CONFERECE | Institute on Teaching and Learning

The pipeline of physiology courses in community colleges: to university, medical school, and beyond

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Submitted 6 September 2016; accepted in final form 6 September 2016

McFarland J, Pape-Lindstrom P. The pipeline of physiology courses in community colleges: to university, medical school, and beyond. Adv Physiol Educ 40: 473–476, 2016; doi:10.1152/advan.00141.2016.—Community colleges are significant in the landscape of undergraduate STEM (science technology, engineering, and mathematics) education (9), including biology, premedical, and other preprofessional education. Thirty percent of first-year medical school students in 2012 attended a community college. Students attend at different times in high school, their first 2 yr of college, and postbaccalaureate. The community college pathway is particularly important for traditionally underrepresented groups. Premedical students who first attend community college are more likely to practice in underserved communities (2). For many students, community colleges have significant advantages over 4-yr institutions. Pragmatically, they are local, affordable, and flexible, which accommodates students’ work and family commitments. Academically, community colleges offer teaching faculty, smaller class sizes, and accessible learning support systems. Community colleges are fertile ground for universities and medical schools to recruit diverse students and support faculty. Community college students and faculty face several challenges (6, 8). There are limited interactions between 2- and 4-yr institutions, and the ease of transfer processes varies. In addition, faculty study and work to improve the physiology education experience often encounter obstacles. Here, we describe barriers and detail existing resources and opportunities useful in navigating challenges. We invite physiology educators from 2- and 4-yr institutions to engage in sharing resources and facilitating physiology education improvement across institutions. Given the need for STEM majors and health care professionals, 4-yr colleges and universities will continue to benefit from students who take introductory biology, physiology, and anatomy and physiology courses at community colleges.

community college; education research; physiology education; medical school

RECENT NATIONAL EFFORTS HAVE RECOGNIZED the importance of community colleges in STEM (science technology, engineering, and mathematics) education as community college faculty and students have been welcomed to national conversations and have been included in funding opportunities regarding STEM education reform. Community colleges offer educational resources to diverse, economically challenged, and place-bound students, and community college faculty are increasingly involved in reform efforts. These efforts include participation in the Vision and Change (http://visionandchange.org/) process and invitations to serve as fellows in the Partnership for Undergraduate Life Science Education (PULSE); six of the 40 original PULSE fellows are from community colleges. Indeed, the construction and validation of the PULSE rubrics (http://www.pulsecommunity.org/page/recognition) intentionally included the community college context, and community college faculty were instrumental in the effort to ensure that these rubrics were measured equitably across institution types (3). Additionally, the first Gordon Research Conference on Undergraduate Biology Education Research in 2015, the 2012 summit on “Community Colleges in the Evolving STEM Education Landscape” (6, 7a), and the December 2005 “Teaching by Choice Leadership Summit on Community College Faculty” (8) provided support for and included community college faculty as discussion leaders. These national efforts underscore the continued importance of community colleges in undergraduate biology education.

The American Physiological Society (APS) has also recognized the role of community college faculty. Teaching section symposia and poster sessions at Experimental Biology have included community college presenters. The APS intentionally constructed the Physiology Educators Community of Practice (PECOP) to include community college faculty. Four of the seven attendees from community colleges at the first APS Institute on Teaching and Learning (APS-ITL) in 2014 were supported by the APS and NSF funding (RCN-UBE Award No. 1346220). Three of these community college faculty were PECOP fellows in 2014 and community college faculty have contributed to the PECOP blog (http://blog.lifesctrc.org/pecop/) since 2014.

This essay summarizes the role of community colleges in undergraduate physiology education, as discussed in our plenary address (7) at the second biennial APS-ITL in June 2016 (5). We framed our plenary talk with the following questions:

• What is the role and impact of community colleges in undergraduate physiology education?
• What challenges do community college students encounter?
• What challenges do community college faculty encounter?
• What resources are abundant and shareable to enable us to overcome these challenges?
• What opportunities exist within the greater physiology education community?
• What are the role and impact of community colleges in physiology education?

