

External Review

Plant Biology Graduate Program

University of California at Riverside

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Review committee:

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Executive Summary

The review committee was very impressed with the Plant Biology graduate program (PLBL) at University of California, Riverside. This is a strong program, with outstanding faculty and students. The review occurred after the pandemic and the graduate student strike, so there were significant concerns among faculty and students about mental health, funding, governance, etc., which are national challenges not unique to this program. Internal and external concerns identified fell under the following three areas with key recommendations noted.

1. Higher administration/funding issues including:

- 1.1 Continued hiring and retention of faculty are critical for maintaining excellence.
- 1.2 Facilities updates of Batchelor Hall are important for recruitment and retention of excellent faculty.

2. Graduate student funding issues such as:

- 2.1 Rotations may need to be shortened to accommodate higher salaries and reduced funding, but it is essential to maintain a minimum cohort of graduate students who participate in rotations for viability of the program.
- 2.2 Flexibility in Teaching Assistantships is important to account for the breadth of research and student interests in teaching as a career

3. Internal program areas that could benefit from further evaluation include:

- 3.1 Examine the current qualifying exam structure to consider options that would have more consistent expectations, less stress for students, and possibly reduced workload for faculty.
- 3.2 Examine current graduate completion rates and time to degree and consider what changes could be undertaken to make sure students are reaching milestones at appropriate times.
- 3.4 Examine the current mechanisms of governance and communication to enable better communication between students as a whole and faculty as a whole and enable students to have more say in issues that affect them.
- 3.5 There is excellent diversity in the student body and a strong commitment to Diversity, Equity and Inclusion in the department. However, many of the issues which affect students generally have a stronger impact on students from under-represented groups.

Strengths of the Program

The University of California at Riverside is internationally recognized for the strength of its Plant Biology Graduate Program (PLBL), including excellence in plant biochemistry and cell and molecular biology. Upon reviewing the Plant Biology graduate program, we discovered many additional strengths including the following:

- Excellence of faculty & research programs
- Broad intellectual diversity, spanning biochemistry to genetics to ecology
- Excellent and highly diverse graduate student body (esp. Latinx)
- Faculty and graduate students who embrace undergraduate education including opportunities for research experience
- Strong career success of graduate students; ~40% are in academia (many went on to post-docs, so long term career outcomes are still unfolding) and many in industry
- Good student support relative to the cost of living, and recruitment of excellent students
- Several training grants have been obtained by faculty including two Department of Education GAANN grants and two IGERT/NRT grants
- Cutting-edge entrepreneurship and engineering collaborations
- A longstanding NSF REU summer program and the Dynamic Genome freshman program which provides a pipeline of undergraduate students into their graduate program and graduate programs at other institutions
- Creation of the 200A/200B course series and flexibility in graduate courses to allow students to choose from a breadth of classes in both classical and modern plant biology
- Strong sense of community among faculty and among students

Recommendations, Concerns, and Future Planning

1. Higher administration/faculty concerns

1.1 Faculty Hiring

The excellence of any graduate program is closely tied to the current and future profile of the faculty and to the availability of high-quality research facilities. While these topics are not strictly within the purview of our review of the graduate program, we feel it is important to address questions and concerns raised by both administrators and department faculty.

As noted above, UCR's Department of Botany and Plant Sciences (BPSC) is internationally known for the excellence of its faculty. UCR's leadership in this area dates back to its origins as an agricultural research station, and its central role in CNAS' position as one of the six Agricultural Experiment Station colleges of the UC system. Based on campus data we reviewed, the number of faculty in the program grew from 33 in 2010 to 44 in 2017 and has subsequently dropped to 36 at present. Collectively the four departments in the Ag and Natural Resources Division of CNAS have declined by 7 FTE since 2010, while Math and Physical Sciences departments have grown by 35. BPSC is rightly concerned about the challenges of maintaining hiring in the face of upcoming retirements; plant biology nationally had a hiring wave in the 80s, following innovations in transformation technologies and other advances, and departments across the country are currently grappling with a 'retirement cliff'.

