



Savitribai Phule Pune University
(Formerly University of Pune)

Syllabus for

Ph.D. coursework in the **Subject of Microbiology.**

(w.e.f. The academic year 2021-22)

Department of Microbiology, SPPU
&
All research centers in Microbiology
(Affiliated to Savitribai Phule Pune University)



Savitribai Phule Pune University
(Formerly University of Pune)
Syllabus for M.Phil. / Ph.D. Coursework: Microbiology
(w. e. f. academic year 2021-22)

- 1] **Coursework Structure:** The coursework shall be of total 18 credits divided into four courses. One credit shall be equal to 15 hours of contact time.
- **Course I (PC I): Research Methodology- Compulsory (4 credits)**
Research methodologies adapted for designing, executing, and publishing research work.
 - **Course II (PC II): Scientific writing and communication – Compulsory (4 credits)**
Activity-based course- Writing research grant proposals, review articles, and presenting research papers.
 - **Course III (PC III): Subject-specific advanced level courses- Elective (8 credits)**
These courses are designed to impart skills and knowledge in advanced research methodologies, to impart hands-on experience or demonstration of different techniques and instrumentations used in biological sciences, and to analyze and interpret data obtained.
 - **Course IV (PC IV): Publication Ethics- Compulsory (2 credits)**
(Research center can have their course to be run and evaluated OR Research center can adopt a payment basis Publication ethics online course run by the Centre of Publication Ethics, SPPU)
(Course structure as per University circular available on the following link:
http://collegecirculars.unipune.ac.in/sites/documents/Revised%20PhdMPhilSyllabus2020/M.Phil.Ph.D.%20Course%20Work_04.06.2021.pdf)
- 2] **Coursework Flexibility:**
- Department conducting the coursework may decide on the optional courses to be floated.
 - Candidates may opt for equivalent online courses floated on the Swayam platform with permission of the guide, coursework coordinator/s, and Head of the Institute/ department.
 - University Department Research center may introduce additional optional course/s on recommendations of the Departmental Committee. The syllabus of the optional course shall be prepared by the concerned teacher and will be flexible to accommodate new developments in that area. Whenever such an optional course is floated, the concerned syllabus will be discussed and approved by the Departmental Committee and forwarded to the Board of studies.
 - If found necessary, coursework may be carried out by candidates in sister Departments/Institutes either within or outside the University for which due credit will be given to them. However, the candidate can opt for such a course upon recommendation of the Guide, Ph.D. coursework coordinator/s, and Head of the Institute/ department.
- 3] **Coursework exemption:** Only those candidates who have completed M.Phil. from any Statutory University and whose admission at M.Phil. was done through an Entrance Examination and whose Course work was prescribed for M.Phil. level, shall be exempted from the Course work.

- 4] **Coursework Evaluation:** The policies and procedures determined by the University shall be followed for the conduct of examinations and declaration of the result of the candidate. The passing for each paper shall be 50%. The Head / Director of the department/institute shall communicate the result to the Ph.D. section of SPPU.

Course No.	Title of the course	No. of credits	Internal Marks	External Marks	Total Marks
PCI	Research Methodology (Compulsory)	4	50	50	100
PCII	Scientific writing and communication (Compulsory)	4	50	50	100
PCIII	Subject-specific advanced-level courses (Elective)	8 (2/course)	100 (25/course)	100 (25/course)	200 (50/course)
PC IV	Publication Ethics (Compulsory)	2	25	25	50
Total		18	225	225	450

