

and then spends approximately three years in the Ph.D. part of the program before completing the M.D. degree. However, the track is also offered to students who have completed the M.D. degree. UCR Biomedical Sciences students may apply for admission concurrently with their applications to the medical school phase or any time after acceptance to the medical phase. For these students only, the MCAT is accepted in lieu of the GRE.

Students from other medical schools should apply in the fall of their sophomore or senior year. Applications from sophomores must be accompanied by official permission for an appropriate leave of absence. The GRE requirement is the same as for regular Ph.D. students.

Master's Degree

The Biomedical Sciences Graduate Group offers an M.S. degree. No students are admitted directly into the program for work toward the master's degree. However, a Plan I (Thesis) or Plan II (Comprehensive Examination) M.S. degree is available in special circumstances when work leading to the Ph.D. degree cannot be completed. The student's advisory committee decides whether the master's degree is an appropriate alternative to the Ph.D. degree. This decision may be made at the end of the student's first year of residence or at other times in the student's career, particularly at the time of the qualifying examination.

Course Descriptions

All Biomedical Sciences courses are listed and described under Biomedical Sciences.

Further information regarding graduate studies in Biomedical Sciences may be obtained from the Division of Biomedical Sciences.

Botany and Plant Sciences

Subject abbreviation: BPSC

College of Natural and Agricultural Sciences

Mikeal L. Roose, Ph.D., Chair
Department Office, 2132 Batchelor Hall
Graduate Student Affairs (800) 735-0717
or (951) 827-5688

Undergraduate Advising Center
(951) 827-3579; plantbiology.ucr.edu

Professors

Edith B. Allen, Ph.D. *Community/Restoration Ecology*

Julia N. Bailey-Serres, Ph.D. *Genetics*
Xuemei Chen, Ph.D. *Plant Cell and Molecular Biology*

Timothy J. Close, Ph.D. *Genetics*
Darleen A. DeMason, Ph.D. *Botany*
Norman C. Ellstrand, Ph.D. *Genetics*
Exequiel Ezcurra, Ph.D. *Ecology*

Jodie S. Holt, Ph.D. *Plant Physiology*
Anthony H. C. Huang, Ph.D. *Plant Cell and Molecular Biology*

Bai-Lian "Larry" Li, Ph.D. *Ecology*
Carol J. Lovatt, Ph.D. *Plant Physiology*
Adam J. Lukaszewski, Ph.D. *Genetics*
Eugene A. Nothnagel, Ph.D. *Plant Physiology*
Natasha Raikhel, Ph.D. *Ernst and Helen Leibacher Chair; Plant Cell Biology*

Mikeal L. Roose, Ph.D. *Genetics*
J. Giles Waines, Ph.D. *Genetics*
Linda L. Walling, Ph.D. *Genetics*
Susan Wessler, Ph.D. *Distinguished Professor of Genetics*

Shizhong Xu, Ph.D. *Genetics*
Zhenbiao Yang, Ph.D. *Plant Biology*

Professors Emeriti

Charles W. Coggins, Jr., Ph.D.
Arturo Gómez-Pompa, Ph.D.
Anthony E. Hall, Ph.D.
Robert L. Heath, Ph.D. *Plant Physiology and Biophysics*
Lowell S. Jordan, Ph.D.
Charles K. Labanuskas, Ph.D.
Elizabeth M. Lord, Ph.D. *Botany/Developmental Biology*
Rainer W. Scora, Ph.D.
William W. Thomson, Ph.D.
Irwin P. Ting, Ph.D.

Associate Professor

Sean Cutler, Ph.D. *Plant Cell Biology*
Thomas A. Eulgem, Ph.D. *Plant Cell Biology*
Thomas Girke, Ph.D. *Bioinformatics*
Patricia S. Springer, Ph.D. *Genetics*

Assistant Professors

Venugopala R. Gonehal, Ph.D. *Plant Cell Biology*
Darrel Jenerette, Ph.D. *Landscape Ecology*
Renyi Liu, Ph.D. *Evolutionary Genomics*
Louis Santiago, Ph.D. *Physiological Ecosystems*
Matthew S.H. "Harley" Smith, Ph.D. *Plant Cell Biology*

**

Lecturers

Mary Lu Arpaia, Ph.D. *Subtropical Horticulture*
James Baird, Ph.D. *Turfgrass Horticulture*
David A. Grantz, Ph.D. *Agronomy and Plant Physiology*
Milton E. McGiffen, Jr., Ph.D.
Vegetable Crops/Plant Physiology
Alan McHughen, Ph.D. *Plant Biotechnology*
Donald J. Merhaut, Ph.D.
Horticulture and Floriculture

