GENERAL INSTRUCTIONS
and
COURSE CURRICULUM

FOR

Ph.D. in MICROBIOLOGY

(Effective from June, 2024)

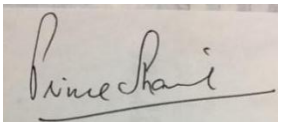
DEPARTMENT OF MICROBIOLOGY

HIMACHAL PRADESH UNIVERSITY

(NAAC Accredited "A" Grade University)

SUMMERHILL – SHIMLA – 171005 (HP) – India

www.hpuniv.ac.in/micro



Ph. D in MICROBIOLOGY PROGRAMME

GENERAL INSTRUCTIONS/ GUIDELINES FOR EXECUTION OF CURRICULUM

All candidates admitted to the Ph.D. programme at the Department of Microbiology have to complete a minimum of 12 credits. The students have to take a minimum of 3 compulsory courses **[PhDMICRO-101, PhDMICRO-102, and PhDMICRO-103]** and at least one additional course which may be out of four **elective courses [PhDMICRO-104 (i), PhDMICRO-104 (ii), PhDMICRO-104 (iii), and PhDMICRO-104 (iv)]**. A Ph.D. scholar must obtain a minimum of 55% marks or its equivalent grade in the UGC 10-point scale in the course work to be eligible to continue in the programme and submit his or her thesis. The detailed syllabi for the courses offered by the Department are appended with a list of suggested readings.

Outline of the Course work for Ph.D. Microbiology

Course No.	Title of the course	Credit Hours	Total Marks
Compulsory Courses			
PhDMICRO-101 (Common with all disciplines under faculty of life sciences)	Research Methodology	4	100
PhDMICRO-102 (Common with all disciplines under faculty of life sciences)	Research and Publication Ethics	2	50
PhDMICRO-103	Instrumentation Methods of Analysis	2	50
Elective any one of the following i.e. PhDMICRO-104 (i-iv)			
PhDMICRO-104 (i)	Cell And Molecular Biology	4	100
PhDMICRO-104 (ii)	Medical Microbiology	4	100
PhDMICRO-104 (iii)	Environment Microbiology	4	100
PhDMICRO-104 (iv)	Enzyme Technology	4	100
Total Credits/ Marks		**12**	**300**

Ph. D in Microbiology (Compulsory Course)
COURSE No.: PhDMICRO-101
RESEARCH METHODOLOGY

TOTAL HOURS: 60 CREDITS: 4	Theory Marks: 100
Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing twenty (20) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks (20 Marks each).	

Course objectives:

i. To provide basic framework and guidelines for researchers to clearly and define research problems, hypotheses, and objectives. Learning outcomes

Course learning outcomes:

i. Will help the researchers to identify the most appropriate research design, sampling technique, and data collection and analysis methods.

ii. Researchers will be able to understand and comprehend the basics of research methodology and applying them in their research

Unit I **15**

Foundation of Research: Meaning, objectives of research; criteria of good research; basic steps of research; Qualitative and Quantitative Research.

Problem Identification & Formulation: selection of research problem.

Hypothesis: Qualities of a good Hypothesis, Null & Alternative Hypothesis, Hypothesis Testing, Logic & Importance

Review of related literature: Meaning, necessity and sources.

Unit II **15**

Research process and Experiment Design: Concept and Importance in Research, features of a good research design, Exploratory Research Design concept, types and uses, Descriptive Research Designs concept, types and uses, Concept of Independent & Dependent variables.

Research Report: Writing preliminaries, main body of research, references and bibliography

Research and Development of Projects: Project formulation, National and international funding agencies for R & D projects, proposal submission, Intellectual Property Right (IPR).

Unit III **15**

Sampling: Meaning and types of sampling; Probability and Non-Probability, Practical considerations in sampling and sample size.

Tools and Techniques of Data Collection: questionnaire, schedule, interview, observation, case study, survey etc. statistics and its significance in research.

Data Analysis: Frequency distribution, measures of central tendency, measures of dispersion, correlation, regression analysis, test of significance (Z-test, t-test, Chi-square test, F-test).

Unit IV **15**

Use of Tools / Techniques for Research: Search engines: NCBI, PubMed, Google Scholar, Thomson Reuters, SCI etc, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office. Bioinformatics tools and applications.