5] **Course Details:**

Course No.	Course Name	Credits
PC I	<p>Research Methodology:</p> <ul style="list-style-type: none"> • History of research. Indian, Egyptian, and Greek ideas, methodologies, and research in agriculture, chemistry, metallurgy, medical. Ancient Indian research methodology • Biostatistics for qualitative and quantitative analysis of biological data and its interpretation. Statistical analysis and its significance. Various software for statistical analysis (Origin, Statistical Package for the Social Sciences (SPSS), MATLAB, Microsoft Excel, Statistical Analysis Software (SAS), GraphPad Prism, Minitab). This module will consist of case studies of the research performed on various subjects using statistical methods, Error and noise analysis, curve fitting • Research Techniques: Spreadsheet tools (features, using formulas and functions for statistical analysis, making graphs and charts), Powerpoint presentations, tools for digital image processing and preparation of graphical abstracts (GIMP, ImageJ, Biorender, Chemdraw, Adobe Illustrator, etc.), tools for managing references (Zotero, Mendeley, Reference Manager, Endnote, etc.) • Literature survey: Referencing institutional and national libraries, and web-based search engines to survey scientific literature and databases (Google Scholar, Science Direct, Medline-Pubmed, Web of Science, Cochrane, EMBASE, etc.). • Publishing Research: Structure of research proposals, patents, thesis, and research publications, Making oral and poster presentations. Journal selection (UGC-CARE listed, SCIE listed, JCR listed), Measures of Indexing (Impact Factor, H-Index, i10 index, citation Index, etc.). • Rules and regulations to be followed for research: Safety in Laboratories, Ethics in research conduct (Institutional biosafety, Human and Animal Ethics, National Biodiversity Act). Ethics in research 	4

	publication (Authorship, Competing interests, Plagiarism, Simultaneous submission, and Research fraud).	
PC II	<p>Scientific writing and communication:</p> <ul style="list-style-type: none"> • Writing a review article OR Scientific Paper (to be internally evaluated by respective research guide) • Preparing a Grant Proposal (to be evaluated by the respective research guide) • Research paper presentations: The candidate shall present at least three research papers. To be evaluated by the external committee appointed by the research center conducting the coursework. Marks for the best two presentations shall be considered. 	4
PC III	Subject-specific advanced-level courses (Elective)	8
PCIII-M1	<p>Advanced Spectroscopy</p> <p>Principle, working, applications, and data analysis of following</p> <ul style="list-style-type: none"> • UV Visible Spectroscopy • Fluorescence spectroscopy • Fourier-transform infrared spectroscopy • Mass spectroscopy • Nuclear magnetic resonance • X-ray diffraction 	2
PCIII-M2	<p>Bioinformatics</p> <ul style="list-style-type: none"> • Introduction and biological databases Nucleic acid, proteins, genomes— structure databases, search engines, sequence data forms, and submission tools, scoring matrices for sequence alignments, algorithms pairwise sequence alignments, database similarity searches-BLAST, FASTA • Gene bank sequence database; submitting DNA sequences to databases and database searching; sequence alignment; pairwise alignment techniques, Multiple sequence alignment, phylogenetic analysis and tree building methods, motif searches, epitope prediction, data mining tools and applications, promoter, and gene 1prediction, comparative analysis • Demonstration of databases (GENBANK, PDB, OMIM) and software (RASMOL, Ligand Explorer) • Phylogenetic prediction. Sequence Analysis, Sequence alignment, Primer Designing, Mass Spectrometry based proteomics tools, Protein structure & functions prediction tools: Modeling: 2D and 3D protein modeling. System Biology approach to understand microbial enzyme machinery. 	2
PCIII-M3	<p>Cell Culture Techniques</p> <ul style="list-style-type: none"> • Animal Culture: Media requirements and sterilization techniques, primary and established cell lines. Culture methods: hanging drop, monolayer, and suspension. Advantages and disadvantages. Scale-up methods. Roux tubes roller bottles. Stem cells: adult and embryonic, applications to tissue engineering. Applications of animal cells. • Plant tissue culture: Cell and callus culture, another culture. Micro-propagation, somatic cell hybridization, protoplast fusion, cybrids, artificial seeds, Agrobacterium-mediated gene transfer, and use of Ti plasmid. Applications of plant tissue culture engineering, pathogen 	

