SHIVAJI UNIVERSITY, KOLHAPUR - 416004,
MAHARASHTRA
PHONE:EPABX-2609000, www.unishivaji.ac.in, bos@unishivaji.ac.in
शिवाजी विद्यापीठ, कोल्हापूर -४१६००४,महाराष्ट्र
दूरध्वनी-ईपीएबीएक्स -२६०९०००, अभ्यासमंडळे विभाग दुरध्वनी ०२३१—२६०९०९४
०२३१—२६०९४८७

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

Ref.No.SU/BOS/Science/259 **Date: 13/07/2026.**

To.

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

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

Subject: Regarding minor change in syllabi of degree programme under the Faculty of Science and Technology.
Ref: No.SU/BOS/Science/147,148,149 &150 Date: 26/05/2026.

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 minor change in syllabi, nature of question paper and equivalence etc. of degree programme under the Faculty of Science and Technology as per NEP-2020.

1.	B.Sc. Part II Microbiology (AEDP)	3.	MCA Part II
2.	B.Sc. Part III Botany	4.	M.Sc. Part II Computer Science

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	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 II / Semester – III and IV)
in Microbiology
Apprenticeship Embedded Degree Programme
(AEDP)

under
Faculty of Science and Technology

(To Be Implemented from Academic Year 2026-27)

SHIVAJI UNIVERSITY, KOLHAPUR

Syllabus for the
Bachelor of Science in Microbiology
Part II ; Semester III and IV

Apprenticeship Embedded Degree Programme (AEDP)
(As per NEP 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) under NEP 2020 is an innovative, industry-aligned undergraduate programme proposed by the Department of Microbiology, Shivaji University, Kolhapur. Developed as per UGC guidelines and the Government of Maharashtra GR dated 22 April 2025 on implementation of the Apprenticeship Embedded Degree Programme (AEDP), it aims to bridge the gap between academic knowledge and industry needs in the evolving field of microbiology.

The programme combines rigorous academic instruction with structured apprenticeship, enabling students to build strong theoretical foundations along with hands-on industrial exposure. It offers comprehensive education in key microbiological domains including microbial diversity, molecular biology, industrial and medical microbiology, immunology, environmental microbiology, bioinstrumentation, and fermentation technology. Its hallmark feature is the full-semester industrial apprenticeship in the final semester, offering real-world experience in areas such as diagnostics, bioprocessing, quality assurance, and regulatory practices.

Designed to enhance employability and entrepreneurial capacity, AEDP empowers students with skill-based learning, problem-solving ability, and industry readiness. It also fosters interdisciplinary learning, innovation, and ethical scientific conduct as well as promotes flexibility, experiential learning, skill development, and multidisciplinary engagement, producing graduates capable of addressing real-world challenges in healthcare, pharmaceuticals, food safety, environment, and life sciences. Through academic–industry collaboration, the B.Sc. Microbiology (AEDP) programme seeks to develop confident, skilled, and career-ready microbiologists suited for today's rapidly evolving scientific and industrial landscape.

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

3. Faculty: Faculty of Science and Technology.

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

5. Objectives of a Bachelor of Science (B.Sc.) in Microbiology (AEDP) program include:

- Understand the fundamental principles, concepts, and laws of Microbiology, including microbial structure, physiology, genetics, biochemistry, and ecology.
- Develop analytical and problem-solving skills to identify, study, and resolve microbiological challenges in healthcare, agriculture, food, environment, and industry.
- Enhance employability by bridging education and industry needs through apprenticeship training, internships, and exposure to real-life microbiological applications.
- Gain hands-on experience with microbiological techniques and instruments, cultivating strong laboratory and biosafety skills essential for research and industry.
- Benefit from practical, work-integrated learning alongside academic studies, ensuring job readiness and a smooth transition into industrial, clinical, or research careers.
- Learn advanced concepts and applications of Microbiology in medical, pharmaceutical, industrial, agricultural, and environmental sectors for higher studies and research.
- Apply theoretical and conceptual knowledge to practical microbiological work, including isolation, identification, culture, and analysis of microorganisms.
- Interpret microbial, biochemical, and molecular phenomena through experimental evidence, fostering scientific reasoning and innovation.
- Develop the ability to collect, analyze, and interpret microbiological data accurately using modern experimental designs, statistical approaches, and hypothesis-driven research.

6. Program Outcomes:

- **PO1:** Knowledge & Understanding - Demonstrate comprehensive knowledge of basic sciences and microbiology, including microbial taxonomy, cell biology, genetics, immunology, and biotechnology.
- **PO2:** Scientific Skills - Apply laboratory skills, biosafety practices, and scientific methodology to analyze and solve microbiological problems.
- **PO3:** Problem-Solving - Critically analyze scientific data, design experiments, and provide innovative solutions for microbiological applications.
- **PO4:** Employability & Entrepreneurship - Gain industry-relevant skills through apprenticeship training, internships, and practical exposure, enhancing job readiness and entrepreneurial abilities.
- **PO5:** Digital Competence - Use computational tools, bioinformatics, and digital laboratory equipment for microbiological data analysis and interpretation.
- **PO6:** Communication Skills - Communicate effectively through scientific reports, presentations, and collaborative teamwork in multidisciplinary settings.
- **PO7:** Social & Ethical Responsibility - Demonstrate professional ethics, environmental consciousness, and commitment to biosafety, bioethics, and societal well-being.
- **PO8:** Lifelong Learning - Pursue higher education, research, and continuous learning in microbiology and allied disciplines.

7. Program Specific Outcomes:

- **PSO1:** Apply microbiological concepts to isolate, identify, and study microorganisms using classical and molecular techniques.
- **PSO2:** Demonstrate technical expertise in handling laboratory instruments (microscopy, spectroscopy, chromatography, PCR, fermenters, biosafety cabinets, etc.).
- **PSO3:** Integrate theoretical and practical knowledge of microbiology in industrial, pharmaceutical, agricultural, food, and environmental sectors.
- **PSO4:** Perform data analysis, statistical interpretation, and hypothesis testing for microbiological research and development.
- **PSO5:** Gain work-integrated experience through apprenticeships in microbiology-related industries (pharma, food, biotech, healthcare, diagnostics, and environment).
- **PSO6:** Develop entrepreneurial skills for start-ups in biofertilizers, probiotics, diagnostics, fermentation, and bioproducts.
- **PSO7:** Contribute to sustainable development by applying microbiology to environmental management, waste treatment, and bioresource utilization.

8. Course Outcomes (COs):

Expected course outcomes are provided at the end of syllabus of each course.

9. Duration of the degree programme:

- Bachelor of Science (B.Sc.) in Microbiology (Apprenticeship Embedded Degree Programme) is three-year full-time degree course, comprising six semesters with last semester full time apprenticeship in industry establishments.
- The B. Sc. Part II (Microbiology) AEDP (Level 5.0) will be of Two Semesters (Semester III and Semester IV).

10. Eligibility Criteria for Admission:

Students who have successfully completed B.Sc. Part-I Microbiology (AEDP) (Level 4.5) under NEP 2020 from Shivaji University, Kolhapur (*either by passing or under the ATKT provisions*) shall be eligible for admission to B.Sc. Part-II Microbiology (AEDP) (Level 5.0).

11. Medium of Instruction: English

12. Pattern of Examination:

The Examinations will be conducted semester-wise for Theory and Practical.

13. Fee structure: As per Shivaji University guidelines.

14. Structure of course: Given in Framework Chart

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)	Apprenticeship	22 credits
Total:	**----**	**132 Credits**

15. Teaching and Examination Scheme:

a. B. Sc. Part II Microbiology (AEDP) Course will be of 44 Credits (1100 marks).

b. Each theory course paper constitute of 2-4 units require 30 hours of teaching lectures and there shall be two lectures per theory course (2 Cr) per week.

c. Examination of each theory course shall be of 50 marks (30 marks university examination + 20 marks internal assessment).

d. University examination of 30 marks (1.5 hours' duration) will be conducted at the end of each Semester. Internal assessment of 20 marks will be done before the semester examination during each semester.

e. Examination of practical course shall be of total 50 marks per semester. Practical course examination shall be conducted as 30 marks per semester (External) and 20 marks per semester (Internal).

f. Question papers will be set in the view of the entire syllabus and preferably covering each unit of the syllabus. Weightage should be provided to each unit as per the hours allotted for teaching.

16. 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 head for Semester-end Examination and Internal Assessment for both theory as well as practical courses.

b. Minimum 40% marks are required for passing of theory as well as practical examination of each course.

17. Nature of Question paper and scheme of marking:

Format of Question paper is provided at the end of the syllabus. Marking scheme shall be followed as per Shivaji University rules and guidelines.

18. 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**	

19. Course Details

Course component	Course Title Title of the subjects	Credits	Teaching Hours
SEMESTER III			
Major V	Major Course V (Theory)	2	30
Major VI	Major Course VI (Theory)	2	30
Major P-III	Major Practical course III (Practical)	2	60
Minor V	Minor Course V (Theory)	2	30
Minor VI	Minor Course VI (Theory)	2	30
Minor P-III	Minor Practical course III (Practical)	2	60
VSC-I	Vocational Skill Course I (Major-specific)	2	60
SEC-I	Skill Enhancement Course I	2	60
OE-III	Open Elective III	2	60
AEC-I	Ability Enhancement Course (English)	2	30
CC-I	Co-curricular Course	2	30
SEMESTER IV			
Major VII	Major Course VII (Theory)	2	30
Major VIII	Major Course VIII (Theory)	2	30
Major P-IV	Major Practical course IV (Practical)	2	60
Minor VII	Minor Course VII (Theory)	2	30
Minor VIII	Minor Course VIII (Theory)	2	30
Minor P-IV	Minor Practical course IV (Practical)	2	60
SEC-II	Skill Enhancement Course II	2	60
OE-IV	Open Elective IV	2	60
AEC-II	Ability Enhancement Course II (English)	2	30
VEC-II	Value Education Course II (Environmental Studies)	2	30
CEP-I	Community Engagement Programme I	2	60

20. SYLLABUS

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

MAJOR COURSES

Course component	Course Title Title of the subjects	Credits	Teaching Hours
SEMESTER III			
Major V	Major Course V (Theory) Microbial Physiology And Metabolism	2	30
Major VI	Major Course VI (Theory) Bioinstrumentation	2	30
Major P-III	Major Practical course III Practical based on Major V & VI	2	60
SEMESTER IV			
Major VII	Major Course VII (Theory) Microbial Genetics & Molecular Biology	2	30
Major VIII	Major Course VIII (Theory) Medical Microbiology & Immunology	2	30
Major P-IV	Major Practical course IV Practical based on Major VII & VIII	2	60

B. Sc. Microbiology (AEDP) Part-II; Semester-III (NEP 2020)		
MAJOR COURSE V : MICROBIAL PHYSIOLOGY & METABOLISM		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

The course is designed to enable students to:

1. Understand the physiological characteristics of microorganisms and the factors influencing microbial growth and survival.
2. Explain microbial nutritional requirements, membrane transport systems, and mechanisms of nutrient uptake.
3. Describe microbial metabolism with emphasis on catabolic and anabolic pathways involved in energy generation and biosynthesis.
4. Understand the biochemical mechanisms of ATP production through respiration, fermentation, and photophosphorylation.
5. Relate microbial physiology and metabolism to industrial fermentation, biotechnology, environmental microbiology, and healthcare applications.

