

Antiracist Opportunities in the *Journal of Microbiology and Biology Education*: Considerations for Diversity, Equity, and Inclusion

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Authors in the *Journal of Microbiology and Biology Education* (JMBE) have demonstrated a clear commitment to diversity, equity, and inclusion (DEI) through commentaries, instructional approaches, and research. However, analysis of JMBE literature using Kendi's antiracist framework (*How To Be an Antiracist*, 2019) offers additional opportunities for growth. These opportunities are discussed and framed under five emergent conceptual categories (ECCs). First, capitalistic goals (e.g., productivity) are often drivers for DEI initiatives but disproportionately benefit those with power. Humanity-centered reasons, like honoring community values, are also important motivations. Second, faculty are often targeted as primary agents of change for DEI, but more powerful stakeholders such as department and institutional leadership can also implement equitable policies and practices to widen the impact of DEI initiatives. Third, study scopes are sometimes focused on the outcomes of inequity (e.g., lower retention rates for students of color) rather than the systemic causes (e.g., exclusivity of science). While outcomes are important to research, studies should create clear connections and distinctions between the systems and symptoms of inequity. Fourth, active learning and authentic research experiences are not automatically inclusive and do not necessarily validate students' identities. Such approaches may be more impactful when tailored for context and student background. Finally, language and communication can have broad impacts on DEI efforts. As a community, we may need to be more critical of our shared language and communication. This review discusses the five ECCs in depth and offers next steps for supporting DEI across the biology and microbiology education community.

KEYWORDS antiracism, antiracist, diversity, equity, higher education, inclusion, institutional, literature review, system, systemic

INTRODUCTION

The *Journal of Microbiology and Biology Education* (JMBE) recently published the *Inclusive Science* issue and included a commentary to further diversity, equity, and inclusion (DEI) across the biological and microbiological sciences (1). The commentary discusses historical and contemporary failures to address DEI in our field ranging from the Tuskegee syphilis studies (1932 to 1972) to treating coronavirus disease 2019 (COVID-19). Schloss and colleagues commit to DEI across academic journals through action like promoting Black scholarship and hiring diverse leadership (1). The *Inclusive Science* issue provided substantial conversation about DEI in our field

and contributed to the difficult task of identifying sociohistorical systemic structures that uphold inequities in science (2). Continuing this conversation, this paper uses Kendi's antiracist framework (3) to characterize existing work about DEI in JMBE and offer considerations for systemically promoting DEI in the biological and microbiological sciences. These considerations are meant for a wide range of stakeholders representing the system of science and science education, from graduate students to grant-funding agencies.

To describe the ways in which science can be more inclusive, it is important to examine the subtle ways in which science is exclusive. Without critical reflection on our practices and the theoretical reasoning behind our practices, we will continue to mitigate the symptoms of inequity without fully conceptualizing the disease itself (4). While the sciences claim to "transcend culture" (5), Western science is derived from European thought and appropriated knowledge from non-European cultures (5, 6). For example, math originates from Indian and Arabic cultures but was claimed by Europeans during the Renaissance (5). Furthermore, Western science upholds Eurocentrism by positioning science as inherently equitable due to the objective and neutral nature of scientific methods; however, critical scholars reject the notion of objectivity or neutrality in any scholarship (7). Science (in close

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collaboration with institutions of education) continues to uphold White supremacy by valuing the cultural knowledge and dispositions of White middle- and upper-class groups and aims to remediate non-White and lower-class students by giving them the knowledge and skills that they need to assimilate and serve societal needs, which are often driven by corporate demands, capitalism, and dominant American values like individualism (7, 8). A crucial assumption for increasing DEI in science is that mainstream science and science education represent one way of knowing and are not value free or neutral (9–12). In support of this assumption, this paper highlights some ways in which the biological and microbiological science education community is not value free or neutral, which impacts systemic DEI efforts.

To understand systemic approaches to DEI, it is important to consider that science subscribes to ideals of Whiteness, a term used to describe the “hegemonic system that perpetuates certain dominant ideologies about who receives power and privilege” (13). Put into real terms, most postsecondary faculty and instructors in the natural sciences hold Ph.D.’s (81%) and represent the dominant culture (14), meaning that elite dominant-culture Ph.D.’s largely control the narrative about what science is and who does science. Given that most cultures do not willingly or consciously subscribe to the ideals of Whiteness because it is well hidden in modern society, some scholars contend that the current enterprise of science can never be multicultural (5). If science remains exactly as it is and simply allows diverse individuals to join, it will always operate as an assimilationist system because it requires individuals from nondominant cultures and low socioeconomic status to abandon certain aspects of their identity, such as values and ways of knowing, and to disregard international and nonexpert contributions to science that may not fit the Eurocentric model that we currently subscribe to (3, 5).

