

Division of Plant Sciences and Technology

Graduate Student Handbook

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Part I — Division of Plant Sciences Guidelines

I. GRADUATE PROGRAMS IN PLANT SCIENCES

The Division of Plant Sciences and Technology offers graduate programs leading to the Master of Science (M.S.) and Doctor of Philosophy (Ph.D.) degrees in *Plant, Insect and Microbial Sciences*. A student can select training from a wide range of courses and research programs to prepare for a career in research, teaching, industry, and extension work.

The information outlined below summarizes the combined regulations and requirements of the Graduate School and the Division of Plant Sciences and Technology. Graduate students must recognize from the start that the planned programs of study leading to an advanced degree are their own responsibility and should be discussed with their academic advisor.

General Requirements

Certain requirements pertain equally to all graduate students whether on an M.S. or a Ph.D. program of study.

A. Selection of a Graduate Program Area and an Advisor

Students may complete their graduate degrees in the division through any of the Graduate Program Areas:

- Crop, Soil & Pest Management
- Entomology
- Horticulture
- Plant Breeding, Genetics & Genomics
- Plant Stress Biology

Advisors for M.S. students must be members of the Graduate Faculty and advisors for Ph.D. students must be members of the Doctoral Faculty.

B. Academic Performance

The GPA in the Graduate School is based on the student's entire graduate record in courses numbered 7000 and above taken at MU. To remain in good standing, a student must maintain a cumulative GPA of 3.0 or better. This is based on a grading system where A=4.0, B=3.0, and C=2.0; there is no D grade for graduate students and no points are given for the failing grade F.

At the end of any semester, a graduate student with a GPA below 3.0 is placed on probation. If, at the end of the following semester, the cumulative GPA is 3.0 or better, probation status is lifted. A student on probation who fails to raise the cumulative GPA to 3.0 may, on the recommendation of the division, be allowed a second and final probationary semester. A student is subject to dismissal upon failure to raise the cumulative GPA to 3.0 by the end of the second probationary semester or at any time that the semester GPA or the cumulative GPA falls below 2.0. To graduate, a student must have a GPA of 3.0 or better.

In addition to dismissal for failure to meet the usual examination and grade requirements, the Division has the right to place on probation and, after at least 30 days of probation, to dismiss from the program any graduate student who is deemed not to be making sufficient academic progress and/or whose work is not of the quality required. The dismissal may occur at any time during the student's work toward a graduate degree.

C. Assessment of Satisfactory Progress

By June 30th of each year, each student will complete an annual progress report. The report will be available for download from the division's [website](#). Once the student has recorded their progress, the advisor/s will fill in their evaluation of the student's progress during the past academic year. The advisor may elect to incorporate the annual evaluation process into a scheduled meeting of the student's advisory committee. Once the annual evaluation is complete, a digital copy signed by both the student and the advisor/s should be emailed to the division's executive assistant for filing. Students may request a meeting with the Director of Graduate Studies to discuss any concerns or issues identified through their annual review.

D. Petitions to Alter Graduate Course of Study

Petitions to alter the divisional graduate program requirements should be made by the Major Advisor to the Director of Graduate Studies, who will convene a meeting of the Graduate Education and Research Committee to discuss the matter and make a decision regarding an exception.

E. Travel to Meetings

Graduate students are strongly encouraged to attend at least one regional or national professional meeting during their graduate program. Participation in such meetings can be an important forum for advanced students. Students should consult with their Major Advisor and other faculty regarding the availability of small grants to defray all or part of expenses associated with meeting travel. Societal meetings often offer travel grants for students and advisors should encourage students to apply. In addition, the Graduate School also offers Travel Scholarships for Graduate Students for domestic and international meetings (<https://gradschool.missouri.edu/graduate-awards-travel-scholarships/travel-scholarships/>).

The division may also provide partial support for students to travel to meetings and the availability of funds will be determined on an annual basis and based on the division's budget allocation.

F. Academic Integrity

Academic honesty is fundamental to the activities and principles of a university. All members of the academic community must be confident that each person's work has been responsibly and honorably required, developed, and presented. Any effort to gain an advantage not given to all students is dishonest whether or not the effort is successful. The academic community regards academic dishonesty as an extremely serious matter, with serious consequences that range from probation to expulsion. When in doubt about plagiarism, paraphrasing, quoting, or collaboration, students should consult with their Major Advisor.

II. MASTER OF SCIENCE DEGREE

Thesis option

For success in a Master's program, knowledge - both general and detailed - must be combined with originality, reliability, and industry. The division encourages the thesis option as the main path for Master's candidates. A well-written thesis should foster scholarly interest and demonstrate knowledge of the tools and techniques necessary for research and the ability to integrate new and existing methods.

All requirements of the chosen Graduate Program Area must be met by the student in addition to the M.S. Degree requirements that follow.

A. Master's Committee Approval and Design of the Program of Study

Once accepted by the Graduate School and the division, the student and his/her Major Advisor should choose the Master's Committee. The Committee must consist of at least three members. Once Committee members have agreed to serve, the **'Request for Thesis Committee'** form (M-2) at <https://gradschool.missouri.edu/wp-content/uploads/2020/05/m2digitalsignature520.pdf> should be filled out and turned in to the Director of Graduate Studies and Jessica Manley for copying and forwarding to the Graduate School. Electronic signatures (via PDF or [DocuSign](#)) and email communication is accepted and preferred over hard copies. This form must be filed before the end of the student's second semester.

A planned course of study established early in the graduate program is essential. Thus, the student and Major Advisor next should design the plan of study and schedule the first meeting with the Committee. Prior to the meeting, the student, in consultation with the Major Advisor, should assemble a brief record of the post baccalaureate course work completed and fill out the **'Program of Study for the Master's Degree'** form (M-1) at <https://gradschool.missouri.edu/wp-content/uploads/2020/05/m1digitalsignature520.pdf> After the student has incorporated any coursework modification(s) suggested by the Committee, the Major Advisor should sign the form (representing approval by the whole Committee) and the student should send an electronic version of the form to the Director of Graduate Studies and Jessica Manley for filing and forwarding to the Graduate School. The plan of study can be revised using the **'Plan of Study Course Substitution Form'** at <https://gradschool.missouri.edu/wp-content/uploads/2020/05/m3digitalsignature520.pdf> This is submitted by the Major Advisor to the Director of Graduate Studies and will be forwarded to Jessica Manley and then to the Graduate Dean. Students should understand when planning their program that a course, once taken, may never be removed from their record.

A plan of research or research proposal written by the student (including a limited literature review) also is required for the first meeting of the Committee. This requirement is intended to assure that the candidate's research area and methods are acceptable to committee members before significant work is undertaken. This meeting must be held before substantial research data are collected, and no later than the end of the second semester.

B. Course of Study

1. General Requirements

- a. A minimum of 30 credit hours must be completed from courses accepted for post-baccalaureate graduate. No more than 40% of the 30-hour credit requirement can be satisfied by research, readings, and problems courses.
- b. At least 24 credit hours must be taken at MU. A maximum of 6 hours credit for post baccalaureate courses may be transferred from other accredited institutions on the recommendation of the student's advisor and with approval of the Graduate Dean. This allowance should be indicated at the time of application on the **'Program of Study'** Form.
- c. A minimum of 15 hours must be of courses numbered at the 8000 or 9000 level. Seventy-five percent of these hours (12 hours) can be fulfilled through Problems, Readings or Research.