Reference Books [Latest Edition]

1. Council of Biology Editors –CRE Style Manual, American Institute of Biological Sciences, Washington. D.C.
2. Effective Writing for Engineers, Managers, Scientists: Tichy AJ.
3. Scientific and Technical papers: Tribcase SF.
4. How to write and publish a scientific paper: Day RA..E.

Ph. D in Microbiology (Compulsory Course)
COURSE No.: PhDMICRO-102
Research and Publication Ethics

TOTAL HOURS: 30 CREDITS: 2	Theory Marks: 50
Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks (10 Marks each).	

Course objectives:

i. To provide students with the fundamental knowledge of basics of philosophy of science, ethics in research and publication.
ii. Concept and understanding of predatory publication, indexing, citation databases, open-access publications and research matrices such as citations, h-index, i-index, impact factor, research interest score etc.
iii. Guide and mentor students in using plagiarism checking tools for a valid and ethical research.
iv. To prepare an evaluation report of a manuscript/ article.

Course learning outcomes:

i. The students will be able to know and practice ethical principles involved in research work and in publication that will help in maintaining integrity and credibility of scientific literature

Unit 1 **7**

Philosophy, ethics and scientific conduct: Introduction to philosophy: definition, nature and scope, concept, branches

Ethics: Definition, moral philosophy, Nature of moral judgements and reaction;

Scientific conduct: Ethics with respect to science research, intellectual honesty and research integrity; Scientific misconduct: Falsification, fabrication and plagiarism; Redundant publications: Duplicate and overlapping publications, salami slicing; Selective reporting & misrepresentation of data.

Unit II **7**

Publication ethics: Definition, introduction and importance, best practices/ standards setting initiatives and guidelines [COPE, WAME etc.], conflict of interest.

Publication misconduct: Definition, concept, problem that lead to unethical behaviour and vice versa, and types; conflict of interest; violation of publication ethics, authorship and contribution ship.; Identification of publication misconduct, complaints and appeals.

Unit III **9**

Open-access Publishing & publication misconduct: Open-access publications and initiatives, SHERPA/ RoMEO online resource to check publisher copyright and self-archiving policies, software tools to identify predatory publications developed by SPPU; journal finder/ journal suggestion tools viz. JANE, Elsevier Journal finder, Springer Journal etc.

Publication misconduct: Group discussion: Subject specific ethical issues, FFP, authorship; Conflict of interest; complains and appeals: Examples and fraud from India and abroad.

Software tools: Use of plagiarism check software's like Turnitin, Urkund and other open-source software tools.

Unit IV **7**

Databases and Research metrics: Databases - Indexing databases, and Citation databases: Web of Science, Scopus etc.

Research Matrices: Impact factor of a journal as per citation report, SNIP, SJR, IPP, Cite Score & Research Interest (Research Gate).

Matrices: H-index, I-Index etc**.**

Books and references [Latest edition]

1. Philosophy of Sciences. Routledge: Bird, A.
2. A Short History of Ethics. London: MacIntyre, Alasdair
3. Ethics in Competitive Research: Do not get Scooped; do not get plagiarized: P. Chandah
4. National Academy of Sciences, National Academy of Engineering and Institute of Medicine, National On being a Scientist: A guide to responsible conduct in Research : third edition, National Academies Press.

Ph. D in Microbiology (Compulsory Course)
COURSE No. :PhDMICRO-103
Instrumentation Methods of Analysis

TOTAL HOURS: 30 CREDITS: 2	Theory Marks: 50

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks (10 Marks each).

Course Outcome

- To develop an understanding of principle and working of the range of instrumental methods.
- To explain theory and instrumentation of GC, HPLC, gel chromatography, ion exchange chromatography and affinity chromatography.
- Learn applications of various chromatographic techniques for organic, inorganic and natural products.
- To provide an understanding in sequencing techniques.

Learning Outcome

The students will be able to:

- Learn the basic principle and applications of centrifugation techniques.
- Explain theory, instrumentation and applications of chromatographic techniques.
- Explain instrumentation, separation and identification of compounds by electrophoresis technique.
- Understand the microscopic techniques.
- Develop a good knowledge of PCR and DNA sequencing techniques.
- Gain knowledge on radioisotope techniques.

Unit I **7**

Centrifugation: Concept and types of centrifugations, Fundamentals of Optical system, Light sources and Detection system, Lens, Mirror, Grating.
Microscopy: Limit of resolution Types and principles of microscopy.

