Savitribai Phule Pune University

(Formerly University of Pune)

Syllabus for

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

*(**w.e.f. The academic year 2025-26**)*

Department of Microbiology, SPPU
&
All research centres 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 2025-26***)

1] **Coursework Structure** (As per SPPU circular 98/2025 dated 8 April 2025)**:**

1. The coursework is for 16 credits.
2. The recognized research center, based on the recommendations of the Research Advisory Committee, shall prescribe courses for the Ph.D. scholar, including research methodology and two subject-specific advanced courses, to be completed within two years of registration.
3. A course on Publication Ethics must be completed within two years from the date of registration by the Ph.D. scholar.
4. Candidates with an M.Phil. degree from SPPU who are admitted to the Ph.D. program, or those who have completed M.Phil. coursework and are permitted to proceed to a Ph.D., will be exempt from Ph.D. coursework, provided both programs are in the same subject. If the M.Phil. and Ph.D. programs are in different subjects, the candidate must complete Courses 2, 3, and 5 as specified, as per University Circular No. 07/2025 Reference Number PGS/87 dated 9th January 2025.
5. All other candidates admitted to the Ph.D. program are required to complete the coursework approved by the Academic Council of SPPU, achieving a minimum of 55% marks or its equivalent grade on the UGC 10-point scale, within the first two years of registration. Candidates will be permitted to continue with their Ph.D. studies and submit the thesis only after fulfilling these requirements.
6. Grades in the course work, including research methodology courses, shall be finalized after a combined assessment by the Research Advisory Committee and the Place of Research, and the final grades shall be communicated to the P. G. Admission Section of the SPPU.
7. All Ph.D. scholars, irrespective of discipline, shall be required to train in teaching /education /pedagogy/writing related to their chosen Ph.D. subject during their doctoral period. Ph.D. scholars may also be assigned 4-6 hours per week of teaching/research assistantship for conducting tutorial or laboratory work and evaluations.
8. The Research Advisory Committee can also recommend online/offline courses offered by UGC/National Agency/MOOCs/SWAYAM/NPTEL., etc., of 4 Credits each as part of the credit requirements for the Ph.D. program. Candidates may such courses with permission of the guide, coursework coordinator/s, and Head of the Institute/ department.

Table 1: Percentage to grade and grade point

Sr. No.	Grade Letter	Grade Point	Marks
1	O Outstanding	10	90 to 100
2	A+ (Excellent)	9	80 to 89
3	A (Very Good)	8	75 to 79
4	B+ (Good)	7	70 to 74
5	B (Above Average)	6	65 to 69
6	C (Average)	5	60 to 64
7	D (Pass)	4	55 to 59
8	F (Fail)	0	<55
9	Ab (Absent)	0	

Table 2: Illustration of the Structure of CGPA and Marks Scheme for Ph. D. Course Work

Course No.	Course Name	Credit	Internal marks	External Marks	Grade letter	Grade points (0-10)	Credit point=(Credit X Grad point)
RM	Research Methodology	4	30	70	A	8	32
SCW	Attending at least one Seminar/ Conference/Workshop (National/ International) and Presenting paper/poster¬	1	-	-	O	10	10
SPAL-1	Subject-specific advanced-level course- 1	4	30	70	O	10	40
SPAL-2	Subject-specific advanced-level course- 2	4	30	70	A+	9	36
RPE	Research and Publication Ethics	2	15	35	B+	7	14
PIA	Pedagogical Training/ Industrial Visit report/Assessment Statement	1	07	18	A	8	8
	Total	**16**	**112**	**263**		**52**	**140**

CGPA: Total Credits Points/ Total Credit for the course: 8.75
Final Grade: A+ Excellent
Result : Pass

Table 3: CGPA Distribution and corresponding class of the degree awarded

Sr. No.	CGPA	Class of the Ph. D. course awarded
1	9.50 or More than 9.5	O Outstanding
2	8.25 or more but less than 9.50	A+ (Excellent)
3	6.75 or more but less than 8.25	A (Very Good)
4	5.75 or more but less than 6.75	B+ (Good)
5	5.25 or more but less than 5.75	B (Above Average)
6	4.75 or more but less than 5.25	C (Average)
7	4.00 or more but less than 4.75	D (Pass)

