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/347 **Date: 29/08/2026.**

To,

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

The Director /Head/Co-ordinator
All Concerned Department (Science)
Shivaji University, Kolhapur.

Subject: Regarding syllabi of B.Sc. Part I Microbiology (AEDP) degree programme

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 and equivalence of B.Sc. Part I Microbiology (AEDP) degree programme under the Faculty of Science and Technology as per NEP-2020.

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. Two 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	7	I.T.Cell /Computer Centre
2	Director, Board of Examinations and Evaluation	8	Eligibility Section
3	Chairman, Respective Board of Studies	9	Affiliation (T.1) Section
4	B.Sc.-M.Sc. Exam Section	10	P.G. Seminar Section
5	Internal Quality Assurance Cell (IQAC Cell)	11	P. G. Admission Section
6	Appointment A & B Section	12	Affiliation (T.2) Section

SHIVAJI UNIVERSITY, KOLHAPUR

Established: 1962
A^{++} Accredited by NAAC (2021) with CGPA 3.52

Structure and Syllabus

in Accordance with
National Education Policy 2020

with Multiple Entry and Multiple Exit

Bachelor of Science

(Part I / Semester – I and II)

in Microbiology

Apprenticeship Embedded Degree Programme (AEDP)

under

Faculty of Science and Technology

(To Be Implemented from Academic Year 2026-27)

SHIVAJI UNIVERSITY, KOLHAPUR

Revised Syllabus for

Bachelor of Science (B.Sc.) in Microbiology
Part I ; Semester I and II
Apprenticeship Embedded Degree Programme (AEDP)
(As per National Education Policy 2020)

Applicable from the Academic Year 2026-27

1. Preamble:

The three-year Bachelor of Science (B.Sc.) in Microbiology – Apprenticeship Embedded Degree Programme (AEDP), developed under the National Education Policy (NEP) 2020, is an innovative, industry-aligned undergraduate programme offered by the Department of Microbiology, Shivaji University, Kolhapur. Developed in accordance with the UGC Guidelines and the Government of Maharashtra Resolution dated 22 April 2025 on the implementation of the Apprenticeship Embedded Degree Programme (AEDP), the programme aims to integrate academic learning with industrial training, thereby promoting skill development, work-integrated learning, and industry readiness.

The curriculum provides a strong foundation in Microbiology through the study of microbial diversity, microbial physiology, molecular biology, immunology, industrial microbiology, environmental microbiology, bioinstrumentation, and fermentation technology. Along with theoretical knowledge, the programme emphasizes hands-on laboratory training, experiential learning, technical competency, scientific inquiry, analytical thinking, problem-solving ability, research aptitude, and professional skills. The full-semester apprenticeship in the final year enables students to gain real-world industrial exposure and develop industry-relevant technical competencies.

Designed to enhance employability, entrepreneurship, and lifelong learning, the programme prepares graduates to meet the requirements of healthcare, pharmaceutical, food, agriculture, biotechnology, environmental, and research sectors. It also promotes ethical scientific practices, multidisciplinary learning, innovation, and Outcome-Based Education (OBE) while supporting the Sustainable Development Goals (SDGs) through microbiological applications in public health, food safety, environmental sustainability, industrial innovation, and bioresource management.

Through effective academia–industry collaboration, the B.Sc. Microbiology (AEDP) programme aims to produce scientifically competent, technically skilled, ethically responsible, and career-ready microbiologists with a strong foundation for higher education, research, entrepreneurship, employment, and lifelong learning.

2. Title of the programme:

B. Sc. Microbiology (AEDP - Apprenticeship Embedded Degree Programme)

3. Faculty: Faculty of Science and Technology.

4. Year of Implementation: From July, 2026 onwards.

5. Programme Objectives:

The Bachelor of Science (B.Sc.) in Microbiology (AEDP) programme aims to:

- Develop a sound understanding of the fundamental principles, concepts, and applications of microbiology, including microbial techniques, physiology, genetics, biochemistry, ecology, immunology, and microbial biotechnology.
- Develop scientific approach, analytical thinking, and problem-solving skills to identify, study, and address microbiological challenges in healthcare, agriculture, food, environment, and industry.
- Develop hands-on laboratory skills through microbiological techniques and instrumentation while cultivating laboratory proficiency, technical competency, and good laboratory practices essential for research and industry.
- Gain practical experience through experiential learning, work-integrated learning, industrial apprenticeship, and internships, ensuring industry readiness and professional competency.
- Enhance employability by integrating academic learning with industry requirements through apprenticeship, skill development, and exposure to real-life microbiological applications.
- Acquire advanced knowledge of the concepts and applications of Microbiology in medical, pharmaceutical, industrial, agricultural, and environmental sectors, providing a strong foundation for higher studies and research.
- Apply theoretical and conceptual knowledge to practical microbiological work, including isolation, identification, cultivation, characterization, and analysis of microorganisms.
- Interpret microbiological, biochemical, and molecular phenomena through experimental evidence, fostering scientific reasoning, innovation, and research aptitude.
- Develop the ability to collect, analyze, interpret, and communicate microbiological data accurately using modern experimental approaches, statistical methods, and hypothesis-driven research.

6. Program Outcomes (POs):

Upon successful completion of the programme, graduates will be able to:

- PO1: Knowledge and Understanding - Demonstrate comprehensive knowledge and understanding of basic sciences and Microbiology, including microbial diversity, taxonomy, cell biology, physiology, genetics, biochemistry, immunology, ecology, and biotechnology.

- PO2: Scientific and Technical Skills - Apply microbiological principles, laboratory skills, biosafety practices, scientific methods, and appropriate instrumentation to analyse and solve microbiological problems.
- PO3: Critical Thinking and Problem Solving - Critically analyse scientific data, design experiments, interpret results, and develop innovative solutions for microbiological applications.
- PO4: Employability and Professional Competency - Develop industry-relevant technical competency, professional skills, and employability through apprenticeship, work-integrated learning, practical training, and industrial exposure.
- PO5: Digital and Analytical Competency - Apply computational tools, bioinformatics, digital technologies, and appropriate statistical methods for microbiological data analysis, interpretation, and scientific communication.
- PO6: Communication and Teamwork - Communicate scientific information effectively through technical reports, presentations, scientific documentation, and collaborative teamwork in multidisciplinary environments.
- PO7: Ethics, Environment and Social Responsibility - Demonstrate professional ethics, biosafety, biosecurity, environmental responsibility, and commitment to sustainable scientific practices for the benefit of society.
- PO8: Lifelong Learning and Research - Demonstrate research aptitude, scientific inquiry, self-directed learning, and professional development to pursue higher education, research, entrepreneurship, and lifelong learning.

7. Program Specific Outcomes (PSOs):

After successful completion of the programme, graduates will be able to:

- **PSO1:** Apply microbiological principles to isolate, identify, characterize, and study microorganisms using classical and modern microbiological techniques.
- **PSO2:** Demonstrate laboratory proficiency and technical competency in handling microbiological instruments and equipment, including microscopes, spectroscopic instruments, chromatographic systems, PCR, fermenters, biosafety cabinets, and other analytical instruments.
- **PSO3:** Integrate theoretical knowledge and practical skills for microbiological applications in industrial, pharmaceutical, agricultural, food, environmental, medical, and biotechnology sectors.
- **PSO4:** Analyze, interpret, and communicate microbiological data using scientific reasoning, statistical methods, and appropriate experimental approaches.
- **PSO5:** Demonstrate professional competency through apprenticeship, work-integrated learning, and industrial training in microbiology-related industries, including pharmaceuticals, biotechnology, food, healthcare, diagnostics, and environmental management.
- **PSO6:** Develop innovation and entrepreneurial skills for establishing microbiology-based enterprises involving biofertilizers, probiotics, diagnostics, fermentation based products, enzymes, and other microbial products.
- **PSO7:** Apply microbiological knowledge for sustainable development through environmental management, waste treatment, bioremediation, bioresource utilization, and public health.

