Estd. 1962
"A++" Accredited by NAAC (2021)
With CGPA 3.52

SHIVAJI UNIVERSITY, KOLHAPUR - 416004, MAHARASHTRA
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शिवाजी विद्यापीठ, कोल्हापूर -४१६००४,महाराष्ट्र
दूरध्वनी-ईपीएबीएक्स -२६०९०००, अभ्यासमंडळे विभाग दुरध्वनी ०२३१-२६०९०९४
०२३१-२६०९४८७

Ref.No.SU/BOS/Science/148 **Date: 26/05/2026**

The Principal,
All Concerned Affiliated Colleges/Institutions
Shivaji University, Kolhapur.

Subject: Regarding revised syllabi of B.Sc. Part-III (Sem.V & VI) degree programme under the Faculty of Science and Technology as per NEP-2020 (2.0)

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the syllabi, nature of question paper of B.Sc. Part-III (Sem.V & VI) degree programme under the Faculty of Science and Technology as per NEP-2020 (2.0).

B.Sc. Part-III (Sem. V & VI) as per NEP-2020 (2.0)			
1.	Botany	9.	Geology
2.	Physics	10.	Zoology
3.	Statistics	11.	Chemistry
4.	Mathematics	12.	Electronics
5.	Microbiology	13.	Drug Chemistry
6.	Industrial Microbiology	14.	Pollution
7.	Biochemistry	15.	Food Science and Quality Control
8.	Computer Science (Optional)	16	Biotechnology (Optional/Vocational)

This syllabus, nature of question and equivalence shall be implemented from the academic year 2026-2027 onwards. A soft copy containing the syllabus is attached herewith and it is also available on university website **www.unishivaji.ac.in>Syllabus>Syllabus as per NEP2020.**

The question papers on the pre-revised syllabi of above-mentioned course will be set for the examinations to be held in October /November 2026 & March/April 2027. These chances are available for repeater students, if any.

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully,

Dy Registrar

Encl: as above

for information and necessary action

Copy to:

1	Dean, Faculty of Science & Technology	6	Appointment Section A & B
2	Director, Board of Examinations and Evaluation	7	I.T.Cell /Computer Centre
3	Chairman, Respective Board of Studies	8	Eligibility Section
4	B.Sc.-M.Sc. Exam Section	9	Affiliation Section (T.1) (T.2)
5	Internal Quality Assurance Cell (IQAC Cell)	10	P.G. Seminar Section

SHIVAJI UNIVERSITY, KOLHAPUR

Established: 1962

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NEW SYLLABUS FOR

B. Sc. Part III

MICROBIOLOGY

SEMESTER V AND VI

(Faculty of Science and Technology)

Structure and Syllabus in Accordance with

National Education Policy - 2020 (NEP 2.0)

with Multiple Entry and Multiple Exit

(To be implemented from Academic Year 2026-27)

1. **Year of Implementation:** Revised syllabus will be implemented from June, 2026 onwards.

2. **Preamble:**

Microbiology is a dynamic and rapidly advancing branch of life sciences that explores the diversity, structure, function, and applications of microorganisms. Microorganisms play a crucial role in health, agriculture, food production, industry, environmental sustainability, and biotechnology. The B.Sc. Microbiology programme is designed to provide students with comprehensive theoretical knowledge and practical skills in various domains of microbiology. The programme emphasizes fundamental concepts of microbial biology, genetics, immunology, virology, medical microbiology, industrial microbiology, and environmental microbiology, while integrating emerging areas such as molecular biology and bioinformatics. It aims to develop laboratory competence, analytical abilities, research aptitude, and problem-solving skills among students.

Aligned with the principles of NEP 2020, the curriculum promotes multidisciplinary learning, skill development, digital literacy, ethical responsibility, and environmental consciousness. The programme also encourages innovation, entrepreneurship, and industry readiness, preparing students for careers in healthcare, pharmaceuticals, food and dairy industries, research laboratories, quality control sectors, and higher education.

Through a blend of classroom teaching, laboratory training, project work and experiential learning, the programme strives to nurture scientifically competent, socially responsible, and ethically sound graduates capable of contributing to national development and global scientific advancement.

3. **Programme Objectives**

1) To provide students with strong foundational and advanced knowledge in basic and applied sciences through theoretical understanding and practical exposure, enabling application of scientific concepts in real-life situations.
2) To develop effective communication abilities, teamwork, collaboration skills, and social competence required for academic, professional and community engagement.
3) To cultivate scientific temper by training students in laboratory techniques, experimentation, data analysis and research methodology, encouraging innovation and inquiry-based learning.

4) To promote multidisciplinary learning by integrating concepts from diverse disciplines, enabling students to address complex societal and scientific challenges through holistic approaches.
5) To create awareness about environmental conservation, sustainability principles and responsible utilization of natural resources for societal well-being.
6) To encourage self-directed learning, adaptability, and continuous skill enhancement in response to emerging scientific and technological advancements.
7) To develop analytical thinking, logical reasoning, and problem-solving skills for interpreting scientific information and making informed decisions.
8) To nurture leadership qualities, professionalism, time management, interpersonal skills, and ethical responsibility necessary for successful careers and responsible conduct.
9) To instill values of ethics, inclusivity, empathy, and social responsibility, preparing students to contribute positively toward community and national development.
10) To equip students with digital literacy, technological competence and entrepreneurial skills that enhances employability and readiness for modern workplaces.

4. Programme Outcomes (POs)

PO1. Disciplinary Knowledge

Demonstrate comprehensive theoretical and practical knowledge of the discipline(s) included in the undergraduate programme and apply this knowledge in academic, professional and real-life contexts.

PO2. Social Competence and Communication

Exhibit social skills required for effective interaction, teamwork, and collaboration, and communicate ideas clearly in oral and written forms in academic and professional settings.

PO3. Research Skills and Scientific Temper

Develop competency in laboratory techniques, instrumentation, and scientific methods; design and conduct experiments, analyze data, formulate hypotheses, and cultivate curiosity towards research and innovation.

PO4. Multidisciplinary and Transdisciplinary Knowledge

Integrate knowledge from multiple disciplines and apply interdisciplinary approaches to understand and solve complex real-world problems.

PO5. Environment and Sustainability

Understand environmental challenges and evaluate the societal impact of scientific solutions, demonstrating commitment to sustainable development practices.

PO6. Self-Directed and Lifelong Learning

Demonstrate the ability for independent learning, adaptability and continuous skill development in response to evolving socio-technological advancements.

PO7. Critical Thinking and Problem Solving

Apply analytical reasoning, interpretation and logical thinking to identify problems, evaluate evidence, and develop appropriate solutions.

PO8. Personal and Professional Competence

Work effectively both independently and collaboratively, demonstrate leadership, interpersonal skills, adaptability, time management, and adherence to professional ethics.

PO9. Effective Citizenship and Ethics

Demonstrate social responsibility, empathy, equity-centred perspective, and ethical behaviour while contributing to community and national development.

PO10. Digital Literacy and Employability (Added — NEP emphasis)

Use digital tools, information technology, and modern resources effectively for learning, research, employability, and entrepreneurship.

5. Programme Specific Outcomes (PSOs)

PSO1: Microbial Diversity and Identification

Understand microbial diversity and perform isolation, staining, cultivation, and identification using conventional and basic molecular approaches.

PSO2: Laboratory Skills and Biosafety

Demonstrate competency in microbiological laboratory techniques, operation of instruments, aseptic handling, quality control practices, and biosafety procedures.

PSO3: Applied Microbiology

Apply microbiological knowledge in medical diagnostics, food and dairy microbiology, industrial production, agriculture, and environmental monitoring.

PSO4: Research and Analytical Skills

Design experiments, analyze microbiological data, interpret results, prepare reports, and develop research aptitude for higher studies and scientific careers.

PSO5: Industrial and Employability Skills

Develop technical and professional skills relevant to microbiology-based industries, entrepreneurship, quality assurance, and regulatory practices.

6. Course Outcomes (COs):

Course outcomes are specified in the respective syllabus for each course.

7. Duration of the Program: The course shall be a full-time course.

8. Medium of Instruction: English

9. Eligibility for Admission: The criterion for admission is as per the rules and regulations set from time to time by concerned departments, HEIs, university, government, and other relevant statutory authorities.

10. Scheme of Teaching and Examination Pattern (Theory/Practical/Internal):

- The scheme of teaching and examination for the programme of study shall be as approved by the Academic Council / Board of Studies.
- The pattern of examination shall consist of a Semester-End Examination along with Internal Assessment.
- Each theory course of 2 credit shall carry 50 marks (40 marks for the Semester-End Examination and 10 marks for Internal Assessment).
- The rule for practical examination shall be as per the circular/ letter issued by respective Board of Studies.
- The examination pattern for On Job Training (OJT) and Field Project (FP) shall be as per the University guidelines.

11. Programme Structure

SHIVAJI UNIVERSITY, KOLHAPUR **NEP-2020 (2.0): Credit Framework for UG (B. Sc. III) Programme under Faculty of Science and Technology**									
SEM (Level)	**COURSES**			**OE**	**VSC/ SEC**	**AEC/VEC/ IKS**	**AEC/VEC/ IKS**	**Total Credits**	**Degree/ Cum. Cr. MEME**
	Course-1	**Course-2**	**Course-3**						
SEM V (5.5)	Major IX (2) Major X (2) Major P V (a) (2) Major P V (b) (2)	Major I (ELEC) (2) Major P I (ELEC) (2)	-	OE-5 (2) (T/P)	VSC II (2) (Major specific) (P)	AEC III (2) (English)	OJT (04)	22	UG Degree 132
SEM VI (5.5)	Major XI (2) Major XII (2) Major P VI (a) (2) Major P VI (b) (2)	Major II (ELEC) (2) Major P II (ELEC) (2)	-	-	VSC III (2) (Major specific) (P) SEC III (2) (T/P)	AEC IV (2) (English) IKS 2 (2) (Major specific)	FP (02)	22	
Credits	**8(T)+8(P)=16**	**4(T)+4(P)=8**		**2(T/P)**	**2(T/P) + 4(P) = 6**	**2+4 = 6**	**4+2 = 6**	**44**	

12. Equivalence in accordance with titles and contents of papers for revised syllabus

Sr. No.	Title of Old Paper	Title of New Paper
1	Course IX (DSE E 49): Virology	Major Mandatory Course IX: Virology
2	Course X (DSE E 50): Immunology	Major Mandatory Course X: Immunology
3	Course XI (DSE E 51): Food and Industrial Microbiology	Major Elective Course I (A): Food and Industrial Microbiology
4	Course XII (DSE E 52): Agricultural Microbiology	Major Elective Course I (B): Agricultural Microbiology
5	Course XIII (DSE F 49): Microbial Genetics	Major Mandatory Course XI: Microbial Genetics
6	Course XIV (DSE F 50): Microbial Biochemistry	Major Mandatory Course XII: Microbial Biochemistry
7	Course XV (DSE F 51): Environmental Microbiology	Major Elective Course II (A): Environmental Microbiology
8	Course XVI (DSE F 52): Medical Microbiology	Major Elective Course II (B): Medical Microbiology

13. Standard of Passing

- The standard of passing shall be as shown in the table below:

	Semester-End Examination	Internal Assessment	Course Exam (Total)
Maximum Marks	40	10	50
Minimum Marks required for passing	14	4	18

- There shall be a separate head of passing for the Semester-End Examination and the Internal Assessment for each theory course.
- A student must obtain a minimum of 14 marks out of 40 in the Semester-End Examination and 4 marks out of 10 in the Internal Assessment to pass the theory course.
- For practical courses carrying 50 marks, a student must obtain a minimum of 18 marks to pass the examination. For practical courses carrying 100 marks, a student must obtain a minimum of 35 marks to pass the examination.
- Passing criteria for On Job Training (OJT) and Field Project (FP) shall be as per the University guidelines.