Unit II

Chromatography: principles and types of chromatographic techniques
Electrophoresis: principles and types of electrophoretic techniques, PCR and its types

Unit III **9**

Introduction to spectroscopic techniques: UV - Vis Spectrophotometry, atomic absorption and atomic emission spectroscopy, IR spectroscopy and NMR Spectroscopy, MALDI-TOF, Florescent activated cell sorter (FACS).

Unit IV **7**

Radioisotope Techniques: Radio-tracers, types of radioisotopes, interaction of radiation with matter, absorbed body dose, auto-radiography and radioimmunoassay, GM counter, Proportional and Scintillation counters, Quench correction and types of Quench correction.

Suggested books [Latest edition]

1. Principles and techniques of Practical biochemistry: Eds. K Wilson and J Walker
2. Fundamentals of Immunology: Paul Williams
3. Biophysical Chemistry: D Freifelder
4. Instrumental Methods of Analysis, CBS: H. Willard, L.L Meritt, J.A Dean and F.A. Settle

Ph. D in Microbiology
COURSE No.:PhDMICRO-104 (i)
Cell and Molecular Biology

TOTAL HOURS: 60 CREDITS: 4	Theory Marks: 100

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing twenty (20) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks (20 Marks each).

Course Outcomes

- To familiarize the students with the basic cellular processes at molecular level
- Conduct independent molecular biology experiments in a laboratory.
- The students will understand the basic mechanism of genetics and will be able to isolate DNA from bacterial, plant and animal cells.

Learning Outcomes

By the completion of this course, the students –

- Get knowledge about structure and function of various cell organelles.
- Understand the structure and genome organization in microorganisms.
- Understand the types of DNA and about its replication process.
- Know the process, mechanism & significance of transcription, translation.
- Understand the process of regulation of gene expression using operon concept.
- Learn the genetic changes due to mutations and recombination.
- Gain knowledge about various types of cancers.

Unit I **14**

Structural organization and function of cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, cytoskeleton. Structure and organization of DNA, genes, chromatin and chromosomes, super-helicity in DNA and its topological properties, DNA denaturation and renaturation, repetitive DNA, COT-curve, C-value paradox. Cell division and cell cycle, and their regulation.

Unit II **16**

DNA replication, DNA damage and repair mechanisms, genetic recombination, transformation, conjugation, and transduction. Transcription, RNA processing, RNA editing, splicing, and polyadenylation, structure, and function of different types of RNA, RNA transport), Overview of Plasmid, Phagemid and Cosmid.

Unit III **14**

Translational process, and its proof-reading, translational inhibitors, Post-translational modification of proteins, Genetic code, Mutation, Control of gene expression at transcription and translation level (regulating the expression of prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing), Operon concept.

Unit IV **16**

Cell signaling, and signal transduction pathways, regulation of signaling pathways. General principles of cell communication, cell adhesion and roles of different adhesion molecules, Cancer genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis.

Suggested books [Latest edition]

1.Molecular Biology of Cell: Bruce Albert *et. al*. (Tylor and FrancisInc.)
2.Lewin Genes XIII: Jones and Barlett Publisher, Inc.
3.Molecular Cell Biology: Lodish *et al*. WH Freeman.
4.Karp's Cell and Molecular Biology: Gerald Karp, John Wiley Publications.
5.Molecular Biology of the Gene: James D. Watson, Pearson Education.

Ph. D in Microbiology
COURSE No.: PhDMICRO-104 (ii)
Medical Microbiology

TOTAL HOURS: 60 CREDITS: 4	Theory Marks: 100
Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing twenty (20) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks (20 Marks each).	

Course Outcomes

The major outcome of the course is to

- Acquire knowledge related to different pathogenic mechanisms of infectious agents
- Develop knowledge related to antimicrobial resistance mechanisms of various pathogenic
- microbes
- Enrich information related to symptoms and diagnosis of various diseases caused by bacteria, virus, fungi and protozoa

Learning Outcomes

The students will be able to:

- Gain information about the concepts of medical microbiology and medically important micro-organisms.
- Gain knowledge of morphology, cultural characteristics, biochemical tests, epidemiology and laboratory diagnosis of bacterial pathogens.
- Gain knowledge on water borne infections caused by bacteria.
- Understanding the biology of various parasitic diseases.
- Gain knowledge on various chemotherapeutic agents and their mode of action including alternatives of antibiotics.
- Explain various types of nosocomial infections, their diagnosis and control