- d. Students who have completed a course numbered at the 4000 level may not include the related 7000-level course in their Program of Study.
 - e. During each Fall and Spring semesters, a Master's students must enroll for 9 credits to be considered full time students. But Graduate School does not require full-time enrollment.
 - f. During the Summer semester, graduate students are not required to enroll for class unless:
 - 1. They are international students whose visas require full-time enrollment. International students should check with the International Office for details.
 - 2. They have loans which would require repayment if they were not enrolled. Such students should check with the Financial Aid office.
 - 3. They have a fellowship or scholarship which requires such enrollment. Such students should check with their financial administrator for details.
 - 4. They intend to graduate that semester, or it is their first semester as a graduate student at Mizzou.
 - g. If graduate students do need to enroll in Summer semester for any reason, then full-time enrollment requires 4 credits for Master's students.
2. Specific Course Requirements

Students must enroll in Plant Sciences Seminar **for at least three semesters**. Students enroll in Plant Sciences 9087 for an A/F grade and make a presentation **during at least one semester**. For at least two semesters when the student does not make a presentation, he/she will enroll in Plant Sciences 7087 for an S/U grade.

The thesis defense seminar cannot be given in fulfillment of the PS 9087 requirement.

Master's students may transfer graduate-level seminar credit towards fulfillment of DPS seminar requirements and the 30-hour credit requirement. A maximum equivalent to one PS 7087 credit may be transferred. Attendance will be considered by the Director of Graduate Studies in consultation with the Graduate Education and Research Committee.

One credit hour of graded seminar may be used in partial fulfillment of the requirement of 15 credit hours completed at the 8000/9000 level.

All students are required to take a research ethics class (e.g., PS 8010 Professionalism and Ethics or BIO/BCH 8060 Ethical Conduct of Research).

There may be additional curricular requirements associated with the students' chosen Graduate Program Area. Consult the relevant sections of this handbook for details.

3. Teaching Experience

All students in the Division of Plant Sciences are required to complete a teaching experience as part of their plan of study (<https://plantsciences.missouri.edu/graduate/teaching-requirement/>). Students may fulfill the teaching experience requirement through attendance in a formal course or as a course assistant in a Division of Plant Sciences and Technology course or extension presentation. The first step is to discuss your plan with your advisor and your graduate committee. Once you have made a decision you will need to submit your plan when you complete the M1 form. All students are required to submit the form, "Student Plan for Teaching Experience." The three options are summarized as categories as follows:

Category A: Completion of a Course in College Science Teaching. The suggested formal courses can be found on the website:

<https://plantsciences.missouri.edu/graduate/teaching-requirement.>

Category B: Teaching Experience as a Course Assistant. You can find opportunities as a course assistant for either the fall or spring semesters. Contact the course instructors as early as possible on availability of teaching opportunities in their course, as individual course instructors will be responsible for choosing their course assistants. To complete the requirements for the teaching experience, you will need to solicit feedback on your performance from the students in the course and the course instructor. Please download the TA evaluation form and make sufficient copies for all of the students in the course. The form can be found at the following link: https://plantsciences.missouri.edu/wp-content/uploads/sites/21/2018/03/Teaching_Experience_Plan.pdf

Allow at least ten minutes of class time for completion of the course evaluation. The course instructor will be responsible for collecting the forms and submitting them to Jessica Manley (1-41 Agriculture Building). The course instructor will also be expected to write a letter evaluating your teaching performance. You should expect to receive a summary of the student evaluations and the letter from the course instructor.

Category C: Extension Teaching Experience. Students will collaborate with extension faculty within the Division of Plant Sciences to participate in an approved extension teaching experience. Examples of appropriate extension experiences could include but are not limited to: the development of training modules, websites, videos, publications, guide sheets, etc. related to a need identified by the student and faculty member within a given extension programmatic emphasis area. The extension faculty member may also choose for the student to develop a series of presentations related to a particular extension programmatic emphasis area and to deliver these presentations to appropriate audiences throughout the course of a given semester.

Individual extension faculty will be responsible for choosing and approving all students who wish to participate in an extension teaching experience and will also decide on and approve each specific project. To complete the requirements for the extension teaching experience, you will need to solicit feedback on your performance from the extension faculty member who will be expected to write a letter evaluating your performance at the end of the semester.

Other courses you may find valuable for your professional development are:

- **ED LPA 9456** The Professoriate
- **ED LPA 9455** The Community College
- Preparing Future Faculty

Students with a strong interest in teaching may be interested in pursuing a minor in College Teaching. Details for this program can be found at:

https://gradschool.missouri.edu/professional_development/minor-in-college-teaching-program/

4. Enrollment Requirements

Continuous enrollment is not required for Master's students. If receiving a GRA, must be enrolled ½ time to avoid FICA. A student must be registered for credit at the time the thesis is submitted, and the final examination conducted. Graduate School regulations stipulate that the program for the M.S. degree must be completed within a period of 8 years after the first semester of enrollment in the M.S. program, not including time spent in the armed forces.

5. Thesis Preparation and Submission

A thesis is required for the Master's degree in Plant, Insect and Microbial Sciences. The thesis must demonstrate the student's capacity for research and independent thought. Organization of the thesis is subject to approval of the Master's Committee.

6. Thesis Defense and Final Examination

The Thesis Defense will consist of a research seminar and final examination, the latter to demonstrate the student's mastery of the academic focus of the chosen Graduate Program Area. It is the student's responsibility to check the Graduate School's graduation deadlines when scheduling the exam.

The candidate must be enrolled to defend the thesis. The examination cannot be administered when MU is not officially in session. Enrollment of 1 credit of Thesis Research (PLNT S 8090) or MISC 8999 is sufficient.

The seminar will be presented by the student for division faculty, staff, students, committee members, and other interested persons. It must summarize the thesis research conducted by the student during the Master's program. The seminar will be followed by the final, oral examination administered by the Master's Committee. Although the general protocol followed during the oral examination shall be at the discretion of the Major Advisor, a typical oral examination lasts about 2 hours and is divided between defense of the thesis and non-thesis subject matter. The research seminar should be scheduled for the same day (preferably) or during the week preceding the remainder of the final examination. The final examination is open to the general faculty; however, only members of the Master's Committee are eligible to sign the '**Report of the Master's Examining Committee**' form (M-3) at

<https://gradschool.missouri.edu/wp-content/uploads/2020/05/m3digitalsignature520.pdf>

After the final examination, the student shall submit a '**Report of the Master's Examining Committee**' form (M-3) to the Director of Graduate Studies for a signature and then to Jessica Manley for submission to the Graduate School, indicating whether the candidate passed or failed his/her examination.

If the Master's Committee decides that certain changes need to be made by the student in the thesis manuscript before approval can be given, the student will make the required changes within **six months**. Extensions beyond six months will require the approval of the Graduate Education and Research Committee. Signatures of all committee members on the cover page of the dissertation will signify their acceptance of the final document. It is the student's responsibility to ensure that all appropriate forms and the thesis arrive at the Graduate School prior to graduation deadlines.

Beginning with the Fall, 2006 semester, the Graduate School will only accept electronic theses and dissertations. Within the Division of Plant Sciences and Technology, each advisor retains the option to require students to supply hard copies of theses/dissertations. As you near your graduation date, check with your advisor to see if a hard copy of your theses/dissertation will be required.

C. Non-thesis option

The division also offers the possibility of completing a non-thesis Master's option. This option is offered under unique circumstances and requires the approval of the Director of Graduate studies in consultation with the Graduate and Research Education Committee.