Current faculty quality is very high, but as noted above the numbers are declining and the program is at risk for future losses due both to retirements and lack of retention due to issues such as low-quality space and the perception that there is a decline in investment in this area of research.

We note these issues because the administration and the department view the data through different lenses. Many faculty shared that they see the decline in department FTE as evidence of disinvestment and lower prioritization of agricultural and plant sciences at the College and campus level, but there did not seem to be a strong shared understanding between the faculty and the administration of the resource constraints and range of issues facing the College. Administration leadership, on the other hand, is engaged in the campus-wide 35x35 strategy, and the growth of undergraduates enrolled in UCR's College of Engineering which is driving increased demand for lower division courses in math and physical sciences, with attendant demand for faculty hiring in those areas.

Recommendation: Agricultural and Life Sciences are central to the excellence of UCR and to UCR's role in the UC system. Commitments to hiring and retention of faculty are critical to maintaining excellence. Improved dialog between the department and administration is needed on long-term strategies for faculty hiring and maintaining excellence in research and education. The faculty should continue to discuss and propose research areas of future investment that will keep plant science at the cutting edge of research and student training.

1.2 Facilities

We heard much concern from faculty about the status of research facilities in Batchelor Hall, while also acknowledging the high-quality facilities for faculty who reside in newer buildings. There was particular concern that the refurbishment of MEP systems, while overdue, does not improve the state of the research labs themselves, and that this may mean the building does not receive further attention in the foreseeable future. We are aware of the resource constraints of the UC system at this time and can only reiterate that the continued excellence of BPSC and PLBL will depend on sustained investment in high-quality research facilities. We also heard one comment that the new greenhouse - a noteworthy fund-raising and capital projects accomplishment for CNAS - is expensive to operate perhaps deterring faculty from using it. While this may be an isolated comment, we hope the facility can be managed in a manner that ensures it is fully and effectively utilized. Updates of other greenhouse facilities on campus are still warranted.

Recommendation: Develop a capital and facilities renewal strategy to provide all faculty with access to high-quality research space commensurate with the excellence of BPSC research and training programs. This is essential for the recruitment and retention of excellent faculty.

1.3 Master's programs

We were asked by the administration to consider the potential value of a professional Master's program to provide an additional revenue stream for the department and the graduate program. The department has a small Master's program, but a professional Master's would need to include a more structured curriculum and career development program to warrant higher self-supporting fees or professional fees on top of the current tuition. With continued expansion of biotech and alt-foods and the key role of agricultural and natural systems as drivers or solutions for climate change, there may be an increase in career paths for students with a professional Master's degree from BLPL. However, this requires a significant investment

of time and resources from the department, and success depends on how teaching in a Master's program contributes to teaching loads and SCH (see below), impacts on faculty mentoring efforts and the PhD graduate curriculum, and the campus financial model for revenue sharing, in the context of UC policies for professional degree programs.

Other programs that offer a Master's degree in plant biology (e.g., Cornell) have a much larger plant biology faculty with a broader range of expertise (e.g., expertise in plant breeding methods and culture of specific crops such as grapes for winemaking) and offer a range of specialty options for Master's students. Students who choose programs such as Cornell's may do so because of the opportunity to specialize. The Plant Sciences program at UC Riverside does not currently have the size and breadth to provide such a range of specialization opportunities. If a Master's focused on plant biology is not feasible for UC Riverside, the broader Biological Sciences community could consider a technical Master's degree with a biomolecular focus that prepares students for a broad range of jobs in the biotechnology industry including plant biotechnology. UC Berkeley has just launched such a program¹.

Recommendation: A modest investment in a market analysis for Master's degrees in plant biology, and a review of other programs nationwide, may be worthwhile, before taking any further steps. An ad-hoc faculty committee could consider the results and present recommendations to the department and Dean on whether to pursue these possibilities further.