Table 4. Course structure

Course No.	Title of the course		No. of credits	Responsibility	Total Marks
RM	Research Methodology	Compulsory	4	Research Center & research Supervisor	100
SCW	Attending at least one Seminar/ Conference/Workshop (National/ International) and Presenting paper/poster	Compulsory	1		25
	Subject-specific advanced-level courses (Select any TWO)				
SPAL-1	Biophysical Techniques	Elective	8 (4+4)	Research Center	100
SPAL-2	Immunology, Virology and Medical Microbiology				100
SPAL-3	Omics-Genomics, Proteomics and Metabolomics				100
SPAL-4	Agriculture and Environmental Microbiology				100
SPAL-5	Bioprocess technology, bioengineering and IPR				100
RPE	Research and Publication Ethics	Compulsory	2	Research Center or Equivalent course run by the Centre of Publication Ethics SPPU.	50
PIA	Pedagogical Training/ Industrial Visit report/Assessment Statement	Compulsory	1	Research Center & research Supervisor	25
Total			16		400

Course Details:

Course No.	Course Name	Credits
RM	**Research Methodology:** • **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 publication (Authorship, Competing interests, Plagiarism, Simultaneous *Evaluation criteria -* *Internal evaluation: Writing a review article / Scientific Paper/ Preparing a Grant Proposal (Marks should be given by the respective research guide)* *External: Research paper presentations- The candidate shall present at least three research papers. To be evaluated by the external committee appointed by the research center. (Marks for the best two presentations shall be considered)*	4
SCW	• Attending at least one Seminar/ Conference/Workshop (National/ International) and Presenting paper/poster. *Evaluation Criteria –* *Marks should be given by the respective research guide*	1

SPAL	Subject-specific advanced-level courses (Elective)	8
	Evaluation criteria: *Internal evaluation: Candidate should perform experiments related to above topics/ attend one or more training or workshops session (minimum five days) to enhance their skill sets. (Marks should be given by the respective research guide)* *External evaluation: Written test conducted by the research center conducting the course work.*	
SPAL-1	**Biophysical Techniques** • **Chromatographic techniques**: Introduction- 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. • **Spectroscopic techniques:** Principle, working, applications, and data analysis of : UV-Visible Spectroscopy, Fluorescence spectroscopy, Fourier-transform infrared spectroscopy, Mass spectroscopy, Nuclear magnetic resonance, X-ray crystallography • **Calorimetric techniques:** Differential scanning calorimetry, Isothermal titration calorimetry (ITC) • **Advanced techniques in Microscopy** Application of Confocal laser scanning microscopy, Spinning disk confocal microscopy, Multiphoton microscopy, cryo-electron 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 • **Analytical and separation techniques:** Analytical ultracentrifugation, dynamic light scattering (DLS), Surface plasmon resonance (SPR) *(In addition to classroom teaching, demonstrate the working of instruments by visiting the instrumentation center/facility)*	4
SPAL-2	**Immunology, Virology and Medical Microbiology** • Epidemiological Study (designs): Case control, cohort, concurrent, cross-sectional, retrospective/prospective. • Clinical/field trials-Randomization, Bias removal (Blinding – single & double), controlled and uncontrolled trials	4

	• 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. • 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, hemagglutinations, and hemagglutination inhibition tests, Complement fixation, neutralization, Western blot, RIPA, flow cytometry, and immuno-histochemistry, etc. • Nanotechnology in Biomedical Sciences: Types of nanomaterials in biomedical sciences, application in drug delivery and cancer therapy, nanotechnology-based diagnostic tools, application gene therapy and RNA interference; Ethical, regulatory, and safety considerations in nanomedicine *(In addition to classroom teaching, demonstrate the working of instruments by visiting the instrumentation center/facility)*	
SPAL-3	**Omics- Genomics, Proteomics and Metabolomics** Introduction to Genomics, Transcriptomics, Proteomics, Epigenomics, Metagenomics and their applications. **Introduction to genomics:** • Overview of key genomics web resources: nucleic acid sequence databases (e.g., GenBank, EMBL, DDBJ), protein sequence databases (e.g., UniProt), gene expression databases (e.g., GEO, ArrayExpress), and metabolic/metabolomic databases (e.g., KEGG, HMDB). • Overview of major sequencing technologies: short-read (Illumina) and long-read (PacBio, Oxford Nanopore); principles, workflows, strengths, limitations, and typical applications. • Data Quality Control & Pre-processing: Importance of raw data quality assessment; Tools: FastQC for read quality checks; Read trimming and filtering (Trimmomatic, Cutadapt); Contamination checks (Kraken, FastQ Screen). • Genome assembly: concepts (reads, contigs, scaffolds, draft vs. complete genomes, chromosomal assemblies); algorithms (de Bruijn graph, overlap-layout-consensus); software tools and pipelines.	**4**