Unit I	Microbial Physiology	No. of Hours: 15

A) Microbial Growth: Growth phases, measurement of microbial growth, continuous growth, synchronous growth and diauxic growth

B) Effect of environmental factors on microbial growth:

i) Temperature: Mesophiles, Psychrophiles, Thermophiles and Hyperthermophiles
Thermal destruction of bacteria – D, F and Z values, TDP and TDT

ii) pH: Neutrophiles, Acidophiles and Alkalophiles

iii) Osmotic pressure: Isotonic, hypotonic and hypertonic environments,
Halophiles, Osmophiles, Xerophiles

iv) Heavy metals - Oligodynamic effect, antimicrobial effect of heavy metals

v) Radiations - U.V. rays, mechanism of microbial inactivation

C) Transport across cell membrane - Diffusion, active transport and group translocation

Unit II	Microbial Metabolism	No. of Hours: 15

A) Concept of microbial metabolism: Catabolism and anabolism with examples

B) Fundamental principles of energetics

i) Exergonic and endergonic reactions

ii) High energy compounds

C) Catabolism of glucose – EMP, TCA cycle

D) Biochemical Mechanisms of ATP generation:

i) Substrate level phosphorylation

ii) Oxidative phosphorylation - Respiration electron transport chain, aerobic and anaerobic respiration

E) Fermentation - Homolactic and Heterolactic fermentation, alcoholic fermentation,
Industrial significance of microbial fermentation

Expected Course Outcomes:

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

1. Explain microbial growth phases and methods used for measuring microbial growth.
2. Evaluate the effects of environmental factors such as temperature, pH, osmotic pressure, heavy metals, and radiation on microbial growth and survival.
3. Describe the mechanisms of transport across microbial cell membranes.
4. Differentiate between catabolic and anabolic pathways and explain their role in microbial metabolism.
5. Explain ATP generation through substrate-level phosphorylation, oxidative phosphorylation, and photophosphorylation.
6. Illustrate glucose catabolism through the EMP pathway and the TCA cycle, and compare different types of microbial fermentation.

References:

1. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. Brock Biology of Microorganisms. Pearson Education, 2018.
2. Willey, J., Sherwood, L., & Woolverton, C. Prescott's Microbiology (11th ed.). McGraw-Hill Education, 2021.
3. Tortora, G. J., Funke, B. R., & Case, C. L. Microbiology: An Introduction (13th ed.). Pearson Education, 2019.
4. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. Microbiology. McGraw-Hill Education, 2001.
5. Nelson, D. L., & Cox, M. M. Lehninger Principles of Biochemistry (7th ed.). W. H. Freeman & Company, 2017.
6. Satyanarayana, U. Essentials of Biochemistry. Books and Allied Pvt. Ltd., 2013.
7. Dubey, R. C., & Maheshwari, D. K. A Textbook of Microbiology. S. Chand Publishing.
8. Brock, T. D., Madigan, M. T., Martinko, J. M., & Parker, J. Biology of Microorganisms. Pearson Education.
9. Atlas, R. M. Principles of Microbiology. McGraw-Hill Education.
10. Stanier, R. Y., Adelberg, E. A., & Ingraham, J. L. General Microbiology. Macmillan.
11. Salle, A. J. Fundamental Principles of Bacteriology. McGraw-Hill Education.

B. Sc. Microbiology (AEDP) Part-II; Semester-III (NEP 2020)		
MAJOR COURSE VI : BIOINSTRUMENTATION		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

The course is designed to enable students to:

1. Understand the Understand the principles, working, and applications of major bioanalytical and bioinstrumentation techniques used in microbiology and biotechnology laboratories.
2. Acquire knowledge of separation, purification, analytical, spectroscopic, and imaging techniques used for biological samples.
3. Understand the applications of chromatographic, electrophoretic, centrifugation, filtration, spectrophotometric, and microscopic techniques in microbiological research and industries.
4. Develop the ability to select appropriate analytical techniques for qualitative and quantitative analysis of biological molecules.
5. Gain the knowledge of bioinstrumentation in research, quality control, diagnostics, pharmaceutical industries, food industries, and environmental laboratories.

Unit I	**Separation Techniques**	**No. of Hours: 15**

A) Chromatography

General principle, working and applications of:

i. Paper chromatography

ii. Thin layer chromatography

iii. HPTLC

B) Electrophoresis

General principle, working and applications of:

i. Agarose gel electrophoresis (DNA/RNA analysis)

ii. Polyacrylamide gel electrophoresis (PAGE) – native PAGE, SDS-PAGE

C) Centrifugation

i. Principles of centrifugation, Sedimentation coefficient

ii. Differential centrifugation, Density gradient centrifugation, Ultracentrifugation

D) Filtration techniques: Filtration, Microfiltration, Ultrafiltration

Unit II	**Spectroscopic and Imaging Techniques**	**No. of Hours: 15**

A) Basic analytical instruments:

Principle, Instrumentation, Working and Applications

i. Colorimeter

ii. UV–Visible spectrophotometry

B) Microscopic techniques

Principle, Instrumentation, working and applications of:

i. Transmission Electron Microscope

ii. Scanning Electron Microscope.

C) Advanced Bioanalytical Instruments

General principle and applications of:

i. High Performance Liquid Chromatography (HPLC)

ii. Gas Chromatography (GC)

iii. Atomic Absorption Spectrophotometer (AAS)

D) Introduction to Good Laboratory Practices (GLP) – Instruments and Equipments

Expected Course Outcomes:

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

1. Explain the principles and applications of chromatographic, electrophoretic, centrifugation, filtration, and preservation techniques.
2. Describe the working principles and applications of colorimetry, UV–Visible spectrophotometry, and microscopic techniques.
3. Select appropriate analytical techniques for the separation, purification, and characterization of biological molecules.
4. Interpret the applications of bioinstrumentation in microbiology, biotechnology, pharmaceutical, food, clinical, and environmental laboratories.
5. Demonstrate an understanding of laboratory instrumentation, quality assurance, and safe handling practices in modern analytical laboratories.

References:

1. Wilson, K., & Walker, J. *Principles and Techniques of Biochemistry and Molecular Biology (8th ed.)*. Cambridge University Press, 2018.
2. Upadhyay, A., Upadhyay, K., & Nath, N. *Biophysical Chemistry: Principles and Techniques*. Himalaya Publishing House, 2018.
3. Chatwal, G. R., & Anand, S. K. *Instrumental Methods of Chemical Analysis.* Himalaya Publishing House, 2022.
4. Plummer, D. T. *An Introduction to Practical Biochemistry (5th ed.).* Tata McGraw-Hill, 2001.
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6. Freifelder, D. *Physical Biochemistry: Applications to Biochemistry and Molecular Biology.* W. H. Freeman & Company.
7. Willey, J., Sherwood, L., & Woolverton, C. *Prescott's Microbiology (11th ed.).* McGraw-Hill Education, 2021.
8. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. *Brock Biology of Microorganisms.* Pearson Education, 2018.
9. Tortora, G. J., Funke, B. R., & Case, C. L. *Microbiology: An Introduction (13th ed.).* Pearson Education, 2019.
10. Dubey, R. C., & Maheshwari, D. K. *A Textbook of Microbiology*. S. Chand Publishing.

B. Sc. Microbiology (AEDP) Part-II; Semester-III (NEP 2020)		
MAJOR P-III: PRACTICALS BASED ON MAJOR V AND VI		
Credits: 02	**Lectures: 60 hours**	**Hours per week: 04**

Learning Objectives:

The course is designed to enable students to:

1. Understand the principles, working, and applications of major bioanalytical and bioinstrumentation techniques used in microbiology and biotechnology laboratories.
2. Acquire knowledge of separation, purification, analytical, spectroscopic, and imaging techniques used for biological samples.
3. Understand the applications of chromatographic, electrophoretic, centrifugation, filtration, spectrophotometric, and microscopic techniques in microbiological research and industries.
4. Develop the ability to select appropriate analytical techniques for qualitative and quantitative analysis of biological molecules.
5. Gain the knowledge of bioinstrumentation in research, quality control, diagnostics, pharmaceutical industries, food industries, and environmental laboratories.

Unit I	**Microbial Physiology & Metabolism**	**No. of Hours: 30**

1. Study of bacterial growth curve by turbidimetric (optical density) method.
2. Study of diauxic growth curve of bacteria by optical density.
3. Effect of environmental factors on growth of microorganisms:
   i. Temperature
   ii) pH
   iii) Heavy metals - Copper
   iv) Salt - NaCl
4. Demonstration of membrane transport by plasmolysis in yeast cells (Saccharomyces cerevisiae).
5. Demonstration of alcoholic fermentation by yeast and estimation of CO_2 production.

Unit II	**Bioinstrumentation**	**No. of Hours: 30**

1. Separation of amino acids from mixture by paper chromatography.
2. Separation of amino acids from mixture by thin layer chromatography.
3. Demonstration of Agarose Gel Electrophoresis for DNA separation.
4. Estimation of protein concentration using Colorimeter / UV-Visible Spectrophotometer.
5. Industrial visit / study tour to a Research Laboratory / Common Facility Centre (CFC) for demonstration of advanced bioinstrumentations used in Research & Industrial Laboratories.

Expected Course Outcomes:

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

1. Explain the principles and applications of chromatographic, electrophoretic, centrifugation, filtration techniques.
2. Describe the working principles and applications of colorimetry, UV–Visible spectrophotometry, and microscopic techniques.
3. Select appropriate analytical techniques for the separation, purification, and characterization of biological molecules.
4. Interpret the applications of bioinstrumentation in microbiology, biotechnology, pharmaceutical, food, clinical, and environmental laboratories.
5. Demonstrate an understanding of laboratory instrumentation, quality assurance, and safe handling practices in modern analytical laboratories.

References:

1. Aneja, K. R. *Experiments in Microbiology, Plant Pathology and Biotechnology (4th ed.).* New Age International Publishers, 2003.
2. Cappuccino, J. G., & Welsh, C. T. *Microbiology: A Laboratory Manual (12th ed.).* Pearson Education, 2020.
3. Chatwal, G. R., & Anand, S. K. *Instrumental Methods of Chemical Analysis.* Himalaya Publishing House, 2022.
4. Dubey, R. C., & Maheshwari, D. K. *A Textbook of Microbiology.* S. Chand Publishing.
5. Harley, J. P. *Laboratory Exercises in Microbiology (10th ed.).* McGraw-Hill Education, 2017.
6. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. *Brock Biology of Microorganisms.* Pearson Education, 2018.
7. Moat, A. G., Foster, J. W., & Spector, M. P. *Microbial Physiology (4th ed.).* Wiley-Liss, 2002.
8. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. *Microbiology.* McGraw-Hill Education, 2001.
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10. Sawhney, S. K., & Singh, R. *Introductory Practical Biochemistry.* Narosa Publishing House, 2015.
11. Sharma, B. K. *Instrumental Methods of Chemical Analysis.* Goel Publishing House, 2014.
12. Skoog, D. A., Holler, F. J., & Crouch, S. R. *Principles of Instrumental Analysis (7th ed.).* Cengage Learning, 2018.
13. Tortora, G. J., Funke, B. R., & Case, C. L. *Microbiology: An Introduction (13th ed.).* Pearson Education, 2019.
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B. Sc. Microbiology (AEDP) Part-II; Semester-IV (NEP 2020)		
MAJOR COURSE VII : MICROBIAL GENETICS & MOLECULAR BIOLOGY		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

The course is designed to enable students to:

1. Understand the fundamental principles of microbial genetics and molecular biology.
2. Explain the structure, organization and function of genetic material in microorganisms.
3. Understand the molecular basis of mutation, DNA repair and bacterial gene transfer mechanisms.
4. Describe the regulation of gene expression using the lac operon as a model system.
5. Develop a foundation for advanced studies in genetic engineering, recombinant DNA technology and microbial biotechnology.