8. Learning Objectives (LOs):

Each course is designed with clearly defined Learning Objectives (LOs) that describe the knowledge, concepts, practical skills, and competencies to be developed through the teaching–learning process. The Learning Objectives provide the academic direction of the course and serve as the foundation for achieving the corresponding Course Outcomes (COs). The Learning Objectives for each theory and practical course are specified at the beginning of the respective course syllabus.

9. Course Outcomes (COs):

The expected Course Outcomes (COs) for each theory and practical course are provided at the end of the respective course syllabus. The Course Outcomes define the knowledge, laboratory skills, technical competencies, analytical abilities, problem-solving skills, professional competencies, and employability skills that students are expected to demonstrate upon the successful completion of the course.

10. Duration of the degree programme:

- Bachelor of Science (B.Sc.) in Microbiology (Apprenticeship Embedded Degree Programme) is a three-year full-time undergraduate degree programme comprising six semesters, with the final semester dedicated to full-time apprenticeship training in industry establishments.
- The B.Sc. Part I Microbiology (AEDP) (Level 4.5) shall consist of two semesters (Semester I and Semester II).

11. Eligibility Criteria for Admission:

i. Candidates who have passed the Higher Secondary School Certificate (H.S.C.) Examination in the Science stream, with Biology as one of the subjects, conducted by the Maharashtra State Board of Higher Secondary Education, or its equivalent, shall be eligible for admission to B.Sc. Microbiology Part I (AEDP) (Level 4.5).

OR

ii. Candidates who have passed the Higher Secondary Examination in the Science stream, with Biology as one of the subjects, conducted by any other Statutory Board or Examining Body recognized as equivalent by Shivaji University, Kolhapur, shall also be eligible for admission.

12. Medium of Instruction: English

13. Pattern of Examination:

The examinations shall be conducted semester-wise for both theory and practical courses as per the rules and regulations of Shivaji University, Kolhapur.

14. Fee structure:

The fee structure shall be as prescribed by Shivaji University, Kolhapur, from time to time.

15. Programme Structure:

The semester-wise programme structure of the Bachelor of Science (B.Sc.) in Microbiology (Apprenticeship Embedded Degree Programme) is given in the following framework.

Semester	Particulars	Credits
B. Sc. Part I (Semester I)	Theory + Practical	22 credits
B. Sc. Part I (Semester II)	Theory + Practical	22 credits
B. Sc. Part II (Semester III)	Theory + Practical	22 credits
B. Sc. Part II (Semester IV)	Theory + Practical	22 credits
B. Sc. Part III (Semester V)	Theory + Practical	22 credits
B. Sc. Part III (Semester VI)	Full Semester Apprenticeship	22 credits
	Total:	**132 Credits**

16. Teaching and Examination Scheme:

a. The B.Sc. Part I Microbiology (AEDP) programme shall comprise 44 Credits (1100 marks).

b. The teaching-learning process shall adopt Outcome-Based Education (OBE) and include classroom teaching, laboratory practicals, hands-on training, experiential learning, ICT-enabled teaching, assignments, seminars, industrial visits, and apprenticeship-oriented learning.

c. Each theory course paper shall consist of 2-4 units and shall require 30 hours of teaching. There shall be two lectures per week for each 2-credit theory course.

d. Examination of each theory course shall be of total 50 marks (30 marks Semester-End University Examination and 20 marks Internal Assessment).

e. The Semester-End University Examination of 30 marks (1.5 hours' duration) shall be conducted at the end of each semester. The Internal Assessment of 20 marks shall be conducted during the respective semester.

f. Examination of each practical course shall be of 50 marks per semester. The practical examination shall comprise 30 marks Semester-End Practical Examination and 20 marks Internal Assessment.

g. Question papers shall be set covering the entire syllabus, ensuring appropriate coverage of each unit. Weightage shall be assigned to each unit in proportion to the teaching hours allotted.

17. Standard of Passing:

The standard of passing shall be as per the following table.

Particulars:	**Maximum Marks**	**Minimum Marks required for passing**
Semester End Exam	30	12
Internal Assessment	20	08
Course Theory Exam (Total)	50	20

a. There shall be separate passing heads for the Semester-End University Examination and Internal Assessment for both theory and practical courses.

b. A candidate shall secure a minimum of 40% marks separately in the Semester-End University Examination and Internal Assessment for both theory and practical courses to be declared as having passed the respective course.

18. Nature of Question paper and scheme of marking:

a. The format of the question paper is provided at the end of the syllabus.

b. The question paper shall be designed to assess the attainment of the prescribed Course Outcomes (COs) and shall cover the entire syllabus with appropriate weightage to all units.

c. The scheme of marking shall be followed as per the rules, regulations, and guidelines of Shivaji University, Kolhapur.

19. Credit Framework

B.Sc. Apprenticeship Embedded Degree Programme (AEDP)

Structure in accordance with National Education Policy – 2020 and UGC-AEDP

With Multiple Entry and Multiple Exit Options

SHIVAJIUNIVERSITY,KOLHAPUR NEP-2020: Credit Framework for UG (B.Sc.) Apprenticeship Embedded Degree Programme (AEDP)									
SEM (Level)	**COURSES**			**OE**	**VSC/SEC**	**AEC/VEC/IKS**	**CEP/CC/AEDP**	**Total Credits**	**Degree/Cum. Cr MEME**
	Course-1	**Course-2**	**Course-3**						
SEMI (4.5)	DSC-I(2) DSC-II(2) DSC P-I(2)	DSC-I(2) DSC-II(2) DSC P-I(2)	DSC-I(2) DSC-II(2) DSC P-I(2)	OE-1(2) (T/P)	--	IKS-I(2)	--	22	**UG Certificate 44**
SEMII (4.5)	DSC-III(2) DSC-IV(2) DSCP-II(2)	DSC-III(2) DSC-IV(2) DSC P-II(2)	DSC-III(2) DSC-IV(2) DSC P-II(2)	OE-2(2) (T/P)	--	VEC-I(2) (Democracy, Election and Constitution)	--	22	
Credits	**8(T)+4(P)=12**	**8(T)+4(P)=12**	**8(T)+4(P)=12**	**2+2=4 (T/P)**	**--**	**2+2=4**	**--**	**44**	**Exit Option:4 credits NSQF/Internship/ Skill courses**
	MAJOR		**MINOR**						
SEMIII (5.0)	Major V(2) Major VI(2) Major P III (2)	--	Minor V(2) Minor VI(2) Minor P III(2)	OE-3(2) (T/P)	VSC I (2) (P) (Major specific) SEC I(2) (T/P)	AEC I(2) (English)	CC-I (2)	22	**UG Diploma 88**
SEMIV (5.0)	Major VII(2) Major VIII (2) Major P IV (2)	--	Minor VII(2) Minor VIII (2) Minor P IV (2)	OE-4(2) (T/P)	SEC-II(2) (T/P)	AEC-II(2) (English) VEC-II(2) (Environmental studies)	CEP-I(2)	22	
Credits	**8(T)+4(P)=12**		**8(T)+4(P)=12**	**2+2=4(T/P)**	**4(T/P)+2(P)=6**	**2+4=6**	**2+2=4**	**44**	**Exit Option:4 credits NSQF/Internship/ Skill courses**
SEMV (5.5)	Major IX(2) Major X (2) Major P V (2)	Major I (ELEC)(2) Major P-I (ELEC) (2)	---	OE-5(2) (T/P)	VSC II (4) (Major specific)(P)	AEC III(4) (English) IKS II (Major specific) (2)	--	22	**UG Degree 132**
SEMVI (5.5)	--	--	--	--	SEC III(2) (T/P)	--	Apprenticeship Training (20)	22	
Credits	**4(T)+2(P)=6**	**2(T)+2(P)=4**	-	**2(T/P)**	**2(T/P)+4(P)=6**	**4+2=6**	**20**	**44**	
Total Credits	**30+16=46**		**24**	**10**	**12**	**16**	**24**	**132**	