The approximately 1,700 US community and tribal colleges serve more than 12 million students annually (13), which is >40% of all undergraduate students in the US (1).

Fifty percent of students earning a Bachelor of Science degree attended a community college, 30% of MS students...
began at a community college, and 30% of first-year medical students have obtained some of their undergraduate education at a community college (10). Student demographics at community colleges resemble the changing US population. Students are more likely to be first-generation college students, students with disabilities, single parents, and/or veterans. Additionally, they are more likely to declare “intentions to practice in underserved communities or work with minority populations” (10). In addition, tuition and fees can be 10 times less expensive than those of 4-yr institutions. The cost of undergraduate education and the geographic convenience of community colleges suggest that the role of community colleges in STEM education in general and physiology education in particular will continue to be significant. Physiology students at community colleges and 4-yr institutions typically enroll in the same lower-division courses (Table 1).

Community colleges engage a significant proportion of undergraduate physiology students and faculty. Accurate national numbers of students enrolled in and faculty teaching physiology and anatomy and physiology courses at more than 1,700 community colleges are difficult to determine because there is no one government agency or national organization that includes all of these institutions. However, using a regional example, we can compare the number of students and faculty in these courses in urban campuses in the Seattle, WA, area. The average class size for introductory biology courses at community colleges in Washington state, where both of the present authors teach, is 30–50 students. At the nearby University of Washington in Seattle (UW-Seattle), the class size ranges from about 300 to 700 students. Many students pursuing a career in health care also enroll in lower division physiology or “anatomy and physiology” courses at community colleges. These courses are ubiquitous across the US, serve as the primary source of undergraduate physiology education, and are taught by a very large number of faculty. For example, in the Seattle area, in spring quarter of 2014, there were 45 sections of human anatomy and physiology taught in the four community college campuses in Seattle and Bellevue, WA. Twenty-two different faculty taught these courses, serving about 1,300 students. In comparison, the 100-level “survey of physiology” and the 300-level “foundations in physiology” courses at UW-Seattle during that term served 465 students and were taught by two faculty. This local example demonstrates the need to include and engage community college students and faculty in the scholarship of teaching and learning (SOTL) and biology education research (BER) if we are to effectively reach the majority of our undergraduates. Typically, the community college sector has not been included in these SOTL and BER activities (Schinske J and Corwin L, unpublished observations), and thus current efforts have failed to reach a large percentage of undergraduate physiology faculty. It is also much easier to reach two faculty at UW-Seattle than 22 faculty at four community colleges. We must also include community college students in undergraduate physiology (and biology) education research or the data collected may not accurately represent undergraduates in Washington state or in the country.

### What Challenges Do Community College Students Encounter?

Community college students face several challenges as they transition to 4-yr institutions. In the application process, transferring credits from one or more community colleges can be difficult, and there is often a long wait for acceptance decisions relative to first-year admissions. There are processes in place in some states that can help, including Direct Transfer Agreements (http://www.sbctc.edu/colleges-staff/program-services/transfer/major-related-programs.asp), online course equivalency resources (https://admit.washington.edu/EquivalencyGuide), and common course numbers (for students who take courses at more than one community college; http://www.sbctc.edu/about/agency/initiatives-projects/common-course-numbering.aspx). Entering first-year students have many resources to help them transition to college, but “orientation” processes and resources for community college students transferring to 4-yr institutions are often lacking. We recommend the replication of successful transition programs such as the Community College Transition program at the University of Wyoming (http://www.uwyo.edu/epscor/fellowships-and-student-programs/transition-award/), the College of Agricultural and Natural Sciences Summer Bridge to Research Program at the University of California Riverside (http://cnas.ucr.edu/stempathway/bridge/), and the Retaining Emerging Alamo College Talent in Science, Technology, Engineering, and Math program at the University of Texas at San Antonio (http://www.utsa.edu/crts/react/).

