Inclusive Science
DOI: https://doi.org/10.1128/jmbe.v21i1.1911

JMBE Journal of Microbiology & Biology Education

The Supervisory Role of Life Science Research Faculty: The Missing Link to Diversifying the Academic Workforce?

Laurence Clement[1]*, Karen Nicole Leung[2], James Bennett Lewis[2], and Naledi Marie Saul[1]
[1]*Office of Career and Professional Development, University of California, San Francisco, San Francisco, CA 94143*
[2]*City College of San Francisco, San Francisco, CA 94112*

In addition to developing innovative research programs, life science research faculty at research-intensive institutions are tasked with providing career mentoring and scientific training to new generations of scientists, including postgraduate, graduate, and undergraduate students. In this essay, we argue for a redefinition of mentoring in laboratory research, to thoroughly distinguish three essential roles played by research faculty relative to their trainees: advisor, educator, and supervisor. In particular, we pay attention to the often unacknowledged and misunderstood role of a faculty member as a supervisor and discuss the impact of neglecting supervisory best practices on trainees, on the diversity of the academic pipeline, and on the research enterprise. We also provide actionable frameworks for research mentors who wish to use inclusive supervisory and pedagogical practices in their laboratory. Finally, we call for more research around the supervisory role of research faculty and its impact on trainees, particularly community college students, in order to help broaden the participation of underrepresented students in STEM fields.

INTRODUCTION

The central role of research faculty in shaping research experiences

Life science academic training pathways rely heavily on research experiences in laboratory environments. In order to sustain long-term research projects, life science research faculty are charged with the important mission of recruiting and training future generations of scientists. By offering undergraduate research experiences (UREs), faculty can positively impact STEM student retention and success, particularly for historically underrepresented (HU) students, and play a mentorship role that can be critical in the success of these students (1–3). Some research suggests that individuals consider going to graduate school after engaging in research experiences with faculty (4–6).

Recently, there has been a call for broadening participation in UREs by community college students, who represent some of the more diverse student undergraduate populations (7). Many HU students begin their academic pathway at the community college level and account for a higher percentage of the enrollees at 2-year colleges than at 4-year colleges (8, 9). In addition, in the life sciences, of the doctorate recipients who had attended community college, 27.4% were Latinx, 44% Native American, and 22.5% black or African American (10).

Research faculty also train the future research faculty of research-intensive (R1) and primarily undergraduate institutions (PUIs), as well as many of the future teaching faculty of R1s, PUIs, and community colleges. Additionally, all PhD-level scientists who manage STEM employees in industry and government spend years training under academic research faculty.

As a consequence, the success of the STEM academic pathway is highly reliant on the scientific training and the professional development provided by research faculty. However, this intense reliance on one or two faculty over the course of a future scientist's training period sets the stage for potentially serious disparities in the experience and success of trainees. This "hierarchical and dependent relationship between trainees and faculty" has been linked to gender disparities in the laboratory and sexual harassment of women in the sciences (11). Additionally, a recent study pointed to evidence of socially irresponsible and even illegal behaviors of research faculty towards their trainees that are mostly left unaddressed by institutions (12). These findings suggest the importance of mentor training in supporting a diverse and healthy life sciences workforce.

*Corresponding author. Mailing address: Office of Career and Professional Development, University of California, San Francisco, 1675 Owens St., Ste. 310, San Francisco, CA 94143. Phone: 415-502-3097. Fax: 415-476-4986. E-mail: laurence.clement@ucsf.edu.
Received: 27 August 2019, Accepted: 21 February 2020, Published: 10 April 2020

In the past decade, several successful interventions have been designed to help faculty develop mentorship skills (13, 14). The "Entering Mentoring" curriculum, an evidence-based mentor training has been foundational in attempting to address disparities and developing culturally competent mentors in the biomedical sciences (13, 15, 16). In recent years, the large-scale interventions developed by the National Research Mentoring Network consortium have begun to change the national narrative around mentor responsibilities and the importance of developing the cultural competence of mentors (17).

However, there is evidence of power differentials between trainees and their research faculty mentors (18) which are not explained by current mentoring definitions and frameworks. They are, in fact, typical of the relationship between supervisors and their subordinates (19).

In this article, we argue for redefining and expanding our understanding of research mentoring by recognizing that research faculty play multiple roles as the mentors of new trainees. We distinguish three essential roles of research faculty towards their trainees within the laboratory research setting, namely as: (i) mentors or advisors, (ii) educators, and (iii) supervisors. Because the importance of the supervisory role is often overlooked in the life sciences, we offer examples of how current laboratory supervisory practices can impact the health of the research enterprise and the diversity of academic training pathways. Finally, we advocate for the life science education research community to expand its definition of the roles of research faculty towards their trainees as it considers the impact of faculty-trainee relationships and research experiences on the retention and success of trainees at all levels.

The three roles of research faculty towards their trainees: advisor, educator, and supervisor

According to social role theory, a role is "a set of behaviors that belong to a specific (…) position" and one individual can be expected to hold more than one role in a given position (20, 21). In this article, we will focus on faculty member's multiple and distinct roles towards trainees as a research advisor, research educator, and research supervisor (Fig. 1).

The research advisor role. There are various definitions of mentoring used in the life sciences, and different groups have different preferences on how to define mentoring in their research field (6, 13, 15, 16, 22–24). The research literature on undergraduate-faculty mentoring relationships tends to highlight the mentor's role as an advisor to their mentee: (i) providing psychological and emotional support to the student, (ii) supporting the student in setting goals and choosing a career path, and (iii) acting as a role model (25). In addition to this advisory role, some of the research literature on mentoring also suggests that mentors transmit academic subject knowledge to their mentees, a responsibility which overlaps with the research educator role described in the next section.

Studies have shown that mentors are overall beneficial to career outcomes (26–28) and that psychosocial and career support, as well as role modeling, are integral to mentee success across gender and cultures, with the strongest effects coming from role modeling (23, 29–31). In the life sciences field, anyone overseeing a trainee can be referred to as a "mentor"; therefore, we will refer to this specific role of research faculty as that of a *research advisor* from here on and will use the term *research mentor* to refer to the three roles together (advisor, educator, supervisor).

The research educator role. Since research faculty are charged with the scientific development of new laboratory scientists at the postdoctoral, graduate, and undergraduate level, the educator role also factors prominently in their role toward trainees. (Fig. 1). Research faculty who take on a new trainee or intern with little or no laboratory experience will be expected to teach them foundational research skills so they can become a productive member of the research team (32). Research faculty are also in charge of teaching more experienced trainees the concepts required for their very specialized research. Therefore, emphasizing this pedagogical role of research mentors as it relates to laboratory research education is an important step to improving the training experience of future scientists.

