

**Punyashlok Ahilyadevi Holkar Solapur University, Solapur**



NAAC Accredited-2022  
'B++' Grade (CGPA 2.96)

Name of the Faculty:

# Science & Technology

As per New Education Policy 2020

Syllabus:

## MICROBIOLOGY

Name of the Course:

## M.Sc. I (Sem I & II)

(With effective from June 2026)

**Revised Syllabus for the  
Master of Science in Microbiology  
Punyashlok Ahilyadevi Holkar Solapur University, Solapur  
(As per National Education Policy 2020)**

Applicable from the academic year 2025-26 (June 2026) for M.Sc. Part I (Microbiology) as per Resolution No. .... dated ..... of Board of Studies in Microbiology) and Resolution No. ....dated ..... of Academic Council of Punyashlok Ahilyadevi Holkar Solapur University, Solapur.

1. Title: M. Sc. Microbiology, Punyashlok Ahilyadevi Holkar Solapur University, Solapur Revised Syllabus as per NEP 2020
2. Faculty: Faculty of Science and Technology.
3. Year of implementation: For M. Sc. I (Semester I and Semester II): From June 2026.

**Preamble:**

Education is fundamental for achieving full human potential. Providing universal access to quality education is the key to India's continued ascent and leadership on the global stage in terms of economic growth, social justice and equality, scientific advancement, national integration and cultural preservation. Universal high- quality education is the best way forward for developing and maximizing our country's rich talents and resources for the good of the individual, the society, the country and the world. India will have the highest population of young people in the world over the next decade and our ability to provide high-quality educational opportunities to them will determine the future of our country. Higher education plays an extremely important role in promoting human as well as societal well-being and in developing India as envisioned in its Constitution—a democratic, just socially-conscious, cultured and human nation upholding liberty, equality, fraternity and justice for all. Higher education significantly contributes towards sustainable livelihood and economic development of the nation. As India moves towards becoming a knowledge economy and society, more and more young Indians are likely to aspire to higher education.

In the last two decades' science faculty students aim at professional courses, particularly in medical sciences, Engineering. Comparatively, a smaller number of students were choosing degrees in Biosciences or life sciences. For several years now, the first preference of students desiring to enter the field of Life Sciences particularly, Microbiology, Botany, Zoology, and for the last 10 to 12 years, it has shifted partly to Biotechnology courses, and this trend has been followed by chemical sciences. Both these disciplines viz.

Microbiology and Biotechnology lead to an overlapping interest. Microbial sciences focus more on the study of the microbial world while Biotechnology focuses more on industrial applications relating to plants and animals.

The main theme of teaching these courses is the application of basic principles of Life Science to develop into technology. Modern biology combines the principles of chemistry and biological sciences (molecular and cellular biology, genetics, immunology, pharmaceutical microbiology) with technological

disciplines (bioinformatics, Biostatistics, and Instrumentation) to produce goods and services and even for environmental management.

The NEP syllabus for M. Sc. Microbiology course is aimed to develop science-based industries as well as a research-oriented curriculum and through research projects students can study microbiology. The Board of Studies in Microbiology has identified the following thrust areas and prospective plans for syllabi reforms at the postgraduate level.

In addition, the BOS feel that the students should be well acquainted with industrial techniques which include different skill developments in various related fields. These skills will help the students to develop themselves as entrepreneurs.

### **Introduction:**

This course provides a broad overview of microbiology and produces expert hands that would have sufficient knowledge and expertise to solve urgent problems in the region by using microbiology. The course structure is biological centric where students learn microbiology and are taught necessary basic subjects and applied for that purpose. In addition to disciplines like Virology, Immunology, Genetics, Molecular Biology, Enzymology, Biostatistics, Bioinformatics, Scientific Writing, Computer Science, Industrial Microbiology and waste management etc., advanced topics are introduced in two years from the field of microbiology.

### **Objectives of the course:**

A prime objective is to maintain an updated curriculum and provide therein inputs to take care of fast-paced developments in the knowledge of Microbiology concerning international context, a two-year/one-year program is formulated for M.Sc. Microbiology.

- To develop competent microbiologists to achieve desirable placements in the country and abroad.
- The program obliges students to read original publications and envisages significant inputs in the laboratory work, communication skills, creativity, planning, execution and critical evaluation of the studies undertaken.
- To develop awareness & knowledge of different organizations' requirement and subject knowledge through varied subjects and training methodologies in students.
- To train the students to take up a wide variety of roles like researchers, scientists, consultants, entrepreneurs, academicians, industry leaders and policy.
- To provide intensive and in-depth learning to the students in the field of microbiology.
- To develop awareness & knowledge of different organization requirements and subject knowledge through varied subjects and training methodologies in students.
- To train the students to take up a wide variety of roles like researchers, scientists, consultants, entrepreneurs, academicians, industry leaders and policy.

**Course outcome:**

1. **Advanced Knowledge in Microbiology:** Graduates will possess a deep understanding of microbial genetics, virology, Microbial diversity, diagnostic microbiology of various diseases Pharmaceutical microbiology, microbial biochemistry.
2. **Research Skills:** Students will be trained in modern research methodologies, including experimental design, data collection, and analysis, preparing them for careers in scientific research or further studies.
3. **Technical Proficiency:** Post Graduates will be proficient in using advanced laboratory techniques and tools related to microbiology, such as microscopy, molecular biology techniques, and bioinformatics, chromatography and electrophoresis techniques.
4. **Environmental Awareness:** Students will develop a strong understanding of plant environment interactions, including the role of microorganisms in ecosystems and their responses to environmental stressors, contributing to sustainable environmental management.
5. **Critical Thinking and Problem-Solving:** The program emphasizes the development of critical thinking and analytical skills, enabling post graduates to identify and solve complex biological problems.
6. **Communication Skills:** Post Graduates will be able to effectively communicate scientific knowledge and research findings to both scientific and non-scientific people through written, oral, and digital formats.
7. **Interdisciplinary Approach:** The program encourages an interdisciplinary approach, integrating knowledge from related fields such as biochemistry, molecular biology, and environmental science.
8. **Ethical and Professional Conduct:** Students will learn to conduct research and professional activities with integrity, following ethical guidelines in scientific practices.
9. **Career Readiness:** The program prepares students for diverse career opportunities in academia, research institutions, environmental consultancy, agriculture, biotechnology, and other related fields.

**Eligibility Criteria:****Eligibility:**

- A Candidate possessing Bachelor's Degree in Microbiology as a principal subject and who has passed the entrance examination conducted by the Punyashlok Ahilyadevi Holkar Solapur University, Solapur shall be held eligible for admission to M. Sc. Course in Microbiology.
- Students from other Universities with B.Sc. in Microbiology as a principal subject and who have passed the entrance examination conducted by the University are also eligible.

**Admission:**

Merit list based on an average of B.Sc. aggregate and entrance exam conducted by the University. For other university students merit lists are only based on entrance examinations conducted by the University and the aggregate of the B.Sc. degree course.

**Duration:**

- The duration for this program is of 2 years with a semester pattern.
- M.Sc. Microbiology NEP comprises four semesters each of 22 credits. M. Sc. Part I is of 2 semesters. In the first semester, there are 2 mandatory papers (DSC I, II) of 4 credits each and one practical each of two credits, one elective paper of 4 credits theory and 2 credits Practical and one research methodology (RM) paper of 4 credits.
- The second semester also comprises 2 mandatory papers (DSC I, II) of 4 credits each and one practical each of 2 credits, one elective paper of 4 credits of theory and 2credits of Practical and one on-the-job training or fieldwork of 4 credits.
- As per the credit system, the assessment of the Theory paper of 100 marks weightage will be as: 60 marks theory assessment by University examination (UA) and 40 marks internal assessment by the college (CA). For internal assessment of candidates, periodical tests/seminars/ viva/oral / quizzes etc. may be suitably adopted.
- As per the credit system, the assessment of a practical paper of 50 marks weightage will be as: 30 marks practical assessment by the University examination (UA) and 20 marks internal assessment by the college (CA).

Punyashlok Ahilyadevi Holkar Solapur University, Solapur  
Structure for M. Sc. I (Sem I & II)  
Subject: Microbiology  
(With effective from June 2026)

<b>M.Sc. I Semester I</b>						
Sr. No.	Course code	Course/Title	Nature	Credits	Marks	
					CA	UA
1	2316101	DSC I- Major mandatory course Microbial Diversity and Taxonomy	Theory	4	40	60
2	2316102	DSC II- Major mandatory course Recent Trends in Virology	Theory	4	40	60
3	2316104	Major mandatory course Microbial Diversity and Taxonomy	Practical	2	20	30
4	2316105	Major mandatory course Recent Trends in Virology	Practical	2	20	30
5	2316107	DSE- I- Major elective course – Diagnostic Microbiology and AI Assistance Or Major elective course Techniques in Microbiology and AI Assistance	Theory	4	40	60
6	2316106	Major elective course (Diagnostic Microbiology and AI Assistance Or Techniques in Microbiology and AI Assistance)	Practical	2	20	30
7	2316103	RM- Research Methodology	Theory	4	40	60
				22	220	330
<b>M.Sc. I Semester II</b>						
Sr. No.	Course code	Course/Title	Nature	Credits	Marks	
					CA	UA
1	2316201	DSC III- Major mandatory course Pharmaceutical Microbiology	Theory	4	40	60
2	2316202	DSC IV- Major mandatory course Microbial Biochemistry	Theory	4	40	60
3	2316204	Major mandatory course Pharmaceutical Microbiology	Practical	2	20	30
4	2316205	Major mandatory course Microbial Biochemistry	Practical	2	20	30
5	2316207	DSE-II-Major elective course Bioinformatics and biostatistics Or Major elective course Physiology and metabolism	Theory	4	40	60
6	2316206	Major elective course Bioinformatics and biostatistics Or Major elective course Physiology and metabolism	Practical	2	20	30
7	2316203	OJT/FP	Theory	4	40	60
				22	220	330

# Punyashlok Ahilyadevi Holkar Solapur University, Solapur

As per NEP 2020

## M.Sc. I Semester I (Microbiology)

(With effective from June 2026)

Sem	Course code	Course/Title
I	2316101	<b>DSC I- Major mandatory course I Microbial Diversity and Taxonomy</b>

Nature	Credits	Total Lectures	Workload Hrs/Week	Marks	
				CA	UA
Theory	4	60	4	40	60

### Objectives:

- Students will be able to understand and explain the microbial diversity present in different extreme environmental conditions in terms of their distribution, abundance, structure and classification.
- To understand the origin, evolution, and diversity of microorganisms.
- To provide a comprehensive knowledge of classical and modern microbial taxonomy.
- To familiarize students with molecular and phylogenetic tools used in microbial classification.
- To develop skills in identification and systematic placement of microorganisms.