Affiliated Emeritus

Junji Kumamoto, Ph.D. (Chemist Emeritus)

Cooperating Faculty

Michael Allen, Ph.D., (Plant Pathology and Microbiology)
Hailing Jin, Ph.D (Plant Pathology and Microbiology)
Isgouhi Kaloshian, Ph.D. (Nematology)
David R. Parker, Ph.D. (Environmental Sciences)
Joel Sachs, Ph.D. (Biology)

Major

The mission of the interdepartmental Undergraduate Program in Plant Biology is to provide students with a solid background in modern principles and research practices of basic Plant Biology and in their area of specialization.

Courses prerequisite to the major, courses used to satisfy major requirements, and the 16 units (for B.S. degree) related to the major must be taken for letter grades. Students may elect to take other courses on a Satisfactory (S)/No Credit (NC) basis. Refer to the Academic Regulations section of this catalog for additional

information on "S/NC" grading.

Information about this program is available from the CNAS Academic Advising Center (1223 Pierce Hall, Monday through Friday, 9 a.m. to noon and 1 to 4 p.m., [951] 827-7294).

Transfer Students

Students planning to transfer to UCR with a major in Plant Biology must have a minimum GPA of 2.7 in transferable college courses and "C" or higher grades in a year sequence of general chemistry and in courses equivalent to our BIOL 005A, BIOL 005B. We also recommend that transfer students complete a year of college calculus before admission. Exceptions may be granted by the faculty advisor.

University Requirements

See Undergraduate Studies section.

College Requirements

See College of Natural and Agricultural Sciences, Colleges and Programs section.

Some of the following requirements for the major may also fulfill some of the college's breadth requirements. Consult with a department advisor for course planning.

Major Requirements

The major requirements for the B.S. and B.A. degrees in Plant Biology are as follows:

1. Life Sciences core requirements (68-72 units)

Students must complete all required courses with a grade of "C-" or better and with a cumulative GPA in the core courses of at least 2.0. Grades of "D" or "F" in two core courses, either separate courses or repetitions of the same course, are grounds for discontinuation from the major.

a) BIOL 005A, BIOL 05LA, BIOL 005B, BIOL 005C

b) CHEM 001A, CHEM 001B, CHEM 001C, CHEM 011A, CHEM 011B, CHEM 011C, CHEM 112A, CHEM 112B, CHEM 112C

c) MATH 008B or MATH 009A, MATH 009B (MATH 009C recommended)

d) PHYS 002A, PHYS 002B, PHYS 002C, PHYS 021A, PHYS 021B, PHYS 021C

e) STAT 100A

f) BCH 100 or BCH 110A (BCH 110A is strongly recommended)

Note for the B.S. degree, courses in Statistics and Biochemistry taken as part of the core may count toward the 16 units from an area of specialization. For the B.A. degree, courses in Statistics and Biochemistry taken as part of the core may not count toward the 12 units required from an area of specialization.

2. Upper-division requirements (40-52 units)

A GPA of at least 2.0 in upper-division courses taken in the field of the major is a graduation requirement. A student is subject to discontinuation from the major whenever

the GPA in upper-division course work is below 2.0. Students finding themselves in this circumstance must meet with an advisor.

- a) BIOL 102
- b) BPSC 104/BIOL 104 (may be waived with consent of the faculty advisor)
- c) BIOL 132/BPSC 132, BIOL 143/BPSC 143, BPSC 133
- d) At least 8 units for B.S. or 4 for B.A. from the following:
BIOL 100/ENTM 100, BIOL 120/MCBL 120/PLPA 120, BIOL 120/MCBL 120/PLPA 120L, BIOL 121/MCBL 121, BIOL 121L/MCBL 121L, BIOL 123/MCBL 123/PLPA 123, BIOL 124/MCBL 124, BIOL 134/PLPA 134, BIOL 134L/PLPA 134L, BIOL 159/NEM 159, BPSC 134/ENSC 134/SWSC 134, ENSC 120/NEM 120/SWSC 120, ENTM 124
- e) Two (2) units of BPSC 195H, BPSC 197, BPSC 198-I, or BPSC 199
- f) BPSC 193 with a grade of C- or better
- g) **For the B.S.** 16 additional units from one of the four areas of specialization (consult with a faculty advisor) and additional upper-division courses in biological sciences and related areas from any of the areas of specialization lists, and students may apply a maximum of 6 units of BPSC 190 and/or BPSC 195H and/or BPSC 197 and/or BPSC 198-I and/or BPSC 199. Requirements a) through g) must be at least 52 units in total.