The research supervisor role. In the life sciences, research programs require extensive resources (e.g., expensive laboratory equipment, large amounts of reagents and supplies, or maintenance of animal or plant models)

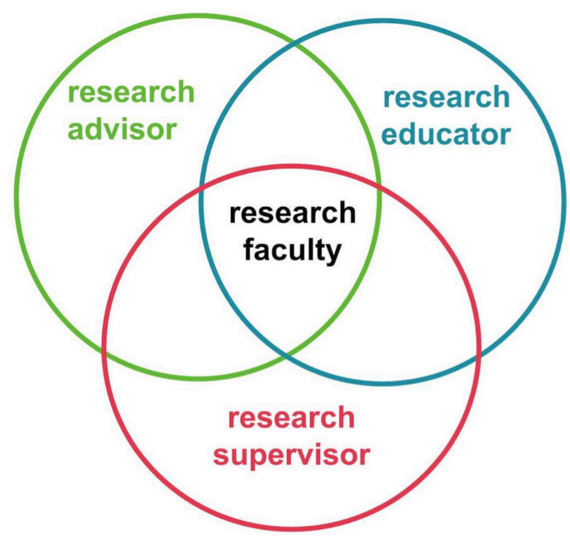

FIGURE 1. Research faculty at research-focused institutions take on multiple roles with their trainees in the laboratory. As research advisors, they support the career development of trainees (green circle); as research educators, they teach concepts and skills (blue circle); and as research supervisors, they oversee human resources (red circle).

TABLE 1.
Example of pedagogical and supervisory practices observed in our work with new trainees (e.g. community college students) in R1 laboratories, the potential impact of these practices, and suggested inclusive practices.

Example of Observed Practice	Potential Impact	Inclusive Practice
Supervisory: The research mentor does not realize that the trainee is not familiar with the implied expectations of the laboratory or the research experiences, including those relating to the laboratory culture. For example, it is not clear to the trainee when and how they should report issues and mistakes, or ask questions.	The trainee fails to meet the mentor's unstated expectations. For example, the trainee fails to report mistakes in a timely manner or the trainee asks too many questions. As a result, the mentor first assumes without sufficient evidence that the trainee is not capable of meeting their expectations.	The research mentor should not assume that the trainee is familiar with unstated laboratory expectations. Instead, the research mentor should make all expectations clear to the trainee at the beginning of their work together. They should first consider trainee errors as an indication that the trainee is unclear with expectations, and (re)state them to the trainee (see Table 2).
Educational: The research mentor does not realize that the trainee is not familiar with foundational science concepts related to the laboratory's research. For example, the mentor bases their assumption of what the trainee must know on their educational background (courses completed, degrees obtained) or the trainee's perception of familiarity with a topic.	The trainee fails to meet the mentor's unstated performance expectations because the trainee doesn't have the foundational knowledge required to understand higher-level concepts. The mentor further incorrectly assumes that the trainee is not capable of learning complex scientific concepts, and is therefore not able to meet the expectations of their laboratory or institution.	Regardless of previous experience or references, the mentor should confirm the trainee's familiarity with concepts and abilities. The mentor should first make learning and performance expectations clear to the trainee and conduct a direct baseline assessment of trainees' knowledge and skills.
Educational: The research mentor sets out to expose the trainee to multiple techniques in their first weeks in the laboratory and to explain numerous new scientific concepts. They provide the trainee with articles to read and invite them to laboratory meetings and scientific seminars. However, they neglect to set boundaries with learning outcomes or articulate which concepts/skills the trainee should prioritize understanding/developing first.	The lack of clearly articulated learning outcomes and priorities incorrectly shapes a trainee's unrealistic and unfocused learning goals. This may impact the trainee's ability to progress, and contribute to repeated mistakes and/or feelings of being overwhelmed. The mentor may view the trainee's substandard performance or behavior as evidence that the trainee does not have the educational foundation, ability or drive to meet expectations.	The trainee's failure to meet expectations should first prompt the research mentor to review if they have clearly set and prioritized learning outcomes. If not, the mentor should narrow in on a few key concepts and techniques to teach and assess during the course of the traineeship and clarify them to the trainee.

and complex technological expertise. To meet the level of productivity expected of them, research faculty need the support of several team members to run their research programs, which requires funding the salary and benefits of technicians, graduate students, and/or postdoctoral trainees. Therefore, to achieve their goals, life science research faculty must take on "managerial" responsibilities: "planning, organizing, leading, and controlling the human, physical, financial, and information resources of the organization in an effective and efficient manner" (33). As managers of human resources, they must accomplish supervisory tasks, such as selecting, hiring, training, evaluating, and when necessary, disciplining and terminating the position of individuals in accordance with university guidelines and/or federal and state employment laws.

As a result, faculty members take on an additional responsibility, that of a research supervisor toward trainees (Fig. 1). Consequently, the trainees who depend on a faculty member to play a supervisory role will take on the role of a subordinate, whose work directly impacts that of their supervisor. Importantly, research faculty currently receive limited to no training when it comes to their supervisory responsibilities towards trainees, and as a result, may struggle to fulfill these responsibilities: "Managing people is the hardest thing about our job because we're not trained to do that at all … We lie awake at night agonizing over people. (…) I think this addresses a real big issue in our whole career" (34).

This supervisor-subordinate relationship can be the source of power differentials that are distinct from that of a purely traditional mentor-mentee dyad (for example, between a junior and a senior faculty member). Drawing from identity and resource dependence theories, Farmer et al. proposed that "supervisors have power over their subordinates when they control resources needed for the subordinates' enactment and maintenance of current and desired identities" (35). For trainees to "enact and maintain" their identities as academics, they need access to the intellectual and technical resources provided by research faculty, as well as to financial and logistical resources controlled by the same faculty member (such as visas for international scholars). This intense reliance on faculty creates a power differential that is not sufficiently accounted for by current life science mentorship frameworks. By recognizing how research faculty assume the role of supervisors relative to their trainees, we are better able to acknowledge and assess how power dynamics operate in these mentoring relationships.

Current supervisory practices and their impact on the academic pipeline and the research enterprise

In this section, we present what is already known of laboratory supervisory practices used in STEM as they relate to the supervisor role outlined above, and when information is available, by life science research faculty, and their potential impact on the diversification of the academic pipeline and the success of the research enterprise.

