

Welcome to The School of Plant Sciences!

For hundreds of years, scientists have chosen plants and their associated microbes to answer basic questions about the world around us. Botanists and microbiologists shaped our fundamental understanding of genetics, cell structure, and evolution, and modern plant science continues to contribute to basic biological research. The study of plants and their pathogens has also emerged as central for solving current world problems such as food security, energy needs, and climate change.

The School of Plant Sciences has a long-standing tradition of excellence in plant science research. The large faculty has diverse research interests ranging from horticulture to genomics and microbiology to evolution. As part of the BIO5 Institute, our faculty are closely associated with colleagues in the Colleges of Science, Engineering, Pharmacy, and Medicine.

This diversity is translated into our graduate curriculum, where students gain a broad understanding of all aspects of plant science while retaining the ability to specialize. Students also benefit from regular opportunities to meet scientists from across the country and around the world. An emphasis on critical thinking and written and oral communication prepares students for a wide variety of 21st century careers in academia and beyond, including positions as university faculty, research scientists, plant breeders, consultants, science writers, teachers, or science lawyer/patent officers, among many others.

Students within our School enjoy excellent research facilities, including modern greenhouses and controlled environment rooms, extensive field sites, advanced microscopes, and high-throughput sequencing facilities. The faculty of the School of Plant Sciences benefit from strong extramural grant support notably including the iPlant Collaborative, the largest NSF grant ever awarded for biological research. Finally, students and faculty both enjoy the friendly community of Tucson and the stunning surroundings of the Sonoran Desert.

The School of Plant Sciences offers M.S. and Ph.D. degrees in two majors: **Plant Sciences** and **Plant Pathology**. Students in each major are part of the same academic unit -- the School of Plant Sciences. Although the programs differ in their specifics (reflecting the different disciplines in each), they are similar in their expectations and structure. We encourage a sense of community and fellowship among all graduate students in our School through shared seminars, a graduate student club, and open doors among labs, classes, faculty, and disciplines.

In the pages that follow we outline some of our graduate program information. Please consult our School website for more information.

On behalf of our students, staff, and faculty, welcome!

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1. Program requirements

Graduate requirements for majors in Plant Sciences and Plant Pathology are similar, differing only in specific coursework. In addition to the requirements of each program, graduate students must comply with all Graduate College policies as stated in the UA General Catalog at the time the student enters the program.

The primary requirements for completion of a graduate degree are coursework, research program, and production of a formal thesis or dissertation. For a non-thesis Master's Degree, a report must be written and presented to the student's Advisory Committee for approval. Graduate students should prepare an Annual Graduate Student Progress Report (APR) and have their Major Advisor complete the Annual Summary by Major Advisor to ensure sufficient progress is made each year. In addition, Ph.D. students must pass written and oral Comprehensive Exams.

A. Provisional advisory committee (PAC), student mentors, and formation of the advisory committee

All aspects of a student's degree are overseen and approved initially by a Provisional Advisory Committee (PAC) and, once a Major Advisor is selected, by the student's Major Advisor and an Advisory Committee.

The PAC will consist of a Major Advisor and two other faculty members selected by the major advisor. The PAC will serve as temporary advisors during the first semester for MS students and the first two semesters for Ph.D. students. Each student must meet with his or her PAC on arrival: preferably before classes begin, but at the latest before the conclusion of the first two weeks of their first semester in the program.

The first meeting between the student and PAC should focus on evaluating the student's background, assisting him/her in selecting courses, and, if appropriate, helping him/her outline potential rotation projects/mentors. The format of the PAC meeting is flexible, but generally includes evaluation of the student's retention and synthesis of knowledge from previous coursework. Importantly, this is not an "exam" in the sense that a student will pass or fail, but rather a formal process to ensure that students receive guidance at the beginning of their graduate career.

In addition to evaluating the student's command of the subject matter in his/her field of study, the PAC may administer an assessment of writing to help the student gain competence in scientific and professional expression. For example, the student may be asked to write a mini-review of a selected research article or articles (2 to 4 pages). This should be entirely the student's own effort and will be used by the PAC to evaluate whether the student needs to receive supplemental instruction on writing skills.

Finally, the PAC should advise the student on course selection including the options on minor fields of study, and should help orient the student to graduate education at the University of Arizona. Throughout, the student will have an opportunity to ask questions and seek constructive feedback from faculty who are invested in helping him/her commence graduate school with a sense of support, focus, and goal-oriented achievement.

In addition, each student will be assigned a Graduate Student Mentor upon entering the program. The Student Mentor will assist with any other questions about the campus, the School of Plant Sciences (SPLS), and/or the graduate major.

Upon establishing a formal mentorship relationship with a Major Advisor, Master's and Ph.D. students will form their committees with input from their Major Advisor, including (as necessary) representation by members from both their major and minor fields of study.

Working with the student and the student's Advisory Committee(s), the Graduate Student Program Committee (GSPC) provides oversight for both graduate degree programs in the School of Plant Sciences. The GSPC is made up of a group of faculty appointed by the SPLS Director to develop policy governing the Program. This Committee is responsible for making recommendations for student admissions and for candidates for assistantships to the SPLS

Director. It also oversees student progress, monitors results of the Comprehensive Exams, moderates any conflicts between advisors and students, and administers general University and SPLS policies regarding graduate student activities. The chair of GSPC is responsible for the administration of the graduate program and serves as the Director of Graduate Studies.

B. Coursework and related requirements

The minimum number of units required for a Master's degree is 30 graduate units (36 for the non-thesis option). For a thesis Master's degree, 8 Thesis units (PLS 910) may count toward the degree. Eight Master's Report units (PLS 909) may count toward the non-thesis degree.

