

Biology educators, professional societies, and practitioner networks within community colleges

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Abstract

Community college biology faculty play an important role in educating the future STEM workforce. These faculty rely on professional organizations to provide programming and networking opportunities to enhance their professional development.

Community college (CC) biology courses/programs, students, and faculty inhabit a unique position within the United States higher education system. CC faculty often face barriers to pursue professional development (PD) opportunities or those opportunities for biology education research (BER) because of their part-time status, teaching loads, and funding (Caffarella & Zinn, 1999; Murray, 2002; Ouellett, 2010). In addition, with the advent of a global coronavirus pandemic, the landscape of biology professional development has changed drastically in 2020. National PD in the life sciences reflects the complex nature of the field; participating faculty members have positive influences on their teaching and leadership opportunities through networking, sharing of ideas, and interdisciplinary

connections. Leadership positions in the disciplinary organizations (often long-term assignments) offer opportunities for faculty to champion CC's role in life science education, as well as to shape national standards, outcomes, and content of biology courses and programs. We address the capacity of selected national organizations and working groups to rise to current and future challenges.

BIOLOGY AT COMMUNITY COLLEGES

Based on a 2018 survey, 41% of nationwide undergraduates are from CCs, and it is important to note a significant proportion of underrepresented minorities in the undergraduate STEM degree programs start their higher education at a community college (American Association of Community Colleges, 2020). Draws to community college for biology include smaller student-to-faculty ratios at CC, lectures AND laboratories taught by full-time faculty (teaching assistants are rare), widespread student support mechanisms, and student-centered institutions. For these reasons, community colleges in the United States have a broader and significant impact on minority, low-income, first generation, and underrepresented students. However, inequities in resources at the CC level and structural barriers in transfer are some of the major losses of students from the STEM pipeline (Kadlec & Ganga, 2016).

Biology as a discipline at the CC level includes general education and majors-specific courses, and these two tracks often have different prerequisites and outcomes. There are generally lab and nonlab options, depending on the general education requirements of the college or system. At many smaller campuses, biology courses are offered as mixed majors and nonmajors, increasing the complexity of designing and teaching the courses. CC biology courses are unique in that they are heavily influenced by articulation agreements with local and regional four-year colleges and universities and because they serve a range of populations with different motivations for taking courses and different end goals.

Outcomes and competencies of biology courses at the CC are generally fit to match those of the most popular four-year transfer institutions. It is difficult to offer specialty courses at community college due to transfer restrictions. One majors-level course will often serve a wide range of students in STEM. For example, students in nursing, animal science, biology, ecology, biotechnology, and so forth will all take the same microbiology course. Serving this diverse population poses logistical challenges in course design and deployment, advising, and prerequisites.

Before addressing these efforts, however, it is important to note the innumerable challenges for full-time (FT) faculty in CC teaching and PD across the board in a "normal" semester. Most FT teachers, while having smaller class sizes, have high teaching loads, which is quite different than most life-science faculty at four-year institutions. Five-to-six courses a semester or quarter is often the contractual requirement, leaving little time to pursue PD opportunities or discipline-based education research (DBER), much less scientific research. Part-time faculty face the same classroom dynamics but their lack of time for PD opportunities are because they are either working full-time elsewhere or have cobbled together full-time equivalent schedules (for far less than FT pay) from several institutions per semester with all of the travel that entails (see Flaherty, 2020). In addition, while many courses are taught by part-time (PT) faculty, FT faculty serve as course coordinators and oversee the courses taught by adjuncts. PD funds are small-to-nonexistent at most institutions, requiring FT/PT faculty to pay out of pocket to attend conferences or webinars. Biology department budgets are typically restricted to necessary laboratory expenses, requiring a great deal of innovation on the part of FT faculty to run course-based undergraduate research (CUREs) or similar inquiry-based models of learning.