2. Concerns about graduate student funding

2.1 Rotations and Graduate Student Funding

Funding from the Graduate School and CNAS previously supported a number of fellowships that enabled the department to fund rotations for 10-12 incoming graduate students in their first year. Rotations, during which students spend several weeks to months in a faculty member's lab, are important for faculty to assess the student and for graduate students to assess the mentoring style, culture, and research of the lab. In the plant molecular and cellular area, rotations are part of the culture in all top-ranked graduate programs, and a key step in the recruitment of graduate students to individual labs. (In plant ecology, the culture is to directly admit students into a faculty lab without rotations.) At the time of the previous program review, the funding for students had been cut from two years of support to one year. At the

¹ <https://mcb.berkeley.edu/masters>

time of this review, recent cuts in funding from CNAS had led to reduction in the length of time of rotation (from 10 weeks to 6 weeks or from 3 quarters to 2 quarters). More recently, there has been a significant cut in the amount of money allocated by the graduate division, covering just 8 fellowships; this apparently was based on enrollment numbers during the COVID pandemic, which is an artificially low number. According to our discussions with the graduate school this number of fellowships was temporary due to uncertainty caused by the strike; however, the faculty seemed unaware of this.

At the time of our review, the UC graduate student strike had recently ended, and it was not clear how the university and the faculty were going to deal with this. With the increased cost of graduate student salaries and benefits, it is clear there will be an impact on graduate student numbers. This is a serious issue nationally. However, there is a minimum number in a graduate student cohort for the program to be sustainable. Peer institutions such as UC Berkeley and Wisconsin support three 5-week rotations to enable their rotation funding to maintain a sustainable number of graduate students in their programs. We note that although there are good arguments for the value of longer rotations including the opportunity for a greater in-depth understanding of areas outside of a student's thesis research; funding and time-to-degree are arguments for 5- to 6-week rotations that are becoming the norm at many peer institutions.

Recommendations: 1) Improved communication between the Graduate School and CNAS and faculty on longer term prospects for graduate student support. 2) Both faculty and administrators should strive to be creative on how to deal with the increased costs of graduate student support, while maintaining a workable rotation system and a minimum cohort size.

2.2 Graduate student teaching assistant (TA) fellowships

The current program requirement is that students must TA for one quarter in their second year. TAs provide an important source of supplemental funding for graduate students and are an excellent training opportunity for students to practice their communication skills and increase their employability after graduation. Additional quarters of TA can be done if the student is interested in career development or if the faculty member does not have other funding. Students in ecology labs tend to rely more on TA for funding, compared to molecular labs. It is admirable that all students are required to TA at least once. Students expressed concerns about the timing of their required teaching, as they were preparing for their qualifying exam, but teaching in an appropriate course can help students prepare for the qualifying exam. Faculty could consider whether teaching in the first year could help with funding rotations (or rounding

out the first year funding package) or whether requiring two teaching assignments would be beneficial for students; however, considering the high level of research activity of the faculty and students, flexibility should be maintained.

Recommendation: We do not see a need to make changes in the program's teaching requirements or opportunities and recommend that, considering the breadth of the program and the reality of research funding, TA fellowships should remain available and flexible.

3. Internal program concerns

3.1 Qualifying exams

After completing required graduate coursework and performing research, students complete a qualifying exam (Quals) as a condition of candidacy for the PhD. The Quals were understandably a significant source of stress for students as is the case with students everywhere. However, the traditional format of the Quals does not necessarily have to remain this way. The current format is that students provide written answers (in two days) to general questions set by a faculty committee in their major and minor areas of interest. The students also write a proposal on their research and do a three-hour oral defense of the research proposal. The committee includes four faculty members from the department and one outside department and does not include the student's advisor.

