

# Savitribai Phule Pune University

## Ph.D. course work in the Subject of Microbiology.

- 1] **Coursework Structure:** The coursework shall be of total **16 credits** divided into three courses. One credit shall be equal to 15 hours of contact time.
- **Course I: Research Methodology- Compulsory (4 credits)**  
Research methodologies adapted for designing, executing and publishing a research work.
  - **Course II: Scientific writing and communication – Compulsory (4 credits)**  
Activity based course- Writing research grant proposal, review article, and presenting research papers.
  - **Course III: Subject specific advanced level courses- Elective (8 credits)**  
These courses are designed to impart skills and knowledge in advance research methodologies, to impart hands on experience or demonstration of different techniques and instrumentations used in biological sciences, to analyze and interpret data obtained.
- 2] **Coursework Flexibility:**
- Department conducting the coursework may decide the optional courses to be floated.
  - Candidates may opt for equivalent online courses floated on 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 will 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 in the Departmental Committee and forwarded to the Board of studies.
  - If found necessary, course work 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 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)
<b>Total</b>		16	200	200	400

## 5] Course Details:

Course No.	Course Name	Credits
PC I	<p><b>Research Methodology:</b></p> <ul style="list-style-type: none"> <li>• <b>History of research.</b> Indian, Egyptian, Greek ideas methodologies and research in agriculture, chemistry, metallurgy, medical. Ancient Indian research methodology</li> <li>• <b>Biostatistics</b> 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 in various subjects using statistical methods, Error and noise analysis, curve fitting</li> <li>• <b>Rules and regulations to be followed for research:</b> 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 submission, and Research fraud).</li> <li>• <b>Literature survey:</b> Referencing at institutional and national libraries, web-based search engines to survey scientific literature and databases (Google Scholar, Science Direct, Medline-Pubmed, Web of science, Cochrane, EMBASE etc.).</li> <li>• <b>Publishing Research:</b> Structure of research proposals, patents, thesis, and research publications, Making oral and poster presentation. Journal selection (UGC-CARE listed, SCIE listed, JCR listed), Measures of Indexing (Impact Factor, H-Index, i10 index, citation Index etc.).</li> <li>• <b>Research Techniques:</b> Spreadsheet tools (features, using formulas and functions for statistical analysis, making graphs and charts), Power point 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.)</li> </ul>	4
PC II	<p><b>Scientific writing and communication</b></p> <ul style="list-style-type: none"> <li>• Writing a review article OR Scientific Paper (to be internally evaluated by respected research guide) (1 credit)</li> <li>• Preparing a Grant Proposal (to be evaluated by respected research guide) (1 credit)</li> <li>• 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 (2 credits)</li> </ul>	4

<b>PC III</b>	<b>Subject specific advanced level courses</b>	<b>8</b>
<b>PCIII-M1</b>	<b>Advanced Spectroscopy</b> Principle, working, applications and data analysis of following <ul style="list-style-type: none"> <li>• UV Visible Spectroscopy</li> <li>• Fluorescence spectroscopy</li> <li>• Fourier-transform infrared spectroscopy</li> <li>• Mass spectroscopy</li> <li>• Nuclear magnetic resonance</li> <li>• X ray diffraction</li> </ul>	<b>2</b>
<b>PCIII-M2</b>	<b>Bioinformatics</b> <ul style="list-style-type: none"> <li>• Introduction and biological databases Nucleic acid, proteins, genomes— structure data bases, search engines, sequence data forms and submission tools, scoring matrices for sequence alignments, algorithms pairwise sequence alignments, database similarity searches-BLAST, FASTA</li> <li>• 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 prediction, comparative analysis</li> <li>• Demonstration of databases (GENBANK, PDB, OMIM) and software (RASMOL, Ligand Explorer)</li> <li>• Phylogenetic prediction. Sequence Analysis, Sequence alignment, Primer Designing, Mass Spectrometry based proteomics tools, Protein structure &amp; functions prediction tools: Modeling: 2D and 3D protein modeling. System Biology approach to understand microbial enzyme machinery.</li> </ul>	<b>2</b>
<b>PCIII-M3</b>	<b>Cell Culture Techniques</b> <ul style="list-style-type: none"> <li>• <b>Animal Culture:</b> 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.</li> <li>• <b>Plant tissue culture:</b> 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. Applications of plant tissue culture engineering, pathogen resistance (BT gene), herbicide tolerance, salt tolerance, production of secondary metabolites and transgenic plants.</li> </ul> <p><i>(In addition to classroom teaching, practical sessions need to be incorporated)</i></p>	