20. Course Details

Course Component	Title	Courses	Credits	Hours per Week	Total Teaching Hours
	SEMESTER – I				
DSC-I	Discipline Specific Course I (Theory)	Subject I	2	2	30
DSC-II	Discipline Specific Course II (Theory)		2	2	30
DSC P-I	Practical based on DSC I & II		2	4	60
DSC-I	Discipline Specific Course I (Theory)	Subject II	2	2	30
DSC-II	Discipline Specific Course II (Theory)		2	2	30
DSC P-I	Practical based on DSC I & II		2	4	60
DSC-I	Discipline Specific Course I (Theory)	Subject III	2	2	30
DSC-II	Discipline Specific Course II (Theory)		2	2	30
DSC P-I	Practical based on DSC I & II		2	4	60
OE-I	Open Elective I (Theory/Practical)	---	2	2	30
IKS-I	Indian Knowledge System I (Generic)	---	2	2	30
		Total Credits:	**22**	---	---
	SEMESTER – II				
DSC-III	Discipline Specific Course III (Theory)	Subject I	2	2	30
DSC-IV	Discipline Specific Course IV (Theory)		2	2	30
DSC P-II	Practical based on DSC III & IV		2	4	60
DSC-III	Discipline Specific Course III (Theory)	Subject II	2	2	30
DSC-IV	Discipline Specific Course IV (Theory)		2	2	30
DSC P-II	Practical based on DSC III & IV		2	4	60
DSC-III	Discipline Specific Course III (Theory)	Subject III	2	2	30
DSC-IV	Discipline Specific Course IV (Theory)		2	2	30
DSC P-II	Practical based on DSC III & IV		2	4	60
OE-II	Open Elective II (Theory/Practical)	---	2	2	30
VEC-I	Democracy, Election & Constitution	--	2	2	30
		Total Credits:	**22**	---	---

21. SYLLABUS

Structure of B. Sc. Microbiology (AEDP) Part I

DISCIPLINE SPECIFIC COURSES
MICROBIOLOGY

Course component	Course Title Title of the subjects	Credits	Total Teaching Hours
SEMESTER I			
DSC-I	Discipline Specific Course I (Theory): Introduction to Microbiology and Microbial Diversity	2	30
DSC-II	Discipline Specific Course II (Theory): Techniques in Microbiology	2	30
DSC P-I	Practical based on DSC I & II	2	60
SEMESTER II			
DSC-III	Discipline Specific Course III (Theory): Fundamentals of Bacteriology	2	30
DSC-IV	Discipline Specific Course IV (Theory): Fundamentals of Microbial Biochemistry	2	30
DSC P-II	Practical based on DSC III & IV	2	60

B. Sc. Microbiology (AEDP) Part-I; Semester-I (NEP 2020)		
DSC-I : INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning outcomes:

The course is designed to enable students to:

1. Understand the historical development, scope, and interdisciplinary nature of microbiology.
2. Describe the diversity, distribution, and general characteristics of microorganisms.
3. Explain the principles of microbial taxonomy, scientific nomenclature, and modern classification systems.
4. Differentiate cellular and acellular microorganisms, and compare prokaryotic and eukaryotic microbial cells.
5. Recognize the beneficial and harmful roles of microorganisms in natural ecosystems and human activities.
6. Develop a strong conceptual foundation for advanced microbiology courses and apprenticeship-based learning.

Unit I	**History, Diversity and Development of Microbiology**	**No. of hours: 15**

A. Introduction to microbiology

a) Definition, history, scope and importance of microbiology

b) Branches of microbiology and interdisciplinary nature of microbiology

c) Distribution and diversity of microorganisms in nature

B. Historical milestones in development of microbiology:

a) Spontaneous generation versus biogenesis

b) Germ theory of disease

c) Development of pure culture techniques

d) Development of immunology and vaccination

e) Discovery of antibiotics

f) Development of electron microscopy

g) Development of Molecular biology and recombinant DNA technology.

C. Pioneers of microbiology and their contributions:

Antonie van Leeuwenhoek, Robert Hooke, Edward Jenner, Louis Pasteur, Robert Koch, Joseph Lister, Dmitri Ivanovsky, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming, Selman A. Waksman

D. Roles of microorganisms in nature and human welfare

Beneficial and harmful microorganisms and their role.

Unit II	Microbial Organization, Taxonomy and Applications	No. of hours: 15

A. Cellular organization of microbial cells
   a) Cellular and acellular microorganisms
   b) Ultrastructure of prokaryotic and eukaryotic microorganisms
   c) Comparative difference between prokaryotic and eukaryotic microorganisms
B. Diversity of the microbial world:
   Introduction, general characteristics and biological significance of:
   Bacteria, Archaea, Fungi, Algae, Protozoa, Viruses, Viroids, Prions
C. Principles of microbial taxonomy
   a) Introduction, objectives and significance of microbial taxonomy
   b) Taxonomic hierarchy / ranks
   c) Scientific nomenclature and binomial nomenclature
   d) Introduction to microbial classification: Phenotypic, Genotypic and Phylogenetic
   e) Five kingdom classification (R. H. Whittaker)
   f) Three domain classification system (Carl Woese)
   g) Introduction to Bergey's Manual of Systematic Bacteriology
D. Introduction to applied branches of microbiology:
   Agricultural Microbiology, Air Microbiology, Water Microbiology, Food Microbiology, Dairy Microbiology, Medical Microbiology, Pharmaceutical Microbiology, Industrial Microbiology, Environmental Microbiology, Geomicrobiology, Microbial biotechnology.
E. Emerging frontiers and career prospects in Microbiology

Expected Course Outcomes:

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

1. Explain the historical development, scope, and significance of microbiology as a biological science.
2. Describe the diversity, distribution, and general characteristics of major groups of microorganisms.
3. Differentiate cellular and acellular microorganisms and compare prokaryotic and eukaryotic microbial cells.
4. Explain the principles of microbial taxonomy, scientific nomenclature, and modern classification systems.
5. Correlate the beneficial and harmful activities of microorganisms in agriculture, food, health, industry, and environmental management.
6. Demonstrate a strong conceptual foundation for higher studies in microbiology and apprenticeship-based professional learning.

Suggested Reading:

1. Bergey, D. J., Brenner, D. J., Krieg, N. R., & Staley, J. T. Bergey's Manual of Systematic Bacteriology. 2nd Edition. Springer.
2. Black, J. G. Microbiology: Principles and Explorations. 10th Edition. Wiley.
3. Dubey, R. C., & Maheshwari, D. K. Textbook of Microbiology. Revised Edition. S. Chand Publishing.
4. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. Brock Biology of Microorganisms. 16th Edition. Pearson Education, 2024.
5. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. Microbiology. 5th Edition. McGraw-Hill Education.
6. Tortora, G. J., Funke, B. R., & Case, C. L. Microbiology: An Introduction. 13th Edition. Pearson Education.
7. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. Prescott's Microbiology. 12th Edition. McGraw-Hill Education, 2023.

B. Sc. Microbiology (AEDP) Part-I; Semester-I (NEP 2020)		
DSC-II : TECHNIQUES IN MICROBIOLOGY		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning outcomes:

The course is designed to enable students to:

1. Understand the organization, Good Laboratory Practices, biosafety requirements and laboratory infrastructure used in microbiology laboratories.
2. Explain the principles and applications of physical and chemical methods employed for sterilization, disinfection and microbial control.
3. Describe the principles, construction, working and applications of microscopes commonly used in microbiology.
4. Explain the principles, mechanisms and applications of microbiological staining techniques.
5. Explain the principles and techniques employed for isolation, cultivation and preservation of pure microbial cultures.
6. Develop a strong theoretical foundation for microbiological laboratory techniques required in practical training, teaching, research and industrial microbiology laboratories.

