

PLANT PATHOLOGY

Graduate Program Head	Maria Del Mar Jimenez Gasco
Program Code	PPATH
Campus(es)	University Park (Ph.D., M.S.)
Degrees Conferred	Doctor of Philosophy (Ph.D.) Master of Science (M.S.) Dual-title Ph.D. in Plant Pathology and Biogeochemistry Dual-title Ph.D. and M.S. in Plant Pathology and International Agriculture and Development Dual-title Ph.D. in Plant Pathology and Microbiome Sciences
The Graduate Faculty	View (https://secure.gradsch.psu.edu/gpms/?searchType=fac&prog=PPATH)

Plant pathology is the study of disease in plants and concerns the dynamic interaction between the plant, the causal agent (bacteria, fungi, viruses, nematodes, etc.), and their environments. A student prepares for a professional career in research, teaching, extension, or industry through advanced studies of the principles of plant infection, the physiology of disease in plants, the ecology of root diseases, the nature and inheritance of disease resistance in plants, epidemiology, microbial ecology, phytobiomes, translational taxonomy, ecology and physiology of air pollution injury to plants, or plant disease management by biological or chemical means. A student may specialize in the etiology and integrated management of diseases of forest trees, agronomic or horticultural crops. Advanced studies in molecular systematics of fungi and applied mycology, related to the production of the commercial mushroom, are also available. Modern, well-equipped laboratories, controlled environment facilities and greenhouses, and well-developed field research areas are available for graduate study.

Admission Requirements

Applicants apply for admission to the program via the J. Jeffrey and Ann Marie Fox Graduate School application for admission (<https://gradschool.psu.edu/admissions/how-to-apply/>). Requirements listed here are in addition to Graduate Council policies listed under GCAC-300 Admissions Policies (<https://gradschool.psu.edu/graduate-education-policies/>).

The best-qualified applicants will be accepted up to the number of spaces and advisers that are available for new students. Students with a 3.00 junior/senior average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. Exceptions to the minimum 3.00 grade-point average may be made at the program's discretion for students with special backgrounds, abilities, and interests. GRE scores are not required for admission.

Students are expected to have a strong foundation in biological and physical sciences. Generally, students with B.S. degrees in biology, microbiology, plant science, molecular biology, or biochemistry are well prepared for graduate study in Plant Pathology.

Degree Requirements

Master of Science (M.S.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-600 Research Degree Policies. (<https://gradschool.psu.edu/graduate-education-policies/>)

The Master of Science degree program in Plant Pathology leads students either to the development of special proficiencies in Plant Pathology, which will allow the individual to directly enter a professional career, or to the development of a basic knowledge of the discipline, allowing for advancement to the Ph.D. degree. M.S. degree students will be introduced to the broad aspects of the field of plant pathology, including:

- exposure to the various causal agents of plant disease and the diseases they incite;
- diseases of current and classical importance affecting a wide range of crop plants;
- a variety of techniques used to isolate, characterize, and identify causal agents of plant disease; and
- an appreciation for the relationship between plant pathology and other biological and physical sciences.

A minimum of 30 credits at the 400, 500, 600, or 800 level is required, with at least 18 credits in the 500 and 600 series combined.

Code	Title	Credits
Required Courses		
PPEM 405	Microbe-Plant Interactions: Plant Disease and Biological Control	3
PPATH 502	Plant Disease Diagnosis	3
PPATH 505	Fundamentals of Phytopathology	4
PPATH 522	Professional Development & Ethics in Plant Pathology	1
PPATH 590	Colloquium ¹	2

ADDITIONAL COURSES

All M.S. students must take a minimum of 9 total credits from the following two lists, as described.

Microbial Groups (choose at least 6 credits): 6

PPEM 416	Plant Virology: Molecules to Populations
PPEM 417W	Mechanisms of Bacterial Pathogenesis in Plants
PPEM 425	Biology of Fungi

Microbial Interactions and the Environment (choose at least 3 credits): 3

PPEM 412	Turfgrass Disease Management
or PPEM 412	
PPEM 440	Introduction to Microbiome Analysis
PPEM 454	Virus Ecology
PPEM 456	Applied Microbial Ecology
AGECO 457	Principles of Integrated Pest Management
PPATH 533	Molecular Genetics of Plant-Pathogen Interactions
PPATH 542	Epidemiology of Plant Diseases
AGBIO 802	Plant Protection: Responding to Introductions of Threatening Pests and Pathogens

Electives

As approved by the thesis adviser, M.S. students must choose an additional two credits of 400, 500, 600 or 800 level courses in PPEM, PPATH or a related field. 2

Culminating Experience²

PPATH 600	Thesis Research	6
or PPATH 610	Thesis Research Off Campus	
Total Credits		30

¹ All students are required to register for and participate in PPATH 590 (1 credit Pass/Fail) for all semesters enrolled. No more than two (2) credits of PPATH 590 may count towards the Master's degree.

