, and ecosystem interactions.

CO2: Explain microbial roles in carbon, nitrogen, sulfur, and phosphorus cycles.

CO3: Analyse water, sewage, air microflora, pollution indicators, and environmental monitoring methods.

CO4: Evaluate wastewater treatment, composting, bioremediation, biofertilizers, biopesticides, and bioenergy processes.

CO5: Explain fermentation types, fermentor design, sterilization, aeration, agitation, and downstream processing.

CO6: Describe microbial production of alcohol, organic acids, enzymes, antibiotics, vitamins, and vaccines.

CO7: Explain fermented foods, recombinant products, GMP, biosafety, green technology, and sustainable processes.

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 80 Marks	
Formative Assessment Occasion/ type	**Weightage in Marks (20)**
House Examination/ Test	10

Written Assignment/ Presentation/ Project/ Term/Seminar	05
Class performance and Participation/ Attendance	05
Total	**80 marks + 20 marks = 100 marks**

Text Books/References

1. Atlas, R.M. and Bartha, R., *Microbial Ecology: Fundamentals and Applications*, 4th Edition, 1998, Benjamin/Cummings Publishing Company, California, USA.
2. Maier, R.M., Pepper, I.L. and Gerba, C.P., *Environmental Microbiology*, 3rd Edition, 2015, Academic Press, Elsevier, London, UK.
3. N. S. Subba Rao, *Soil Microbiology*, 4th Edition, 2017, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India.
4. Mitchell, R. and Gu, J.D., *Environmental Microbiology*, 3rd Edition, 2010, Wiley-Blackwell Publishing, New Jersey, USA.
5. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R., *Microbiology*, 5th Edition, 2001, Tata McGraw-Hill Publishing Company Ltd., New Delhi, India.
6. Prescott, L.M., Harley, J.P. and Klein, D.A., *Microbiology*, 10th Edition, 2017, McGraw-Hill Education, New York, USA.
7. Metcalf and Eddy, *Wastewater Engineering: Treatment and Resource Recovery*, 5th Edition, 2014, McGraw-Hill Education, New York, USA.
8. Rittmann, B.E. and McCarty, P.L., *Environmental Biotechnology: Principles and Applications*, 2nd Edition, 2020, McGraw-Hill Education, New York, USA.
9. Stanbury, P.F., Whitaker, A. and Hall, S.J., *Principles of Fermentation Technology*, 3rd Edition, 2016, Elsevier Ltd., Oxford, UK.
10. Crueger, W. and Crueger, A., *Biotechnology: A Textbook of Industrial Microbiology*, 2nd Edition, 2000, Panima Publishing Corporation, New Delhi, India.
11. Casida, L.E., *Industrial Microbiology*, Reprint Edition, 2007, New Age International Publishers, New Delhi, India.
12. Patel, A.H., *Industrial Microbiology*, 2nd Edition, 2016, Macmillan Publishers India Ltd., New Delhi, India.
13. Waites, M.J., Morgan, N.L., Rockey, J.S. and Higton, G., *Industrial Microbiology: An Introduction*, 1st Edition, 2001, Blackwell Science Ltd., Oxford, UK.
14. Glazer, A.N. and Nikaido, H., *Microbial Biotechnology: Fundamentals of Applied Microbiology*, 2nd Edition, 2007, Cambridge University Press, Cambridge, UK.
15. Subhash Chandra Parija, *Environmental Microbiology and Biotechnology*, 1st Edition, 2014, Ahuja Publishing House, New Delhi, India.