Unit I	**Microbiology Laboratory Practices, Microbial Control and Microscopy**	**No. of hours: 15**

A. Good laboratory practices (GLP) and biosafety in microbiology laboratories:

a) Organization and layout of a microbiology laboratory

b) Laboratory equipment and glassware used in microbiology

c) Introduction to microbiological culture media, laboratory reagents, stains, and their laboratory applications.

d) Good laboratory practices, laboratory safety, biosafety, PPEs (Introduction)

B. Sterilization, disinfection and control of microorganisms:

a) Introduction to sterilization, disinfection, antiseptic, germicide, microbiostasis, antisepsis, sanitization

b) Physical methods of sterilization and microbial control:

Principle, mode of action, applications and advantages of temperature (dry heat, moist heat), filtration, radiation (ultraviolet and gamma radiation), desiccation, osmotic pressure.

c) Chemical methods of microbial control:

Principle, mode of action, applications and advantages of alcohols, phenolic compounds, halogens, heavy metals, gaseous sterilizing agents

C. General principles of microscopy

a) Principles of microscopy: Magnification, Resolution and resolving power, Numerical aperture and working distance

b) Construction, working principle, applications of compound (light) microscope

c) Principles, working and applications of: Dark-field microscope, Phase-contrast microscope, Fluorescence microscope, Electron microscopy (TEM and SEM)

Unit II	**Staining, Isolation and Preservation Techniques**	**No. of hours: 15**

A. Stains and staining techniques:

a) Definition, classification and types of stains - acidic, basic and neutral

b) Principles, procedure and applications of staining techniques:

i. Simple staining,

ii. Negative staining,

iii. Differential staining: Gram staining and acid fast staining

c) Special staining techniques:

i. Capsule staining

ii. Flagella staining

iii. Cell wall staining

iv. Endospore staining

v. Metachromatic granule staining

B. Isolation of microorganisms from natural habitats:

a) Introduction, concept and significance of pure culture

b) Methods of obtaining pure cultures:

Streak plate, spread plate, pour plate, micromanipulator, serial dilution technique

c) Methods of cultivation of anaerobic microorganisms:

Cultivation by using reducing media and by exclusion of oxygen, Hungate Roll tube method.

C. Preservation of microbial cultures:

a) Periodic subculturing

b) Preservation by sterile mineral oils overlay

c) Preservation by low-temperature storage: refrigeration and deep freezing

d) Lyophilization (Freeze drying)

e) Introduction to microbial culture collection centres (ATCC, MTCC, NCIM)

Expected Course Outcomes:

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

1. Explain the organization, laboratory practices, biosafety measures and essential infrastructure of a microbiology laboratory.
2. Describe the principles, mechanisms and applications of physical and chemical methods used for sterilization, disinfection and microbial control.
3. Explain the working principles and applications of light and advanced microscopes used in microbiological investigations and laboratory diagnosis.
4. Differentiate various microbiological staining techniques and describe their principles, procedures and diagnostic applications.
5. Explain the principles and methods employed for isolation, cultivation and preservation of pure microbial cultures.
6. Apply the fundamental concepts of microbiological laboratory techniques as a foundation for practical training, advanced microbiology courses, and apprenticeship-based learning.

Suggested Reading:

1. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition. New Age International (P) Limited Publishers, New Delhi, 2003.
2. Atlas, R. M. Handbook of Microbiological Media. 4th Edition. CRC Press, 2010.
3. Atlas, R. M. Principles of Microbiology. 2nd Edition. Wm. C. Brown Publishers.
4. Cappuccino, J. G., & Welsh, C. T. Microbiology: A Laboratory Manual. 12th Edition. Pearson Education, 2020.
5. Dubey, R. C., & Maheshwari, D. K. Practical Microbiology. S. Chand Publishing, Revised Edition.
6. Harley, J. P. Laboratory Exercises in Microbiology. 10th Edition. McGraw-Hill Education, 2017.
7. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. Brock Biology of Microorganisms. 16th Edition. Pearson Education, 2024.
8. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. Microbiology. 5th Edition. McGraw-Hill Education.
9. Tortora, G. J., Funke, B. R., & Case, C. L. Microbiology: An Introduction. 13th Edition. Pearson Education, 2019.
10. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. Prescott's Microbiology. 12th Edition. McGraw-Hill Education, 2023.

B. Sc. Microbiology (AEDP) Part-I; Semester-I (NEP 2020)		
DSC-P-I : PRACTICAL BASED ON DSC-I AND DSC-II		
Credits: 02	**Total hours: 60 hours**	**Hours per week: 04**

Learning outcomes:

The course is designed to enable students to:

1. Demonstrate Good Laboratory Practices (GLP), biosafety measures, and aseptic techniques in microbiology laboratories.
2. Handle, operate, and maintain commonly used microbiological laboratory instruments safely and correctly.
3. Perform microbiological staining techniques for observation and differentiation of microorganisms.
4. Prepare, sterilize, and dispense microbiological culture media required for cultivation of microorganisms.
5. Perform isolation, cultivation, and preservation of pure microbial cultures using standard microbiological techniques.
6. Develop laboratory proficiency, technical competency, observation skills, documentation skills, and professional practices required for apprenticeship-based learning.

Unit I	**Practicals based on DSC-I**	**No. of hours: 30**

1. Demonstration of good laboratory practices (GLP), biosafety measures and aseptic techniques in the microbiology laboratory.

   Aseptic techniques, disinfection procedures, hand hygiene, laboratory safety practices, use of personal protective equipment (PPE), cleaning and sterilization of laboratory glassware, and proper disposal of laboratory waste
2. Study the principles, working and applications of commonly used microbiology laboratory equipment and instruments.

   Laminar air flow cabinet, autoclave, incubator, hot air oven, colorimeter, colony counter, pH meter and centrifuge
3. Study the parts, handling, focusing, use, care and maintenance of the compound (light) microscope.
4. Study of the morphology of fungi, algae and protozoa by observation of permanent slides.
5. Study of microbial diversity by collection of environmental samples, preparation of temporary slides and microscopic observation of microorganisms.

   Garden soil, compost, pond water, sewage water, curd, fermented foods, root nodules

Unit II	Practicals based on DSC-II	No. of hours: 30

1. Preparation of microbiology laboratory reagents and stains.
2. Bacterial staining techniques:

   Simple (Monochrome) staining, Negative staining, Gram staining, Cell wall staining (Chance's method), Capsule staining (Maneval's method), Metachromatic granule staining (Albert's method).
3. Demonstration of sterilization by moist heat (autoclave) and dry heat (hot air oven).
4. Preparation, sterilization and dispensing of nutrient broth and nutrient agar as plates, slants and agar butts for cultivation of microorganisms.
5. Preparation of commonly used liquid media for bacterial cultivation and biochemical studies. *(Peptone Water - 1% and 2%, Glucose Phosphate Broth and Koser's Citrate Broth, MacConkey's Broth)*
6. Isolation of pure bacterial cultures using streak plate, spread plate and pour plate techniques.
7. Isolation of pure cultures by four-quadrant streak plate method and study of colony morphology, Gram reaction, and bacterial motility.

   a. *Escherichia coli* b. *Staphylococcus aureus* c. *Bacillus subtilis*
8. Study of the oligodynamic action of heavy metals (copper) on bacterial growth.
9. Demonstration of the methods of preservation of microbial cultures.