Hiring practices. There is little research on how supervisory practices impact diversity in academia, aside from one key practice: hiring. Research faculty have shown biases in favor of male candidates (from technicians to graduate and postdoctoral trainees) (36, 37) and those from prestigious institutions and labs (38). Generally, these hiring biases are more obvious when an application involves conflicting information about the candidate or involves candidates with high but "slightly ambiguous competence" (36, 39, 40). Since HU trainees are less represented at the most research-intensive institutions, this bias could disproportionately impact them (41). In our work, we regularly see community college students from City College of San Francisco, a large urban community college and a Hispanic-serving institution, compete with undergraduate volunteers from the University of California (UC) Berkeley for the same internship positions at UC San Francisco. In fact, even in the absence of 4-year candidates, faculty members have asked postgraduate mentors (graduate students and postdocs) to consider finding a 4-year undergraduate instead of hiring existing community college internship candidates.

Systematic hiring methods, such as blinding application materials, developing detailed interview evaluation rubrics, and using multiple evaluators, have been shown to be effective for countering bias, and yet these methods are not usually required practices in research laboratories (42, 43). These methods are inclusive laboratory supervisory practices, and their absence could lead to systematic bias and, as a result, have a rippling effect on the diversity of the academic enterprise. A system where HU and female trainees are less likely to be hired at each transition point in the academic pipeline reduces the opportunities to diversify the faculty body, which in turn prevents new generations of trainees from being hired and retained by diverse faculty. By explicitly acknowledging that part of a research faculty member's role is that of a supervisor, we can clarify the expectation that faculty members should be using hiring practices that are inclusive of all the trainees they hire, and we can develop processes to support faculty in achieving these goals.

Laboratory culture. Supervisors are also responsible for creating and monitoring the organizational culture of their laboratory (44). As a supervisor, a research faculty member uses expectation setting and role modeling to set the tone for the culture of the lab (34). Research faculty must also ensure that these expectations are met consistently and must take action when they are not. In the absence of such practices, the laboratory environment can be less inclusive to certain subgroups and, in some instances, outright dysfunctional. Fourteen percent of researchers describe their lab culture as "abusive," "oppressive," or "hostile" (45). In addition, there is evidence of systemic gender inequities and instances of bias against biomedical female trainees and sexual harassment of female trainees (46). These findings suggest the need to support faculty by teaching them better supervisory practices to cultivate a supportive and functional lab culture. It is likely that research faculty who are unclear about their supervisory role will also lack the language and frameworks to intentionally cultivate a productive laboratory environment or will not know how to skillfully respond to difficult situations where trainees engage in unproductive behaviors, including those that are not fully inclusive of their peers (47, 48).

Trainees and laboratory members have requested more supervisory training for their principal investigators (PIs), and in our experience, many faculty agree, especially future and junior faculty (45). However, the responsibilities of research faculty towards their trainees are often shared or passed on to graduate students and postdoctoral scholars, resulting in varied outcomes for different HU groups (44, 49, 50). In particular, undergraduates have reported negative experiences with graduate students and postdoctoral scholars that involve "scapegoating" and described how these negative relationships "hardened [their] shell" (44). These situations can be especially detrimental for HU trainees who may already be functioning in an environment that does not fully support their values and beliefs and could at least in part explain the loss of interest for academic careers of these trainees observed by others (51, 52). This underscores a need to develop the supervisory skills of not only current faculty, but also those of future faculty, with an emphasis on inclusive supervisory practices (53).

Effective and inclusive laboratory practices: applying the scientific teaching framework to supervising and educating in the laboratory

Together, these findings illustrate how the absence of laboratory practices supportive of all trainees can hinder progress on different fronts: toward more diversity in STEM fields, as well as toward a more productive and rigorous research enterprise.

The question, then, is: Can we identify best supervisory and pedagogical practices in the laboratory that can supplement well-established effective and inclusive mentoring practices (13)? In this section, we suggest potential frameworks for such practices.

A framework for pedagogical practices in the laboratory. In the undergraduate classroom, modern pedagogical frameworks advocate for transparency and specificity of teaching goals, assessment of prior knowledge and skills of learners, and the development of a teaching strategy that bridges prior skills to goals and promotes systematic evaluation of progress by providing specific feedback through frequent formative assessments, as well as transparent summative assessment methods (54–56). This additional structure has been shown to decrease the achievement gap and appears to be particularly beneficial to underprepared students and students from some minority groups (57). For this reason, these evidence-based pedagogical methods are considered more inclusive than traditional teaching methods and are being broadly adopted across institutions in the United States (54, 55, 58).

To ensure the retention and success of all trainees, this evidence-based approach to teaching should be extended to teaching research skills and scientific concepts in the laboratory (Table 2). While teaching in a lab can be considered "hands-on," it can lack the basic elements of successful evidence-based teaching. In evidence-based pedagogical laboratory practices, clear goals and formative assessments with regular feedback are used to scaffold the hands-on learning experience. However, in many laboratories using the apprenticeship model, trainees are expected to "absorb" what they need to learn by watching others speak about science in laboratory meetings and by reading papers, but without a clear sense of what knowledge they need to acquire or feedback on how well they are acquiring that knowledge. For new trainees, this lack of clarity in expectations and absence of feedback can be overwhelming. This is also true when it comes to skills development: new trainees are often "exposed" to all sorts of techniques without a clear sense of what skills they need to master first.

Therefore, ideally, research mentors should design training plans that take into account the prior conceptual knowledge and skills of the trainee, the duration of the research experience, and the goals of the research experience. Using backward design principles and specific language, research faculty can hereby set clear learning objectives for the trainee, provide information of success metrics to evaluate said learning goals, and develop a training plan to ensure that research mentors have used appropriate teaching techniques that meet the laboratory's standards (Table 3) (56).

When it comes to postgraduate training, it is best for the institution to set up a structured training that gives graduate students and postdoctoral scholars more transparent and specific training outcomes. A study of graduate programs suggested that developing a "culture of structure," where both faculty and trainees have a clear sense of the expectations for trainee success, like the need to present scientific findings at a conference, creates a more equitable environment for underrepresented and female trainees (35, 36). To ensure the retention of a diverse workforce in the academic pipeline, these training outcomes may need to be mapped to the hiring requirements of trainees' future desired positions, including faculty positions (59).

A framework for supervisory practices in the laboratory. When it comes to the responsibilities of a supervisor, the literature on effective and inclusive supervisory practices aligns surprisingly well to that of evidence-based pedagogical practices and positive outcomes described above. Respect, Recognition, Responsiveness and Responsibility, summarized as "the four Rs" of inclusive leadership (which includes managers and supervisors) positively impacts employee morale, performance, and conduct (60). Employees who experience inclusive leadership best practices report an improved sense of belonging and mental well-being at work, as well as increased feelings of being valued, trusted, and psychologically safe (61–63). Furthermore, inclusive leadership has been shown to increase overall employee productivity and boost performance in innovation skills valued by organizations, such as employee creativity and the ability to solve problems (64–66). Finally, inclusive practices positively affect employee involvement, motivation, and retention (60, 62, 65–68).

