Punyashlok Ahilyadevi Holkar Solapur University, Solapur

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

Name of the Faculty: Science & Technology

New Education Policy 2020

Syllabus: MICROBIOLOGY

Name of the Course: M.Sc. I (Sem I & II)

(Syllabus to be implemented from June 2023)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Proposed structure for Two-year PG Program (M. Sc.) Degree

Subject: Microbiology

Sr. No	Course/Title	Nature	Credit	Marks	
				CA	UA
	SEMESTER- I				
1	DSC I- Major mandatory course I Microbial Diversity and Taxonomy	Theory	4	20	80
2	DSC II- Major mandatory course II Recent Trends in Virology	Theory	4	20	80
3	Major mandatory course I	Practical	2	10	40
4	Major mandatory course II	Practical	2	10	40
5	DSE- I- Major elective course I Diagnostic Microbiology Or Major elective course I Techniques in Microbiology I	Theory	4	20	80
6	Major elective course I	Practical	2	10	40
7	RM- Research Methodology	Theory	4	20	80
	Total credits with marks		22	110	440
	SEMESTER-II				
1	DSC III- Major mandatory course I Pharmaceutical Microbiology	Theory	4	20	80
2	DSC IV- Major mandatory course Microbial Biochemistry	Theory	4	20	80
3	Major mandatory course I	Practical	2	10	40
4	Major mandatory course II	Practical	2	10	40
5	DSE-II-Major elective course II Bioinformatics and biostatistics Or Major elective course I Physiology and metabolism	Theory	4	20	80
6	Major elective course I	Practical	2	10	40
7	OJT/FP		4	20	80
	Total credits with marks		22	110	440

Revised Syllabus for the Master of Science in Microbiology,

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

(National Education Policy 2020)

Applicable from the academic year 2023 – 2024 (July 2023) for M.Sc. Part I and Part II (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 July 2023 and for M. Sc. II (Semester III and Semester IV): From July 2024.

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, less 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.

Eligibility of Course:

- Eligibility: A Candidate possessing Bachelor's Degree in Microbiology as a principal subject and who has passed the entrance examination conducted by the PAH 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 2credits 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: 80 marks theory assessment by University examination (UA) and 20 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:
- 40 marks practical assessment by the University examination (UA) and 10 marks internal assessment by the college (CA).

M. Sc. (Microbiology) Part – I (Sem- I)

Major Mandatory Course- I

DSC- I Microbial Diversity and Taxonomy ((4 Credits, Total -60 L)

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.

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 I **Microbial Evolution and Systematics** **10 L**

- Origin of cellular life
- Microbial Diversification: Consequences for Earth's Biosphere
- Endosymbiotic Origin of Eukaryotes
- Microbial Evolution
- The Evolutionary Process
- Evolutionary Analysis: Theoretical Aspects
- Evolutionary Analysis: Analytical Methods
- Microbial Phylogeny -Introduction
- Phylogenetic Methods

Unit-II Concept of speciation and species **5 L**

- Differences in the concept of 'species' in eukaryotes and prokaryotes.
- Definition of species in prokaryotes.
- Types of 'species'
- Current Definition of Prokaryotic Species

Unit-III Bacterial Taxonomy: **20 L**

- Definition, nomenclature rules and identification, hierarchical organization and the position of microbes in the living world.
- Classification systems – artificial and phylogenetic– dendrogram. Haeckel's three-kingdom classification, Whittaker's five-kingdom approach, and Three domain classification of Carl Woese.
- 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.
- significance of 16SrRNA in microbial taxonomy, Numerical Taxonomy and Chemotaxonomy.
- Bergey's Manual of determinative bacteriology.