Expected Course Outcomes:

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

1. Demonstrate good laboratory practices (GLP), biosafety measures, and aseptic techniques during microbiological laboratory work.
2. Operate commonly used microbiological laboratory equipment and explain their principles and applications.
3. Perform microbiological staining techniques and interpret microscopic observations.
4. Prepare, sterilize, dispense, and use microbiological culture media for cultivation of microorganisms.
5. Isolate, cultivate, preserve, and maintain pure microbial cultures using standard microbiological techniques.
6. Demonstrate laboratory proficiency, technical competency, documentation skills, and professional practices required for advanced microbiology courses and apprenticeship-based learning.

Suggested Reading:

1. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition. New Age International (P) Limited Publishers, New Delhi, 2003.
2. Cappuccino, J. G., & Welsh, C. T. Microbiology: A Laboratory Manual. 12th Edition. Pearson Education, 2020.
3. Harley, J. P. Laboratory Exercises in Microbiology. 10th Edition. McGraw-Hill Education, 2017.
4. Dubey, R. C., & Maheshwari, D. K. Practical Microbiology. Revised Edition. S. Chand Publishing.
5. Benson, H. J. Microbiological Applications: Laboratory Manual in General Microbiology. McGraw-Hill Education.
6. Atlas, R. M. Handbook of Microbiological Media. 4th Edition. CRC Press, 2010.

B. Sc. Microbiology (AEDP) Part-I; Semester-II (NEP 2020)		
DSC-III : FUNDAMENTALS OF BACTERIOLOGY		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning outcomes:

The course is designed to enable students to:

1. Understand the morphology, cellular organization, and structural components of bacterial cells.
2. Explain the nutritional requirements, nutritional diversity, and cultivation of bacteria using different culture media.
3. Describe the principles governing bacterial growth and the environmental factors influencing bacterial cultivation.
4. Explain the morphological, cultural, and biochemical characteristics used for characterization of bacteria.
5. Develop a strong conceptual foundation for advanced courses in microbial physiology, microbial ecology and environment, diagnostic microbiology, medical microbiology and industrial microbiology.

Unit I	Bacterial Cell Biology, Nutrition and Cultivation	No. of hours: 15

A. Morphology of bacteria:

Cell size, shape and arrangement of bacteria

B. Bacterial cell structure and functions:

a) Cell wall: chemical composition, functions and detailed structure of Gram-positive and Gram-negative bacterial cell walls

b) Cytoplasmic membrane: chemical composition, functions and detailed structure of cell membrane

c) Structure and functions of capsule, slime layer, flagella, pili (fimbriae)

d) Structure and functions of cytoplasmic components: cytoplasm, ribosomes, nucleoid, plasmids, reserve food materials - nitrogenous and non-nitrogenous reserves materials, endospore - structure, stages of sporulation and biological significance

C. Microbial nutrition and nutritional classification:

a) Nutritional requirements of bacteria

Water, energy sources, macronutrients (carbon, hydrogen, oxygen, nitrogen, sulphur and phosphorus), micronutrients (trace elements), growth factors

b) Concept of auxotrophs, prototrophs and fastidious bacteria

c) Nutritional classification of microorganisms based on carbon and energy sources:

Autotrophs, Heterotrophs, Phototrophs, Chemotrophs, Photoautotrophs, Chemoautotrophs, Photoheterotrophs, Chemoheterotrophs

Unit II	Microbiological culture media, Cultivation and Characterization of Bacteria	No. of hours: 15

A. Microbiological culture media and cultivation of bacteria:

a) Components of culture media

b) Types of culture media:

Natural, synthetic, chemically defined, complex, enriched, enrichment, selective, differential media

c) Cultivation of bacterial cultures:

i. Cultivation of aerobic, anaerobic and microaerophilic microorganisms using appropriate culture media.

ii. Physical conditions required for microbial growth:

Temperature, pH, oxygen, moisture, osmotic pressure

iii. Introduction to cultivation of extremophilic microorganisms:

Thermophiles, psychrophiles, acidophiles, alkaliphiles, halophiles

B. Characterization of pure cultures:

a) Morphological characteristics:

b) Cultural characteristics:

Colony morphology on solid media, growth in broth, growth on agar slants and stabs

c) Biochemical characteristics:

Sugar fermentation, enzyme production - catalase, amylase, caseinase, oxidase, and Hydrogen sulphide (H_2S) production

Expected Course Outcomes:

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

1. Describe the morphology, cellular organization, and structural components of bacterial cells, and explain their biological functions.
2. Explain the nutritional requirements and nutritional diversity of bacteria, and classify microorganisms based on carbon and energy sources.
3. Differentiate various types of culture media and explain the environmental conditions required for cultivation of bacteria.
4. Characterize bacteria based on their morphological, cultural, and biochemical characteristics.
5. Correlate the biological characteristics of bacteria with their significance in microbiology, biotechnology, medicine, agriculture, food, and environmental sciences.

Suggested Reading:

1. Atlas, R. M. Principles of Microbiology. 2nd Edition. Wm. C. Brown Publishers.

2. Dubey, R. C., & Maheshwari, D. K. Textbook of Microbiology. Revised Edition. S. Chand Publishing, 2019.
3. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. Brock Biology of Microorganisms. 16th Edition. Pearson Education, 2024.
4. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. Microbiology. 5th Edition. McGraw-Hill Education.
5. Tortora, G. J., Funke, B. R., & Case, C. L. Microbiology: An Introduction. 13th Edition. Pearson Education, 2019.
6. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. Prescott's Microbiology. 12th Edition. McGraw-Hill Education, 2023.

B. Sc. Microbiology (AEDP) Part-I; Semester-II (NEP 2020)		
DSC-IV : FUNDAMENTALS OF MICROBIAL BIOCHEMISTRY		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning outcomes:

The course is designed to enable students to:

1. Understand the chemical composition of microbial cells and the structure, properties, and biological significance of major microbial biomolecules.
2. Explain the relationship between biomolecule structure and function in microbial growth, metabolism and cellular organization.
3. Explain the catalytic role of enzymes, cofactors and vitamins in microbial metabolic processes.
4. Describe the structural and functional organization of carbohydrates, lipids and nucleic acids in microorganisms.
5. Develop a conceptual foundation for microbial physiology, molecular biology, industrial microbiology, fermentation technology and microbial biotechnology.

Unit I	**Functional Biomolecules of Microbial Cells**	**No. of hours: 15**

A. Introduction to microbial biochemistry
   a) Scope and importance of microbial biochemistry
   b) Chemical composition and molecular organization of microbial cells
   c) Major biomolecules of microbial cells and their biological functions

B. Proteins
   a) General structure, classification and properties of amino acids based on R-groups
   b) Peptide bond and levels of structural organization of proteins (primary, secondary, tertiary, quaternary)
   c) Biological functions of proteins in microbial cells

C. Enzymes
   a) Definition, properties, structure, nomenclature and classification of enzymes
   b) Apoenzyme, cofactor, coenzyme, prosthetic group and active site
   c) Mechanism of enzyme action (Lock and key and Induced fit hypotheses)
   d) Types of enzymes (Intracellular, Extracellular, Constitutive and Inducible)
   e) Factors affecting enzyme activity (temperature, pH, enzyme concentration, substrate concentration and inhibitors)
   f) Industrial importance and applications of microbial enzymes (introduction)

D. Vitamins and Coenzymes

a) Classification of vitamins

b) Vitamins as coenzyme precursors

c) Role of vitamins in microbial metabolism

Unit II	Nucleic Acids, Carbohydrates and Lipids	No. of hours: 15

A. Nucleic Acids

a) Chemical composition of nucleic acids: nitrogenous bases, nucleosides and nucleotides

b) Structure and biological functions of DNA (Watson and Crick model)

c) Types and biological functions of RNA (mRNA, tRNA and rRNA)

d) Role of nucleic acids in microbial heredity and protein synthesis

B. Carbohydrates

a) Definition and classification of carbohydrates

i. Monosaccharides (glucose, fructose, galactose, ribose and deoxyribose)

ii. Disaccharides (lactose and sucrose)

iii. Polysaccharides (starch, glycogen and cellulose)

b) Formation and biological significance of glycosidic bond

c) Biological functions of carbohydrates in microbial cells

C. Lipids

a) Classification of lipids: simple lipids, compound lipids, derived lipids

b) Saturated and unsaturated fatty acids

c) Biological functions of lipids in microbial cells

Expected Course Outcomes:

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

1. Explain the chemical composition and biomolecule organization of microbial cells.
2. Describe the structure, classification, properties and biological functions of proteins, enzymes, carbohydrates, lipids, vitamins and nucleic acids.
3. Explain enzyme structure and catalysis, and correlate the role of enzymes, cofactors, and vitamins in microbial metabolism and cellular processes.
4. Relate the structure and function of microbial biomolecules to microbial growth, physiology and industrial applications.
5. Apply the concepts of microbial biochemistry as a foundation for understanding microbial physiology, molecular biology, industrial microbiology, fermentation technology and microbial biotechnology.