Unit I	Microbial Genetics	No. of Hours: 15

A) Basic concepts of microbial genetics:

i) DNA - Structure and forms of DNA (A, B and Z DNA)

ii) RNA - Structure, Types (mRNA, tRNA, and rRNA), and functions

iii) Gene, genome, genotype, phenotype, mutagen, recon, muton, cistron, Split genes

iv) Genetic code - Definition and properties of genetic code

B) Mutation:

i) Basic Concepts of Mutation:

Base pair substitutions, Frame shift, Missense, Nonsense, Neutral, Silent, Pleiotropic and Suppressor mutations

ii) Spontaneous mutation - Definition, basic concept and significance

iii) Induced mutations - Definition, Mechanism of mutagenesis by

a) Base analogues: 5-Bromouracil and 2- amino purines

b) Mutagens modifying nitrogen bases- Nitrous acid, Hydroxylamine, Alkylating agents

c) Mutagens that distort DNA - Acridine dyes, UV light

D) Use of mutagenesis in industrial strain improvement.

Unit II	Molecular Biology	No. of Hours: 15

A) Gene transfer in bacteria:

i) Fate of exogenote in recipient cell

ii) Modes of gene transfer:

a) Transformation: Definition, Natural and Artificial transformation

b) Conjugation: Definition, F^+ x F^- conjugation, Hfr conjugation, F′ x F^- conjugation

c) Transduction: Definition, Generalized and specialized Transduction

B) DNA repair mechanisms:

i) Photoreactivation

ii) Dark repair mechanism (Excision repair)

C) Regulation of gene expression:

Lac operon - Discovery, Components of lac operon, Structure and working - Structural genes, Regulator gene, Promoter, Operator, Inducer, Mechanism of induction

D) Recombinant DNA technology - Introduction and applications

Expected Course Outcomes:

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

1. Explain the structure, forms and functions of DNA and RNA, and describe fundamental genetic terminology including gene, genome, genotype, phenotype and operon.
2. Classify mutations based on their origin, molecular changes and phenotypic effects, and explain the mechanisms of spontaneous and induced mutagenesis.
3. Describe the mechanisms of horizontal gene transfer in bacteria, including transformation, conjugation and transduction.
4. Explain the importance of DNA repair systems in maintaining genome stability.
5. Illustrate the organization and regulation of the lac operon as a classical model of gene regulation.
6. Relate microbial genetics to modern applications in molecular biology, industrial microbiology, medical microbiology and microbial biotechnology.

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1. Brown, T. A. *Genetics: A Molecular Approach.* Garland Science, 2012.
2. Dubey, R. C. *A Textbook of Biotechnology.* S. Chand Publishing, 2022.
3. Freifelder, D. *Microbial Genetics.* Narosa Publishing House, 2004.
4. Glick, B. R., & Pasternak, J. J. *Molecular Biotechnology: Principles and Applications of Recombinant DNA.* ASM Press.
5. Jogdand, S. N. *Gene Biotechnology.* Himalaya Publishing House, 2016.
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B. Sc. Microbiology (AEDP) Part-II; Semester-IV (NEP 2020)		
MAJOR COURSE VIII : MEDICAL MICROBIOLOGY & IMMUNOLOGY		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

The course is designed to enable students to:

1. Understand the basic concepts and principles of Medical Microbiology and Immunology.
2. Explain the relationship between microorganisms and human diseases, including the mechanisms of pathogenicity and host defense.
3. Describe the epidemiology, transmission, prevention, and control of infectious diseases.
4. Understand the structure and functions of the immune system, including innate and acquired immunity.
5. Explain the principles of antigen-antibody interactions and their applications in disease diagnosis.

Unit I	Medical Microbiology	No. of Hours: 15

A) Definitions:

Host, Parasite, Saprophytes, Commensal, Infection, Etiological agent, Disease, Pathogen, Opportunistic pathogen, True pathogen, Virulence, Pathogenicity, Fomite, Incubation period, Carrier, Morbidity rate, Mortality rate, Epidemiology, Etiology, Prophylaxis, Antigen, Antibody, Hapten, Vaccine, Immunity.

B) Virulence factors:

Endotoxins, Exotoxins, Extracellular enzymes, Mechanisms of evading phagocytosis

C) Types of diseases:

i) Epidemic, ii) Endemic, iii) Pandemic, iv) Sporadic

D) Types of infections:

Chronic, Acute, Primary, Secondary, Reinfection, Iatrogenic, Congenital, Local, Generalized, Covert, Overt, Simple, Mixed, Endogenous, Exogenous, Latent, Pyogenic, Nosocomial.

E) Modes of transmission of diseases:

Air-borne transmission, Water-borne transmission, Food-borne transmission, Contact transmission, Vector-borne transmission

F) General principles of prevention and control of microbial diseases

Personal hygiene, Sanitation, Disinfection, Sterilization, Isolation and quarantine, Vaccination, Health education

G) Normal flora of human body & its significance

Unit II	Immunology	No. of Hours: 15

A) Immunity: Definition, Types

ii) Innate Immunity: Characteristics, types, factors influencing innate immunity

iii) Acquired Immunity: Active & passive immunity

B) Non-Specific defense mechanisms of the vertebrate body:

i) First line of defense – skin, mucous membrane, secretions

ii) Second line of defense – Phagocytosis, inflammation, Fever, Complement system.

B) Non-Specific defense mechanisms of the vertebrate body:

i) First line of defense – skin, mucous membrane, secretions

ii) Second line of defense – Phagocytosis, inflammation, Fever, Complement system

C) Antigen: Chemical nature, types of antigens, factors affecting antigenicity

D) Antibody: Types of antibodies - Structure, properties and functions

E) Theories of antibody production - Clonal selection theory

F) Immune Response: Primary and secondary immune responses

G) Types of antigen-antibody reaction

i) Precipitation: Slide test and tube test

ii) Agglutination: Slide, Tube and Passive agglutination

Expected Course Outcomes:

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

1. Define the fundamental terms and concepts related to Medical Microbiology and Immunology.
2. Differentiate various types of infectious diseases and infections, and explain their modes of transmission.
3. Describe microbial virulence factors and their role in disease pathogenesis.
4. Explain the principles of prevention and control of infectious diseases and the significance of normal human microbiota.
5. Describe the components of innate and acquired immunity and the non-specific defense mechanisms of the human body.
6. Explain the structure, properties, types, and functions of antigens and antibodies.
7. Illustrate primary and secondary immune responses and explain the principles of antigen-antibody reactions used in diagnostic microbiology.

References:

1. Ananthanarayan, R., Paniker, C. K. J., Kanungo, R., et al. Ananthanarayan and Paniker's Textbook of Microbiology. 12th Edition. Universities Press, 2021.
2. Atlas, R. M. Handbook of Microbiological Media. 4th Edition. CRC Press, 2010.
3. Brooks, G. F., Carroll, K. C., Butel, J. S., Morse, S. A., & Mietzner, T. A. Jawetz, Melnick & Adelberg's Medical Microbiology. 29th Edition. McGraw-Hill Education, 2023.
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9. Willey, J., Sherwood, L., & Woolverton, C. Prescott's Microbiology. 11th Edition. McGraw-Hill Education, 2021.

B. Sc. Microbiology (AEDP) Part-II; Semester-IV (NEP 2020)		
MAJOR–P-IV: PRACTICALS BASED ON MAJOR VII AND VIII		
Credits: 02	**Lectures: 60 hours**	**Hours per week: 04**

Learning Objectives:

The course is designed to enable students to:

1. Develop practical skills in microbial genetics, molecular biology, medical microbiology, and immunology techniques.
2. Understand the principles and applications of DNA extraction, mutagenesis, bacterial gene transfer, and agarose gel electrophoresis.
3. Acquire laboratory skills for isolation, cultivation, identification, and characterization of clinically important microorganisms.
4. Perform basic immunological and diagnostic microbiology techniques used in clinical and research laboratories.
5. Develop competency in safe laboratory practices, aseptic techniques, documentation, and interpretation of experimental results relevant to diagnostic, research, pharmaceutical, and healthcare laboratories.

Unit I	**Microbial genetics & Molecular biology**	**No. of Hours: 30**

1. Study of the effect of exposure time of UV radiation on bacterial survival.
2. Demonstration of mutagenic effect of chemical mutagens.
3. Extraction and purification of DNA / plasmid from bacterial culture.
4. Demonstration of agarose gel electrophoresis for DNA separation.
5. Demonstration of bacterial transformation / conjugation

Unit II	**Medical microbiology & Immunology**	**No. of Hours: 30**

1. Isolation and study of normal microflora of the human body by swab test.
2. Demonstration of hand hygiene effectiveness by comparing microbial flora before and after hand washing.
3. Study of composition and use of differential medium for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
4. Isolation and identification of pathogenic microorganisms from clinical sample on the basis of cultural, morphological and biochemical characteristics. (Laboratory strains like E. coli, Salmonella, Pseudomonas, Staphylococcus, Shigella, Vibrio)
5. Blood grouping (ABO and Rh typing) by slide agglutination method.
6. Serological test - Widal test (qualitative).
7. Study of the antibacterial activity of disinfectants and antiseptics by agar well/disc diffusion method.
8. Determination of minimal inhibitory concentration (MIC) of an antibiotic.
9. Visit to a Clinical diagnostic laboratory / Hospital laboratory / Blood bank to study routine diagnostic microbiology and immunological techniques.

Expected Course Outcomes:

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

1. Perform basic molecular biology techniques including DNA/plasmid isolation, agarose gel electrophoresis, and demonstration of bacterial gene transfer methods.
2. Evaluate the effects of physical and chemical mutagens on microorganisms and explain their applications in microbial genetics and strain improvement.
3. Isolate, identify, and characterize clinically important microorganisms using cultural, morphological, and biochemical methods.
4. Perform basic immunological and diagnostic procedures including blood grouping, Widal test, antimicrobial susceptibility testing, and determination of minimum inhibitory concentration (MIC).
5. Demonstrate good laboratory practices, biosafety measures, aseptic techniques, and proper documentation while carrying out microbiological and molecular biology experiments.
6. Interpret experimental observations and relate molecular biology, medical microbiology, and immunological techniques to their applications in clinical diagnostics, pharmaceutical industries, biotechnology, and research laboratories.

References:

1. Cappuccino, J. G., & Welsh, C. T. Microbiology: A Laboratory Manual. 12th Edition. Pearson Education, 2020.
2. Harley, J. P. Laboratory Exercises in Microbiology. 10th Edition. McGraw-Hill Education, 2016.
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4. Brown, T. A. Genetics: A Molecular Approach. 1st Edition. Garland Science, 2012.
5. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. Molecular Biology of the Gene. 7th Edition. Pearson Education, 2017.
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9. Tortora, G. J., Funke, B. R., & Case, C. L. Microbiology: An Introduction. 13th Edition. Pearson Education, 2019.
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12. Forbes, B. A., Sahm, D. F., & Weissfeld, A. S. Bailey & Scott's Diagnostic Microbiology. 14th Edition. Elsevier, 2017.

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

MINOR COURSES

Course component	Course Title Title of the subjects	Credits	Teaching Hours
SEMESTER III			
MINOR V	Minor Course V (Theory) Applied Microbiology and Bioentrepreneurship	2	30
MINOR VI	Minor Course VI (Theory) Fundamentals of Medical Microbiology	2	30
MINOR P-III	Minor Practical course III Practical based on Major V & VI	2	60
SEMESTER IV			
MINOR VII	Minor Course VII (Theory) Environmental Microbiology And Microbial Ecology	2	30
MINOR VIII	Minor Course VIII (Theory) Food Microbiology and Fermentation Technology	2	30
MINOR P-IV	Minor Practical course IV Practical based on Minor VII & VIII	2	60

B. Sc. Microbiology (AEDP) Part-II; Semester-III (NEP 2020)		
MINOR COURSE V : APPLIED MICROBIOLOGY AND BIOENTREPRENEURSHIP		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

The course is designed to enable students to:

1. Understand the principles and applications of air and water microbiology in environmental quality monitoring.
2. Explain the significance of microorganisms in public health, disease prevention, and diagnostic microbiology.
3. Develop an understanding of the role of microorganisms in pharmaceutical production and microbiological quality assurance.
4. Recognize the industrial, agricultural, and environmental applications of microorganisms and microbial technologies.
5. Appreciate the scope of bioentrepreneurship, innovation, and intellectual property rights in microbiology-based industries.