### Outcomes:

- Able to understand and explain distribution, abundance and ecological niches of microbes, Construct, & Demonstrate Phylogenetic relationships between Bacterial, Archaea and Eukaryotes.
- Illustrate the Classification of thermophiles based on their habitat. Comparative, study of thermophilic enzymes
- Able to understand and explain the Classification of Acidophiles & Alkalophiles. Compare different Cell structures of Alkalophiles with mesophilic organisms.
- Able to differentiate Microbial diversity at different climatic conditions.
- Able to explain and understand microbes in Hypersaline and high-pressure Environments in terms of their structure, and classification.
- Applications of halophiles and their extremozymes.

Unit	Particulars	Lectures
I	<p><b>Microbial Evolution and Systematics</b></p> <ul style="list-style-type: none"> <li>• Origin of cellular life</li> <li>• Microbial Diversification: Consequences for Earth's Biosphere</li> <li>• Endosymbiotic Origin of Eukaryotes</li> <li>• Microbial Evolution</li> <li>• The Evolutionary Process</li> <li>• Evolutionary Analysis: Theoretical Aspects</li> <li>• Evolutionary Analysis: Analytical Methods</li> <li>• Microbial Phylogeny -Introduction</li> <li>• Phylogenetic Methods</li> </ul> <p><b>Concept of speciation and species</b></p> <ul style="list-style-type: none"> <li>• Differences in the concept of 'species' in eukaryotes and prokaryotes.</li> <li>• Definition of species in prokaryotes.</li> <li>• Types of 'species'</li> <li>• Current Definition of Prokaryotic Species</li> </ul>	15

II	<p><b>Bacterial Taxonomy:</b></p> <ul style="list-style-type: none"> <li>• Definition, nomenclature rules and identification, hierarchical organization and the position of microbes in the living world.</li> <li>• Classification systems – artificial and phylogenetic– dendrogram. Haeckel’s three-kingdom classification, Whittaker’s five-kingdom approach, and Three domain classification of Carl Woese.</li> <li>• Major characteristics used in taxonomy – morphological, physiological, metabolic, genetic and molecular characteristics, comparison of proteins, nucleic acid hybridization, nucleic acid sequence comparison, DNA and RNA homology, and G+C ratio.</li> <li>• significance of 16SrRNA in microbial taxonomy, Numerical Taxonomy and Chemotaxonomy. • Bergey’s Manual of determinative bacteriology</li> </ul>	20
III	<p><b>Characteristics and Classification of Archaeobacteria</b></p> <ul style="list-style-type: none"> <li>• Thermophiles: Classification, hyperthermophilic habitats and ecological aspects. Extremely Thermophilic Archaeobacteria, commercial aspects of thermophiles. Applications of thermozyms.</li> <li>• Methanogens: Classification, Habitats and applications</li> <li>• Alkalophiles and Acidophiles: Classification, alkaline environment, soda lakes and deserts, life at low pH, acid tolerance and applications.</li> <li>• Halophiles and Barophiles Classification, Dead Sea, discovery basin, cell walls and membranes, Osmoadaptation / halotolerance, high-pressure habitats, life under pressure, barophily, death under pressure. and applications and their extremozymes.</li> <li>• Psychrophiles</li> </ul>	15
IV	<p><b>Characteristics and Classification of Eukaryotes General characteristics and outline classification of</b></p> <ul style="list-style-type: none"> <li>• Fungi</li> <li>• Yeasts</li> <li>• Lichens and Mycorrhiza</li> <li>• Algae</li> <li>• Protozoa</li> </ul>	10

**References:**

1. Bergey’s Manual of Systematic Bacteriology, Springer
2. Prescott, Harley & Klein – Microbiology
3. Madigan et al. – Brock Biology of Microorganisms
4. Stanier, Adelberg & Ingraham – General Microbiology
5. Pelczar, Chan & Krieg – Microbiology
6. General Microbiology – Pawar and Dagainawala Vol I & II
7. Microbiology – Prescott, Harley and Klein, Willey Sherwood

Sem	Course code	Course/Title
I	2316102	<b>DSC II- Major mandatory course II Recent Trends in Virology</b>

Nature	Credits	Total Lectures	Workload Hrs/Week	Marks	
				CA	UA
Theory	4	60	4	40	60

**Objectives:**

Students will be able to understand virology and viral emerging diseases it also covers the research views of virology

**Outcomes:**

- Able to study the general characteristics and discovery of viruses, morphology and ultra-structure of viruses
- Able to understand the concept of Viroids and Prions and Classification and nomenclature of animal and plant viruses
- Able to perform the cultivation of viruses, purification of viruses and assay of viruses.
- Able to study bacteriophages Lytic life and Lysogenic interactions and cascade
- Able to study the pathogenesis of viruses.
- Able to understand the control of viruses and emerging viral infections.

Unit	Particulars	Lectures
I	<p><b>Classification and Morphological Concept of Viruses</b></p> <ul style="list-style-type: none"> <li>• Introduction, general characteristics and discovery of viruses</li> <li>• Morphology and ultra-structure of viruses</li> <li>• Concept of Viroids and Prions with its replication.</li> </ul> <p>Classification and nomenclature of animal and plant viruses in detail.</p> <p><b>Viral replication</b></p> <ul style="list-style-type: none"> <li>• Bacteriophages – a) Lytic l life cycle b) Lysogenic interactions and cascade</li> <li>• Animal viruses –DNA and RNA viruses.</li> <li>• Mechanism of virus adsorption and entry into the host cell, genome replication, transcription, post-transcriptional changes, translation, assembly, exit and maturation of progeny virions</li> </ul>	15
II	<p><b>Cultivation and assay of viruses</b></p> <ul style="list-style-type: none"> <li>• Cultivation of viruses by using a) Embryonated eggs b) Experimental animals c) Cell cultures.</li> <li>• Purification of viruses by a) Adsorption, b) Precipitation, c) Enzymatic and serological methods d) Hemagglutination e) ELISA.</li> <li>• Assay of viruses – a) Physical and Chemical methods. b) Infectivity Assays.</li> <li>• Genetic analysis of viruses by genetic methods. Animal and plant viruses- DNA and RNA viruses</li> </ul>	15
III	<p><b>Pathogenesis and control of Viruses</b></p> <ul style="list-style-type: none"> <li>• Host and viral factors involved in pathogenesis, Concept of animal viruses and plant viruses</li> <li>• Pathogenesis of animal viruses: one example each DNA viruses- SS, DS, RNA viruses - SS, DS</li> <li>• Pathogenesis of plant viruses [TMV], Satellite viruses and their role in plant virus replication. Insect viruses [NPV]</li> <li>• Host cell transformation by viruses, oncogenesis by DNA and RNA viruses.</li> <li>• Pathogenesis of viroid and prions</li> </ul>	15

	<ul style="list-style-type: none"> <li>• Control of viral infections with • Vaccines • Antiviral drugs • Antibodies • Interferons • Topical antiviral chemicals- detergents, alcohols, and antiseptics</li> </ul>	
IV	<p><b>Control of Viruses and Emerging Viral Infections</b></p> <ul style="list-style-type: none"> <li>• Control of viral infections with a) Vaccines b) Antiviral drugs c) Antibodies d) Interferons e) Topical antiviral chemicals- detergents, alcohols and antiseptics</li> <li>• Emerging viral infections: a) SARS. b) EBOLA, c) Coronavirus. d) Zika virus e) Influenza viruses, f) Chikungunya, g) Nipah virus.</li> </ul>	15

**References:**

1. Bacterial & Bacteriophage Genetics by Edward A. Birge.
2. Principles of Bacteriology, Virology & Immunity 8th edition (Vol. 4) by Topley & Wilson's.
3. General Virology – Luria.
4. Introduction to Plant Virology – Bos I. (1983) Longman, London & New York.
5. Animal Virology – Fenner, F & White, D. O. (1976) Academic Press Inc., New York.
6. Chemistry of Viruses (2nd edition) – Knight C. A. (1975) Springer Verlag Inc. New York.
7. Virology – Dulbecco R. and Ginsberg H. S. (1980), Harper and Ravi Publishers Inc. New York.
8. Introduction to modern virology by Dimmock. Fourth Edition. Blackwell Scientific Publication, Oxford.
9. Virology by Conrat, Kimbal and Levy, Third Edition, Englewood Cliff New Jersey Medical virology by Morag and Tim, 10th Edition. Churchill Livingstone publication, London. Publication
10. Principles of virology by Edward Arnold. 2000
11. Medical virology by Morag and Tim, 10th Edition. Churchill Livingstone publication, London.

Sem	Course code	Course/Title
I	2316104	<b>Major mandatory course I Microbial Diversity and Taxonomy</b>

Nature	Credits	Total Lectures	Workload Hrs/Week	Marks	
				CA	UA
Practical	2	-	4	20	30

**Outcomes:**

After completing this course, students will be able to:

CO1: Identify microorganisms based on the kind of roles they perform in ecology.

CO2: Discover novel characteristics present in microorganisms for benefits to humans.

CO3: Employ learned cultivation techniques for the isolation as well as enrichment of microorganisms effectively.

CO4: Explain complex phenomena like bioluminescence and methane production with the help of experiments conducted during the course.

CO5: Find errors in the methodology obtained by them while experimenting.

CO6: Integrate skills acquired during the practical course to welcome better outcomes.

**Practical:**

1. Isolation of thermophiles, alkaliphiles and Barophiles from any natural source.
2. Isolation of bacteria or fungi from rhizosphere.
3. Studies on halophiles isolated from seawater/or any natural source. [Pigmentation and Salt tolerance]
4. Studies on Alkaliphiles and thermophiles isolated from lonar water/seawater/any natural source. [Study at least one enzyme]
5. Biogenic methane production using different wastes. (Demonstration)
6. Isolation and Morphological studies of the following Eukaryotes.
7. Molds- Aspergillus, Penicillium, Rhizopus, Fusarium, Trichoderma, (Saprophytic) Yeasts- Candida, Saccharomyces
8. Morphological studies of the- Protozoa- Paramecium, Plasmodium and Entamoeba
9. Isolation and Morphological studies of the Algae – Spirulina, Spirogyra, Nostoc and Anabaena
10. Morphological studies of the Mycorrhiza and Lichen
11. Use of Bergey's Manual for bacterial identification
12. Construction and interpretation of phylogenetic trees
13. Isolation of bacteria or fungi from rhizosphere and Phyllosphere.