Unit I **15**

Pathogenicity of various infectious agents: host pathogen interaction, Pathogenesis of bacterial diseases, pathogenesis of viral diseases, toxigenicity, host defence against microbial diseases. Diagnosis of microbial diseases: Sample collection and transport, preliminary processing of clinical pathogens/samples. Various diagnostic methods including Clinical, microbiological, immunological, and molecular methods of disease diagnosis. Modern methods of microbial diagnosis

Unit II **14**

Antimicrobial Chemotherapy: History of chemotherapy, general characteristics of antimicrobial drugs, determining levels of antimicrobial activity, Minimum Inhibitory concentration (MIC), Different types of drug toxicity testing, antimicrobial drugs and their mode of action, factors

affecting antimicrobial drug effectiveness, nosocomial infections, common types of hospital infections, their diagnosis and control.

Unit III **18**

Epidemiological terminologies, Recognition of epidemic, infectious disease cycle, Human diseases caused by important Gram positive bacteria: *Staphylococcus, Streptococcus, Pneumococcus, Corynebacterium, Bacillus, Clostridium* and *Mycobacterium.*

Human diseases caused by important Gram negative pathogens: *Neisseria, E.coli, Klebsiella, Proteus, Salmonella, Shigella, Vibrio, Yersinia, Haemophilus, Bordetella, Brucella, Rickettsiae, Chlamydiae, Helicobacter, Campylobacter, Legionella, Leptospira, Borrelia, Pasteurella,* and *Coxiella.*

Unit IV **13**

Pathogenic fungi and Protists: Airborne fungal diseases, Brief account of parasitic diseases caused by protozoa and helminthes: (*Entamoeba*, *Giardia*, *Leishmani*a, *Trypanosoma*and *Plasmodium*) and helminth parasites (*Schistosoma*, *Taenia*, *Ascaris*, *Hookworms* and *Wuchereria*).

Suggested books [Latest edition]

1. Text of Microbiology: R. Ananthanarayanan and C.K.J. Paniker, Orient Longman.
2. Mackie and McCartney: Medical Microbiology Vol 1: Microbial infection, Vol 2: Practical medical microbiology. Churchill Livingstone.

Ph. D in Microbiology
COURSE No.:
PhDMICRO-104 (iii)
Environment Microbiology

TOTAL HOURS: 60 **CREDITS: 4**	**Theory Marks: 100**
Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing twenty (20) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks (20 Marks each).	

Course Outcomes

- Students acquire knowledge about the different types of microorganisms found in soil, water, air, etc. and their beneficial and harmful potential in different areas
- Understanding the importance of microorganisms in biogeochemical cycling of nutrients, sustainable development and bioremediation of pollutants with a view to developing strategies of environmental conservation and remediation
- Students will gain knowledge and use the properties of microorganisms, principally bacteria, as bioindicators of contamination and to remedy problems of contamination and other environmental impacts

Learning Outcomes

By the completion of this course, the students -

- will develop a fairly good knowledge and understanding of different types of environments and habitats where microorganisms grow.
- would be able to know the important role of microorganisms in maintaining healthy environment by degradation of solid or liquid wastes.
- would be able to identify the Role of microorganisms in biogeochemical cycling.
- will understand the application and use of microbes as biofertilizers.
- gain knowledge on environmental pollution, bioremediation and role of microbes in soil microbiology and xenobiotics.
- will develop the practical skills for conducting experiments to assess the BOD/COD of waste waters and their interpretation; practically assess the potability of drinking water by the use of standard microbiological tests.

Unit I **15**

Plant Growth Promoting Rhizobacteria and their metabolites. Mechanism of action for biotic and abiotic stress management Biological Nitrogen Fixation, Biogeochemical cycles (C, N, P & S). Biofertilizers, Biofertilizer production technology-strain selection, sterilization, growth and fermentation, standards and quality control, biofertilizer application technology, constraints in the commercialization of biofertilizer technology.

Unit II **15**

Biofilms and Solid Waste Remediation Biofilms in natural and manmade environments. Solid waste treatment (Agricultural/urban): Degradable wastes: Saccharification, gasification, composting, vermicompost, mushroom compost, ensilage. Utilization of solid wastes- food (SCP, mushroom, yeast), fuel (ethanol, methane-biogas plant), manure (composting). Non biodegradable solid waste and its management: Landfill development, incineration and recycling.