Unit I	Air and Water Microbiology	No. of Hours: 15

A) Introduction to Applied Microbiology:

a) Definition, scope and importance of Applied Microbiology
b) Major fields of Applied Microbiology
c) Role of microorganisms in human welfare, agriculture, environmental sustainability and industry.

B) Air Microbiology:

a) Sources of microorganisms in air, Air microflora and airborne microorganisms
b) Infectious dust, droplets and droplet nuclei
c) Sampling methods for microbiological examination of air
Settle plate method, Solid impaction (Sieve sampler), Liquid impingement (Bead bubbler sampler)
d) Microbiological standards of air quality (Introduction)

C) Water Microbiology:

a) Sources of microorganisms in water
b) Faecal pollution of water, Indicator microorganisms (Escherichia coli, coliform bacteria)
c) Routine bacteriological examination of water:
Standard Plate Count (SPC), Coliform detection tests
d) Qualitative detection of coliform bacteria:
Presumptive test, Confirmed test, Completed test, IMViC test, Eijkman test
e) Quantitative estimation of coliform bacteria:
Most Probable Number (MPN) method, Membrane filtration technique
f) Municipal drinking water treatment and microbiological quality standards.

Unit II	Microbial Applications in Human Health and Industry	No. of Hours: 15

A) Public Health and Diagnostic Microbiology:

a) Introduction, Definition, scope, concept and importance of public health microbiology
b) Chain of infection and modes of disease transmission,
c) Waterborne, foodborne and airborne diseases
d) Clinical specimens: Collection, transport and preservation
e) Laboratory diagnosis of infectious diseases
a) Hygiene, sanitation and infection control
b) Vaccination and immunization (introduction)

B) Pharmaceutical Microbiology:

a) Scope and importance of Pharmaceutical Microbiology
b) Types of pharmaceutical products: sterile and non-sterile formulations
c) Sources and effect of microbial contamination in pharmaceutical products
d) Microbiological quality control of pharmaceutical products (Overview)

C) Microbial Technologies and Bioentrepreneurship:

a) Industrially important microorganisms and microbial products
b) Biofertilizers, biopesticides
c) Microorganisms in bioremediation and waste treatment
d) Bioentrepreneurship and microbiology-based start-up opportunities
e) Introduction to Intellectual Property Rights (IPR)

Expected Course Outcomes:

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

1. Describe the sources, transmission, and methods used for the microbiological examination of air and water.
2. Explain the principles of public health microbiology, disease transmission, and basic laboratory diagnosis of infectious diseases.
3. Describe the significance of pharmaceutical microbiology, microbial contamination, and microbiological quality control of pharmaceutical products.
4. Explain the applications of microorganisms in industrial production, agriculture, environmental management, and waste treatment.
5. Identify opportunities for microbiology-based entrepreneurship and recognize the importance of innovation and Intellectual Property Rights (IPR) in the commercialization of microbial technologies.
6. Correlate the role of applied microbiology in promoting human health, environmental sustainability, industrial development, and socio-economic well-being.

References:

1. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. Prescott's Microbiology. 11th Edition. McGraw-Hill Education, 2021.
2. Tortora, G. J., Funke, B. R., & Case, C. L. Microbiology: An Introduction. 13th Edition. Pearson Education, 2019.
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11. Kumar, V. Bioentrepreneurship. 2nd Edition. Scientific Publishers (India), 2021.
12. Ganguli, P. Intellectual Property Rights: Unleashing the Knowledge Economy. Tata McGraw-Hill Education, Latest Edition.

B. Sc. Microbiology (AEDP) Part-II; Semester-III (NEP 2020)		
MINOR COURSE VI : FUNDAMENTALS OF MEDICAL MICROBIOLOGY		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

The course is designed to enable students to:

1. Understand the basic concepts, scope and significance of Medical Microbiology in relation to human health and disease.
2. Explain the role of normal human microbiota, pathogenic microorganisms and virulence factors in disease development.
3. Describe the basic principles of epidemiology, modes of transmission and classification of infectious diseases.
4. Understand the etiology, transmission, clinical features, prevention and control of selected bacterial and viral diseases.
5. Develop awareness of personal hygiene, vaccination, sanitation and other preventive measures for controlling infectious diseases and promoting public health.

Unit I	Introduction to Medical Microbiology	No. of Hours: 15

A) Definition and scope of medical microbiology

B) Normal flora of human body and its significance

C) Basic terminologies:

Host, Parasite, Saprophytes, Commensal, Infection, Etiological agent, Disease, Pathogen, Opportunistic pathogen, True pathogen, Virulence, Pathogenicity, Fomite, Incubation period, Carriers, Morbidity rate, Mortality rate, Epidemiology, Etiology, Prophylaxis, Antigen, Antibody, Hapten, Vaccine, Immunity

D) Virulence factors:

Endotoxins, exotoxins, enzymes, and mechanisms of evading phagocytosis

E) Types of infections:

Chronic, acute, primary, secondary, reinfection, iatrogenic, congenital, local, generalized, covert, overt, simple, mixed, endogenous, exogenous, latent, pyogenic, nosocomial

Unit II	Epidemiology, Transmission and Control of Microbial Diseases	No. of Hours: 15

A) Types of diseases: Epidemic, Endemic, Pandemic, Sporadic

B) Modes of transmission of diseases:

Air, water & food, contact transmission, vector-borne transmission

C) Common Bacterial and Viral Diseases:

Causative agent, transmission, symptoms, diagnosis, prevention & treatment of:

i) Enteric fever

ii) Staphylococcal wound infections

iii) Dengue fever

iv) COVID-19

D) General principles of prevention and control of microbial diseases:

Expected Course Outcomes:

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

1. Explain the basic concepts and terminology used in Medical Microbiology and infectious diseases.
2. Describe the importance of normal human microbiota, microbial virulence factors and host–pathogen interactions in disease causation.
3. Classify infectious diseases based on their occurrence, transmission and epidemiological characteristics.
4. Explain the modes of transmission, clinical manifestations, prevention and control of selected bacterial and viral diseases.
5. Describe the general principles of prevention and control of communicable diseases through hygiene, sanitation, vaccination and public health measures.
6. Recognize the significance of Medical Microbiology in healthcare, disease diagnosis, infection control and community health.

References:

1. Ananthanarayan, R., Paniker, C. K. J., Kanungo, R., et al. Ananthanarayan and Paniker's Textbook of Microbiology. 12th Edition. Universities Press, 2021.
2. Chakraborty, P. Textbook of Microbiology. 2nd Edition. New Central Book Agency, 2022.
3. Brooks, G. F., Carroll, K. C., Butel, J. S., Morse, S. A., Mietzner, T. A. Jawetz, Melnick & Adelberg's Medical Microbiology. 29th Edition. McGraw-Hill Education, 2023.
4. Tortora, G. J., Funke, B. R., & Case, C. L. Microbiology: An Introduction. 13th Edition. Pearson Education, 2019.
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6. Dubey, R. C., & Maheshwari, D. K. Textbook of Microbiology. Revised Edition. S. Chand Publishing, 2019.
7. Atlas, R. M. Principles of Microbiology. 2nd Edition. Wm. C. Brown Publishers, 1997.
8. Atlas, R. M. Encyclopedia of Microbiology. 4th Edition. Academic Press, Elsevier, 2019.
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B. Sc. Microbiology (AEDP) Part-II; Semester-III (NEP 2020)		
MINOR-P-III: PRACTICALS BASED ON MINOR COURSE V AND VI		
Credits: 02	**Lectures: 60 hours**	**Hours per week: 02**

Learning Objectives:

The course is designed to enable students to:

1. Develop practical skills in the microbiological examination of air, water, pharmaceutical products, and clinical specimens using standard laboratory techniques.
2. Understand the principles and applications of microbiological methods used for environmental monitoring and assessment of potable water quality.
3. Acquire fundamental laboratory skills in medical microbiology, including isolation of normal microbiota, identification of selective and differential culture media, and basic immunological tests.
4. Understand the significance of hygiene, sanitation, and microbiological quality control in public health and pharmaceutical applications.
5. Develop competency in laboratory practices, biosafety, data recording, interpretation of results, and scientific reporting.

Unit I	**Applied Microbiology**	**No. of Hours: 30**

1. Microbiological examination of air by settle plate technique.
2. Assessment of microbiological quality of drinking water by Standard Plate Count (SPC).
3. Estimation of coliform bacteria by Most Probable Number (MPN) method.
4. Differentiation of coliform bacteria in drinking water based on IMViC test.
5. Evaluation of effect of chlorination on microbial quality of drinking water.
6. Demonstration of membrane filtration technique for water analysis.
7. Microbial enumeration of pharmaceutical products (tablet/syrup) for Total Aerobic Microbial Count (TAMC) and Total Yeast and Molds Count (TYMC)

Unit II	**Fundamentals of Medical Microbiology**	**No. of Hours: 30**

1. Isolation and observation of normal microflora of human skin by the swab sampling technique.
2. Demonstration of the effectiveness of hand washing using the finger dab/contact plate method.
3. Preparation of selective and differential culture media used in Medical Microbiology (Nutrient Agar, Blood Agar, MacConkey Agar, EMB Agar and Mannitol Salt Agar).
4. Demonstration of blood grouping (ABO and Rh typing) by slide agglutination method.
5. Demonstration of the Widal test (qualitative) by slide agglutination method.

Expected Course Outcomes:

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

1. Perform microbiological examination of air and water using standard microbiological techniques and interpret the results.

2. Assess the microbiological quality of drinking water using Standard Plate Count (SPC), Most Probable Number (MPN), IMViC tests, and membrane filtration techniques.
3. Evaluate the effect of chlorination on potable water quality and determine microbial contamination in pharmaceutical products using standard microbial enumeration methods.
4. Demonstrate basic laboratory techniques used in medical microbiology, including isolation of normal human microbiota, identification of selective and differential culture media, and simple serological tests.
5. Apply good laboratory practices (GLP), aseptic techniques, biosafety measures, and scientific documentation during microbiological investigations.
6. Correlate laboratory findings with applications of microbiology in environmental monitoring, public health, disease diagnosis, and pharmaceutical quality assurance.

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6. Casida, L. E. Industrial Microbiology. Reprint Edition. New Age International Publishers, 2006.
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B. Sc. Microbiology (AEDP) Part-II; Semester-IV (NEP 2020)		
MINOR COURSE VII : ENVIRONMENTAL MICROBIOLOGY AND MICROBIAL ECOLOGY		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

The course is designed to enable students to:

1. Understand the fundamental concepts, scope and significance of Environmental Microbiology and Microbial Ecology.
2. Explain the diversity of microorganisms in natural ecosystems and their ecological interactions with plants, animals and other microorganisms.
3. Describe the role of microorganisms in biogeochemical cycling and maintenance of ecosystem functions.
4. Understand the applications of microorganisms in sustainable agriculture, wastewater treatment and environmental management.
5. Develop awareness of the importance of microorganisms in environmental conservation, pollution control and sustainable development.