PURPOSE

The primary purpose of this literature review is to use Kendi’s antiracist framework (3) to identify considerations and opportunities for growth among published works in JMBE. Although bright spots of antiracist ideals exist in JMBE, such as institutional- and program-level approaches and the integration of diverse history, storytelling, empathy, and critical consciousness (1, 2, 15–39), there remain opportunities for reflection. The intent of highlighting opportunities for growth is to further our commitment to systemic change among all positions of power in science education, from graduate assistants and adjunct faculty to department leads, institutional administrators, and even journal editors and grant-funding agencies.

Major journals in the field of microbiology have expressed a commitment to DEI, including JMBE, *Infection and Immunity*, *Applied and Environmental Microbiology*, and *Molecular and Cellular Biology* (1). However, this commitment could extend to all biology journals, grant funders, and researchers who aim to publish in those journals. A review of current award (2014–2020)

abstracts from National Science Foundation Improving Undergraduate STEM Education (NSF IUSE) for biological sciences reveals that the majority (48/69; 70%) include some intent to increase diverse representation or foster inclusive practices. This is a promising observation that indicates that DEI is advancing as a priority in our field. To further advance these efforts, we need to deepen our theoretical understandings related to DEI and ground our interventions and work in those theories. Some JMBE authors have already begun unpacking complex critical and social theories in recent years (see references 17, 24, 28, 29, and 38 as examples).

This biology education literature review will not offer a checklist of approaches that enact antiracism, but it will unpack current DEI efforts in our field and offer new considerations for furthering antiracism. Ultimately, the work of establishing antiracist systems must be done in partnership with the communities that we hope to serve, not for and without the communities that we hope to serve. Because I cannot guarantee an approach to being antiracist without evidence of impact, the approximate terms of “liberating” or “subjugating” practices are used to represent antiracism that may (or may not) exist in our community prior to this review. This literature review does not take the positivist lens of “problem-solving”; it takes the post-positivist lens of “problem-setting” (12). In other words, this literature review is meant to highlight promising practices that are subject to growth and revision and not to uncover so-called “best” practices that suggest a conclusive solution. Additionally, I use this review as a search for critical ideas existing or missing in science education research, not to create novel critical scholarship about DEI. The DEI considerations that I offer have roots in critical theory and are not my own (7, 40–43).

FRAMEWORK

The antiracist framework as conceptualized by Kendi (3) in *How To Be An Antiracist*, used to guide this review, is complex and requires careful reading and reflection. I suggest reading Kendi’s full work (3). To summarize, the antiracist framework focuses on systemic change and boils down to one simple rule, which is to determine the extent to which values, policies, and practices (collectively referred to here as “constructs”) are racist or antiracist. In postsecondary education, systemic change means extending our critique beyond individual actors (like individual faculty and their classroom practices) toward systemic causes of inequity such as policies and normative practices of departments and institutions that are often regulated by more powerful stakeholders, like top-level administrators. While instructors can employ antiracist practices in the classroom without much oversight, such as integrating content about how social and political factors have influenced science theory throughout history (e.g., eugenics) (8, 44), it is more difficult for faculty to employ antiracist practices beyond the classroom without allies. For example, faculty may be able to promote antiracist hiring practices through their roles in search committees (44), but these committees are rarely