	<p>resistance (BT gene), herbicide tolerance, salt tolerance, production of secondary metabolites, and transgenic plants.</p> <p><i>(In addition to classroom teaching, practical sessions need to be incorporated)</i></p>	
PCIII-M4	<p>Techniques in Nanotechnology</p> <ul style="list-style-type: none"> • Nanoparticle types – Metallic, polymeric, carbon-based, lipid-based, semiconductor nanoparticles, etc. • Synthesis of nanoparticles • Tools and techniques for characterization of nanoparticles- in vitro and in vivo characterization of nanoparticles • Principle, working, applications, and data analysis of SEM, TEM, powdered X-ray, AFM, SPM, EDAX, Zeta analysis, and DLS used for characterization of nanoparticles • Applications of Nanobiotechnology: Quantum dots, magnetic nanoparticles, plasmonic nanoparticles, carbon nanotubes, graphene nanoparticles, and core-shell nanoparticles in medicine, environment, and agriculture. 	2
PCIII-M5	<p>Techniques in virology</p> <ul style="list-style-type: none"> • Cultivation and purification of viruses: In vivo, in vitro, and in ovo systems for virus growth, estimation of yields, methods for purification of viruses with special emphasis on ultracentrifugation methods • Diagnostic methods: Serological and Nucleic acid-based diagnosis. Immuno-diagnosis, hemagglutininations, and hemagglutination inhibition tests, Complement fixation, neutralization, Western blot, RIPA, flow cytometry, and immuno-histochemistry, etc. • Microscopic techniques: Fluorescence, confocal, and electron microscopic techniques • Analytical techniques: Electrophoresis, chromatography, membrane filtration, NMR, X-ray crystallography. 	2
PCIII-M6	<p>Immunology and Medical Microbiology</p> <ul style="list-style-type: none"> • Epidemiological Study (designs): Case control, cohort, concurrent, cross-sectional, retrospective/prospective. • Clinical/field trials-Randomization, Bias removal (Blinding – single & double), controlled and uncontrolled trials • Immunological techniques: ELISA, RIA, immunofluorescence, RAST, RIST, MLR, flow cytometry, Magnetic sorting, MHC tetramer technology, multiplex assays, fluorescence, FACS, and immunoelectron microscopy, spectra typing, surface plasmon resonance (SPR). Hybridoma technology, monoclonal antibodies, and abzymes; Antibody engineering. • Animal model of immunological disease (Transgenic and knockout animals). • Generation of bone-marrow chimeras, humanized mice, parabiosis. 	2
PCIII-M7	<p>Applied and Environmental Microbiology</p> <ul style="list-style-type: none"> • Recent advances in Bacterial Taxonomy -Identification of Prokaryotes, current Bergey's Manual, Computer taxonomy, 16s rRNA fingerprinting and lipid profile, mass spectra, API, etc 	2

	<ul style="list-style-type: none"> • Application of biocatalysis in organic synthesis, biotransformation, enzymes in organic media, lipases, and nitrilases • Advances in biofertilizers and biopesticides • Plant disease control: Antisense RNA and RNA interference technology • Generation of electricity using waste- principles and technological implications • Application of lactic acid bacteria – probiotics, criteria for selection, functional foods, Human health, and microbiome • Quorum sensing and Quorum quenching in bacteria • Bioremediation, Biostimulation, Bioaugmentation, and Biosorption. • Applications of bioremediation to various contaminants & sites: Marine oil spills & Metal-contaminated soils, hyper-accumulators • Recent industrial wastewater treatment and disposal processes 	
PCIII-M8	<p>Chromatography techniques</p> <ul style="list-style-type: none"> • Chromatography- Partition Coefficient, Selectivity, Resolution, Column Efficiency, Van Deemter equation, Interpretation of chromatograms • Principle, components of the instrument, operation, and application of Gas chromatography, High-Performance Liquid Chromatography, Gel filtration chromatography, Ion-exchange Chromatography, and Affinity chromatography. <p><i>(In addition to classroom teaching, demonstrate the working of instruments by visiting the instrumentation center/facility)</i></p>	2
PCIII-M9	<p>Genomics</p> <ul style="list-style-type: none"> • Pre and Post Genomic era, Major advancements in Genomic approaches, Epigenetics and Metagenomics, forward versus reverse Genomics, Genome Analysis- Genome editing approaches and their applications, CRISPR-Cas9 genome editing. • Gene expression approaches and their applications. Next Generation Sequencing (NGS)-Illumina (Solexa), Roche 454, Sequencing by Oligonucleotide Ligation and detection (SOLiD), Ion Torrent Technology, etc. Parallel sequencing, Nanopore sequencing • Sequence analysis and their applications: Human Genetics and Human Genome Project, Genomic insights into evolution, advantages of comparative genomic analysis, Analysis of microarray data. • DNA/ Protein micro-arrays- DNA/ Protein Markers- DNA fingerprinting- Gene knockout - RNAi and Gene silencing- Metagenomics, application of metagenomic libraries, Metabolic engineering. • Culture-independent molecular methods for identifying unculturable bacteria (PCR, FFLP, ARDRA, DGGE, TGGE, RAPD, Microarray, FISH, RISA), metagenomics analysis. 	2
PCIII-M10	<p>Proteomics</p> <ul style="list-style-type: none"> • Introduction, types of proteomics investigation & importance of proteomics • Tools of proteomics-Separation technology (SDS PAGE, 2D PAGE), Liquid Chromatography, Mass Spectrometry (Ionizers, analyzers, and detectors), Protein and peptide microarray-based technology, Protein 	2