The highly individualized nature of the written exam questions can lead to perceptions of inequity. Many students and some faculty perceive that different faculty members have very different expectations and that there are no standardized expectations. The two-day format for the written questions is difficult for all students but places undue stress on students with disabilities, single parents, etc. Although we recognize that limiting the time for students to answer the questions to two days avoids creating a longer stressful period in which students might perceive that even more is expected, this component of the Quals ought to be evaluated further.

Students also expressed concern about points such as the use of Powerpoint vs. chalk board; this in part reflects the transition out of the adjustments made during the pandemic, and the program should re-examine and clarify all expectations for format going forward. Other issues raised by students, for example about lack of clarity about what they were supposed to know, are expected from Quals of this format, yet it seemed that a better understanding of expectations might be conveyed. It is understood that this time in a student's career may be

stressful, but there is good stress due to the intellectual challenge, and bad stress due to inflexibility, unfairness in expectations depending on the committee, difficulties in scheduling, etc.

We note that the level of individual attention in the current Qualls system, such as questions on the written part specific for each student and faculty feedback on a draft of the student's research proposal is admirable. However, this level of individual attention works best if both faculty and student expectations are clear and the faculty have the time to do this in a thorough manner. For example, a preliminary proposal on which the faculty are expected to provide feedback only works well if the faculty are fully committed to reading and meaningfully commenting on this material; if the feedback is not thorough, such a system can be a negative. If having all members of the committee provide feedback on the preliminary proposal requires too much faculty time, perhaps 1 or 2 members of each committee could be charged with this task.

Recommendations: 1) There needs to be more clarity in the expectations of students and faculty in the qualifying exam. Faculty are encouraged to look at the current qualifying exam structure, what is traditional, what is required by the graduate school, what is preparing students for the future, and determine if changes could be made to standardize expectations and decrease stress for students. It is worth considering whether having five members is necessary as this leads to scheduling issues. 2) Use opportunities such as 200A/200B/seminars and peer mentoring to demystify the transition from undergraduate student to graduate student² and clarify expectations that are required.

3.2 Graduate Completion Rates and Time to Degree

Completion rates and time to degree are critical performance indicators of a graduate program. Program averages, provided in the review materials and obtained from UC databases ([Appendix 1](#)), appear reasonable and comparable to peer programs. However, there are concerning indications of a long tail of students taking 8 or more years. Moreover, in the UC data ([Appendix 1](#)), while the sample sizes are small, completion rates are markedly lower for Hispanic/Latino students, and time to degree is longer for African American, Native American, and Hispanic/Latino students (taken together), compared to White students (unfortunately this mirrors a national trend³). Another concern is that some students expressed the belief that certain PIs do not support students finishing in a timely manner, but rather hold students back

² <https://press.princeton.edu/books/paperback/9780691201092/a-field-guide-to-grad-school>

³ [Doctorate Recipients from U.S. Universities: 2019 | NSF - National Science Foundation](#), Table 32

(for additional work and publication). While we cannot assess whether the data correctly identify an equity issue, or properly evaluate student concerns about being held back, both warrant careful consideration by the department.

Recommendations: 1) PLBL program staff conduct a data analysis to determine if the patterns noted above are indicative of potential areas of concern, including in the time to degree for students with particular professors, research areas, or by race/ethnicity. 2) Better tracking of students during their program to make sure they are hitting milestones and add additional review of progress to degree, if required. (Also see related 'Annual Committee Meetings' section below) and 3) Potential program interventions be considered for all students beyond year 5.

3.3 Annual Committee Meetings

It is important to provide a clear path for a graduate student who is having difficulties of any kind to discuss their situation with faculty other than their major professor. It is the norm in many science graduate programs for a graduate student to have an opportunity to discuss any concerns with their thesis committee in the absence of their major professor at yearly committee meetings. Many programs accomplish this by having as a standard practice that the major professor leaves the room at some point of the yearly committee meeting and the committee can ask the student how things are going. Although this approach is common, some students might be intimidated by the prospect of presenting concerns to the *entire* committee, and an alternative is to require the student to schedule a yearly "how-is-it-going" chat with just one member of the committee, or one of a group of faculty, who serve on a student "well-being" committee. The key point is that formalizing a yearly opportunity to check in on student well-being that does not involve the major professor is an important part of a graduate program in science. The graduate advisor for recruitment or the graduate education committee (see governance below) may already be doing this, but it wasn't mentioned.