without the input of administrators, and faculty are subject to racist institutional constructs after hire as well (such as science, technology, engineering, and math [STEM] department norms that preference quantitative research over qualitative research and can negatively impact performance reviews and tenure). Thus, faculty are powerful actors to drive change (44), but their antiracist actions can go only so far without support from more powerful stakeholders in the form of resources, such as money or staff, and transfer of power, such as the ability to write institutional policy or establish programs to promote antiracism (45). For example, the “short-lived” funding of the Certificate in Anti-racist Research and Practice (CARRP) at York University in 1989 resulted in the downfall of a cohesive effort toward antiracism across an institution, and disjointed efforts by individual faculty to promote antiracist research practices with mentees and research partners (45). Furthermore, a construct is racist if it subjugates (oppresses), and it is antiracist if it liberates (equalizes) (3). For example, the practice of recruiting diverse individuals to science without challenging the exclusive culture of science is racist because it relies on assimilation and subjugation. In other words, individuals must abandon aspects of their culture, identity, and belief systems to fully assimilate and are subjugated through traditional hierarchical structures of science. Notice that with this broad definition, antiracism as described by Kendi (3) is not a microscope on racism or colorism and is not limited by context (discussed more below): it is broadly based on subjugation or liberation. Antiracism is derived from critical race theory (44) and, like most critical theories, leans on philosophies like feminism, Marxism, and queer theory to be inclusive of a wide range of intersectional identities and systemic problems (3, 7). To be truly antiracist requires challenging all forms of oppression because all oppressions are tangled. For example, one cannot liberate the entire Black community without also liberating the queer and trans community. The list of intersectional identities is endless. Thus, potentially antiracist approaches identified in this review may be used to challenge other systems of oppression.

Notably, while many other authors have conceptualized and used antiracism in their scholarship for decades (44, 46, 47), much of this literature focuses on antiracism at the individual and classroom levels, such as the importance of faculty having a critical understanding of their social positioning and their contribution to racist systems and how that plays out in relation to their curriculum and student relationships (44, 47, 48). These are important contributions to antiracist scholarship because without acknowledging individual contributions to racism, those with power and privilege evade responsibility (44). Perspectives for faculty are offered, but Kendi’s antiracist framework (3) is the primary guide for this review because it better addresses the flip side, which is to develop actionable insight for those with the power to enact policies and reinforce practices, rather than the “bottom-up” approach offered by Kishimoto (44) and others. As Lawrence and Tatum (46) found in their conversations with White educators, individuals tend to view racial oppression

as the result of individual actions rather than the combination of individual and systemic actions. Faculty rarely hold powerful positions in postsecondary institutions, and the offered tactic for faculty building movements is by acting as individual cases of model antiracist behavior (44). This might be reflected in the observation that more DEI articles in JMBE are focused on faculty-level change. Furthermore, while authors such as Das Gupta (45) discuss antiracism more broadly in research practices to undermine the dominant assumptions of science (e.g., objectivity is possible) and even problematize traditional definitions of “institutions,” research tends to be directed and critiqued by the educated elite (i.e., faculty), making a research focus functionally the same as a pedagogical focus for antiracism. Kendi’s antiracist framework (3) has a broader and more simplified definition of antiracism that enables it to more easily include stakeholders other than faculty and translate across contexts. For faculty searching for ways to transform themselves and their classrooms toward antiracism and for information about how to navigate difficult conversations about race, I recommend Kishimoto’s paper (44) for a selected review of this literature, which includes scholars such as Tatum (47) and specific articles for STEM and biology.

METHODS

To complete this review, I conducted a search history of DEI work in JMBE from 2015 to 2020. I limited the search term to 5 years in order to capture the most recent work. While important contributions to DEI may have been lost given this restrictive time frame, the purpose of this review is not to provide a list of practices but to identify recent trends in the literature for additional DEI considerations. In total, there were 480 papers published in JMBE during this time (excluding ASM Conference for Undergraduate Educators [ASMCUE] abstracts and errata), and I identified 113 papers for inclusion by accessing each JMBE volume and issue online and manually scanning titles, abstracts, and introductions for keywords such as race, ethnicity, diversity, identity, and culture. For papers that contained these words, I then reviewed each paper in depth for relevance. I excluded papers if they used terms such as “diversity” or “inclusion” in unrelated ways, such as in reference to biodiversity or content inclusion (in reference to a curriculum). In addition, I excluded papers if there was no effort to interpret outcomes based on underrepresented status or to acknowledge the significance of DEI in the context of the work. Without data disaggregation, we cannot unpack the complex ways in which DEI efforts impact diverse communities. Additionally, a paper might mention vague ideals about DEI but go no further to describe the significance of DEI in the context of the manuscript. This was interpreted as an acknowledgment of DEI rather than a selected focus on DEI. Only papers that contributed to the overall intent of this review were retained, as advocated by Wolcott (49). Fifty-seven JMBE papers were used to create the five emergent conceptual categories (ECCs) in this review, which reflect