In the day-to-day responsibilities of a manager, best practices include the use of performance management systems, which involve a dynamic process for managing employee performance and which matches the recommended pedagogical practices in scientific teaching. It advocates for (i) the development of measurable performance goals in alignment with a defined role, (ii) the measurement of these goals in a systematic and objective way, (iii) the assessment of these goals continuously through constant informal feedback and coaching, (iv) the modification of roles and goals as they change, and (v) an assessment of overall performance (Table 2) (69, 70).

As described in Table 3, performance expectations can be laid out clearly for new trainees, particularly undergraduate and community college interns, by using a simple backward design process (56). Alternatively, simple rubrics can allow the trainee to understand clearly what is expected of them and provide a framework for the research faculty to provide corrective feedback to the trainee. By also making conduct expectations clear for everyone in the laboratory, research faculty can also set the tone for a laboratory culture that is inclusive for all.

Whether students succeed or fail to progress as expected towards learning goals, successful pedagogical practices emphasize the importance of being transparent and clear in regard to the criteria that determine all rewards and consequences. In classroom pedagogy, this refers to details of the grading criteria and point allocation, for example, by using syllabi and grading rubrics (71, 72). In supervision, rewards for successful performance are a source of significant power over the subordinate (34). In laboratory supervision, rewards for successful performance can take different forms: publication authorship, travel to a conference, permission to submit a K99 grant proposal, or letters

TABLE 2.
Guiding questions to develop evidence-based and inclusive practices for each of the three research mentor roles: advisor, educator, and supervisor.

Practice	Research advisor	Research educator	Research supervisor
1. Define and communicate clear expectations	• At what stage of career development is the trainee? • What are the trainee's career goals? • What do the trainee and mentor expect of their relationship, when it comes to career development?	• What concepts should the trainee know to perform adequately in the laboratory? What concepts should they learn to get to the next stage of their career? • What skills should they master? • What is the timeline for learning these concepts and skills?	• What overall projects and individual tasks are trainees expected to complete? • At what level of competency are trainees expected to perform? • What are the expected standards of productivity and quality of the work produced by the trainee? • What is a reasonable timeline in which to meet developmental and independence benchmarks?
2. Define and assess baseline-level competencies systematically and align them with expectations	• How close is the trainee to their career goal? • How well do they understand what activities will allow them to advance towards the next step in their career? • Does the trainee have an individual development plan?	• What is the prior knowledge and skills mastery of the trainee? • How early in the training process are the trainee's prior knowledge and skills assessed? • Are they assessed through direct and systematic assessment measures, or is the research mentor relying on the trainee's self-assessment?	• What is the baseline performance of the trainee on key tasks and projects? • How well does the trainee meet the expected standards of productivity and quality of work? • How should the trainee respond in specific situations that have been problematic in the past? • How will the trainee engage with other team members? • Is the trainee responsive to feedback on their behavior and performance?
3. Assess intermediate milestones and provide formative feedback regularly	• Does the research mentor check in regularly regarding the trainee's progress toward their career goals? • Does the trainee feel like they can approach the research mentor when needed? • Is the trainee receiving feedback from the research mentor on what they are doing well to prepare for their career goals? • Does the trainee know what they should do differently and/or how to improve to reach their career goals?	• Is the trainee's progress toward learning goals assessed directly and regularly? • Is the trainee receiving specific and regular feedback on their progress? • Does the trainee know what they still need to learn?	• Is the trainee's performance and conduct assessed directly and regularly? • Is the trainee receiving specific and regular feedback on their performance and conduct, including how they are meeting expectations? • If the trainee is not meeting expectations, are they informed in a timely manner? • Is the trainee given achievable steps, benchmarks, and support to correct their performance or conduct?

TABLE 2. continued

Practice	Research advisor	Research educator	Research supervisor
4. Set transparent consequences and rewards for attainment of outcomes	• Are the criteria for providing recommendations or sponsorship or the reasons for terminating the research mentor-trainee relationship transparent?	• Is overall learning in a laboratory environment evaluated using transparent, systematic evaluation tools (e.g., grading rubrics)? • Do trainees know when they have succeeded or failed at achieving the learning goals established for them? • Is the trainee provided with a clear explanation of what will happen if they do not meet these goals?	• Are the decision criteria for rewards and consequences transparent, systematic, and fair (e.g., authorship position, permission for travel to conferences, assignment of projects, support for fellowship and grant proposals)?
5. Provide access to appropriate resources for success	• Does the research mentor provide psycho-emotional support to the trainee? • Does the research mentor provide the trainee access to their network? • Does the research mentor advocate for the trainee and provide sponsorship when the trainee needs it?	• Based on the assessment of prior knowledge and skills, what is the expected learning curve of the trainee? • What is the training plan and its timeline for the trainee? • Is the trainee being taught using evidence-based teaching strategies? • Is the trainee provided with the types of resources that meet their needs as learners?	• Does the research mentor support the needs of the trainee by providing access to resources in a timely manner, including information, collaborators, mentors, experts, supplies, and equipment? • Does the supervisor take into account the professional needs of diverse populations of trainees, some of which may be impacted by the personal characteristics of the trainee?
6. Define, communicate, and address conflicts around culture, values, and behavioral expectations	• What are the values of the trainee? What are the values of the research mentor? • Which of these values are shared with the trainee? • Can the research mentor and trainee accommodate differences? If so, how?	• What is the culture of teaching and learning in the laboratory? • What are the expectations when it comes to self-directed learning? • How is the trainee expected to identify and fill their knowledge and skills gaps? • How are differences (e.g., cultural differences) accounted for in the education of new trainees?	• What are the behavioral and conduct expectations in the lab? • What values are being modeled by the research mentor and the other team members? • What rules must be enforced to maintain the intended lab culture? • How are differences managed in the laboratory culture? • What are the consequences for poor or inappropriate conduct?
7. Define transparent and objective eligibility criteria that align with the requirements of the experience	• Can the trainee's needs and goals be met by the research mentor's skills, knowledge, resources, and/or network? • Is the trainee at the right level for the mentorship offered by the research mentor?	• What are the knowledge and skills requirements for the position? • Is the assessment of prior knowledge and skills conducted in a systematic and direct manner, or is it based solely on indirect measures (e.g., prestige of the institution, colleague's recommendation, or grade in a class)?	• Are the requirements of the job description aligned with the performance expectations of trainees?