For the B.A. 12 additional units from one of the four areas of specialization (consult with a faculty advisor).

Note Students planning a B.A. degree should schedule the required language courses in place of a series of electives.

Areas of Specialization

Individual student career goals may be achieved by selecting an area of specialization within the diverse disciplines of botany and plant sciences. Adjustments within these programs can be made to accommodate students' interests. Students must consult with a faculty advisor to clarify educational goals and to plan a program of study.

1. Plant Cellular, Molecular, and Developmental Biology
 - a) BPSC 135
 - b) Additional units from the following to meet either the B.S. or B.A. requirement: BCH 102, BCH 110B, BCH 110C or BIOL 107A, BCH 153/BIOL 153/BPSC 153, BCH 162, BCH 183/BPSC 183, BIOL 107B, BIOL 113, BIOL 114, BIOL 121/MCBL 121, BIOL 121L/MCBL 121L, BIOL 123/MCBL 123/PLPA 123, BIOL 155/BPSC 155, BIOL 168, BPSC 138/BIOL 138, BPSC 185, CBNS 101, CBNS 108

2. Plant Genetics, Breeding, and Biotechnology
 - a) BPSC 150
 - b) Additional units from the following to meet either the B.S. or B.A. requirement: BCH 153/BIOL 153/BPSC 153, BIOL 105, BIOL 107A, BIOL 107B, BIOL 108, BIOL 119, BIOL 148/BPSC 148, BIOL 155/BPSC 155, BPSC 135, BPSC 158, BPSC 185, CBNS 108
3. Ecology, Evolution, and Systematics
 - a) BPSC 146
 - b) Additional units from the following to meet either the B.S. or B.A. requirement: ANTH 170/BPSC 170, BIOL 105, BIOL 108, BIOL 112/BPSC 112/ENTM 112, BIOL 116, BIOL 116L, BIOL 117, BIOL 138/BPSC 138, BIOL 165/BPSC 165, BPSC 134/ENSC 134/SWSC 134, BPSC 158, BPSC 166, BPSC 185, ENSC 100/SWSC 100, GEO 151, GEO 153, GEO 169
4. Plant Pathology, Nematology, and Pest Management
 - a) BIOL 120/MCBL 120/PLPA 120
 - b) Additional units from the following to meet either the B.S. or B.A. requirement: BCH 183/BPSC 183, BIOL 121/MCBL 121, BIOL 121L/MCBL 121L, BIOL 124/MCBL 124, BPSC 133, BPSC 146, BPSC 150, BPSC 158, BPSC 166, ENSC 134/SWSC 134/BPSC 134, ENTM 100/BIOL 100, ENTM 109, ENTM 124, ENTM 127/BIOL 127, ENTM 129, ENTM 129L, ENSC 100/SWSC 100, ENSC 120/NEM 120/SWSC 120, NEM 159/BIOL 159, PLPA 120/BIOL 120/MCBL 120, PLPA 120L/BIOL 120L/MCBL 120L, PLPA 123/BIOL 123/MCBL 123, PLPA 134/BIOL 134, PLPA 134L/BIOL 134L, SWSC 104/ENSC 104

Minor

The minor in Plant Biology allows students majoring in other departments to obtain in-depth training in Plant Biology.

Requirements for the minor in Plant Biology are as follows:

1. BIOL 104/BPSC 104 (4 units)
2. One course (4–5 units) from the following: BIOL 132/BPSC 132, BIOL 138/BPSC 138, BIOL 143/BPSC 143, BPSC 133
3. Twelve (12) to 20 units from the following: ANTH 170/BPSC 170, BCH 183, BCH 153/BIOL 153/BPSC 153, BIOL 132/BPSC 132, BIOL 138/BPSC 138, BIOL 143/BPSC 143, BIOL 148/BPSC 148, BIOL 155/BPSC 155, BIOL 165/BPSC 165, BPSC 133, BPSC 134/ENSC 134/SWSC 134, BPSC 135, BPSC 146, BPSC 150, BPSC 158, BPSC 166, BPSC 190, BPSC 195H, BPSC 197,

BPSC 198-I, BPSC 199, PLPA 120/BIOL 120/MCBL120

Note No more than 4 units of BPSC 190–199 may be used to fulfill this requirement. The course used to fulfill the requirement in 2. cannot also be used to fulfill the requirement in 3.

