GENERAL INSTRUCTIONS
and
COURSE CURRICULUM

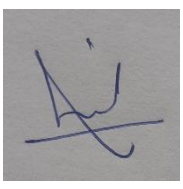
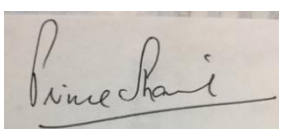
FOR

Ph.D. in MICROBIOLOGY
(Effective from 2024-25)

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 2 compulsory courses **[RPE-PhD, and PhDMICRO-101,** and at least one additional course which may be out of four **elective courses [PhDMICRO-EL-102 (i)**, **PhDMICRO-EL-102 (ii), PhDMICRO-EL-102 (iii), and PhDMICRO-EL-102 (iv)]**. A Ph.D. scholar must obtain a minimum of 55% marks, with minimum 50% in each individual course (all three courses) 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 code	Title of the course	Maximum Marks	Credits
Compulsory Courses			
RPE-PhD (Common for all Ph.D. Program)	Research and Publication Ethics	50	2
PhDMICRO-101	Research Methodology	100	5
Discipline Specific Elective Course: any one of the following i.e. PhDMICRO-EL-102 (i-iv)			
PhDMICRO-EL-102 (i)	Cell And Molecular Biology	100	5
PhDMICRO-EL-102 (ii)	Medical Microbiology	100	5
PhDMICRO-EL-102 (iii)	Environment Microbiology	100	5
PhDMICRO-EL-102 (iv)	Enzyme Technology	100	5
Total Marks /Credits		**250**	**12**

Ph.D. in Microbiology (Compulsory Courses)
Research and Publication Ethics
Course Code: RPE-PhD

L	T	P
2	0	0

Credits: 2	Maximum Marks: 50

Course description

This course has a total of 6 units focusing on the basis of philosophy of science and ethics, research integrity, and publication ethics. Hands-on sessions are designed to identify research misconduct and predatory publication. Indexing and citation databases, open-access publications, research metrics (citations, h-index, Impact Factor, etc.), and plagiarism tools will be discussed in this course.

Objectives

a. Promote the importance of research integrity.
b. Discuss the principles of publication ethics.
c. Educate on identifying research misconduct and predatory publishing.
d. Discuss indexing and citation databases.
e. Provide information on open-access publications and research metrics.
f. Introduce various plagiarism detection tools.

Evaluation

Continuous assessment will be conducted through tutorials, assignments, quizzes, and group discussion. At the end of the course, a final written examination of 50 marks will be conducted.
a. Students who have at least 75% attendance in classes will be considered eligible for the final written examination.
b. The exam will be conducted for three hour duration.
c. The passing marks for PhD coursework will be 55% aggregate, with minimum 50% in each individual course.

NOTE: Instructions for setting question paper

There will be 7 questions covering all the units. The first six questions (1, 2, 3, 4, 5 & 6) of 6 marks each will consist of one question from each unit, with internal choice provided, meaning there will be two questions from each unit. The 7th question will consist of 10 short answer type questions using Roman numerals (I, ii, iii….x) each with 2 marks. There will be at least one question from each unit and students will be required to attempt any seven questions out of ten.

Course Content

Unit-01 Philosophy and Ethics

1. Introduction to philosophy: definition, nature and scope, concept, branches
2. Ethics: Definition, moral philosophy, Nature of moral judgements and reaction

Unit 02: Scientific conduct:

1. Ethics with respect to science research
2. Intellectual honesty and research integrity
3. Scientific misconduct: Falsification, fabrication and plagiarism (FFP)
4. Redundant publications: Duplicate and overlapping publications, salami slicing
5. Selective reporting & misrepresentation of data

Unit 03: Publication Ethics

1. Publication ethics: definition, introduction and importance
2. Best practices/ standards setting initiatives and guidelines: COPE, WAME etc.
3. Conflict of interest
4. Publication misconduct: Definition, concept, problem that lead to unethical behaviour and vice versa, and types;
5. Violation of publication ethics, authorship and contributionship
6. Identification of publication misconduct, complaints and appeals