² A maximum of 6 thesis credits can be applied to the 18 credits required at the 500-600 level.

Students may complete additional course work at other levels as required and/or approved by their committee.

Equivalent courses taken in a previous program may be substituted for M.S. course requirements, by approval of the Program. However, equivalent courses cannot be applied to the 30-credit requirement.

Master's degree students must prepare and present seminars in the departmental PPATH 590, which will evaluate English communication skills. During their studies, Master's degree students may have an opportunity to assist in teaching a disciplinary subject.

All Master's degree students must write a thesis proposal which must be accepted by the adviser(s), committee members, and the Head of the Graduate Program. All Master's degree students must write a thesis which must be accepted by the adviser(s), committee members, the Head of the Graduate Program, and the Graduate School. The student must present and pass a final oral thesis defense.

Doctor of Philosophy (ph.D.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-600 Research Degree Policies. (<https://gradschool.psu.edu/graduate-education-policies/>)

Code	Title	Credits
Required Courses		
PPEM 405	Microbe-Plant Interactions: Plant Disease and Biological Control	3
PPATH 502	Plant Disease Diagnosis	3
PPATH 505	Fundamentals of Phytopathology	4
PPATH 522	Professional Development & Ethics in Plant Pathology	1
PPATH 590	Colloquium ¹	2
PPATH 602	Supervised Experience in College Teaching ²	1

ADDITIONAL COURSES

All Ph.D. students must take a minimum of 6 total credits from the following two lists, taking a minimum of 3 each as described.

<i>Microbial Groups (choose at least 3 credits):</i>		3
PPEM 416	Plant Virology: Molecules to Populations	
PPEM 417W	Mechanisms of Bacterial Pathogenesis in Plants	
PPEM 425	Biology of Fungi	
<i>Microbial Interactions and the Environment (choose at least 3 credits):</i>		3
PPEM 412	Turfgrass Disease Management	
or PPEM 412WC		
PPEM 440	Introduction to Microbiome Analysis	
PPEM 454	Virus Ecology	

PPEM 456	Applied Microbial Ecology
AGECO 457	Principles of Integrated Pest Management
PPATH 533	Molecular Genetics of Plant-Pathogen Interactions
PPATH 542	Epidemiology of Plant Diseases
AGBIO 802	Plant Protection: Responding to Introductions of Threatening Pests and Pathogens

Culminating Experience

PPATH 600	Thesis Research	6
or PPATH 610	Thesis Research Off Campus	
Total Credits		26

¹ Ph.D. students enrolled in the PPATH graduate program must enroll in PPATH 590 every semester until they have passed their comprehensive exam. Two credits of PPATH 590 can be counted toward the degree requirements.

² Students may take up to 3 credits of PPATH 602 Supervised Experience in College Teaching.

Students may enroll in other courses tailored to the individual by the student's Ph.D. committee.

Ph.D. students must prepare and present seminars in the departmental PPATH 590, which will evaluate English communication skills. During their studies, Ph.D. students will have an opportunity to assist in teaching a disciplinary subject.

All doctoral students must pass a qualifying examination, a comprehensive examination, and a final oral examination (the dissertation defense). To earn the Ph.D. degree, doctoral students must also write a dissertation proposal and a dissertation. The dissertation proposal must be accepted by the adviser(s), committee members, and the head of the graduate program. The dissertation must be accepted by the adviser(s), committee members, and the head of the graduate program, and the Graduate School. The student must present and pass a dissertation defense.

Dual-Titles**Dual-Title Ph.D. in Plant Pathology and Biogeochemistry**

Requirements listed here are in addition to requirements listed in GCAC-208 Dual-Title Graduate Degree Programs (<https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-200/gcac-208-dual-titles/>).