Students approved to pursue a non-thesis option need to complete, in consultation with the Major Advisor a **'Program of Study for the Master's Degree'** form (M-1) at <https://gradschool.missouri.edu/wp-content/uploads/2020/05/m1digitalsignature520.pdf> (Note: the M-2 form is not required for the non-thesis option).

In addition, and in order to complete the non-thesis option, the student must complete an independent project under a faculty advisor approved by the division. This project is carried out by enrolling in PS 8980 (Non-Thesis Research) for at least one hour of credit. This project is documented and presented to a faculty committee of at least three graduate faculty members and defended in a public defense as part of a final oral examination. The PS 8980 course grade is assigned by the student's faculty advisor upon the conclusion of the oral examination. This course is graded on an S/U basis and cannot be used to increase the student's overall GPA in graduate work.

In this option, at most 3 credit hours of Research, Reading, and/or Problem courses can be counted toward the 30-hour MS graduate requirements.

III. DOCTOR OF PHILOSOPHY DEGREE

The Doctor of Philosophy (Ph.D.) degree is the highest degree conferred by the University. It is a degree in philosophy and is not a technical degree. A candidate is expected to develop an awareness of the relationship between his/her/them expertise and society. Required course work is but one means of acquiring the broad-based knowledge fundamental in establishing one's philosophy.

The dissertation should demonstrate a candidate's acumen for pursuing the scientific method; illustrating the difference between observations and hypothesis, between answering questions and testing hypotheses, and between opinion and truth.

All requirements of the chosen Graduate Program Area must be met by the student in addition to the Ph.D. degree requirements that follow.

A. Doctoral Committee Approval

Once accepted by the Graduate School and the Division, the student and his/her Major Advisor should plan for the Qualifying Exam (see below). A Doctoral Committee should be formed. The Committee must consist of at least four members including: the Major Advisor, two members from the Division of Plant Sciences, and one member from outside the division. Two members of the Committee must be members of the Doctoral Faculty.

B. Qualifying Examination

Once Committee members have agreed to serve, a date for the Qualifying Examination should be set and the Exam conducted. The Qualifying Exam must be scheduled for not later than the end of the second full semester of residence. The purpose of the Qualifying Exam is to ascertain the general background of the student. Students should expect questions in the exam that are related to any prior coursework and are appropriate for their program area. To assist their committee in the development of questions, the student should provide transcripts to their committee two weeks before the exam. The Qualifying Exam is strictly an oral exam. Based on the results of the Qualifying Exam, the committee will make recommendations on coursework for the student's Plan of Study.

A student will be considered to have passed the Qualifying Exam if all members, or all but one, of the Advisory Committee vote affirmatively. A student failing the Qualifying Exam will be given a second opportunity to pass. However, a student who fails the second exam shall terminate his/her course of study in the division not later than the end of the semester in which the examination was failed.

A planned course of study established early in the graduate program is essential. Prior to the Qualifying Exam, the student, in consultation with the Major Advisor, should assemble a brief record of the post baccalaureate course work completed and the plan of study he/she plans during his/her tenure at MU (the '**Plan of Study for the Doctoral Degree Form**' (D-2) at <https://gradschool.missouri.edu/wp-content/uploads/2020/05/d2digitalsignature520.pdf>). The proposed plan of study will be discussed at the same Committee meeting, immediately following the Qualifying Exam.

After the student has incorporated any coursework modification(s) suggested by the Committee, the Major Advisor should sign the '**Qualifying Examination Results and Doctoral Committee Approval Form**' (D-1) at <https://gradschool.missouri.edu/wp-content/uploads/2020/05/d1digitalsignatures520.pdf> and the student should submit it to the Director of Graduate Studies for a signature and then to Jessica Manley for filing and forwarding to

the Graduate School. This form must be filed by the end of the student's second semester. If necessary, the plan of study can be revised using the '**Plan of Study Course Substitution Form**' at <https://gradschool.missouri.edu/wp-content/uploads/2020/05/subformdigitalsignatures520.pdf>. This is submitted to the Director of Graduate Studies for a signature and then to Jessica Manley to be forwarded to the Graduate School. Students should understand when planning their program that a course, once taken, may never be removed from their record.

A plan of research or a research proposal written by the student (including a moderately detailed literature review) must also be received by the Committee. This requirement is intended to assure that the candidate's research area and methods are acceptable to committee members before significant work is undertaken. A Committee meeting to discuss the proposal must be held before substantial research data are collected, and no later than the end of the second semester. This discussion can be held immediately following the Qualifying Exam, or at a separate meeting.

C. Residence Requirement

To satisfy the residency requirement, a student must complete at least two nine-hour semesters or three six-hour semesters in an 18-month period at MU. All courses taken to satisfy the residency requirement must be MU courses approved for graduate credit and approved by the student's Doctoral Program Committee.

D. Course of Study

1. General Requirements

a. A minimum of 72 credit hours must be completed from courses accepted for post-baccalaureate graduate credit. This can include credit hours from a Master's degree, if approved by the Doctoral Committee.

b. A minimum of 15 hours must be completed of courses numbered at the 8000 or 9000 level (but exclusive of research, problems, and independent study experiences).

c. During each Fall and Spring semesters, PhD students who have not completed their comps must enroll for 9 credits to be considered full time students. PhD students who have passed their comps and are on 'continuous enrollment' must enroll for 2 credits for each Fall and Spring semester to be considered full-time students.

d. During the Summer semester, graduate students are not required to enroll for class unless:

1. They are international students whose visas require full-time enrollment. International students should check with the International Office for details.
2. They have loans which would require repayment if they were not enrolled. Such students should check with the Financial Aid office.
3. They have a fellowship or scholarship which requires such enrollment. Such students should check with their financial administrator for details.
4. They intend to graduate that semester, or it is their first semester as a graduate student at Mizzou.

e. If graduate students do need to enroll in the Summer semester for any reason, then full-time enrollment requires:

1. 4 credits for PhD students who have not completed their comps.
2. 1 credit for PhD students who have passed their comps.

2. Specific Course Requirements

a. Students must enroll in Plant Sciences Seminar **for at least five semesters**. Students enroll in Plant Sciences 9087 for an A/F grade and make a presentation during at least two semesters. **For at least three semesters** when the student does not make a presentation, he/she will enroll in Plant Science 7087 for a S/U grade. Doctoral students on 'continuous enrollment' **who have not fulfilled all seminar requirements** must contact the Graduate School to indicate that they will be enrolling for 1 credit of seminar and 1 credit of dissertation research (Plant Science 9090).

The dissertation defense seminar cannot be given in fulfillment of the PS 9087 requirement.

PhD students may transfer graduate-level seminar credit towards fulfillment of DPS seminar requirements and the 72-hour credit requirement. A maximum equivalent to one PS 9087 and two PS 7087 credits may be transferred.

Exemptions to seminar enrollment and attendance will be considered by the Director of Graduate Studies in consultation with the Graduate Education and Research Committee.

Two credit hours of graded seminar may be used in partial fulfillment of the requirement of 15 credit hours completed at the 8000/9000 level.

b. All students are required to take a research ethics class (e.g., PS 8010) unless the course was completed in the Master's degree.

c. There may be additional curricular requirements associated with the students' chosen Graduate Program Area. Consult relevant sections of this handbook for details.

d. Students who have completed a course numbered at the 4000 level may not include the related 7000-level course in their Program of Study.