<b>PCIII-M4</b>	<b>Techniques in Nanotechnology</b> <ul style="list-style-type: none"> <li>• Nanoparticles types – Metallic, polymeric, carbon based, lipid based, semiconductor nanoparticles etc.</li> <li>• Synthesis of nanoparticles</li> <li>• Tools and techniques for characterization of nanoparticles- in vitro and in vivo characterization of nanoparticles</li> <li>• Principle, working, applications and data analysis of SEM, TEM, powdered X-ray, AFM, SPM, EDAX, Zeta analysis and DLS used for characterization of nanoparticles</li> <li>• Applications of Nanobiotechnology: Quantum dots, magnetic nanoparticles, plasmonic nanoparticles, carbon nanotubes, graphene nanoparticles and core shell nanoparticles in medicine, environment and agriculture.</li> </ul>	<b>2</b>
<b>PCIII-M5</b>	<b>Techniques in virology</b> <ul style="list-style-type: none"> <li>• 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</li> <li>• Diagnostic methods: Serological and Nucleic acid-based diagnosis. Immuno-diagnosis, hemagglutinations and hemagglutination inhibition tests, Complement fixation, neutralization, Western blot, RIPA, flow-cytometry and immunohistochemistry etc.</li> <li>• Microscopic techniques: Fluorescence, confocal and electron microscopic techniques</li> <li>• Analytical techniques: Electrophoresis, chromatography, membrane filtration, NMR, X-ray crystallography.</li> </ul>	<b>2</b>
<b>PCIII-M6</b>	<b>Immunology and Medical Microbiology</b> <ul style="list-style-type: none"> <li>• Epidemiological Study (designs): Case control, cohort, concurrent, cross-sectional, retrospective/prospective.</li> <li>• Clinical/field trials-Randomization, Bias removal (Blinding – single &amp; double), controlled and uncontrolled trials</li> <li>• 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.</li> <li>• Animal model of immunological disease (Transgenic and knockout animals).</li> <li>• Generation of bone-marrow chimeras, humanized mice, parabiosis.</li> </ul>	<b>2</b>
<b>PCIII-M7</b>	<b>Applied and Environmental Microbiology</b> <ul style="list-style-type: none"> <li>• Recent advances in Bacterial Taxonomy -Identification of Prokaryotes, current Bergey's Manual, Computer taxonomy, 16s</li> </ul>	<b>2</b>

	<p>rRNA fingerprinting and lipid profile, mass spectra, API, etc</p> <ul style="list-style-type: none"> <li>• Application of biocatalysis in organic synthesis, biotransformation, enzymes in organic media, lipases and nitrilases</li> <li>• Advances in biofertilizers and biopesticides</li> <li>• Plant disease control: Antisense RNA and RNA interference technology</li> <li>• Generation of electricity using waste- principles and technological implications</li> <li>• Application of lactic acid bacteria – probiotics, criteria for selection, functional foods, Human health, and microbiome</li> <li>• Quorum sensing and Quorum quenching in bacteria</li> <li>• Bioremediation, Biostimulation, Bioaugmentation and Biosorption.</li> <li>• Applications of bioremediation to various contaminants &amp; sites: Marine oil spills &amp; Metal-contaminated soils, hyper-accumulators</li> <li>• Recent industrial wastewater treatment and disposal processes</li> </ul>	
<b>PCIII-M8</b>	<p><b>Chromatography techniques</b></p> <ul style="list-style-type: none"> <li>• Chromatography- Partition Coefficient, Selectivity, Resolution, Column Efficiency, Van Deemter equation, Interpretation of chromatograms</li> <li>• Principle, components of instrument, operation and application of: Gas chromatography, High Performance Liquid Chromatography, Gel filtration chromatography, Ion-exchange Chromatography and Affinity chromatography.</li> </ul> <p><i>(In addition to classroom teaching, demonstrate the working of instruments by visiting instrumentation center/facility)</i></p>	<b>2</b>
<b>PCIII-M9</b>	<p><b>Genomics</b></p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• 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</li> <li>• Sequence analysis and their applications: Human Genetics and Human Genome Project, Genomic insights into evolution, advantages of comparative genomic analysis, Analysis of microarray data.</li> <li>• DNA/ Protein micro-arrays- DNA/ Protein Markers- DNA finger printing- Gene knockout - RNAi and Gene silencing- Metagenomics, application of metagenomic libraries, Metabolic engineering.</li> <li>• Culture independent molecular methods for identifying unculturable bacteria (PCR, FFLP, ARDRA, DGGE, TGGE,</li> </ul>	<b>2</b>