	• Genome annotation: gene prediction tools, functional annotation platforms (e.g., Prokka, RAST, NCBI pipelines). • Basic Downstream Analyses: Variant calling (SNPs and Indels — concepts & workflows e.g., GATK basics); Gene expression quantification RNA-Seq pipeline basics (alignment, quantification, differential expression); Metagenomic binning (Concepts and introductory tools - e.g., MetaBAT, MEGAHIT for assembly) **Proteomics:** • 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 identification by peptide mass fingerprinting. Polymerase chain reaction (PCR)-directed protein in situ arrays • Structural proteomics, Applications of proteomics: Host-pathogen interaction, protein-protein interaction, drug discovery. • Protein structure & functions prediction tools: Modeling: 2D and 3D protein modeling. **Metabolomics:** • 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. *(In addition to classroom teaching students should learn - Accessing and using web-based tools; Basic command-line tasks, Small guided exercises: e.g., retrieving data, running a simple analysis, interpreting output)*	
SPAL-4	**Agriculture and Environmental Microbiology** • Application of agriculturally important microbes (PGPR, Biocontrol agents (Biopesticides/bioherbicides), Development of Biofertilizers and Biocontrol agents' formulations • Abiotic (salt, pH, temperature, heavy metal, etc.) and biotic stress response (pathogens/pest) in plants	**4**

	- Techniques in agriculture research: Pot assay, Cell and callus culture, Anther culture, Micro-propagation, Somatic cell hybridization, Protoplast fusion, Cybrids, Artificial seeds, *Agrobacterium*-mediated gene transfer and use of Ti plasmid, pathogen resistance (BT gene), herbicide tolerance, salt tolerance, Antisense RNA and RNA interference technology - Plant- microbes interaction Study: Advanced microscopic techniques (SEM, TEM, Fluorescence microscope, Confocal laser scanning microscopy, etc) , omics techniques (genomics, transcriptomics, proteomics, metabolomics, metagenomic, phenomics), - Recent advances in Bacterial Taxonomy -Identification of Prokaryotes using Bergey's Manual, 16s rRNA fingerprinting and lipid profile, mass spectra, API; Culture-independent molecular methods for identifying unculturable bacteria (PCR, FFLP, ARDRA, DGGE, TGGE, RAPD, Microarray, FISH, RISA) - Application of biocatalysis in organic synthesis, biotransformation, enzymes in organic media, lipases, and nitrilases **Environmental Microbiology** - Generation of microbial electricity from waste- principles and technological implications, Microbial fuel cell - 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. - Bioremediation of various contaminants & sites: oil spills cleanup, Heavy metal-contaminated soil detoxification - Use of microbial processes for industrial wastewater treatment and disposal processes **Applications of Nanotechnology in agriculture** - Types of nanomaterials used in Agriculture - Use of nanomaterials for crop growth, Soil Management, Pest and Disease Control, Water Management in Agriculture *(In addition to classroom teaching, demonstrate the working of instruments by visiting the instrumentation center/facility)*	
SPAL-5	**Bioprocess technology, bioengineering and IPR:** - 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;	4

	- 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. - Biofuel production: Types of Biofuels, Feedstocks for Biofuel Production, Biethanol, Biodiesel, biogas and biohydrogen production technology. **Intellectual property rights** - 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. - Regulatory Aspects of Biotech Products: Regulatory approvals for biopharmaceuticals and genetically engineered organisms, Safety and efficacy regulations, Role of regulatory bodies (FDA, EMA, etc.) - Deposition of microorganisms for Patent; Biosafety issues, Ethical, legal, and social issues in Scientific research. *(Visit the culture collection center, a presentation on case studies and mock-patent writing need to be included)*	
RPE	**Research and Publication Ethics** **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-**	2

	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 (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)	
PIA	**Pedagogical Training/ Industrial Visit report/Assessment Statement** *Evaluation Criteria –* *Grades should be given by the respective research guide*	**1**

****