3. Teaching Experience

All students in the Division of Plant Sciences are required to complete teaching experience as part of their plan of study <https://plantsciences.missouri.edu/graduate/teaching-requirement/>. Students may fulfill the teaching experience requirement through attendance in a formal course or as a course assistant in a Division of Plant Sciences course or extension presentation. The first step is to discuss your plan with your advisor and your graduate committee. Once you have made a decision you will need to submit your plan when you complete the D2 form. All students are required to submit the form, "Student Plan for teaching Experience." The three options are summarized as categories below:

Category A: Completion of a Course in College Science Teaching. The suggested formal courses can be found on the website:

<https://plantsciences.missouri.edu/graduate/teaching-requirement/>.

Category B: Teaching Experience as a Course Assistant. You can find opportunities as a course assistant for either the fall or spring semesters. Contact the course instructors as early as possible on availability of teaching opportunities in their course, as individual course instructors will be

responsible for choosing their course assistants. To complete the requirements for the teaching experience, you will need to solicit feedback on your performance from the students in the course and the course instructor. Please download the TA evaluation form and make sufficient copies for all of the students in the course. The form can be found at the following link:

https://plantsciences.missouri.edu/wp-content/uploads/sites/21/2018/03/Teaching_Experience_Plan.pdf

Allow at least ten minutes of class time for completion of the course evaluation. The course instructor will be responsible for collecting the forms and submitting them to Jessica Manley (1-41 Agriculture Building). The course instructor will also be expected to write a letter evaluating your teaching performance. You should expect to receive a summary of the student evaluations and the letter from the course instructor.

Category C: Extension Teaching Experience. Students will collaborate with extension faculty within the Division of Plant Sciences to participate in an approved extension teaching experience. Examples of appropriate extension experiences could include but are not limited to: the development of training modules, websites, videos, publications, guide sheets, etc. related to a need identified by the student and faculty member within a given extension programmatic emphasis area. The extension faculty member may also choose for the student to develop a series of presentations related to a particular extension programmatic emphasis area and to deliver these presentations to appropriate audiences throughout the course of a given semester.

Individual extension faculty will be responsible for choosing and approving all students who wish to participate in an extension teaching experience and will also decide on and approve each specific project. To complete the requirements for the extension teaching experience, you will need to solicit feedback on your performance from the extension faculty member who will be expected to write a letter evaluating your performance at the end of the semester.

Other courses you may find valuable for your professional development are:

- **ED LPA 9456** The Professoriate
- **ED LPA 9455** Thee Community College
- Preparing Future Faculty https://gradschool.missouri.edu/professional_development/teaching-learning-courses/

Students with a strong interest in teaching may be interested in pursuing a minor in College Teaching. Details for this program can be found at:

https://gradschool.missouri.edu/professional_development/minor-in-college-teaching-program/

4. Comprehensive Examination

a. Purpose

The Comprehensive Examination is a major milestone in the Ph.D. candidate's progress towards completion of the degree requirements. A candidate is expected to clearly demonstrate his/her knowledge and understanding of the principles and concepts of the chosen Graduate Program Area, related biological sciences, and the scientific method. The Comprehensive Exam should be scheduled when the student has essentially completed the required plan of study. The Comprehensive Exam must be completed at least seven months before the final examination (defense). The Comprehensive Exam Committee is the same as the Doctoral Committee.

b. Administration

The entire exam must be completed within one month. At the completion of the oral examination, a **'Doctoral Comprehensive Examination Results Form'** (form D-3 at <https://gradschool.missouri.edu/wp-content/uploads/2020/05/d3digitalsignature520.pdf>) must be submitted to the Director of Graduate Studies for a signature and then to Jessica Manley, who will submit to the Graduate School. It should indicate whether the student has passed or failed and carry the signatures of all members of the Doctoral Committee. Committee members should cast one vote based on the student's performance on both the written and oral sections of the examination. A candidate will be considered to have passed the Comprehensive Exam if all, or all but one, of the Committee vote affirmatively. In case of failure, the Committee may recommend remedial measures. After a lapse of at least 12 weeks (about 3 months), the candidate may be given a second examination. **Failure on the second examination terminates the student's candidacy.**

c. Format

The Comprehensive Exam requires both written and oral performance by the student to achieve candidacy. The student's advisor will select either Track I or Track II for the format of the exam. The student arranges the written and oral portion of the Comprehensive Exam with each member of the Committee.

Track I: The format comprises a series of written questions followed by a comprehensive oral examination. Each member of the Comprehensive Exam committee, including the student's advisor, poses a single set of written questions. The format, design, and subject material of the questions are at the discretion of each committee member. Each question set should be completed within 24 hours, and the entire written examination should be completed within 5-10 days. Student responses should be returned to the committee member, who reviews and grades them.

The student should arrange for the oral examination to occur within three weeks of the written examination. The format of the oral examination is at the discretion of the Comprehensive Exam committee and may include a brief (≤ 30 min) presentation describing the student's research to date. Questions posed in the oral examination should demonstrate the student's breadth of knowledge in plant science and applicable sub disciplines and need not be restricted to topics in the written exam or the student's current research project. Any MU graduate faculty member may attend the oral examination, question the student, and present any concerns to the committee and student. A closed session of questioning with only the committee and student should conclude the oral examination. Deliberation and decision on whether the student passed or failed should immediately follow the oral examination.

Track II: The format is a proposal that must communicate a compelling plan to address a focused set of objectives within an important question. These are the same core criteria used by all major federal funding agencies (NIH, NSF (National Science Foundation), NASA, etc.), and a successful proposal and defense should be similar in many respects to proposals that are funded by these agencies.

The topic of the proposal is at the discretion of the Comprehensive Exam committee and need not be restricted to the student's current research project. The central question(s) and the importance of those questions must be clear. What is the scientific context of the proposed work? How does the proposed work relate to what has been done previously? Does the proposal communicate a good depth of understanding of the field? Is the approach (or the question itself) innovative? What would be the impact on the field if the work is successful? Is the work likely to be transformational?

The proposed experiments must describe a plan that is scientifically and strategically sound. Do the proposed experiments answer the questions identified above? Will the answers from the proposed experiments be at a satisfactory scientific depth, rather than superficial? How will the data be analyzed? Has the proposer anticipated potential alternative outcomes and incorporated those possibilities into the design? Is data interpretation likely to be confounded by alternate explanations?

Are the questions phrased in such a way that it will be evident when they are answered, rather than being open-ended? Are the individual aims sufficiently linked that they address the same overall question from different angles? Are the individual aims sufficiently independent such that no one aim is excessively dependent upon results from another aim?

Keep in mind that this is an exercise in logic and critical thinking. It is an exercise in knowing where the edge of knowledge lies in a given field, identifying important questions, and assembling the appropriate tools and approaches so that you can push back the frontiers of knowledge. These are the same goals the student should strive to meet in completing their dissertation research, which may or may not be the same as the work described in the written Comprehensive Exam. This exercise is not an evaluation of the student's laboratory research progress to date. If the student has supporting data, by all means, it is appropriate to include them, but the focus is on crafting a solid plan that is likely to work in addressing an important question.

In preparation for the written Comprehensive Exam, a pre-proposal should be submitted to each committee member at least six weeks in advance of the scheduled oral exam date. The pre-proposal should include a few paragraphs of project background, three specific aims, the hypothesis of each and the experimentally planned approaches to the problem. The pre-proposal is limited to 1-page in length and should be the student's own ideas, but students may discuss these ideas with their advisor and committee prior to submission of the pre-proposal. The advisor and committee members should approve the pre-proposal within two weeks of receipt. During this time, specific feedback from the advisor and committee members can be incorporated into the pre-proposal. Once approved by the committee, the student should initiate development of the full proposal. During this period the student may use example proposals, other proposal writing resources, and may discuss their proposal with individuals outside of their committee; however, the advisor and committee members should not be consulted further during the development of the full proposal.