Unit I	Microbial Ecology and Biogeochemical Cycling	No. of Hours: 15

A) Introduction to Environmental Microbiology and Soil Microbiology

a) Scope and significance of environmental microbiology
b) Definition, composition and properties of soil
c) Diversity of soil microorganisms
d) Role of microorganisms in soil fertility and ecosystem functioning

B) Microbial Ecology and Interactions

a) Concept of microbial ecology and interactions:
   i. Positive interactions: Mutualism, Synergism (Protocooperation), Commensalism
   ii. Negative interactions: Competition, Amensalism, Parasitism and Predation
   iii. Neutral interaction (Neutralism)
b) Microbe - Plant interactions (Symbiotic and non-symbiotic associations)
c) Microbe - Animal interactions:

C) Microorganisms in biogeochemical cycle:

a) Carbon cycle: Microbial degradation of cellulose, hemicellulose, lignin and chitin
b) Nitrogen cycle: Biological nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction
c) Phosphorus cycle: Phosphate solubilization

Unit II	Environmental Applications of Microorganisms	No. of Hours: 15

A) Agricultural Microbiology and Biofertilizers

a) Definition, classification and advantages of biofertilizers

b) Isolation, mass production and field application of:

Nitrogen fixing bacteria - Rhizobium, Azotobacter, Acetobacter, Phosphate Solubilizing bacteria, Potash mobilizing bacteria, VAM

c) Role of biofertilizers in sustainable agriculture

B. Microorganisms in waste treatment:

a) Characteristics and composition of water: Municipal and Industrial waste water.

Composition and characteristics of sewage: Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Solids.

b) Wastewater treatment: Primary treatment, Secondary treatment: Oxidation ponds, trickling filter, activated sludge process, Settling tank, Tertiary treatment.

C. Environmental sustainability and microbial bioremediation:

a) Definition, principles and types of bioremediation

b) Microorganisms used in bioremediation (bacteria, fungi, algae)

c) Factors affecting microbial bioremediation

Expected Course Outcomes:

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

1. Explain the basic concepts of Environmental Microbiology, Soil Microbiology and Microbial Ecology.
2. Describe the ecological interactions among microorganisms and between microorganisms, plants and animals.
3. Explain the role of microorganisms in the carbon, nitrogen and phosphorus cycles and their significance in maintaining ecosystem balance.
4. Describe the production, application and importance of biofertilizers in sustainable agriculture.
5. Explain the principles and major stages involved in wastewater treatment using microorganisms.
6. Describe the principles, applications and significance of microbial bioremediation in environmental pollution management.
7. Recognize the role of microorganisms in environmental sustainability, agricultural productivity and ecosystem health.

References:

1. Atlas, R. M., & Bartha, R. Microbial Ecology: Fundamentals and Applications. 4th Edition. Benjamin/Cummings Publishing Company, 1998.
2. Atlas, R. M. Principles of Microbiology. 2nd Edition. Wm. C. Brown Publishers, 1997.
3. Atlas, R. M. Encyclopedia of Microbiology. 4th Edition. Academic Press, Elsevier, 2019.

4. Maier, R. M., Pepper, I. L., & Gerba, C. P. Environmental Microbiology. 3rd Edition. Academic Press, 2015.
5. Pepper, I. L., Gerba, C. P., & Gentry, T. J. Environmental Microbiology. 4th Edition. Academic Press, 2022.
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7. Willey, J., Sherwood, L., & Woolverton, C. Prescott's Microbiology. 11th Edition. McGraw-Hill Education, 2021.
8. Tortora, G. J., Funke, B. R., & Case, C. L. Microbiology: An Introduction. 13th Edition. Pearson Education, 2019.
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11. Alexander, M. Introduction to Soil Microbiology. 2nd Edition. John Wiley & Sons, 1977.
12. Metcalf & Eddy Inc. Wastewater Engineering: Treatment and Resource Recovery. 5th Edition. McGraw-Hill Education, 2014.

B. Sc. Microbiology (AEDP) Part-II; Semester-IV (NEP 2020)		
MINOR COURSE VIII : FOOD MICROBIOLOGY AND FERMENTATION TECHNOLOGY		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

The course is designed to enable students to:

1. Understand the fundamental concepts, scope and significance of Food Microbiology and Fermentation Technology.
2. Explain the role of microorganisms in food production, food spoilage, food preservation and food safety.
3. Describe the principles of food preservation and prevention of foodborne diseases.
4. Understand the basic principles of fermentation processes, fermenter design and industrial production of fermented products.
5. Develop an understanding of the applications of fermentation technology in food, feed, pharmaceutical and biotechnology industries.

Unit I	Fundamentals of Food Microbiology	No. of Hours: 15

A) Introduction to Food Microbiology

a) Scope and importance of food microbiology
b) Microorganisms associated with foods: Beneficial and harmful microorganisms in foods
c) Fermented foods: Bread, Curd/Yogurt, Cheese, Vinegar, Pickles, Soy-based fermented foods, traditional indian fermented foods
d) Sources of microbial contamination, Food spoilage

B) Food preservation:

a) Principles of food preservation
b) Physical methods: Heat, Cold, Drying, Irradiation,
c) Chemical methods: Salt (NaCl), Sugar, Organic acids, Food preservatives - Benzoates (Sodium benzoate), Sorbates (Potassium sorbate)
d) Biological preservation: Concept and principles of biopreservation
e) Hurdle technology

C) Foodborne diseases:

a) Food infection vs Food intoxication
b) Common foodborne pathogens
c) Food hygiene and sanitation

Unit II	Fermentation Technology and Industrial Applications	No. of Hours: 15

A) Fundamentals of Fermentation:

a) Definition and history of fermentation:
b) Scope and importance of fermentation technology
c) Primary and secondary metabolites
d) Industrially important microorganisms: Bacteria, Yeasts, Fungi

B. Fermentation Process:

a) Basic design of fermenter: design, parts and their functions

b) Types of fermentation: Batch fermentation, Fed-batch fermentation, Continuous fermentation

c) Fermentation media (composition): Water, Carbon sources, Nitrogen sources, Growth factors, Precursors, Antifoam agents, Chelating agents, antifoaming agent

d) Factors affecting fermentation: Temperature, pH, Aeration, Agitation, DO, Inoculum size

e) Screening of industrially important microorganisms: Primary and secondary screening

f) Downstream processing.

C. Industrial production:

a) Applications of fermentation technology in food, pharmaceutical and biotechnology industries

b) Production of alcohol, organic acids, Baker's yeast, probiotics, single cell protein (SCP)

Expected Course Outcomes:

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

1. Explain the role of beneficial and harmful microorganisms associated with foods and fermented food products.
2. Describe the principles and methods of food preservation and their significance in improving food quality and shelf life.
3. Differentiate food infections and food intoxications, and explain the importance of food hygiene and sanitation in preventing foodborne diseases.
4. Describe the principles of fermentation technology, types of fermentation and the basic components of industrial fermenters.
5. Explain the composition of fermentation media, factors influencing fermentation and methods used for screening industrially important microorganisms.
6. Describe the production of important fermentation products such as alcohol, organic acids, baker's yeast, probiotics and single-cell protein.
7. Recognize the applications of fermentation technology in the food, pharmaceutical and biotechnology industries and its role in sustainable industrial production.

References:

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

1. Frazier, W. C., & Westhoff, D. C. Food Microbiology. 4th Edition. Tata McGraw-Hill Publishing Company, 2008.
2. Jay, J. M., Loessner, M. J., & Golden, D. A. Modern Food Microbiology. 7th Edition. Springer, 2005.
3. Adams, M. R., & Moss, M. O. Food Microbiology. 3rd Edition. Royal Society of Chemistry, 2008.
4. Doyle, M. P., Diez-Gonzalez, F., & Hill, C. Food Microbiology: Fundamentals and Frontiers. 5th Edition. ASM Press, 2019.
5. Stanbury, P. F., Whitaker, A., & Hall, S. J. Principles of Fermentation Technology. 3rd Edition. Butterworth-Heinemann, Elsevier, 2017.

6. Casida, L. E. Industrial Microbiology. Reprint Edition. New Age International Publishers, 2006.
7. Crueger, W., & Crueger, A. Biotechnology: A Textbook of Industrial Microbiology. 2nd Edition. Panima Publishing Corporation, 2000.
8. Patel, A. H. Industrial Microbiology. 2nd Edition. Macmillan India Ltd., 2016.
9. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. Microbiology. 5th Edition. McGraw-Hill Education, 2001.
10. Willey, J., Sherwood, L., & Woolverton, C. Prescott's Microbiology. 11th Edition. McGraw-Hill Education, 2021.
11. Tortora, G. J., Funke, B. R., & Case, C. L. Microbiology: An Introduction. 13th Edition. Pearson Education, 2019.
12. Dubey, R. C., & Maheshwari, D. K. Textbook of Microbiology. Revised Edition. S. Chand Publishing, 2019.

B. Sc. Microbiology (AEDP) Part-II; Semester-IV (NEP 2020)		
MINOR-P-IV: PRACTICALS BASED ON MINOR COURSE VII AND VIII		
Credits: 02	**Lectures: 60 hours**	**Hours per week: 04**

Learning Objectives:

The course is designed to enable students to:

1. Develop practical skills in the isolation and observation of environmentally important microorganisms.
2. Understand the role of microorganisms in soil, agriculture, environmental sustainability and waste management.
3. Perform simple microbiological techniques used for the examination of food and fermented products.
4. Study the beneficial and harmful roles of microorganisms in food production, preservation and spoilage.
5. Develop competency in basic fermentation techniques and microbiological quality assessment of food samples.
6. Acquire laboratory skills relevant to environmental, food and agricultural microbiology.

Unit I	Environmental Microbiology and Microbial Ecology	No. of Hours: 30

1. Isolation and enumeration of soil microorganisms by serial dilution and spread plate technique.
2. Microscopic examination of microorganisms present in rhizospheric soil.
3. Microscopic examination of root nodules of leguminous plants and demonstration of Rhizobium.
4. Study of commonly used biofertilizers and biopesticides.
5. Screening and isolation of phosphate solubilizing bacteria from soil.
6. Determination of BOD and COD of sewage sample.

Unit II	Food Microbiology and Fermentation Technology	No. of Hours: 30

1. Microscopic examination of baker's yeast (Saccharomyces cerevisiae).
2. Microscopic examination of microorganisms present in fermented foods (curd, idli batter, dosa batter and pickles).
3. Determination of microbiological quality of food samples by Standard Plate Count (SPC).
4. Preparation of curd using starter culture and observation of fermentation.
5. Demonstration of alcoholic fermentation by yeast using sugar solution.
6. Screening and isolation of amylase / protease producing microorganisms from soil sample.
7. Screening and isolation of organic acid producing bacteria from soil.
8. Industrial visit to a dairy, bakery, food processing unit or fermentation industry to study quality control practices and/or fermentation processes.

Expected Course Outcomes:

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

1. Isolate and observe microorganisms from environmental and food samples using basic microbiological techniques.
2. Explain the role of microorganisms in soil fertility, agriculture and environmental sustainability.
3. Perform simple microbiological quality assessment of food and water samples.
4. Demonstrate the preparation and observation of fermented food products.
5. Recognize common microbial spoilage of food and explain methods of food preservation.