For a Ph.D. degree a minimum of 36 units of course work in the area of the major subject, 9 units in the minor subject, and 18 units of dissertation (PLS 920) must be completed. More information regarding GPA requirements, transfer credit, and minimum enrollment levels can be found at the Graduate College website.

Students have four components to their graduate requirements: the School of Plant Sciences Seminar; journal club; presentation of their own research; and core courses. These are outlined below.

1. Students are expected to attend all seminars in the Interdisciplinary Plant Sciences seminar series, and are required to enroll in the seminar for course credit by signing up for PLS 596A for at least two semesters (MS students) and five semesters (Ph.D. students).
2. Students are required to present their work during their graduate program. In addition to the final defense seminar, MS students must present at least one seminar, and Ph.D. students must present at least two seminars. Presentations at national and international meetings, or in other academic departments, may meet this requirement pending approval by the Director of Graduate Studies. It is the responsibility of the student and his/her advisory committee to schedule their seminar presentations in conjunction with the Seminar Committee.
3. Because evaluation of the literature is a critical component of graduate training, all students are required to enroll in a journal- or literature-based course (i.e., a journal club) for either two semesters (MS students) or four semesters (Ph.D. students). We strongly encourage all students to enroll in the Plant Sciences Journal Club course, to be held each spring term. Other journal clubs from within or beyond the School also can count toward the required total; please contact Dr. Arnold prior to enrolling to confirm that the course is acceptable.
4. Finally, students must complete the core courses outlined below (in addition to elective courses selected by the student with approval from his/her Major Advisor and Advisory committee). Overall, the balance of a student's coursework will be shaped by the student's particular areas of emphasis in consultation with the Major Advisor and Advisory Committee.

Plant Sciences Core Courses (for Master's and Ph.D. students):

- PLS 540 Mechanisms of Plant Development
- PLS 548A Plant Biochemistry and Metabolic Engineering

Ph.D. students in Plant Sciences also must take

- MCB 546 Advanced Genetics or approved equivalent
- One core elective of ≥ 3 units from the list shown here, pending approval by Major Advisor:
<http://cals.arizona.edu/spls/graduate/list>

Plant Pathology Core Courses (for Master's and Ph.D. students):

- PLP 550 Principles of Plant Microbiology
- PLP 551 Biology and Characterization of Plant Pathogenic Agents

Ph.D. students in Plant Pathology must also take:

- PLP 528 Microbial Genetics or approved equivalent
- One core elective of ≥ 3 units from the list shown here, pending approval by Major Advisor:
<http://cals.arizona.edu/spls/graduate/list>

C. Comprehensive exam for Ph.D. students

After completion of coursework (but no later than the third year), students studying for a Ph.D. degree will take both the written and the oral portions of the Comprehensive Exams covering both the major and minor fields of study. Both exams are evaluated by the student's Advisory Committee and successful completion leads to promotion to "degree candidate" status.

In the written exam, the student develops and writes a research proposal. If the proposal covers the student's research topic, an additional written test of general knowledge will also be administered. For the oral exam, the student will present a brief summary of the proposal, before answering questions based on the proposal and on fundamental knowledge of the major and minor fields of study. For more information, see the Guide to Comprehensive Examinations (pdf file).

D. Research program

On an individual student basis, the School of Plant Sciences offers the opportunity for rotations through various faculty research programs in the first 1-2 semesters of study. Rotations enable the student to identify a suitable laboratory for research and identify faculty who might serve as Major Advisor or members of the student's Advisory Committee. Rotations also expose the student to various disciplines within the field of plant sciences and to techniques that may be useful in the course of her/his research. Ph.D. and M.S. students receiving departmental funding are required to rotate through labs prior to selecting a Major Advisor. Students receiving funding from a faculty grant are also encouraged to consider rotations; however, the student and the Major Advisor will make the final decision. If laboratory rotations are to be undertaken, students should complete the Notice of Lab Rotation form and submit it to the Student Records Office (Forbes 319). Students may receive up to three units of credit (PLS 695C) each semester for laboratory rotations.

Once a suitable laboratory for thesis or dissertation research has been selected, the student will work with the Major Advisor and Advisory Committee to develop a research plan. Annual meetings with the Advisory Committee are required to ensure the student is making appropriate progress toward completion of the degree program.

E. Thesis or dissertation

The culmination of a graduate degree is the submission and defense of a Master's Thesis or Doctoral Dissertation. Although a student may begin writing this document in the last few months of the graduate program, the process of preparing a thesis or dissertation begins with the development of a research plan and continues with regular input from the Advisory Committee.

To complete the requirements for a Master's or Ph.D. degree, students must present their research in an open seminar and defend their Thesis or Dissertation in a closed oral examination administered by the Advisory Committee. At the completion of the examination, the Advisory Committee votes to determine if the student is awarded the degree. Doctoral students must submit the Announcement of Final Oral Examination to the Graduate Degree Certification Office at least 7 days prior to the examination and bring appropriate documentation to the exam for committee signatures. See the Graduate College website for more information.

A Manual for Theses and Dissertations is available on the Graduate College website and it is strongly recommended that students read the manual carefully before beginning preparation of a thesis or dissertation. It is the responsibility of the student to ensure that the thesis or dissertation complies with the University's strict guidelines.

Under the non-thesis Master's option, the Advisory Committee and student determine the nature and extent of the written report describing the results from the research activities. At completion, this report is submitted to the student's Advisory Committee for approval.