Unit- IV Characteristics and Classification of Archaebacteria. 15 L

A) Thermophiles:
Classification, hyperthermophilic habitats and ecological aspects. Extremely Thermophilic Archaebacteria, commercial aspects of thermophiles. Applications of thermozymes.
B) Methanogens:
Classification, Habitats and applications
C) Alkalophiles and Acidophiles:
Classification, alkaline environment, soda lakes and deserts, life at low pH, acid tolerance and applications.
D) Halophiles and Barophiles
Classification, Dead Sea, discovery basin, cell walls and membranes, Osmoadaptation / halotolerence, high-pressure habitats, life under pressure, barophily, death under pressure. and applications and their extremozymes.
E) Psychrophiles

Unit- V Characteristics and Classification of Eukaryotes 10 L

General characteristics and outline classification of

- Fungi
- Yeasts
- Lichens and Mycorrhiza
- Algae
- Protozoa

Practical- Microbial Diversity Credit:02

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)

7. Isolation and Morphological studies of the following Eukaryotes.

- 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

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) Bergy'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.

Major Mandatory Course- II

DSC- II Recent Trends in Virology ((4 Credits, Total -60 L)

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: I: Classification and Morphology of Viruses. 12L

1. Introduction, general characteristics and discovery of viruses
2. Morphology and ultra-structure of viruses
3. Concept of Viroids and Prions.
4. Classification and nomenclature of animal and plant viruses **in detail**.

Unit: II: Viral replication 10 L

1. Bacteriophages –
   a) Lytic life cycle
   b) Lysogenic interactions and cascade
2. Animal viruses —DNA and RNA viruses.
3. Mechanism of virus adsorption and entry into the host cell, genome replication, transcription, post-transcriptional changes, translation, assembly, exit and maturation of progeny virions

Unit: III: Cultivation and assay of viruses. 12 L

1. Cultivation of viruses by using

a) Embryonated eggs
b) Experimental animals
c) Cell cultures.

2. Purification of viruses by
   a) Adsorption,
   b) Precipitation,
   c) Enzymatic and serological methods
   d) Hemagglutination
   e) ELISA.
3. Assay of viruses –
   a) Physical and Chemical methods.
   b) Infectivity Assays.
4. Genetic analysis of viruses by genetic methods.

   Animal and plant viruses- DNA and RNA viruses

Unit: IV: Pathogenesis of Viruses . 14 L

1. Host and viral factors involved in pathogenesis,
2. Pathogenesis of animal viruses: one example each DNA viruses- SS,DS, RNA viruses - SS,DS
3. Pathogenesis of plant viruses [TMV], Satellite viruses and their role in plant virusreplication. Insect viruses [NPV]
4. Host cell transformation by viruses, oncogenesis by DNA and RNA viruses.
5. Pathogenesis of viroids and prions

Unit: V: Control of Viruses and Emerging Viral Infections . 12L

1. Control of viral infections with
    a) Vaccines
    b) Antiviral drugs
    c) Antibodies
    d) Interferons
    e) Topical antiviral chemicals- detergents, alcohols and antiseptics
2. **Emerging viral infections:**
    a) SARS.
    b) EBOLA,
    c) Coronavirus.
    d) Zikavirus
    e) Influenza viruses,
    f) Chikungunya,
    g) Nipah virus.

Practical
Major mandatory II-
Recent Trends in Virology

Credits- 2

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. NewYork.
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 Publication.10.Principles of virology by Edward Arnold. 2000.

11. Medical virology by Morag and Tim, 10th Edition. Churchil Livingstone publication, London.

Major Elective Course -I

DSE- I Diagnostic Microbiology (4 Credits, Total -60 L)

Course learning outcomes:

1]Full knowledge of working in a microbiology laboratory taking all safety measures, handling live bacteria, disposal of infectious waste, care of the equipment

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.

3] Have developed a very good understanding of the practical aspects of the diagnosis of common human infections.