There are a number of different opportunities for CC biology faculty to expand pedagogical knowledge and develop subject-specific practices. These include different national PD organizations, a variety of formal networks, grant-funded special projects, and informal grassroots collaborative efforts. By probing these varied opportunities to see where CC PD in biology is exemplary and innovative, best practices and future areas for growth can be identified for other organizations to become more inclusive of CC life science teaching and learning. In addition, as teaching is central to the mission of CCs, and funding and time for PD is in such short supply, more attention to the logistical hurdles for both CC faculty and institutions may help increase membership, workshop participation, and convention attendance for these same organizations.

NATIONAL PROFESSIONAL DEVELOPMENT ORGANIZATIONS

From the array of sizes and specialties of national biology PD organizations, there are a few large organizations able to address many needs of diverse CC biology educators. Many smaller organizations tend to specialize in specific subdisciplines of biology. The largest organizations also have regional affiliates and conferences separate from their annual national conference. Academic journals, websites, and social media are forms of outreach used by these national PD organizations. A concern is that these resources are less known to PT faculty and isolated faculty at small CCs.

In general, some national PD organizations for biology education address the unique challenges faced by CC educators, yet not all include CC faculty. As noted, student and faculty needs, resources, and approaches at CCs vary greatly from those at traditional four-year institutions and differential programming is often required. Depending on their mission, vision, and prior methods of outreach and professional development, some of these national organizations are more flexible and adaptable than others. Some recognize the limitations of CC faculty time and funding and offer conference scholarships and reduced membership rates. Online conferences and webinars may offer many more opportunities for CC educators to obtain quality, discipline-specific PD. However it has become clear in the time of the coronavirus pandemic, that those organizations that did not have sufficient groundwork laid with past technology norms and webinar offerings have found the transition to online professional development much more of a challenge. By looking at a selection of the larger PD organizations for biology teaching and learning, it is clear that some incorporate CC faculty into their biology education research (BER) and PD offerings.

The National Association of Biology Teachers

The National Association of Biology Teachers (NABT) is the leader in life science education and has been serving life science educators since 1938 (About NABT, 2020; see www.nabt.org). The group includes approximately 3000 dues-paying members and over 10,000 Facebook members. The membership of NABT is almost evenly split between secondary and higher education educators, with about 30% of the higher education educators comprising CC faculty. While the CC faculty are not a majority, they are a very engaged group of educators. In 1980, they organized a two-year college committee, and in 1984 they formalized the committee into the first NABT section. Years later, following their lead, the four-year and AP Biology sections were added. This dedicated Two-Year College Section has its own elected governance, is responsible for developing guidelines for biology education at two-year colleges, and celebrates the teaching accomplishments and innovations

of CC educators. Leadership includes overseeing the NABT awards for two-year educators like the Two-year College Biology Teaching Award and the Professor Chan Two-Year College Award for the Engaged Teaching of Biology.

For interested faculty, NABT provides a pathway to national leadership in biology education. The NABT Board always contains CC faculty representatives. Every three years the President of the organization is a CC faculty member elected by the membership. In addition, CC faculty have served as program directors and regional coordinators. CC faculty also have the opportunity to present their best practices and innovative activities at the National Conference and publish them in the NABT journal, *The American Biology Teacher* (ABT). The ABT offers practical lessons and pedagogical perspectives from an array of practitioners. About 10% of the articles published in ABT are written by CC faculty.

During the annual national conference, numerous strands address the faculty needs within two-year biology education and 7% of the workshops and 23% of the posters are presented by CC faculty. They present on issues unique to CCs such as teaching biology to a multigenerational class and addressing articulation issues with competencies rather than concepts as well as share their best practices with other CC as well as secondary and four-year biology educators. In fall 2020, the conference was conducted online with fewer sessions than have been traditionally offered. Webinars, a new undertaking for NABT, help expand the reach of the association.

As part of a larger society of biology educators, NABT amplifies the voice of all introductory biology teachers by being vocal supporters of science education, literacy, and research. They also publish position statements on issues that society may see as controversial, like dissection and evolution, that biology educators can use to support their teaching when confronted by administrators or legislators. These position statements are written by and approved by the board, which includes at least one CC faculty member.