F. Petitioning to have requirements waived

The requirements described on these pages have been implemented to provide a well-rounded background for all students in areas important to the pursuit of a degree in Plant Sciences/Plant Pathology. While the described guidelines are to be fulfilled by all graduate students, the GSPC recognizes that specific cases may arise in which: 1) equivalent requirements (especially course requirements) have been fulfilled recently at a comparable university, or 2) a student's program would benefit if specific aspects of the School requirements were modified. If a student feels this is the case, a formal written petition (Graduate College Petition Instructions and General Petition Form) may be submitted to the GSPC to request a waiver or modification of requirements. Students may petition only once for each issue, and in all cases, sufficient documentation must accompany the request. Petitions should be made in a timely fashion prior to graduation (generally within the first year for M.S. students and the first two years for Ph.D. students).

A petition to waive SPLS course requirements would include, but not be limited to: grade received, institution and date the course was taken, a letter from the course instructor if possible, a copy of the course syllabus, a description of general areas covered, a list of textbooks used in the course, and a letter of support from the student's PAC or Major Advisor. Other areas open to petition include substitutions in general course area requirements. In all cases, the student should clearly describe why the current requirement would not meet their needs and what would be gained from the requested change.

The primary requirements for completion of a graduate degree are coursework, research program, and production of a formal thesis or dissertation. For a non-thesis Master's Degree, a report must be written and presented to the student's Advisory Committee for approval. Graduate students should prepare an Annual Graduate Student Progress Report (APR) and have their Major Advisor complete the Annual Summary by Major Advisor to ensure sufficient progress is made each year. In addition, Ph.D. students must pass written and oral Comprehensive Exams.

G. Assessment

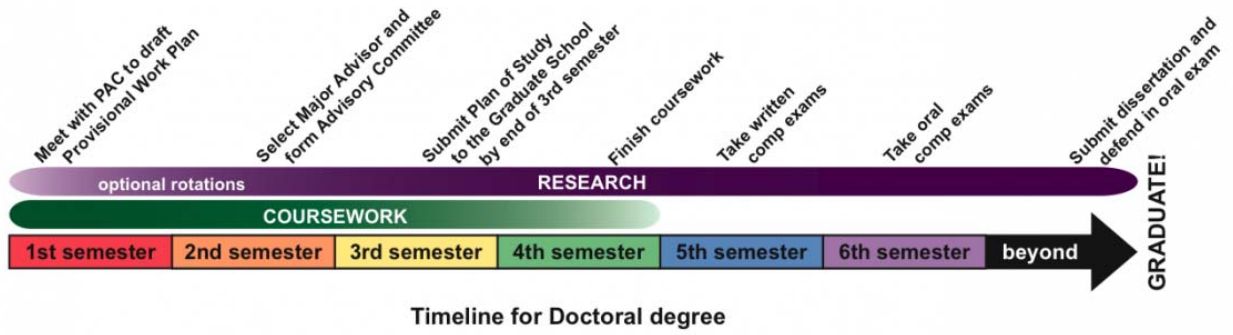
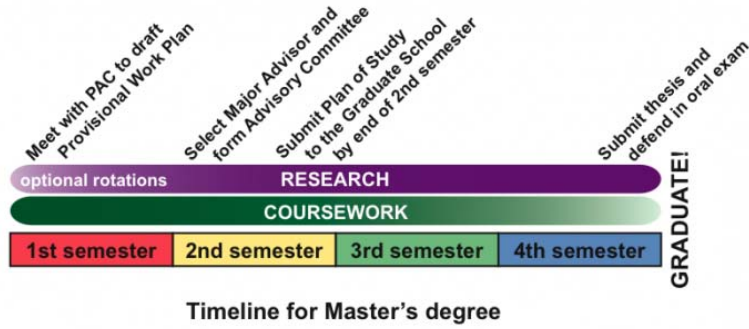
Learning outcomes for students in the School are consistent for our two majors: at completion of the program, each student should be able to:

1. Describe the existing body of information and recognize key concepts and research questions underlying his/her general subject area (i.e. plant biology, microbial biology, genomics, plant pathology)
2. Evaluate the scientific literature essential for his/her research area and articulate how his/her research fits into and/or advances the discipline
3. Use multiple research approaches to collect scientific data related to his/her research area, and interpret, analyze and critique his/her data
4. Communicate his/her research (importance, approaches taken and interpretation of results) effectively in writing and orally
5. Express in lay terms the potential impact of his/her work on society

Assessment forms will be used to evaluate and enhance the quality of our course of study, mentorship, and training. Forms will be distributed to faculty before each student's PAC and defense, and for Ph.D. students, at the oral portion of the comprehensive exam.

2. Timelines

These timelines are guidelines to help you stay on track in graduate school.



3. Policies

A. CODE OF CONDUCT FOR GRADUATE STUDENTS

Graduate students in the School of Plant Sciences must abide by all relevant standards and rules established by the University and School of Plant Sciences (SPLS); failure to do so can result in dismissal from the Program. If there is concern about a specific situation, the student should consult with his/her PAC, Major Advisor, Graduate Student Coordinator, or SPLS Director. University of Arizona Code of Conduct can be found online.

B. CODE OF ACADEMIC INTEGRITY

Students must abide by the Code of Academic Integrity in all academic work including coursework and research activities. University of Arizona Code of Academic Integrity can be found online.