14. Nature of Question Paper, Duration and Scheme of Marking:

A) Theory Examinations

a) Maximum Marks : 40

b) Duration : 1 hr 30 min

c) Nature of the Theory Examination Question Paper and Scheme of Marking

Question No.	Nature/Type of Question	Marks
1	Multiple Choice Questions (MCQs) (8 Questions)	8 Marks (1 Mark for Each Question)
2	Broad Answer/Descriptive Type Questions (Attempt Any 2 Out of 3)	16 Marks (8 Marks for Each Question)
3	Short Note Type Questions (Attempt Any 4 Out of 6)	16 Marks (4 Marks for Each Question)
	Total Marks	**40**

B) Practical Examinations

a) The examination of the Major Practical Course shall carry 150 marks per semester (Major Mandatory – 100 marks and Major Elective – 50 marks). It shall be conducted over three consecutive days, with a minimum duration of six hours per day.

b) The Practical Examination for Vocational Skill Courses (VSC–II and VSC–III), Skill Enhancement Course (SEC–III), and Open Elective Course (OE–5) shall carry 50 marks each. These examinations shall be conducted separately over two consecutive days, with a minimum duration of three hours per day.

c) Each candidate must produce a certificate from the Head of the Department of the respective college stating that the candidate has satisfactorily completed the practical course in accordance with the guidelines laid down by the Academic Council on the recommendations of the Board of Studies and that the laboratory journal has been properly maintained. Every candidate must record observations in the laboratory journal and prepare a report for each exercise performed. The journal shall be checked and signed periodically by a member of the teaching staff and certified by the Head of the Department at the end of the semester. Candidates must produce their certified journals at the time of the practical examination.

d) The nature of question paper and scheme of marking are provided at the end of syllabus.

Structure of B. Sc. Part III Microbiology

SEM (Level)	Course Code	Course Name	No. of Credits
SEM V (5.5)	MM-L-3-24-E-9	Major Mandatory Course IX: Virology	2
	MM-L-3-24-E-10	Major Mandatory Course X: Immunology	2
	ME-L-3-24-E-1a ME-L-3-24-E-1b	Major Elective Course I (A): Food and Industrial Microbiology **OR** Major Elective Course I (B): Agricultural Microbiology	2
	MM-P-3-24-E-5a	Major Mandatory Practical Course V (A): Virology	2
	MM-P-3-24-E-5b	Major Mandatory Practical Course V (B): Immunology	2
	ME-P-3-24-E-1a ME-P-3-24-E-1b	Major Elective Practical Course I (A): Food and Industrial Microbiology **OR** Major Elective Practical Course I (B): Agricultural Microbiology	2
	VSC-P-3-24-E-2	VSC II: Food Testing and Quality Control- I	2
	OE-P-3-24-E-5	OE 5: Introduction to Soil Science and Soil Microbiology	2
		OJT: On Job Training	4
		AEC III: English	2
SEM VI (5.5)	MM-L-3-24-F-11	Major Mandatory Course XI: Microbial Genetics	2
	MM-L-3-24-F-12	Major Mandatory Course XII: Microbial Biochemistry	2
	ME-L-3-24-F-2a ME-L-3-24-F-2b	Major Elective Course II (A): Environmental Microbiology **OR** Major Elective Course II (B): Medical Microbiology	2
	MM-P-3-24-F-6a	Major Mandatory Practical Course VI (A): Microbial Genetics	2
	MM-P-3-24-F-6b	Major Mandatory Practical Course VI (B): Microbial Biochemistry	2
	ME-P-3-24-F-2a ME-P-3-24-F-2b	Major Elective Practical Course II (A): Environmental Microbiology **OR** Major Elective Practical Course II (B): Medical Microbiology	2
	VSC-P-3-24-F-3	VSC III: Food Testing and Quality Control- II	2
	SEC-P-3-24-F-3	SEC III: Microbial Quality Assurance in Pharmaceutical Industries	2
	IKS-L-3-24-F-2	IKS 2: Indian Knowledge System in Microbiology	2
		FP: Field Project	2
		AEC IV: English	2
		Total Credits	**44**

B. Sc. Part III

MICROBIOLOGY

SEMESTER V

MAJOR MANDATORY COURSE IX: VIROLOGY

(Credit-2, Total Lectures- 30)

Course Objectives

1. To understand the basic concepts, structure, classification and general characteristics of viruses.
2. To acquire knowledge of isolation, cultivation, purification and enumeration techniques used for animal, plant and bacterial viruses.
3. To explain the replication mechanisms of bacteriophages, animal viruses and plant viruses.
4. To understand the role of viruses in oncogenesis and study the characteristics of cancer cells associated with viral infections.

Course Outcomes

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

1. Describe the morphology, structure and general properties of important viruses such as HIV, TMV and T4 bacteriophage.
2. Demonstrate understanding of methods for cultivation, purification and quantification of viruses using standard virological techniques.
3. Differentiate between lytic and lysogenic cycles and explain replication strategies of bacteriophages, animal viruses and plant viruses.
4. Explain the basic concepts of viral oncogenesis and identify major characteristics of cancer cells.

UNIT – I / CREDIT – I **Lectures – 15**

1) Basic concepts of Virology:
    a) Definition and General characteristics of viruses
    b) Structure of viruses: Capsids, Nucleic acids and Envelope
    c) Structure of HIV, TMV and T4 bacteriophage
2) Isolation and cultivation of viruses:
    a) Animal virus - Tissue culture, Embryonated chicken egg
    b) Plant virus - Whole plant, Protoplasts culture
    c) Bacteriophages - Plaque method
3) Purification of viruses based on physico-chemical properties:
    a) Density gradient centrifugation
    b) Precipitation
4) Enumeration of viruses:
    a) Latex droplet method (Direct electron microscopic count)
    b) Plaque and pock assay method

UNIT – II / CREDIT - II **Lectures – 15**

1) Reproduction of Bacteriophages:
    a) One step growth experiment
    b) Reproduction of T4 phage- Adsorption, Penetration, Biosynthesis, Assembly and Release
    c) Virulent and Temperate phage- Definition, characteristics, examples and differences
2) Reproduction of animal virus - Adenovirus
3) Reproduction of plant virus - TMV
4) Oncogenesis:
    a) Definition of oncogenesis
    b) Types of cancers
    c) Characteristics of cancer cells

References

1. General Microbiology – R. Y. Stanier, J. L. Ingraham, M. L. Wheelis & P. R. Painter – 5th Edition – Macmillan Press.
2. Microbiology – L. M. Prescott, J. P. Harley & D. A. Klein – 7th Edition – McGraw-Hill Education.
3. Microbiology – B. D. Davis, R. Dulbecco, H. N. Eisen & H. S. Ginsberg – 4th Edition – Harper & Row Publishers.
4. General Virology – S. E. Luria – 3rd Edition – John Wiley & Sons.
5. The Genetics of Bacteria and Their Viruses – William Hayes – 2nd Edition – Blackwell Scientific Publications.
6. General Microbiology (Vol. II) – C. B. Powar & H. F. Daginawala – 8th Edition – Himalaya Publishing House.
7. Virology – P. K. Biswas & S. K. Biswas – 1st Edition – Wiley Eastern Limited.
8. Topley and Wilson's Principles of Bacteriology, Virology and Immunity (Vol. IV: Virology) – G. R. Smith and others – 8th Edition – Edward Arnold Publishers.
9. Principles of Virology – S. J. Flint, L. W. Enquist, R. M. Krug, V. R. Racaniello & A. M. Skalka – 4th Edition – ASM Press.
10. Bacterial and Bacteriophage Genetics – E. A. Birge – 5th Edition – Springer-Verlag.
11. Fields Virology – David M. Knipe & Peter M. Howley – 7th Edition – Wolters Kluwer/Lippincott Williams & Wilkins.
12. Introduction to Modern Virology – N. J. Dimmock, A. J. Easton & K. N. Leppard – 7th Edition – Wiley-Blackwell.

MAJOR MANDATORY COURSE X: IMMUNOLOGY

(Credit-2, Total Lectures- 30)

Course Objectives:

1. To understand the organization of the immune system, including its organs, tissues, and cells.
2. To learn the molecular mechanisms of antibody production and the role of cytokines.
3. To comprehend the complement system and monoclonal antibodies, including their mechanisms and applications.
4. To understand the role of interferons and the mechanisms of hypersensitivity reactions
5. To gain knowledge about self-tolerance, autoimmunity, and autoimmune diseases, including their treatment.

Course Outcomes:

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

1. Describe the structure and functions of immune organs and cells involved in innate and adaptive immunity.
2. Explain antigen processing, antibody production, and the role of cytokines in immune responses.
3. Explain complement activation pathways and monoclonal antibody production, classification, and applications.
4. Describe interferons and hypersensitivity reactions, including their mechanisms and clinical examples.
5. Explain self-tolerance and autoimmune diseases, their types, and treatment strategies.

UNIT – I / CREDIT – I **Lectures - 15**

1) Cells and organs of the immune system
   a) Primary Lymphoid Organs- Thymus and Bursa of fabricus
   b) Secondary lymphoid organs- Lymph nodes and Spleen
   c) Cells of the Immune System- Structure and functions of B Lymphocytes, Plasma Cells, Memory cells, T- Lymphocytes, T cell Subsets- TH cells, TC cells, NK Cells, Neutrophils, Monocytes and Macrophages
2) Molecular mechanism of antibody production
   a) Processing and presentation of antigen by antigen presenting cell- Endocytic and Cytosolic pathway
   b) Interaction of APC with TH cell
   c) Interaction of B cell and TH cell
   d) Proliferation and differentiation of activated B cells
   e) Role of cytokines in proliferation and differentiation
3) Complement
   a) Nature, Properties, Complement activation by classical and alternate pathway
   b) Biological consequences of complement activation

4) Monoclonal antibodies
   a) Concepts of polyclonal and monoclonal antibodies
   b) Production of mouse monoclonal antibodies by hybridoma technology
   c) Types of monoclonal antibodies- Mouse, Chimeric, Humanized and Human antibodies
   d) Applications of monoclonal antibodies

UNIT – II / CREDIT - II **Lectures - 15**

1) Interferons
   Properties, Types, Inducers of Interferon, Mechanism of action- antiviral and immunoregulatory
2) Hypersensitivity
   a) Basic concept, Gell and Coombs classification
   b) Type I hypersensitivity- Anaphylaxis
   c) Type II hypersensitivity- Blood transfusion reactions
   d) Type III hypersensitivity- Serum sickness
   e) Type IV Delayed type hypersensitivity - Allograft rejection
3) Autoimmunity
   Introduction, Role of self-tolerance,
   Autoimmune diseases: Types with examples, Treatment of autoimmune diseases

References

1. Immunology – Kuby, Kindt, Goldsby & Osborne – 6th Edition – W. H. Freeman and Company.
2. Essential Immunology – Ivan Roitt – 13th Edition – Wiley-Blackwell.
3. Immunology – Richard A. Goldsby, Thomas J. Kindt & Barbara A. Osborne – 5th Edition – W. H. Freeman and Company.
4. Cellular and Molecular Immunology – Abbas, Lichtman & Pillai – 10th Edition – Elsevier Saunders.
5. Janeway's Immunobiology – Murphy & Weaver – 9th Edition – Garland Science.
6. Basic Immunology: Functions and Disorders of the Immune System – Abbas & Lichtman – 6th Edition – Elsevier Saunders.
7. Textbook of Immunology – V. K. Mahajan – 3rd Edition – Jaypee Brothers Medical Publishers.
8. Immunology and Serology in Laboratory Medicine – Mary Louise Turgeon – 6th Edition – Elsevier.
9. Fundamental Immunology – William E. Paul – 7th Edition – Lippincott Williams & Wilkins.
10. Textbook of Microbiology – Ananthanarayan & Paniker – 11th Edition – Universities Press.