	<p>identification by peptide mass fingerprinting. Polymerase chain reaction (PCR)-directed protein in situ arrays</p> <ul style="list-style-type: none"> • Structural proteomics, Applications of proteomics: Host-pathogen interaction, protein-protein interaction, drug discovery. • Protein structure & functions prediction tools: Modeling: 2D and 3D protein modeling 	
PCIII-M11	<p>Intellectual property rights</p> <ul style="list-style-type: none"> • Intellectual Property Rights: Patentable subject matter and patent types, Trademarks, and Copyrights. Purpose of a patent claim example • Determining the scope of a patent claim, the language of a patent claim, focus on point of novelty. Introduction to Patenting of Microbiological materials and GMOs, the implication of patenting, current issues, patenting of genes and DNA sequences. • Deposition of microorganisms for Patent; Biosafety issues, Ethical, legal, and social issues in Scientific research. <i>(Visit the culture collection center, a presentation on case studies and mock-patent writing need to be included)</i> 	2
PCIII-M12	<p>Recent Trends in microbial drug resistance, pathogenicity, and therapeutics</p> <ul style="list-style-type: none"> • Antimicrobial resistance: types of antimicrobial agents, mechanisms of drug resistance, global emergence and spread of multidrug-resistant pathogens (ESKAPE group and <i>M. tuberculosis</i>), control strategies. • Microbial Pathogenicity: biochemical and molecular assays for screening of Virulence factors, pathogenicity islands, and host-pathogen interaction. • Novel antimicrobials: Alternative therapies (bacteriophage therapy, nanomedicine, antimicrobial peptides, other natural products of plant or microbial origin, screening and development approaches of novel antimicrobials (<i>in vitro</i> and <i>in vivo</i> assays, high content screening, safety assays, etc.). 	
PCIII-M13	<p>Bioprocess technology and bioengineering:</p> <ul style="list-style-type: none"> • Microbial Products: Enzymes, metabolites, biomass, recombinant products. Screening assays, production, purification, characterization • Industrially important microorganisms: Isolation methods, screening assay, and strain improvement (Mutation, Genetic recombination) • Applications of microbial products (Bioremediation, medical, food, agriculture, cosmetics, pharmaceutical, etc); Toxicological evaluation; formulations of microbial products; • Large-scale production and recovery of value-added products: Media formulation, pretreatment, and optimization (by Plackett Burman design, response surface methodology, simplex design), Fermentation, and Downstream processing 	
PCIII-MI17	<p>Advances in Agriculture Microbiology:</p> <ul style="list-style-type: none"> • Soil Structure and components • Application of agriculturally important microbes (PGPR, metal chelators, nitrogen fixating microbes, Hydrogen cyanide producers, and 	