Unit- I: Microbiological Laboratory and Safe Practices 12 L

- Good laboratory practices - Good laboratory practices, Good microbiological practices.
- Biosafety cabinets – Working on biosafety cabinets, using protective clothing, and specification for BSL-1, BSL-2, and BSL-3.
- Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration

Unit- II: Microbial Diseases 14 L

Etiological agent, modes of transmission, pathogenesis, symptoms, laboratory diagnosis, prophylaxis and treatment of following diseases

1) Bacterial: *Helicobacter pyelori, leptospirosis*
2) Viral: *Herpes, Rubella and Rubiola*
3) Protozoal: *Balantidium coli, Ascaris lubricoides*

Unit- III: Collection of Clinical Samples 6 L

- Definition, types, methods of collection of clinical samples (oral cavity, throat, skin, Blood, CSF, urine and faeces) and precautions required.
- Method of transport of clinical samples to laboratory and storage.

Unit- IV: Diagnosis of Microbial Diseases 18 L

1) Traditional methods
2) Serological methods
3) Molecular techniques: PCR, RFLP, rRNA

4) Diagnostic instruments- Vitek

Unit-V: Human Microbio meand Health 10 L

- Introduction, Diversity,
- Human microbiome and disease association, microbiome and therapy: Probiotic therapy, faecal transplant therapy

References

1) Medical Microbiology,13th EditionbyE.Jawetz,J.L.Melnick,E.A.Adelberg

2) Medical Microbiology,6thEditionbyS.Gupte,JaypeeBrothersPublications

3) Medical Microbiology,byW.Irving,T.BoswellandD.Aladeen.

4)MedicalMicrobiology,byR.Cruickshank,J.P.Duguid,B.P.Marmion,R.H.A.Swain.

5) TheTextbook of Microbiology, by R.C.DubeyandD.K.Maheshwari.

6) Textbook of Microbiology by R.Vasanthkumari.

7) Medical Microbiology by S.RajanMJPPublishers.

8) Unsworth K. E. and David W. Holden, (2000), Identification and analysis ofbacterial 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 pathogenesisofmelioidosis and glanders, Trends Microbiol, 10(11):483-5

10) Eduardo A. G.roisman 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 andSerology, 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 Pathogenecity, inMicrobiology – 1979, American Society for Microbiology, Washington D. C., 79-230

14) Mark J. Pallen1 & Brendan W. Wren, (2007), Bacterial pathogenomics, NatureRev. 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 ofhost-cell pathways by bacterial pathogens, Nature Rev 449/18:827-834

17) David N. Fredricks and David A. Relman, (1996), Sequence-Based Identificationof Microbial Pathogens: a Reconsideration of Koch's Postulates, ClinicalMicrobiology Reviews, 18–33

Major elective I- Diagnostic Microbiology

Practical (LAB. COURSE)

(Credits- 2)

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

Major Elective Course -II

DSE- II Techniques in Microbiology-I (4 Credits, Total -60 L)

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- I : Introduction to Microbiological Laboratory Instruments- Principle, Working and Applications 12 L

a) pH meter

b) Colorimeter, and Spectrophotometer.

c) Laminar airflow and Bio-safety cabinet.

d) Centrifuge machine

e) Electron microscope, fluorescence, dark field and phase contrast microscope.

Unit- II Analytical Techniques 12 L

a) Radio-isotopic techniques- nature of radioactivity
b) Methods of detection and measurement
c) Methods of Applications – tracer, autoradiography.
d) Chromatographic techniques Paper and TLC Chromatography.
e) Electrophoretic techniques – Agarose and SDS- PAGE
f) Centrifugation and its types- Preparatory and Analytical

Unit-III Spectroscopy 10 L

Principles and Applications of the Following Techniques

a)Principles, instrumentation and applications

UV-visible spectrophotometry

b)IR and NMR,
c)fluorescence and atomic absorption
d)ORD and CD spectroscopy

Unit- IV Advanced Microscopy 14 L

Principles and Applications of the following microscopy

i) Confocal fluorescence microscopy
ii) Multiphoton microscopy, Image deconvolution and quantification,
iii) Advanced fluorescence microscopy techniques: Foerster Resonance Energy Transfer (FRET) microscopy,
iv) Fluorescence Lifetime Imaging microscopy (FLIM) and Fluorescence Correlation Spectroscopy (FCS),
v) Total internal Reflection Fluorescence (TIRF) microscopy, Breaking the diffraction barrier: Concept of optical superresolution,
vi) Stimulation Emission Depletion (STED) microscopy, Single-molecule localization microscopy:
vii) Stochastic Optical Reconstruction Microscopy (STORM) and
viii) Photoactivation Localization Microscopy (PALM).
ix) STEM- Scanning Tunnelling Electron Microscopy