TABLE I
References by emergent conceptual category

Conceptual category	References
Capitalism	2, 15, 20, 29, 31–34, 37–39, 50, 54, 55, 59, 60, 70, 75, 101–103
Faculty	2, 11, 18, 24, 25, 27, 28, 32, 36, 38, 59–61, 72, 104, 105
Study scope	15, 16, 23, 61, 67, 70, 71
Active learning and authentic research experiences	20, 21, 29, 31, 36, 54, 67, 72, 74–76, 106–112
Language and communication	16, 17, 21, 24, 26, 29–32, 35, 37, 58, 60, 77, 79, 80, 85, 102, 104, 108, 111, 113, 114

areas of opportunity for antiracism (Table I). Overall, 76 JMBE papers were included to create the five ECCs and inform future directions because some JMBE papers already offer antiracist approaches, as mentioned in Purpose, above. Notably, references in each ECC may utilize liberating or subjugating practices, but I did not individually identify which papers utilize each approach (or a mix of approaches). My goal is not to label authors as using subjugating practices; rather, my aim is to point readers toward various takes on the topic and highlight at least one liberating take on the ECCs using antiracism as a compass. To read excerpts from papers that led me to categorize them in different sections of this paper, see my notes in Text S1 in the supplemental material.

ANALYSIS OF JMBE LITERATURE

I started this review without preconceived conceptual categories; however, my approach and the final ECCs were heavily influenced by critical theories such as *WhiteCrit*, which problematizes the dominant culture shaped by Whiteness (7). Additionally, this was not a “code-and-count” project; this is my interpretation of the selected literature using Kendi’s antiracist framework (3) as my guide. My goal is to describe findings and not to quantify findings. Kendi’s antiracist framework (3) aligns with critical theory and my own beliefs that oppressive systems were built intentionally and are working as they were designed. In other words, oppression did not develop by chance: oppression is an intentional (but often subtle and invisible) act by dominant groups to retain power and privilege. I chose Kendi’s antiracist framework (3) given its overlap of critical theories and intersectional focus (i.e., not just concerned with oppression due to racism). The conceptual categories that emerged were meaningful to me because they illuminate subjugating systems that extend beyond individual instructor or classroom approaches. Different categories may have emerged if a different person performed this work.

In this review, I discuss the five ECCs that I identified. Table I includes references for further reading at the end of the ECC section. The ECCs are equally important and are not discussed in any intentional order other than to facilitate flow. The sections apply to all positions of power in the science education community, whether the reader is an adjunct faculty or a journal editor. The review concludes

with considerations for next steps and key takeaways from the antiracist framework and across the five ECCs.

EMERGENT CONCEPTUAL CATEGORIES FROM THE LITERATURE

Capitalism may not be an antiracist driver of DEI

Capitalism is frequently referenced by authors in JMBE as a major impetus for increasing DEI in science education, specifically in regard to workforce or industry needs (Table I, Capitalism). For example, one JMBE paper prefaces its overall purpose by stating that a “diversity deficit impacts the productivity of American companies and organizations” (50). Statements like this explicitly reflect capitalist values and subjugating ideals because capitalism is designed to prevent people (and, disproportionately, people of color) from accumulating wealth and power (8). When we train students to serve capitalism, we devalue their individuality, identity, sense of purpose, and communities. This issue is discussed in depth by W. E. B. DuBois and Paulo Freire (51–53). People of color notice and internalize disingenuous reasons behind equity initiatives, such as financial gain, as can be seen when a Hispanic student described their institution’s effort to recruit more Hispanic students as a method to “get more hue for funding” (20). It is not uncommon for diversity campaigns to be viewed as a profitable pipeline for the institution to gain prestige and funding, a tactic that continues to subjugate diverse students rather than liberate them. This concern is substantiated by Kishimoto, who states that “diversity [is] about managing race rather than challenging racism” (44). When we highlight capitalistic ideals as our motivation or justification for DEI, we demonstrate a lack of empathy and awareness for issues surrounding diversity initiatives.

On the other hand, it is important to consider that many researchers and graduate students default to a capitalist-based value assessment of their work because it is appealing to grant funders seeking a return on investment. Here, we can see how more powerful stakeholders (i.e., grant funders) have an opportunity to challenge the traditional narrative. It is possible to prioritize DEI while acknowledging that capitalism, while a major driver of inequity, is the current system of survival in the United States through employment and the production of goods and services. For example, Behling et al. (54) call for an increase in