C. ACADEMIC STANDING

Students enrolled in the Graduate College are required to maintain a “B” average (3.0); failure to do so can result in dismissal from the Program. Students who have a cumulative grade-point average of less than 3.0 will be placed on academic probation. Students on probation are required to meet with their Major Advisor to discuss steps to correct the problems that led to the probationary status, and to devise a written plan of action to be submitted to the Graduate College. After two consecutive semesters of probation, students will be converted automatically to Non-Degree status by the Graduate College – while in Non-Degree status, students may continue to take graduate courses. Students can apply for readmission to a degree program as early as the semester after their conversion to Non-Degree status if they achieve a cumulative grade point average of at least 3.0 through additional graduate course work. Such a request must be supported by the Director of SPLS and approved by the Dean of the Graduate College. Students who do not maintain a 3.0 GPA are not eligible for assistantships of any kind and cannot be recommended for scholarships or for the award of an advanced degree.

D. VACATION POLICY

Graduate students supported on assistantships are considered both students and University employees. As students, they will have time off from classes, and can expect to take advantage of major holidays, e.g., Thanksgiving, Winter Break, etc. However, they should plan to take no more than two weeks of additional vacation per year, usually in the summer. Once students select a Major Advisor, they should discuss vacation plans far in advance.

E. LEAVE OF ABSENCE

Graduate students may request a temporary Graduate Student Leave of Absence from the Graduate Program. Leave of absences are granted on a case-by-case basis for compelling reasons including birth or adoption of a child, personal or family reasons, medical reasons, military duty, or financial hardship. A Graduate Student Leave of Absence may be approved for one semester or one year on the written recommendation of the student’s Major Advisor and the School Director. Students returning after an approved leave of absence will be readmitted to the Program without reapplying. Student insurance is not available while on Graduate Student Leave of Absence and a Graduate Student Leave of Absence does not exempt students from obligations to lending institutions. In addition, use of all University facilities (e.g., libraries, computer services, faculty time, etc.) is suspended while on leave, only academic services or facilities available to the general public can be used. Only when the leave is approved prior to the beginning of the semester for which it is being sought will students be exempted from fees for that semester. Graduate students who do not return at the end of the approved leave or who do not enroll for a semester and have not received an official leave of absence are required to apply for readmission and are subject to all rules and regulations of the admissions process. Failure to obtain a Graduate Student Leave of Absence or to remain in continuous enrollment will result in penalties as described in the Continuous Enrollment Policy Requirements (below).

F. ACADEMIC LEAVE

Academic leaves that are taken elsewhere for course work, research, field work, internships, or professional development, are handled on a case-by-case basis by SPLS and the Graduate College.

G. LEAVING THE PROGRAM

Students may resign from the Graduate Program at any time. To do so, they should write a letter to the Graduate Program Coordinator stating their intent. It is advised that students contemplating such a move should consult with their Major Advisor or the Graduate Program Coordinator before beginning this process. To re-enter the Program, the student must petition the Graduate Student Program Committee (GSPC); acceptance will depend on issues including past performance, funding availability, and whether there is an advisor willing to accept the student for continued graduate studies.

H. DISMISSAL FROM A FACULTY MEMBER'S RESEARCH PROGRAM

Students can be dismissed from a faculty member's research program at any time based on the Major Advisor's determination (in consultation with the student's Advisory Committee) that the student is not making satisfactory progress. Such dismissal does not constitute dismissal from SPLS, but it is the responsibility of the student to find a replacement Major Advisor in the School within one semester. Students will not be allowed to continue their education in SPLS without a Major Advisor. If a student finds him/herself in this situation, he/she should schedule a meeting with the Graduate Program Coordinator and Director of Graduate Studies immediately to determine the best course of action.

I. DISMISSAL FROM THE GRADUATE PROGRAM

Students can be terminated from the Graduate Program by their Advisory Committee for failure to: 1) meet minimum academic standards, 2) make satisfactory progress in their degree work, 3) meet generally acceptable ethical standards of the University, 4) pass the Comprehensive Exams, 5) successfully defend their master's thesis or doctoral dissertation.

J. GRADUATE COLLEGE MASTER'S/SPECIALIST CONTINUOUS ENROLLMENT POLICY

A student admitted to a Master's/Specialist degree program must register each fall and spring semester for a minimum of three graduate units from the original matriculation date until all degree requirements are met. If degree program requirements are to be completed in the summer, the student must register for a minimum of one unit of graduate credit during that term. Summer-Only students are required to enroll continuously for a minimum of three units during consecutive summers until all degree requirements are met. *Students receiving SPLS support are required by the College of Agriculture and Life Sciences to register for a minimum of 10 units each fall and spring semester.*

K. GRADUATE COLLEGE DOCTORAL CONTINUOUS ENROLLMENT POLICY

A student admitted to a doctoral program must register each fall and spring semester for a minimum of three graduate units from the original matriculation date until the completion of all course requirements, Written and Oral Comprehensive Exams, and 18 dissertation units. When these requirements are met, doctoral students must register for a minimum of one unit each semester until final copies of the dissertation are submitted to the Graduate Degree Certification Office. However, students receiving funding such as assistantships, fellowships, loans, grants, scholarships, or traineeships may be required by their funding source to register for more than one unit to meet full-time status requirements, and should check with the Major Advisor/Graduate Program Coordinator to ensure that they remain qualified for funding.

Doctoral students who have maintained continuous enrollment and are taking only comprehensive exams during either Summer or winter term do not have to register for graduate credit during that summer or winter session. Doctoral students who have maintained continuous enrollment, fulfilled all their other degree requirements as well as the 18 hours of dissertation and were enrolled in the prior semester may defend in the summer or winter term without registration. However, Master's students, if the degree requirements are completed during the summer term, they must be registered for a minimum of one unit of graduate credit during that term.