Suggested Reading:

1. Berg, J. M., Tymoczko, J. L., Gatto, G. J., & Stryer, L. Biochemistry. 9th Edition. W. H. Freeman and Company, 2019.
2. Jain, J. L., Jain, S., & Jain, N. Fundamentals of Biochemistry. 8th Edition. S. Chand Publishing, 2019.
3. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. Brock Biology of Microorganisms. 16th Edition. Pearson Education, 2024.
4. Moat, A. G., Foster, J. W., & Spector, M. P. Microbial Physiology. 4th Edition. Wiley-Liss.
5. Nelson, D. L., & Cox, M. M. Lehninger Principles of Biochemistry. 8th Edition. W. H. Freeman and Company, 2021.
6. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. Microbiology. 5th Edition. McGraw-Hill Education.
7. Satyanarayana, U., & Chakrapani, U. Biochemistry. 6th Edition. Elsevier India, 2022.
8. Voet, D., Voet, J. G., & Pratt, C. W. Fundamentals of Biochemistry: Life at the Molecular Level. 6th Edition. Wiley, 2023.
9. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. Prescott's Microbiology. 12th Edition. McGraw-Hill Education, 2023.

B. Sc. Microbiology (AEDP) Part-I; Semester-II (NEP 2020)		
DSC-P-II : PRACTICAL BASED ON DSC-III AND DSC-IV		
Credits: 02	**Total hours: 60 hours**	**Hours per week: 04**

Learning outcomes:

The course is designed to enable students to:

1. Prepare, sterilize, and use different microbiological culture media for cultivation of microorganisms.
2. Cultivate bacteria under different environmental conditions and observe the effects of temperature and pH on microbial growth.
3. Isolate and characterize bacteria using staining, cultural, and biochemical techniques.
4. Isolate microorganisms from natural habitats and recognize their physiological adaptations.
5. Prepare biochemical reagents and perform qualitative analysis of major biomolecules.
6. Perform basic biochemical and enzymatic assays using standard microbiological laboratory methods.

Unit I	**Practical based on DSC-III**	**No. of hours: 30**

1. Preparation and sterilization of synthetic, complex, enriched, selective and differential culture media.

   (Czapek-Dox medium, Tryptic soy broth, Starch Agar, *Blood agar, Mannitol salt agar,* Sabouraud Dextrose Agar, MacConkey Agar, *Eosin methylene blue agar)*
2. Cultivation of aerobic, anaerobic and microaerophilic bacteria using appropriate culture media and cultivation techniques.
3. Isolation of acidophilic and alkaliphilic microorganisms from natural sources.

   (Pickle, fermented foods, acidic soil, alkaline soil samples.)
4. Study of the effect of temperature on bacterial growth.
5. Study of the effect of pH on bacterial growth.
6. Study of carbohydrate fermentation using the following sugar fermentation tests: glucose, lactose, sucrose, mannitol, and maltose.
7. Study of bacterial enzyme activities by catalase, oxidase and amylase tests.
8. Endospore staining (*Bacillus spp.*) and microscopic observation.
9. Demonstration of bacterial motility by the hanging drop method.

Unit II	**Practical based on DSC-IV**	**No. of hours: 30**

1. Preparation of commonly used biochemical reagents for qualitative analysis of biomolecules.

   (Benedict's reagent, Biuret reagent and Ninhydrin reagent.)
2. Qualitative analysis of carbohydrates by Molisch's test.
3. Qualitative analysis of reducing sugars by Benedict's test.

4. Qualitative analysis of proteins by Biuret test.
5. Qualitative analysis of free amino acids by Ninhydrin test.
6. Qualitative analysis of lipids by Sudan III staining test.
7. Estimation of glucose by the 3,5-Dinitrosalicylic Acid (DNSA) method.
8. Study of amylase enzyme activity by starch hydrolysis test.

Expected Course Outcomes:

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

1. Prepare microbiological culture media and cultivate microorganisms under appropriate laboratory conditions.
2. Apply bacteriological techniques for characterization of microorganisms using staining methods, cultural characteristics, and biochemical tests.
3. Isolate microorganisms from different natural habitats and relate their physiological adaptations to environmental conditions.
4. Prepare biochemical reagents and qualitatively analyze carbohydrates, proteins, amino acids and lipids using standard laboratory methods.
5. Perform basic enzymatic assays and biochemical estimations to understand the functional role of microbial biomolecules.
6. Demonstrate laboratory proficiency and technical competency in fundamental bacteriological and biochemical laboratory techniques required for advanced microbiology courses.

Suggested Reading:

1. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition. New Age International (P) Limited Publishers, New Delhi, 2003.
2. Atlas, R. M. Handbook of Microbiological Media. 4th Edition. CRC Press, 2010.
3. Cappuccino, J. G., & Welsh, C. T. Microbiology: A Laboratory Manual. 12th Edition. Pearson Education, 2020.
4. Dubey, R. C., & Maheshwari, D. K. Practical Microbiology. Revised Edition. S. Chand Publishing.
5. Harley, J. P. Laboratory Exercises in Microbiology. 10th Edition. McGraw-Hill Education, 2017.
6. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. Brock Biology of Microorganisms. 16th Edition. Pearson Education, 2024.
7. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. Microbiology. 5th Edition. McGraw-Hill Education.
8. Satyanarayana, U., & Chakrapani, U. Biochemistry. 6th Edition. Elsevier India, 2022.
9. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. Prescott's Microbiology. 12th Edition. McGraw-Hill Education, 2023.

OPEN ELECTIVE COURSE
MICROBIOLOGY

Course component	Course Title Title of the subjects	Credits	Total Teaching Hours
SEMESTER I			
OE-I	OE-I: Introduction to Microorganisms (सूक्ष्मजीवांची ओळख)	2	30
SEMESTER II			
OE-II	OE-II: Importance of Microorganisms in Human Life (मानवी जीवनातील सूक्ष्मजीवांचे महत्त्व)	2	30

B. Sc. Microbiology (AEDP) Part-I; Semester-I (NEP 2020)		
OE-I: INTRODUCTION TO MICROORGANISMS		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Course Focus:

"What are microorganisms and what is their significance in human life and nature?"

This course provides a basic understanding of microorganisms, their diversity, distribution, characteristics and importance in nature and human life. It is designed to develop scientific awareness, promote healthy practices and help students appreciate the role of microorganisms in maintaining environmental balance and supporting human well-being.

Learning outcomes:

The course is designed to enable students to:

1. Understand the basic concept, diversity and characteristics of microorganisms.
2. Identify the major groups of microorganisms and their natural habitats.
3. Recognize the beneficial and harmful roles of microorganisms in everyday life.
4. Explain the importance of microorganisms in human health and environmental sustainability.
5. Develop awareness of hygiene, sanitation and the significance of microorganisms in maintaining ecological balance.