diverse physicians by highlighting the need to support medically underserved communities, which often include diverse racial and ethnic groups in urban settings. Because physicians of color are more likely to practice in medically underserved communities, Behling et al. (54) specifically call for more physicians of color. This workforce demand argument aligns more with liberating ideals because it encourages strengthening our diverse workforce for equitable community well-being and bridges personal and academic lives. By validating the lack of resources in some underserved communities, we also validate the needs of our diverse students who represent those communities and empower them to create positive change for their people. Community-based approaches tend to be more valued by students (55) and collectivist societies because they provide opportunities to reinvest in the community and/or promote personal and collective healing from racial trauma (a liberating ideal). For example, some Indigenous communities promote individual social-emotional wellness by encouraging students to seek mentors and service in their communities, strengthening individual and community well-being (56). Individuals in the science community must tread thoughtfully when using capitalism as a driver for systemic change, but this recommendation reflects Das Gupta's (45) argument for antiracism in research, rather than Kendi's (3) broader antiracist recommendations. More powerful stakeholders must dismantle the narrative as well. In support of this, Knippenberg et al. (57) outline seven steps to forming strong community partnerships for science outreach, which can be used as a model to establish institution-wide community-based research. Also, these relationships facilitate broader impacts, which is appealing to grant funders.

Faculty are one level of systemic change

Many published works in JMBE (42/76; 55%) make strong arguments for faculty-focused DEI efforts (Table 1, Faculty), and faculty approaches tend to dominate JMBE overall (24). For example, Cooper et al. (58) highlight subjugating instructor humor in the classroom that might be offensive to students and create a negative classroom climate. Furthermore, Clement et al. (59) argue that faculty heavily influence academic and scientific industries by training graduate-level degree holders for these careers. And while we tend to speak about faculty as mentors, most faculty relationships with graduate students and lab assistants are reflective of "supervisors and their subordinates" (59). Subjugating practices by faculty across the system contribute to a problematic hierarchical system, which can be observed through biased recruiting and evaluation practices of graduate students and postdoctoral candidates and explicit discrimination or harassment of subordinates (59). Without a doubt, these articles highlight serious and important perspectives for faculty and reflect antiracist values.

Workplace norms, policies, training, and evaluation systems drive faculty to act in subjugating or liberating ways toward students and colleagues with less power and can foster a collaborative or competitive environment (11, 17, 28, 59). In competitive environments, higher-ranking and/or

tenured stakeholders tend to garner more credibility, giving them a social and professional advantage (59, 60). However, internal and external institutional stakeholders with more power than faculty could enact systems to mitigate inequity. Elliot's (61) argument for gender equity in biology hints at the need to extend beyond faculty as the sole agents of change for DEI efforts. According to Elliot (61), admitting diverse students and supporting them in introductory courses may be shortsighted because students are systematically weeded out as they progress in academia and their careers (2, 61). As Segarra et al. (33) note in their JMBE publication, the number of Ph.D. graduates of color increased by 9.3-fold between 1980 and 2013 but did not lead to greater representation at the faculty level (62). This means that faculty as mentors and instructors are likely not the sole drivers of systemic exclusion. As brought up by Schloss et al. (1), an analysis of proposals submitted to the National Institutes of Health showed that Black scientists were less likely to be funded for their community- and population-level research ideas (63). Thus, while faculty should continue with equity-driven self-development, as suggested by antiracist scholars and many JMBE authors, administrators and external stakeholders (e.g., journal editors, grant funders, and conference organizers) should also consider liberating practices such as changing the written requirements around graduate admissions and examinations, setting expectations for DEI in faculty hiring and tenure decisions, implementing faculty training programs and professional development (PD), and integrating DEI benchmarks for conferences, funding, and publication (1, 2, 11, 59, 60). The latter goal reaches toward Kendi's (3) broader conceptualization of antiracism.

Study scope may limit the reach of DEI efforts

Sometimes, science education research aims to dismantle systemic issues through liberating practices, as advocated by Kendi (3), but the purpose of the research and the results are not interpreted as intended by all readers. For example, Ballen and Holmegaard (16) describe a novel article by Stoet and Geary (64) that reported that girls in more gender-equal countries are less likely to pursue STEM careers. The authors appropriately postulate that this observation may be due to STEM climate, inclusivity, or cultural incongruence; however, the media shifted the narrative to blame girls for their internal lack of interest in STEM (65). This is problematic because the culture of science is exclusive in explicit and subtle ways, and these observations should not be blamed on the subjugated, as several JMBE authors have discussed (2, 16, 20, 38, 61). While this is a secondary source error and easier to dismiss as "not the scientists' problem," our community, from individual contributors to journals, should be cognizant of perpetuating subjugation in primary literature as well.