The American Society of Microbiology

The American Society of Microbiology (ASM) provides professional development and community through ASMCUE (American Society for Microbiology Conference for Undergraduate Educators), its annual national conference, and additional workshops throughout the year (About ASM, 2020; see www.asm.org). Since 2015, 16% of attendees at ASMCUE are from a CC. In addition, ASM helped to sponsor two Concept Inventories designed for assessment, a majors and nonmajors instrument. The nonmajors instrument development was led by CC faculty and included input from a team made up of over 50% CC faculty. ASM publishes the *Journal of Microbiology and Biology Education* (JMBE), which has multiple entry points for authors and is full of teaching resources. Editorial board membership has included CC faculty and, in comparison with other biology education journals, JMBE has published a larger percentage of manuscripts from CC faculty. The summer 2020 ASMCUE conference was conducted remotely with synchronous webinars also recorded for later viewing. This format and reduced cost structure allowed a much larger population of faculty including CC faculty to attend. ASM also provides a unique opportunity for CC faculty in the form of the ASM-IUSSTF Indo-US Teaching Professorship in Microbiology. This competitive program provides support for faculty to spend two weeks teaching in India and is open to actively engaged microbiology teaching faculty. Since there is no research or doctoral degree requirement, it provides one of the few professorship opportunities available to CC biology faculty who often have a master's degree and are not actively involved in research.

The Ecological Society of America and the Life Discovery Conference

The Ecological Society of America (ESA) is another very large professional society that offers one large national and several smaller conferences per year featuring the latest primary and applied research in ecology: www.esa.org (About ESA, 2020). The main annual ESA conference does have a strand intended for higher-education teaching faculty, including community college educators, but it is a very small portion of the overall conference.

A more explicit conference on ecological/environmental biology education is the Life Discovery Conference (About LDC, 2020; see <https://www.esa.org/ldc/>). This is a small, but growing, conference that welcomes CC educators and facilitates communication between various levels of ecology/environmental biology education. The conference began in 2014, and prior conferences encouraged teaching faculty to share their best practices and success stories from the classroom, encouraging educators to share directly with one another what has worked well in courses that are not often funded well or given as much administrative support. The 2020 conference was moved to a virtual format allowing more educators the opportunity to attend. Many sessions are moving away from a traditional one speaker/webinar per time slot format to one of panel discussions, which provides more opportunities for participation.

American College and University Biology Educators

American College and University Biology Educators (ACUBE) has an annual conference and a journal (About ACUBE, 2020; see www.acube.org). This conference is smaller as compared to others referenced earlier (200-300 participants per year), and does have some CC faculty that attend. The conference is primarily focused on active learning approaches to biology laboratories and lecture classrooms. Their fall 2020 conference was held online, ideally making the conference more accessible to CC faculty.

Professional development opportunities for broader audiences in STEM such as the annual American Association for the Advancement of Science conference and the Undergraduate Biology Education Gordon Research Conference are less familiar to CC biology faculty and less attentive to CC faculty PD needs. Registration costs are often a barrier and programming does not include presentations applicable to teaching in the CC context. One way to change groups like these is to attend and apply to positions that have input on things like the costs, grants, and programming. Many authors of this chapter have recently attended, given feedback, and volunteered for elected leadership positions to raise the voices of CC colleagues in national PD events such as these.

INITIATIVES IN BIOLOGY EDUCATION FOR COMMUNITY COLLEGES

Partnership for Undergraduate Life Science Education (PULSE) is a nonprofit organization that includes a network of Fellows and Ambassadors who provide academic departments with resources and training that promote alignment of undergraduate life sciences programs with best educational practices, including those recommended in the Vision & Change Report: www.pulse-community.org (About PULSE, 2020; Vision & Change Final Report, 2011). The organization was formed in 2012 and transitioned to a tax-exempt nonprofit in 2016.