Recommendation: Although research rarely follows a predictable, linear path, yearly student meetings in the 4th year and beyond should formalize a focus on expectations for completion of the Ph.D. One route to formalization is for all members of the committee to collaborate in filling out a form in which they address specific questions about the path to completion. The faculty are working on aligning learning goals with the annual meeting so this maybe in progress. As noted above, additional review procedures should be considered for students in year 5 or beyond, to ensure that all possible support is provided to expedite completion.

3.4 Governance/Communication

The current governance of the graduate program includes the department chair, vice chair for teaching, graduate advisor for recruitment, graduate advisor for continuing students, and a graduate education advisory committee (GEAC) on which there are two graduate students. There is also a very active graduate student association (BGSA).

From climate surveys and from our interviews with the students, there seemed to be a disconnect between faculty satisfaction with graduate students (faculty were uniformly praiseworthy of the students), and student satisfaction in the program. The opinions of graduate students may have been influenced by the recent UC strike, and it is possible that the students filling in the survey and meeting with us were the most dissatisfied. Nonetheless, it is clear there needs to be an improved forum or mechanism for communication between all of the faculty and students (as opposed to a few individuals on certain committees).

Part of the change in graduate student culture nationally is for students to play a greater role in the governance of their programs. This may require a change to the current governance structure or at minimum an improvement in communication between faculty and students. Faculty-student relations were damaged by the strike and there needs to be a discussion locally and nationally about how to repair it; examples include town hall events, mediation, social activities, etc. This department with its strong community and faculty with a commitment to graduate training is in a good position to address this. A specific concern that we heard is that graduate students raised issues in the GEAC, but it was not clear if these were then brought to the faculty as a whole (some faculty seemed unaware of key issues).

One area of concern we heard from several students was the level of responsibility placed on BGSA for both hosting, as well as financing, social events. Our understanding is that students are responsible for organizing fund-raising for department social events. Perhaps asking students to fund-raise for social events is a carryover from an earlier era, but the arrangement as described by the students is not appropriate now. Furthermore, because BGSA needs students to volunteer for activities, such as recruiting or cleaning up after events, and there is little incentive to do so (students were eligible for travel funding), an undue burden is being carried by a subset of the students, particularly female students.

Recommendations: 1) The most significant way to improve faculty-student relations would be for students to feel that their concerns are heard, thoroughly discussed, and, as appropriate, acted upon. If student requests are not acted upon, an explanation should be provided. 2) PLBL

should examine funding models for student social events, and relieve the students of some current responsibilities, for example by providing admin support, and seek to balance student contributions to program needs more evenly so that a disproportionate workload is not taken on by a small number of students. 3) There needs to be a mechanism for students to report issues (minor and major), and for the department to provide feedback to the students on the resulting actions or reasons for non-action. The current reporting structure is the DGS, which some students might perceive as a conflict if there are concerns with other faculty. Appointing an ombudsperson outside of the department or a retired faculty member or ex DGS member might be helpful⁴.

3.5 Diversity, Equity, and Inclusion

The department is strongly committed to diversity, and the diversity of the graduate and undergraduate student body is a significant strength appreciated by the faculty and the students. Furthermore, the increase in the diversity of the student body is noted as an improvement from the previous report. However, despite this commitment, some students reported instances of microaggressions and inflexibility, especially in relation to the qualifying exam. Moreover, mental health concerns were very high among graduate students in general, but especially among students of underrepresented groups. As stated previously, time to degree was of particular concern amongst students of color as noted above.