The student should arrange the oral examination to occur within four weeks of initiation of the full proposal. A copy of the full proposal should be provided to the committee at least one full week in advance of the exam date. The format of the oral examination should include a brief (≤ 30 min) presentation describing the full proposal. Questions posed in the oral examination should demonstrate the student's breadth of knowledge in plant science and applicable sub disciplines and need not be restricted to topics in the full proposal or the student's current research project. Any MU graduate faculty member may attend the oral examination, question the student, and present any concerns to the committee and student. A closed session of questioning with only the committee and student should conclude the oral examination. Deliberation and decision on whether the student passed or failed should immediately follow the oral examination.

Here is a small sampling of the many web-based resources designed to help in writing effective NSF proposals:

NSF

How to write an NSF proposal (from Oregon State web site. See the links at the bottom of the page: "Anatomy of an NSF proposal," and "Do's and Don'ts."

<https://web.engr.oregonstate.edu/~grimmc/NSF/nsf.html>

"Advice on Writing Proposals to the National Science Foundation" from Susan Finger, Carnegie Mellon University: <http://www.cs.cmu.edu/~sfinger/advice/advice.html>

5. Continuous Enrollment Requirement

Following successful completion of the Comprehensive Exam, students who have completed all coursework requirements may elect to go to part-time status. However, continuous enrollment, requiring enrollment in each Fall and Spring term is mandatory for all doctoral candidates who have passed their Comprehensive Exam.

Continuous enrollment is retained by registering in Plant Sciences 9090, Research, for 2 credit hours each Fall and Spring and 1 credit hour in Summer under the Major Advisor's section.

All continuous enrollment doctoral students are charged in-state fees for the required hours of 9090 Research. If they choose to take additional hours or courses, they will be charged out-of-state fees, if applicable.

Please check with The Cashiers office regarding information about FEE PAYMENT DEADLINES for continuous enrollment of doctoral students.

Should students not be enrolled for one full calendar year, they are considered by the Graduate School as having dropped from the program, although their file will technically still be open in the division. Re-entry to active status will require a petition to the division by letter to the Director of Graduate Studies, who will refer the issue to the Graduate Education and Research Committee. Following approval, the request must then be forwarded for approval by the Graduate School. The Graduate School also requires payment of full tuition and fees for missed enrollment, for up to seven semesters (see the Graduate Catalog for details).

6. Reasonable Rate of Progress

A reasonable rate of progress toward the degree is required. A Ph.D. student must successfully complete the comprehensive exam within 5 years of their first semester of enrollment as a Ph.D. student. In addition, the remaining program for the doctoral degree must be completed within 5 more years after passing the Comprehensive Exam.

Before the expiration of the applicable period, any candidate requiring additional time must submit a request for an extension. The student must petition the Graduate School by submitting a request to the Director of Graduate Studies who, in turn, submits a written recommendation to the Graduate School that has been endorsed by the division faculty. The extension, if granted, may entail a revision of the candidate's program to update coursework and research, and will indicate a specific date by which the degree must be completed.

7. Dissertation Preparation and Submission

A dissertation is required of every Ph.D. Candidate in the Division of Plant Sciences. This is to be a substantial scholarly manuscript of original research conducted by the student. The dissertation should reflect the depth of understanding, independent thought, and original work worthy of a Ph.D.

The Graduate School will only accept electronic theses and dissertations. Within the Division of Plant Sciences, each advisor retains the option to require students to supply hard copies of theses/dissertations. As you near your graduation date, check with your advisor to see if a hard copy of your theses/dissertation will be required.

8. Final Semester Timeline

Milestone	Fall Semester	Spring Semester	Summer Semester
Apply for Graduation (Office of Grad Studies†	1 st two weeks of semester	1 st two weeks of semester	1 st week of June
Set defense date, time, and location†	1 st two weeks of semester	1 st two weeks of semester	Early June
Thesis/Dissertation turned into advisor*	First week of October	First week of March	Early June
Thesis/Dissertation turned in to Committee*	Two weeks before defense	Two weeks before defense	~July 1 st
Target for Defense date*	Friday before Thanksgiving ~Nov. 20 th	~April 20 th	~July 14 th
Thesis/Dissertation due to Office of Grad Studies*	Friday before semester end ~Dec. 10 th	Friday before semester end ~May 5 th	Last week of July ~July 22 nd

†Deadline for this milestone, *Suggested target dates.

9. Dissertation Defense

Dissertation Defense consists of a research seminar and final examination. It is the student's responsibility to check the Graduate School's graduation deadlines when scheduling the exam.

The seminar will be presented by the student for division faculty, staff, students, committee members, and other interested persons. The student may choose to present the seminar as part of the Division Seminar Series. It must summarize the dissertation research conducted by the student during the Doctoral program. The seminar will be followed by the final oral examination administered by the Doctoral Committee. Although the general protocol followed during the oral examination shall be at the discretion of the Major Advisor, a typical oral examination lasts about 2 hours and is divided between discussion of the dissertation and related, dissertation subject matter. The research seminar should be scheduled for the same day (preferably) or during the week preceding the remainder of the final examination. The final examination is open to the general faculty; however, only members of the Doctoral Committee are eligible to sign the D-4 form (see below).

The candidate must be enrolled to defend the dissertation. The examination cannot be administered when MU is not officially in session.

After the final examination, the student shall submit a **'Report of the Dissertation Defense**

Form' (D-4) at <https://gradschool.missouri.edu/wp-content/uploads/2020/10/D4-Dissertation-Defense.pdf> to the Director of Graduate Studies for a signature and then to Jessica Manley for submission to the Graduate School, indicating whether the candidate passed or failed his examination.

If the Doctoral Committee finds that certain changes need to be made by the student in the dissertation manuscript before approval can be granted, the student will make the required changes within **six months**. Extensions beyond six months require approval of the Graduate Education and Research Committee. Signatures of all committee members on the cover page of the dissertation will signify their acceptance of the final document. Immediately following completion of the final exam, the student should bring the signed D-4 form to the Director of Graduate Studies. It is the student's responsibility to ensure that all appropriate forms and the dissertation arrive at the Graduate School prior to graduation deadlines.

IV. GENERAL GUIDELINES AND INFORMATION

A. Graduate Student Responsibilities

1. New Student Orientation

The division and the Graduate School will offer several orientation sessions the week before classes start in August and we encourage incoming students to attend either or both sessions.

2. Duties

Students pursuing graduate degrees in the Division of Plant Sciences should understand that certain duties in addition to thesis research and any teaching requirements may be assigned by their major advisor. These are considered to be an integral part of graduate training and to contribute to the comprehensiveness of the student's program. Such duties are not so extensive that they add materially to the duration of the degree program.

3. Authorship of Manuscripts and Talks

Results of research accomplished using University facilities or funds become the property of the supporting institution. The Division of Plant Sciences has no set policy on priority of authorship for publication; this decision is the responsibility of each project leader or major advisor. Students should consult with their advisor to determine his/her policy regarding authorship of manuscripts resulting from graduate research. Students must obtain permission from the respective project leader prior to making any presentations of unpublished research results. Approval of the project leader also is required prior to any discussion of research with news reporters.

4. Vacation Policy

Graduate students supported by Agricultural Experiment Station or other official stipends are not automatically entitled to vacation time. A reasonable vacation can be determined after consultation with the Major Advisor.