	<p>secondary metabolite producers), Developing Biofertilizers and Biocontrol strategies</p> <ul style="list-style-type: none"> • Analysis of plant- microbes interaction using advanced microscopic techniques, omics techniques -Arbuscular mycorrhizae used in agriculture • Abiotic (salt, pH, Temperature, metal) and biotic stress response (pathogens/Herbivores) in plants. • Analytical Techniques in agriculture research: Pot assay, Cell and callus culture, Anther culture, Micro-propagation, Somatic cell hybridization, Protoplast fusion, Cybrids, Artificial seeds, <i>Agrobacterium</i>-mediated gene transfer and use of Ti plasmid, pathogen resistance (BT gene), herbicide tolerance, salt tolerance, Antisense RNA and RNA interference technology 	
PCIII-M14	<p>Metabolomics</p> <ul style="list-style-type: none"> • Metabolome- basic overview • Preparation of experimental design; basic sample preparation-extraction and derivatization; • Analytical methods in metabolomics (introduction to mass spectrometry); Data acquisition and processing; Annotation and confirmation of metabolites; Structural elucidation of new compounds, software used for metabolomic studies. • Inclusion of metabolites into biosynthetic pathways; Using stable isotopes for pathway determination • Examples of metabolomic studies on various models (plant, food, microbes, etc.), on models • Integration of metabolomics with other ‘omics’ approaches such as genomics, transcriptomics, and proteomics. 	2
PCIII-M15	<p>Advanced techniques in Microscopy</p> <ul style="list-style-type: none"> • Principles of image formation, Concept of point spread function and optical resolution, Confocal laser scanning microscopy, Spinning disk confocal microscopy, Multiphoton microscopy, • Advanced fluorescence microscopy techniques: FRET, FLIM, FCS, TIRF, Super-resolution microscopy: STED, Single molecule localization microscopy (PALM and STORM), SIM, digital image formation and image processing, Image deconvolution, and quantification 	2
PCIII-M16	<p>Current Perspectives in Cancer biology :</p> <ul style="list-style-type: none"> • Origin and adaptation mechanisms of cancer cells, • Hallmarks of cancer, a tumor suppressor and Oncogenes, Tumor microenvironment and tumor growth, Cancer stem cells, Epithelial to mesenchymal transition and metastasis, cell signaling in cancer, cancer-immune system evasion mechanisms, • Concept of cancer biomarkers and their use in cancer diagnosis and prognosis, • Emerging concepts in cancer therapy: cancer immunotherapy, hyperthermia, etc. 	2

PC IV	Publication Ethics	2
	<ul style="list-style-type: none"> • Philosophy and Ethics: Introduction to philosophy, definition, nature, scope, concept, and branches. Ethics: definition, moral philosophy, nature of moral judgments and reactions. • Scientific Conduct: Ethics concerning science and research; Intellectual honesty and research integrity; Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP); Redundant publications: duplicate and overlapping publications, salami slicing; Selective reporting and misrepresentation of data • Publication Ethics: definition, introduction, and importance; Best practices/standards setting initiatives and guidelines: COPE, WAME, etc.; Conflicts of interest; Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types; Violation of publication ethics, authorship, and contributorship; Identification of publication misconduct, complaints, and appeals • Open Access Publishing: Open access publications and initiatives; SHERPARoMEO online resource to check publisher copyright & self-archiving policies; Software tool to identify predatory publications developed by SPPU; Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc. • Publication Misconduct: A. Group Discussions- Subject-specific ethical issues, FFP, authorship; Conflicts of interest; Complaints and appeals: examples and fraud from India and abroad; B. Software tools- Use of plagiarism software like Turnitin, Urkund, and other open source software tools • Databases and Research Metrics -Databases- Indexing databases; Citation databases: Web of Science, Scopus, etc.; Research Metrics: Impact Factor of a journal as per Journal Citation Report, SNIP, SJR IPP, Cite Score; Metrics: h-index, g index, i10 index, altmetrics 	
	<p>(Note Two Credit course, approved by UGC and compulsory for all Ph.D. students. The link for the same is given below. http://sppudocs.unipune.ac.in/sites/circulars/MPhilPhDAdmission%20Circulars/Research%20and%20Publication%20Ethics.pdf?Mobile=1&Source=%2Fsites%2Fcirculars%2F%5Flayouts%2Fmobile%2Fdispform%2Easpx%3FList%3Df5fad69e%252Dd3e8%252D4ac5%252D90f6%252D0786c34fce20%26View%3D0ea15891%252D5dd2%252D436a%252Dbe77%252D0bedc1d2817a%26ID%3D186%26CurrentPage%3D1)</p>	