PULSE has been intentional about including CC faculty as fellows, originally 25% of PULSE fellows were from a CC, today that number is lower at 10%; however, PULSE has

been actively recruiting CC faculty. All three of PULSEs programs have included CC life science departments. Community colleges make up approximately 21% of institutions that have worked with PULSE. PULSE functions to provide departments with tools and experiences that guide them through a process of organizational and institutional change with the goal of incorporating the evidence-based teaching and learning practices and strategies outlined in the Vision and Change report. The organization does not provide direct PD to educators but rather supports departments in the process of identifying their needs and in developing plans for systemic change. Their theory of change, which is the foundation of their work, can be applied outside of the Vision and Change framework. This should place them in a good position to help higher education life science departments adapt to the changing landscape.

Workforce development

Workforce development is an area of biology education also affiliated with several different professional organizations and initiatives, including within the Advanced Technological Education (ATE) community. Presently there are at least 22 funded National Science Foundation (NSF) projects in Biology education that were partially or completely funded by the NSF ATE program. An example of one project is the InnovATEBio Center (NSF DUE 1901984) funded by an NSF-ATE grant for five years; it includes in its outcomes for biotechnology education the following three areas of PD: pedagogy on student-centered classrooms and competency-centered programs to ready students for the workplace or transfer; leadership training to prepare faculty to take on educational challenges including management roles, grant writing, and educational research; and opportunities around emerging biotechnologies such as CRISPR, immunobiology, vaccine development, synthetic biology, and regulatory affairs (www.innovatebio.org, 2020). The Leadership Academy is to be held every two years and is led by leaders in the biotechnology industry. During the pandemic, the Center has hosted weekly webinars for CC faculty that include networking, information on biotechnology relevant to the novel coronavirus as resources for the classroom, and other topics such as algae biotechnology (see <https://innovatebio.org/event/webinar-13-algal-biotechnology-education-and-training-atecs-support-for-the-post-covid-19>). Over 100 teachers attended these 13 webinars. The trend within the ATE Centers is to merge best practices in workforce education with those in academic education; the pandemic is accelerating this trend.

Quantitative biology professional development and biology education research

Research in life sciences has become increasingly quantitative as large data sets generated by high-throughput technologies, long-term and large-scale data collection, and increased computational power can be used to tackle more complex biological problems. These developments have made quantitative skills as one of the critical core competencies for career success in biology and thus have an important place in all bioscience curricula (BIO2010, 2002; Patton, 2008; Scientific Foundations for Future Physicians, 2009). Yet, most courses taught in all types of higher education institutions provide minimal opportunities for students to acquire and/or develop the quantitative skills essential for their success in biological science careers. This trend may at least partly be due to the current general practice of teaching biology and mathematics as isolated, independent knowledge domains.

This practice creates a limitation among students and faculty to identify and understand the intersection between mathematical and biological concepts and is a major challenge to seamlessly integrate quantitative skills into the pedagogical approaches in biology courses (Usher et al., 2010). A recent survey of 20 biology faculty from community colleges across the United States identified the constraints and affordances of the faculty in teaching quantitative skills in biology curriculum (Corwin et al., 2019). The surveyed faculty acknowledged a lack of pedagogical content knowledge to teach quantitative skills as part of biology course content and the lack of PD opportunities to get the training, among other factors. Cost and travel time away from the classroom were additionally cited as barriers to further participation in PD.

The online Quantitative Undergraduate Biology Education and Synthesis (QUBES) Project Hub (About QUBES, 2020; see www.qubeshub.org) provides a commonly used portal, in addition to social media, for STEM PD to occur. This National Science Foundation (NSF) funded project was “launched in 2014 to address challenges in quantitative biology education and now provides logistical, intellectual, and community support for innovative quantitative biology education projects and the extended community of instructors seeking resources” (About QUBES, 2020; Donovan et al., 2015). Numerous PD opportunities are then funded by QUBES or by other entities that use QUBES as their communication portal. These include professional learning communities (PLCs)/faculty mentoring networks (FMNs), project repositories, development and sharing of Open Educational Resources specific to quantitative biology, and workshops/meetings.