Unit I	Introduction to Microorganisms	No. of hours: 15

A. Introduction to Microorganisms

a) Definition and general characteristics of microorganisms
b) Distribution of microorganisms in nature
c) Introduction to microbiology and its historical development

B. Major groups of microorganisms

a) Bacteria
b) Fungi
c) Algae
d) Protozoa
e) Viruses

C. Importance of Microorganisms

a) Beneficial microorganisms
b) Harmful microorganisms
c) Role of microorganisms in nature

Unit II	Microorganisms Around Us	No. of hours: 15

A. Microorganisms in the environment

a) Microorganisms in air, water and soil
b) Microorganisms in food and dairy products
c) Beneficial microorganisms associated with plants
d) Beneficial microorganisms associated with the human and animal body
e) Decomposition of waste, organic matter
f) Role of microorganisms in maintaining environmental balance

B. Microorganisms and human health

g) Personal hygiene
h) Cleanliness and human health
i) Importance of microorganisms in everyday life

Expected Course Outcomes:

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

1. Describe the basic characteristics and major groups of microorganisms.
2. Explain the occurrence and distribution of microorganisms in nature.
3. Differentiate between beneficial and harmful microorganisms with suitable examples.
4. Relate the role of microorganisms to human health, food, and the environment.
5. Demonstrate awareness of personal hygiene, sanitation, and the importance of microorganisms in everyday life.

Suggested Reading:

1. Dubey, R. C., & Maheshwari, D. K. Textbook of Microbiology. S. Chand Publishing.
2. Sharma, P. D. Microbiology. Rastogi Publications.
3. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. Brock Biology of Microorganisms. 16th Edition. Pearson Education, 2024.
4. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. Microbiology. 5th Edition. McGraw-Hill Education.

B. Sc. Microbiology (AEDP) Part-I; Semester-I (NEP 2020)		
OE-I: सूक्ष्मजीवांची ओळख		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

"सूक्ष्मजीव म्हणजे काय आणि ते आपल्या जीवनात व निसर्गात कोणती भूमिका बजावतात?"

या अभ्यासक्रमाद्वारे विद्यार्थ्यांना सूक्ष्मजीवांचे स्वरूप, विविधता, अधिवास, मूलभूत वैशिष्ट्ये तसेच मानवी जीवन आणि पर्यावरणातील त्यांचे महत्त्व यांची प्राथमिक माहिती मिळेल. हा अभ्यासक्रम विद्यार्थ्यांमध्ये वैज्ञानिक दृष्टीकोन, स्वच्छतेबाबत जागरूकता आणि सूक्ष्मजीवांविषयी मूलभूत समज विकसित करण्यासाठी तयार करण्यात आला आहे.

अध्ययन उद्दिष्टे (Learning Objectives - LOs)

हा अभ्यासक्रम पूर्ण केल्यानंतर विद्यार्थ्यांना:

1. सूक्ष्मजीवांची संकल्पना, विविधता व मूलभूत वैशिष्ट्ये समजावीत.
2. सूक्ष्मजीवांचे प्रमुख प्रकार आणि त्यांचे नैसर्गिक अधिवास यांची माहिती मिळावी.
3. मानवी जीवनातील उपयुक्त व हानिकारक सूक्ष्मजीवांची भूमिका समजावी.
4. मानवी आरोग्य, पर्यावरण आणि दैनंदिन जीवनातील सूक्ष्मजीवांचे महत्त्व समजावे.
5. वैयक्तिक स्वच्छता, आरोग्य आणि पर्यावरण संवर्धनाबाबत वैज्ञानिक दृष्टिकोन विकसित व्हावा.

घटक १	सूक्ष्मजीवांची ओळख	१५ तास

अ. सूक्ष्मजीवांचा परिचय

ब. सूक्ष्मजीवांचे प्रमुख प्रकार

1. जीवाणू (Bacteria)
2. बुरशी (Fungi)
3. शैवाल (Algae)
4. आदिजीव (Protozoa)
5. विषाणू (Viruses)

क. सूक्ष्मजीवांचे महत्त्व

1. निसर्गातील भूमिका
2. उपयुक्त व हानिकारक सूक्ष्मजीव

घटक २	आपल्या आजूबाजूचे सूक्ष्मजीव	१५ तास

अ. पर्यावरणातील सूक्ष्मजीव

1. हवा, पाणी आणि मातीतील सूक्ष्मजीव
2. अन्न व दुग्धजन्य पदार्थांतील सूक्ष्मजीव
3. पिकांच्या वाढीसाठी उपयुक्त सूक्ष्मजीव
4. मानव आणि प्राणी यांच्या शरीरातील उपयुक्त सूक्ष्मजीव
5. घनकचरा आणि सेंद्रिय पदार्थांचे विघटन

6. पर्यावरणाचा समतोल राखण्यात सूक्ष्मजीवांचे योगदान

ब. सूक्ष्मजीव आणि आरोग्य

7. वैयक्तिक स्वच्छता
8. स्वच्छता व मानवी आरोग्य
9. दैनंदिन जीवनातील सूक्ष्मजीवांचे महत्त्व

अपेक्षित अभ्यासक्रम निष्पत्ती (Expected Course Outcomes - COs)

हा अभ्यासक्रम यशस्वीरीत्या पूर्ण केल्यानंतर विद्यार्थी:

1. सूक्ष्मजीवांची संकल्पना, वैशिष्ट्ये आणि प्रमुख प्रकार स्पष्ट करू शकतील.
2. निसर्गातील सूक्ष्मजीवांचे वितरण व त्यांचे महत्त्व स्पष्ट करू शकतील.
3. उपयुक्त व हानिकारक सूक्ष्मजीवांमधील फरक उदाहरणांसह सांगू शकतील.
4. मानवी आरोग्य, अन्न आणि पर्यावरणामध्ये सूक्ष्मजीवांचे योगदान स्पष्ट करू शकतील.
5. वैयक्तिक स्वच्छता, आरोग्य आणि पर्यावरण संरक्षणामध्ये सूक्ष्मजीवांचे महत्त्व ओळखून दैनंदिन जीवनात त्याचा अवलंब करू शकतील.

संदर्भग्रंथ (Suggested Reading)

1. Dubey, R. C., & Maheshwari, D. K. Textbook of Microbiology. S. Chand Publishing.
2. Sharma, P. D. Microbiology. Rastogi Publications.
3. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. Brock Biology of Microorganisms. 16th Edition. Pearson Education, 2024.
4. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. Microbiology. 5th Edition. McGraw-Hill Education.

B. Sc. Microbiology (AEDP) Part-I; Semester-II (NEP 2020)		
OE-II: IMPORTANCE OF MICROORGANISMS IN HUMAN LIFE		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Course Focus:

"How do microorganisms contribute to human health, food, agriculture, industry and environmental sustainability?"

This course introduces students to the beneficial role of microorganisms in human life and their applications in health, food, agriculture, industry and environmental sustainability. It provides an understanding of how microorganisms contribute to human welfare through food production, disease prevention, sustainable agriculture, waste management and industrial fermentation. The course promotes scientific awareness, healthy living and environmental responsibility while highlighting the significance of microorganisms in everyday life.

Learning outcomes:

The course is designed to enable students to:

1. Understand the beneficial role of microorganisms in human life.
2. Explain the applications of microorganisms in food, health, agriculture and industry.
3. Recognize the contribution of microorganisms to environmental sustainability.
4. Develop awareness about microbial products and their importance in everyday life.
5. Identify career and entrepreneurship opportunities related to microbiology.