TABLE 3.
Examples of backward design applied to the three roles of a research mentor, in a scenario where the trainee is an undergraduate or community college intern.

	Conceptual Knowledge (Educating)[a]	**Technical Skills (Educating)**	**Performance (Supervising)**	**Professional Skills and Attitudes (Advising)**
Goals and Expectations: What final goal would you like your trainee to reach? *Start the sentence with "Be able to…"*	Be able to interpret results from an IP and WB of the insulin receptor.	Be able to independently run a WB from a given protein sample and antibody, with a given protocol.	Be able to produce IP and WB results that are at the quality standard required for publication.	Be able to describe how the experience they have acquired in the internship can help them attain their career goals
Evaluation: (measure of success) How will you and the trainee know they have attained this goal?	When asked to analyze the results of a WB after IP, the intern can describe how the results relate to changes in the insulin receptor signaling pathway.	When given a protocol, protein sample, and antibody, the intern can perform the experiment independently. If given a new protocol, protein, and/or antibody, the intern will take the initiative to review the protocol with the mentor first and ask questions as needed.	When asked to perform a technique for which the intern has been trained, the intern can produce results that are of the following quality (provide an example of the type of result expected here; provide an example of a result that is of poor quality).	When asked how this research experience makes them a good candidate for a position in an interview, the candidate can describe the skills they have learned, the quality of their work and results, and how they contributed to the advancement of the lab's goals.
Assessing Baseline Level: How will you directly assess the trainee's level of competency before they start?	Ask the intern to describe the insulin receptor signaling pathway, the principles of IP and WB. Ask the intern to interpret IP and WB results.	Ask the intern to explain the principles of the WB and describe the main steps of the experiment. If they have performed the technique before in class or in a lab setting, ask them to describe its goals, the steps of the experiments, and the protein and antibody samples they used. If possible, have them perform a short experiment during the interview as a job simulation.	Show examples of appropriate-quality vs. poor-quality results and ask the intern if he or she can distinguish between them, to list potential reasons for getting poor-quality results, and how this will impact their project.	Ask the intern to describe their career goals, their ideal position after this experience, the expectations of candidates for this type of position, and how their prior and current experiences can help them attain this type of position.

TABLE 3. continued

	Conceptual Knowledge (Educating)[a]	Technical Skills (Educating)	Performance (Supervising)	Professional Skills and Attitudes (Advising)
Teaching Strategy and Support: What will the mentor do to help the trainee reach the goals and expectations from their baseline level?	Tailor teaching to the intern's current knowledge and preferred learning medium and current level: 1. Provide slides from a cell signaling seminar or lecture. 2. Provide a section of a review paper relating to the insulin receptor signaling pathway. 3. Assign iBiology or Khan Academy videos on the insulin signaling pathway. 4. Assign educational materials on IP and WB. 5. Talk through the analysis of IP and WB results with the intern, then ask them to analyze new results with feedback. Set up a meeting in 2 weeks to have the intern describe or diagram the principles of IP and WB back to the mentor.	Tailor training to the intern's current skills level: 1. Review or teach the principles of WB. 2. Read through the protocol with the intern, explaining each step. 3. Demo the experiment slowly while the intern takes notes and asks questions, allow the intern to review the protocol on their own, and schedule a meeting to discuss new questions. 4. Perform a new demo in front of the intern, at a normal pace. Let the intern ask questions again. 5. Let the intern practice the technique in front of the mentor twice with thorough, constructive feedback. 6. Let the intern do it without the mentor while the mentor is accessible for support.	The mentor and intern will regularly meet and discuss the results obtained by the intern and describe the difference between quality vs. poor results. The mentor will go over possible reasons for getting poor results and the impact on the project when results are poor.	Tailor mentoring to the intern's baseline level: 1. Help the intern meet current staff members who have a similar educational background and/or similar career goals. 2. Provide information to the intern on how to conduct an informational interview to gain better understanding of expectations of their target positions. 3. Help the intern develop an understanding of how their experience will help them attain this position. 4. Have the intern practice explaining how their experience serves this position.

a IP, immunoprecipitation assay; WB, Western blot assay.

of recommendation for future positions. For each of these important rewards in a trainee's career, what is the faculty member's decision-making process? This framework applies to conduct expectations as well, particularly in situations where trainees do not conduct themselves in a professional manner with their peers. How should trainees communicate with each other? What should they do when they have a conflict with a laboratory member? How does the faculty member want to hear difficult news? What should someone do if they notice inappropriate behaviors in the laboratory?

Just like in a class syllabus, expectations and evaluation criteria for performance and conduct can be delineated through a "Welcome" letter, a laboratory philosophy web page, and/or a laboratory manual (73–75). By making the criteria for their decision-making more transparent, faculty members can clarify the expectations for new trainees and mitigate their own bias in the decision-making process. Additionally, this can also ensure that all trainees are assessed using the same criteria, thereby making the research environment more inclusive. In situations when research faculty must delegate their supervisory responsibilities to postgraduate mentors, they will ensure that these postgraduate mentors have a clear understanding of the expectations and evaluation criteria as well. These are essential steps in maintaining an inclusive culture and ensuring that the work performed meets the research faculty's standards of scientific rigor.

Future directions

In this essay, we have argued that research faculty and the postgraduate trainees who take on research mentor roles in academic research actually take on multiple roles advising, educating, and supervising. We believe that differentiating these three different roles and training research mentors in effective practices around them should allow for increased productivity, efficiency, and sustainability of the research enterprise. Using inclusive evidence-based practices in all three roles should also lead to decreased biases in hiring, managing, and teaching laboratory skills to trainees, hopefully increasing diversity to the STEM pipeline. We advocate for a three-pronged approach for the life sciences community to address these systemic issues that affect both faculty and trainees.