**References:**

1. Brocks Biology of Microorganisms. 8th Edition. (International Edition - 1997) by Michael T. Madigan, John M. Martinko. Jack Parker. Prentice Hall International Inc.
2. Jacquelyn G. Black (2013) Microbiology: Principles and Explorations, 6th Edition, John Wiley & Sons, Inc.,
3. Microbial Diversity: Form and Function in Prokaryotes Published Online: 30 NOV 2007. DOI: 10.1002/9780470750490.ch1 Copyright © 2005 by Blackwell Science Ltd
4. Bergey's manual of systemic bacteriology Vol. 1, 2,3, 4 Williams, Wilkins & Baltimore, Academic Press.
5. Bergey's manual of Determinative Bacteriology Williams, Wilkins & Baltimore, Academic Press. Microbial Life in Extreme Environments. Edited by D. J. Kushner. Academic Press.

6. Microbiology of Extreme Environments. Edited by Clive Edward. Open University Press. Milton Keynes.
7. Barnett, H. L. and Hunter, B. B. 1960. Illustrated Genera of Imperfect Fungi. Burgess Publishing Co., Minnesota
8. Lodder J. (1974). The Yeasts: A Taxonomic Study, North Holland Publishing Co. Amsterdam.
9. Mycotechnology: Present status and future prospects. Edited by Mahendra Rai. I.K., International Publishing House Pvt. Ltd.; 2007.
10. The Yeast Handbook: Biodiversity and Ecophysiology of yeasts by Carlos A. Rosa and Gabor Peter. Springer- Verlag Berlin Heidelberg; 2006.

Sem	Course code	Course/Title
I	2316105	<b>Major mandatory course II Recent Trends in Virology</b>

Nature	Credits	Total Lectures	Workload Hrs/Week	Marks	
				CA	UA
Practical	2		4	20	30

#### Outcomes:

After completing this course students will be able to:

- CO1: Describe various sites for egg inoculation techniques.
- CO2: Understand the process isolation of coliphages from sewage and will be able describe the method of titration of phages.
- CO3: Apply hemagglutination and ELISA for purification of viruses.
- CO4: Correlate the phage typing and identification of bacterial phages.
- CO5: Evaluate the plaque, end point assays, and infectivity assays of plant viruses.
- CO6: Design the one step growth curve experiment.

#### Practical:

1. Isolation, titration and high titer stock preparation of *E. coli* phages from sewage.
2. Phage typing of *E. coli*.
3. Phage typing of Salmonella strains.
4. Infectivity Assays (Plaque and end-point).
5. Study of viral plant diseases using infected samples.
6. Study of the one-step growth curve of phage T4
7. Study of Egg inoculation techniques.
8. Study of electron microphotographs of structure of viruses and study of photographs of symptoms of emerging viral diseases.
9. Purification of viruses by serological methods – hemagglutination.
10. Purification of viruses by serological methods – ELISA.
11. Demonstration of diagnosis of emerging viral diseases with Tri Dot kits-ELISA, Dengue.

#### References:

1. Bacterial & Bacteriophage Genetics by Edward A. Birge.
2. Principles of Bacteriology, Virology & Immunity 8th edition (Vol. 4) by Topley & Wilson's.
3. General Virology – Luria.
4. Introduction to Plant Virology – Bos I. (1983) Longman, London & New York.
5. Animal Virology – Fenner, F & White, D. O. (1976) Academic Press Inc., New York.
6. Chemistry of Viruses (2nd edition) – Knight C. A. (1975) Springer Verlag Inc. New York.
7. Virology – Dulbecco R. and Ginsberg H. S. (1980), Harper and Ravi Publishers Inc. New York.
8. Introduction to modern virology by Dimmock. Fourth Edition. Blackwell Scientific Publication, Oxford.
9. Virology by Conrat, Kimbal and Levy, Third Edition, Englewood Cliff New Jersey Medical virology by Morag and Tim, 10th Edition. Churchill Livingstone publication, London. Publication
10. Principles of virology by Edward Arnold. 2000
11. Medical virology by Morag and Tim, 10th Edition. Churchill Livingstone publication, London.

Sem	Course code	Course/Title
I	2316107	<b>DSE- I- Major elective course I – Diagnostic Microbiology and AI Assistance</b>

Nature	Credits	Total Lectures	Workload Hrs/Week	Marks	
				CA	UA
Theory	4	60	4	40	60

**Objectives:**

**Outcomes:**

After completing this course students will:

- CO 1-Full knowledge of working in a microbiology laboratory taking all safety measures, handling live bacteria, disposal of infectious waste, care of the equipment
- CO 2-Have developed a very good understanding of practical aspects of the collection of different clinical samples, their transport, culture and examination by staining, and molecular and immunological diagnostic methods for the diagnosis of microbial diseases.
- CO 3-Have developed a very good understanding of the practical aspects of the diagnosis of common human infections.

Unit	Particulars	Lectures
I	<p><b>Microbiological Laboratory and Safe Practices</b> Microbiological Laboratory Practices and Biosafety 1. Microbiological Laboratory Practices i. Good Laboratory Practices (GLP): Principles, quality assurance, documentation, SOPs ii. Good Microbiological Practices (GMP): Aseptic techniques, contamination control, laboratory ethics Laboratory-acquired infections: Sources, prevention, reporting mechanisms 2. Biosafety and Biosecurity Biosafety cabinets: i. Types (Class I, II, III), working principles, airflow patterns Validation, certification and maintenance ii. Personal Protective Equipment (PPE): Laboratory coats, gloves, masks, face shields iii. Biosafety levels: BSL-1, BSL-2, BSL-3 – design, infrastructure, containment practices, examples of microorganisms iv. Enhanced biosafety norms post-COVID-19 Risk assessment and biosecurity measures in microbiology laboratories</p>	15
II	<p><b>Clinical Sampling and Handling</b> Clinical Sample Handling and Biomedical Waste Management 1. Biohazardous Waste Management i. Classification of biomedical waste ii. Methods of decontamination: Chemical disinfection: phenolics, aldehydes, halogens Physical methods: autoclaving, incineration, microwave treatment iii. Biomedical Waste Management Rules (India) – latest amendments 2. Collection, Transport and Storage of Clinical Samples i. Definition and importance of clinical specimens ii. Types and methods of sample collection: Oral cavity, throat swab, skin scraping, blood, CSF, urine, faeces iii. Precautions during sample collection iv. Transport media and storage conditions v. Cold-chain management and biosafe transport of clinical samples 3. Automated Systems Automated blood culture systems: Principles, advantages and applications in diagnostics</p>	15
III	<p><b>Microbial Diseases and Diagnostic Approaches</b> 1. Bacterial Diseases i. Helicobacter pylori: Etiology, transmission, virulence factors, pathogenesis Clinical manifestations Laboratory diagnosis: culture, urease test, PCR Treatment and antibiotic resistance ii. Leptospira (Leptospirosis): Epidemiology, pathogenesis, diagnosis and prevention</p>	15

	<p>2. Viral Diseases i. Herpes simplex virus (HSV) ii. Rubella virus iii. Rubella (Measles virus) Etiology, transmission, pathogenesis and symptoms Laboratory diagnosis: serological and molecular methods Vaccines and antiviral therapy</p> <p>3. Protozoal and Helminthic Diseases Balantidium coli Ascaris lumbricoides Life cycle, pathogenesis and clinical features Laboratory diagnosis and treatment</p>	
IV	<p><b>Diagnostic Technologies, Human Microbiome and Therapeutic Applications</b></p> <p>1. Diagnosis of Microbial Diseases</p> <p>i. Traditional methods: Microscopy, staining, culture, biochemical tests</p> <p>ii. Serological methods: ELISA, agglutination, immunofluorescence</p> <p>iii. Molecular diagnostic techniques: PCR, real-time PCR, RFLP, rRNA-based identification</p> <p>iv. Automated diagnostic instruments: VITEK system – principles and applications Point-of-care diagnostics Syndromic panels and rapid molecular diagnostic kits AI-assisted microbial identification</p>	15

## References

1. Medical Microbiology, 13th Edition by E. Jawetz, J.L. Melnick, E.A. Adelberg
2. Medical Microbiology, 6th Edition by S. Gupte, Jaypee Brothers Publications
3. Medical Microbiology, by W. Irving, T. Boswell and D. Aladeen.
4. Medical Microbiology, by R. Cruickshank, J.P. Duguid, B.P. Marmion, R.H.A. Swain.
5. The Textbook of Microbiology, by R.C. Dubey and D.K. Maheshwari.
6. Textbook of Microbiology by R. Vasanthkumari.
7. Medical Microbiology by S. Rajan MJP Publishers.
8. Unsworth K. E. and David W. Holden, (2000), Identification and analysis of bacterial virulence genes in vivo, Phil. Trans. R. Soc. London B. 355, 613-622
9. Woods D. E., (2002), The use of animal infection models to study the pathogenesis of melioidosis and glanders, Trends Microbiology, 10(11):483-5
10. Eduardo A. Groisman and Howard Ochman, (1994), How to become a pathogen, Trends in Microbiology, 2(8):289-294
11. Carpenter Philip L., (1975), Saunders International Edition – Immunology Serology, W. B. Saunders and Co., London
12. Schlessinger David, Editor, Mechanism of Microbial Virulence, in Microbiology – 1979, American Society for Microbiology, Washington D. C., 79-230
13. Schlessinger David, Editor, Biochemical Genetics of Pathogenicity, in Microbiology – 1979, American Society for Microbiology, Washington D. C., 79- 230
14. Mark J. Pallen<sup>1</sup> & Brendan W. Wren, (2007), Bacterial pathogenomics, Nature Rev. 449|18: 835-842
15. Hughes Eric A. and Jorge E. Galan, (2002), Immune Response to Salmonella: Location, Location, Location?, Immunity, 16: 325–328
16. Bhavsar Amit P., Julian A. Guttman and B. Brett Finlay, (2007), Manipulation of host-cell pathways by bacterial pathogens, Nature Rev 449/18:827-834

**OR**

Sem	Course code	Course/Title
I	2316107	<b>Major elective course I Techniques in Microbiology and AI Assistance</b>

Nature	Credits	Total Lectures	Workload Hrs/Week	Marks	
				CA	UA
Theory	4	60	4	40	60

**Objectives:**

Students will be able to identify, cultivate, and analyze microorganisms to understand their biology, ecology, and potential impact on human health and the environment.

**Outcomes:**

- Able to introduce microbiological laboratory instruments- principle, working and applications.
- Able to learn molecular interaction and spectroscopic study
- Able to study advanced Microscopy.
- Able to understand Nanobiotechnology, different types of nanoparticles, Nanoparticle synthesis and characterization, and Biomimetics and nanotechnology.
- Able to study the applications of Nanobiotechnology: Quantum dots, magnetic nanoparticles and plasmonic nanoparticles in biology and medicine, Carbon nanotubes and graphene.