Unit- V Nanobiotechnology 12 L

1. Introduction to Nanotechnology:
2. Different types of nanoparticles,
3. Nanoparticles synthesis and characterization,
4. Biomimetics and nanotechnology.
5. Applications of Nanobiotechnology: Quantum dots, magnetic nanoparticles and plasmonic nanoparticles in biology and medicine, Carbon nanotubes and graphene

6. Nanotechnology in agriculture – Fertilizers and pesticides.

Techniques in Microbiology-I

Practical [credits -2]

1. Determine the pH of the solution using a pH meter and preparation of buffers using KH2PO4 and K2HPO4, acetic acid and sodium acetate, K2HPO4 and H3PO4.
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 Nölting, 2nd Edition Springer 2006
5. Biophysics – VasanthaPattabhi 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 PublicationHouse, Mumbai.

Research Methodology (RM)

(Credits -4, Total Lectures- 60)

Learning 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 I **7 L**

a) Introduction to Research: Meaning, Objectives, Motivation,
b) Utility of Research,
c) Types of Research
d) Methods of Research

Unit- II **16 L**

a) Research Design: 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 & Dependent Variables

b) Hypothesis: Meaning, characteristics of good hypothesis, types

Unit III: Literature survey **7 L**

a) Literature survey using the Internet
b) Use of search engines like Google / NCBI / PUBMED and other resources for searching the literature

Unit IV: Tools and Techniques of Data Collection **10 L**

a) Sources of Data Collection: Primary and Secondary.

b) Data collection methods/ Tools and Techniques

Unit V: Scientific Communication **20L**

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, 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, Inflibnet, Shdhaganga.
9. Preparing and submitting the manuscript. Revising, editing, proofreading

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

D. Problem while writing scientific documents: plagiarism, software for plagiarism.
E. Scientific presentation: oral, online and poster

Reference books:

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 towrite 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 Pres

M.Sc. (Microbiology) – Part – I
SEMESTER – II
Major Mandatory Course- III
DSC- III Pharmaceutical Microbiology ((4 Credits, Total -60 L)

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.

Outcome-

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

Syllabus

Unit – I principles of Chemotherapy 12 L

- Origins of antimicrobial drugs
- Characteristics of ideal antimicrobial agents
- Classification of antimicrobial agents: antibiotic [classification in detail]
- Mechanism of Action of Antimicrobial Agents:
- Bacterial resistance to antibiotics.
- Mechanism of action of Chemical disinfectants, antiseptics and preservatives

Unit-II Molecular Principles of drug targeting ,gene therapy 12 L

- Molecular Principles of drug targeting
- Drug delivery system in gene therapy.
- Penetrating defences- How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion).

Unit –III **12 L**

Microbial Production and Spoilage of Health Care Products:

- 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).
- New vaccine technology, DNA vaccines, synthetic peptide vaccines, and multivalent subunit vaccines. Vaccine clinical trials.

Unit–IV **12 L**

Regulatory Practices, Biosensors.Applications in Pharmaceuticals:

- Financing R & D capital and market outlook, IP, BP, USP.Government regulatory practices and policies, FDA perspective Reimbursement of drugs and biological, legislative perspective.
- Rational drug design Immobilization procedures for pharmaceutical applications (liposomes).
- Macromolecular , cellular and synthetic drug carriers. Biosensors in pharmaceuticals. Application of microbial enzymes in pharmaceuticals.

Unit –V **12 L**

Quality Assurance and Validation of Pharmaceutical products:

- 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.
- Sterilization control and sterility testing (heat sterilization, D value, Z value, F value, survival curve, Radiation, gaseous and filter sterilization), environmental monitoring,waste disposal.