The QUBES Project created a new model for PD called faculty mentoring networks (FMNs), which are free and delivered in flexible formats. FMNs are designed to engage faculty in defining and addressing a curricular issue in the faculty members’ classes by customizing and implementing existing resources. Of the 703 participants, approximately 13.7% are from CCs, and 16.4% of the mentors are CC based.

Some of the QUBES projects can serve as models for other disciplines interested in building networks of educators working on discipline-specific or interdisciplinary projects and curricula:

- Community College Biology Instructor Network Supporting Inquiry into Teaching and Education Scholarship (CC BioINSITES or CC Bio), hosted on QUBES, is a PLC composed of CC and four-year college (4YC) faculty and staff. CC Bio promotes collaboration between CCs and 4YCs and focuses support on research specifically involving community college populations. This NSF-funded project emerged from a meeting of community college leaders and biology education researchers who discovered that discipline based education literature mostly excluded community college populations with a mere ~3% including CC faculty researchers or students. Roughly ~97% of the literature focused exclusively on 4YC populations (Schinske et al., 2017). This imbalance in the literature was despite approximately half of all bachelor’s degree recipients in STEM having attended a CC during their academic career (National Student Clearinghouse Research Center, 2017, NSF NCSES, 2010). The absence of CC data represents a giant gap in the literature, and CC Bio was formed starting with 65 members (now over 160 members) to help fulfill that gap.
- The Society for the Advancement of Biology Education Research (SABER) focuses on developing theory and generating evidence with the goal of improving postsecondary biology education (Offerdahl et al., 2011). More CC faculty are being trained and supported in conducting biology education research (see CC BioINSITES above) and presenting at SABER conferences. SABER was started in 2010 by a small group of faculty, journal editors, textbook writers and editors, graduate students, and postdoc fellows who

wanted to accomplish the development of something that supported and promoted the BER community (Offerdahlet. al., 2011). SABER continues to promote CC involvement by maintaining a Community College and Biology Education Research special interest group that is closely tied to CC BioINSITES and promoting collaboration and interaction between the two groups. CC researchers are further encouraged to submit abstracts and attend either SABER conference (SABER or SABER West) in order to ensure more CC BER are included in programming (Diversity and Inclusion Council Committee Member email communication, 2020).

- BioQUEST Curriculum Consortium has been offering PD for biology faculty from across the country for almost 35 years, built around a commitment to learning science by engaging in scientific practices captured in the 3Ps of Problem posting, Problem solving, and Peer persuasion (Peterson & Jungck, 1988). BioQUEST programming currently focuses on quantitative skills, including data science literacy, and Universal Design for Learning. Much of the programming for quantitative skills is in conjunction with the NSF-funded Quantitative Undergraduate Biology and Education and Synthesis (QUBES) project, including the annual summer workshop and Faculty Mentoring Networks (FMNs). Additionally, QUBES provides a cyberinfrastructure for project hosting, faculty collaboration, Open Education Practices, and the adoption of modern biological research tools for teaching and learning.
- Quantitative Biology at Community Colleges (About QB@CC, 2020) is a five-year (2019–2024) initiative, funded by the National Science Foundation's Research Coordination Network (qubeshub.org/community/groups/qbcc). This grant emerged as part of a working group that was supported by the National Institute for Mathematical and Biological Synthesis (NIMBioS) focused on quantitative biology at community colleges (http://www.nimbios.org/workinggroups/WG_quantbio-cc). The QB@CC leadership team includes an eight-member steering committee represented by community college faculty teaching biology and math and a six-member advisory board represented by faculty and administrators from different types of institutions. QB@CC network is distinctive in that it promotes team-building between math and biology faculty from Community Colleges across the United States. These teams have been and will collaboratively develop teaching modules that integrate quantitative components within the biology content.