Unit	Particulars	Lectures
I	<p><b>Introduction to Microbiological Laboratory Instruments</b> - Principle, Working and Applications: a) pH meter b) Colorimeter, c) Laminar airflow and Bio-safety cabinet. Separation Techniques, Proteomics: 1. Chromatographic Techniques i. Paper chromatography: principle and applications ii. Thin Layer Chromatography (TLC) iii. Introduction to modern chromatography: High Performance Liquid Chromatography (HPLC) Gas Chromatography (GC) (Recent trends)</p> <p><b>Analytical Techniques</b> a) Radio-isotopic techniques- nature of radioactivity b) Methods of detection and measurement c) Methods of Applications – tracer, autoradiography. d) Electrophoretic techniques – Agarose and SDS- PAGE e) Centrifugation and its types- Preparatory and Analytical</p>	15
II	<p><b>Spectroscopy</b> Spectroscopic &amp; Radioisotopic Techniques 1. Spectroscopic Techniques i. UV–Visible spectroscopy: instrumentation and applications ii. Infrared (IR) spectroscopy iii. Nuclear Magnetic Resonance (NMR) spectroscopy iv. Fluorescence spectroscopy v. Atomic Absorption Spectroscopy (AAS) vi. Optical Rotatory Dispersion (ORD) vii. Circular Dichroism (CD) spectroscopy</p> <p>2. Radioisotopic Techniques i. Nature of radioactivity ii. Detection and measurement: Geiger–Müller counter Scintillation counter iii. Applications: Tracer techniques Autoradiography Radiolabeling in microbiology. Applications of AI in analytical techniques</p>	15
III	<p><b>Advanced Microscopy</b> Microscopy Techniques (Conventional to Advanced)</p> <p>1. Light and Electron Microscopy i. Light microscopy: Bright field Dark field Phase contrast Fluorescence microscopy ii. Electron microscopy: Transmission Electron Microscopy (TEM) Scanning Electron Microscopy (SEM) Principle, sample preparation and applications</p>	15

	<p>2. Advanced &amp; Super-Resolution Microscopy i. Confocal fluorescence microscopy ii. Multiphoton microscopy iii. TIRF microscopy iv. Image deconvolution and quantitative image analysis</p> <p>3. Advanced Fluorescence Techniques i. FRET microscopy ii. FLIM iii. FCS</p> <p>4. Super-Resolution Microscopy i. Concept of diffraction limit ii. STED microscopy iii. Single-molecule localization microscopy iv. STORM and PALM v. STEM – Scanning Tunneling Electron Microscopy (introductory) Additions: Digital microscopy AI-assisted image analysis (introductory)</p>	
IV	<p><b>Nano-biotechnology</b></p> <ol style="list-style-type: none"> <li>1. Introduction to nanotechnology and nanobiotechnology</li> <li>2. Types of nanoparticles: Metallic Polymeric Carbon-based Magnetic</li> <li>3. Synthesis and characterization of nanoparticles</li> <li>4. Biomimetics and nanotechnology</li> </ol> <p>Applications in biology, medicine and agriculture: Quantum dots Magnetic nanoparticles Plasmonic nanoparticles Carbon nanotubes and graphene Nano-fertilizers and nano-pesticides Biosensors Additions: Nano-diagnostics, Nano-vaccines, Antimicrobial nanomaterials, Bio sensing and precision agriculture</p>	15

**References:**

1. Principles of Physical Biochemistry – Van Holde, et al., Prentice Hall.
2. Crystallography made crystal clear – G. Rhodes, Academic Press.
3. Introduction to Protein Structure – Branden and Tooze, Garland Publishing Co.
4. Methods in Modern Biophysics -Bengt Noting, 2nd Edition Springer 2006
5. Biophysics –Vasantha Pattabhi N. Gautham Narosa Publishing House.
6. Principles of Protein X-Ray Crystallography - Jan Drenth Third Edition.
7. Instrumental methods of chemical analysis by Chatwal and Anand, Himalaya Publication House, Mumbai

Sem	Course code	Course/Title
I	2316106	<b>Major elective course I Diagnostic Microbiology</b>

Nature	Credits	Total Lectures	Workload Hrs/Week	Marks	
				CA	UA
Practical	2		4	20	30

**Objectives:**

Apply biosafety practices, operate laboratory instruments as per SOPs, understand BSL laboratory design, enumerate environmental microbial flora, analyze skin bacterial flora, perform antibiotic susceptibility testing and determine MIC/MBC, identify malarial stages and other pathogens using slides and kits, conduct latex agglutination, apply traditional pathogen identification methods, and interpret ELISA and Western blot techniques.

**Outcomes:**

- CO 1-Full knowledge of working in a microbiology laboratory taking all safety measures, handling live bacteria, disposal of infectious waste, care of the equipment
- CO 2-Have developed a very good understanding of practical aspects of the collection of different clinical samples, their transport, culture and examination by staining, and molecular and immunological diagnostic methods for the diagnosis of microbial diseases.
- CO 3-Have developed a very good understanding of the practical aspects of the diagnosis of common human infections.

**Practical:**

1. Microbiology Good Laboratory Practices and Bio-safety.
2. SOPs of commonly used laboratory instruments.
3. Study of components and design of a BSL laboratory.
4. Enumeration of microbial flora of different environments- operation theatre, Hospital, kitchen etc.
5. Study of bacterial flora of skin by swab and swipe method
6. Antibacterial sensitivity by the Kirby-Bauer method
7. Determination of MIC and MBC of antibiotics.
8. Study of various stages of malarial parasite in RBCs using permanent mounts.
9. Kits for rapid Detection of Pathogens: Typhoid, Dengue HIV, Swine flu, malaria.
10. Latex agglutination test
11. Study of microbial pathogens using permanent slides of: acid-fast bacilli, parasites.
12. Identification of the pathogen in clinical samples by traditional methods.
13. Demonstration of Western blot technique/ ELISA

**References:**

1. Medical Microbiology, 13th Edition by E. Jawetz, J.L. Melnick, E.A. Adelberg
2. Medical Microbiology, 6th Edition by S. Gupte, Jaypee Brothers Publications
3. Medical Microbiology, by W. Irving, T. Boswell and D. Aladeen.
4. Medical Microbiology, by R. Cruickshank, J.P. Duguid, B.P. Marmion, R.H.A. Swain.
5. The Textbook of Microbiology, by R.C. Dubey and D.K. Maheshwari.
6. Textbook of Microbiology by R. Vasanthkumari.
7. Medical Microbiology by S. Rajan MJP Publishers.
8. Unsworth K. E. and David W. Holden, (2000), Identification and analysis of bacterial virulence genes in vivo, Phil. Trans. R. Soc. London B. 355, 613-622

**OR**

Sem	Course code	Course/Title
I	2316106	<b>Major elective course I Techniques in Microbiology I</b>

Nature	Credits	Total Lectures	Workload Hrs/Week	Marks	
				CA	UA
Practical	2		4	20	30

**Objectives:**

Apply standard biosafety guidelines and good laboratory practices to ensure safe handling of microorganisms.

Demonstrate proper operation and maintenance of common microbiology laboratory instruments as per SOPs.

Explain the structural design and essential components of different Biosafety Level laboratories.

Assess and quantify microbial load from various environments such as OT, hospital wards, and kitchen areas.

**Outcomes:**

Isolate and identify normal bacterial flora of skin using swab and swipe techniques.

Perform antibiotic susceptibility testing using the Kirby-Bauer disc diffusion method and interpret results.

Determine the minimum inhibitory and bactericidal concentrations of antibiotics against bacterial isolates.

Identify different developmental stages of Plasmodium species in stained blood smears.

Demonstrate the principle and application of rapid diagnostic kits for detection of infectious diseases like Typhoid, Dengue, HIV, Swine flu, and Malaria.

Perform and interpret latex agglutination tests for rapid antigen or antibody detection.

Recognize key morphological features of acid-fast bacilli and parasitic pathogens using permanent slides.

Identify pathogens in clinical samples using conventional microbiological techniques.

Explain and interpret immunological techniques such as Western blot and ELISA for pathogen detection.

**Practical:**

1. Determine the pH of the solution using a pH meter and preparation of buffers using  $\text{KH}_2\text{PO}_4$  and  $\text{K}_2\text{HPO}_4$ , acetic acid and sodium acetate,  $\text{K}_2\text{HPO}_4$  and  $\text{H}_3\text{PO}_4$ .
2. Determination of pKa of a monoprotic weak organic acid
3. Estimation of protein samples by using Colorimetry and spectrophotometry.
4. Chromatography: Separation of protein sample by using paper chromatography.
5. Chromatography: Separation of protein sample by using thin-layer chromatography.
6. Separate the DNA samples by using agarose gel electrophoresis
7. Separate the protein samples by using SDS-PAGE.
8. Synthesis of Nanoparticles from microorganisms
9. Characterization of Nanoparticles by FTIR
10. Characterization of Nanoparticles by UV. Visible Spectroscopy.

**References:**

1. Principles of Physical Biochemistry – Van Holde, et al., Prentice Hall.
2. Crystallography made crystal clear – G. Rhodes, Academic Press.
3. Introduction to Protein Structure – Branden and Tooze, Garland Publishing Co.
4. Methods in Modern Biophysics -Bengt Noting, 2nd Edition Springer 2006
5. Biophysics –Vasantha Pattabhi N. Gautham Narosa Publishing House.

Sem	Course code	Course/Title
I	2316103	<b>RM- Research Methodology</b>

Nature	Credits	Total Lectures	Workload Hrs/Week	Marks	
				CA	UA
Theory	4	60	4	40	60

**Objectives:**

Develop the ability to design microbiological research studies by applying appropriate methodologies, experimental techniques, data collection, and ethical principles.

Analyze, interpret, and present research findings using statistical tools and scientific writing for publication and academic dissemination.

**Outcomes:**

Upon completing the course, students will be able to:

- Gain Knowledge and understanding of the basics of the research process
- Identify and formulate research problems
- Search for valuable information
- Write research paper
- Design/conduct experiments
- Recognize the ethical principles of conducting applied research.