MAJOR ELECTIVE COURSE I (A): FOOD AND INDUSTRIAL MICROBIOLOGY

(Credit-2, Total Lectures- 30)

Course Objectives

1. To introduce the role of microorganisms in food systems and explain how intrinsic factors influence microbial growth in foods.
2. To provide knowledge about sources of food contamination, food poisoning, food-borne infections, and the importance of probiotics in human health.
3. To familiarize students with basic principles of industrial microbiology including strain improvement, fermentation processes, and microbiological assays.
4. To develop an understanding of industrial production processes of selected microbial products and the principles of downstream processing and quality testing.

Course Outcomes

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

1. Explain the factors affecting microbial growth in foods and identify sources of microbial contamination and food-borne diseases.
2. Differentiate between food poisoning and food infections and describe the causative agents and their health impacts.
3. Describe methods of strain improvement, scale-up of fermentation, and microbiological assays used in industrial microbiology.
4. Outline the industrial production processes of alcohol, wine, and penicillin, including downstream processing and product safety testing.

UNIT – I/ CREDIT I: FOOD MICROBIOLOGY **Lectures - 15**

1) Food as a substrate for microorganisms: Intrinsic factors: pH, Moisture content, Oxidation- Reduction potential, nutrient content, antimicrobial constituents and biological structure.
2) Sources of microorganisms to food
3) Food poisoning
   a) Staphylococcal
   b) Fungal: Aflatoxins
4) Food infections: Salmonellosis
5) Probiotics: Concept and applications

UNIT – II / CREDIT II: INDUSTRIAL MICROBIOLOGY ` Lectures - 15

1) Strain Improvement:
   Mutation approach, Auxotroph, Resistant and Revertant mutants
2) Scale up of fermentations
3) Microbiological assays

4) Industrial production of:
    a) Alcohol- Organisms used, Inoculum preparation, Fermentation media, Fermentation conditions, Extraction and Recovery.
    b) Grape wine- Definition, Types, Production of table wine (Red and White) and Bacterial defects of wine
    c) Penicillin- Organisms used, Inoculum preparation, Fermentation media, Fermentation conditions, Extraction and Recovery. Concept of semi synthetic penicillin
    d) Citric acid production- Organism used, Substrates, Production processes and Product recovery.
5) Downstream processing & product recovery: Centrifugation, flocculation, filtration, solvent extraction and distillation
6) Testing of sterility, Pyrogen, Carcinogenicity and Toxicity.

References

1. Principles of Fermentation Technology – Peter F. Stanbury & Allan Whitaker – 2nd Edition, 1984, Pergamon Press.
2. Principles of Microbial Technology – Harvey J. Peppler – Vol. I & II, 1979, Academic Press.
3. Industrial Microbiology – L. E. Casida Jr. – 1st Edition, 1968, Wiley Eastern Ltd.
4. Industrial Microbiology – A. H. Patel – 1st Edition, 2005, CBS Publishers & Distributors.
5. Industrial Microbiology – Samuel C. Prescott & Cecil G. Dunn – 4th Edition, 1987, McGraw-Hill Book Company.
6. Industrial Microbiology – B. M. Miller – 1st Edition, 1976, Tata McGraw-Hill Publishing Company.
7. Pharmaceutical Microbiology – W. B. Hugo & A. D. Russell – 6th Edition, 1998, Blackwell Scientific Publications.
8. Modern Food Microbiology – James M. Jay, Martin J. Loessner & David A. Golden – 7th Edition, 2005, Springer.
9. Food Microbiology – William C. Frazier & Dennis C. Westhoff – 4th Edition, 1988, McGraw-Hill Book Company.
10. Industrial Microbiology – Wulf Crueger & Anneliese Crueger – 2nd Edition, 2000, Springer-Verlag.
11. Fermentation Technology – A. H. Modi – Vol. I & II, 1st Edition, 2009, CBS Publishers & Distributors.

MAJOR ELECTIVE COURSE I (B): AGRICULTURAL MICROBIOLOGY

(Credit-2, Total Lectures- 30)

Course Objectives

1. To introduce the fundamentals of soil microbiology including soil properties, soil microorganisms, and their role in maintaining soil fertility.
2. To explain microbial interactions and the role of microorganisms in biogeochemical cycles, with special reference to carbon and nitrogen cycling.
3. To provide knowledge of organic manures, composting, biofertilizers, and biopesticides, emphasizing their production, application, and agricultural importance.
4. To develop an understanding of biodegradation processes and basic plant pathology, including plant diseases, symptoms, and modes of disease transmission.

Course Outcomes

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

1. Describe soil characteristics and soil microbial diversity and explain their role in soil fertility and sustainable agriculture.
2. Explain microbial interactions and biogeochemical cycles, particularly carbon and nitrogen cycles and their agricultural significance.
3. Identify and explain the use of biofertilizers, biopesticides, and composting methods in improving crop productivity and soil health.
4. Recognize common plant diseases and explain biodegradation processes, modes of disease transmission, and microbial involvement in agriculture.

UNIT – I / CREDIT – I **Lectures - 15**

1) Introduction to Soil Microbiology
   a) Definition and composition of soil
   b) Physical characters- Soil structure, Soil texture, Soil profile, Soil colour
   c) Chemical characters- pH, Cation exchange capacity, Soil nutrient, Electrical conductivity
   d) Types of microorganisms in soil
2) Microbiological interactions
   a) Positive association- Mutualism, Proto-cooperation, Commensalism
   b) Negative association- Amensalism, Parasitism, and Predation
   c) Neutral association- Neutralism
3) Role of Microorganisms in Biogeochemical Cycles
   a) Carbon cycle
   b) Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification, and nitrate reduction
4) Manures and Composts
   i) Green manure- Definition, Green manure crops, In situ and ex situ green manuring, Benefits

ii) Vermicompost- Definition, Preparation, and Benefits
iii) Optimal conditions for composting with reference to - Composition of organic waste, Availability of microorganisms, Aeration, C: N ratio, Moisture content, Temperature, pH and Time.

UNIT – II / CREDIT – II **Lectures - 15**

1) Types, production, methods of application and uses of
   a) Biofertilizers
      i) Nitrogen fixing- *Azotobacter* and *Rhizobium*
      ii) Phosphate Solubilizing Microorganisms
   b) Biopesticides
      i) *Bacillus thuringiensis*
      ii) *Tricoderma* sp.
2) Biodegradation of
   a) Cellulose
   b) Pesticides
3) Plant Pathology
   a) Common symptoms produced by plant pathogens
   b) Modes of transmission of plant diseases
   c) Plant diseases
      i) Citrus Canker
      ii) Tikka disease of groundnut

References

1. Soil Microbiology: An Exploratory Approach – Mark Coyne – Macmillan Press.
2. Agricultural Microbiology – N. Mukherjee & J. Ghosh – Kalyani Publishers.
3. Introduction to Soil Microbiology – Martin Alexander – 2nd Edition – John Wiley & Sons.
4. Agricultural Microbiology – Rangaswamy & Bhagyaraj – 2nd Edition – Prentice-Hall.
5. Plant Diseases – R. S. Singh – Kalyani Publishers.
6. Plant Pathology – R. S. Mehrotra – Tata McGraw-Hill.
7. Diseases of Crop Plants in India – G. Rangaswamy – Prentice-Hall.
8. Principles of Soil Science – M. M. Rai – Kalyani Publishers.
9. Soils and Soil Fertility – Frederick R. Troeh – 6th Edition – Blackwell Publishing Co.
10. Soil Microbiology – Singh, Purohit & Parihar – Agrobios India, 2010.
11. Soil Microbiology and Biochemistry – Ghulam Hassan Dar – New India Publishing Agency, 2010.

MAJOR MANDATORY PRACTICAL COURSE V (A): VIROLOGY

(Credit-2, Total Lectures- 60)

Course Objectives

1. To understand the basic principles and techniques used in isolation, cultivation, and enumeration of viruses and bacteriophages.
2. To learn methods for enrichment and plaque assay of coliphages from environmental samples.
3. To acquire practical knowledge of virus cultivation and transmission techniques in plant and animal systems.
4. To develop observational and analytical skills for identification of viral disease symptoms and cytopathic effects produced by viruses.

Course Outcomes

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

1. Isolate host bacteria and coliphages from sewage samples using standard microbiological and virological techniques.
2. Perform enrichment, plaque assay, and plaque count methods for cultivation and enumeration of coliphages.
3. Demonstrate virus cultivation by chick embryo inoculation and study mechanical transmission of plant viruses through sap inoculation methods.
4. Identify characteristic symptoms of plant viral diseases and recognize cytopathic effects (CPE) produced by animal viruses.

Practical Experiments

1) Isolation of host bacterium for coliphages from sewage samples
2) Enrichment of coliphages from sewage samples
3) Isolation of coliphages from sewage samples by plaque assay technique
4) Enumeration of coliphages from sewage samples by plaque count method
5) Demonstration of virus cultivation by chick embryo inoculation technique
6) Study of mechanical transmission of plant viruses by sap inoculation method
7) Observation and identification of symptoms of viral diseases in plants
8) Observation and identification of cytopathic effects (CPE) produced by animal viruses

References

1. An Introduction to Virology – K. S. Bilgrami & Shagufta Ashraf – 1st Edition – CBS Publishers & Distributors, 2006.
2. Textbook of Virology – R. C. Dubey & D. K. Maheshwari – 1st Edition – S. Chand Publishing, 2013.
3. Microbiology and Immunology – A. P. Kulkarni & K. G. Barve – 3rd Edition – Nirali Prakashan, 2018.
4. General Virology – C. P. Baveja – 4th Edition – Arya Publications, 2017.
5. Plant Pathology – P. D. Sharma – 3rd Edition – Rastogi Publications, 2011.
6. Plant Virology – Roger Hull – 5th Edition – Academic Press, 2014.

7. Virology: Principles and Applications – John Carter & Venetia Saunders – 2nd Edition – Wiley, 2013.
8. Medical Virology – Dimmock, Easton & Leppard – 6th Edition – Wiley-Blackwell, 2016.
9. Principles of Virology – S. J. Flint, L. W. Enquist, V. R. Racaniello & A. M. Skalka – 4th Edition – ASM Press, 2015.
10. Laboratory Biosafety Manual – World Health Organization – 3rd Edition – WHO Press, 2004.

MAJOR MANDATORY PRACTICAL COURSE V (B): IMMUNOLOGY

(Credit-2, Total Lectures- 60)

Course Objectives

1. To understand the basic principles and applications of immunological, serological, and hematological laboratory techniques.
2. To learn methods for estimation and analysis of important blood parameters such as haemoglobin, ESR, RBC count, WBC count, and differential leukocyte count.
3. To acquire practical knowledge of diagnostic immunology tests including Widal test, CRP test, RPR test, and ELISA.
4. To develop laboratory skills in handling blood samples, performing immunological assays, interpreting results, and maintaining laboratory safety practices.

Course Outcomes

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

1. Perform hematological investigations including haemoglobin estimation, ESR determination, total RBC count, total WBC count, and differential leukocyte count using standard laboratory methods.
2. Demonstrate bactericidal activity of human serum against bacterial cultures and explain the role of immune factors involved in microbial killing.
3. Conduct serological and immunological diagnostic tests such as Widal test, CRP test, RPR test, and ELISA, and interpret the obtained results.
4. Apply laboratory techniques and analytical skills for diagnosis and evaluation of infectious and immunological conditions using blood-based investigations.

Practical Experiments

1) Study of bactericidal activity of human serum against *E. coli* and *S. aureus*
2) Estimation of haemoglobin by Sahli's method
3) Determination of ESR of the blood sample (Westergren / Wintrobe method)
4) Quantitative Widal test
5) Determination of C- Reactive Protein (CRP) in Blood
6) RPR test
7) Demonstration of ELISA test
8) Determination of Total WBC count
9) Determination of Total RBC count
10) Determination of differential leukocyte count

References

1. Immunology – Kubay, Kindt, Goldsby & Osborne – 6th Edition – Macmillan Press.
2. Essential Immunology – Delves, Martin, Burton & Roitt – 11th Edition – Blackwell Science.
3. Immunology: An Introduction – Tizzard – 4th Edition – Elsevier.