Unit III **15**

Aerobiology: Assessment of air quality. Brief account of air borne transmission of microbes – viruses – bacteria and fungi, their diseases and preventive measures. Aquatic microbiology: Water ecosystems – fresh water and marine habitats. Potability of water – microbial assessment of water quality, brief account of major water borne diseases and their control measures. Waste water treatment techniques.

Unit IV **15**

Bioremediation and Bioaugmentation: Pollution, wastes, their types and characterization. Methods of treatment-Physical, chemical, biological-aerobic and anaerobic (Oxidation ponds, HRABP, ASP, Trickling Filter, Fluidized Bed Reactor, Biogas, Rotating contactor). Bioaccumulation of metals and detoxification, biosorption, scavenging. Biodegradation of Xenobiotics (Pesticides and dyes)

Suggested books [Latest edition]

1. Pollution: Ecology and biotretament. Longman Scientific Technical: Eldowney Ec S., Hardman DJ. and Waite.
2. Environmental Microbiology and Biotechnology by Singh and Dwivedi. New Age Int. Sci. Publication. Environmental Microbiology by Riana Environmental Microbiology: Principles and Applications. Patrick K. Jjemba
3. Microbial ecology: Alexander M; John Wiley and Sons, Inc., NewYork.
4. Pollution - Ecology and biotreatment: Longman Scientific Technical.
5. Advances in microbial ecology: S McEldowney, DJ Hardman, S Waite S and KC Marshall.
6. Environmental Microbiology: Mayer & Mayer

Ph. D in Microbiology
COURSE No.: PhDMICRO-104 (iv)
ENZYME TECHNOLOGY

TOTAL HOURS: 60 CREDITS: 4	Theory Marks: 100

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing twenty (20) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks (20 Marks each).

Course Outcomes

- Understand the role of enzymes in biological system.
- Acquire thorough knowledge on the enzyme kinetics and inhibition.
- Analyze the biological importance of immobilized enzymes.

Learning Outcomes

By the completion of this course the students able to:

- Explain basic functions, properties and components of enzymes.
- Understand the localization of enzymes in the cell.
- Demostrate working principle of enzymes.
- Describe methods for selection and optimization of industrial enzymes using genetic and biochemical techniques.
- Describe the principles and methods of metabolic engineering of microorganisms to produce industrial chemicals.
- Compare and contrast the historical uses of enzyme technology with current applications in a diverse range of industries.
- Gain knowledge about applications of enzyme technology.

Unit I **13**

Commercial sources of enzymes: Sources of commercial enzymes, microbial enzymes, screening strategies for isolation of hyper-enzyme producing microbes, control of microbial enzyme production, genetic manipulation techniques, legal implications in the use of enzymes, growth of enzyme industry, economic considerations in the use of enzymes on a large scale.

Unit II **15**

Extraction and purification of enzymes: Enzyme extraction, enzyme purifications, large-scale purification enzyme specification, criteria of purity, molecular weight determination and characterization of enzyme.

Enzyme kinetics: Nomenclature of enzymes, simple and complex (bisubstrate) enzyme, inhibition of enzyme reactions, factors effecting enzyme activity, enzyme reactors with simple kinetics.

Unit III **15**

Immobilization of enzymes: Immobilization techniques, effect of mass transfer resistance, kinetics of immobilized enzymes, immobilization of amylase, cellulase, protease and lipase.

Biocatalyst stabilization: Immobilization, medium engineering, enzyme reactions in water restricted

media and super critical fluids. Use of additives chemical modifications and protein engineering for enzyme stabilization.

Unit IV **17**

Enzyme engineering: Design and specialized construction of novel enzymes, synthetic enzymes, covalent modifications of enzymes, enzymic modifications of enzymes, substitution of bound metals in enzymes, non-and site-specific mutagenesis for the construction of desired enzymes.

Specialized biocatalysts: Abzymes and Ribozymes.

Application of enzymes (Free & immobilized): Enzyme therapy, analytical, food processing and pharmaceutical applications, development of novel processes, enzymes in biosensors

Suggested books [Latest edition]

1. Enzyme Technology: MF Chaplin and DC Bucks
2. Industrial Enzymology: Godfrey and West
3. Enzyme: Copeland
4. Enzymes in Industry: W Gerhartz