Unit	Particulars	Lectures
I	<p><b>Research Methodology</b></p> <p>a) Introduction to Research: Meaning, Objectives, Motivation,  b) Utility of Research,  c) Types of Research  d) Methods of Research  E) <b>Research Design:</b>  Concept and Importance in Research - Features of a good research design - Exploratory Research Design - concept, types and uses, selection of research problem, Descriptive Research Designs - concept, types and uses. Experimental Design: Concept of Independent &amp; Dependent Variables  b) <b>Hypothesis:</b> Meaning, characteristics of good hypothesis, types</p>	15
II	<p><b>Literature survey</b></p> <p>a) Literature survey using the Internet  b) Use of search engines like Google / NCBI / PUBMED and other resources for searching the literature</p>	15
III	<p><b>Tools and Techniques of Data Collection</b></p> <p>a) Sources of Data Collection: Primary and Secondary.  b) Data collection methods/ Tools and Techniques Quantitative research, qualitative research, experimental research, and mixed method approaches, data analysis and interpretation.</p>	15
IV	<p><b>Scientific writing and reports:</b></p> <p>A. Types of reports, layout format of reports, the importance of communication science  B. Writing a research paper 1. Preparing the manuscript, guidelines for authors, and The IMRAD format. 2. Title, byline, abstract and Summary; keywords 3. Introduction: Defining the problem, Literature survey; Justification of study. 4. Material and Methods: Contents, sources, procedures, techniques, reproducibility,</p>	15

<p>Units of measurements, metric system and SI units. Basic statistical techniques, confidence limits, tests, probability, and significance. 5. Results: Text; How to present data; Tables and illustrations. Writing captions, labels and legends. 6. Discussion: components and sequences. Analysis, comparison and integration of data. Likely sources of errors in Results; Conclusions and significance. Implications for further study. 7. Acknowledgements: 8. Literature citation system. Sources of references: Journals, books, eBooks, e Journals, bibliographies, abstracting journals; databases, Inflightnet, Shdhaganga. 9. Preparing and submitting the manuscript. Revising, editing, proofreading</p> <p>C. Process of Publication of research findings: Peer review process and problems, recent developments such as open access and non-blind review, h index, Scopus, Web of science, Google scholar etc</p> <p>D. Problem while writing scientific documents: plagiarism, software for plagiarism.</p> <p>E. Scientific presentation: oral, online and poster</p>	
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## References

1. Gopen GD, and Smith JA. The Science of Scientific Writing. American Scientist, 78, (Nov-Dec. 1090), 550-558.
2. Day D.A., Sakaduski N, Day N. (2011) Scientific English: A guide for scientists and other professionals. ABC-CLIO Publications.
3. Day R.A. & Gastel B 6th Edition (2006) How to write and publish a scientific paper, Cambridge University Press.
4. On Being a Scientist: a Guide to Responsible Conduct in Research. (2009) Washington DC, National Academies Press.
5. Alley M (1996). The craft of scientific writing. Springer Publication.
6. Valiela I. (2001). Doing Science: Design, Analysis and Communication of Scientific Research. Oxford: Oxford University Press.
7. Day R.A. (1988) How to write & publish a Scientific paper, Cambridge University Press.
8. Movie: Naturally Obsessed, the making of Scientist. Day R.A. & Gastel B 6th Edition (2006) How to write and publish a scientific paper, Cambridge University Press.
9. Alley M (1996). The craft of scientific writing. Springer Publication.
10. Day R.A. (1988) How to write & publish a Scientific paper, Cambridge University Press

# Punyashlok Ahilyadevi Holkar Solapur University, Solapur

As per NEP 2020

## M.Sc. I Semester II (Microbiology)

(With effective from June 2026)

Sem	Course code	Course/Title
II	2316201	<b>DSC III- Major mandatory course Pharmaceutical Microbiology</b>

Nature	Credits	Total Lectures	Workload Hrs/Week	Marks	
				CA	UA
Theory	2	60	4	20	30

### Objectives:

- To study pharmaceutical products, antibiotics and their mechanism of action.
- To study the production of healthcare products like injectables, and vaccines.
- To learn Regulatory Practices, Biosensors Applications in Pharmaceuticals.
- Studying quality assurance aspects and validation of pharmaceutical products.

### Outcomes:

- Students will know various antimicrobial agents and their mechanisms of action.
- Students will get the knowledge of Microbial Production and Spoilage of Health Care Products like injectables and vaccines.
- Able to learn regulatory practices, impacts 4) Know about biosensors and applications
- Able to understand quality assurance and validation of pharmaceutical products

Unit	Particulars	Lectures
I	<p><b>Principles of Chemotherapy</b></p> <ul style="list-style-type: none"> <li>• Origins of antimicrobial drugs</li> <li>• Characteristics of ideal antimicrobial agents</li> <li>• Classification of antimicrobial agents: antibiotic [classification in detail]</li> <li>• Mechanism of Action of Antimicrobial Agents:</li> <li>• Bacterial resistance to antibiotics.</li> </ul> <p>Mechanism of action of Chemical disinfectants, antiseptics and preservatives</p> <p><b>Molecular Principles of drug targeting, gene therapy</b></p> <ul style="list-style-type: none"> <li>• Molecular Principles of drug targeting</li> <li>• Drug delivery system in gene therapy.</li> <li>• Penetrating defences- How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion).</li> </ul> <p>Pharmaceutical Products, Vaccines &amp; Microbial Technology</p> <p>A: Microbial Contamination &amp; Sterilization</p> <p>i. Microbial contamination and spoilage of pharmaceutical products</p> <p>Sterile injectables</p> <p>Non-injectables</p> <p>Ophthalmic preparations</p> <p>Implants</p> <p>ii. Sources of contamination in pharmaceutical manufacturing</p> <p>iii. Sterilization methods in pharmaceuticals</p> <ul style="list-style-type: none"> <li>• Heat, radiation, filtration, gaseous sterilization</li> </ul>	15
II	<b>Microbial Production and Spoilage of Health Care Products:</b>	12

	<ul style="list-style-type: none"> <li>• Microbial contamination and spoilage of pharmaceutical products (sterile injectables, non-injectables, ophthalmic preparations and implants) and their sterilization Manufacturing procedures and in-process control of pharmaceuticals other pharmaceuticals produced by microbial fermentations (streptokinase, streptodornase).</li> <li>• New vaccine technology, DNA vaccines, synthetic peptide vaccines, and multivalent subunit vaccines. Vaccine clinical trials.</li> <li>• Quality Assurance &amp; Validation</li> </ul> <p>i. Quality control vs quality assurance in pharmaceuticals  ii. Good Manufacturing Practices (GMP)  iii. Good Laboratory Practices (GLP)  iv. Quality Management Systems (QMS)  ISO, WHO-GMP, US-FDA, BIS, FSSAI  v. Regulatory aspects of pharmaceutical quality</p>	
III	<p><b>Regulatory Practices, Biosensors. Applications in Pharmaceuticals:</b></p> <ul style="list-style-type: none"> <li>• Financing R &amp; D capital and market outlook, IP, BP, USP. Government regulatory practices and policies, FDA perspective Reimbursement of drugs and biological, legislative perspective.</li> <li>• Rational drug design Immobilization procedures for pharmaceutical applications (liposomes).</li> </ul> <p>Macromolecular, cellular and synthetic drug carriers. Biosensors in pharmaceuticals. Application of microbial enzymes in pharmaceuticals.</p>	12
IV	<p><b>Quality Assurance and Validation of Pharmaceutical products:</b></p> <ul style="list-style-type: none"> <li>• Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in the pharmaceutical industry Regulatory aspects of quality control. Quality assurance and quality management in pharmaceuticals ISO, ISI, BIS, FSSAI, WHO and US certification.</li> <li>• Sterilization control and sterility testing (heat sterilization, D value, Z value, F value, survival curve, Radiation, gaseous and filter sterilization), environmental monitoring, waste disposal.</li> <li>• Chemical and biological indicators. Design and layout of sterile product manufacturing unit (Designing of Microbiology laboratory) Safety in Microbiology laboratory</li> </ul>	12

## References

1. Pharmaceutical Microbiology – Edt. By W. B. Hugo and A. D. Russell Sixth edition. Blackwell Scientific Publications.
2. Analytical Microbiology – Edt. By Frederick Kavanagh Volume I and II.
3. Quinolone antimicrobial agents – Edt. By David C. Hooper, John S. Wolfson. ASM Washington DC.
4. Quality control in the Pharmaceutical Industry – Edt. By Murray S. Cooper Vol. 2. Academic Press New York.
5. Biotechnology – Edt. By H. J. Rehm and G. Reed, Vol. 4. VCH Publications, Federal Republic of Germany

Sem	Course code	Course/Title
II	2316202	<b>DSC IV- Major mandatory course Microbial Biochemistry</b>

Nature	Credits	Total Lectures	Workload Hrs/Week	Marks	
				CA	UA
Theory	4	60	4	40	60

**Objectives:**

Students will be able to learn that biochemistry studies the chemistry of life, and its objective is to explain form and function based on chemical principles.

**Outcomes:**

- Able to study biomolecules like protein, carbohydrates, lipids and vitamins etc. classification and structure.
- Able to understand the kinetics of enzymes and the catalytic power of enzymes.
- Able to learn the regulation of enzymes and their changes in covalent structure- irreversible and reversible and ligand-induced conformation.
- Able to understand the oxidation of hydrocarbons and Drug Metabolism.

Unit	Particulars	Lectures
I	<p><b>Biomolecules</b></p> <p>1)Protein Chemistry: -  a)Amino acids: -Classification, structural features and Chemical reactions.  b)Protein Structure and Types  c)Ramachandran Plot  d)Hormones -examples</p> <p>2)Carbohydrates chemistry: -  a)Nomenclature  b)Types and structures</p> <p>3)Lipid Chemistry: -  a)Fatty acids, structure and types  b)Types of lipids and structural aspects  c)Steroids, Terpenes and Prostaglandins.</p> <p>4)Vitamins: -  a)Water-soluble and fat-soluble vitamins  b)Structure and functions of vitamins</p> <p>5)Chemistry of Porphyrins, bacterial pigments (Chlorophylls), Cytochromes, Hemoglobin, Leghemoglobin and Bacteriorhodopsin.</p>	15
II	<p><b>Kinetics of Enzyme</b></p> <p>1)Introduction to Chemical Kinetics  2)Kinetics of single substrate enzyme-catalyzed reactions: -  a) Henri-Michaelis-Menten Equation  b) Briggs and Halden Modification  c)Significance of the M-M equation  d)Significance of Km and Vmax  e) Modification of M-M equation by-  i)Lineweaver –Burk plot  ii)Eadie-Hofstee Plot  iii)Hanes-Woolf plot  iv)Athel Cornish-Bowden plot</p> <p>3)Kinetics of multi-substrate reactions</p>	15