B. Divisional Operations

1. Office Supplies and Equipment

Divisional office supplies and equipment, including photocopy machines, are not available for general student use. Graduate students may access such material and equipment only after securing permission from their Major Advisor. Computers are available through individual research projects. Of special concern is misuse of the photocopy facility. Students must be aware that current copyright regulations forbid multiple copying of most printed matter, and that in all cases permission from their major advisor must be obtained prior to copying any material. Material for a personal file may be copied for nominal fees at Ellis Library, Printing Services, and at Quick Copy facilities.

2. Incidental Departmental Expenses

Expenses associated with preparation of materials required for seminars, theses and dissertations will be borne by the individual student or by the project under which the student is working. The Major Advisor is responsible for determining those expenses which are appropriate for project funding.

3. Divisional Telephone Policy

Students generally have access to telephones in the laboratory or office to which they are assigned. It is important that such telephone numbers be provided to relatives so that students can be reached in case of emergencies. Students are permitted to use telephones in their assigned office or laboratory to make local calls, provided such calls do not tie up the telephone line for excessive periods of time. No personal long-distance calls will be charged to Divisional telephones. In the event that a personal long-distance call is necessary during working hours, students can bill the call to their personal calling card or credit card. *Divisional telephone use is monitored closely, and misuse will not be tolerated.*

WATS (Wide Area Telephone Service) lines. -- Long distance WATS capability in all divisional telephones facilitates economical communication for official business. Individual project leaders are provided with special access codes for this service, and their permission and assistance should be sought when it is necessary to make official long-distance calls. In addition, many project leaders have official telephone calling card numbers. Such numbers may be provided to students whose research projects call for extensive travel within the state.

4. Division Vehicle Policy

Individual research projects frequently make use of vehicles through University Leasing for official transportation requirements. According to the University Policy and Procedural Manual, only employees, official visitors on University business, and University students can be passengers in official vehicles. This means that a member of an employee's family cannot be a passenger. One cannot take a friend along as this violates University policy. The liability insurance which the University carries is void whenever there is a violation of the "use policy", and should a person be operating an official vehicle in violation, any cost of repairs or injury to a person is the sole responsibility of the driver. Use of any University vehicle by anyone requires approval of Project Leader and the Division of Plant Sciences. All potential drivers must possess a valid Missouri driver's license.

5. Keys

Forms and instructions needed to obtain official keys to University facilities are distributed to new graduate students along with the requisite personnel forms. Generally, keys issued will

be (1) exterior doors of the research building, (2) particular office or laboratory to which assignment is made, and (3) other facilities as determined appropriate by the Major Advisor. Subsequent key issues will be made only after review by the major advisor. All keys should be returned upon termination of residency.

6. Reporting of Accidents

It is important that students immediately report accidents of all types to their Major Advisor. This is primarily for the students' protection, and to assist with determination of liability.

7. Hazardous Materials Disposal

Hazardous material is defined as any unwanted chemical which will pose a present or potential threat to the health of humans or any other living organism. All students must be aware of appropriate procedures for disposal of such material because severe penalties are imposed for violations. No hazardous material should be discharged into the sanitary sewer system. Divisional and project guidelines for approved disposal of such material can be obtained from individual major advisors. Examples of hazardous materials include, but are not limited to, solvents, reagents of all types, photographic chemicals, radioactive and biologically active or pathogenic materials.

Of particular concern to the Division of Plant Sciences is safe and appropriate disposal of pesticide, unused pesticide mixtures, containers, and excess toxic material of all types. Guidelines for disposition of pesticide can be obtained from Major Advisors, and no students should handle these materials without appropriate instruction and supervision. In no cases will pesticide materials be brought to research buildings, except for small quantities designated for laboratory study and confirmed by the Major Advisor.

All students working with chemicals are required to attend the mandatory College safety training. Also, those working with pesticides should be familiar with CAFNR Memo No. 41 entitled "Pesticide Handling Guidelines for the University of Missouri Agricultural Experiment Station Research Operations"

8. Borrowing of Equipment

Under no circumstances will equipment be removed from any Division of Plant Sciences laboratory or other research facility without permission from the appropriate project leader. In general, Division policy is to make necessary equipment available to all *bona fide* users; however, accountability for supplies and equipment is through individual projects.

9. Student Travel Accident Insurance

The University of Missouri-Columbia provides the aforementioned coverage. The insurance is available for all students desiring coverage on authorized trips off campus as required by their regular curriculum and for students on trips off campus which are organized or sponsored by a University recognized and approved student organization.

10. Use of Division Facilities during Non-Duty Hours

Access to division facilities is severely limited during other than normal working hours. Students needing permission to perform essential research activities during such time periods should consult with their Major Advisor. All students should be aware that late-night or weekend work with hazardous materials is potentially dangerous because emergency notification and treatment capabilities are limited.

11. Use of Computer Related Facilities

The division's computer facilities ensure computer accessibility for all faculty, staff, and students. Each research and extension project has personal computers. These provide capabilities for word processing, data analysis, and access to the university and campus main-frame computers. The division has a computer graphics workstation to produce high-quality graphics and slides. Faculty, staff, and students have the capability to produce computer graphics for manuscripts, extension and research presentations, and classroom use. Graduate students in the Division of Plant Sciences are encouraged to use this equipment.

License agreements for all computer software used in the Division must be honored. Scheduling time on computer equipment usually can be accommodated by checking with resident programming staff. Additional facilities are available at several campus locations. Information and Access Technology Services (IATS) offers non-credit short courses at no charge to faculty, staff, and graduate students each semester on a variety of mainframe, internet, and personal computer topics. Contact IATS or consult their newsletter, or web site (<http://www.missouri.edu/iats/>) for details.

C. Other Useful Information

1. Student Health Insurance

Visit this link for more information about health insurance for Domestic and International students. <https://gradschool.missouri.edu/funding/student-medical-insurance/>

2. Graduate Student Family Leave Policy (revised 9/18/2013)

Graduate students may submit a written petition to the division director to request up to two months of family leave annually (during a calendar year). Family leave will be considered for maternity or paternity, as well as for illness or death of an immediate family member (grandparent, parent, in-law, sibling, or child). Up to one month of leave under this policy may be paid leave provided by the Division of Plant Sciences, upon the approval of the division director. The petition document should state the reason for the requested leave, give the dates of the requested leave, and provide any other background information that might be helpful in assessing the request.

Part II — Graduate Program Area Guidelines

I. Crop, Soil and Pest Management

Coordinator: Dr. Kevin Bradley

The Crop, Soil and Pest Management Graduate Program Area prepares students for careers in research, teaching, extension, production agriculture and related industries. Current research programs emphasize Soil and Nutrient Management, Forage Management, Cereal and Oil Seed Crop Production, Alternative Crops, Cropping Systems, Weed Management, Integrated Pest Management, Turfgrass Management and Precision Agriculture. Many degree programs are cross-disciplinary to give students a comprehensive view of the field.

A. Specific Curricular Requirements

The Crop, Soil and Pest Management program area emphasizes a customized approach towards

the course of study. Each student will work with their advisor and graduate committee to develop a course of study best suited to the student's educational and career goals.