Unless excused by an official Graduate Student Leave of Absence, all graduate students are subject to the Continuous Enrollment Policy and must pay in-state and out-of-state tuition and fees in order to remain in the Program. If the student fails to obtain a Graduate Student Leave of Absence or maintain continuous enrollment, he or she will be required to apply for re-admission to the Program, pay the Graduate College application fee, and pay all overdue tuition and fees, including cumulative late penalties. No tuition or registration waivers will be applied retroactively.

Students receiving SPLS support are required by the College of Agriculture and Life Sciences to register for a minimum of 10 units each fall and spring semester.

4. Comprehensive exams

Before admission to degree candidacy, Ph.D. students must pass a general examination in their chosen field of study. The Comprehensive Examination is the occasion when the student has both the opportunity and the responsibility to display broad knowledge of plant sciences and/or plant pathology and sufficient depth of understanding in areas of specialization.

A. Comprehensive Exam Policies

The Comprehensive Examination includes written and oral portions covering the major and minor fields and should be held when essentially all course work has been completed. The written portion of the Comprehensive Examination must be taken no later than the middle of the 3rd year (5th semester) and the oral portion must be completed by the end of the 3rd year (6th semester) or the semester following completion of the written portion. Any deviation from this timeline for either the written or the oral examination must be approved by the Graduate Student Program Committee (GSPC). There must be at least 3 months between completion of the Comprehensive Oral Examination and the Final Oral Defense Examination.

The student's Advisory Committee also serves as the Comprehensive Examination Committee (CEC). One member of the CEC (chosen by the student in consultation with his/her Major Advisor) serves as Chair of the CEC. The Major Advisor has the option to participate on the CEC, but cannot serve as Chair. If the Major Advisor elects not to be a member of the CEC, the student must select another faculty member to serve. The choice must be approved by the GSPC and should be based on the fact that the Comprehensive Examination is intended to test a student's general fundamental knowledge of the major and minor fields of study.

The student is responsible for filling out the "Results of Oral Comprehensive Exam for Doctoral Candidacy" (available at the Graduate College website) and providing this form to his/her CEC at the oral examination. The CEC Chair will complete the *Results of Written Examination* section and gather the needed signatures. A faculty representative of the CEC will take the form to the Graduate College (Admin 316) within 24 business hours of completion of the exam.

B. Nature of the Exams

1. Written comprehensive examination

There are two options for the written portion of the Comprehensive Examination. The choice should be made by the student in consultation with his or her Major Advisor.

In the first option, the student writes a proposal unrelated to his/her dissertation project in terms of the experimental system and the conceptual question being addressed. The second option consists of two parts: a test of general knowledge and a written proposal on the student's research topic. The test of general knowledge consists of answering three (chosen by the student) of five questions provided by the members of the CEC. All three questions should be answered within a three-week period. Upon completion, the answers should be submitted to the Chair of the CEC for distribution to the members. After successful completion of the test of general knowledge, the student writes a proposal on his/her research topic.

For either option, the development of the proposal must be entirely by the student; the student should not seek suggestions for how to approach the problem.

The student must provide the CEC members with a 1-2 page outline of the questions to be asked and the approaches to be taken to answer them for approval by the CEC. Once the outline has been approved, the proposal must be completed within four weeks. The completed proposal should be turned in to the Chair of the CEC for Committee evaluation and approval. The proposal must be approved by the CEC before the oral portion of the Comprehensive Examination can be scheduled.

2. Oral comprehensive examination

Once the completed proposal has been approved by the student's CEC, the student is responsible for scheduling the oral examination following Graduate College guidelines (see above). The members of the CEC (including both major and minor representatives), participate in the oral examination. At the beginning of the exam, the student should present a brief (10 – 15 minute) summary of the proposal. The first half of the oral exam should be devoted to questions based on the proposal, and the last half of the exam to questions that test general fundamental knowledge of the major and minor fields of study. The CEC evaluates the student's examination based on both the written and oral portions of the examination. Options to be pursued in the event of failure are determined by the CEC based on guidelines established by the Graduate College. If the student fails the first comprehensive examination and a second examination is recommended, at least 4 months must pass between the first and second attempt.

C. Development of the research proposal

The topic of the proposal must be related to plants, plant microbes, or plant-microbe interactions and must ultimately be approved by the student's CEC. The proposal should be unrelated to the student's dissertation project in terms of the experimental system, the conceptual question being addressed, and any major techniques that are used.

It is important for the student to find a topic that interests him/her since he/she will spend considerable time developing the proposal. Students are advised to read some of the latest literature from major journals to determine what questions remain unanswered and to decide what techniques might be used to answer them. Ideas can then be researched with additional reading and the student should discuss the idea, in general terms, with a faculty member who might be familiar with the subject in the SPS or another department. Since the development of the proposal must be entirely the student's, he/she should not ask for specific suggestions for how to approach the problem.

1. General considerations

The quality of the proposed research is of primary importance and the research must be novel, creative, and compelling in terms of its ultimate importance to society. The best proposals have a solid hypothesis and ask questions to prove or disprove it. The work proposed should be limited in scope so that a postdoctoral fellow (perhaps with the help of a technician) could accomplish the majority of the proposed work in three years. It is important to avoid asking questions that are too general. By being specific, the proposal will remain focused. Proposing too much is not fatal; however, it can suggest to reviewers that the student doesn't have a clear grasp of what is feasible.

Once the topic is narrowed to a manageable problem, the student should write down a series of specific questions that he/she wants to answer. After a few critical and specific questions have been identified, the experiments that might be done to answer them can be outlined. The next step is to work through the details to clarify all ideas.