	<p>4)Enzyme Inhibition: -Basic Concept, Kinetics, examples and significance of reversible and irreversible inhibition.</p> <p>5)Catalytic Power of Enzymes</p> <p>1)The basic concept of catalysis-activation energy barrier and the transition state theory</p> <p>2)Enzyme catalytic mechanisms: -Acid-base, covalent and electrochemical reactions</p> <p>3)Functional groups involved in the catalytic mechanism: -</p> <p>a) Amino acids</p> <p>b) Cofactors-Prosthetic groups, coenzymes, co-substrates</p> <p>c)Metal ions, metal activated and metalloenzymes,</p> <p>d)Ternary complexes</p> <p>6)Examples of enzyme function: -</p> <p>a) Chymotrypsin</p> <p>b) Lysozyme</p> <p>c) Isomerase</p>	
III	<p><b>Catalytic Power of Enzymes</b></p> <ul style="list-style-type: none"> <li>• The basic concept of catalysis- activation energy barrier and the transition state theory</li> <li>• Enzyme catalytic mechanisms: - Acid-base, covalent and electrochemical reactions</li> <li>• Functional groups involved in the catalytic mechanism: - a) Amino acids b) Cofactors- Prosthetic groups, coenzymes, co-substrates c) Metal ions, metal activated and metalloenzymes, d) Ternary complexes</li> <li>• Examples of enzyme function: - a) Chymotrypsin b) Lysozyme c) Isomerase</li> </ul> <p><b>Regulation of Enzyme Function</b></p> <p>1)Control of enzyme activity by-</p> <p>a) Changes in covalent structure-irreversible and reversible</p> <p>b) Ligand-induced conformational changes-</p> <p>i) Allosteric enzymes- Basic concepts Cooperativity, the model proposed to explain the mechanism of functioning (MWC and KNF)</p> <p>ii) Structural aspects of aspartate carbamoyl transferase,</p> <p>iii) The role of allosteric enzymes in metabolic regulation (feedback inhibition).</p> <p>2)Enzymes in organized systems and their role in control function</p> <p>a) Multienzyme system- Basic concepts, significance and types with examples,</p> <p>b) Structural aspects of pyruvate dehydrogenase and fatty acid synthesis</p>	15
IV	<p><b>Oxidation of hydrocarbons</b></p> <p>1)Oxidation of hydrocarbons and Drug Metabolism</p> <p>a) Alkanes and alkenes and other hydrocarbons–alpha, beta, and omega oxidation.</p> <p>b) Aromatic hydrocarbons –beta ketoacid pathway, valerate pathway.</p> <p>c)Drug metabolism and detoxification.</p> <p>2)Osmosis, Oxygen toxicity and Microbial hormones</p> <p>a) Osmosis –definition, microbial response to osmotic stress, avoidance of osmotic stresses, responses of microbial –plasma –membrane –to osmotic –stresses. Reverse osmosis. Mechanism of ROS toxicity.</p> <p>b) Oxygen toxicity –catalase, peroxidase, superoxide dismutase, mechanism of O toxicity</p> <p>c)Microbial hormones and their significance.</p>	15

#### References

1. Biological Chemistry by Melhar H.R. and E.H. Cord 1968 Harper and RowPublisher inc New York
2. Biochemistry by Stryer, L. 1981 2nd edition, W.H. Freeman and company, Sanfrancisco.
3. Biochemistry by Stryer, L. 1988 3rd edition, W.H. Freeman and company, Sanfrancisco
4. Enzyme nomenclature- International Union of Biochemists (IUB) Academic press.
5. Understanding enzymes- Trevor Palmer Ellis Harwood Publications.

6. Fundamentals of Enzymology- N.C. Price and L. Stevenson, Oxford University Press.
7. Enzymes P.Boyer, Academic Press.
8. The Enzymes M. Dixon and E.C. Webb.
9. Advances in Enzymology- Series edited by N.O. Kaplan, Academic Press.
10. Enzyme structure and Mechanism- A. Fershit, Freeman, USA.
11. Biochemistry by Lehninger A.L. Kalyani Publisher, New Delhi
12. Principles of Biochemistry by Lehninger A.L.1984 1st Indian edition, LBS Publisher and Distributor Pvt. Ltd, New Delhi.
13. Basic Biochemistry 2nd Edition – Lehninger, A. L. (1984) Kalyani Publications,Ludhiyan, New Delhi.

Sem	Course code	Course/Title
II	2316204	<b>Major mandatory course I Pharmaceutical Microbiology</b>

Nature	Credits	Total Lectures	Workload Hrs/Week	Marks	
				CA	UA
Practical	2		4	20	30

**Objectives:**

To provide comprehensive knowledge of microorganisms relevant to pharmaceutical sciences and develop skills in sterilization, contamination control, quality assurance, and microbiological evaluation of pharmaceutical products as per regulatory standards.

**Outcomes:**

- Explain the role of microorganisms in pharmaceutical industries and their impact on product quality and safety.
- Apply sterilization, disinfection, and aseptic techniques in pharmaceutical manufacturing processes.
- Perform microbiological quality control tests for raw materials, finished products, and sterile preparations.
- Evaluate antimicrobial agents and preservatives used in pharmaceutical formulations.
- Assess microbial contamination and implement control measures in pharmaceutical environments.

**Practicals:**

1. Spectrophotometric / Microbiological methods for the determination of Griseofulvin.
2. Bioassay of Chloramphenicol by plate assay method or turbidimetric assay method.
3. Treatment of bacterial cells with cetrimide, phenol and detection of Leaky substances such as potassium ions, amino acids, purines, pyrimidines and pentoses due to cytoplasmic membrane damage.
4. To determine MIC, MBC, LD50 of Beta-lactam/aminoglycoside/tetracycline
5. Sterility testing by Bacillus stearothermophilus with chemical indicator strips.
6. Statistical sampling of pharmaceuticals for microbial contamination and load (syrups, suspensions, creams and ointments, ophthalmic preparations).
7. Determination of D value, and Z value for heat sterilization in pharmaceuticals.
8. Determination of the antimicrobial activity of a chemical compound (ethanol, phenol, resorcinol, thymol, formaldehyde) to that of phenol under standardized experimental conditions

**References**

1. Pharmaceutical Microbiology – Edt. By W. B. Hugo and A. D. Russell Sixth edition. Blackwell Scientific Publications.
2. Analytical Microbiology – Edt. By Frederick Kavanagh Volume I and II.
3. Quinolone antimicrobial agents – Edt. By David C. Hooper, John S. Wolfson. ASM Washington DC.
4. Quality control in the Pharmaceutical Industry – Edt. By Murray S. Cooper Vol. 2. Academic Press New York.
5. Biotechnology – Edt. By H. J. Rehm and G. Reed, Vol. 4. VCH Publications, Federal Republic of Germany

Sem	Course code	Course/Title
II	2316205	<b>Major mandatory course Microbial Biochemistry</b>

Nature	Credits	Total Lectures	Workload Hrs/Week	Marks	
				CA	UA
Practical	2		4	20	30

### Objectives:

To develop practical skills in biochemical analysis, enzyme purification, characterization, immobilization, and clinical enzyme assays.

### Outcomes:

- Prepare standard buffer solutions and determine physicochemical properties such as pKa of acids.
- Estimate biomolecules including carbohydrates, proteins, and lipids using quantitative biochemical methods.
- Perform enzyme extraction, partial purification, and quantitative assay of amylase and protease.
- Analyze the effect of substrate concentration, pH, temperature, and metal ions on enzyme activity and determine kinetic parameters ( $K_m$  and  $V_{max}$ ).
- Demonstrate enzyme immobilization techniques and evaluate stability and activity of immobilized enzymes.
- Conduct clinical enzyme assays such as LDH and ALP and interpret their diagnostic significance.

### Practicals:

1. Preparation of Buffers- Phosphate, Acetate, Citrate etc.
2. Determination of pKa of given acid
3. Estimation of total carbohydrates, proteins, lipids.
4. Studies on enzyme Amylase- a) Precipitation of enzyme by solvent & salt and partial purification by dialysis. b) Quantitative estimation of the enzyme and enzyme activity.
5. Effect of following factors on amylase activity a) Substrate concentration ( $S_0$ )- determination of  $V_{max}$  and  $K_m$ . b) pH for amylase activity c) Temperature for amylase activity. d) Metal ions for activity.
6. Immobilization of amylase in Na- alginate.
7. Studies on a) Stability- thermal storage - wet and dry b) Effect of Substrate concentration, temperature, pH on immobilized amylase/protease.
8. Study and detection of levels of lactate dehydrogenase, alkaline phosphatase in serum.
9. Assay of Protease

### References

1. Biological Chemistry by Melhar H.R. and E.H. Cord 1968 Harper and Row Publisher inc New York
2. Biochemistry by Stryer, L. 1981 2nd edition, W.H. Freeman and company, Sanfrancisco.
3. Biochemistry by Stryer, L. 1988 3rd edition, W.H. Freeman and company, Sanfrancisco
4. Enzyme nomenclature- International Union of Biochemists (IUB) Academic press.
5. Understanding enzymes- Trevor Palmer Ellis Harwood Publications.
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9. Advances in Enzymology- Series edited by N.O. Kaplan, Academic Press.
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11. Biochemistry by Lehninger A.L. Kalyni Publisher, New Delhi
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Sem	Course code	Course/Title
II	2316207	<b>DSE-II-Major elective course Bioinformatics and biostatistics</b>

Nature	Credits	Total Lectures	Workload Hrs/Week	Marks	
				CA	UA
Theory	4	60	4	40	60

**Objectives:**

- To introduce computational approaches for biological data analysis.
- To develop skills in handling biological databases and sequence analysis tools.
- To impart statistical concepts essential for biological research.
- To train students in applying biostatistical methods to experimental and research.

**Outcomes:**

Course outcome After completing this course students will be able to:

- After completing this course, students will be able to:
- CO-1 Use biological databases for sequence retrieval and analysis.
- CO-2 Perform basic bioinformatics analyses for DNA and protein sequences.
- CO-3 Apply statistical methods to analyze biological and microbiological data.
- CO-4 Interpret experimental results using appropriate biostatistical tools.
- CO5: Evaluate genomic and proteomics sequences after running query in databases like NCBI, DDBJ, SWISSPROT for similarities , dissimilarities etc.
- CO6: simulate protein models available in database in 3D using RasMol and PDB databank.