B. Teaching

Graduate students in the Crop, Soil and Pest Management Graduate Program Area will be required to participate in an approved Extension teaching experience. A student must obtain his/her major advisor's consent to participate in a teaching capacity in courses other than those taught by his/her major advisor. It is recommended that all graduate students involved in teaching participate in the teaching orientation program offered by the Program for Excellence in Teaching. Each student is responsible for obtaining the approval of the Director of Graduate Studies for the activity which will be used to fulfill this requirement before the proposed activity begins. For more information see <https://plantsciences.missouri.edu/graduate/teaching-requirement/>

C. Participating Faculty and Potential Advisors

Kevin Bradley, Professor, weed science
Felix B. Fritschi, C. Alice Donaldson Professor in Bioenergy Crop Physiology & Genetics
Bruce E. Hibbard, Adjunct Professor, insect resistance management
John A. Lory, Extension Associate Professor, environmental nutrient management
Ron Mittler, Professor, plant stress biology
Kelly A. Nelson, Professor, crop production systems
Craig Roberts, Professor, forage quality
Peter C. Scharf, Professor, nutrient management
Reid J. Smeda, Professor, weed science
Qisheng Song, Professor, molecular insect physiology
Andrew Thomas, Research Assistant Professor, horticultural crop production techniques
Michele R. Warmund, Professor, fruit and nut crop physiology
Xi Xiong, Associate Professor, turfgrass science

II. Entomology

Coordinator: Dr. Deborah Finke

Within the Entomology Graduate Program Area, a student can select training from a variety of courses and research programs to prepare for a career in many areas of professional entomology, including research, teaching, industry and extension work.

Current research programs emphasize the following disciplines: ecology, integrated pest management, insect behavior, plant-insect interactions, biochemistry, molecular biology, physiology, morphology, and systematics. Work is done in natural systems, including aquatic and terrestrial, and in managed horticultural and agricultural systems.

A. Specific Curricular Requirements

In partial fulfillment of Division requirements, Masters and Doctoral students are required to complete the following four entomology courses:

- PLNT SCI 7710 Systematic Entomology
- PLNT SCI 7820 Principles of Insect Physiology
- PLNT SCI 9810 Insect Ecology
- One elective formal entomology course

Elective formal entomology courses include:

- PLNT SCI 7720 Aquatic Entomology
- PLNT SCI 7970 Readings in Plant-Insect Interactions
- PLNT SCI 8001 Molecular and Proteomic Techniques of Insects
- PLNT SCI 8720 Insect Behavior

B. Teaching

Students in the Entomology Program Area will be required to complete teaching experience as part of their plan of study. For more information see

<http://plantsciences.missouri.edu/graduate/teaching-requirement/>

C. Participating Faculty and Potential Advisors

Deborah Finke, Professor, ecology, plant-insect interactions
Bruce Hibbard, Adjunct Professor, insect resistance management
Kent Shelby, Adjunct Assistant Professor, insect physiology and immunobiology
Robert Sites, Professor, insect systematics, ecology of aquatic insects
Qisheng Song, Professor, insect physiology and molecular biology
David Stanley, Adjunct Professor, biological control of insect research laboratory

D. Awards, Honors and Financial Assistance

At the beginning of each Spring semester, an announcement will be sent to all entomology students and faculty regarding the application procedures and submission deadlines for the various entomology student awards.

1. Philip C. and Ruth E. Stone Scholarship in Entomology. This annual award recognizes an outstanding entomology master's graduate student based on scholarship and professional activities. Nominations and selection of the winner are made by the entomology faculty, and the recipient receives a check for \$500.

2. Leonard and Elosia Haseman Memorial Scholarship Award in Entomology. This annual award recognizes an outstanding entomology doctoral student based on scholarship and professional activities. Nominations and selection of the winner are made by the entomology faculty, and the recipient receives a check for \$1,000.

3. Lloyd E. Adams and E.P. Meiner's Doctoral Scholarship in Entomology. This award is available annually on a competitive basis to an entomology doctoral graduate student. The goals of the award are to improve the quality of the program's doctoral students and their dissertations, and to enhance their professional credentials. The award covers up to \$1,500 of the expenses associated with a scholarly experience that would not normally be included in the recipient's program, such as participation in a workshop, short course, or visit to a laboratory or field station to learn a new research technique. Submitted student proposals are evaluated by an entomology faculty review committee.

4. Thomas R. Yonke Biodiversity Fellowship. This award is for master's or doctoral students and covers up to \$500 of the expenses associated with a scholarly experience in insect biodiversity that would not normally be included in the awardee's program, such as participation in a workshop, short course, visit to a laboratory or field station or any activity or project that will enhance the recipient's understanding of insect biodiversity. Submitted proposals by the students are evaluated by an entomology faculty review committee.

5. Fred Clute Memorial Scholarship in Entomology. This award is available annually on a competitive basis for an entomology master's or doctoral student who has demonstrated excellence in an area of pest management in their research and outreach activities, both in agricultural and urban settings. The submitted student proposals are evaluated by an entomology faculty review committee, and the recipient receives a check for \$500.

6. Gilbreath McLorn Fund in Entomology. This fund was designated to promote teaching and research in entomology. By agreement of the faculty, a part of the fund is used to support entomology graduate student travel to regional and national entomological meetings when they are giving oral or poster presentations, and also to support speakers for entomological seminars.

III. Horticulture

Coordinator: Dr. Michele Warmund

The Horticulture program focuses on intensively grown food crops and ornamental plants. The program provides a meaningful educational opportunity for the student with career interests in any of the many fields of the diverse discipline of horticulture, including commercial crop production on tree and small fruits, viticulture, turf, or ornamentals. Interdisciplinary experiences with fields related to horticulture are an important component of this program. The Horticulture program provides scientific advances through its research programs and disseminates those advancements to the academic community, horticultural industry, and general public through its teaching, extension and public service programs.

One of the chief missions of this program is to find solutions to current horticultural problems that can be readily adopted by clientele. Additionally, horticultural graduate research addresses basic questions that may be used to solve future problems. Teaching and outreach activities are elements of this program and are intricately interwoven into our research effort.

A. Specific Curricular Requirements

In partial fulfillment of Division requirements, Master students will take 15 hours of the required 30 hours in courses numbered 8000 or above. Within the 30-hour requirement, 12 credit hours can

be satisfied by research, reading and problems courses.

All Doctoral students will have successfully completed the requirements for a Master's degree before beginning a Doctoral program. The student, their advisor, and graduate committee develop a customized program of study in partial fulfillment of Division requirements. No more than 30 hours of research (24 hours from the Ph.D. and 6 hours from the M.S. degrees) may be counted toward the 72-hour minimum requirement. No more than 6 hours may be transferred from other institutions.

B. Teaching

Graduate students in the Horticulture program area will be required to complete teaching experience as part of their plan of study. For more information see <https://plantsciences.missouri.edu/graduate/teaching-requirement/>

C. Participating Faculty and Potential Advisors

Andrew Thomas, Research Assistant Professor, horticultural crop production techniques
Dean Volenberg, Assistant Extension Professor, viticulture & winery operations
Michele R. Warmund, Professor, fruit and nut crop physiology
Xi Xiong, Associate Professor, turfgrass management and physiology

IV. Plant Breeding, Genetics and Genomics

Coordinator: Dr. Andrew Scaboo

Understanding the fundamental concepts of plant breeding, genetics and genomics is essential to providing solutions to the wide array of problems in food, fiber and energy production that are facing the growing world population. In the Plant Breeding, Genetics and Genomics graduate program area, students receive an education and training in a wide range of courses and research programs in plant physiology, biochemistry, molecular biology, classical and modern genetic theories, plant-microbe interactions, breeding for cultivar development, bioinformatics, and biotechnology. We encourage interdisciplinary education and training that provides a comprehensive base of knowledge for careers in research and education in plant genetics and related areas.