Doctoral students with research and educational experiences in plant pathology and environmental microbiology may apply to the Plant Pathology/Biogeochemistry Dual-Title Doctoral Degree Program. The goal of the dual-title Ph.D. degree in Plant Pathology and Biogeochemistry is to enable PPATH graduate students to acquire the knowledge and skills of their major area of specialization in PPATH, while at the same time gaining expertise and skills in biogeochemistry. Graduate study in this program seeks to provide students with the intellectual foundation for integrated and mechanistic understanding of interactions between plant hosts, microbes, and environmental systems. Interdisciplinary training that includes biogeochemistry will prepare students for positions in academia, government, non-profit organizations, and the private sector. It will also prepare students for a wide array of research careers in the private sector, including agricultural and environmental sciences, energy

industries, and the integrated study of the sustainability of biological systems.

Admission Requirements

For admission to the dual-title doctoral degree in Biogeochemistry, a student must first apply and be admitted to the Plant Pathology graduate program and The Graduate School, preferably but not necessarily discussing the dual-title interest beforehand with a major adviser who has been appointed to the Biogeochemistry program. After admission to their primary program, students must apply for admission to and meet the admissions requirements of the Biogeochemistry dual-title program. Refer to the Admission Requirements section of the Biogeochemistry Bulletin page (<https://bulletins.psu.edu/graduate/programs/majors/biogeochemistry/>). Doctoral students must be admitted into the dual-title degree program in Biogeochemistry prior to taking the qualifying examination in their primary graduate program.

Degree Requirements

To qualify for the dual-title degree, students must satisfy the Plant Pathology Ph.D. degree requirements. In addition, students pursuing the dual-title Ph.D. in Plant Pathology and Biogeochemistry must complete the degree requirements for the dual-title Biogeochemistry Ph.D., listed on the Biogeochemistry Bulletin page (<https://bulletins.psu.edu/graduate/programs/majors/biogeochemistry/>). Students are required to have two advisers from separate disciplines: one individual serving as a primary adviser in their major degree program and a secondary adviser in an area within a field covered by the dual-title program who is a member of the Biogeochemistry Graduate Faculty. The major program adviser normally will also be a member of the Biogeochemistry Graduate Faculty. The two faculty advisers can represent different academic programs, but this is not required, as faculty from a scientifically diverse department could represent very different areas of expertise.

The qualifying examination committee for the dual-title Ph.D. degree will be composed of Graduate Faculty from Plant Pathology and must include at least one Graduate Faculty member from the Biogeochemistry program. Faculty members who hold appointments in both programs' Graduate Faculty may serve in a combined role. There will be a single qualifying examination, containing elements of both Plant Pathology and Biogeochemistry. Dual-title graduate degree students may require an additional semester to fulfill requirements for both areas of study and, therefore, the qualifying examination may be delayed one semester beyond the normal period allowable.

In addition to the general Graduate Council requirements for Ph.D. committees (<http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/phd-dissertation-committee-formation/>), the Ph.D. committee of a Plant Pathology and Biogeochemistry dual-title doctoral degree student must include at least one member of the Biogeochemistry Graduate Faculty. Faculty members who hold appointments in both programs' Graduate Faculty may serve in a combined role. If the chair of the Ph.D. committee is not also a member of the Graduate Faculty in Biogeochemistry, the member of the committee representing Biogeochemistry must be appointed as co-chair. The Biogeochemistry representative on the student's Ph.D. committee will develop questions for and participate in the evaluation of the comprehensive examination.

Students enrolled in the dual-title program are required to write and orally defend a dissertation on a topic that reflects their original research and education in Plant Pathology and Biogeochemistry. Upon completion of the doctoral dissertation, the candidate must pass a final oral examination (the dissertation defense) to earn the Ph.D. degree. The

dissertation must be accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School.

Dual-Title M.S. and Ph.D. in Plant Pathology and International Agriculture and Development

Requirements listed here are in addition to requirements listed in GCAC-208 Dual-Title Graduate Degree Programs (<https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-200/gcac-208-dual-titles/>).

Graduate students with research and educational interests in international education may apply to the Plant Pathology/INTAD Dual-Title Degree Program. The goal of the dual-title degree in Plant Pathology and INTAD is to enable graduate students to acquire the knowledge and skills of their primary area of specialization in Plant Pathology, while at the same time gain the perspective and methods needed for work in international agriculture. Graduate study in this program seeks to prepare students to assume leadership roles in science, science education, outreach, and project management anywhere in the world. Students are required to write research proposals and grants to support their research activities, reflecting the dual-title degree. As part of their professional development presentations, publication of research articles and active participation in professional societies is expected. Emphasis is placed upon the professional development of the student. Students are able to specialize in the research program areas of:

- plant-microbe interactions,
- plant disease biology and epidemiology,
- environmental microbiology,
- mycology,
- plant virology,
- mushroom biology,
- genomics, and
- disease management.