References:

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

1. Frazier, W. C., & Westhoff, D. C. Food Microbiology. 4th Edition. Tata McGraw-Hill Publishing Company, 2008.
2. Jay, J. M., Loessner, M. J., & Golden, D. A. Modern Food Microbiology. 7th Edition. Springer, 2005.
3. Adams, M. R., & Moss, M. O. Food Microbiology. 3rd Edition. Royal Society of Chemistry, 2008.
4. Doyle, M. P., Diez-Gonzalez, F., & Hill, C. Food Microbiology: Fundamentals and Frontiers. 5th Edition. ASM Press, 2019.
5. Stanbury, P. F., Whitaker, A., & Hall, S. J. Principles of Fermentation Technology. 3rd Edition. Butterworth-Heinemann, Elsevier, 2017.
6. Casida, L. E. Industrial Microbiology. Reprint Edition. New Age International Publishers, 2006.
7. Crueger, W., & Crueger, A. Biotechnology: A Textbook of Industrial Microbiology. 2nd Edition. Panima Publishing Corporation, 2000.
8. Patel, A. H. Industrial Microbiology. 2nd Edition. Macmillan India Ltd., 2016.
9. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. Microbiology. 5th Edition. McGraw-Hill Education, 2001.
10. Willey, J., Sherwood, L., & Woolverton, C. Prescott's Microbiology. 11th Edition. McGraw-Hill Education, 2021.
11. Tortora, G. J., Funke, B. R., & Case, C. L. Microbiology: An Introduction. 13th Edition. Pearson Education, 2019.
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Structure of B. Sc. Microbiology (AEDP) Part II
VOCATIONAL SKILL COURSE

Course component	Course Title Title of the subjects	Credits	Teaching Hours
SEMESTER III			
VSC-I	Vocational Skill Course I (Major-specific) Quality control of Food and Dairy Products	2	60

B. Sc. Microbiology (AEDP) Part-II; Semester-III (NEP 2020)		
VSC I: QUALITY CONTROL OF FOOD AND DAIRY PRODUCTS		
Credits: 02	**Lectures: 60 hours**	**Hours per week: 04**

Learning Objectives:

The course is designed to enable students to:

1. Understand the principles and practices of quality control in food and dairy industries.
2. Develop practical skills in sampling, physical, chemical and microbiological analysis of food and dairy products.
3. Identify common sources of contamination, adulteration and spoilage in food and dairy products.
4. Understand food safety management systems and quality assurance practices followed in food industries.
5. Develop employable skills required for quality control, quality assurance and food safety laboratories in the dairy and food processing sectors.

Unit I	Quality Control of Food Products	No. of Hours: 30

1. Evaluation of sources of microbial contamination into food products and their potential effects.
2. Food sampling and storage:

   Sampling techniques, collection, transportation and storage of food samples
3. Physical quality analysis of food products

   Organoleptic (Sensory) evaluation of food products - Appearance, Colour, Flavour, Taste, Texture, Consistency
4. Chemical quality analysis of food products: Determination of pH, Determination of titratable acidity
5. Detection of common food adulterants:

   Artificial colours, Starch, Chalk powder, Metanil yellow, Argemone seeds, Brick powder, Added preservatives (Benzoates and Sulphites)
6. Microbiological quality analysis of food products
   i. Standard plate count (SPC) / Total viable count (TVC)
   ii. Yeast and Mold Count
   iii. Total coliform count
   iv. Detection of food pathogens - Escherichia coli, Salmonella spp., Staphylococcus aureus, Pseudomonas aeruginosa, Listeria monocytogens

Unit II	Quality Control of Dairy Products	No. of Hours: 30

1. Evaluation of sources of microbial contamination into milk and milk products and their control measures.
2. Organoleptic examination of milk: Colour, Flavour, Taste, Appearance
3. Chemical analysis of milk:

   Platform test : Clot-on-boiling (COB) Test, Alcohol precipitation test, Titratable acidity test
4. Detection of adulteration in milk: Cane sugar, Starch, Soap, Formalin, Urea, Ammonium sulphate
5. Microbiological analysis of milk:
   i. Methylene Blue Reduction Test (MBRT)
   ii. Standard Plate Count (SPC)
   iii. Direct Microscopic Count (DMC)
   iv. Yeast and Mold Count
   v. Test for coliform
6. Enzymatic test: Phosphatase test.
7. Identification of food safety hazards and critical control points in dairy processing unit and preparation of a HACCP Plan.

Expected Course Outcomes:

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

1. Evaluate and analyse the sources of microbial contamination into food and dairy products.
2. Perform sampling, handling and quality evaluation of food and dairy products using standard laboratory procedures.
3. Conduct physical, chemical and microbiological quality control tests for food and milk samples.
4. Detect common adulterants in food and milk using standard analytical methods.
5. Evaluate the microbiological quality and safety of food and dairy products using indicator microorganisms and routine quality control tests.
6. Identify food safety hazards and develop a basic Hazard Analysis and Critical Control Point (HACCP) plan for food and dairy processing.
7. Apply quality assurance principles and food safety practices relevant to food processing and dairy industries.

References:

1. Cappuccino, J. G., & Welsh, C. T. Microbiology: A Laboratory Manual. 12th Edition. Pearson Education, 2020.
2. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition. New Age International Publishers, 2003.
3. Harrigan, W. F. Laboratory Methods in Food Microbiology. 3rd Edition. Academic Press, 1998.

4. Downes, F. P., & Ito, K. (Eds.). Compendium of Methods for the Microbiological Examination of Foods. 4th Edition. American Public Health Association (APHA), 2001.
5. Wehr, H. M., & Frank, J. F. (Eds.). Standard Methods for the Examination of Dairy Products. 17th Edition. American Public Health Association (APHA), 2004.
6. Banwart, G. J. Basic Food Microbiology. 2nd Edition. CBS Publishers & Distributors, 2004.
7. Robinson, R. K. (Ed.). Dairy Microbiology Handbook: The Microbiology of Milk and Milk Products. 3rd Edition. John Wiley & Sons, 2002.
8. Jay, J. M., Loessner, M. J., & Golden, D. A. Modern Food Microbiology. 7th Edition. Springer, 2005.
9. Frazier, W. C., & Westhoff, D. C. Food Microbiology. 4th Edition. McGraw-Hill Education, 1988.
10. Roday, S. Food Hygiene and Sanitation. 2nd Edition. McGraw-Hill Education (India), 2007.
11. Food Safety and Standards Authority of India (FSSAI). Manual of Methods of Analysis of Foods (Microbiological Testing). 2015 Edition.
12. Bureau of Indian Standards (BIS). Indian Standards for Food and Dairy Quality Testing. Relevant IS Standards.

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

VOCATIONAL SKILL COURSE

Course component	Course Title Title of the subjects	Credits	Teaching Hours
SEMESTER III			
SEC-I	Skill Enhancement Course-I : Fundamental Practices In Microbiology Laboratory-I	2	60
SEMESTER IV			
SEC-II	Skill Enhancement Course-II : Fundamental Practices In Microbiology Laboratory-II	2	60

B. Sc. Microbiology (AEDP) Part-II; Semester-III (NEP 2020)

SKILL ENHANCEMENT COURSE-I (SEC-I):

FUNDAMENTAL PRACTICES IN MICROBIOLOGY LABORATORY-I

Credits: 02	**Lectures: 60 hours**	**Hours per week: 04**

SEC-I: Learn good laboratory practices and laboratory operations.

This course develops the fundamental laboratory competencies, professional practices, documentation skills and laboratory discipline essential for apprenticeship training in microbiology, biotechnology, pharmaceutical, food, dairy, environmental and research laboratories.

Learning Objectives:

The course is designed to enable students to:

1. Develop competency in Good Laboratory Practices (GLP), laboratory safety and biosafety.
2. Acquire skills in preparation, handling, sterilization and maintenance of microbiological media, reagents, glassware and laboratory equipment.
3. Understand laboratory operations, equipment calibration, quality documentation and Standard Operating Procedures (SOPs).
4. Perform routine laboratory operations following Good Documentation Practices (GDP).
5. Develop professional laboratory ethics, discipline and competency required for apprenticeship training and industrial laboratory practices.

Practicals

1. Laboratory safety, biosafety, Personal protective equipment (PPE) and Good laboratory practices (GLP).
2. Operation and maintenance of microbiology laboratory equipment and glassware.
3. Preparation of laboratory solutions (1 N HCl, 1 N NaOH and 0.85% saline), phosphate buffer (pH 7.0) and microbiological stains (Crystal Violet, Basic Fuchsin and Lactophenol Cotton Blue).
4. Cleaning, wrapping, cotton plugging of laboratory glassware.
5. Preparation of microbiological culture media (Nutrient Agar, Nutrient Broth, Potato Dextrose Agar and Sabouraud Dextrose Agar).
6. Sterilization of laboratory media and glassware using autoclave and hot air oven with assessment of sterility.
7. Calibration and operation of micropipette and pH meter.
8. Basic aseptic laboratory techniques: preparation of agar slants, agar butts and broth cultures and aseptic transfer of microbial cultures.
9. Preparation of Standard Operating Procedures (SOPs) and laboratory documentation (laboratory notebook, equipment logbook and reagent register) and laboratory audit checklist preparation.

10. Biomedical waste segregation, hazardous waste labelling, laboratory chemical safety and waste disposal practices.

Expected Course Outcomes:

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

1. Demonstrate safe laboratory practices by following biosafety guidelines, GLP and laboratory safety procedures.
2. Prepare laboratory solutions, buffers, stains and microbiological culture media using standard laboratory procedures.
3. Perform sterilization, aseptic handling and basic laboratory operations independently.
4. Operate and calibrate commonly used microbiology laboratory equipment.
5. Prepare and maintain laboratory records, SOPs, calibration records and equipment logbooks following Good Documentation Practices.
6. Demonstrate professional laboratory competency suitable for apprenticeship training in microbiology laboratories.

References:

1. Cappuccino, J. G., & Welsh, C. T. Microbiology: A Laboratory Manual. 12th Edition. Pearson Education, 2020.
2. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition. New Age International Publishers, 2003.
3. Harley, J. P. Laboratory Exercises in Microbiology. 10th Edition. McGraw-Hill Education, 2016.
4. Dubey, R. C., & Maheshwari, D. K. Practical Microbiology. 1st Edition. S. Chand Publishing, 2014.
5. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. Microbiology. 5th Edition. McGraw-Hill Education, 2001.
6. Cappuccino, J. G. Laboratory Safety: Principles and Practices for the Microbiology Laboratory. 2nd Edition. Pearson Education.
7. World Health Organization (WHO). Laboratory Biosafety Manual. 4th Edition. WHO, 2020.
8. World Health Organization (WHO). Good Practices for Pharmaceutical Microbiology Laboratories. WHO Technical Report Series (TRS).
9. Tim Sandle (Ed.). Pharmaceutical Microbiology: Essentials for Quality Assurance and Quality Control. 1st Edition. Woodhead Publishing (Elsevier), 2016.

B. Sc. Microbiology (AEDP) Part-II; Semester-IV (NEP 2020)

SKILL ENHANCEMENT COURSE - II (SEC-II):

FUNDAMENTAL PRACTICES IN MICROBIOLOGY LABORATORY-II

Credits: 02	**Lectures: 60 hours**	**Hours per week: 04**

SEC-II: Learn fundamental microbiological techniques.

This course develops competency in routine microbiological laboratory techniques required for microbial isolation, cultivation, staining, preservation, enumeration and basic microbiological quality analysis, providing the foundation for advanced industrial and applied microbiology courses.

Learning Objectives:

The course is designed to enable students to:

1. Develop practical competency in fundamental microbiological techniques.
2. Acquire skills in microbial isolation, cultivation, staining, preservation and enumeration.
3. Apply microbiological methods for routine examination of food, water and environmental samples.
4. Develop laboratory documentation and reporting skills used in microbiology laboratories.
5. Prepare students for advanced industrial microbiology and apprenticeship training.

Practicals

1. Isolation of microorganisms by streak plate technique and study of colony morphology.
2. Preparation, preservation and maintenance of microbial cultures by subculturing.
3. Differential staining of bacteria by Gram staining, Acid-fast staining and Endospore staining.
4. Mounting and microscopic examination of fungi using Lactophenol Cotton Blue.
5. Enumeration of microorganisms from product contact surfaces by swab sampling.
6. Enumeration of microorganisms by membrane filtration technique.
7. Determination of potability of water by Most Probable Number (MPN) method.
8. Environmental monitoring (air, contact surfaces, personnel) by settle plate technique and by swab technique.
9. Microbiological quality assessment of food samples by Standard Plate Count (SPC).
10. Preparation and maintenance of laboratory records, quality control reports and analytical test reports.