The student should consult with his/her CEC at this stage for approval of the topic (if Option 1 is chosen) and the hypothesis and questions (for Options 1 and 2) prior to spending too much time developing an idea that the Committee might not approve. To do this, the student should provide the Committee Chair with a 1-2 page summary of the proposal for distribution to all committee members. While the Committee members will not test the student on the subject prior to the Comprehensive Oral Examination, they may ask for additional details about the research plan.

Once the summary has been approved, the completed proposal should be provided to the CEC Chair within 4 weeks for distribution to all Committee members for evaluation. Committee members communicate their evaluation to the Chair within 3 weeks, at which time the Chair notifies the student, his/her Major Advisor, and the Committee of the outcome of the written portion of the Comprehensive Examination.

2. The specifics of the proposal

There are many ways to set up a proposal; some funding agencies have very specific guidelines. The elements discussed below would be useful for grants submitted to any agency. The student can follow the format shown below or use any format provided by the agencies (e.g., NSF, DOE, USDA); this information can be found on their websites.

If writing a proposal for funding, the goal would be to convince very busy reviewers that this research should be part of the small percentage of proposals they recommend for funding. For the Comprehensive Exam, the goal is to convince the CEC that the student is ready to take the oral portion of the exam. In both cases, it is extremely important that the student make it easy for the reviewer to understand the specific goals of the research, its significance, and how it will be done. To do this, the proposal must be logically and clearly written.

Cover Page

The cover page should include the title of the proposal and the name of the principal investigator. The title must be descriptive and no longer than 80 characters.

Table of Contents

To make it easy for the reviewer to find information, each proposal must contain a table of contents.

Abstract/Project Summary (typically half of a page to one page)

The abstract should include a brief statement of the overall goals of the project, its importance and the specific questions or objectives of the proposed research. Some of the most effective abstracts identify a set of deliverables (e.g., new knowledge, answers to age-old questions, tools for improving the human condition) that might be expected if the research is funded.

Project Description

The text of the project description must not exceed a total of 10 single-spaced pages with 1" margins all around and a 12 point font. Inclusion of illustrations (photographs, color prints, figures, etc.) is encouraged; they are not counted as part of text page limitations.

a. Objectives (usually half a page)

It is critical to provide the reviewer with the most important information (what is being proposed, why it is important, and how it will be done) early. Reviewers will lose interest if they have to wait until half way through the grant to know what is being proposed!

The objectives section represents the beginning of the body of the proposal, so it will have many of the same elements as the Abstract (the big biological picture or the importance of the proposed research, a general sense of what is known that serves as the foundation for the proposed research, and the specific goals of the work).

Number each objective using subject headings where appropriate. A format to follow might be: "The overall aim is to ..." or "The long-term goal is to ..." followed by one or two sentences. Specific objectives could be numerically listed with sub-headings, if necessary; e.g., 1. [1.a., 1.b.], 2. [2.a., 2.b.], 3, etc.

b. Significance of the Proposed Research (typically half of a page to one page)

This is the hit it hard "big picture" paragraph. Clearly show how the results from the study will contribute to our understanding of the fundamental nature of plants, plant microbes or plant-microbe interactions and, if appropriate, the potential of the work for long-term improvement of U.S. agriculture. Any novel idea or contributions that the proposed project offers also should be discussed in this section. It should convince the reviewer that, even if the research is very basic, the implications for making an impact on society are significant.

c. Background (2-4 pages)

Like the introduction in a manuscript, this section should provide enough information for the non-expert reviewer (which may include some of the CEC members) to understand the proposed research and to convince the expert reviewer that the student knows the literature and won't duplicate efforts. It should include sections for each topic that needs to be reviewed relative to the proposed research with the appropriate references to the primary literature. An option to consider is to conclude each background section with a brief (1-2 sentences) summary of how the

information just reviewed relates to the proposed work. This approach keeps the proposed research and its importance in the reviewer's mind.

d. Experimental Plan

This is the most important part of the proposal. In this section, each aim is carefully described. It should start with a very brief statement of the significance of the aim and then describe the approaches/ experiments that will be taken to address the aim. There should be enough detail that a knowledgeable scientist can evaluate the feasibility of the experiments. Appropriate controls should be included for all experiments. It is not necessary to provide details about commonly used procedures since these can be referenced. For example, molecular biological methods that are described in a manual or manuscript do not need to be detailed, but should be referenced. However, variations of the basic protocols that are integral to the proposed work should be detailed. Reviewers will look for indications that each step in the proposed procedure has been carefully considered. If it is uncertain whether every step is feasible, this should be indicated and alternatives included that can be used if the experiment is not successful. It is important to design experiments that will yield results no matter the outcome. It is also important to include information about how the experimental data will be analyzed or interpreted. Grants are seldom funded just to make measurements and are frequently criticized because the results are "purely descriptive." What is the meaning of the data that will be collected and how does it relate to the overall biological problem? Interpretation of possible outcomes is a key element in convincing reviewers that results from the work will make a significant contribution to the field. It is also important to discuss possible pitfalls and solutions (what will be done if the experiments don't work or don't support the hypothesis) and any limitations to the proposed procedures.

e. Timetable

This section includes some indication of the timeframe for completion of each aim. It can be in the form of written descriptions (year 1, year 2, year 3), tables or charts. Some staggering of the different aims is expected relative to when work towards each aim is started and finished.

5. Financial information

Graduate students in the School of Plant Sciences (SPLS) are supported, as possible, by fellowships, training grants, research, and/or teaching assistantships.