- Chemical and biological indicators. Design and layout of sterile product manufacturing unit (Designing of Microbiology laboratory) Safety in Microbiology laboratory

Major mandatory I (Pharmaceutical Microbiology)

Practical

(Credits- 2)

1. Spectrophotometric / Microbiological methods for the determination of Griseofulvin.
2. Bioassay of Chloramphenicol by plate assay method or turbidometric 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. Quinolinone 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.

Major Mandatory Course- IV
DSC- IV Microbial Biochemistry ((4 Credits, Total -60 L)

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.

Outcome:-

- 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- I Biomolecules **12 L**

1) Protein Chemistry: -
   a) Amino acids: - Classification, structural features and Chemical reactions.
   b) Protein Structure and Types
   c) Ramachandran Plot
   d) Hormones -examples
2) Carbohydrates chemistry: -
   a) Nomenclature
   b) Types and structures
3) Lipid Chemistry: -
   a) Fatty acids, structure and types
   b) Types of lipids and structural aspects
   c) Steroids, Terpenes and Prostaglandins.
4) Vitamins: -
   a) Water-soluble and fat-soluble vitamins
   b) Structure and functions of vitamins
5) Chemistry of Porphyrins, bacterial pigments (Chlorophylls), Cytochromes, Hemoglobin, Leghemoglobin and Bacteriorhodopsin.

Unit- II Kinetics of Enzyme 12 L

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
3) Kinetics of multi-substrate reactions
4) Enzyme Inhibition: - Basic Concept, Kinetics, examples and significance of reversible and irreversible inhibition.

Unit- III Catalytic Power of Enzymes 12 L

1) The basic concept of catalysis- activation energy barrier and the transition state theory
2) Enzyme catalytic mechanisms: - Acid-base, covalent and electrochemical reactions
3) 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
4) Examples of enzyme function: -
   a) Chymotrypsin
   b) Lysozyme
   c) Isomerase

Unit-IV Regulation of Enzyme Function **12 L**

1) Control of enzyme activity by-

   a) Changes in covalent structure- irreversible and reversible
   b) Ligand-induced conformational changes-
      i) Allosteric enzymes- Basic concepts Cooperativity, the model proposed to explain the mechanism of functioning (MWC and KNF)
      ii) Structural aspects of aspartate carbamoyl transferase,
      iii) The role of allosteric enzymes in metabolic regulation (feedback inhibition).

2) Enzymes in organized systems and their role in control function

   a) Multienzyme system- Basic concepts, significance and types with examples,
   b) Structural aspects of pyruvate dehydrogenase and fatty acid synthesis

Unit-V Oxidation of hydrocarbons **12L**

1) Oxidation of hydrocarbons and Drug Metabolism
   a) Alkanes and alkenes and other hydrocarbons– alpha, beta, and omega oxidation.
   b) Aromatic hydrocarbons – beta ketoadipate pathway, valerate pathway.
   c) Drug metabolism and detoxification.

2) Osmosis, Oxygen toxicity and Microbial hormones
   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.
   b) Oxygen toxicity – catalase, peroxidase, superoxide dismutase, mechanism of O toxicity
   c) Microbial hormones and their significance.

Subject: - Microbial Biochemistry

Practical

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 (So)- determination of Vmax and Km.
    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 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 UniversityPress.
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. Kalyni Publisher, New Delhi
12. Principles of Biochemistry by Lehninger A.L.1984 1st Indian edition, LBSPublisher and Distributor Pvt. Ltd, New Delhi.
13. Basic Biochemistry 2nd Edition – Lehninger, A. L. (1984) Kalyani Publications,Ludhiyan, New Delhi.