See Minors under the College of Natural and Agricultural Sciences in the Colleges and Programs section of this catalog for additional information on minors.

Graduate Program

The Department of Botany and Plant Sciences offers programs leading to the M.S. degree in Plant Biology with two tracks, Botany or Plant Science, and a program leading to Ph.D. degrees in Plant Biology or Plant Biology (Plant Genetics)*. Research in these programs can focus on basic and/or applied questions.

Admission Applicants who have a baccalaureate degree and who satisfy the general requirements of the university listed in the Graduate Studies section of this catalog are considered for admission to graduate status. Students applying to the Ph.D. program and domestic applicants to the M.S. program must submit GRE General Test scores (verbal, quantitative, and analytical).

Regardless of the area of their major for the baccalaureate degree, students must have had, or complete soon after entering graduate school the following:

1. A year of course work in general biology and general chemistry
2. A course in genetics, biochemistry, and calculus
3. Two courses in physics and/or statistics.

Credit from these courses does not count toward the graduate degree.

Immediately after being admitted, each student should identify a faculty advisor and consult with that advisor or the graduate advisor regarding educational goals; scheduling initial course work and possible lab rotations; and forming a guidance committee. Further guidance on these matters is provided in the Botany and Plant Sciences Graduate Student Handbook.

Master's Degree

The Department of Botany and Plant Sciences offers programs leading to the M.S. degree in Plant Biology with tracks in Botany or Plant Science.

The master's degree may be earned under Plan I (Thesis) or Plan II (Comprehensive Examination). Students must meet all general requirements of the Graduate Division. The detailed course program is determined by the guidance committee after considering the specific interests of the student. Department requirements are as follows:

Plan I (Thesis)

1. Three courses from Section I of either the Botany track or the Plant Science track M.S. list
2. Two courses from Section II. In fulfilling the Section II requirement, students may use no more than one course cross-listed by Botany and Plant Sciences and another program. If such a cross-listed course is used toward fulfilling the Section II requirement, the same course may not be used toward fulfilling the Section I or III requirements.
3. At least 6 units from Section III of either the Botany track or Plant Science track M.S. list
4. Preparation of a thesis (not more than 12 units from Section V may apply toward the degree)

If the student takes research courses from Section IV, not more than 6 units may be applied toward the degree. Students who have taken courses comparable to those in Section I during their baccalaureate training may have a portion or all of this section waived. In such instances, however, it is expected that their programs include increased units in courses from Sections II, III, and/or IV. Recommendations for waivers should specify alternative courses and should be sent to the department educational advisory committee for approval.

Plan II (Comprehensive Examination)

1. Three courses from Section I of either the Botany track or Plant Science track M.S. list
2. Two courses from Section II. In fulfilling the Section II requirement, students may use no more than one course cross-listed by Botany and Plant Sciences and another program. If such a cross-listed course is used toward fulfilling the Section II requirement, the same course may not be used toward fulfilling the Section I or III requirements.
3. At least 12 units from Section III of either the Botany track or Plant Science track M.S. list
4. At least 6 units from Section IV for a research project or literature review, which should be described in a report to be submitted for evaluation by the comprehensive examination committee
5. Comprehensive written and oral examinations

Students who have taken courses comparable to those in Section I during their baccalaureate training may have a portion or all of this section waived. In such instances, however, it is expected that their programs include increased units in courses from Section II and/or III. Recommendations for waivers should specify alternative courses and should be sent to the educational advisory committee for approval.

Seminar Requirement All full-time students must enroll in the BPSC 250 seminar during each quarter in which it is offered. Part-time students must take one BPSC 250 seminar for every 12 units of courses. One quarter per year, students may enroll in an equivalent seminar course as a replacement for the BPSC 250 seminar course. All students must present at

least one BPSC 250 seminar and complete at least two quarters of BPSC 240 (or equivalent).