Unit	Particulars	Lectures
I	<p><b>Introduction to Bioinformatics</b> Introduction to Bioinformatics A. Definition, Goal, scope, and applications of bioinformatics B. Biological data types: genomic, transcriptomic, proteomic C. Biological databases- a. Primary databases: NCBI, GenBank, EMBL, DDBJ b. Protein databases: UniProt-KB, SWISSPROT, PIR c. Structural databases: PDB, NDB, CATH, SCOP d. Specialized databases: KEGG, Pfam, InterPro e. Literature database: Basic concept of open access, bibliographic resources related to Life Sciences, the major content of the databases, how to search and use these resources/databases with special reference to PubMed, PubMed Central, Public Library of Sciences etc.</p> <p><b>Phylogeny and Advanced Bioinformatics</b> a) Phylogenetic analysis and tree-building methods, b) Phylogenetic analysis algorithms such as Maximum Parsimony, UPGMA. Transformed Distance, Neighbors- Relation, and Neighbor-Joining; Probabilistic models and associated algorithms, such as Probabilistic models of evolution and the Maximum likelihood algorithm. c) Sequence Analysis – Algorithms, Types of Algorithms. d) Sequence analysis, pairwise alignment, programming, global and local alignment. e) Tools- BLAST and FASTA, Clustal Omega, and Clustal W, Muscle. f) Demonstration of databases (GENBANK, PDB, OMIC and OMIM) and software (RASMOL, Ligand Explorer).</p>	15
II	g) DNA microarray: understanding of microarray data and correlation of gene expression data to biological processes and computational analysis tools (especially clustering approaches).	15

	<p>h) Protein arrays: bioinformatics-based tools for analysis of proteomics data (Tools available at ExPASy Proteomics server); databases (such as InterPro) and analysis tools. Prediction of the 3D structure of proteins.</p> <p>Applications of Bioinformatics</p> <p>A. Sequence Analysis –</p> <ol style="list-style-type: none"> <li>Algorithms, Types of Algorithms.</li> <li>Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues and xenologues.</li> <li>Sequence analysis, pairwise alignment, programming-global and local alignment.</li> <li>Tools- BLAST and FASTA, Clustal omega and Clustal X, Muscle.</li> </ol> <p>B. Designing of primer and tools used for it.</p> <p>C. Open Reading frame (ORF), epitope and restriction sites prediction in genes.</p> <p>D. In silico prediction of mutation and concept of Bio-Edit</p> <p>E. DNA microarray: understanding of microarray data and correlation of gene expression data to biological processes and computational analysis tools (especially clustering approaches).</p> <p>F. Protein arrays: bioinformatics-based tools for analysis of proteomics data (Tools available at ExPASy Proteomics server); databases (such as InterPro) and analysis tools. Prediction of the 3D structure of proteins.</p> <p><b>Advanced Bioinformatics</b></p> <ul style="list-style-type: none"> <li>Motif searches, epitope prediction, data mining tools and applications, promoter and gene prediction, and comparative analysis.</li> <li>Demonstration of databases (GENBANK, PDB, OMIC and OMIM) and software (RASMOL, Ligand Explorer).</li> <li>DNA microarray: understanding of microarray data and correlation of gene expression data to biological processes and computational analysis tools (especially clustering approaches).</li> </ul> <p>Protein arrays: bioinformatics-based tools for analysis of proteomics data (Tools available at ExPASy Proteomics server); databases (such as InterPro) and analysis tools. Prediction of the 3D structure of proteins.</p>	
III	<p><b>Biostatistics and Univariate Data</b></p> <p>A. Importance of biostatistics in life sciences</p> <p>B. Types of biological data- primary Vs secondary, Qualitative Vs Quantitative, Variables.</p> <p>C. Classification and Representation of Data: Classification of data, organization of data, Tabulation of data, diagrammatic and graphical representation of data.</p> <p>D. Introduction to experimental designs – CRD, RBD, Factorial experiment.</p> <p>E. Measures of Central Tendency: Mean, Median, Mode.</p> <p>F. Measures of Dispersion: Range, Standard deviation, variance and coefficient of variance. Standard error. Skewness and concept of p value, F value</p>	15
IV	<p><b>Probability and Bivariate Data</b></p> <p>A. Probability: definitions, properties, and rules; Probability Distribution: Binomial, poisson and Normal distributions with their applications in biological system. Confidence interval.</p> <p>B. Correlation: Scatter diagram, Karl Pearson Coefficient of correlation.</p> <p>C. Regression: Lines of regression, regression coefficient.</p> <p>D. Hypothesis testing and Test Statistics: – error probabilities, critical region. Chi-square (X<sup>2</sup>) test for goodness of fit, Tukey’s HSD Test, t-test for comparison on means.</p> <p>E. Analysis of Variance (ANOVA): Introduction and types of ANOVA</p>	15

**References**

1. Bal H. P. (2003). Perl Programming for Bioinformatics. India: Tata McGraw-Hill. Ingvar
2. Baxevanis A. D., Ouellette B. F. F. (2009). Bioinformatics: a practical guide to the analysis of genes and proteins. 3rd Edition. India: Wiley India Pvt. Limited.
3. Eidhammer I., Taylor W. R., Jonassen I., Taylor W. R., Taylor W. R. (2004). Protein bioinformatics: an algorithmic approach to sequence and structure analysis. United Kingdom: Wiley.
4. Mallick B. and Ghosh Z. (2008). Bioinformatics: Principles and Applications. India: Oxford University Press.
5. Mount D. W. (2005). Bioinformatics: Sequence and Genome Analysis. India: CBS Publishers & Distributors.
6. Narayanan P. (2007). Essentials of Biophysics. India: New Age International.
7. Orengo C., Jones D. and Thornton J. (Editors). (2003). Bioinformatics: Genes, Proteins and Computers. United Kingdom: CRC Press.
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10. N. A., Banaganapalli B., Elango R. and Hakeem K. R. (2019). Essentials of Bioinformatics, Volume I: Understanding Bioinformatics: Genes to Proteins. Germany: Springer International Publishing.
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15. P. S. S. Sundar Rao, J. Richard, (2012): Introduction to Biostatistics and Research Methods, 4th Edition, PHI Learning Publication.
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17. Rastogi V B (2015): Biostatistics, 3rd Revised Edition, Medtech Publications, New Delhi

Sem	Course code	Course/Title
II	2316207	<b>Major elective course Physiology and metabolism</b>

Nature	Credits	Total Lectures	Workload Hrs/Week	Marks	
				CA	UA
Theory	4	60	4	40	60

**Objectives:**

Students will be able to understand Microbes' Physiology & their Metabolism provide insight knowledge on their sources of energy & utilization as they are tiny factories for the production of high-value low volume products to low-value high-volume products which are its primary & secondary metabolites.

**Outcomes:**

- Able to study the Transport mechanism of Nutrients across the cell membrane- Simple diffusion, facilitated diffusion, group translocation, active transport, and Passive transport.
- Able to understand the Electron transport chain and TCA Cycle.
- Able to learn the Biosynthesis of Purines and pyrimidines by de novo synthesis. Saturated fatty acids and Amino acid synthesis pathways.
- Able to study the Oxidation of hydrocarbons and Drug metabolism.
- Able to understand Osmosis, Oxygen toxicity and Microbial hormones.

Unit	Particulars	Lectures
I	<p><b>Transport in Bacteria</b></p> <ul style="list-style-type: none"> <li>• Transport mechanism of Nutrients across the cell membrane- Simple diffusion, facilitated diffusion, group translocation, active transport, and Passive transport.</li> <li>• Permeation – different permeation systems in E. coli amino acid permeases transport of inorganic ions physiological consequences and significance of permease mechanism.</li> </ul> <p><b>Electron transport chain and TCA Cycle</b></p> <ul style="list-style-type: none"> <li>• ETC: Concept, components involved in electron transport and oxidative phosphorylation, theories of ATP formation.</li> <li>• Bacterial Electron Transport Chain- photosynthetic and non- photosynthetic, aerobic and anaerobic bacterial ETC.</li> <li>• Mitochondrial ETC: structure of mitochondria, mitochondrial ETC, shuttle system across the membrane, Atkinson`s energy change.</li> <li>• Citric acid cycle: steps involved, amphibolic nature, anapleurotic reaction.</li> </ul>	20
II	<p><b>Biosynthesis</b></p> <ul style="list-style-type: none"> <li>• Purines and pyrimidines by de novo synthesis.</li> <li>• Saturated fatty acids.</li> </ul> <p>Amino acid synthesis pathways</p>	15
III	<p><b>Oxidation of Hydrocarbons and Drug Metabolism</b></p> <ul style="list-style-type: none"> <li>• Alkanes and alkenes and other hydrocarbons – alpha, beta, and omega oxidation.</li> <li>• Aromatic hydrocarbons – beta ketoadipate pathway, valerate pathway,</li> </ul> <p>Drug metabolism and detoxification.</p>	15
IV	<p><b>Osmosis, Oxygen toxicity and Microbial hormones</b></p> <ul style="list-style-type: none"> <li>• Osmosis – definition, microbial response to osmotic stress, avoidance of osmotic stresses, responses of microbial – plasma – membrane –to osmotic – stresses. Reverse osmosis.</li> </ul>	10

	<ul style="list-style-type: none"><li>• Oxygen toxicity – catalase, peroxidase, superoxide dismutase, mechanism of O<sub>2</sub> toxicity</li></ul> <p>Microbial hormones and their significance.</p>	
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## References

1. Bacterial Physiology and Metabolism by R. J. Sokath.
2. Metabolism by Doelle, Academic Press, London.
3. Biochemistry of Microbial growth – by Mandelstam.
4. Methods in Microbiology Vol. 3 A, Norris & Ribbons (eds) Academic Press.
5. Microbial Physiology – Dawes I. W., and Sutherland J. W, (1976) Halsted press
6. Metabolic Pathways 3rd edition – Greenberg D. M, (1976) Springer Verlag, New York
7. Microbial Physiology - Albert G. Moat, John W. Foster.

Sem	Course code	Course/Title
II	2316206	<b>Major elective course Bioinformatics and biostatistics</b>

Nature	Credits	Total Lectures	Workload Hrs/Week	Marks	
				CA	UA
Practical	2		4	20	30

**Objectives:**

- To develop the ability to use computational tools and databases for analysis, interpretation, and management of biological sequence and molecular data.
- To provide knowledge of statistical methods for designing experiments, analyzing biological data, and drawing valid scientific conclusions.

**Outcomes:**

After completing this course student will be able to:

After completing this course, students will be able to:

CO-1 Use biological databases for sequence retrieval and analysis.

CO-2 Perform basic bioinformatics analyses for DNA and protein sequences.

CO-3 Apply statistical methods to analyse biological and microbiological data.

CO-4 Interpret experimental results using appropriate bio statistical tools.

CO5: Evaluate genomic and proteomics sequences after running query in databases like NCBI, DDBJ, SWISSPROT for similarities, dissimilarities etc.

CO6: simulate protein models available in database in 3D using RasMol and PDB databank.

**Practicals:**

1. Retrieving protein and nucleic acid sequences from databases.
2. Assignment on Single and multiple Sequence alignment using BLAST, Clustal and Clustal W.
3. Assignment on Gen Bank and study of Nucleic acid and protein sequence data.
4. Studying protein 3D structure using RASMOL.
5. Measures of Central Tendency – Mean, Median, Mode, P value- problem solving.
6. Diagrammatic representation of data in Excel, histogram, introduction to R software, Origin Pro.
7. Graphical representation of data in Excel.
8. Measures of dispersion – Standard deviation and variance.
9. Estimation of the confidence interval for normal distribution.
10. A finding of correlation and regression of the data using Excel.
11. Student t-test and chi-square on sample data.
12. Study of experimental layout for CRD and RBD.
13. Primer designing using online tools
14. Phylogenetic tree construction and interpretation
15. Study of Structural diversity in protein using bioinformatic tool
16. In Silico Prediction of epitope, mutation and virulence gene.
17. Data presentation using graphs and charts

**References:**

1. Bal H. P. (2003). Perl Programming for Bioinformatics. India: Tata McGraw-Hill. Ingvar
2. Baxevanis A. D., Ouellette B. F. F. (2009). Bioinformatics: a practical guide to the analysis of genes and proteins. 3rd Edition. India: Wiley India Pvt. Limited.
3. Eidhammer I., Taylor W. R., Jonassen I., Taylor W. R., Taylor W. R. (2004). Protein bioinformatics: an algorithmic approach to sequence and structure analysis. United Kingdom: Wiley.
4. Mallick B. and Ghosh Z. (2008). Bioinformatics: Principles and Applications. India: Oxford University Press.

