

Assessment of Botany and Plant Sciences (BPSC) Undergraduate Major, University of California, Riverside

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Review Process and summary: During our assessment of the BPSC Undergraduate Major at the University of California, Riverside we evaluated the available data provided by the department and met with some of the current students and recent graduates of the program. Our overall evaluation is that the individualized curriculum and regular advising combined with the availability of outstanding research opportunities provide a full breadth of instruction and research training in plant sciences. As such, this is an excellent program. As with all programs, we identified several avenues for improvement that could alleviate structural and other barriers limiting the growth of this program. Specifically, these revolve around communication and other social barriers that could be alleviated by the Department and by Campus to allow students to connect more quickly with the BPSC major sooner in their undergraduate career. Similarly, we noted a critical physical constraint in lab space (a converted headhouse for the greenhouse) that limits the availability of a lab course that is key to the on-time graduation of both major and non-majors alike. Finally, there was a longer-term concern that various pressures are pushing a disconnect between faculty hiring and teaching requirements that could be alleviated by better integration of these decisions. We have summarized our findings in three sections below focused on first an assessment of the program, then suggestions for program improvement achievable by the department and finally suggestions for program improvement that are achievable by the college and/or campus.

1) Quality of the BPSC Undergraduate Major

All individuals that we interviewed for this evaluation agreed that this is one of the stronger majors on campus with one of the strongest faculty cohorts. There was a general desire by all parties to expand access to this major to more undergraduates to provide them with the broad integrative and organismal training that is a hallmark of the major and is a key component for future STEM careers. Below is a description of the key noted strengths for this major.

a. Student demographics and their perspectives

The demographics of the program indicate that the student cohort is academically well prepared and maintains a high level of academic performance at UCR. In fact, the program has graduated a higher proportion of students with honors in the past three years compared to the previous years. Like for many non-professionally-oriented STEM degrees, the students who enter the program are motivated mainly by intellectual curiosity rather than prestige or high salary. Many of the students and graduates we met with realize the potential of a degree in plant biology in preparing them for graduate or professional schools. Overall student

satisfaction with the program is generally high especially with respect to access to individualized advising, small classes, and diverse research opportunities.

Remarkably, the major attracts a higher diversity of under-represented STEM communities than the average for college. As discussed below, multiple factors likely contribute to this, including the high diversity of the transfer student cohort. The program should consider existing opportunities and further enhance student diversity by increasing recruitment and retention of under-represented student groups.

b. Focused and individualized attention

A key feature of student support provided by the program is the availability of Faculty Undergraduate Advisors who meet individually with the students throughout their undergraduate career at UCR. We are not aware of many programs of equivalent size in the country that can provide such support. Direct contact with a faculty member who can advise on course work, research opportunities and career planning is likely a major reason for high student retention and general student satisfaction. The panel heard from multiple students and recent alumni that Professors Close and Jenerette helped them identify research opportunities early in their studies. In a couple of cases, transfer students were guided to find labs nearly immediately upon arriving at UCR.

Nearly all students we spoke to commented on the personal attention they received from the faculty advisors, the instructors, and the faculty in general. A general theme was how approachable everyone is both inside and outside the classroom. The small size of the upper division courses offered by the department was acknowledged many times by the students as a major “selling point” of the program, despite the difficulties with getting through the Life Science Core as expressed by nearly all students who met with us. Students commented positively on faculty instructors and TAs (very approachable), peer to peer feedback, and faculty and TA feedback on written work in lecture and lab courses.

c. Access to research opportunities

The requirement for two credits of research or internship helps to drive the majors into research and ultimately prepare them for careers and post-graduate work related to plant sciences. The individualized advising helps both the incoming freshmen and transfer students identify and engage with research opportunities. The successful Dynamic Genome course initiated and taught by Sue Wessler is a major early gateway for research engagement. However, the continuation of this course beyond the current HHMI-funded period may be in doubt as we heard that there is no clear commitment by the college to continue supporting it. A major distinguishing characteristic of the undergraduate program is student access to a breadth of research opportunities in plant sciences. Below we have identified some existing and potential barriers to students access to research opportunities. Notably, expected retirements of faculty in plant breeding and plant physiology will impact both teaching and research training opportunities in two “growth areas” of modern plant sciences. The department is internationally recognized as one of the top programs in plant sciences both in breadth and quality of research in individual sub-disciplines. The panel feels that any loss of

faculty members in short term will impact the quality of education and training offered by the department.