For example, SPLS students can apply for extramural support from numerous agencies (see below). Some require an application during your first year of studies; others can be applied for later in your graduate career. Keep an eye out for funding opportunities and talk with your major advisor about them well ahead of deadlines!

National Science Foundation Graduate Research Fellowship
NSF Minority Graduate Fellowships
National Defense Science and Engineering Graduate (DOD)
EPA STAR Fellowship
USDA NIFA Predoctoral/Postdoctoral fellowships
American Association of University Women
Hertz Foundation
Ford Foundation
NIH F Awards

Graduate students supported by assistantships, scholarships, fellowships, and traineeships are expected to meet all requirements as defined by the Graduate College and SPLS. To maintain funded status, **all students on SPLS funds are expected to maintain a GPA of 3.2 or higher**, and show evidence of continuing progress in their graduate education.

Students will be reviewed after each spring semester by the Graduate Student Program Committee (GSPC) based on their **Annual Progress Reports**; the GSPC will then make recommendations regarding continuation of financial support. Additional information on financial support can be obtained from the Office of Student Financial Aid: <https://financialaid.arizona.edu>.

ADDITIONAL SUPPORT

SPLS students also may obtain financial support for tuition, travel, and completion of their dissertation studies from sources including the following:

1. Graduate Tuition Scholarships, University of Arizona Graduate College
2. Travel support to attend research conferences or workshops, School of Plant Sciences
3. Financial support to complete the doctoral dissertation, Marshall Foundation Dissertation Fellowships
4. New opportunities come up from time to time. Develop a habit of keeping an eye out for funding sources.

6. Support information

Numerous resources exist within the School, College, and University to assist you in professionally and personally during your graduate career. Here are some important links and resources.

Campus Health Service: <http://www.health.arizona.edu/main.htm>
Urgent care clinic, immunizations, pharmacy, counseling and general medicine

UA LifeWork Connections: <http://lifework.arizona.edu/>
 Child care resources, employee wellness, and assistance

Graduate and Professional Student Council: <http://www.gpsc.arizona.edu/>
 Links to resources, funding, advice and community

<p>General Teaching Topics Resources</p> <p>Print sources available 8-5 p.m. (M-F) in OIA</p>	<ul style="list-style-type: none"> • On-Line & Print Articles • Library of Books • Teaching.OIA.arizona.edu
<p>TA Training On-Line (TATO) Modules</p> <p>available anytime; *required</p>	<ul style="list-style-type: none"> • Staying Out of Trouble* • Getting to Know Your Students • Creating and Using Grading Rubrics • Assessment Basics • Assessing Student Writing • Leading Discussions • Copyright and Fair Use • Writing Instructional Objectives • Teaching in Labs and Studios (Coming Fall 2011)
<p>“Talking Teaching” Brownbags</p> <p>3rd Wednesday of each month at noon or upon request</p>	<p>Tips on:</p> <ul style="list-style-type: none"> • Facilitating Discussions • Supervising Labs • Assessing assignments, including assessing student writing • Using D2L
<p>Teaching Workshops</p> <p>available upon request; also check OIA website for scheduled workshops</p>	<ul style="list-style-type: none"> • Planning a course or lesson • Working effectively with groups • Facilitating Discussion • Promoting Academic Honesty • Teaching with Technology
<p>Certificate in College Teaching</p> <p>Apply at: http://grad.arizona.edu</p>	<ul style="list-style-type: none"> • 10-credit curriculum including supervised practice (designed for those who aspire to a career in college teaching)

7. Course descriptions

Students in the School take courses within their major and minor areas of study, plus electives determined on the basis of specific training needs and chosen in consultation with the Major Advisor and advising committee. A representative sample of courses offered by the School is given below; courses offered by other academic units, and that can fulfill our 'core elective' requirements as well as provide excellent educational opportunities, are highlighted on the school website.

PLS 505 - [Weed Science](#)

Typically offered: Fall; 3 units

Principles of controlling agronomic and horticultural weeds. Emphasis on weed biology and crop-weed competition in relation to chemical, mechanical, cultural and biological control strategies. Graduate-level requirements include a literature review and research project.

PLS 508 - [Crop Ecology](#)

Typically offered: Spring; 3 units

Physical and biotic environment of crops in relation to crop culture, production, and geographical distribution; relations among the human population, crop productivity and man's environment.

PLS 528L - [Microbial Genetics Laboratory](#)

Typically offered: Spring; 2 units

Laboratory associated with lecture course on Prokaryotic gene structure and function; methods of gene transfer and mapping, DNA structure, replication, transcription, and translation. Hands-on computer analysis of DNA sequences and gene cloning strategies. Graduate-level requirements include the DNA sequence of an entire operon from any one of a variety of bacteria and additionally analyze one product from the operon using several GCG protein analysis programs. Also extra exam questions.

PLS 528R - [Microbial Genetics](#)

Typically offered: Spring; 3 units

Prokaryotic gene structure and function; methods of gene transfer and mapping, DNA structure, replication, transcription, and translation. Hands-on computer analysis of DNA sequences and gene cloning strategies. Principles of regulation of gene expression. Graduate-level requirements include a DNA sequence of an entire operon from any one of a variety of bacteria and additionally analyze one product from the operon using several GCG protein analysis programs plus an extensive exam.

PLS 539 - [Methods in Cell Biology and Genomics](#)

Typically offered: Fall; 3 units

In-depth, practical and theoretical analysis of novel, experimental methods that advance our understanding of modern biology.