Expected Course Outcomes:

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

1. Isolate, cultivate, preserve and maintain microbial cultures using standard microbiological techniques.
2. Perform routine staining, microscopic examination and enumeration of microorganisms.
3. Apply microbiological techniques for the examination of food, water and environmental samples.

4. Prepare laboratory records, analytical reports and quality control documentation.
5. Demonstrate competency in routine microbiological laboratory procedures required for apprenticeship training and advanced microbiology courses.

References:

1. Cappuccino, J. G., & Welsh, C. T. Microbiology: A Laboratory Manual. 12th Edition. Pearson Education, 2020.
2. Harley, J. P. Laboratory Exercises in Microbiology. 10th Edition. McGraw-Hill Education, 2016.
3. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition. New Age International Publishers, 2003.
4. Dubey, R. C., & Maheshwari, D. K. Practical Microbiology. 1st Edition. S. Chand Publishing, 2014.
5. Dubey, R. C., & Maheshwari, D. K. Textbook of Microbiology. 4th Edition. S. Chand Publishing, 2010.
6. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. Microbiology. 5th Edition. Tata McGraw-Hill Education, 2001.
7. Willey, J., Sherwood, L., & Woolverton, C. Prescott's Microbiology. 11th Edition. McGraw-Hill Education, 2021.
8. Tortora, G. J., Funke, B. R., & Case, C. L. Microbiology: An Introduction. 13th Edition. Pearson Education, 2019.
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12. FSSAI. Manual of Methods of Analysis of Foods – Microbiological Testing. Food Safety and Standards Authority of India, New Delhi, 2016.
13. World Health Organization (WHO). Laboratory Biosafety Manual. 4th Edition. WHO, Geneva, 2020.

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

Community Engagement Programme

Course component	Course Title Title of the subjects	Credits	Teaching Hours
	SEMESTER III		
CEP-I	Community Engagement Programme - I Microbiology for Human Welfare and Sustainable Development	2	60

B. Sc. Microbiology (AEDP) Part-II; Semester-IV (NEP 2020)		
CEP-I: Microbiology for Human Welfare and Sustainable Development		
Credits: 02	**Lectures: 60 hours**	**Hours per week: 04**

CEP-I:

Field-based experiential learning for community welfare and sustainable development.

The Community Engagement Programme (CEP) is a mandatory field-based experiential learning course that promotes active student participation in society through microbiology-related community engagement activities. The course enables students to apply microbiological knowledge and skills to address issues related to public health, food safety, agriculture and environmental sustainability while fostering scientific temper, social responsibility and sustainable development.

Learning Objectives:

The course is designed to enable students to:

1. Apply fundamental concepts of microbiology to address community issues related to public health, food safety, agriculture and environmental sustainability.
2. Participate in field-based experiential learning through community surveys, awareness programmes, site visits and outreach activities.
3. Develop communication, teamwork, leadership and problem-solving skills through interaction with rural and urban communities.
4. Promote scientific awareness, health, hygiene, sanitation and environmentally sustainable practices among community members using microbiological knowledge.
5. Strengthen social responsibility, ethical values and professional competency by contributing to community welfare through microbiology-based interventions.

ACTIVITIES

*** Students are advised to participate in any one of the following activities and submit a comprehensive report:**

Community Awareness and Outreach Activities:

1. Organize **Microbiology Awareness Week** in schools, villages or community centres. (Prepare and distribute posters, pamphlets, brochures, videos or digital educational materials related to microbiology).
2. Organize awareness programmes related to personal hygiene, hand hygiene, sanitation and prevention of communicable diseases.
3. Conduct awareness campaigns related to food safety, safe drinking water, vaccination and antimicrobial resistance.
4. Organize awareness programmes related to use of biofertilizers, biopesticides, composting and sustainable agriculture.
5. Demonstrate simple microbiology-based activities related to beneficial microorganisms, fermented foods and environmental sanitation.

6. Participate in cleanliness drives, waste management programmes and environmental conservation activities related to microbiology.
7. Undertake any other community engagement activity related to microbiology, human welfare and sustainable development.

Field Visits and Community Surveys:

8. Field visit to dairy, food, fermentation, pharmaceutical, biotechnology, biofertilizer and/or biopesticides industries related to microbiology.
9. Field visit to hospitals, clinical diagnostic laboratories, blood banks or public health laboratories related to medical microbiology.
10. Field visit to agricultural farms, composting units, organic farming units or microbial-based enterprises related to agricultural and environmental microbiology.
11. Field visit to drinking water treatment plants, sewage treatment plants (STP), effluent treatment plants (ETP) or solid waste management facilities related to environmental microbiology.
12. Conduct community surveys related to hygiene, sanitation, drinking water quality, food safety, infectious diseases, antimicrobial resistance or environmental health.

Expected Course Outcomes:

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

1. Recognize beneficial microorganisms associated with soil, plants and fermented foods.
2. Describe the role of microorganisms in improving soil fertility, crop productivity and environmental sustainability.
3. Identify common plant diseases caused by microorganisms through field and laboratory observations.
4. Explain the agricultural applications of biofertilizers, biopesticides and bioinsecticides.
5. Demonstrate the preparation and significance of fermented foods using beneficial microorganisms.
6. Recognize the antimicrobial properties of selected medicinal plants and spices used in traditional Indian practices.
7. Appreciate the industrial applications of microorganisms in food processing, agriculture and biotechnology.

Assessment Pattern of CEP-I (2 credits) as:

1. Field visit / Activity participation = 40%
2. Note book/Diary and Report submission = 40%
3. Final presentation by the participant = 20%

Structure of B. Sc. Microbiology (AEDP) Part II
OPEN ELECTIVE

Course component	Course Title Title of the subjects	Credits	Teaching Hours
	SEMESTER III		
OE-III	Open Elective - III: Role of Microorganisms in Human Life (मानवी जीवनातील सूक्ष्मजीवांची भूमिका)	2	60
	SEMESTER IV		
OE-IV	Open Elective - IV: Microorganisms in Agriculture, Environment And Industry (कृषी, पर्यावरण आणि उद्योगक्षेत्रामध्ये सूक्ष्मजीवांची उपयुक्तता)	2	60

B. Sc. Microbiology (AEDP) Part-II; Semester-III (NEP 2020)		
OE-III: Role of Microorganisms in Human Life		
Credits: 02	**Lectures: 60 hours**	**Hours per week: 04**

OE-III: Learn Fundamental Microbiological Techniques.

This course develops competency in routine microbiological laboratory techniques required for microbial isolation, cultivation, staining, preservation, enumeration and basic microbiological quality analysis, providing the foundation for advanced industrial and applied microbiology courses.

Learning Objectives:

The course is designed to enable students to:

1. Understand the significance of microorganisms in everyday life, health, food, and the environment.
2. Observe common microorganisms and recognize their beneficial and harmful activities.
3. Develop awareness regarding personal hygiene, sanitation, food spoilage, and safe drinking water.
4. Perform simple observation-based microbiological activities using basic laboratory techniques.
5. Appreciate the importance of microorganisms in maintaining environmental and public health.

PRACTICAL

1. Microscopic examination of baker's yeast.
2. Microscopic examination of algae.
3. Microscopic examination of protozoa.
4. Isolation and enumeration of airborne microorganisms by the settle plate technique.
5. Observation of the normal microflora of human skin by the swab sampling technique.
6. Assessment of the microbiological quality of drinking water by SPC.
7. Microscopic observation of microbial spoilage in bread / rice.
8. Microscopic observation of microbial spoilage in fruits (Banana, Orange or Strawberry).
9. Demonstration of the effectiveness of hand sanitizer by the contact plate method/ finger dab method.
10. Demonstration of the effect of copper utensils / copper coins on microbial growth in drinking water.

Expected Course Outcomes:

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

1. Recognize common microorganisms associated with food, water, air, and the human body.
2. Differentiate between beneficial and harmful microorganisms encountered in daily life.
3. Observe microbial growth using simple microbiological demonstration techniques.
4. Explain the importance of hygiene, sanitation, and safe food and water practices in preventing microbial diseases.
5. Describe the role of microorganisms in food fermentation, spoilage, and environmental sustainability.
6. Appreciate the applications of microbiology in healthcare, agriculture, food production, and everyday living.

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1. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. Microbiology. 5th Edition. Tata McGraw-Hill Education, 2001.
2. Tortora, G. J., Funke, B. R., & Case, C. L. Microbiology: An Introduction. 13th Edition. Pearson Education, 2019.
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B. Sc. Microbiology (AEDP) Part-II; Semester-III (NEP 2020)		
OE-III: मानवी जीवनातील सूक्ष्मजीवांची भूमिका		
Credits: 02	**Lectures: 60 hours**	**Hours per week: 04**

OE-III: दैनंदिन जीवनातील सूक्ष्मजीवांचे निरीक्षण व मूलभूत सूक्ष्मजीवशास्त्रीय तंत्रांचे अध्ययन.

हा अभ्यासक्रम विद्यार्थ्यांना दैनंदिन जीवनात आढळणाऱ्या सूक्ष्मजीवांचे निरीक्षण, त्यांचे उपयुक्त व अपायकारक कार्य, वैयक्तिक स्वच्छता, सुरक्षित अन्न व पिण्याचे पाणी, तसेच मूलभूत सूक्ष्मजीवशास्त्रीय प्रयोगांची ओळख करून देतो. यामुळे विद्यार्थ्यांमध्ये सूक्ष्मजीवांचे दैनंदिन जीवनातील महत्त्व आणि सार्वजनिक आरोग्याबाबत वैज्ञानिक दृष्टीकोन विकसित होतो.

अध्ययन उद्दिष्टे:

अभ्यासक्रम पूर्ण केल्यानंतर विद्यार्थी::

1. दैनंदिन जीवन, आरोग्य, अन्न व पर्यावरणामधील सूक्ष्मजीवांचे महत्त्व समजून घेतील.
2. विविध सूक्ष्मजीवांचे सूक्ष्मदर्शकीय निरीक्षण करून त्यांचे उपयुक्त व अपायकारक कार्य ओळखतील.
3. वैयक्तिक स्वच्छता, स्वच्छ पिण्याचे पाणी, अन्नाची सुरक्षितता व अन्न खराब होण्यामध्ये सूक्ष्मजीवांची भूमिका समजून घेतील.
4. मूलभूत सूक्ष्मजीवशास्त्रीय प्रयोग व निरीक्षणे करण्याचे कौशल्य आत्मसात करतील.
5. पर्यावरण संरक्षण व सार्वजनिक आरोग्य राखण्यात सूक्ष्मजीवांचे योगदान समजून घेतील.