4. Basic and Clinical Immunology – Stites, Stobo, H. H. Fudenberg – 5th Edition – Lange Medical Books.
5. Essentials of Immunology – S. K. Gupta – University Press.
6. Immunology – M. P. Arora – CBS Publishers.
7. The Elements of Immunology – Fahim Khan – Pearson Publication, 2009.
8. Practical Immunology: Techniques and Applications – Ivan Lefkovits & Robert L. Malech – Springer, 2000.
9. Clinical Laboratory Immunology – Steven L. Berger – ASM Press, 2015.
10. Hematology and Immunology Laboratory Manual – K. S. Ghai – CBS Publishers, 2010.

MAJOR ELECTIVE PRACTICAL COURSE I (A): FOOD AND INDUSTRIAL MICROBIOLOGY

(Credit-2, Total Lectures- 60)

Course Objectives

1. To understand the principles and applications of industrial microbiology and fermentation technology.
2. To learn microbiological and biochemical techniques used for assay, production, and analysis of industrially important products.
3. To acquire practical knowledge of microbial fermentation processes involved in production of beverages, organic acids, and fermented foods.
4. To develop laboratory skills for isolation, cultivation, and enumeration of industrially important microorganisms.

Course Outcomes

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

1. Perform microbiological assays of antibiotics and vitamins such as penicillin and vitamin B12 using standard assay methods.
2. Produce fermented products such as wine and citric acid through microbial fermentation and analyze their physicochemical properties.
3. Enumerate bacteria present in food products such as curd and fruit juice using serial dilution and plating techniques.
4. Isolate and identify lactic acid bacteria from fermented food samples and explain their role in food fermentation and preservation.

Practical Experiments

1) Microbiological assay of penicillin
2) Microbiological assay of vitamin B12
3) Production of wine
4) Examination of wine for pH, colour and alcohol content
5) Production of citric acid by submerged fermentation
6) Estimation of citric acid by titrimetric method
7) Enumeration of bacteria from curd by serial dilution and plating
8) Enumeration of bacteria fruit juice by serial dilution and plating
9) Isolation of lactic acid bacteria from fermented food

References

1. Principles of Microbial Technology, Vol. I & II – Peppler – 2nd Edition – Academic Press.
2. Industrial Microbiology – Casida, L. E. – 1st Edition – Wiley.
3. Industrial Microbiology – Patel, A. H. – 1st Edition – CBS Publishers.
4. Industrial Microbiology – Prescott, L. M. & Dunn, R. – 4th Edition – McGraw-Hill.

5. Pharmaceutical Microbiology – Hugo, W. B. & Russell, A. D. – 8th Edition – Wiley-Blackwell.
6. Modern Food Microbiology – Jay, J. M., Loessner, M. J. & Golden, D. A. – 7th Edition – Springer.
7. Food Microbiology – Frazier, W. C. – 4th Edition – McGraw-Hill.
8. Fermentation Technology, Vol. I & II – Modi, A. H. – 1st Edition – CBS Publishers.
9. Food Microbiology – Frazier, W. C. & Westhoff, D. C. – 4th Edition – McGraw-Hill.
10. FSSAI Manuals – Food Safety and Standards Authority of India – Latest Edition – Basic Level Manuals.

MAJOR ELECTIVE PRACTICAL COURSE I (B): AGRICULTURAL MICROBIOLOGY

(Credit-2, Total Lectures- 60)

Course Objectives

1. To understand the physicochemical properties of soil and their importance in agriculture and soil fertility.
2. To learn microbiological techniques for isolation and cultivation of agriculturally important soil microorganisms.
3. To acquire practical knowledge of beneficial and plant pathogenic microorganisms associated with soil and plants.
4. To develop laboratory skills for soil analysis and interpretation of soil microbial and chemical parameters.

Course Outcomes

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

1. Determine important soil characteristics such as colour, pH, calcium, magnesium, and organic carbon content using standard analytical methods.
2. Isolate and identify beneficial soil microorganisms including *Azotobacter*, *Rhizobium*, and phosphate solubilizing bacteria from soil samples.
3. Isolate and study the plant pathogenic bacterium *Xanthomonas* from infected citrus fruits using microbiological techniques.
4. Perform soil microbiological and chemical analyses and interpret their significance in soil fertility and plant health.

Practical Experiments

1) Determination of colour and pH of a soil sample
2) Isolation of *Azotobacter* from a soil sample
3) Isolation of *Rhizobium* from root nodules of leguminous plant
4) Isolation of phosphate solubilizing bacteria from a soil sample
5) Isolation of *Xanthomonas* from infected citrus fruit
6) Estimation of Calcium from a soil sample (EDTA method)
7) Estimation of Magnesium from a soil sample (EDTA method)
8) Determination of organic carbon content of a soil sample (Walkley and Black method)

References

1. Soil Microbiology: An Exploratory Approach – Mark Coyne – Macmillan Press.
2. Agricultural Microbiology – N. Mukherjee & J. Ghosh – Kalyani Publishers.
3. Agricultural Microbiology – Rangaswamy & Bhagyaraj – 2nd Edition – Prentice-Hall.
4. Plant Diseases – R. S. Singh – Kalyani Publishers.
5. Plant Pathology – R. S. Mehrotra – Tata McGraw-Hill.
6. Soil Microbiology – Singh, Purohit & Parihar – Agrobios India, 2010.

7. Agricultural Microbiology Laboratory Manual – K. S. Bilgrami & U. S. Ghosh – CBS Publishers, 2012.
8. Practical Soil Microbiology – K. R. Aneja – 4th Edition – New Age International Publishers, 2014.
9. Textbook of Soil Science – T. D. Biswas & S. K. Mukherjee – McGraw Hill, 2019.
10. Soil Microbiology – D. K. Maheshwari – I.K. International, 2021.

VOCATIONAL SKILL COURSE IN MICROBIOLOGY

VSC II: FOOD TESTING AND QUALITY CONTROL- I

(Credit-2, Total Lectures- 60)

Course Objectives

1. To understand food quality standards, food safety regulations, and the role of regulatory agencies in maintaining food quality and consumer safety.
2. To learn analytical techniques for evaluation of physicochemical properties of food samples such as pH and titratable acidity.
3. To acquire practical knowledge of microbiological methods used for detection, isolation, and enumeration of microorganisms in foods.
4. To develop skills for detection and evaluation of traditional and chemical preservatives used in food products.

Course Outcomes

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

1. Explain the role of food regulatory agencies such as Food Safety and Standards Authority of India (FSSAI), AGMARK, and Bureau of Indian Standards (BIS) in food safety and quality assurance.
2. Perform physicochemical analysis of food samples including measurement of pH and determination of titratable acidity.
3. Isolate, enumerate, and detect microorganisms including coliform bacteria in food samples using standard microbiological techniques such as the MPN method.
4. Evaluate the effectiveness of traditional preservatives and detect commonly used chemical preservatives in market food products.

Practical Experiments

1) Study of Food Quality Standards and Regulatory Agencies involved in Food Safety (FSSAI, AGMARK, BIS)
2) Measurement of pH of selected food samples (Fruit Juice/Dairy Products)
3) Determination of titratable acidity in selected food samples (Fruit Juice/Dairy Products)
4) Isolation and enumeration of bacteria in selected food samples
5) Detection of coliforms in food samples by MPN method
6) Evaluation of the efficacy of traditional food preservatives
   a) Salt
   b) Sugar
   c) Vinegar
7) Detection of chemical preservatives in market foods (Jam/ Sauce/ Juice/ Mithai)
   a) Benzoic acid / Sodium benzoate
   b) Salicylic acid
   c) Sulphites

References

1. Food Microbiology – Frazier, W. C. & Westhoff, D. C. – 4th Edition – Tata McGraw-Hill Publishing Co., New Delhi.
2. Modern Food Microbiology – Jay, J. M., Loessner, M. J. & Golden, D. A. – 7th Edition – Springer, New York.
3. Laboratory Methods in Food and Dairy Microbiology – Harrigan, W. F. & McCance, M. E. – 8th Edition – Academic Press, London.
4. Food Microbiology – Adams, M. R. & Moss, M. O. – 3rd Edition – Royal Society of Chemistry, Cambridge.
5. Handbook of Analysis and Quality Control for Fruit and Vegetable Products – Ranganna, S. – 2nd Edition – Tata McGraw-Hill Publishing Co., New Delhi.
6. Food Safety and Standards Act, Rules and Regulations – Food Safety and Standards Authority of India (FSSAI) – Latest Edition – Government of India.
7. Compendium of Methods for the Microbiological Examination of Foods – American Public Health Association (APHA) – 5th Edition – APHA Press, USA.
8. Microbial Quality and Safety of Foods – R. Subhashini – 1st Edition – NPH India Publishers, India.

Nature of the Practical Examination Question Paper and Distribution of Marks

A) MAJOR MANDATORY PRACTICAL COURSE V (A)

Question No.	Nature/Type of Question	Marks
1	Isolation of coliphages from sewage samples by plaque assay technique **OR** Enumeration of coliphages from sewage samples by plaque count method.	20
2	Isolation of host bacterium for coliphages from sewage samples. **OR** Enrichment of coliphages from sewage samples.	15
3	Spotting	10
4	Journal	05
	Total Marks	**50**

B) MAJOR MANDATORY PRACTICAL COURSE V (B)

Question No.	Nature/Type of Question	Marks
1	Study of bactericidal activity of human serum against *E. coli* and *S. aureus* **OR** Estimation of haemoglobin / Determination of ESR / Quantitative Widal test	20
2	Determination of C- Reactive Protein (CRP) / RPR test / Total WBC count / Total RBC count / Differential leukocyte count	15
3	Spotting / Viva	10
4	Journal	05
	Total Marks	**50**

C) MAJOR ELECTIVE PRACTICAL COURSE I (A)

Question No.	Nature/Type of Question	Marks
1	Penicillin / Vitamin B12 assay **OR** Enumeration of bacteria from curd / fruit juice	20

2	Estimation of citric acid / alcohol **OR** Isolation of lactic acid bacteria	15
3	Spotting / Viva	10
4	Journal	05
	Total Marks	**50**

D) MAJOR ELECTIVE PRACTICAL COURSE I (B)

Question No.	Nature/Type of Question	Marks
1	Isolation of *Azotobacter* / *Rhizobium* / *Xanthomonas* / Phosphate solubilizer	20
2	Estimation of Calcium / Magnesium / Organic carbon content of soil	15
3	Spotting / Viva	10
4	Journal	05
	Total Marks	**50**

E) VSC II: FOOD TESTING AND QUALITY CONTROL- I

Question No.	Nature/Type of Question	Marks
1	Isolation and enumeration of bacteria in selected food samples **OR** Detection of coliforms in food samples by MPN method **OR** Effect of Salt / Sugar / Vinegar on microbial growth	20
2	Determination of titratable acidity in food samples **OR** Detection of Sodium benzoate / Salicylic acid / Sulphite in Market Foods	15
3	Spotting / Viva	10
4	Journal	05
	Total Marks	**50**

B. Sc. Part III

MICROBIOLOGY

SEMESTER VI

MAJOR MANDATORY COURSE XI: MICROBIAL GENETICS

(Credit-2, Total Lectures- 30)

Course Objectives

1. To provide conceptual understanding of microbial gene expression with emphasis on operon models and regulation of gene activity.
2. To introduce the concept of mutations and mutant analysis, including time course of phenotypic expression and methods for isolation and detection of mutants.
3. To familiarize students with basic molecular biology techniques such as DNA sequencing, DNA fingerprinting, and PCR along with their applications.
4. To develop fundamental knowledge of genetic engineering, including tools, techniques, and applications in medicine, agriculture, industry, and environment.

Course Outcomes

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

1. Explain the molecular mechanisms of gene expression in microorganisms, including operon concept and regulation of the tryptophan operon.
2. Describe the nature of mutations and methods for isolation and detection of mutants based on survival, growth, and visual screening techniques.
3. Discuss the principles, methodologies, and applications of important molecular biology techniques such as DNA sequencing, DNA fingerprinting, and PCR.
4. Illustrate the principles and applications of genetic engineering, including tools, cloning strategies, recombinant DNA technology, and their applications in various fields.