### What Challenges Do Community College Faculty Encounter?

Community college faculty are critical for undergraduate physiology education. We are student-centered; teaching and learning are the primary focus of our profession. The community college faculty teaching load is typically 15–20 contact hours and 5–6 office hours/wk. Ironically, however, most community colleges do not have teaching and learning centers for faculty development. Funds for professional development are scarce, which make society memberships and national conferences inaccessible. Many community college faculty are not aware of professional society opportunities, resources, and meetings. Access to scientific literature, including education research, is limited to online open access journals. Scientific talks and seminars typically do not occur at community colleges. The faculty promotion and tenure process is based on

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**Table 1. The core preprofessional courses (prerequisites for medicine, pharmacy, physical therapy, physician assistant programs, and others) often completed at community colleges, taken as part of a direct transfer agreement and an associates of science degree**

**STEM courses**
- Three quarters or two semesters of introductory biology with laboratory
- Three quarters or two semesters of general chemistry with laboratory
- Three quarters or two semesters of organic chemistry with laboratory
- Calculus and statistics
- Three quarters or two semesters of physics with laboratory
- Quarter/semester of physiology or two of combined anatomy & physiology with lab

**Non-STEM courses**
- Two quarters or two semesters of English composition or writing
- Social science and humanities: psychology, sociology, communications, etc.
- Physical education and/or health

Science, technology, engineering, and mathematics.
student evaluations, course enrollments, and college service. At the majority of 2-yr institutions, research, publications, and grants are not considered for tenure, retention, or advancement decisions. Community college faculty engaged in education research often do not have access to statistical software or statistician collaborators. Finally, many community college faculty lack job security and teach as adjunct, not permanent, faculty (although many are long-term) with limited opportunities to enter the tenure track.

What Resources are Abundant and Shareable?

In academic settings, it is easy to be drawn into the “scarcity mentality” (4), and we are well aware of the challenges of lack of time, space, and funding. Although it is useful to understand both the constraints and the existing and potential resources in our departmental and institutional systems, we advocate a transition to the “abundance mentality” (4). Faculty should focus on available resources and then determine what can best be done to promote inclusion of community college faculty and ensure success of community college students. A scarcity mentality perspective might view collaboration between university and community college faculty as too time-consuming, with few benefits for either population. The alternative, abundance mentality, would invite community college faculty to use existing structures at universities (invited talks, journal clubs, teaching and learning center workshops) to build relationships across institutions that can grow into collaborative efforts without creating new structures or increasing existing costs.

What Opportunities Exist Within the Greater Physiology Education Community?

Several opportunities for scientific societies, 4-yr institutions, and individual physiology or biology education researchers to collaborate with community college faculty and to include community college students are summarized in Table 2.

We recognize that opportunities for collaboration with and inclusion of community college faculty and students in professional society, university, and department activities currently exist, and the adoption of an abundance mentality would lead us to realize the potential of these options. We know that it is not possible for institutions and individual faculty to implement all of the suggestions in Table 2. However, we urge that faculty at all institution types within the physiology education community to do at least one of these. In particular, we advocate for four actions.

First, make personal connections. When sending an e-mail flier announcing a departmental seminar at a 4-yr school to the local community college, include a personal e-mail or short voice message encouraging attendance and an invitation to meet afterward. This personal contact can lead to important conversations and potentially begin a mentoring relationship.

Second, engage community college students that have successfully transitioned to a 4-yr school as resources for those students currently enrolled at the community college. One simple example of this is inviting former students to come and speak at the community college to students about success strategies employed as they moved into the 4-yr academic environment.