प्रात्यक्षिके

1. बेकर्स यीस्ट (Saccharomyces cerevisiae) चे सूक्ष्मदर्शकाखाली निरीक्षण करणे.
2. शैवाल (Algae) चे सूक्ष्मदर्शकाखाली निरीक्षण करणे.
3. आदिजीव (Protozoa) चे सूक्ष्मदर्शकाखाली निरीक्षण करणे.
4. सेटल प्लेट (Settle Plate) तंत्राद्वारे हवेतील सूक्ष्मजीवांचे संख्यात्मक परीक्षण करणे.
5. स्वॅब नमुना पद्धतीद्वारे मानवी त्वचेवरील सामान्य सूक्ष्मजीवांचे निरीक्षण करणे.
6. प्रमाणित पटल गणना (SPC) पद्धतीद्वारे पिण्याच्या पाण्याचे सूक्ष्मजीवशास्त्रीय गुणवत्ता परीक्षण करणे.
7. खराब झालेल्या ब्रेड / भात यांवरील सूक्ष्मजीवाचे निरीक्षण करणे.
8. केळी, संत्रे किंवा स्ट्रॉबेरी यांसारख्या खराब झालेल्या फळांचे सूक्ष्मजीवशास्त्रीय निरीक्षण करणे.
9. बोटांचे ठसे (फिंगर-डॅब) पद्धतीद्वारे हँड सॅनिटायझरच्या परिणामकारकतेचे परीक्षण करणे.
10. तांब्याची भांडी किंवा तांब्याची नाणी वापरून पिण्याच्या पाण्यातील सूक्ष्मजीवांच्या वाढीवरील परिणामाचे परीक्षण करणे.

अभ्यासक्रम पूर्ण केल्यानंतर अपेक्षित अध्ययन निष्पत्ती:

अभ्यासक्रम यशस्वीरीत्या पूर्ण केल्यानंतर विद्यार्थी:

1. अन्न, पाणी, हवा व मानवी शरीराशी संबंधित सामान्य सूक्ष्मजीव ओळखू शकतील.
2. दैनंदिन जीवनातील उपयुक्त व अपायकारक सूक्ष्मजीवांमधील फरक स्पष्ट करू शकतील.
3. मूलभूत सूक्ष्मजीवशास्त्रीय तंत्रांचा वापर करून सूक्ष्मजीवांचे निरीक्षण करू शकतील.
4. वैयक्तिक स्वच्छता, स्वच्छता व्यवस्थापन, सुरक्षित अन्न व सुरक्षित पिण्याचे पाणी यांचे संसर्गजन्य रोगांच्या प्रतिबंधामधील महत्त्व स्पष्ट करू शकतील.
5. अन्न किण्वन (Fermentation), अन्न खराब होणे आणि पर्यावरणीय संतुलन यामधील सूक्ष्मजीवांची भूमिका स्पष्ट करू शकतील.
6. आरोग्य, शेती, अन्न उत्पादन आणि दैनंदिन जीवनातील सूक्ष्मजीवशास्त्राच्या विविध उपयोगांचे महत्त्व समजावून सांगू शकतील.

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2. Tortora, G. J., Funke, B. R., & Case, C. L. Microbiology: An Introduction. 13th Edition. Pearson Education, 2019.
3. Willey, J., Sherwood, L., & Woolverton, C. Prescott's Microbiology. 11th Edition. McGraw-Hill Education, 2021.
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7. Cappuccino, J. G., & Welsh, C. T. Microbiology: A Laboratory Manual. 12th Edition. Pearson Education, 2020.

B. Sc. Microbiology (AEDP) Part-II; Semester-IV (NEP 2020)		
OE-IV: MICROORGANISMS IN AGRICULTURE, ENVIRONMENT AND INDUSTRY		
Credits: 02	**Lectures: 60 hours**	**Hours per week: 04**

OE-IV: Learn Fundamental Microbiological Techniques.

This course develops competency in routine microbiological laboratory techniques required for microbial isolation, cultivation, staining, preservation, enumeration and basic microbiological quality analysis, providing the foundation for advanced industrial and applied microbiology courses.

Learning Objectives:

The course is designed to enable students to:

6. Understand the beneficial role of microorganisms in agriculture, environmental management, food production and industrial applications.
7. Observe microorganisms associated with soil, plants and fermented foods using simple laboratory techniques.
8. Develop awareness regarding biofertilizers, biopesticides, bioinsecticides and environmentally sustainable agricultural practices.
9. Appreciate the importance of microorganisms in traditional food fermentation and natural antimicrobial products.
10. Recognize the applications of microbiology in sustainable agriculture, environmental conservation and industrial biotechnology.

PRACTICAL

1. Microscopic examination of microorganisms present in rhizospheric soil.
2. Observation of common plant diseases caused by microorganisms (Citrus canker / Black rust of wheat / Groundnut rust).
3. Collection and microscopic examination of root nodules of ground nut.
4. Study of commonly used biofertilizers and their agricultural applications.
5. Study of commonly used biopesticides.
6. Study of commonly used bioinsecticides.
7. Preparation of curd using starter culture.
8. Microscopic examination of microorganisms present in fermented foods (curd, idli/dosa batter and pickles).
9. Demonstration of the antimicrobial properties of medicinal plants and spices. (Neem, Tulsi, Turmeric, Garlic and Clove).

Expected Course Outcomes:

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

8. Recognize beneficial microorganisms associated with soil, plants and fermented foods.
9. Describe the role of microorganisms in improving soil fertility, crop productivity and environmental sustainability.
10. Identify common plant diseases caused by microorganisms through field and laboratory observations.
11. Explain the agricultural applications of biofertilizers, biopesticides and bioinsecticides.
12. Demonstrate the preparation and significance of fermented foods using beneficial microorganisms.
13. Recognize the antimicrobial properties of selected medicinal plants and spices used in traditional Indian practices.
14. Appreciate the industrial applications of microorganisms in food processing, agriculture and biotechnology.

References:

1. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. Microbiology. 5th Edition. Tata McGraw-Hill Education, 2001.
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9. Satyanarayana, U. Biotechnology. 1st Edition. Books and Allied (P) Ltd., 2013.
10. ICAR. Handbook of Agriculture. 7th Edition. Indian Council of Agricultural Research, New Delhi, 2016.

B. Sc. Microbiology (AEDP) Part-II; Semester-IV (NEP 2020)		
OE-IV : कृषी, पर्यावरण आणि उद्योगक्षेत्रामध्ये सूक्ष्मजीवांची उपयुक्तता		
Credits: 02	**Lectures: 60 hours**	**Hours per week: 04**

OE-IV: कृषी, पर्यावरण आणि उद्योगातील सूक्ष्मजीवांचे मूलभूत उपयोग समजून घेणे.

हा अभ्यासक्रम विद्यार्थ्यांना कृषी, पर्यावरण, अन्नप्रक्रिया व उद्योग क्षेत्रांमध्ये सूक्ष्मजीवांचे महत्त्व समजावून देतो. तसेच मृदा, वनस्पती, किण्वित अन्नपदार्थ, जैवखते, जैवकीटकनाशके आणि पर्यावरणीय जैवतंत्रज्ञानाशी संबंधित मूलभूत प्रयोग व निरीक्षणे करण्याची क्षमता विकसित करतो.

अध्ययन उद्दिष्टे:

या अभ्यासक्रमाच्या अध्ययनानंतर विद्यार्थी खालील बाबी समजून घेतील :

1. कृषी, पर्यावरण व्यवस्थापन, अन्ननिर्मिती आणि औद्योगिक क्षेत्रामधील सूक्ष्मजीवांची उपयुक्त भूमिका समजून घेणे.
2. मृदा, वनस्पती आणि किण्वित अन्नपदार्थांशी संबंधित सूक्ष्मजीवांचे साध्या प्रयोगशाळीय तंत्रांच्या साहाय्याने निरीक्षण करणे.
3. जैवखते, जैवकीटकनाशके, जैवकीटकनियंत्रके आणि पर्यावरणपूरक शेती पद्धतींचे महत्त्व समजून घेणे.
4. पारंपरिक अन्न किण्वन प्रक्रियेमध्ये तसेच नैसर्गिक प्रतिजैविक गुणधर्म असलेल्या वनस्पतींच्या उपयोगामध्ये सूक्ष्मजीवांचे योगदान समजून घेणे.
5. शाश्वत शेती, पर्यावरण संवर्धन आणि औद्योगिक जैवतंत्रज्ञानामधील सूक्ष्मजीवांच्या विविध उपयोगांची ओळख करून घेणे.

प्रात्यक्षिके

1. पिकांच्या मुळाभोवतालच्या मातीमधील सूक्ष्मजीवांचे सूक्ष्मजीवशास्त्रीय परीक्षण करणे.
2. सूक्ष्मजीवांमुळे उद्भवणाऱ्या वनस्पती रोगांचे निरीक्षण करणे (लिंबूवर्गीय पिकांवरील कॅंकर / गव्हावरील काळी बुरशी / ऊसावरील चाबूक काणी रोग किंवा भुईमुगावरील तांबेरा रोग).
3. भुईमुगाच्या मुळांवरील गुठल्यांचे संकलन करून त्यांतील सूक्ष्मजीवांचे सूक्ष्मदर्शकाखाली निरीक्षण करणे.
4. शेतीमध्ये वापरल्या जाणाऱ्या जैवखतांचे व त्यांच्या कृषी क्षेत्रातील उपयोगांचे अध्ययन करणे.
5. शेतीमध्ये सर्वसाधारणपणे वापरल्या जाणाऱ्या जैवकीटकनाशकांचे अध्ययन करणे.
6. शेतीमध्ये सर्वसाधारणपणे वापरल्या जाणाऱ्या जैवकीटकनियंत्रकांचे अध्ययन करणे.
7. प्रारंभिक संवर्ध (स्टार्टर कल्चर) वापरून दही तयार करणे.
8. किण्वित अन्नपदार्थांमधील (दही, इडली/दोसा पीठ व लोणचे) सूक्ष्मजीवांचे सूक्ष्मदर्शकाखाली निरीक्षण करणे.
9. कडुनिंब, तुळस, हळद, लसूण व लवंग यांसारख्या औषधी वनस्पती आणि मसाल्यांच्या प्रतिजैविक गुणधर्मांचे प्रात्यक्षिक करणे.

अभ्यासक्रम पूर्ण केल्यानंतर अपेक्षित अध्ययन निष्पत्ती:

अभ्यासक्रम यशस्वीरित्या पूर्ण केल्यानंतर विद्यार्थी पुढील बाबी साध्य करू शकतील :

1. माती, वनस्पती आणि किण्वित अन्नपदार्थांशी संबंधित उपयुक्त सूक्ष्मजीवांची ओळख करून सांगू शकतील.
2. मातीची सुपीकता, पीक उत्पादन आणि पर्यावरणीय शाश्वतता वाढविण्यात सूक्ष्मजीवांची भूमिका स्पष्ट करू शकतील.
3. वनस्पतींमध्ये आढळणाऱ्या सामान्य सूक्ष्मजीवजन्य रोगांची क्षेत्रीय व प्रयोगशाळीय निरीक्षणांच्या आधारे ओळख करू शकतील.
4. जैवखते, जैवकीटकनाशके आणि जैवकीटकनियंत्रकांच्या कृषी क्षेत्रातील उपयोगांचे स्पष्टीकरण देऊ शकतील.

5. उपयुक्त सूक्ष्मजीवांच्या साहाय्याने किण्वित अन्नपदार्थ तयार करण्याची प्रक्रिया व त्यांचे महत्त्व समजावून सांगू शकतील.
6. भारतीय पारंपरिक ज्ञानामध्ये वर्णन केलेल्या निवडक औषधी वनस्पती व मसाल्यांमधील प्रतिजैविक गुणधर्मांची माहिती सांगू शकतील.
7. अन्नप्रक्रिया, कृषी आणि जैवतंत्रज्ञान उद्योगांमध्ये सूक्ष्मजीवांचे विविध उपयोग स्पष्ट करू शकतील.

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21. FORMAT OF QUESTION PAPER

[THEORY EXAMINATION]

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

March/April / Oct./Nov. XXXX

Sub. Name: Microbiology Paper III & IV / Paper V & VI

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]**

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

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

a.
b.

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

a.
b.
c.

****

[PRACTICAL EXAMINATION]

B. Sc. Microbiology (AEDP) Part II / Semester III/IV

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

Major / Minor P-III / IV
Practicals based on Microbiology Paper V & VI / VII & VIII

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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