First, we must develop interventions that can support faculty and their trainees to develop inclusive practices. By training faculty, graduate students, and postdoctoral scholars to be more mindful of the different roles they play as mentors in the laboratory environment, helping them develop strategies for advising, educating, and supervising more effectively, we can foster better communication and ultimately more productive working relationships. They must be supported in dealing preemptively with conflicts which may arise in the absence of inclusive practices. Our group has been piloting novel interventions to address some of the issues described in this paper for several years, particularly as they relate to two types of mentor-mentee dyads described here: the faculty-postgraduate dyads and the postgraduate-community college dyads (76, 77). The training involves two parallel curricula: first, a training for trainees (in the first dyads, postgraduate trainees, in the second dyads, community college students) to "manage up" their relationship with their R1 research mentor, and second, a training for R1 (faculty and postgraduate) research mentors to advise, educate and supervise other trainees inclusively in the laboratory. The R1 mentor curriculum has been offered and iteratively improved over several semesters to postgraduate mentors and is now being piloted with research faculty. In addition to teaching inclusive practices in supervision, education and mentoring these trainings attempt to change the "deficit thinking" that participants bring to the training (78). On one hand, research mentors often believe that mentoring issues arise from the lack of skills, knowledge, or motivation of trainees (a student deficit model). On the other hand, trainees often believe these same issues are due to a lack of quality mentorship from their research mentor (a mentor deficit model). Instead, we believe that many of these issues are caused by systemic issues with the academic system itself that perpetuate social disparities (78, 79). We believe that our field should increase its focus on the institutional or systemic deficits that cause these conflicts and potential strategies to mitigate them.

The second prong is building recognition of all three roles of faculty mentors at research-intensive institutions and government agencies which can develop policies and support infrastructures that will support faculty and trainees, including equal incentives for all three roles. Recent efforts to improve the NIH T32 funding expectations and evaluation process have laid the groundwork for change, but more should be done to recognize the power differentials between supervisors and their subordinates and mitigate any inhibiting consequences in order to ensure that trainees are provided with a high-quality educational experience (80). In parallel, there must be more efforts to assess the ways in which training grants incentivize the use of inclusive practices for all three roles.

Third, we call for the biology education research field to develop more robust research around the supervisory role of research faculty and their impact on trainees. For example, we must begin to explore how the supervisory role of research mentors may be beneficial and how it may be detrimental to the achievement of undergraduate, graduate, and postdoctoral research training goals. How does the research faculty's supervisory role support trainees' ability to attain their training goals? How does the supervisory role conflict with the attainment of these goals? We have begun exploring this, as well as identifying the factors that predict the importance of each role in the mentor-trainee relationship. For example, one of our questions is whether full financial independence between postgraduate trainees and faculty (i.e., not just salary and benefit support) can lessen the pressures of the supervisor- subordinate power structure. These findings could help inform policy and training to create a more supportive and inclusive training environment for undergraduate, graduate, and postdoctoral trainees.

Through an NSF ATE collaboration, we are currently exploring how community college trainees are integrated into academic research laboratories, as these are students who are often nontraditional, historically disadvantaged, and frequently have career goals that differ from their R1 mentors (77, 81). Specifically, how do supervisory practices (for example, the hiring practices and monitoring of laboratory culture) impact the success of community college trainees in research laboratories?

More generally, our community needs to understand how different types of laboratory practices impact the health of the research environment, its inclusivity, and the productivity of research teams. Lessons learned in biology education research, which have been extensively used to study graduate student teaching assistants, for example, and to a lesser extent, the mentoring relationships of faculty, postgraduates, and undergraduates, should be expanded to these supervisory relationships and power structures, as they may impact the diversity of the entire academic career path and therefore, the STEM workforce.

In conclusion, we believe that it is vital that the academic research community recognizes how the different roles of research faculty towards their trainees are operative in the workplace culture of the research lab. Research faculty are driven to sustain their research labs as enduring enterprises, and the disentanglement and clarification of the three roles outlined in this paper will allow the life science community to further assess and improve research mentoring overall as a means of supporting and growing research teams and developing the future STEM workforce.

ACKNOWLEDGMENTS

This work was funded in part by a collaborative National Science Foundation award (#1801186 and #1800998) attributed to City College of San Francisco and the University of California, San Francisco (UCSF) Office of Career and Professional Development (OCPD). We acknowledge the important contribution of Ying-Tsu Loh in the early stages of development of this framework. We thank Elaine Johnson (CCSF Bio-Link) as well as Elizabeth Watkins (UCSF Student Academic Affairs and Graduate Division) and Bill Lindstaedt (UCSF Career Advancement, International and Postdoctoral Services) for their support throughout this project. We also thank M. Aikens, F. Dunn, A. Gaspara Maia, M. Estrada, E. Johnson, R. McGee, S. Safgren, J. Schinske, J. Schlatterer and J. Vasquez, the UCSF OCPD team, especially K. Albus, R. Care, A. Hunter, M. Matrone, G. Monsalve, T. Solvik and A. Spence, and attendees of the UCSF Trends, Issues and Programs meeting for providing thoughtful ideas, clarifications, and corrections to this work. The National Science Foundation had no involvement in the design, planning, or writing of the manuscript. The authors declare that they have no conflicts of interest.

REFERENCES

1. Hurtado S, Cabrera NL, Lin MH, Arellano L, Espinosa LL. 2009. Diversifying science: underrepresented student experiences in structured research programs. Res High Educ 50:189–214.
2. Linn MC, Palmer E, Baranger A, Gerard E, Stone E. 2015. Undergraduate research experiences: impacts and opportunities. Science 347:1261757.
3. Espinosa L. 2011. Pipelines and pathways: women of color in undergraduate STEM majors and the college experiences that contribute to persistence. Harv Educ Rev 81:209–241.
4. Hunter A-B, Laursen SL, Seymour E. 2007. Becoming a scientist: the role of undergraduate research in students' cognitive, personal, and professional development. Sci Educ 91:36–74.
5. Carpi A, Ronan DM, Falconer HM, Lents NH. 2017. Cultivating minority scientists: undergraduate research increases self-efficacy and career ambitions for underrepresented students in STEM. Mentored undergraduate research at a MSI. J Res Sci Teach 54:169–194.
6. Estrada M, Hernandez PR, Schultz PW. 2018. A longitudinal study of how quality mentorship and research experience integrate underrepresented minorities into STEM careers. CBE Life Sci Educ 17.
7. Hewlett JA. 2018. Broadening participation in undergraduate research experiences (UREs): the expanding role of the community college. CBE Life Sci Educ 17:es9.
8. Coley RJ. 2000. The American community college turns 100: a look at its students, programs, and prospects. Policy Information Report. Educational Testing Service, Princeton, NJ.
9. Fletcher LA, Carter VC. 2010. The important role of community colleges in undergraduate biology education. CBE Life Sci Educ 9:382–383.
10. National Science Foundation. 2017. NCSES Survey of Earned Doctorates: FY 2016. National Science Foundation, Arlington, VA.
11. National Academies of Sciences, Engineering, and Medicine. 2018. Sexual Harassment of Women: Climate, Culture, and Consequences in Academic Sciences, Engineering, and Medicine. National Academies Press, Washington, DC.
12. Hayter C, Parker MA. 2018. Factors that influence the transition of university postdocs to non-academic scientific careers: an exploratory study. Res Policy https://doi.org/10.1016/j.respol.2018.09.009.
13. Pfund C, Branchaw JL, Handelsman J. 2015. Entering Mentoring, rev. ed. W.H. Freeman, New York, NY.
14. Sorkness CA, Pfund C, Ofili EO, et al. 2017. A new approach to mentoring for research careers: the National Research Mentoring Network. BMC Proc 11:22.
15. Pfund C, House SC, Asquith P, Fleming MF, Buhr KA, Burnham EL, Eichenberger Gilmore JM, Huskins WC, McGee R, Schurr K, Shapiro ED, Spencer KC, Sorkness CA. 2014. Training