Unit 04: Open-access Publishing

1. Open-access publications and initiatives
2. SHERPA/ RoMEO online resource to check publisher copyright and self-archiving policies
3. Software tools to identify predatory publications developed by SPPU
4. Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal finder, Springer Journal *etc.*

Unit 05: Publication Misconduct

A. Group Discussions
   1. Subject specific ethical issues, FFP, authorship
   2. Conflict of interest
   3. Complains and appeals: Examples and fraud from India and abroad.

B. Software tools

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

Unit 06: Databases and Research Matrices

A. Databases
   1. Indexing databases
   2. Citation databases: Web of Science, Scopus *etc.*

B. **Research Matrices:**
   1. Impact factor of a journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score
   2. Matrices: h-index, g index, i10 Index, almetices

Suggested Readings

Beall, J.(2012). Predatory publishers are corrupting open access.Nature,Vol.489(7415), 179. https://doi.org/10.1038/489 l 79a.

Bird, A.(2006). Philosphy of Science. Routledge.

Bretag, Tracey (2016). The Handbpook of Academic Integrity.Springer

Chaddah, P.(2018).Ethics in Competitive Research: Do not get scooped; do not get Plagiarized. ISBN:978-9387480865.

Grudniewicz, Agnes, D. Moher, Kelly D. Cobey+32 authors (2019). Predatory journels: no definition, no defense.Nature, Vol.576.

Indian National Science Academy (2019). Ethics in Science Education , Research and Governance (2019). ISBN:978-81-939482-1-7. http://www.insaindia.res.in/pdf/Ethics_Book.pdf

Israel, Mark, lain Hay (2006). Research Ethics for Social Scientists. London.

Lang, James M. (2013). Cheating Lessons: Learning from Academic Dishonesty. Harvard University Press.

Maclntyre, Alasdair (1967).A Short History of Ethics. London.

National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Guide to Responsible Conduct in Research. Third Edition.National Academies Press.

Resnik, D.B.(2011). What is ethics in research & why is it important. National Institute of Environmental Health Sciences, 1-10. https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfrn

Whitley Jr., Bernard E. & Patricia Keith-Spiegel (2001). Academic Dishonesty: An Educator's Guide. Psychology Press.

Ph. D in Microbiology (Compulsory Course)
Research Methodology
Course Code: PhDMICRO-101

L	T	P
5	0	0

Credits: 5	Maximum Marks: 100
Note: There will be eleven questions covering all the units. The first 10 questions of explanatory answers (1,2,3,……10) of 12 marks each will consist of one question from each unit, with internal choice provided, meaning there will be two questions from each unit (5x2=10). The students will be required to attempt one question from each unit. The 11th question will consist of 10 short answer type questions using Roman numerals (i, ii, iii,……x) each with five marks covering all the units. The students will be required to attempt any eight questions out of ten.	

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

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

Unit II

Review of related literature: Meaning, necessity and sources.

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.

Unit III

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 IV

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 V

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.

Biosafety: Biosafety levels of specific microorganisms, Biosafety guidelines: Government of India.

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.
5. IPR, Biosafety and Bioethics (2013) 1st edi., Goel D and Parashar S. Pearson Education. ISBN: 978-8131774700
6. An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology (2017) Nambisan P, Academic Press, ISBN: 9780128092316.

Ph. D in Microbiology (Elective Course)
Cell and Molecular Biology
Course Code: PhDMICRO-EL-102 (i)

L	T	P
5	0	0

Credits: 5	Maximum Marks: 100

Note: There will be eleven questions covering all the units. The first 10 questions of explanatory answers (1,2,3,……10) of 12 marks each will consist of one question from each unit, with internal choice provided, meaning there will be two questions from each unit (5x2=10). The students will be required to attempt one question from each unit. The 11th question will consist of 10 short answer type questions using Roman numerals (i, ii, iii,……x) each with five marks covering all the units. The students will be required to attempt any eight questions out of ten.