SEMESTER VI
MBP-603 – Agricultural, Food, Environmental, and Industrial Microbiology

Course Title : Agricultural, Food, Environmental, and Industrial Microbiology

(Practical)	
Course Code : MBP-603	L-T-P per week: 0-0-3
Total Hours: 36	Course Credits: 02
Formative Assessment(IA) Marks: 10	Duration of ESA/ Exam: 4 Hrs
Summative Assessment Marks: 40	

Course Objectives:

The objectives of this course are to enable students to:

1. Develop practical skills in isolating, enumerating, and observing microorganisms from soil, water, air, root nodules, and food samples.
2. Understand the role of agriculturally important microorganisms such as *Rhizobium*, *Azotobacter*, cyanobacteria, phosphate-solubilizing microorganisms, and cellulose-degrading microorganisms.
3. Acquire hands-on knowledge of food microbiology techniques, including milk examination, standard plate count, spoilage microorganism isolation, yeast fermentation, and lactic acid bacteria observation.
4. Perform environmental microbiology tests such as MPN method, microbial load determination, airborne microbial enumeration, BOD analysis, compost preparation, and sewage treatment demonstration.
5. Demonstrate industrial microbiology techniques related to alcohol fermentation, citric acid production, antibiotic production, sterilization, fermentor components, and downstream processing.
6. Interpret charts, models, and demonstrations related to nitrogen cycle, biofertilizers, biopesticides, food spoilage, HACCP, sewage treatment, biogas production, fermentors, and product recovery.

Sessions Per Week	**Total Contact Units**	**Marks**		**Duration of Examination**	**Total Marks**
		Internal Assessment	**End Semester Exam**		**50 Marks**
3	**18**	**10 marks**	**40 marks**	**3 hours**	

No.	**Experiments**	**Units**
1	Isolation of microorganisms from soil by serial dilution technique,	1
2	Enumeration of soil microorganisms by plate count method	1
3	Isolation of Rhizobium from root nodules	1
4	Observation of Azotobacter and cyanobacteria	1
5	Isolation of phosphate solubilizing microorganisms	1
6	Study of plant disease symptoms caused by fungi, bacteria and viruses	1
7	Microbiological examination of milk by methylene blue reduction test	1
8	Standard plate count of food samples	1
9	Isolation of microorganisms from spoiled food materials	1
10	Yeast fermentation experiment	1

11	Preparation of curd and observation of lactic acid bacteria	1
12	Detection of coliform bacteria in water by MPN method	1
13	Charts on agricultural and food microbiology: a) Nitrogen cycle b) Biofertilizers and biopesticides c) Food spoilage microorganisms d) HACCP principles	1
14	Isolation of microorganisms from soil and water	1
15	Enumeration of airborne microorganisms by settle plate method	1
16	Determination of microbial load in water samples	1
17	Biological oxygen demand (BOD) analysis of water	1
18	Detection of coliforms in water by MPN method	1
19	Demonstration of sewage treatment process	1
20	Preparation of compost and study of compost microorganisms	1
21	Isolation of cellulose degrading microorganisms	1
22	Alcohol fermentation using yeast	1
23	Production of citric acid by Aspergillus niger (demonstration)	1
24	Production of antibiotics by Streptomyces species (demonstration)	1
25	Sterilization techniques used in fermentation industries	1
26	Study of fermentor components using charts/models	1
27	Charts on environmental and industrial microbiology: a) Sewage treatment process b) Biogas production c) Batch and continuous fermentors d) Downstream processing	1

Course Outcomes (COs):

After the successful completion of the course, the student will be able to:

CO1: Isolate and enumerate microorganisms from soil, water, air, root nodules, and food samples.

CO2: Identify agriculturally important microorganisms such as *Rhizobium*, *Azotobacter*, cyanobacteria, and phosphate solubilizers.

CO3: Perform food microbiology tests involving milk, food samples, spoilage organisms, fermentation, and curd.

CO4: Analyse water, air, BOD, sewage, compost, and environmental microbial quality.

CO5: Demonstrate alcohol fermentation, citric acid production, antibiotic production, and sterilization techniques.

CO6: Explain fermentor components, batch and continuous fermentors, and downstream processing methods.

CO7: Interpret charts and models on biofertilizers, biopesticides, HACCP, sewage treatment, and biogas production.