PLS 548A - [Plant Biochemistry and Metabolic Engineering](#)

Typically offered: Spring; 3 units

Covering topics in plant metabolic engineering; photosynthesis; carbohydrate, nitrogen and lipid metabolism; specialized metabolism. This course covers biochemical processes specific to plants and allows students to gain an understanding and appreciation of how (bio)chemical components are synthesized and utilized by plants during growth and development and in their interactions with their environment, as well as how these processes can be manipulated. A background in plant biology, general biochemistry or chemistry is expected. Note that concurrent registration in any of these courses will NOT meet this requirement. Students must have completed both semesters of O-chem and a biochemistry course that covers general metabolism prior to taking this course. Graduate-level requirements include 2 or 3 short individual oral presentations and a term paper.

PLS 549A - [Plant Genetics and Genomics](#)

Typically offered: Spring; 3 units

A 3-unit lecture/discussion course that provides an advanced treatment of the current knowledge and experimental approaches used in genetic and genomic analysis, with emphasis on plants. Basic understanding of Mendelian genetics, gene and genome structure and function is required. Graduate-level requirements include leading 3 course discussions on review articles and problem sets and write a paper based on each of the three research discussions that they lead.

PLS 560 - [Current Topics in Plant Biology](#)

Typically offered: Fall; 3 units

This course will build on your fundamental knowledge in the fields of plant biology, genetics, molecular biology, and biochemistry to enable you to gain a better understanding of the processes regulating plant growth and development and how these processes change during plant interactions with the environment and with other organisms. Information will be presented through lectures, review of the primary literature, and classroom discussions. An equally important goal will be to foster development of the skills needed to critically evaluate the primary research literature and effectively communicate scientific concepts orally and in writing. Successful completion of the course will lead to a better understanding of the concepts that underlie modern research in the field of plant signaling and will prepare you for more advanced courses and for conducting graduate research.

PLS 583 - [Controlled Environment Systems](#)

Typically offered: Fall; 3 units

An introduction to the technical aspects of greenhouse design, environmental control, hydroponic crop production, plant nutrient delivery systems, intensive field production systems, and post-harvest handling and storage of crops. Graduate-level requirements include submission of a comprehensive report related to a specific greenhouse design project.

PLS 463/563 - [Postharvest Physiology, Technology and Produce Safety](#)

Typically offered: Summer I; 3 units

The course provides an overview of the various biological and physiological phenomena affecting post harvest life of agricultural commodities. Proper harvesting, handling, packaging, storage, transportation and marketing procedures to deliver good quality produce are addressed. The course gives specific emphasis relating physiological and biochemical processes to shelf life of intact and fresh-cut commodities. A half of this course is dedicated to microbial safety issues of vegetable production and handling. This section introduces the inherent risks and safety of the food supply and the use of public policy, and food technology and traceability to reduce those risks.

PLS 500 - [Computer Concepts and Perl Programming](#)

Typically offered: Fall; 3 units

Basic Perl programming with applications to biology and fundamental computer concepts that are necessary to efficiently utilize computers in biological research. Graduate-level requirements include writing two functional specifications.

PLS 540 - [Mechanisms of Plant Development](#)

Typically offered: Spring; 3 units

Focuses on the molecular genetic mechanisms of plant development using primarily the current model systems. Graduate-level requirements include seven journal club discussions and presentations for graduate students and honors undergraduate students.

PLS 565 - [Practical Skills for Next-Generation Sequencing Data Analysis](#)

Typically offered: Spring; 3 units

This course is intended to introduce the application of NGS in modern systems biology and to teach the students the practical skills on operating high-performance computers (HPC) and using the bioinformatic tools for NGS data analysis.

PLS 572 - [Systemic Botany](#)

Typically offered: Spring; 4 units

Evolutionary relationships and characteristics of seed plants: systems of classification; acquisition of skills to identify members of almost 50 families, collection and identification of local flora.

PLS 575A - [Physiology of Plant production under Controlled Environment](#)

Typically offered: Spring; 3 units

Students will learn the major environmental factors affecting plant growth and development and will understand interactions between plants and their microenvironments, including light penetration and CO₂/H₂O diffusion. Students will learn energy and mass balance of leaves and canopy and correlate these phenomena with plant productivity and related plant physiological mechanisms. Lectures cover critical controlled environment issues and practices of plant production in greenhouse, plant production factory, tissue culture vessels and post-harvest storage, with an introduction to the current research status in these areas. This course will be offered in spring of even years. Graduate-level requirements include a research paper on a specific topic within plant physiology under controlled environment. The paper should be a critical review of the current literature on the topic chosen.

PLS 579 - [Applied Instrumentation for Controlled Environment Agriculture](#)

Typically offered: Spring; 3 units

Students will learn principles, methods, and techniques related to the measurement and control of environmental factors affecting plant growth and plants, surrounding climate under controlled environments. Light intensity, light quality, temperature (air, plant), relative humidity, carbon dioxide, water, air current, and related factors are important variables in controlled environment plant production systems to measure and control since they affect and determine plant growth and development and processes such as heating, ventilating and air conditioning, fertigation etc. Therefore, students will learn application of sensors, instrumentation and designing of a simple system to measure and control environments for plant production systems. Graduate-level requirements include higher grading percentages for midterm, design project, and final exams.

PLS 580 - [Medicinal Plants](#)

Typically offered: Fall; 3 units

Historical and cultural aspects of plants and medicine, therapeutic uses of plants, psychoactive and food plants, contribution of medicinal plants to modern medicine, future of medicinal plants. Graduate-level requirements include review of at least two leading papers in the field.