mentors of clinical and translational research scholars: a randomized controlled trial. Acad Med 89:774–782.
16. Pfund C, Pribbenow CM, Branchaw J, Lauffer SM, Handelsman J. 2006. The merits of training mentors. Science 311:473–474.
17. Pfund C, Spencer KC, Asquith P, House SC, Miller S, Sorkness CA. 2015. Building national capacity for research mentor training: an evidence-based approach to training the trainers. CBE Life Sci Educ 14:ar24.
18. Meng Y, He J, Luo C. 2014. Science research group leader's power and members' compliance and satisfaction with supervision. Res Manag Rev 20:1-15.
19. Elias S. 2013. Fifty years of influence in the workplace. J Manage History, 14(3):267–283.
20. Colbeck CL. 1998. Merging in a seamless blend: how faculty integrate teaching and research. J Higher Educ 69:647–671.
21. Sarbin TR, Allen VL. 1968. Role theory: handbook of social psychology. Addison-Wesley, Boston, MA
22. Berk RA, Berg J, Mortimer R, Walton-Moss B, Yeo TP. 2005. Measuring the effectiveness of faculty mentoring relationships. Acad Med 80:66–71.
23. Hernandez PR, Hopkins PD, Masters K, Holland L, Mei BM, Richards-Babb M, Quedado K, Shook NJ. 2018. Student integration into STEM careers and culture: a longitudinal examination of summer faculty mentors and project ownership. CBE Life Sci Educ 17:ar50.
24. Fleming M, House S, Hanson VS, Yu L, Garbutt J, McGee R, Kroenke K, Abedin Z, Rubio DM. 2013. The mentoring competency assessment: validation of a new instrument to evaluate skills of research mentors. Acad Med 88:1002–1008.
25. Crisp G, Cruz I. 2009. Mentoring college students: a critical review of the literature between 1990 and 2007. Res High Educ 50:525–545.
26. Chao GT, Walz P, Gardner PD. 2006. Formal and informal mentorships: a comparison on mentoring functions and contrast with nonmentored counterparts. Pers Psychol 45:619–636.
27. Dreher. 1990. A comparative study of mentoring among men and women in managerial, professional, and technical positions. J Appl Psychol 75:539–546.
28. Allen TD, Eby LT, Poteet ML, Lentz E, Lima L. 2004. Career benefits associated with mentoring for protégés: a meta-analysis. J Appl Psychol 89:127.
29. Pellegrini EK, Scandura TA. 2005. Construct equivalence across groups: an unexplored issue in mentoring research. Educ Psychol Meas 65:323–335.
30. Hu C, Pellegrini EK, Scandura TA. 2011. Measurement invariance in mentoring research: a cross-cultural examination across Taiwan and the U.S. J Vocat Behav 78:274–282.
31. Dickson J, Kirkpatrick-Husk K, Kendall D, Longabaugh J, Patel A, Scielzo S. 2014. Untangling protégé self-reports of mentoring functions: further meta-analytic understanding. J Career Dev 41:263–281.
32. Balster N, Pfund C, Rediske R, Branchaw J. 2010. Entering research: a course that creates community and structure for beginning undergraduate researchers in the STEM disciplines. CBE Life Sci Educ 9:108–118.
33. Bovee CL. 1993. Management, International Ed edition. Mcgraw-Hill College.
34. Dolan EL, Johnson D. 2010. The undergraduate-postgraduate-faculty triad: unique functions and tensions associated with undergraduate research experiences at research universities. CBE Life Sci Educ 9:543–553.
35. Farmer SM, Aguinis H. 2005. Accounting for subordinate perceptions of supervisor power: an identity-dependence model. J Appl Psychol 90:1069–1083.
36. Moss-Racusin CA, Dovidio JF, Brescoll VL, Graham MJ, Handelsman J. 2012. Science faculty's subtle gender biases favor male students. Proc Natl Acad Sci USA 109:16474–16479.
37. Sheltzer JM, Smith JC. 2014. Elite male faculty in the life sciences employ fewer women. Proc Natl Acad Sci USA 111:10107–10112.
38. Clauset A, Arbesman S, Larremore DB. 2015. Systematic inequality and hierarchy in faculty hiring networks. Sci Adv 1:e1400005.
39. Hodson G, Dovidio JF, Gaertner SL. 2002. Processes in racial discrimination: differential weighting of conflicting information. Pers Soc Psychol Bull 28:460–471.
40. Dovidio JF, Gaertner SL. 2000. Aversive racism and selection decisions: 1989 and 1999. Psychol Sci 11:315–319.
41. National Science Foundation. 2015. Women, minorities, and persons with disabilities in science and engineering. NSF 15-311. National Science Foundation, Arlington, VA.
42. Bohnet I. 18 April 2016. "How to Take the Bias Out of Interviews." Harvard Bus Rev https://hbr.org/2016/04/how-to-take-the-bias-out-of-interviews
43. Bohnet I, Van Geen A, Bazerman M. 2016. When performance trumps gender bias: joint vs. separate evaluation. Manage Sci 62:1225–1234.
44. Groysberg B, Lee J, Price J, Cheng JY-J, Groysberg B. 1 January 2018. The culture factor. Harvard Bus Rev. https://hbr.org/2018/01/the-culture-factor.
45. Van Noorden R. 2018. Some hard numbers on science's leadership problems. Nature 557:294–296.
46. Remich R, Jones R, Wood CV, Campbell PB, McGee R. 2016. How women in biomedical PhD programs manage gender consciousness as they persist toward academic research careers. Acad Med 91:1119–1127.
47. Jarvis ED. 2015. Surviving as an underrepresented minority scientist in a majority environment. Mol Biol Cell 26:3692–3696.
48. Colón Ramos DA, Quiñones-Hinojosa A. 4 August 2016. Racism in the research lab. New York Times.
49. Aikens ML, Sadselia S, Watkins K, Evans M, Eby LT, Dolan EL. 2016. A social capital perspective on the mentoring of undergraduate life science researchers: an empirical study of undergraduate-postgraduate-faculty triads. CBE Life Sci Educ. doi:10.1187/cbe.15-10-0208.
50. Aikens ML, Robertson MM, Sadselia S, Watkins K, Evans M, Runyon CR, Eby LT, Dolan EL. 2017. Race and gender differences in undergraduate research mentoring structures and research outcomes. CBE Life Sci Educ. doi:10.1187/cbe.16-07-0211.
51. Gibbs KD Jr, Griffin KA. 2013. What do I want to be with my PhD? The roles of personal values and structural dynamics