<table>
<thead>
<tr>
<th>Table 2. Opportunities for collaboration with and inclusion of community college faculty and students in existing society, university and department activities</th>
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<tr>
<td>Professional and scientific societies</td>
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<td>• Travel awards, discounted memberships, and registration for community college faculty.</td>
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<td>• Invite community college faculty to participate in regional and national meetings.</td>
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<td>• Encourage and support community college faculty on society committees and leadership.</td>
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<td>DBER and SOTL journals</td>
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<td>• Provide open online access to DBER papers (Advances in Physiology Education is a good example).</td>
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<td>• Encourage community college faculty to contribute to journals: letters, essays, and papers.</td>
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<td>• Invite community college faculty to serve as reviewers and/or associate editors.</td>
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<tr>
<td>Universities and 4-yr colleges and departments</td>
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<tr>
<td>• Institutions can share teaching and learning resources with community college faculty, including:</td>
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<td>Lectures on specific teaching and learning topics.</td>
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<td>Faculty workshops for improving teaching and learning.</td>
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<td>Departments can invite and welcome local or regional community college faculty to their existing activities.</td>
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<td>Attend departmental seminars, lectures, and invited research talks.</td>
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<td>Participate in journal clubs for traditional, “bench” research, or DBER articles.</td>
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<tr>
<td>Invite a community college faculty to give a departmental BER talk or seminar.</td>
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<tr>
<td>• Individual faculty can collaborate with community college faculty in DBER research.</td>
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<td>Can be significant collaborator PIs or co-PIs on grants.</td>
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<td>May serve on project or grant advisory boards or steering committees.</td>
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<td>Can provide access to community college students for DBER studies.</td>
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<td>Student focus groups</td>
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<td>Student interviews</td>
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<td>Student surveys (affect, metacognition, time constraints, demographics)</td>
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<td>Written responses to open-ended questions</td>
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<td>Forced choice responses (MCQ, TF) to validate assessment instruments</td>
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</table>

Third, include community college faculty and students in biology education research. Recent collaborative work initiated at the Building Capacity for Biology Education Research at Community Colleges Meeting, funded by the National Science Foundation in October 2015, highlighted the critical need for more information about the teaching and learning of biology at community colleges (Schinske J and Corwin L, unpublished observations). We encourage physiology education researchers to engage more community college faculty and students in their research and to create opportunities for interested community college faculty to direct and shape their own research questions. This engagement will be instrumental in influencing student success and pedagogical change.

Fourth, to promote further engagement of community college faculty in educational scholarship (SOTL) and encourage evidence-based physiology education practice and research, offer support for community college faculty to travel to and attend conferences, workshops, and meetings. At the first APS-ITL in Bar Harbor, ME, in June 2014, seven of the 94 registered participants were faculty from 2-yr colleges. One of the authors also received support from the PECOP grant (NSF No. 1346220), and three other community college faculty were...
supported as PECOP fellows (5). Without the PECOP grant support, none of the three PECOP fellows from 2014 returned for the second APS-ITL in 2016 in Madison, WI. Of the 124 registered participants at the second APS-ITL in 2016, six were faculty from community colleges (compared to 7 of 94 in 2014). These attendance figures illustrate the effect that direct support can have on inclusion of community college faculty at important national meetings. Travel support could come from federal conference or networking [Research Coordination Networks (RCN)] or other grants. Requesting travel funds for community college faculty to attend meetings within grant proposals for biology/physiology education research and having a lower registration fee for community college faculty to attend national meetings would be two simple strategies to increase their participation in and ultimately their contribution to these national meetings.

Conclusion
The purpose of this paper and our presentation (7) at the second APS-ITL is twofold. First, we aim to increase awareness of the critical role of community colleges in undergraduate physiology education nationwide. Second, we aspire to identify ways that all members of the physiology education community can act to include community college faculty and our diverse students in the broader community of physiology educators, education research, and the scholarship of teaching and learning.

ACKNOWLEDGMENTS
We thank our colleagues and partners in this effort, including other PULSE fellows from 2-yr colleges. We also thank APS for the invitation to speak and for support to attend the ITL. We thank Lisa A. Corwin for helpful suggestions and Madison A. Lindstrom for editorial assistance. Additionally, the authors thank our diverse, persistent, and talented community college students who motivate us.

DISCLOSURES
No conflicts of interest, financial or otherwise, are declared by the authors.

REFERENCES