d. Integrative nature of the BPSC degree program

The program offers a solid breadth of courses in modern principles of plant biology and its sub-disciplines. This is line with or exceeds most comparable undergraduate programs nationally. The other components of the program including advising and research mentoring are well integrated into the degree program based on our review of student outcomes, student evaluations, and our discussions with the faculty and students. The program would benefit from better integrated career counseling that can help students identify non-academic careers in plant sciences (see below). However, it is clear to us that students graduating from the program have many career options available to them given the integrative nature of the program. This includes graduates who are competitive in the top graduate programs in the country. Our overall evaluation is that the BPSC major program checks off most of the key features that we want all majors to provide when we as academics try to market our universities to prospective students, their parents, and our state legislatures.

2) What the department can do to improve the BPSC Undergraduate Major.

We find a number of areas where the Botany and Plant Biology department could improve the major and possibly increase enrollment without significant additional resources from the College.

a. Enhance the social community among the undergraduates and build cohorts of students at all stages.

i. Social events. The department could do more to capitalize on the small size of the major to create more opportunities for student connection and networking. The annual fall social at the botanical garden attracts ca. 250-300 people and is generally successful but is a one-off event. We suggest that similar events need to be offered more frequently to have a real impact on cohesion in the program. Scheduling is always a challenge for students so relying on a single annual event to provide the necessary social “glue” is not realistic. In addition, not all students are comfortable in large groups. A thoughtfully planned set of events involving different venues, topics, and numbers of students should help with integrating students into the department. Such events could be combined with career networking opportunities as noted below, and could also include informal field trips or agricultural tours.

ii. Clubs. Students mentioned the value of clubs for letting them meet other undergrads not only in BPSC but in other departments. The clubs offer many workshops that are useful for undergraduates. The Entomology club (Six-legs) includes only a few BPSC students. Joining this or other similar activities could be encouraged by the advisors.

iii. Courses. Foundations of Plant Biology (BPSC 104) seems as though it should help integrate students into the program. However, it is offered four times and year, fills up to its maximum of 80 students, and includes many upper level students from other majors trying to add a lab course, it cannot serve this function well. Nonetheless it could help to target students and advertise other possible activities.

iv. Web site and social media. The students suggested improving the undergraduate portion of the web site. They made the very constructive suggestions to include more information on undergraduate research, consider creating an undergraduate video featuring one or more current students, and add a section highlighting what alumni of the program are doing. One student said that they didn't know what to expect from the BPSC major. We were not given information (and didn't think to ask) on how the department maintains a presence on social media. We note that any web site needs to be updated with new content continually, as does a twitter feed or Instagram site and thus requires someone dedicated to the effort. It could be an appropriate part-time position for a grad student or upper level undergrad interested in science communication if the department does not have a staff member dedicated to this area. Consistent attention to social media would also help with recruitment to the major to pull people out of the default Biology track. Students noted that many more courses were listed in the catalog than were actually offered, which created false expectations of what they could take.

v. Research. Research itself enhances the connection of the student to the department by placing them in a lab setting. The department needs to pursue ways to make this happen earlier for all students. With the exception of Sue Wessler's tremendous HHMI course, most students do not get involved in research until their junior year with the next largest number in their senior year; this seems like a missed opportunity for creating social connections. We note that the department does not have any real numbers on who does research and when. This would be useful information to have.

vi. Volunteer activities. Some of the students we met with were involved in volunteer activities such as Science Ambassadors, tutoring, and helping at the botanical garden. Making sure that all students are aware of these opportunities and that volunteers are recruited widely will provide another point of connection.

b. *Enhance the visibility of other career tracks earlier in the major, and to non-majors to maximize their knowledge of opportunities.*

The students we talked to were aiming for graduate school and were largely unaware of career options outside of academia. The Freshman Discovery Seminar is one step in the right direction, but needs to be followed by other informational events. We note that few people end up doing what they thought they would do when they were freshman; career trajectories are rarely linear. Also some students face opposition from their families if they indicate that they want to major in Plant Biology rather than attend medical school. Given this, career information has to be presented in many disparate ways at many different times so that the information is available when the students are ready to hear and act on it.

The Career Center currently serves very few BPSC students; in their list of events over the last year or two, with one or two exceptions each event only attracted one BPSC student. It is unclear what is causing the disconnect between the Career Center and students but it does mean that the department is getting little help from them.