in shaping the career interests of recent biomedical science PhD graduates. CBE Life Sci Educ 12:711–723.
52. Estrada M, Woodcock A, Hernandez PR, Schultz PW. 2011. Toward a model of social influence that explains minority student integration into the scientific community. J Educ Psychol 103:206–222.
53. Shupp MR, Wilson AB, McCallum CM. 2018. Development and validation of the inclusive supervision inventory for student affairs. J Coll Stud Dev 59:122–128.
54. Handelsman J, Ebert-May D, Beichner R, Bruns P, Chang A, DeHaan R, Gentile J, Lauffer S, Stewart J, Tilghman SM, Wood WB. 2004. Scientific teaching. Science 304:521–522.
55. Handelsman J, Miller S, Pfund C. 2007. Scientific teaching. Macmillan, New York, NY.
56. Wiggins G, McTighe J. 2005. Understanding by design, 2nd expanded ed. Association for Supervision and Curriculum Development, Alexandria, VA
57. Freeman S, Eddy SL, McDonough M, Smith MK, Okoroafor N, Jordt H, Wenderoth MP. 2014. Active learning increases student performance in science, engineering, and mathematics. Proc Natl Acad Sci USA 111:8410–8415.
58. American Association for the Advancement of Science. 2011. Vision and change in undergraduate biology education: a call to action. A summary of recommendations made at a national conference organized by the American Association for the Advancement of Science, July 15–17, 2009. AAAS, Washington, DC.
59. Clement L, Dorman JB, McGee R. 2019. The academic career readiness assessment: clarifying training expectations for future life sciences faculty. bioRxiv https://doi.org/10.1101/829200.
60. Hollander EP. 2009. Inclusive leadership: the essential leader-follower relationship by Edwin Hollander. Routledge, New York, NY.
61. McClure JP, Brown JM. 2008. Belonging at work. Human Resource Dev Intl 11:3–17.
62. Moss G. 2019. Inclusive Leadership. Routledge, New York, NY.
63. Travis DJ, Shaffer E, Thorpe-Moscon J. 21 February 2019. Getting real about inclusive leadership. Catalyst. https://www.catalyst.org/research/inclusive-leadership-report/.
64. Javed B, Sayyed Muhammad Mehdi, Khan AK, Arjoon S, Tayyeb HH. 2019. Impact of inclusive leadership on innovative work behavior: the role of psychological safety. J Mgmt Organiz 25:117–136.
65. Randel AE, Galvin BM, Shore LM, Ehrhart KH, Chung BG, Dean MA, Kedharnath U. 2018. Inclusive leadership: realizing positive outcomes through belongingness and being valued for uniqueness. Human Res Mgmt Rev 28:190–203.
66. Carmeli A, Reiter-Palmon R, Ziv E. 2010. Inclusive leadership and employee involvement in creative tasks in the workplace: the mediating role of psychological safety. Creat Res J 22:250–260.
67. Nishii LH, Mayer DM. 2009. Do inclusive leaders help to reduce turnover in diverse groups? The moderating role of leader-member exchange in the diversity to turnover relationship. J Appl Psychol 94:1412–1426.
68. Nembhard IM, Edmondson AC. 2006. Making it safe: the effects of leader inclusiveness and professional status on psychological safety and improvement efforts in health care teams. J Organ Behav 27:941–966.
69. Huprich J. 2008. A Brief Introduction to Performance Management. Library Worklife, Chicago, IL.
70. Armstrong M. 2017. Armstrong's Handbook of Performance Management: an Evidence-Based Guide to Delivering High Performance, 6th ed. Kogan Page, London, UK.
71. Allen D, Tanner K. 2006. Rubrics: tools for making learning goals and evaluation criteria explicit for both teachers and learners. CBE Life Sci Educ 5:197–203.
72. Dasgupta AP, Anderson TR, Pelaez N. 2014. Development and validation of a rubric for diagnosing students' experimental design knowledge and difficulties. CBE Life Sci Educ 13:265–284.
73. Bennett LM, Maraia R, Gadlin H. 2014. The "welcome letter": a useful tool for laboratories and teams. J Transl Med Epidemiol 2(2):1035.
74. Voytek B. Lab philosophy, Voytek Lab. accessed 13 April 2019. https://voyteklab.com/lab-philosophy/.
75. Bennett LM, Gadlin H, Marchand C. 2018. Collaboration and team science field guide. NIH National Cancer Institute, Bethesda, MD.
76. Clement L, Leung K, Lewis J, Saul N. 2015. TRAIN-UP introduction to mentoring program. UCSF Career. UCSF Office of Career and Professional Development. https://career.ucsf.edu/TRAIN-UP-course.
77. Lewis J, Saul N, Leung K, Clement L. 2018. CCSF-UCSF: a collaborative approach to work-based learning. UCSF Career. UCSF Office of Career and Professional Development. https://career.ucsf.edu/NSFATE2018.
78. Smit R. 2012. Towards a clearer understanding of student disadvantage in higher education: problematising deficit thinking. Higher Educ Res Dev 31:369–380.
79. Zhao Y. 2016. From deficiency to strength: shifting the mindset about education inequality. J Soc Issues 72:720–739.
80. Gammie A, Lorsch J, Singh S. Catalyzing the modernization of graduate education. NIGMS Feedback Loop Blog. National Institute of General Medical Sciences, Bethesda, MD.
81. Schinske JN, Balke VL, Bangera MG, Bonney KM, Brownell SE, Carter RS, Curran-Everett D, Dolan EL, Elliott SL, Fletcher L, Gonzalez B, Gorga JJ, Hewlett JA, Kiser SL, McFarland JL, Misra A, Nenortas A, Ngeve SM, Pape-Lindstrom PA, Seidel SB, Tuthill MC, Yin Y, Corwin LA. 2017. Broadening participation in biology education research: engaging community college students and faculty. CBE Life Sci Educ 16. https://doi.org/10.1187/cbe.16-10-0289.