5. Mount D. W. (2005). Bioinformatics: Sequence and Genome Analysis. India: CBS Publishers & Distributors.
6. Narayanan P. (2007). Essentials of Biophysics. India: New Age International.
7. Orengo C., Jones D. and Thornton J. (Editors). (2003). Bioinformatics: Genes, Proteins and Computers. United Kingdom: CRC Press.

Sem	Course code	Course/Title
II	2316206	<b>Major elective course Physiology and metabolism</b>

Nature	Credits	Total Lectures	Workload Hrs/Week	Marks	
				CA	UA
Practical	2		4	20	30

**Objectives:**

To develop experimental skills in microbial physiology, biochemical analysis, and evaluation of disinfectants and cellular responses under different environmental conditions.

**Outcomes:**

- Explain and analyze mechanisms of nutrient transport such as glucose uptake in microorganisms.
- Determine microbial growth kinetics including specific growth rate and generation time.
- Quantitatively estimate cellular biomolecules such as proteins, carbohydrates, DNA, and RNA using chemical and colorimetric methods.
- Evaluate the efficacy of disinfectants by determining the phenol coefficient.
- Assess the effect of osmotic stress (hypotonic and hypertonic conditions) on microbial cells.

**Practicals:**

1. Study of glucose transport in yeasts.
2. Determination of specific growth rate and generation time of E. coli
3. Chemical estimation of the total protein content in bacteria
4. Chemical estimation of the carbohydrate content in bacteria
5. Colorimetric estimation of total DNA content in bacteria
6. Colorimetric estimation of RNA content in bacteria
7. Determination of phenol coefficient of disinfectants
8. Effect of hypotonic and hypertonic solutions on cell.

**References**

1. Bacterial Physiology and Metabolism by R. J. Sokath.
2. Metabolism by Doelle, Academic Press, London.
3. Biochemistry of Microbial growth – by Mandelstam.
4. Methods in Microbiology Vol. 3 A, Norris & Ribbons (eds) Academic Press.
5. Microbial Physiology – Dawes I. W., and Sutherland J. W, (1976) Halsted press
6. Metabolic Pathways 3rd edition – Greenberg D. M, (1976) Springer Verlag, New York
7. Microbial Physiology - Albert G. Moat, John W. Foster.

Sem	Course code	Course/Title
II	2316203	<b>OJT/FP</b>

Nature	Credits	Total Lectures	Workload Hrs/Week	Marks	
				CA	UA
Theory	4	60	4	40	60

### **On Job Training/ Field projects Guidelines for ON JOB Training / Field Projects**

#### **Introduction:**

India is going to have the largest working-age population in the world by 2030, but gainful employment for general-stream students is a major challenge. Improving the employability of these students requires a new vision with curricular support for employment. Apprenticeship/Internship has a prominent role to play in linking higher education with the requirements of the industry and the world of work. This is considered to be one of the most effective ways to develop skilled manpower for the country / Field Project program aims to promote comprehensive employment and training program that utilizes various training activities and field-based activities to systematically develop the employability of eligible youth. It provides for industry-led, practice-oriented and outcome-based learning. Striving to fulfil this objective of improving employability and forming robust industry-academia linkage. This will focus on outcome-based learning in the degree programme and will enable students to demonstrate workforce professional abilities for potential employment.

#### **The major advantages of On-the-Job Training include the following:**

1. It is relevant to the subject and the competencies to be acquired by the trainees, as it is directly in the context of a job.
2. It is most effective because it is learning by experience.
3. Trainees are more likely to retain the knowledge and skills, as they learn through hands-on training.
4. Trainees are highly motivated and develop self-confidence.
5. It helps trainees to understand and learn about the new tasks and skills that will help them to adapt to the new project more effectively.
6. It is useful in reducing the cost of training.
7. Trainees can also get an opportunity to earn while they learn.

#### **A. On-the-Job Training (OJT)**

OJT is a strategic training service that supports and encourages students in their hiring process by adding staff capacity. OJT benefits the students in a hands-on environment, acquire job and career advancement skills, and provides an opportunity for long-term employment.

#### **Objectives:**

1. To improve the employability of students pursuing postgraduate level.
2. To focus on outcome-based learning in degree programmes.
3. To promote active linkage between the higher education system and industry, non-commercial and commercial enterprises/organizations.
4. The HEIs should have a prior Memorandum of Understanding (MoU) with discipline-specific commercial and non-commercial organizations or enterprises, offices, industry etc. for providing apprenticeship/internship, before introducing the apprenticeship/internship embedded degree programme.
5. The HEIs may plan the number of seats for apprenticeship/internship training as per the facility and infrastructure available.

#### **Duration of OJT:**

The period of apprenticeship/internship training shall be a total of 60 Contact hours or 2hrs / day for 30 days along with regular lectures and practical sessions as mentioned in the curriculum.

### **Selection of Institute for On-Job Training:**

The following may serve as the important qualification descriptors for a UG/UG Honors/PG degree in Microbiology:

1. Knowledge of the diverse places where microbiology is involved.
2. Understanding of diverse Microbiological processes.
3. Basic skills such as culturing microbes, maintaining microbes, safety issues related to the handling of microbes, Good Microbiological practices etc.
4. Moderately advanced skills in working with microbes such as pilot scale culturing, downstream processes, diagnostics etc.
5. Ability to participate in teamwork through small microbiology projects.
6. Ability to present and articulate their knowledge of Microbiology.
7. Knowledge of recent developments in the area of Microbiology.
8. Analysis of data collected through study and small projects.
9. Ability to innovate to generate new knowledge.
10. Awareness of how some microbiology leads may be developed into the enterprise.
11. Awareness of requirements for the fruition of a microbiology-related enterprise. The Institute offers OJT should have all the Supportive services and facilities required to fulfil its aims and objectives. Tools, equipment and uniforms must be necessary to complete the training objectives; The tools and equipment remain the property of the OJT Service Provider while the worker is in training; The OJT institute requires to maintain daily attendance records for each Trainee employed under an OJT Agreement. These records may be kept in any of several ways including sign-in/out sheets, time clocks, or other time cards that record hours worked. The Employer must submit documentation that supports the number of hours worked each day by the Trainee at the time of examination.

### **Objectives of On Job Training:**

- Training is occurring as outlined in the Training Plan;
- Trainee is on target for skill attainment TRAINING
- The OJT Contract must be completed and signed before the OJT Trainee starts the OJT Training.
- The OJT Employer shall develop a training plan for the OJT Trainee that includes competencies needed to be satisfactorily skilled in the OJT position. These competencies will be listed on the Training Plan/Evaluation Form.
- The OJT Employer will provide an orientation to the OJT Trainee that covers, at a minimum, the OJT Employer's rules, expectations, safety information,
- No fees shall be charged to any OJT Trainee or OJT Employer for referral or placement services relative to this OJT contract.
- This contract may be amended by the mutual written agreement of the parties. All amendments shall be signed by both parties before the start date of the amendment and must be attached to the contract.
- Credits for the apprenticeship/internship programme shall be included in the total credits of the entire programme.
- The students must pass the apprenticeship/internship course. Reappearance for failed/uncompleted apprenticeship/internship training is mandatory.
- The marks secured by the student in the apprenticeship/internship course will be reflected in the semester and final grade sheet.

**Duration of OJT:**

The period of apprenticeship/internship training shall be total of 60 Contact hours Evaluation of OJT:  
Based on attendance, report submission  
Presentation/ Viva- Voce

The evaluation of OJT shall be of 100 marks of which 60 Marks for UA and 40 Marks for CA

**Field Project:**

Field Project is included in the programme where students work individually or in groups to design experiments to solve/answer a problem suggested by the Mentor or identified by the students in consultation with the Mentor. The students are mentored regularly during the duration of the project in progress.

**Evaluation of Field Project:**

The evaluation of FP shall be of 100 marks of which 60 Marks for UA and 40 Marks for CA.

**Punyashlok Ahilyadevi Holkar Solapur University, Solapur**  
**Structure for M. Sc. I (Sem I & II)**

**Subject: Microbiology**

**Equivalent Subjects for Old Syllabus**

**M.Sc. I Semester I**

<b>Paper No. and Name of the Old Paper NEP-2020 (wef June 2023)</b>	<b>Paper No. and Name of the New Paper NEP-2020 (wef June 2026)</b>
DSC I- Major mandatory course I Microbial Diversity and Taxonomy	DSC I- Major mandatory course Microbial Diversity and Taxonomy
DSC II- Major mandatory course II Recent Trends in Virology	DSC II- Major mandatory course Recent Trends in Virology
Major mandatory course I (Practical)	Major mandatory course Microbial Diversity and Taxonomy (Practical)
Major mandatory course II (Practical)	Major mandatory course Recent Trends in Virology (Practical)
DSE-I- Major elective course I – Diagnostic Microbiology Or Major elective course I Techniques in Microbiology I	DSE- I- Major elective course – Diagnostic Microbiology and AI Assistance Or Major elective course Techniques in Microbiology and AI Assistance
Major elective course I (Practical)	Major elective course (Diagnostic Microbiology and AI Assistance Or Techniques in Microbiology and AI Assistance) (Practical)
RM- Research Methodology	RM- Research Methodology

**M.Sc. I Semester II**

DSC III- Major mandatory course I Pharmaceutical Microbiology	DSC III- Major mandatory course Pharmaceutical Microbiology
DSC IV- Major mandatory course Microbial Biochemistry	DSC IV- Major mandatory course Microbial Biochemistry
Major mandatory course I (Practical)	Major mandatory course Pharmaceutical Microbiology (Practical)
Major mandatory course II (Practical)	Major mandatory course Microbial Biochemistry (Practical)
DSE-II-Major elective course II Bioinformatics and biostatistics Or Major elective course I Physiology and metabolism	DSE-II-Major elective course Bioinformatics and biostatistics Or Major elective course Physiology and metabolism
Major elective course I (Practical)	Major elective course Bioinformatics and biostatistics Or Major elective course Physiology and metabolism (Practical)
OJT/FP	OJT/FP