Recommendations: There is a mental health crisis in graduate student education nationally and for students of color specifically⁵, that has been exacerbated by the pandemic. We recommend getting professional guidance on this and having a professional (rather than a faculty member) provide wellness and mental health information in 200A. The Plant Biology program at UC Davis has initiated a very innovative approach to mental wellness⁶ and *The Hidden Curriculum*⁷ outlines many of the issues that are common in graduate education and could be a useful framework for discussion.

⁴ National Academies of Sciences, Engineering, and Medicine 2019. *The Science of Effective Mentorship in STEMM*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25568>. Recommendation #7.

⁵ National Academies of Sciences, Engineering, and Medicine 2018. *Graduate STEM Education for the 21st Century*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25038>. Chapter three.

⁶ Dewa et al (2020) *Introducing plant biology graduate students to a culture of mental well-being* <https://doi.org/10.1002/pld3.211>

⁷ <https://press.princeton.edu/books/paperback/9780691201092/a-field-guide-to-grad-school>

Conclusions

We want to conclude by drawing attention again to the strengths of the Plant Biology program highlighted at the beginning of the report. We have not described them in greater detail, as we believe they are known and appreciated by both the BPSC department and the CNAS and UCR administration. We have tried to focus our report on the specific issues that came to light during our virtual visit, and where we felt that some clear and practical recommendations may prove useful in charting the steps ahead. We want to thank the CNAS and Graduate Division leadership, the BPSC faculty, and the PLBL students for their candor and engagement during our interviews.

Appendix 1. Completion rates and Time to Degree - UC Plant Biology program

From: <https://www.universityofcalifornia.edu/about-us/information-center/doctoral-program>

		Doctorate completion data (All discipline, 2009 - 2012 entering cohorts)			Doctoral completion rate
					Eight year rate
Overall doctoral completion rates (Eight year rate)		Berkeley	Davis	Riverside	
Headcount		33	28	48	
Completion rate		84.8%	78.6%	79.2%	
Demographic Ethnicity		Doctoral completion rates by demographic (Eight year rate)			
		Berkeley	Davis	Riverside	
African American	Headcount	1			
	Completion rate	100.0%			
Hispanic/Latino(a)	Headcount	1	4	5	
	Completion rate	100.0%	100.0%	60.0%	
Asian/Pacific Isl	Headcount	2	4	3	
	Completion rate	100.0%	50.0%	66.7%	
White	Headcount	20	15	22	
	Completion rate	80.0%	80.0%	86.4%	
Other/Unknown	Headcount	4		1	
	Completion rate	75.0%		100.0%	
International	Headcount	5	5	17	
	Completion rate	100.0%	80.0%	76.5%	

		Time to doctorate data (All discipline, 2018 - 2021 graduating cohorts)			Time to doctorate
					Elapsed time to doctorate
Median time to doctorate (Elapsed time to doctorate)		Berkeley	Davis	Riverside	
Headcount		24.00	32.00	24.00	
Time to doctorate		5.5	6.5	5.8	
Demographic Ethnicity		Median time to doctorate by demographic (Elapsed time to doctorate)			
		Berkeley	Davis	Riverside	
African American	Headcount		1.00	1.00	
	Time to doctorate		8.0	8.0	
American Indian	Headcount			1.00	
	Time to doctorate			7.0	
Asian	Headcount	5.00	4.00	1.00	
	Time to doctorate	5.0	6.8	8.0	
Domestic Unknown	Headcount	3.00	1.00	2.00	
	Time to doctorate	6.5	6.0	4.7	
Hispanic/Latino(a)	Headcount	1.00	4.00	4.00	
	Time to doctorate	6.0	5.5	7.3	
International	Headcount	3.00	8.00	3.00	
	Time to doctorate	5.0	6.0	5.0	
White	Headcount	12.00	14.00	12.00	
	Time to doctorate	5.5	6.7	5.8	