They will acquire a broad perspective on applying their research findings in the context of the broader international community. The dual-title will allow students to master their field of specialization from an international perspective allowing them to compare practices and outcomes between countries and regions.

Admission Requirements

Students must apply and be admitted to the graduate program in Plant Pathology and The Graduate School before they can apply for admission to the dual-title degree program. After admission to their primary program, students must apply for admission to and meet the admissions requirements of the INTAD dual-title program. Refer to the Admission Requirements section of the INTAD Bulletin page (<https://bulletins.psu.edu/graduate/programs/majors/international-agriculture-development/>). Doctoral students must be admitted into the dual-title degree program in INTAD prior to taking the qualifying examination in their primary graduate program.

Degree Requirements

To qualify for the dual-title degree, students must satisfy the degree requirements for the degree they are enrolled in Plant Pathology. In addition, students pursuing the dual-title in Plant Pathology and INTAD must complete the degree requirements for the dual-title in INTAD, listed on the INTAD Bulletin page (<https://bulletins.psu.edu/graduate/programs/majors/international-agriculture-development/>).

The qualifying examination committee for the dual-title Ph.D. degree will be composed of Graduate Faculty from Plant Pathology and must include at least one Graduate Faculty member from the INTAD program. Faculty members who hold appointments in both programs' Graduate Faculty may serve in a combined role. There will be a single qualifying examination, containing elements of both Plant Pathology and INTAD. Dual-title graduate degree students may require an additional semester to fulfill requirements for both areas of study and, therefore, the qualifying examination may be delayed one semester beyond the normal period allowable.

In addition to the general Graduate Council requirements for Ph.D. committees (<http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/phd-dissertation-committee-formation/>), the Ph.D. committee of a Plant Pathology and INTAD dual-title doctoral degree student must include at least one member of the INTAD Graduate Faculty. Faculty members who hold appointments in both programs' Graduate Faculty may serve in a combined role. If the chair of the Ph.D. committee is not also a member of the Graduate Faculty in INTAD, the member of the committee representing INTAD must be appointed as co-chair. The INTAD representative on the student's Ph.D. committee will develop questions for and participate in the evaluation of the comprehensive examination.

Students enrolled in the dual-title program are required to write and orally defend a dissertation on a topic that reflects their original research and education in Plant Pathology and INTAD. Upon completion of the doctoral dissertation, the candidate must pass a final oral examination (the dissertation defense) to earn the Ph.D. degree. The dissertation must be accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School.

Dual-Title Ph.D. in Plant Pathology and Microbiome Sciences

Requirements listed here are in addition to requirements listed in GCAC-208 Dual-Title Graduate Degree Programs (<https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-200/gcac-208-dual-titles/>).

Doctoral students with research and educational experiences in plant pathology and environmental microbiology may apply to the Plant Pathology-Microbiome Sciences Dual- Title Doctoral Degree Program. The goal of the dual-title Ph.D. degree in Plant Pathology and Microbiome Sciences is to enable PPATH graduate students to acquire the knowledge and skills of their major area of specialization in PPATH, while at the same time gaining expertise and skills in Microbiome Sciences. Graduate study in this program seeks to provide students with the intellectual foundation for integrated and mechanistic understanding of interactions between plant hosts, microbes, and environmental systems. Interdisciplinary training that includes Microbiome Sciences will prepare students for positions in academia, government, non-profit organizations, and the private sector, including agricultural and environmental sciences, energy industries, and the integrated study of the sustainability of biological systems.

Admission Requirements

For admission to the dual-title doctoral degree in Microbiome Sciences, a student must first apply and be admitted to the Plant Pathology PhD graduate program and The Graduate School, preferably but not necessarily discussing the dual-title interest beforehand with a major adviser who has been appointed to the Microbiome Sciences program. After admission to their primary program, students must apply for admission to and meet the admissions requirements of the Microbiome Sciences dual-title program. Refer to the Admission

Requirements section of the Microbiome Sciences Bulletin page (<https://bulletins.psu.edu/graduate/programs/majors/microbiome-sciences/>). Doctoral students should enroll in a dual-title graduate degree program early in their training, and no later than the end of the fourth semester (not counting summer semesters) of entry into the graduate major program.