Courses available for fulfilling the requirement for the M.S. degree:

Section I — Upper-division undergraduate courses:

Botany track ANTH 170/BPSC 170, BCH 153/BIOL 153/BPSC 153, BCH 183/BPSC 183, BIOL 104/BPSC 104, BIOL 112/BPSC 112/ENTM 112, BIOL 120/MCBL 120/PLPA 120, BIOL 132/BPSC 132, BIOL 134/PLPA 134, BIOL 138/BPSC 138, BIOL 143/BPSC 143, BIOL 155/BPSC 155, BIOL 165/BPSC 165, BPSC 133, BPSC 134/ENSC 134/SWSC 134, BPSC 135, BPSC 146, BPSC 148, BPSC 166

Plant Science track ANTH 170/BPSC 170, BCH 153/BIOL 153/BPSC 153, BCH 183, BIOL 104/BPSC 104, BIOL 112/BPSC 112/ENTM 112, BIOL 120/MCBL 120/PLPA 120, BIOL 132/BPSC 132, BIOL 134/PLPA 134, BIOL 138/BPSC 138, BIOL 143/BPSC 143, BPSC 148, BPSC 150, BIOL 155/BPSC 155, BIOL 165/BPSC 165, BPSC 133, BPSC 134/ENSC 134/SWSC 134, BPSC 135, BPSC 146, BPSC 158, BPSC 166

Section II — Graduate and upper-division undergraduate courses in related departments or programs: applicable courses are determined by the educational advisory committee and require approval of the graduate advisor.

Section III —

Botany track BCH 205/BPSC 205/CMDB 205/GEN 205/MCBL 205/PLPA 205, BCH 231/BPSC 231, BPSC 201 (E-Z) (for a maximum of 2 units), BPSC 210, BPSC 230, BPSC 232, BPSC 234, BPSC 237, BPSC 239, BPSC 240 (only if taken in addition to the required seminar units; see seminar requirement), BPSC 243, BPSC 245, BPSC 247

Plant Science track BCH 205/BPSC 205/CMDB 205/GEN 205/MCBL 205/PLPA 205, BCH 231/BPSC 231, BPSC 201 (E-Z) (for a maximum of 2 units), BPSC 221, BPSC 222, BPSC 232, BPSC 234, BPSC 237, BPSC 239, BPSC 240 (only if taken in addition to the required seminar units; see seminar requirement), BPSC 243, BPSC 245, BPSC 247

Section IV — Research courses: BPSC 290 and BPSC 297

Section V — Thesis research: BPSC 299, Thesis for Plan I

Normative Time to Degree 7 quarters

Doctoral Degree

The Department of Botany and Plant Sciences offers programs leading to Ph.D. degrees in Plant Biology or Plant Biology (Plant Genetics)*.

The student must meet the general requirements of the Graduate Division.

* The Plant Biology (Plant Genetics) program is in the process of being phased out and replaced by a concentration in Plant Genetics within the Plant Biology program.

Admission Either prior to entering the graduate program or before advancement to candidacy, students must have completed the equivalent of BPSC 104 and one other course from the core plant biology courses (BIOL 107A, BPSC 132, BPSC 135, BPSC 138, BPSC 143, BPSC 146). Course requirements for each student are determined by individual guidance committees and by the educational advisory committee. No later than the second quarter in residence, students meet with a guidance committee to (1) determine a course program to be submitted to the educational advisory committee, and (2) choose a major area of specialization and two minor areas.

Course Work Guidance committees and students should design individual course programs that meet the specific needs of the student and the requirements of the Ph.D. program. Course programs should prepare students for the qualifying examination and dissertation research. All first-year students must enroll in BPSC 200A and 200B during their first Fall and Winter quarters. Students must take a minimum of 12 additional graduate-level units relevant to the specialization. Graduate courses taken previously may be considered towards fulfilling this requirement. Students' course programs must be approved by the educational advisory committee. At the time of submission of course programs to the educational advisory committee, the area of specialization and two minor areas to be covered on the qualifying examination should be specified. Students may petition to change the course program, area of specialization, or minor areas at any time.

Students entering the Plant Biology Ph.D. program have four choices, as listed below. Students with a general interest in plant biology and/or evolution are encouraged to choose the first.

Ph.D. in Plant Biology Students who choose to obtain a Ph.D. in Plant Biology without one of the following concentrations are encouraged to – with the advice and consent of their Major Professor and Guidance Committee – create a set of coursework that is specifically tailored to their individual research interests and career objectives.

Students can also choose from one of three concentrations:

Ph.D. in Plant Biology (Concentration in Plant Cell, Molecular, and Developmental Biology) To earn the concentration in Plant Cell, Molecular, and Developmental Biology (appears on the transcript only), students must complete BPSC 231, BPSC 232, and BPSC 237. In addition, the required BPSC 240 course must be on a topic related to the concentration.