Unit I	Microorganisms in Health, Food and Agriculture	No. of hours: 15

A. Microorganisms in human health

1. Beneficial microorganisms associated with the human body
2. Probiotics and their importance
3. Introduction to antibiotics
4. Introduction to vaccines

B. Microorganisms in food

1. Microorganisms in fermented foods
2. Microorganisms in dairy products
3. Role of microorganisms in food preservation

C. Microorganisms in agriculture

1. Biofertilizers
2. Biopesticides
3. Composting
4. Role of microorganisms in organic farming

Unit II	Microorganisms in Industry and Environment	No. of hours: 15

A. Industrial applications of microorganisms

1. Food and Dairy industry
2. Pharmaceutical industry
3. Industrial production of enzymes and organic acids

B. Environmental applications of microorganisms

1. Sewage treatment
2. Biogas production
3. Biodegradation
4. Waste management
5. Environmental sustainability

C. Career and entrepreneurship opportunities

1. Microbiology in agriculture
2. Food and dairy industries
3. Pharmaceutical and biotechnology industries
4. Environmental management
5. Entrepreneurship based on microbial technologies and products

Expected Course Outcomes:

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

1. Explain the beneficial role of microorganisms in human health, food and agriculture.
2. Describe the industrial and environmental applications of microorganisms.
3. Relate microbial activities to sustainable development and environmental protection.
4. Recognize the importance of microbial products in improving the quality of human life.
5. Identify career, skill development and entrepreneurship opportunities related to microbiology.

Suggested Reading:

1. Dubey, R. C., & Maheshwari, D. K. Textbook of Microbiology. S. Chand Publishing.
2. Sharma, P. D. Microbiology. Rastogi Publications.
3. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. Brock Biology of Microorganisms. 16th Edition. Pearson Education, 2024.
4. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. Microbiology. 5th Edition. McGraw-Hill Education.

B. Sc. Microbiology (AEDP) Part-I; Semester-II (NEP 2020)		
OE-II: मानवी जीवनातील सूक्ष्मजीवांचे महत्त्व		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

"अन्न, आरोग्य, शेती, उद्योग आणि पर्यावरणातील सूक्ष्मजीवांची उपयुक्तता "

हा अभ्यासक्रम विद्यार्थ्यांना मानवी जीवनातील सूक्ष्मजीवांच्या विविध उपयुक्त उपयोगांची माहिती देतो. अन्न, आरोग्य, शेती, उद्योग आणि पर्यावरण या क्षेत्रांमध्ये सूक्ष्मजीवांचे योगदान सोप्या भाषेत समजावून सांगितले जाते. या अभ्यासक्रमामुळे विद्यार्थ्यांमध्ये वैज्ञानिक दृष्टीकोन, पर्यावरणीय जबाबदारी आणि शाश्वत विकासाबाबत जागरूकता निर्माण होते.

अध्ययन उद्दिष्टे (Learning Objectives - LOs)

हा अभ्यासक्रम पूर्ण केल्यानंतर विद्यार्थ्यांना:

1. मानवी जीवनातील उपयुक्त सूक्ष्मजीवांचे महत्त्व समजेल.
2. अन्ननिर्मिती, आरोग्य आणि शेतीमध्ये सूक्ष्मजीवांचा उपयोग समजेल.
3. पर्यावरण संरक्षणामध्ये सूक्ष्मजीवांचे योगदान समजेल.
4. उद्योग आणि जैवतंत्रज्ञानामधील सूक्ष्मजीवांच्या उपयोगाची प्राथमिक माहिती मिळेल.
5. सूक्ष्मजीवांवर आधारित रोजगार व उद्योजकतेच्या संधींची ओळख होईल.

घटक १	आरोग्य, अन्न व शेतीतील उपयुक्त सूक्ष्मजीव	१५ तास

अ. आरोग्य क्षेत्रातील सूक्ष्मजीव

1. मानवी शरीरातील उपयुक्त सूक्ष्मजीव
2. प्रोबायोटिक्स
3. प्रतिजैविके
4. लसी

ब. अन्नातील सूक्ष्मजीव

1. दही
2. ब्रेड
3. चीज
4. इडली, ढोकळा व इतर आंबवलेले अन्नपदार्थ
5. अन्न संरक्षणातील सूक्ष्मजीव

क. शेतीतील उपयुक्त सूक्ष्मजीव

1. जैवखते (Biofertilizers)
2. जैवकीटकनाशके (Biopesticides)
3. कंपोस्ट निर्मिती
4. सेंद्रिय शेती

घटक २	उद्योग व पर्यावरणास उपयुक्त सूक्ष्मजीव	१५ तास

अ. उद्योगातील सूक्ष्मजीव

1. दुग्ध आणि अन्न प्रक्रिया उद्योग
2. औषधनिर्मिती उद्योग
3. एन्झाइम्स व इतर सूक्ष्मजीवजन्य उत्पादने (परिचय)

ब. पर्यावरणातील सूक्ष्मजीव

1. सांडपाणी प्रक्रिया
2. बायोगॅस निर्मिती
3. जैवविघटन (Biodegradation) व कचरा व्यवस्थापन

क. सूक्ष्मजीव आणि भविष्यातील संधी

1. सूक्ष्मजीव तंत्रज्ञान आणि संबंधित उद्योगविश्वाचा परिचय
2. सूक्ष्मजीवशास्त्रातील रोजगाराच्या संधी आणि उद्योजकता

अपेक्षित अभ्यासक्रम निष्पत्ती (Expected Course Outcomes - COs)

हा अभ्यासक्रम यशस्वीरीत्या पूर्ण केल्यानंतर विद्यार्थी:

1. मानवी जीवनातील विविध क्षेत्रांमध्ये सूक्ष्मजीवांचे उपयुक्त योगदान स्पष्ट करू शकतील.
2. अन्न, आरोग्य आणि शेतीमध्ये सूक्ष्मजीवांचा उपयोग उदाहरणांसह सांगू शकतील.
3. उद्योग आणि पर्यावरण संरक्षणामध्ये सूक्ष्मजीवांचे महत्त्व स्पष्ट करू शकतील.
4. शाश्वत विकासामध्ये सूक्ष्मजीवांची भूमिका ओळखू शकतील.
5. सूक्ष्मजीवशास्त्राशी संबंधित रोजगार व उद्योजकतेच्या प्राथमिक संधींची माहिती सांगू शकतील.

संदर्भग्रंथ (Suggested Reading)

1. Dubey, R. C., & Maheshwari, D. K. Textbook of Microbiology. S. Chand Publishing.
2. Sharma, P. D. Microbiology. Rastogi Publications.
3. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. Brock Biology of Microorganisms. 16th Edition. Pearson Education, 2024.
4. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. Microbiology. 5th Edition. McGraw-Hill Education.

22. FORMAT OF QUESTION PAPER

[THEORY EXAMINATION]

B. Sc. Microbiology (AEDP) Part I / Semester I/II Examination

March/April / Oct./Nov. XXXX

Sub. Name: Microbiology Paper I&II / Paper III & IV

Sub. Code: XXXXXX

Day and Date: **Total Marks: 30**

Time:

****

Instructions:

1. All questions are compulsory
2. Draw neat labelled diagrams wherever necessary
3. Figures to the right indicate full marks

Q1. Rewrite the sentence by choosing correct alternative. **[10 Marks]**

i.
ii.
iii.
iv.
v.
vi.
vii.
viii.
ix.
x.

Q2. Attempt any ONE of the following. **[10 Marks]**

a.
b.

Q3. Attempt any TWO of the following. **[10 Marks]**

a.
b.
c.

****

[PRACTICAL EXAMINATION]

B. Sc. Microbiology (AEDP) Part I / Semester I / II

Practical Examination March/April / Oct./Nov. XXXX

DSC P-I: Practicals based on Microbiology Paper I & II

DSC P-II: Practicals based on Microbiology Paper III & IV

Number of days: 02 Days

Day and Date: **Total Marks: 30 Marks**

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Q1. Experiment 01 (Based on Unit I). **[15 Marks]**

Q2. Experiment 02 (Based on Unit II). **[15 Marks]**

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