Opportunities for enhancing career development could include:

i. Exposure to other careers could be accomplished by including networking opportunities or integrating short presentations by people from other careers into other social activities. Since everyone has become much more adept at on-line gatherings over the last year, this may open an opportunity to offer such events as zoom meetings or

webinars followed by a social event. BPSC would need to deputize someone to line up career events throughout the year at different venues and different times. These could be the some of the same events as noted in 2a above.

- ii. BPSC students have strong connections to faculty because of the emphasis on research. This suggests that the department could do more to be sure that the faculty are aware of career possibilities for their students. The department might also offer informational activities for students in particular groups of labs.
- iii. Involve former students in career development information. This could be done on-line, minimizing the amount of time required from both former and current students. Former students could identify particular courses as having been particularly helpful for their careers.

c. *Further enhance the already strong connections with local community colleges to recruit transfer students from under-served diverse communities.*

We met with several transfer students who indicated that the transfer process was generally smooth and the advising that they received at UCR was helpful and appropriate. This group of students appears to be more culturally and ethnically diverse than that non-transfer group. BPSC includes a higher proportion of Latinx and Black students than the College as a whole. This may reflect the ability to attract and retain transfer students as well as the small size of the department that permits more individual attention. We heard several times over the four days about the quality of the undergraduate advising and this undoubtedly helps particularly with the transfer students. (We also noted among the faculty responses in the self-study that a number seemed to have no idea how undergraduate advising works or who does it. This is an obvious area for improved communication.)

All the suggestions under points 2a and 2b would apply to transfer students. The transfer students themselves could be identified as a cohort with a unique set of needs and interests that sets them apart from continuing UCR students.

3) What the campus can do to improve the BPSC Undergraduate Major.

All parties that the committee met with voiced a desire to increase the impact of the BPSC undergraduate major. Our discussions identified some recurrent impediments that constrained this effort and which were largely outside Department's ability to control or influence and instead fall within the purview of the Campus and/or the College. The three recurring themes of what the Campus and/or the College could facilitate to improve the BPSC major are discussed below.

a. *Remove physical structural barriers on gateway courses, in particular BPSC104.*

A major benefit and selling point of the BPSC undergraduate major is the availability and requirement of direct research experience being provided to the students. In discussions with the Department, it was noted that they could relatively easily make this experience available to two to three times the number of current students and thus increase the size of the major. However, discussions with the students in the major and the faculty indicated that a major constraint on increasing the number of students is the availability of core gateway courses leading to entry into the major. Particularly noted was the physical limitation on the BPSC104 gateway lab course. Specifically, the lab portion of this gateway course occurs

within a lab space carved out of an older greenhouse and is physically constrained to a small number of students and limits enrollments. There are no other teaching facilities on campus that can accommodate this lab.

The department has tried to alleviate this bottleneck by greatly expanding the offerings of the course, running the course every term including summers. While this has increased overall enrollment, it has not alleviated the bottleneck because the course also fulfills the upper division lab course requirement for other majors. As such, the course is largely filled with seniors from other majors who per the registrar's system have priority enrollment in the course over juniors/sophomores within the major who require the course to begin the focused curricula for the BPSC major.

Since this course serves a vital role to two student populations, it seems readily apparent that providing a new larger physical space for the lab section of the course would alleviate the enrollment issues that are preventing students within the BPSC major from readily taking it and beginning their focused curricula. Further, new space would enhance the department's ability to alleviate constraints on other majors' access to upper division lab courses; optimally, relieving such constraints would include allowing juniors interested in transferring to the BPSC major to take this course to allow them to decide quickly if they are indeed interested in transferring. In combination, this could boost the majors' ability to get through the degree in time, maximize the program's ability to recruit younger students and enhance the availability to non-majors. Without a change in facilities the program appears to be physical constrained in the ability to grow while maintaining time to degree.

b. Remove sociological/psychological barriers that limit the movement of undergraduate students between majors.