PROFESSIONAL DEVELOPMENT AND BIOLOGY EDUCATION IN THE TIME OF COVID

As with the rest of the world, community college (CC) biology faculty and students in the United States began a massive educational experiment in the spring of 2020 upon the spread of the novel coronavirus. With the rapid transition to emergency remote teaching, faculty leaned on all the pedagogical and technology tools in their toolbox to retain and educate students through a difficult three months at the end of the academic year. Because of the unique student population at CCs, faculty were fielding questions from students beyond the scope of the classroom: students asking for resources for sick family and friends, students who lost jobs and income or were forced to work longer hours, incompletes or extensions from students who lost all childcare, and moral support for students taking exclusively remote classes who would not have otherwise signed up for any online learning. During this time, some biology education PD organizations rose to the challenge, hosting online discussions and resource sharing for educators across the country and sometimes the globe. Others took time to gain their foothold in this new

landscape or are maintaining their standard PD offerings until education resumes a semblance of “normalcy.”

The novel coronavirus only made meeting the needs of these diverse populations even more challenging and highlighted the resource inequities for CC students across the country. Contrary to some of the harsh criticisms in the media regarding the end of spring wholesale performance of education, it is important to note that what happened was not a reflection of traditional online teaching. This shift was emergency remote teaching in a time of crisis and, by and large, CC faculty did their very best to serve students in a time of crisis.

Beyond the confines of a PD biology education organization, FMN, or PLC, during the beginning phases of the pandemic, faculty began turning in masses to online message boards, list-servs, and shared drives to exchange ideas and resources in a very informal way. Many of these were done through various professional development societies' Facebook pages, Twitter hashtags, and other social media venues as they are known to reach the most people in the shortest amount of time.

This large-scale, grassroots organizing on the part of biology educators from K-16, working in solidarity for all students with the resources available to them, was a unique occurrence in education history. In one instance, a collection of resources on active learning was compiled into a shared Google Doc, and then eventually a Google Sheet “Online Resources for Science Laboratories (POD) - Remote Teaching,” for all to use, initially drawn from posts on the NABT Facebook page (which eventually grew from a few thousand to 10,000 followers) (Unknown, 2020). Similar resource collaboration was happening within other disciplines and between disciplines, revealing the power of networking and crowdsourcing knowledge. Many of those using the social media of PD organization's online space met and become trusted colleagues, leading it to be a more professional, vetted, and trustworthy network.

It is important to note that CC biology educators are early adopters of online and hybrid coursework as compared to their four-year college and university colleagues and quickly become comfortable in online spaces (Hussar et al., 2020). Many CC biology faculty have online components to their lecture courses and use the flipped classroom model, even if they do not teach exclusively online. These models emerged due to the need for flexible, asynchronous coursework to meet the requirements of CC students. This comfort with online spaces is not universal, however. Some within the postsecondary and biology education communities still express reservations about online learning and have been resistant to putting forth online offerings (Straumsheim, 2015). This, of course, has made the conversion to online teaching that much more of a challenge for late adopters during the current pandemic (Legon & Garrett, 2020).

One area of common ground for most, however, is the avoidance of online laboratories. These sections have not been the norm as faculty around the country recognize students require hands-on learning to master the skills needed in their future careers. Several professional organizations have formal statements about the need for on-ground lab sections with maximum numbers of students and sufficient lab support, including from NABT (National Association of Biology Teachers, 2019).

However, in the time of the novel coronavirus, virtual labs are now a necessity in many regions. PD organizations are helping to facilitate best practices and identify resources that best simulate the lab experience for students at all levels. This includes the Summer Institutes on Science Teaching, which postponed its in-person regional institutes and recrafted it into a weekly webinar and Friday afternoon online social hour to discuss and exchange ideas on all areas of science teaching and learning in 2020 (Yale Poorvu Center for Teaching and Learning & Howard Hughes Medical Institute, 2020). The organizers also

developed a shareable Google Doc with resources to move biology courses online, began a Slack workspace for conversations and idea sharing, and critical discussions and literature on three pillars of this summer's workshops: inclusivity, active learning, and assessments. This type of flexibility is what many PD organizations will need to strive for to stay relevant and viable throughout and after a pandemic landscape.