	RAPD, Microarray, FISH, RISA), metagenomics analysis.	
<b>PCIII-M10</b>	<p><b>Proteomics</b></p> <ul style="list-style-type: none"> <li>• Introduction, types of proteomics investigation and importance of proteomics</li> <li>• 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</li> <li>• Structural proteomics, Applications of proteomics: Host-pathogen interaction, protein-protein interaction, drug discovery.</li> <li>• Protein structure &amp; functions prediction tools: Modeling: 2D and 3D protein modeling</li> </ul>	<b>2</b>
<b>PCIII-M11</b>	<p><b>Intellectual property rights</b></p> <ul style="list-style-type: none"> <li>• Intellectual Property Rights: Patentable subject matter and patent types, Trademarks, Copyrights. Purpose of a patent claim Patent claim example</li> <li>• 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 GMO, implication of patenting, current issues, patenting of genes and DNA sequences.</li> <li>• Deposition of microorganisms for the purposes of Patent; Biosafety issues, Ethical, legal and social issues in Scientific research.</li> </ul> <p><i>(Visit to culture collection center, presentation on case studies and mock-patent writing need to be included)</i></p>	<b>2</b>
<b>PCIII-M12</b>	<p><b>Recent Trends in microbial drug resistance, pathogenicity and therapeutics</b></p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• Microbial Pathogenicity: biochemical and molecular assays for screening of Virulence factors, pathogenicity islands, host pathogen interaction.</li> <li>• 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.).</li> </ul>	
<b>PCIII-M13</b>	<p><b>Bioprocess technology and bioengineering:</b></p> <ul style="list-style-type: none"> <li>• Microbial Products: Enzymes, metabolites, biomass, recombinant products. Screening assays, production, purification, characterization</li> <li>• Industrially important microorganisms: Isolation methods, screening assay and strain improvement ( Mutation, Genetic recombination)</li> </ul>	

	<ul style="list-style-type: none"> <li>• Applications of microbial products (Bioremediation, medical, food, agriculture, cosmetics, pharmaceutical etc); Toxicological evaluation; formulations of microbial products;</li> <li>• 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</li> </ul>	
<b>PCIII-MI17</b>	<p><b>Advances in Agriculture Microbiology:</b></p> <ul style="list-style-type: none"> <li>• Soil Structure and components</li> <li>• Application of agriculturally important microbes (PGPR, metal chelators, nitrogen fixating microbes, Hydrogen cyanide producers and secondary metabolite producers), Developing Biofertilizers and Biocontrol strategies</li> <li>• Analysis of plant- microbes inteaction using advanced microscopic techniques, omics techniques -Arbuscular mycorrhizae use in agriculture</li> <li>• Abiotic (salt, pH, Temperature, metal) and biotic stress response (pathogens/Herbivore) in plants.</li> <li>• Analytical 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</li> </ul>	
<b>PCIII-M14</b>	<p><b>Metabolomics</b></p> <ul style="list-style-type: none"> <li>• Metabolome- basic overview</li> <li>• Preparation of experimental design; basic sample preparation-extraction and derivatization;</li> <li>• 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.</li> <li>• Inclusion of metabolites into biosynthetic pathways; Using stable isotopes for pathway determination</li> <li>• Examples of metabolomic studies on various models (plant, food, microbes etc), on models</li> <li>• Integration of metabolomics with other ‘omics’ approaches as genomics, transcriptomics and proteomics.</li> </ul>	<b>2</b>
<b>PCIII-M15</b>	<p><b>Advanced techniques in Microscopy</b></p> <ul style="list-style-type: none"> <li>• Principles of image formation, Concept of point spread function and optical resolution, Confocal laser scanning microscopy, Spinning disk confocal microscopy, Multiphoton microscopy,</li> <li>• Advanced fluorecence microscopy techniques: FRET, FLIM, FCS, TIRF, Super-resolution microscopy: STED, Single molecule</li> </ul>	<b>2</b>

	localization microscopy (PALM and STORM), SIM, digital image formation and image processing, Image deconvolution and quantification	
<b>PCIII-M16</b>	<b>Current Perspectives in Cancer biology :</b> <ul style="list-style-type: none"> <li>• Origin and adaptation mechanisms of cancer cells,</li> <li>• Hallmarks of cancer, 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,</li> <li>• Concept of cancer biomarkers and their use in cancer diagnosis and prognosis,</li> <li>• Emerging concepts in cancer therapy: cancer immunotherapy, hyperthermia etc.</li> </ul>	<b>2</b>

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