UNIT – I/ CREDIT I **Lectures - 15**

1) Molecular mechanism of gene expression:
   a) Concept of operon
   b) Pribnow box
   c) Structure of tryptophan operon
   d) Genetic regulation in tryptophan operon
      i) Regulation by repression
      ii) Regulation by attenuation
2) Time course of phenotypic expression of mutations
3) Methods of isolation and detection of mutants based on
   a) Relative survival
   b) Relative growth
   c) Visual detection
4) Techniques in Molecular Biology- Principle, Methods and Applications of
   a) DNA sequencing (Sanger's method)
   b) DNA fingerprinting
   c) PCR

UNIT – II / CREDIT II **Lectures - 15**

GENETIC ENGINEERING

1) Introduction to Genetic engineering
2) Tools of genetic engineering
   a) Enzymes-
      Restriction endonucleases, T4 DNA ligase, Alkaline phosphatase, Polynucleotide kinase, Terminal Transferase, Reverse transcriptase, DNA polymerase I, Taq DNA polymerase, RNase H, Exonuclease III, S1 nuclease and Mung bean nuclease
   b) Vectors- i) Plasmid- pBR322 and pUC 19 ii) Phage- lambda phage
      iii) Cosmid
   c) Cloning organisms – i) Bacteria- *Bacillus subtilis* and *E. coli*
      ii) Yeasts- *Saccharomyces cerevisiae*
   d) The concept of Genomic library and cDNA library
3) Techniques
   a) Isolation of desired DNA segment- Shotgun Method, cDNA synthesis, Chemical synthesis
   b) Construction of r-DNA using appropriate vector- Use of restriction enzymes, Linkers, Adaptors, Homopolymer tails
   c) Transfer of r-DNA into cloning organisms (Bacteria and Yeasts)- Transformation, Electroporation, PEG treatment
   d) Selection of recombinant bacteria and yeasts – Blue and white screening, Colony hybridization technique
4) Applications of genetic engineering in
   a) Medicine
   b) Agriculture
   c) Industry
   d) Environment

References

1. An Introduction to Genetic Engineering – Desmond S. T. Nicholl – 3rd Edition – Cambridge University Press.
2. Biotechnology – U. Satyanarayana – 1st Edition – Books and Allied (P) Ltd.
3. Biotechnology: Fundamentals and Applications – S. S. Purohit – 6th Edition – Agrobios (India).
4. Gene Cloning and DNA Analysis – T. A. Brown – 7th Edition – Wiley-Blackwell.
5. Genes XII – Benjamin Lewin – 12th Edition – Jones & Bartlett Learning.
6. Genetic Engineering – S. Rastogi & N. Pathak – 2nd Edition – Oxford University Press.
7. Microbial Genetics – Maloy, Cronan & Freifelder – 2nd Edition – Jones and Bartlett Publishers.
8. Molecular Biology of the Gene – James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine & Richard Losick – 7th Edition – Pearson Education.

9. Molecular Biotechnology: Principles and Applications of Recombinant DNA – Glick, Pasternak & Patten – 5th Edition – ASM Press.
10. Molecular Biotechnology: Principles and Applications of Recombinant DNA – Bernard R. Glick, Jack J. Pasternak & Cheryl L. Patten – 5th Edition – ASM Press.
11. Molecular Cell Biology – Lodish, Berk, Kaiser, Krieger, Bretscher, Ploegh, Amon & Scott – 8th Edition – W. H. Freeman and Company.
12. Principles of Gene Manipulation and Genomics – Primrose & Twyman – 7th Edition – Blackwell Publishing.
13. Principles of Gene Manipulation and Genomics – Sandy B. Primrose & Richard Twyman – 7th Edition – Blackwell Publishing.
14. Recombinant DNA Technology – A. Chakravarty – 1st Edition – CBS Publishers & Distributors.
15. Textbook of Biotechnology – R. C. Dubey – 5th Edition – S. Chand & Company Ltd.

MAJOR MANDATORY COURSE XII: MICROBIAL BIOCHEMISTRY

(Credit-2, Total Lectures- 30)

Course Objectives:

1. To understand the basic principles of enzymes, including their structure, properties, specificity, classification, and mechanisms of action.
2. To learn the regulatory features of enzymes, including allosteric behavior and environmental factors affecting enzyme activity.
3. To gain knowledge of enzyme extraction, purification, assay techniques, and immobilization methods.
4. To understand the kinetics of enzyme-catalyzed reactions and the significance of kinetic parameters.
5. To learn the biosynthesis of major biomolecules and the regulation of enzyme synthesis in cells.

Course Outcomes

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

1. Explain enzyme structure, properties, classification, and mechanisms of action using appropriate models.
2. Describe allosteric regulation and environmental factors influencing enzyme activity.
3. Explain methods for enzyme extraction, purification, assay, and immobilization, along with their applications.
4. Derive and interpret enzyme kinetics, including the Michaelis–Menten equation, Km, and Vmax.
5. Describe biosynthetic pathways of RNA, DNA, proteins, and peptidoglycan, and explain regulation of enzyme synthesis using operon models.

UNIT – I / CREDIT – I **Lectures - 15**

1) Enzymes- Definition, properties, structure, specificity, mechanism of action (Lock & Key, Induced fit hypothesis), Basics of enzyme classification.
2) Allosteric enzymes- Definition, properties, models explaining mechanism of action (Concerted and sequential models).
3) Extraction and purification of enzymes
   a) Methods of extraction of intracellular and extracellular enzymes: Choice of source and biomass development
   b) Methods of homogenization - cell disruption methods
   c) Purification of enzymes based on
      i) Molecular size,
      ii) Solubility differences
      iii) Electrical charge
      iv) Adsorption characteristic differences
      v) Differences in biological activity

4) Assay of enzymes - Based on substrate and product estimation
5) Ribozymes and Isozymes
6) Immobilization of enzymes- Methods and applications

UNIT – II / CREDIT – II **Lectures - 15**

1) Environmental factors influencing enzyme activity-
   a) Substrate concentration
   b) Temperature
   c) pH
   d) Metal ions
2) Kinetics of Single Substrate-enzyme catalyzed reactions-
   Derivation of Michaelis-Menten equation, Significance of Km and Vmax
3) Biosynthesis of
   a) RNA
   b) DNA
   c) Proteins
   d) Peptidoglycan
4) Regulation of enzyme synthesis.
   a) Positive Control- Arabinose operon
   b) Negative Control- Lac operon
   c) Catabolite repression

References

1. Principles of Biochemistry – Lehninger, Nelson & Cox – 8th Edition – W. H. Freeman and Company.
2. Biochemistry – Donald Voet & Judith G. Voet – 5th Edition – Wiley.
3. Biochemistry – Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto & Lubert Stryer – 9th Edition – W. H. Freeman and Company.
4. Principles and Techniques of Biochemistry and Molecular Biology – Wilson & Walker – 8th Edition – Cambridge University Press.
5. Fundamentals of Enzymology – Nicholas C. Price & Lewis Stevens – 3rd Edition – Oxford University Press.
6. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry – Trevor Palmer & Philip Bonner – 2nd Edition – Woodhead Publishing.
7. Biochemical Calculations – Irwin H. Segel – 2nd Edition – John Wiley & Sons.
8. Molecular Biology of the Gene – Watson, Baker, Bell, Gann, Levine & Losick – 7th Edition – Pearson Education.
9. Molecular Cell Biology – Lodish, Berk, Kaiser, Krieger, Bretscher, Ploegh, Amon & Scott – 8th Edition – W. H. Freeman and Company.
10. Microbial Biochemistry – G. N. Cohen – 3rd Edition – Springer.
11. Biochemical Methods – Sadasivam, S. & Manickam, A. – 3rd Edition – New Age International Publishers.

MAJOR ELECTIVE COURSE II (A): ENVIRONMENTAL MICROBIOLOGY

(Credit-2, Total Lectures- 30)

Course Objectives

1. To introduce the characteristics of liquid and solid wastes and explain the physicochemical and biological parameters used for waste and sewage analysis as per regulatory standards.
2. To provide knowledge of sewage microbiology and wastewater treatment processes, with emphasis on biological and chemical treatment methods.
3. To familiarize students with environmental monitoring, laboratory biosafety, and impact assessment concepts relevant to industrial and pharmaceutical environments.
4. To develop an understanding of bioremediation and bioleaching processes and their applications in pollution control and resource recovery.

Course Outcomes

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

1. Describe the characteristics of wastes and sewage and explain treatment methods used for municipal and industrial wastewater management.
2. Explain the treatment of wastes generated by different industries and assess environmental issues such as eutrophication and its control measures.
3. Apply concepts of laboratory biosafety and environmental monitoring, including cleanroom classification, bioburden testing, and environmental impact assessment.
4. Explain the principles and applications of bioremediation and bioleaching, including the role of microorganisms in environmental cleanup and metal recovery.

UNIT – I / CREDIT – I **Lectures - 15**

1) General characteristics of waste-
   a) Liquid waste - pH, electrical conductivity, COD, BOD, total solids, total dissolved solids, total suspended solids
   b) Solid waste- pH, electrical conductivity, total volatile solids, ash
2) Sewage Microbiology
   a) Physico-chemical and biological characteristics
   b) Treatment
      i) Biological treatment: Trickling filter, Activated sludge process, Oxidation ponds, Anaerobic digestion, Septic tank, Root zone technology
      ii) Chemical treatment – Chlorination
3) Characteristics and treatment of waste generated by
   a) Sugar Industry
   b) Distillery
   c) Dairy Industry
4) Eutrophication
   a) Classification of lakes

b) Sources
c) Consequences
d) Control

UNIT – II / CREDIT – II **Lectures - 15**

1) Biological safety in laboratory
   a) Good Laboratory Practices
   b) Bio safety levels (BSL)
2) Environmental monitoring
   a) Definition and purpose
   b) Cleanroom classification
   c) Routine Environmental monitoring programme in pharmaceutical industries- Air monitoring, Surface monitoring and Personnel monitoring.
   d) Bioburden test
3) Environmental Impact Assessment- Concept and Brief introduction
4) Bioremediation and Bioleaching
   a) Bioremediation
      i) Definition
      ii) Types
      iii) Applications
   b) Bioleaching
      i) Introduction
      ii) Microorganisms involved
      iii) Chemistry of Microbial leaching
      iv) In situ leaching- Slope and heap
      v) Leaching of Copper

References

1. Biochemistry and Microbiology of Pollution – Higgins & Burns – Academic Press.
2. Environmental Pollution – Laurent Hodge – Holt Publishers.
3. Waste Water Treatment – Datta & Rao – Oxford & IBH Publishing.
4. Sewage and Waste Treatment – Hammer – McGraw-Hill.
5. Environmental Chemical Hazards – Ram Kumar – Swarup & Sons, New Delhi.
6. Environment and Metal Pollution – Khan – ABD Publishers, Jaipur.
7. Environmental Pollution – Timmy Katyal – Satke Anmol Publishers, New Delhi.
8. Ecology of Polluted Water, Vol. II – Anand Kumar – APH Publishing Co., New Delhi.
9. Environmental Pollution and Management of Waste Waters by Microbial Techniques – Pathade & Goel – ABD Publishers, Jaipur.
10. Current Topics in Environmental Sciences – Tripathi & Pandey – ABD Publishers, Jaipur.
11. Environmental Impact Assessment – R. K. Trivedy – Macmillan Press.
12. Microbial Limit and Bioburden Tests – Lucia Clontz – 2nd Edition – CRC Press.

MAJOR ELECTIVE COURSE II (B): MEDICAL MICROBIOLOGY

(Credit-2, Total Lectures- 30)

Course Objectives:

1. To provide comprehensive knowledge of the morphological, cultural, biochemical, and antigenic characteristics of medically important bacteria, protozoa, viruses, and fungi.
2. To familiarize students with the modes of transmission, pathogenesis, clinical symptoms, laboratory diagnosis, prevention and control of major infectious diseases.
3. To impart fundamental understanding of chemotherapy, including principles, chemoprophylaxis, and mechanisms of action of antimicrobial agents.
4. To develop awareness about drug resistance mechanisms and the role of immunoprophylaxis through vaccines and immune sera in disease prevention.