Practical Assessment

Formative Assessment/ Internal	**Total Marks-10**	**Summative Assessment Marks**
Assessment Occasion/ type	**Weightage in Marks**	**Practical Exam**
House Examination/Test	05	40 Marks
Class Performance/Attendance	05	

Text Books/References

1. Aneja, K.R., *Experiments in Microbiology, Plant Pathology and Biotechnology*, 4th Edition, 2003, New Age International Publishers, New Delhi, India.
2. Cappuccino, J.G. and Sherman, N., *Microbiology: A Laboratory Manual*, 12th Edition, 2020, Pearson Education, New York, USA.
3. Dubey, R.C. and Maheshwari, D.K., *Practical Microbiology*, Revised Edition, 2012, S. Chand & Company Ltd., New Delhi, India.
4. Gunasekaran, P., *Laboratory Manual in Microbiology*, 1st Edition, 1996, New Age International Publishers, New Delhi, India.
5. Harley, J.P. and Prescott, L.M., *Laboratory Exercises in Microbiology*, 10th Edition, 2016, McGraw-Hill Education, New York, USA.
6. Benson, H.J., *Microbiological Applications: Laboratory Manual in General Microbiology*, 14th Edition, 2018, McGraw-Hill Education, New York, USA.
7. Atlas, R.M., *Handbook of Microbiological Media*, 4th Edition, 2010, CRC Press, Boca Raton, USA.
8. APHA, AWWA and WEF, *Standard Methods for the Examination of Water and Wastewater*, 23rd Edition, 2017, American Public Health Association, Washington, D.C., USA.
9. Harrigan, W.F. and McCance, M.E., *Laboratory Methods in Food and Dairy Microbiology*, 1st Edition, 1976, Academic Press, London, UK.
10. Harrigan, W.F., *Laboratory Methods in Food Microbiology*, 3rd Edition, 1998, Academic Press, San Diego, USA.
11. Frazier, W.C. and Westhoff, D.C., *Food Microbiology*, 4th Edition, 1988, Tata McGraw-Hill Publishing Company Ltd., New Delhi, India.
12. Casida, L.E., *Industrial Microbiology*, Reprint Edition, 2007, New Age International Publishers, New Delhi, India.
13. Stanbury, P.F., Whitaker, A. and Hall, S.J., *Principles of Fermentation Technology*, 3rd Edition, 2016, Elsevier Ltd., Oxford, UK.
14. Subba Rao, N.S., *Biofertilizers in Agriculture and Forestry*, 3rd Edition, 2001, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India.
15. Rangaswami, G. and Bagyaraj, D.J., *Agricultural Microbiology*, 2nd Edition, 2006, PHI Learning Pvt. Ltd., New Delhi, India.

B.Sc. Microbiology, VI Semester:
Practical Exam Question Paper
MBP 603: Agricultural, Food, Environmental, and Industrial Microbiology (Practical)

Duration: 3 Hrs **Max.**

Marks: 40

Q.no	Experiment	Marks
1	Preparation of synthetic seed / Isolation of liver parenchyma cells. (Principle – 2M, Performance – 4M, Result – 1M)	6 marks
2	Estimation of Citric acid/ Lactic acid (Principle – 2M, Performance – 4M, Result – 1M)	6 marks
3	Demonstrate the surface sterilization of an explant/ Comment on trypan blue exclusion method	4 marks
4	Estimation of percentage of alcohol by specific gravity method / Draw a neat diagram of a fermenter, label its parts, and explain its uses. (Principle – 2M, Procedure – 2M)	5marks
5	Identify and Comment on 'C' & 'D' Identification -1M, Key points – 2M	2x3=6 marks
6	Class Records and Industrial Visit	8 marks
7	Viva- voce	5 marks

Skill-3: Compulsory Practical Knowledge

Course title **Internship / Project**

No of contact hours	**90 – 120 Hrs**
No credits	**2**
Method of evaluation	**Report submission/ Presentations /Viva voce**

Formative Assessment		**Total Marks**
Assessment Occasion/ type	**Weightage in Marks**	
Report Preparation	20	**50**
Report Presentation	20	
Viva voce	10	
Total	**50**	

Note:

1. **Internship / Project is Compulsory**
2. **Certification by the organization and submission of attendance log sheet is mandatory..**