Major Elective Course II

DSE-II-Bioinformatics and Biostatistics (Credits-4, Total Lectures- 60)

Unit- I Introduction to Bioinformatics 10L

a) Introduction to biological information and databases:-
   i) Nucleic acid,
   ii) proteins,
   iii) Genome structure and sequence databases
   iv) search engines,
   v) sequence data forms and submission tools,
   vi) scoring matrices for sequence alignments, algorithms pairwise sequence alignments, database similarity searches-BLAST, FASTA

b) Nucleic acid sequence databases:
   i) GenBank, EMBL, DDBJ

c) Protein sequence databases: SWISS-PROT, TrEMBL.

d) Genome Databases at NCBI, EBI, TIGR, SANGER Viral Genomes Archael and Bacterial Genomes

e) Open access bibliographic resources and literature databases: 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.

Unit- II Phylogeny and Genomics: 10 L

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 Maximum likelihood algorithm.

c) Genomics and Proteomics. Large-scale genome sequencing strategies. Gene networks/basic concepts, computational models such as Lambda receptor

and Lac-operon.

d) Functional genomics: application of sequence-based and structure-based approaches to the assignment of gene functions

Unit- III Advanced Bioinformatics 10 L

a) Motif searches, epitope prediction, data mining tools and applications, promoter and gene prediction, and comparative analysis.

b) Demonstration of databases (GENBANK, PDB, OMIC and OMIM) and software (RASMOL, Ligand Explorer).

c) DNA microarray: understanding of microarray data and correlation of gene expression data to biological processes and computational analysis tools (especially clustering approaches).

d) 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.

Unit IV – Biostatistics and Univariate Data 15 L

1) Biostatistics: Introduction, Basic terms, Sampling methods, Types of data – primary *Vs* secondary, Qualitative *Vs* Quantitative, Variables.

2) Classification and Representation of Data: Classification of data, organization of data, Tabulation of data, diagrammatic and graphical representation of data.

3) Measures of Central Tendency: Mean, Median, Mode. Measures of Dispersion: Range, Standard deviation, variance and coefficient of variance. Standard error. Skewness and Kurtosis, P value.

Unit V – Probability and Bivariate Data 15 L

1) Probability: definitions, properties and rules; Probability Distribution: Binomial, poisson and normal distribution with their applications in biological system. Confidence interval.

2) Correlation: Scatter diagram, Karl Pearson Coefficient of correlation. Regression: Lines of regression, regression coefficient.

3) Hypothesis testing and Test Statistics: – error probabilities, critical region. Chi-square (χ^2) test for goodness of fit. t-test for comparison on means.

4) Analysis of Variance (ANOVA): Introduction and types of ANOVA Introduction to experimental designs – CRD, RBD, Factorial experiment.

References:

Bioinformatics

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.

8. Ramsden J. J. (2012). Bioinformatics: An Introduction. Netherlands: Springer Netherlands.

9. Rastogi S. C., Rastogi P. and Mendiratta N. (2013). Bioinformatics: Methods and Applications: (Genomics, Proteomics and Drug Discovery). India: PHI Learning.

10. Shaik 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.

11.Chap T. Le, Lynn E. Eberly, (2016): Introductory Biostatistics, 2nd Edition, Wiley Publications

12.Jan Lepš, Petr Šmilauer (2020): Biostatistics with R: An Introductory Guide for Field Biologists, Cambridge University Press.

13.Khan, Khanum, Shiba Khan (2020): Fundamentals of Biostatistics, Edition – 6th, Ukaaz Publications, Hyderabad.

14. N. Gurumani (2021): An Introduction to Biostatistics, 2nd Revised Edition, MJP Publishers, Chennai

15.P. S. S. Sundar Rao, J. Richard, (2012): Introduction to Biostatistics and Research Methods, 4th Edition, PHI Learning Publication.