Course Outcomes:

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

1. Describe the morphology, cultural and biochemical characteristics, antigenic structure and pathogenicity of major bacterial, protozoan, viral and fungal pathogens of medical importance.
2. Explain the modes of transmission, clinical manifestations, laboratory diagnosis, prevention and control measures of infectious diseases caused by selected microorganisms.
3. Understand and interpret the principles of chemotherapy, modes of action of antibacterial, antiviral, antifungal and antiprotozoal drugs, and the basis of chemoprophylaxis.
4. Analyze the causes and mechanisms of antimicrobial drug resistance and differentiate various types of vaccines and immune sera used in immunoprophylaxis.

UNIT – I / CREDIT – I **Lectures - 15**

1) Morphology, cultural and biochemical characteristics, antigenic structure, modes of transmission, pathogenesis, symptoms, laboratory diagnosis, prevention and control of diseases caused by following bacteria
   i) *Mycobacterium tuberculosis*
   ii) *Salmonella* spp.
   iii) *Treponema pallidum*
   iv) *Pseudomonas aeruginosa*
   v) *Vibrio cholera*
   vi) *Staphylococcus aureus*

UNIT – II / CREDIT – II **Lectures - 15**

1) Morphology, cultural and biochemical characteristics, antigenic structure, modes of transmission and pathogenesis, symptoms, laboratory diagnosis, prevention and control of diseases caused by-
   a) Protozoa: *Plasmodium falciparum* (Malaria)
   b) Viruses: i) Rabies virus ii) Dengue virus

c) Fungus: *Candida albicans*

2) Chemotherapy
   a) Chemoprophylaxis
   b) General principles of chemotherapy
   c) Mode of action of antimicrobial agents:
      i) Antibacterial drugs:
         - Cell wall (Penicillin)
         - Cell membrane (Polymyxin)
         - Protein synthesis (Streptomycin)
         - Nucleic Acids (Quinolones)
         - Metabolic pathways (Sulphonamides)
      ii) Antiviral drug: AZT
      iii) Antifungal drugs: Griseofulvin, Ketoconazole
      iv) Antiprotozoal drugs: Mepacrine
3) Drug resistance: Reasons and Mechanism of drug resistance
4) Immunoprophylaxis:
   i) Vaccines-live attenuated, inactive, subunit, conjugate, and DNA vaccines
   ii) Immune Sera- examples with applications

References

1. Infectious Diseases – Dr. Salunkhe Anil K. – 1st Edition – 2025 – Himalaya Publishing House.
2. Ananthanarayan and Paniker's Textbook of Microbiology – Editor Arati Kapil – 9th Edition – 2013 – Universities Press.
3. Medical Microbiology – Jawetz, Melnick & Adelberg – 28th Edition – McGraw-Hill Education.
4. Medical Parasitology – Chatterjee, K. D. – 13th Edition – CBS Publishers & Distributors.
5. Medical Virology – Dimmock, Easton & Leppard – 4th Edition – Wiley-Blackwell.
6. Pharmacology – Rang & Dale – 9th Edition – Elsevier.
7. Goodman and Gilman's The Pharmacological Basis of Therapeutics – Brunton, Hilal-Dandan & Knollmann – 13th Edition – McGraw-Hill Education.
8. Microbiology – Davis, B. D., Dulbecco, R., Eisen, H. N. & Ginsberg, H. S. – 4th Edition – 1990 – J. B. Lippincott Co., New York.
9. Medical Bacteriology – Dey, N. C. & Dey, T. K. – 17th Edition – 1988 – Allied Agency, Calcutta.
10. Medical Bacteriology including Medical Mycology and AIDS – T. K. Dey, D. Sinha & N. C. Dey – 1st Edition – New Central Book Agency, Kolkata.
11. Principles and Practice of Clinical Bacteriology – A. M. Emmerson – 2nd Edition – Wiley-Blackwell.
12. Medical Microbiology – Chakraborty, P. – 2nd Edition – New Central Book Agency.
13. Antimicrobial Chemotherapy – David Greenwood – 5th Edition – Oxford University Press.

MAJOR MANDATORY PRACTICAL COURSE VI (A): MICROBIAL GENETICS

(Credit-2, Total Lectures- 60)

Course Objectives

1. To understand the effects of physical and chemical mutagens on bacterial cells and the principles of microbial mutation.
2. To learn techniques for isolation and identification of different types of bacterial mutants.
3. To acquire practical knowledge of molecular biology methods for isolation, detection, and analysis of DNA.
4. To develop laboratory skills in microbial genetics, electrophoresis, and interpretation of experimental results through graphical analysis.

Course Outcomes

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

1. Demonstrate the effect of ultraviolet radiation on bacterial survival and present experimental data graphically.
2. Isolate and identify different bacterial mutants including auxotrophic, lac negative, and streptomycin resistant mutants of *Escherichia coli* using standard microbial genetic techniques.
3. Perform chromosomal DNA isolation from bacteria and separate DNA fragments using electrophoresis techniques.
4. Detect DNA qualitatively using biochemical methods and interpret results obtained from microbial genetics and molecular biology experiments.

Practical Experiments

1) Effect of U.V. light on bacteria and graphical presentation of result
2) Isolation of auxotrophic mutants of *E. coli* by replica plate technique
3) Isolation of lac negative mutants of *E. coli*
4) Isolation of streptomycin resistant mutants of *E. coli* by gradient plate technique
5) Isolation of chromosomal DNA from bacteria by J. Marmurs method
6) Electrophoretic separation of DNA
7) Qualitative detection of DNA in a sample by Diphenylamine method

References

1. Prescott's Microbiology – Willey, Sherwood & Woolverton – 10th Edition – McGraw-Hill Education.
2. Microbiology – Pelczar, Chan & Krieg – 5th Edition – Tata McGraw-Hill Publishing Co.
3. Microbiology: Principles and Explorations – Jacquelyn G. Black – 9th Edition – John Wiley & Sons.

4. Molecular Biology of the Gene – Watson, Baker, Bell, Gann, Levine & Losick – 7th Edition – Pearson Education.
5. Principles of Gene Manipulation and Genomics – Primrose & Twyman – 7th Edition – Blackwell Publishing.
6. Gene Cloning and DNA Analysis – T. A. Brown – 7th Edition – Wiley-Blackwell.
7. Experiments in Microbiology, Plant Pathology and Biotechnology – K. R. Aneja – 4th Edition – New Age International Publishers.
8. Laboratory Manual in General Microbiology – American Society for Microbiology – Latest Edition – ASM Press.
9. Molecular Cloning: A Laboratory Manual – Sambrook & Russell – 3rd Edition – Cold Spring Harbor Laboratory Press.
10. Experiments in Molecular Genetics – J. H. Miller – 1st Edition – Cold Spring Harbor Laboratory Press.

MAJOR MANDATORY PRACTICAL COURSE VI (B): MICROBIAL BIOCHEMISTRY

(Credit-2, Total Lectures- 60)

Course Objectives

1. To understand the principles of enzyme assays and factors affecting enzyme activity.
2. To learn biochemical techniques for estimation of enzymes and proteins using standard analytical methods.
3. To acquire practical knowledge of the effects of temperature, pH, and substrate concentration on enzyme activity.
4. To develop laboratory skills in enzyme and microbial cell immobilization techniques and interpretation of experimental data.

Course Outcomes

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

1. Perform quantitative assay of amylase using the DNSA method and represent the results graphically.
2. Analyze the effects of temperature, pH, and substrate concentration on enzyme activity and interpret the results.
3. Estimate protein concentration in biological samples using the Biuret method.
4. Demonstrate immobilization of enzymes and yeast cells using calcium alginate techniques and explain their industrial applications.

Practical Experiments

1) Assay of Amylase by DNSA method (Graphical estimation)
2) Effect of temperature on enzyme (amylase) activity
3) Effect of pH on enzyme (amylase) activity
4) Effect of substrate concentration on enzyme (amylase) activity
5) Estimation of proteins by Biuret method
6) Study of enzyme immobilization by calcium alginate method
7) Study of yeast cell immobilization by calcium alginate method

References

1. Principles of Biochemistry – Lehninger, Nelson & Cox – 8th Edition – W. H. Freeman and Company.
2. Principles and Techniques of Biochemistry and Molecular Biology – Wilson & Walker – 8th Edition – Cambridge University Press.
3. Biochemistry – U. Satyanarayana & U. Chakrapani – 6th Edition – Elsevier India.
4. Biochemistry – Donald Voet & Judith G. Voet – 5th Edition – Wiley.
5. Fundamentals of Enzymology – Nicholas C. Price & Lewis Stevens – 3rd Edition – Oxford University Press.
6. Practical Biochemistry – David Plummer – 5th Edition – McGraw-Hill Education.

7. Biochemical Methods – Sadasivam, S. & Manickam, A. – 3rd Edition – New Age International Publishers.
8. Introductory Practical Biochemistry – S. K. Sawhney & Randhir Singh – 2nd Edition – Narosa Publishing House.
9. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry – Trevor Palmer & Philip Bonner – 2nd Edition – Woodhead Publishing.
10. Industrial Microbiology – Casida, L. E. – 1st Edition – Wiley Eastern Ltd.

MAJOR ELECTIVE PRACTICAL COURSE II (A): ENVIRONMENTAL MICROBIOLOGY

(Credit-2, Total Lectures- 60)

Course Objectives

1. To understand the physical, chemical, and biological characteristics of sewage samples.
2. To learn standard methods used for analysis of important sewage quality parameters such as pH, solids, BOD, and COD.
3. To acquire practical knowledge of microbiological techniques for isolation and enumeration of bacteria from sewage samples.
4. To develop laboratory skills for assessment and interpretation of sewage pollution and wastewater quality

Course Outcomes

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

1. Analyze physical characteristics of sewage including colour, odour, and temperature using standard procedures.
2. Determine important physicochemical parameters of sewage such as pH, total solids (TS), total suspended solids (TSS), total dissolved solids (TDS), biological oxygen demand (BOD), and chemical oxygen demand (COD).
3. Isolate and enumerate bacteria from sewage samples using microbiological techniques such as serial dilution and plate count methods.
4. Interpret sewage analysis results to evaluate wastewater quality and the extent of organic and microbial pollution.

Practical Experiments

1) Determination of colour, odour and temperature of a sewage sample
2) Determination of pH of a sewage sample
3) Estimation of Total solids (TS) of a sewage sample
4) Estimation of Total suspended solids (TSS) of a sewage sample
5) Estimation of Total dissolved solids (TDS) of a sewage sample
6) Determination of Biological Oxygen Demand (BOD) of a sewage sample
7) Determination of Chemical Oxygen Demand (COD) of a sewage sample
8) Isolation and enumeration of bacteria from sewage sample

References

1. Environmental Microbiology – Maier, Pepper & Gerba – 3rd Edition – Academic Press.
2. Environmental Microbiology – Raina M. Maier, Ian L. Pepper & Charles P. Gerba – 2nd Edition – Elsevier Academic Press.
3. Wastewater Engineering: Treatment and Resource Recovery – Metcalf & Eddy – 5th Edition – McGraw-Hill Education.

4. Standard Methods for the Examination of Water and Wastewater – APHA, AWWA & WEF – 23rd Edition – American Public Health Association.
5. Environmental Pollution Control Engineering – C. S. Rao – 3rd Edition – New Age International Publishers.
6. Introduction to Environmental Engineering and Science – Gilbert M. Masters & Wendell P. Ela – 3rd Edition – Pearson Education.
7. Elements of Environmental Engineering – K. N. Duggal – 1st Edition – S. Chand Publishing.
8. Environmental Biotechnology – Indu Shekhar Thakur – 2nd Edition – I.K. International Publishing House.
9. Microbiology: A Laboratory Manual – James G. Cappuccino & Natalie Sherman – 11th Edition – Pearson Education.
10. Practical Microbiology – Dubey, R. C. & Maheshwari, D. K. – 1st Edition – S. Chand Publishing.
11. Environmental Engineering – Peavy, Rowe & Tchobanoglous – 1st Edition – McGraw-Hill Education.
12. Manual on Water and Wastewater Analysis – NEERI – 2nd Edition – National Environmental Engineering Research Institute, Nagpur.