Another noted constraint on the BPSC majors' enrollment was a set of non-physical barriers that constrained the students' investigation of alternative majors. A large body of students enter any University into default biology majors for a number of reasons ranging from a focus on pre-medical or veterinary tracks to simply knowing they are interested in biology but not understanding the options and specific foci available to them. Discussions with the students and advising groups identified a limitations on both the ability of students to identify other majors more linked to their interest and also the ability to transfer once identified. These limitations are likely also constraining enrollment in other focused under-utilized majors within the College and solutions could aid the distribution of enrollment in majors. College-wide efforts to encourage students to shift to under-utilized majors will help with general student enthusiasm for their experience and help to maximize the use of limited campus facilities and faculty.

i. There has been an effort to provide Freshman seminars to students as a solution to provide exposure to alternative paths, but in discussions, these seminars seem to have two limitations that hinder their ability to achieve this goal. The first is that students seem to be taking them not out of interest but out of a focus on getting credits. Secondly, the students noted that as Freshman they are just getting used to college and how life works and don't have the full capacity to even contemplate alternative majors.

One solution to this problem might be to shift the Freshman focused course to early Sophomores and to empower the academic advisors to work to direct students into seminars where they may actually have an interest in exploring that topic as an alternative major. Alternatively, it might be possible to encourage and provide the necessary resources to the academic advisors to enable them to redirect students to majors in which they might have more interest and to do this very early. Any attempt to create active efforts to encourage students who are in large majors by default to explore and contemplate alternative majors during their Sophomore year would help to expand these majors at minimal cost to the large majors and provide a ready avenue to more evenly distribute teaching efforts.

ii. A second constraint on students' ability to identify and transfer to majors that better align with their interests was the intensity of the core biology requirements. Students and faculty noted that the need to complete these requirements before taking specialized courses meant that students don't begin their core major requirements until their Junior year. This means that the students have one or maybe two quarters at the start of their Junior year in which to contemplate shifting majors. By the time they have expended time meeting the requirements of their major for two Junior quarters, they are locked into the existing major unless they are willing to delay their graduation significantly. Students noted that the combination of core course timing and advising did not alert them to this possibility until the middle of their Junior year by which time they were constrained to their "default" major by time to degree issues.

This suggests that there is a need to re-evaluate the series and timing of required courses for undergraduate majors to enable the students to have more space in their academic career to explore other majors with minimal penalty in time-to-degree. This likely involves a combination of possibly shrinking the required credits from some of the longer series of specific topics like Chemistry, Physics, etc. Of equal importance though is devising a way of enabling exploratory courses, like a rigorous Plant Biology or Entomology course, to be taken during the student's sophomore year while being applicable to a wide range of majors. This would enable exploration without penalizing time-to-degree.

c. Improve connection of hiring to the department's academic plans

A key component of the BPSC major is teaching the full breadth of biology from ecology to evolution to cellular mechanism to quantitative topics, all in the guise of the organism. Undergrads trained in this way are in high demand by both academia and industry as they are key components to any team that is working to develop collaborative and integrative research across disciplines. These students provide the key glue connecting to make group efforts maximally efficient. However, we heard a significant amount of input on the recent history of allocation of faculty positions to departments over the past couple of years and how these are beginning to limit the ability to teach the breadth of topics required to provide this integrative major. This arises from the interaction of a period of cluster hires that were largely disconnected from the teaching component of any academic plan followed by the recent period of COVID-19 budget constraints limiting new hires. Specifically, within the BPSC

major and department there were noted upcoming limitations in faculty positions within plant breeding and plant physiology that will start to limit the teaching of the upper division programs. Two efforts could help alleviate these constraints once new positions are budgetarily feasible.

- i. Returning the connection of departmental hiring to the departments academic plan will help to greatly facilitate this effort. This will help to provide an immediate connection between hiring and teaching assuming it is utilized as such.

- ii. There is always the desire to communicate with alumni, donors and other supporters that the campus is hiring the newest and brightest especially with linkages to the topics considered at the forefront of science. In the discussions, it was noticed that there was a disconnect in the naming of the department's faculty limitations with what might be considered a critical new research topic. For example, we were asked how the seemingly "old" terms of Plant Breeding and Plant Physiology possibly be connected to the new hot topics of machine learning, artificial intelligence, high throughput phenotyping, predictive genomics, computer vision, etc. This seemed to highlight a communication disconnect where the connection between these old/new topics are implicit and readily understood within the department and less understood outside the department. Within the field of Plant Breeding are some of the world experts on a large number of these topics like predictive genomics, machine learning and artificial intelligence and its application to genetics in any organism. Similarly, within the field of Plant Physiology are some of the world experts on high throughput phenotyping and the application of computer vision to biological problems. Communication between the college and department seems to need improvement to make clearer the connections between how new faculty hires can simultaneously fill the department's academic plan and the college's and university's research goals.