Even though the future is wildly uncertain for both professional biology education organizations and CC, past economic crises can inform what CCs education may look like in the next 2–10 years. It is predicted that the number of students who take courses at community colleges will increase over the next two to five years in response to social conditions, health concerns, and recession. For example, Connecticut, which has one of the largest wealth and education gaps in the country, enrollment within the twelve community colleges has increased by upwards of 30% from this time last year at some institutions, and the recent declines in most other states have been within historical trends (American Association of Community Colleges, 2019; Massaro, 2020). Prior to the pandemic, nearly half of all college students in the country complete one or more of their degree requirements at a community college.

CONCLUSIONS

Several national PD organizations for the life sciences, and a number of formal networks, explicitly invite community college (CC) educators into leadership, advisor, and mentoring position. More can be done to encourage participation by both FT and PT staff through virtual convenings, scholarships/reduced rates, and opportunities scheduled during holiday and summer breaks. We encourage all FT and PT faculty in the life sciences to engage with one of the organizations previously mentioned to learn from experts, colleagues, and researchers in the field of biology teaching and learning. Biology education research (BER) and quantitative biology education is becoming more widespread nationally. However, BER requires many more resources to fully benefit both students and faculty. More funding is needed for BER, and faculty should be allowed release time to conduct BER, especially at CC where FT faculty teaching loads are high.

The innovative programs, centers, and initiatives in biology and workforce education that are taking place at CCs around the country need to be recognized and promoted with the same level of effort as those occurring at 4-year universities. More students overall, and many four-year students, take their introductory and foundational life science coursework at CC and this number is likely to increase moving forward. More effort by CC institutions, systems, and higher education in general is needed to recognize the rigor and innovation within biology at CC.

Diversity, equity, and inclusion initiatives in curriculum, instructional approaches, and student supports are being undertaken at many CC biology departments. Individual faculty or departments will not be able to change systemic inequities without systemic change at much higher levels of education. These changes will require similar efforts at the governmental, societal, and institutional levels, including admissions and advising, as well as transfer institutions. Biology faculty are recognizing the important work to be done as part of their role within the larger, inequitable system, and many are doing the work to change, using national professional development organizations as guides.

Ideally, we would like to predict that in ten years, science education will be more inclusive, more diverse, and more effective at retaining and graduating students. Currently only 18% of all students in higher education earn STEM degrees, and the percentage of black and Hispanic students earning STEM degrees is even lower, 13% and 15% respectively

(National Center for Education Statistics, 2019). As well, a STEM brain drain due to current immigration, visa, and travel policies, and now the novel coronavirus, in the United States challenges building a STEM educated workforce (Zong & Batalova, 2018). Given that 35% of Black undergraduates and 44% of Hispanic undergraduates enroll in community colleges, the important role that CCs play in recruiting more of these students into STEM fields needs to be recognized. (Community College Research Center, 2020). Current data has yet to be gathered on LGBT+, disabled, nontraditional and other measures of inclusivity for the STEM pipeline. Yet, institutions and departments will need to address systemic racism, issues of equity and inclusion, identify areas to improve accessibility, and develop mentoring programs to increase the chances of student success in STEM programs and careers.

Finally, in the age of the coronavirus pandemic, CCs are poised to be relatively nimble with the changing needs in the higher education landscape. Typically, CCs are more flexible with teaching methodology, technology, and programming than their four-year counterparts. However, funding is currently of great concern for many biology departments around the country as institutions are tied to tax bases. As students struggle economically, so will CCs across the country, just as demand for services begins to grow again. Professional development for both FT and PT faculty will be central for CCs to remain strong through this current crisis and those in the future. As go CCs, so go their communities. Given the number of the nation's undergraduates that attend CCs, and the long-standing leaky STEM pipeline, institutions and organizations must prioritize equity and inclusion initiatives, invest time and funding in CC BER, support practitioner communities, identify areas of interdisciplinary work, strengthen holistic workforce development, and recognize faculty leaders.

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