MAJOR ELECTIVE PRACTICAL COURSE II (B): MEDICAL MICROBIOLOGY

(Credit-2, Total Lectures- 60)

Course Objectives

1. To understand methods for isolation, cultivation, and identification of clinically important bacteria from clinical specimens.
2. To learn techniques used for antimicrobial susceptibility testing and determination of minimum inhibitory concentration (MIC) of antibiotics.
3. To acquire practical knowledge of routine biochemical and diagnostic tests used in clinical microbiology laboratories.
4. To develop laboratory skills for analysis and interpretation of microbiological and urine diagnostic tests associated with human diseases.

Course Outcomes

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

1. Isolate and identify clinically important bacteria such as *Pseudomonas aeruginosa* and *Staphylococcus aureus* based on morphological, cultural, and biochemical characteristics.
2. Determine the antimicrobial sensitivity pattern of pathogenic bacteria and evaluate the minimum inhibitory concentration (MIC) of antibiotics against *Escherichia coli*.
3. Perform standard antibiotic susceptibility testing using the paper disc diffusion method and interpret the results.
4. Conduct routine urine analysis tests for detection of sugar, protein, ketone bodies, and bile salts using standard biochemical methods.

Practical Experiments

1) Isolation of *Pseudomonas aeruginosa* from clinical samples (wherever possible) and identification of the same by morphological, cultural, and biochemical characteristics.
2) Isolation of *Staphylococcus aureus* from clinical samples (wherever possible) and identification of the same by morphological, cultural, and biochemical characteristics.
3) Determination of MIC of streptomycin against *E. coli* using broth dilution method
4) Determination of sensitivity of common pathogens to antibiotics by paper disc method.
5) Detection of presence of sugar in urine (Benedict's method)
6) Detection of presence of protein in urine (Acetic acid test)
7) Detection of presence of ketone bodies in urine (Rothera's test)
8) Detection of presence of bile salt in urine (Hay's Sulphur Test)

References

1. Ananthanarayan and Paniker's Textbook of Microbiology – C. K. Jayaram Paniker – 10th Edition, 2017, Universities Press.
2. Clinical Microbiology Procedures Handbook – Lynne S. Garcia – 4th Edition – ASM Press, 2010.

3. Essential Clinical Microbiology – Greenwood, Slack & Peutherer – 7th Edition – Elsevier, 2012.
4. Laboratory Manual in Microbiology – P. Gunasekaran – 1st Edition, 1996, New Age International Publishers.
5. Manual of Clinical Microbiology – James H. Jorgensen & Michael A. Pfaller – 11th Edition, 2015, ASM Press.
6. Medical Laboratory Technology – Ramnik Sood – 6th Edition, 2006, Jaypee Brothers Medical Publishers.
7. Medical Laboratory Technology: Microbiology – Kanai L. Mukherjee – 2nd Edition – Tata McGraw-Hill, 2012.
8. Medical Microbiology – Jawetz, Melnick & Adelberg – 27th Edition, 2016, McGraw-Hill Education.
9. Microbiology: A Laboratory Manual – James G. Cappuccino & Natalie Sherman – 10th Edition, 2014, Pearson Education.
10. Practical Clinical Microbiology – A. K. Chakraborty – 1st Edition – Academic Publishers, 2011.
11. Practical Microbiology: Techniques and Exercises – Arnold L. Demain & Julian E. Davies – ASM Press, 2009.

IKS 2: INDIAN KNOWLEDGE SYSTEM IN MICROBIOLOGY
(Major Specific)

(Credit-2, Total Lectures- 30)

Course Objectives

1. To introduce students to the fundamental concepts of Vedic Microbiology and the traditional understanding of microorganisms (Sukshma Jivanu) described in ancient Indian texts.
2. To examine indigenous methods of infection control, water purification, agriculture, and healthcare practices from a microbiological perspective.
3. To explore the principles and microbiological basis of traditional Indian fermentation systems and ethno-microbiological practices.
4. To develop an integrative understanding of Indian Knowledge Systems (IKS) and modern microbiology for promoting sustainable health, agriculture, and environmental practices.

Course Outcomes

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

1. Explain references to microorganisms (Krimis) and disease prevention methods described in Vedic and classical texts, and relate them to modern microbiological concepts.
2. Analyze traditional practices such as Panchagavya, Jeevamrita, ancient water purification techniques, and medicinal plant usage in terms of their scientific and microbiological relevance.
3. Describe the microbial diversity and biochemical basis involved in traditional Indian fermented foods, beverages, and dairy products.
4. Evaluate the role of indigenous fermented foods and probiotics in nutrition, gut microbiome health, food safety, and sustainable living.

UNIT I: VEDIC MICROBIOLOGY AND TRADITIONAL PRACTICES Lectures – 15

1) Introduction to Vedas and Vedic Microbiology
2) Contributions of key Vedic scholars: Sage Kanva, Agastya, Badarayani, Charak, Sushruta
3) *Sukshma jivanu* in Vedas- The forgotten part of Microbiology
4) Major groups of germs (*Krimis*) in Vedas
5) Controlling of germs (*Krimis)*
    a) Prevention of infection
    b) Precaution of Spread
    c) Elimination of Pathogens- Destruction of microorganisms, Use of Sunrays
    d) Eradication of Pathogens- Use of medicinal plants
6) Microbial diseases described during vedic period

7) Traditional agricultural practices and indigenous biofertilizers (Panchagavya, Dhanyagavya, Sasyagavya, and Jeevamrita): composition, impact on soil health, plant growth, and sustainable agriculture
8) Ancient water purification techniques: Use of Moringa seed extracts, Copper vessel, purification, and Sand filtration

UNIT II: ETHNO-MICROBIOLOGY **Lectures – 15**

1) Traditional food fermentation, preservation, and healthcare practices
2) Role of fermentation in nutrition, food safety, and preservation
3) Traditional fermentation versus modern microbial processes
4) Ethno-microbiology of Indian fermented foods:
   a) Fermented rice–legume foods
   b) Fermented soybean and non-soybean legume foods
   c) Fermented vegetables and fruits
   d) Fermented milk products
   e) Fermented cereals
5) Traditional alcoholic beverages and their microbiological basis
6) Probiotics in Indian diets: Yogurt, Lassi, and Buttermilk
7) Role of fermented foods in gut microbiome diversity and health benefits

References

1. Vedic Microbiology: A Scientific View. R. C. Dubey- Aastha Prakashan Banarasidass, 2020.
2. Vedic Microbiology – Gurus of Vedic Microbiology. C. F. Anjista and S. Kurup.
3. Microorganism in Vedas – R. K. Jakhmola.
4. *Sukshmjeevanu* in Vedas – The Forgotten Past of Microbiology in Indian Vedic Knowledge. Kuhad, U., Goel, G., Maurya, P.K., & Kuhad, R.C. *Indian Journal of Microbiology, 61*, 108 – 110 (2021). https://doi.org/10.1007/s12088-020-00911-5
5. Microbiological properties of Beejamrit, an ancient Indian traditional knowledge, uncover a dynamic plant beneficial microbial network. Mukherjee, S., Sain, S., Ali, M.N. *et al.* World Journal of Microbiology and Biotechnology, 38, 111 (2022). https://doi.org/10.1007/s11274-022-03296-3
6. "Ethno-microbiology" of ethnic Indian fermented foods and alcoholic beverages, Jyoti Prakash Tamang. Journal of Applied Microbiology. https://doi.org/10.1111/jam.15382

VOCATIONAL SKILL COURSE IN MICROBIOLOGY

VSC III: FOOD TESTING AND QUALITY CONTROL- II

(Credit-2, Total Lectures- 60)

Course Objectives

1. To understand microbiological and chemical methods used for detection of foodborne pathogens, contaminants, toxins, and adulterants in food samples.
2. To learn standard laboratory techniques for isolation and identification of bacterial and fungal contaminants associated with food spoilage and foodborne diseases.
3. To acquire practical knowledge of methods used for detection of aflatoxins and common adulterants present in food products.
4. To develop analytical and laboratory skills required for food quality assessment and food safety evaluation.

Course Outcomes

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

1. Detect and identify common foodborne bacterial pathogens such as *Staphylococcus aureus* and *Escherichia coli* from food samples using microbiological techniques.
2. Isolate and identify fungal contaminants from food samples and evaluate their significance in food spoilage and food safety.
3. Detect aflatoxins in food samples using the BGYF (Bright Greenish Yellow Fluorescence) method and explain their importance in food safety.
4. Perform qualitative tests for detection of common adulterants in honey, ghee, butter, and paneer and interpret the results for assessment of food quality.

Practical Experiments

1) Detection of common foodborne bacterial pathogens from food samples (Minced Meat/Creamy Dessert/Street Food).
   a) *Staphylococcus aureus*
   b) *Escherichia coli*
2) Detection of fungal contaminants from given food samples (Bread/Onion)
3) Detection of Aflatoxins in food samples (Corn/Fig/Peanuts) using UV fluorescence (BGYF) method
4) Detection of common adulterants in Honey
   a) Water Test (for Sugar syrup / Glucose)
   b) Flame Test (for Moisture / Sugar syrup)
   c) Iodine Test (for Starch)
5) Detection of common adulterants in Ghee / Butter
   a) Iodine Test (for Starch)
   b) Baudouin Test (for Vanaspati / Sesame oil)
   c) Nitric Acid Test (for Vegetable oils)

6) Detection of common adulterants in Paneer
   a) Iodine Test (for Starch)
   b) Hot Water Test (for Detergents / Synthetic milk)
   c) Acid Test (for Excess acid / Baking powder)

References

1. Food Adulteration and Food Safety – B. Srilakshmi, New Age International Publishers, New Delhi.
2. Food Microbiology – Frazier, W. C. & Westhoff, D. C., Tata McGraw-Hill Publishing Co., New Delhi.
3. Modern Food Microbiology – Jay, J. M., Loessner, M. J. & Golden, D. A., Springer, New York.
4. Handbook of Food Analysis – S. S. Nielsen, Springer, New York.
5. Official Methods of Analysis – Association of Official Analytical Chemists (AOAC), AOAC International, Washington, DC.
6. Manual of Methods of Analysis of Foods – Food Safety and Standards Authority of India (FSSAI), Ministry of Health and Family Welfare, Government of India.
7. Food Safety and Quality Assurance – S. M. Reddy & M. S. Reddy, CBS Publishers, New Delhi.

SKILL ENHANCEMENT COURSE IN MICROBIOLOGY

SEC III: MICROBIAL QUALITY ASSURANCE IN PHARMACEUTICAL INDUSTRIES

(Credit-2, Total Lectures- 60)

Course Objectives

1. To understand the principles and practices of microbiological quality control in pharmaceutical industries.
2. To learn methods for preparation, sterilization, quality testing, and sterility assessment of culture media and pharmaceutical products.
3. To acquire practical knowledge of environmental, personnel, and pharmaceutical water monitoring techniques used in pharmaceutical microbiology.
4. To develop laboratory skills for microbial enumeration, contamination detection, and sterility testing of sterile and non-sterile pharmaceutical products.

Course Outcomes

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

1. Prepare and sterilize culture media and perform quality testing using growth promotion tests (GPT) and sterility assessment methods.
2. Conduct environmental and personnel monitoring using settle plate, swab, and finger dab methods for assessment of microbial contamination.
3. Perform microbiological testing of pharmaceutical water systems and determine Total Aerobic Microbial Count (TAMC) in potable water, purified water, and water for injection (WFI).
4. Carry out sterility testing, Gram staining, and microbial enumeration of sterile and non-sterile pharmaceutical products for quality control evaluation.