A. Specific Curricular Requirements

To meet the Division of Plant Sciences requirements, each student will work with their advisor and graduate committee to develop a customized course of study best suited to the student's educational and career goals by building a foundation of knowledge skills and abilities to meet those goals.

B. Teaching

Graduate students in the Plant Breeding, Genetics and Genomics Graduate Program Area will be required to participate in an approved teaching opportunity. A student must obtain his/her major advisor's consent to participate in a teaching capacity in courses other than those taught by his/her major advisor. It is recommended that all graduate students involved in teaching participate in the teaching orientation program offered by the Program for Excellence in Teaching. Each student is

responsible for obtaining the approval of the Director of Graduate Studies for the activity which will be used to fulfil this requirement before the proposed activity begins. For more information see <https://plantsciences.missouri.edu/graduate/teaching-requirement/>

C. Participating Faculty and Potential Advisors

Kristin D. Bilyeu, Adjunct Professor, soybean seed quality
Pengyin Chen, Endowed Professor, soybean breeding
Christine Elsik, Associate Professor, computational biology & bioinformatics
Sherry Flint-Garcia, Adjunct Professor, maize genetic diversity
Felix Fritschi, C. Alice Donaldson Professor in Bioenergy Crop Physiology & Genetics, crop physiology; abiotic stress
Walter Gassmann, Professor, molecular plant pathogen interactions
Jason Gillman, Adjunct Associate Professor, genetic basis for valuable seed traits
Bruce Hibbard, Adjunct Professor, insect resistance management
Chin-Feng, Hwang, Adjunct Assistant Professor, grape genetics & breeding
Hari B. Krishnan, Adjunct Professor, soybean molecular biology
David Mendoza-Cozatl, Associate Professor, plant stress biology
Blake Meyers, Professor, plant RNA & genomics
Ron Mittler, Professor, plant stress biology
Henry Nguyen, Professor, genetics and biotechnology
Andrew Scaboo, Assistant Professor, soybean breeding
James E. Schoelz, Professor, molecular plant virus interactions
Robert E. Sharp, Professor, plant physiology
Gary Stacey, Curators Distinguished Professor, functional genomics of soybean microbe interactions
Chris Topp, Adjunct Assistant Professor, plant root phenotyping and genetics
Bing Yang, Professor, plant-bacterial interactions

V. Plant Stress Biology

Coordinator: Dr. Ron Mittler

Many of us take for granted the fact that we have a safe, abundant food supply. However, plant abiotic stresses such as drought and heat, and biotic stresses such as pathogens and insect pests, result in major limitations to agricultural production in Missouri, the nation, and the world. In many parts of the world, plant stresses can be devastating not only to plants themselves, but also to the humans who rely on them. Through the study of plant responses to the abiotic and biotic environment, we can develop economical and environmentally sustainable solutions to limit the effects of plant stress on agricultural production. We also recognize that plant-associated microbes provide beneficial effects and may even be essential to maintenance of plant health.

A. Specific Curricular Requirements for the PhD Degree

Required entry level courses (to be completed in the first year):

PLNT SCI 7315 Crop Physiology (3 credits, spring) or **PLNT S 7320** Molecular Plant Physiology (3 credits, fall)
PLNT SCI 7500 Biology and Pathogenesis of Plant-Associated Microbes (4 credits, fall)
PLNT SCI 8010 Professionalism and Ethics (or equivalent).

Required plant stress biology series:

PLNT SCI 8505 Plant Stress Biology (3 credits, spring)

Participation in readings once each year:

PLNT SCI 7965 Readings in Plant Stress Biology (1 credit)

Participation in the student seminar series:

PLNT SCI 9087 (2 credits - Must enroll twice; only 1 credit counts towards the 15-credit hour requirement of 8000/9000 level courses)

PLNT SCI 7087 (3 credits - Must enroll 3 times)

Dissertation research (1 - 10 credits per semester):

PLNT SCI 9090

Elective courses to fulfill the requirement for 15 credit hours at the 8000 or 9000 level. Selections include, but are not limited to:

PLNT SCI 8430 Introduction to Bioinformatics Programming (4 credits)

BIO S 8300 Advanced Plant Genetics (3 credits)

INFO INST 8005 Applications of Bioinformatics Tools in Biological Research (3 credits)

BIO S 8310 Fungal Genetics and Biology (3 credits)

PLNT SCI 8330 Molecular Breeding and Genomic Technology (3 credits)

PLNT SCI 9415 Advanced Plant Physiology: Physiology of Plant Growth Responses to the Environment (1-3 credits)

PLNT SCI 9540 Genetics of the Plant-Microbe Interaction (3 credits)

PLNT SCI 9810 Insect Ecology (3 credits)

Additional 7000 courses of interest:

STAT 7070 Statistical Methods for Research (3 credits)

PLNT SCI 7550 Plant Biotechnology (4 credits)

PLNT SCI 7400 Plant Anatomy (4 credits)

During the Fall and Spring semesters, PhD students who have not completed their comprehensive exam must enroll for 9 credits to be considered a full-time student.

B. Teaching

Graduate students in the Plant Stress Biology Graduate Program Area will be required to complete teaching experience as part of their plan of study. For more information see <https://plantsciences.missouri.edu/graduate/teaching-requirement/>

C. Participating Faculty

- **Christine Elsik**, Associate Professor, computational biology & bioinformatics
- **Richard Ferrieri**, Adjunct Research Professor, plant stress biology; radiochemical imaging
- **Deborah Finke**, Associate Professor, insect ecology; plant-insect interactions
- **Felix B. Fritschi**, C. Alice Donaldson Professor in Bioenergy Crop Physiology & Genetics, crop physiology; abiotic stress
- **Walter Gassmann**, Professor, molecular plant-pathogen interactions
- **David Mendoza-Cozatl**, Associate Professor, stress biology; trace metal homeostasis
- **Ron Mittler**, Professor, plant stress biology
- **Henry T. Nguyen**, Professor, molecular genetics of plant stress; soybean biotechnology
- **James E. Schoelz**, Professor, plant-virus interactions
- **Robert E. Sharp**, Professor & Director, Interdisciplinary Plant Group, plant physiology; drought
- **Qisheng Song**, Professor, molecular insect physiology
- **Gary Stacey**, Professor, soybean genomics; molecular soybean-microbe interactions
- **Dean Volenberg**, Assistant Extension Professor, viticulture
- **Xi Xiong**, Associate Professor, turfgrass science; stress physiology
- **Bing Yang**, Professor, plant-bacterial interactions

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- **Jason Gillman**, USDA-ARS Adjunct Assistant Professor, genetic basis of seed traits
- **Bruce E. Hibbard**, USDA-ARS Adjunct Professor, insect resistance management
- **Hari B. Krishnan**, USDA-ARS Adjunct Professor, soybean molecular biology & seed composition

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- **Ivan Baxter**, Adjunct Assistant Professor, Donald Danforth Plant Science Center, plant elemental composition in different environments; ionomics
- **Malia Gehan**, Adjunct Assistant Professor, Donald Danforth Plant Science Center, high throughput phenotyping, temperature stress
- **Ru Zhang**, Adjunct Assistant Professor, Donald Danforth Plant Science Center, photosynthesis, temperature stress

Missouri State University, Springfield, Missouri

- **Chin-Feng Hwang**, Adjunct Assistant Professor, grape genetics & breeding
- **Laszlo Kovacs**, Adjunct Professor, molecular grape pathology
- **Wenping Qiu**, Adjunct Professor, Vitis genomics & gene discovery; plant virology