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

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.

Unit II

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

Translational process, and its proof-reading, translational inhibitors, Post-translational modification of proteins, Genetic code, 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), CRISPR/Cas9, Operon concept.

Unit IV

Mutation and its types, Cell signaling, and signal transduction pathways, regulation of signaling pathways. General principles of cell communication, cell adhesion and roles of different adhesion molecules.

Unit V

Cell division and cell cycle, and their regulation

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 Francis Inc.)
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 (Elective Course)
Medical Microbiology
Course Code.: PhDMICRO-EL-102 (ii)

L	T	P
5	0	0

Credits: 5	Maximum Marks: 100

Note: There will be eleven questions covering all the units. The first 10 questions of explanatory answers (1,2,3,……10) of 12 marks each will consist of one question from each unit, with internal choice provided, meaning there will be two questions from each unit (5x2=10). The students will be required to attempt one question from each unit. The 11th question will consist of 10 short answer type questions using Roman numerals (i, ii, iii,……x) each with five marks covering all the units. The students will be required to attempt any eight questions out of ten.

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

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

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, Antimicrobial Resistance (AMR).

Unit III

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

Unit IV

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 V

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.
3. Apurba Sankar Sastry, Sandhya Bhat K: Essentials of Medical Microbiology. JP Medical Ltd.
4. Topley and Wilson's principles of Bacteriology, Virology, and Immunity. Topley, W.W.C., Wilson, S.G.S. and Parker, M.T. Edward Arnold, London.
5. A.J. Salle, Brock T.D, Madigan M.T: Biology of Microorganisms. Prentice Hall Int. Inc.

Ph. D in Microbiology (Elective Course)
Environment Microbiology
Course Code: PhDMICRO-EL-102 (iii)

L	T	P
5	0	0

Credits: 5	Maximum Marks: 100

Note: There will be eleven questions covering all the units. The first 10 questions of explanatory answers (1,2,3,……10) of 12 marks each will consist of one question from each unit, with internal choice provided, meaning there will be two questions from each unit (5x2=10). The students will be required to attempt one question from each unit. The 11th question will consist of 10 short answer type questions using Roman numerals (i, ii, iii,……x) each with five marks covering all the units. The students will be required to attempt any eight questions out of ten.

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

Plant Growth Promoting Rhizobacteria and their metabolites. Mechanism of action for biotic and abiotic stress management Biogeochemical cycles (Carbon cycle, Nitrogen cycle: Biological Nitrogen Fixation, Biochemistry of nitrogen fixation-nitrogensae, ammonia assimilation and transport, physiological aspects of nitrogen fixation, nodulation-early and late events, molecular biology of nitrogenase activity; Phosphorus & Sulfur cycle).

Unit II

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

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

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).

Unit V

Biofertilizers, Biofertilizer production technology-strain selection, sterilization, growth and fermentation, standards and quality control, biofertilizer application technology, constraints in the commercialization of biofertilizer technology.

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 (Elective Course)

Enzyme Technology

Course Code: PhDMICRO-EL-102 (iv)

L	T	P
5	0	0

Credits: 5	Maximum Marks: 100

Note: There will be eleven questions covering all the units. The first 10 questions of explanatory answers (1,2,3,……10) of 12 marks each will consist of one question from each unit, with internal choice provided, meaning there will be two questions from each unit (5x2=10). The students will be required to attempt one question from each unit. The 11th question will consist of 10 short answer type questions using Roman numerals (i, ii, iii,……x) each with five marks covering all the units. The students will be required to attempt any eight questions out of ten.

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

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

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

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

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.

Unit V

Specialized biocatalysts: Abzymes and Ribozymes. Free enzymes & immobilized enzymes and their applications: 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
5. Principles of Biochemistry: AL Lehninger, DL Nelson and MM Cox.