Degree Requirements

To qualify for the dual-title degree, students must satisfy the Plant Pathology Ph.D. degree requirements. In addition, students pursuing the dual-title Ph.D. in Plant Pathology and Microbiome Sciences must complete the degree requirements for the dual-title Microbiome Sciences Ph.D., listed on the Microbiome Sciences Bulletin page (<https://bulletins.psu.edu/graduate/programs/majors/microbiome-sciences/>). Students are required to have two advisers from separate disciplines: one individual serving as a primary adviser in their major degree program and a secondary adviser in an area within a field covered by the dual-title program who is a member of the Microbiome Sciences Graduate Faculty. The major program adviser normally will also be a member of the Microbiome Sciences Graduate Faculty. The two faculty advisers can represent different academic programs, but this is not required, as faculty from a scientifically diverse department could represent very different areas of expertise.

The qualifying examination for Plant Pathology will satisfy the qualifying examination requirement for the dual-title degree program in Microbiome Sciences.

In addition to the general Graduate Council requirements for Ph.D. committees (<https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/gcac-602-phd-committee-formation/>), the Ph.D. committee of a Plant Pathology and Microbiome Sciences dual-title doctoral degree student must include at least one member of the Microbiome Sciences Graduate Faculty. Faculty members who hold appointments in both programs' Graduate Faculty may serve in a combined role. If the chair of the Ph.D. committee is not also a member of the Graduate Faculty in Microbiome Sciences, the member of the committee representing Microbiome Sciences must be appointed as co-chair. The Microbiome Sciences representative on the student's Ph.D. committee will develop questions for and participate in the evaluation of the comprehensive examination.

Students enrolled in the dual-title program are required to write and orally defend a dissertation on a topic that reflect their original research and education in Plant Pathology and Microbiome Sciences. Upon completion of the doctoral dissertation, the candidate must pass a final oral examination (the dissertation defense) to earn the Ph.D. degree. The dissertation must be accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School.

Minor

A graduate minor is available in any approved graduate major or dual-title program. The default requirements for a graduate minor are stated in Graduate Council policy GCAC-218 Minors (<https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-200/gcac-218-minors/>).

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the Tuition & Funding (<https://gradschool.psu.edu/funding/>) section of the J. Jeffrey and Ann Marie Fox Graduate School's website. Students on graduate assistantships must adhere to the course load limits (<https://gradschool.psu.edu/graduate->

education-policies/gsad/gsad-900/gsad-901-graduate-assistants/) set by the Fox Graduate School.

Courses

Graduate courses carry numbers from 500 to 699 and 800 to 899. Advanced undergraduate courses numbered between 400 and 499 may be used to meet some graduate degree requirements when taken by graduate students. Courses below the 400 level may not. A graduate student may register for or audit these courses in order to make up deficiencies or to fill in gaps in previous education but not to meet requirements for an advanced degree.

Plant Pathology (PPATH) Course List (<https://bulletins.psu.edu/university-course-descriptions/graduate/ppath/>)

Learning Outcomes

Master of Science (M.S.)

1. Graduates will demonstrate breadth and depth in their knowledge of the principles, concepts and methods of the field of Plant Pathology and its related disciplines, and be able to critically evaluate, integrate, and apply that knowledge.
2. Graduates will execute a scientific plan that furthers knowledge in plant pathology and its related disciplines.
3. Graduates will effectively communicate in oral and written format research findings to professional peers, and be capable of translating knowledge to stakeholders and the public.
4. Students will engage in professional activities that promote values for diversity, mentorship and public and professional service, in accordance with the American Phytopathological Society's Code of Professional Conduct.

doctor of Philosophy (Ph.d.)

1. Graduates will demonstrate breadth and depth in their knowledge of the principles, concepts and methods of the field of Plant Pathology and its related disciplines, and be able to critically evaluate, integrate and apply that knowledge.
2. Graduates will be capable of independently formulating and executing a scientific plan that significantly furthers knowledge in Plant Pathology and its related disciplines.
3. Graduates will effectively communicate in oral and written format research findings to professional peers, and effectively translate knowledge to stakeholders and the public.
4. Graduates will have a strong working knowledge of the past, current and future impacts of Plant Pathology and its related disciplines on human affairs, and use this knowledge to guide their research and pedagogical activities.
5. Students will conduct professional activities in ways that promote values for diversity, mentorship and public and professional service, in accordance with the American Phytopathological Society's Code of Professional Conduct.

Contact

Campus	University Park
Graduate Program Head	Maria Del Mar Jimenez Gasco
Director of Graduate Studies (DGS) or Professor-in-Charge (PIC)	Gretchen Kuldau
Program Contact	Kim Hall 210 Buckhout Lab 361 Science Drive University Park PA 16802 kah6753@psu.edu (814) 865-7448
Program Website	View (http://plantpath.psu.edu/)