16.Pundir S.K. (2022): Biostatistics, CBS Publishers and Distributors Pvt. Ltd., New Delhi

17.Rastogi V B (2015): Biostatistics, 3rd Revised Edition, Medtech Publications, New Delhi

Major elective course 2

Bioinformatics and Biostatistics

Practical [credits –2]

1. Assignment on Google for scientific information search by using Pub Med/Medline/Pub MedCentral for biological information.
2. Retrieving protein and nucleic acid sequences from databases.
3. Assignment on Single and multiple Sequence alignment using BLAST, Clustal and Clustal W.
4. Assignment on Gen Bank. and study of Nucleic acid and protein sequence data.
5. Studying protein 3D structure using RASMOL.
6. Measures of Central Tendency – Mean, Median, Mode, P value- problem solving
7. Diagrammatic representation of data in Excel, histogram,introduction to R software, Origin Pro.
8. Graphical representation of data in Excel.
9. Measures of dispersion – Standard deviation and variance
10. Estimation of the confidence interval for normal distribution.
11. A finding of correlation and regression of the data using Excel.
12. Student t-test and chi-square on sample data.
13. Study of experimental layout for CRD and RBD.

Major Elective Course 2

DSE II- Microbial Physiology and Metabolism (Credits-4, Total Lectures- 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- I Transport in Bacteria 12L

1) Transport mechanism of Nutrients across the cell membrane- Simple diffusion, facilitated diffusion, group translocation, active transport, and Passive transport.
2) Permeation – different permeation systems in ***E. coli*** amino acid permeases transport of inorganic ions physiological consequences and significance of permease mechanism.

Unit-II Electron transport chain and TCA Cycle 12 L

1) ETC: Concept, components involved in electron transport and oxidative phosphorylation,theories of ATP formation.
2) Bacterial Electron Transport Chain- photosynthetic and non-photosynthetic, aerobic andanaerobic bacterial ETC.
3) Mitochondrial ETC: structure of mitochondria, mitochondrial ETC, shuttle system acrossthemembrane, Atkinson`s energy change.
4) Citric acid cycle: steps involved, amphibolic nature, anapleurotic reaction.

Unit- III Biosynthesis 12 L

1) Purines and pyrimidines by de novo synthesis.
2) Saturated fatty acids.
3) Amino acid synthesis pathways

Unit-IV Oxidation of Hydrocarbons and Drug Metabolism 12 L

1) Alkanes and alkenes and other hydrocarbons – alpha, beta, and omega oxidation.
2) Aromatic hydrocarbons – beta ketoadipate pathway, valerate pathway,
3) Drug metabolism and detoxification.

Unit-V Osmosis, Oxygen toxicity and Microbial hormones 12L

1) Osmosis – definition, microbial response to osmotic stress, avoidance of osmotic stresses, responses of microbial — plasma — membrane —to osmotic — stresses. Reverse osmosis.
2) Oxygen toxicity – catalase, peroxidase, superoxide dismutase, mechanism of O2 toxicity
3) Microbial hormones and their significance.

Major Elective Course 2

Microbial Physiology and Metabolism (Credits-2)

Practical

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. Colourimetric estimation of total DNA content in bacteria
6. Colourimetric estimation of RNA content in bacteria
7. Determination of phenol coefficient of disinfectants
8. Effect of hypotonic and hypertonic solutions on cell.

References:

Microbial Physiology and Metabolism

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 John John Wiley & So

On Job Training/ Field projects

Guidelines for ON JOB Training / Field Projects

I. 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.OJT / 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/organisations.
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:

1. 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; and

TRAINING

1. The OJT Contract must be completed and signed before the OJT Trainee starts the OJT Training.

2. 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.

3. The OJT Employer will provide an orientation to the OJT Trainee that covers, at a minimum, the OJT Employer's rules, expectations, safety information,

4. No fees shall be charged to any OJT Trainee or OJT Employer for referral or placement services relative to this OJT contract.

5. 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.

6. Credits for the apprenticeship/internship programme shall be included in the total credits of the entire programme.

7. The students must pass the apprenticeship/internship course. Reappearance for failed/uncompleted apprenticeship/internship training is mandatory.

8. The marks secured by the student in the apprenticeship/internship course will be reflected in the semester and final grade sheet.

Duration of OJT**:**

1. 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 80 Marks for UA and 20 Marks for CA

B. 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 80 Marks for UA and 20 Marks for CA.