Practical Experiments

1) Preparation of culture media, sterilization and quality testing using growth promotion test (GPT) and pre-incubation sterility assessment.
2) Environmental & Personnel Monitoring
   a) Microbial monitoring of air (by Settle plate method)
   b) Surface monitoring (by Swab method)
   c) Personnel monitoring (by Finger dab method)
3) Microbiological testing of pharmaceutical water systems using Total Aerobic Microbial Count (TAMC) method
   a) Potable water (Raw feed)
   b) Purified water (PW)
   c) Water for injection (WFI)
4) Sterility testing of injectable pharmaceutical products by direct inoculation method.
5) Detection of contaminants in sterile pharmaceutical products by Gram staining.
6) Total Aerobic Microbial Count (TAMC) of non-sterile pharmaceutical products (Tablet/Syrup).

References

1. Handbook of Microbiological Media – Atlas, R.M., CRC Press, Boca Raton, 2010.
2. Handbook of Microbiological Quality Control in Pharmaceuticals and Medical Devices – Baird, R.M., Hodges, N.A. & Denyer, S.P. (Eds.), CRC Press, Boca Raton, 2012.
3. Indian Pharmacopoeia (IP) – Microbiological Tests, Government of India, Ghaziabad, 2018 Edition.
4. Industrial Microbiology: A Laboratory Manual – Mathur, P., Agrobios, Jodhpur, 2010.
5. Industrial Pharmaceutical Microbiology: Standards and Control, 3rd Edition – Hanlon, G. & Sandle, T., EC Pharma Publisher, 2015, ISBN 978-0957349124.
6. Pharmaceutical Microbiology – Jusko, W.J., John Wiley & Sons, New York, 2017.
7. Pharmaceutical Microbiology Practical Manual – Agnihotri, S. & Garg, R., University Press, Hyderabad, 2018.
8. Practical Microbiology – Plummer, D.T., CBS Publishers, New Delhi, 2005.
9. Standard Operating Procedures: Care and Maintenance of Laboratory Equipment – AMREF Publisher, Nairobi, 2008, ISBN 978-9966874948.
10. Writing High-Quality Standard Operating Procedures: A Practical Guide – Johnson, M., Wiley, New York, 2016.

Nature of the Practical Examination Question Paper and Distribution of Marks

A) MAJOR MANDATORY PRACTICAL COURSE VI (A)

Question No.	Nature / Type of Question	Marks
1	Effect of U.V. light on bacteria **OR** Isolation of chromosomal DNA **OR** Isolation of auxotrophic mutant of *E. coli*.	20
2	Isolation of lac negative mutant / streptomycin resistant mutant of *E. coli*. **OR** Electrophoretic separation of DNA **OR** Qualitative detection of DNA	15
3	Spotting / Viva	10
4	Journal	05
	Total Marks	**50**

B) MAJOR MANDATORY PRACTICAL COURSE VI (B)

Question No.	Nature / Type of Question	Marks
1	Effect of pH / temperature / substrate concentration on enzyme activity	20
2	Amylase assay **OR** Estimation of protein **OR** Enzyme/ Yeast cell immobilization	15
3	Spotting / Viva	10
4	Journal	05
	Total Marks	**50**

C) MAJOR ELECTIVE PRACTICAL COURSE II (A)

Question No.	Nature / Type of Question	Marks
1	Determination of BOD / COD of a given sewage sample **OR** Enumeration of bacteria from sewage sample	20
2	Estimation of TS / TSS / TDS of a given sewage sample	15
3	Spotting / Viva	10
4	Journal	05
	Total Marks	**50**

D) MAJOR ELECTIVE PRACTICAL COURSE II (B)

Question No.	Nature / Type of Question	Marks
1	Isolation of *Pseudomonas aeruginosa* / *Staphylococcus aureus* **OR** Determination of MIC of streptomycin against *E. coli*	20
2	Determination of sensitivity of common pathogens to antibiotics by paper disc method. **OR** Detection of presence of sugar / protein / ketone bodies / bile salt in urine	15
3	Spotting / Viva	10
4	Journal	05
	Total Marks	**50**

E) VSC III: FOOD TESTING AND QUALITY CONTROL- II

Question No.	Nature / Type of Question	Marks
1	Detection of *Staphylococcus aureus* / *E. coli* from given food samples **OR** Detection of fungal contaminants from given food samples	20
2	Detection of Aflatoxins in food samples (Corn / Fig / Peanuts) using UV fluorescence method **OR** Detection of Common Adulterants in Honey / Ghee / Paneer	15
3	Spotting / Viva	10
4	Journal	05
	Total Marks	**50**

F) SEC III: MICROBIAL QUALITY ASSURANCE IN PHARMACEUTICAL INDUSTRIES

Question No.	Nature / Type of Question	Marks
1	Total Aerobic Microbial Count (TAMC) of Potable water / Purified water / Water for injection / Tablet / Syrup	20
2	Microbial monitoring of air (by Settle plate method) / Surface monitoring (by Swab method) / Personnel monitoring (by Finger dab method) **OR** Sterility testing of injectable pharmaceutical products **OR** Detection of contaminants in sterile pharmaceutical products by Gram staining.	15
3	Viva/ Spotting	10
4	Journal	05
	Total Marks	**50**

SHIVAJI UNIVERSITY, KOLHAPUR

Established: 1962

A^{++} Accredited by NAAC (2021) with CGPA 3.52

NEW SYLLABUS FOR

OPEN ELECTIVE COURSE IN MICROBIOLOGY

B. A. Part III / B. Com. Part III

Semester V

Structure and Syllabus in Accordance with National Education Policy - 2020 (NEP 2.0) with Multiple Entry and Multiple Exit

(To be implemented from Academic Year 2026-27)

OE 5: INTRODUCTION TO SOIL SCIENCE AND SOIL MICROBIOLOGY

(Credit-2, Total Lectures- 60)

Course Objectives

1. To introduce students to soil as an important natural resource and its role in the environment.
2. To develop basic understanding of soil properties through simple observation and demonstration.
3. To create awareness about soil organic matter and soil microorganisms in maintaining soil fertility.
4. To help students relate soil characteristics to agriculture, plant growth, and sustainable practices.

Course Outcomes

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

1. Collect and prepare soil samples and identify different soil types based on colour and texture.
2. Demonstrate basic soil properties such as pH, moisture content, and water holding capacity.
3. Explain the importance of organic matter and microorganisms in soil health.
4. Describe the role of root nodules of leguminous plants in improving soil fertility and sustainability.

Practical Experiments

1) Collection and preparation of soil samples from different locations
2) Study of soil colour
3) Study of different soil types
4) Determination of soil texture
5) Determination of soil pH
6) Determination of soil moisture content
7) Study of water holding capacity of soil
8) Observation of presence of organic matter in soil by hydrogen peroxide
9) Observation of presence of microorganisms in soil
10) Collection of root nodules of leguminous plants and study their importance

References

1. T.D. Biswas & S.K. Mukherjee – Textbook of Soil Science – McGraw Hill, 2019.
2. D.K. Maheshwari – Soil Microbiology – I.K. International, 2021.
3. G. Rangaswami & D.J. Bagyaraj – Agricultural Microbiology – PHI Learning, 2004.
4. P.C. Jaiswal – Soil, Plant and Water Analysis – New Age International, 2010.
5. R.K. Trivedy & P.K. Goel – Chemical and Biological Analysis of Water – Environmental Publications, New Delhi, 1986.

6. S. Sadasivam & A. Manickam – Biochemical Methods – New Age International, 2008.
7. J. Jayraman – Practical Biochemistry – New Age International, 2005.
8. F.R. Troeh, J.A. Hobbs & R.L. Donahue – Soils and Soil Fertility, 6th Edition – Blackwell Publishing, 2004.
9. M.M. Rai – Principles of Soil Science – New Age International, 2008.
10. Purohit & Singh – Soil Microbiology – Agrobios India, 2010.

OE 5: मृदाविज्ञान व मृदा सूक्ष्मजीवशास्त्राची ओळख

(क्रेडिट्स: 02 **एकूण तास:** 60)

अभ्यासक्रमाची उद्दिष्टे (Course Objectives)

1. मृदा ही एक महत्त्वाची नैसर्गिक संपत्ती आहे याची विद्यार्थ्यांना ओळख करून देणे.
2. निरीक्षण व सोप्या प्रात्यक्षिकांच्या माध्यमातून मृदेचे मूलभूत गुणधर्म समजावून देणे.
3. मृदेतील सेंद्रिय पदार्थ व सूक्ष्मजीवांची मृदेची सुपीकता टिकवून ठेवण्यात असलेली भूमिका स्पष्ट करणे.
4. शेती, वनस्पती वाढ व शाश्वत पद्धतींशी मृदेचे संबंध विद्यार्थ्यांना समजावून देणे.

अभ्यासक्रमाचे परिणाम (Course Outcomes)

अभ्यासक्रम यशस्वीरीत्या पूर्ण केल्यानंतर विद्यार्थी:

1. मृदेचे नमुने गोळा करून त्यांची तयारी करू शकतील तसेच रंग व पोताच्या आधारे मृदेचे प्रकार ओळखू शकतील.
2. pH, आर्द्रता व जलधारण क्षमता यांसारख्या मृदेच्या मूलभूत गुणधर्मांचे प्रात्यक्षिक सादर करू शकतील.
3. मृदेच्या आरोग्यात सेंद्रिय पदार्थ व सूक्ष्मजीवांचे महत्त्व स्पष्ट करू शकतील.
4. मृदेची सुपीकता व शाश्वत शेतीमध्ये शेंगपिकांच्या मुळांवरील गाठींची भूमिका वर्णन करू शकतील.

प्रात्यक्षिक अभ्यासक्रम (Practical Syllabus)

1) विविध ठिकाणांहून मृदेचे नमुने गोळा करणे व त्यांची तयारी करणे
2) मृदेच्या रंगाचा अभ्यास करणे
3) मृदेचे विविध प्रकार अभ्यासणे
4) मृदेच्या पोताचे निर्धारण करणे
5) मृदेच्या pH चे निर्धारण करणे
6) मृदेतील आर्द्रतेचे प्रमाण निश्चित करणे
7) मृदेच्या जलधारण क्षमतेचा अभ्यास करणे
8) हायड्रोजन पेरॉक्साइडच्या सहाय्याने मृदेतील सेंद्रिय पदार्थांच्या उपस्थितीचे निरीक्षण करणे
9) मृदेतील सूक्ष्मजीवांच्या उपस्थितीचे निरीक्षण करणे
10) शेंगपिकांच्या मुळांवरील गाठींचे संकलन व त्यांच्या महत्त्वाचा अभ्यास करणे

Nature of the Practical Examination Question Paper and Distribution of Marks

OE 5: INTRODUCTION TO SOIL SCIENCE AND SOIL MICROBIOLOGY

Question No.	Nature/Type of Question	Marks
1	Determination of soil texture **OR** Determination of soil pH **OR** Determination of soil moisture content	20
2	Observation of presence of organic matter in soil by hydrogen peroxide **OR** Observation of presence of microorganisms in soil	15
3	Viva	10
4	Journal	05
	Total Marks	**50**

OE 5: मृदाविज्ञान व मृदा सूक्ष्मजीवशास्त्राची ओळख

प्रश्न क्र.	प्रश्नाचा प्रकार	गुण
1	मृदेच्या पोताचे निर्धारण करणे **किंवा** मृदेच्या pH चे निर्धारण करणे **किंवा** मृदेतील आर्द्रतेचे प्रमाण निश्चित करणे	20
2	हायड्रोजन पेरॉक्साइडच्या सहाय्याने मृदेतील सेंद्रिय पदार्थांच्या उपस्थितीचे निरीक्षण करणे **किंवा** मृदेतील सूक्ष्मजीवांच्या उपस्थितीचे निरीक्षण करणे	15
3	तोंडी परीक्षा	10
4	जर्नल	05
	एकूण गुण	**50**