Some JMBE authors have systemic issues in mind and propose appropriate methods to promote or study them. For example, Bankston and McDowell (66) instruct "multiple stakeholders" to support the implementation of ethical science communication training in undergraduate programs for several

reasons, one being to increase the participation and engagement of diverse individuals in science (a liberating practice). Bankston and McDowell (66) appropriately consider that stakeholders at multiple levels of an institution will be needed to secure the required funding, support, resources, and staff for such an effort. However, other authors misrepresent systemic factors or focus on nonsystemic factors to promote systemic change, resulting in a limited research scope that cannot broadly encourage liberating practices (Table 1, Research scope). For example, several papers in JMBE considered only Latinx, Hispanic, Black, and Indigenous students to be underrepresented minorities (15, 60, 67). This misrepresents a systemic factor because Pacific Islanders and certain Asian demographics, such as Filipinos and Vietnamese, are underserved as well (33, 53, 68, 69) and limits the ability of the research community to determine if the suggested approaches are inclusively liberating. Notably, some authors defined “underrepresented” using the National Science Foundation (NSF) definition (60), pointing to the need for more powerful stakeholders to examine NSF DEI practices because they directly influence the research and education practices in our community. In other words, the NSF definition has contributed to the systematic exclusion of inequities impacting Pacific Islanders and some Asian groups by limiting the scope of study.

A different JMBE author examined the relationship between study habits, course grades, and persistence in college (70). The author suggested that faculty reevaluate their study expectations for community college students, which is a fair and appropriate recommendation for a study about a student-level factor, but also identified policymakers as an intended audience (70). Remarkable political reform would be needed to support students’ study habits, ranging from widespread academic support to nonpredatory financial aid for students with jobs or dependents. Thus, study habits are likely just a symptom of the disease and not the disease itself (4). In other words, this study positions a nonsystemic factor as a systemic factor. When talking about student-level factors, we need to be careful. For example, Nallapothula et al. (71) chose a framework to explain college students’ academic outcomes (e.g., grades and persistence) that balances students’ beliefs about themselves, as measured by growth mindset, and their assumptions about agency. They caution that students with a growth mindset may still experience academic hardship or dropout because they face “institutional barriers, such as institutionalized racism” (71). Explicit caveats such as these and careful choice of inclusive frameworks help to situate student-level interventions within the system of barriers and offer appropriate contrast for the different ways in which we can approach DEI.

Active learning does not equal inclusive teaching

Similarly, and more broadly, JMBE literature about active learning and authentic research experiences poses issues for antiracist action. In 2017, Dewsbury titled a paper *Context Determines Strategies for ‘Activating’ the Inclusive Classroom* (72). In other words, an active learning strategy is not synonymous

with an inclusive learning strategy. The JMBE community clearly values inclusive pedagogy (Table 1, Active learning and authentic research), but sometimes we are researching and enacting active learning and authentic research strategies without a detailed justification for why the intended strategy validates the identities of the student population. When practices do not validate students’ identities or reinforce student capabilities, students may be less likely to benefit. For example, one student holding an undergraduate research position reported feeling “nowhere as smart as these people” and stated, “I don’t know when I could, or if I could, be good enough to do anything productive in this field” (72). This student intended to switch majors despite inclusion in an authentic research experience. Our community may benefit from a scaled-up discussion about the nuances of equity and inclusion with active learning and research experiences, which may uncover opportunities for widespread culturally responsive pedagogy (CRP) approaches and antiracist action.

Appropriate active learning techniques require careful consideration of the context, the content, the students, and the role of the teacher because pedagogy is culturally laden (24, 72). These are underlying assumptions of what was termed “culturally responsive pedagogy” by Ladson-Billings (73). For example, students who identify with the Confucian Heritage Culture (CHC) tend to prefer hierarchical classroom structures that are in opposition to many active learning strategies (36). For these students, Western academic and science spaces pose unique challenges for CRP because cultural values are in conflict. Smith-Keiling (36) recommends modeling learning strategies for CHC students and similar cultures, which honors teacher expertise (the top of the classroom hierarchy). Additionally, instructors may consider leaving the classroom so that students can speak openly and avoid disrespecting hierarchies (36). These are liberating practices for CHC students. While the current JMBE literature offers similar approaches for instructors across contexts, this idea can be expanded to include department and institutional programming for certain contexts (e.g., CHC and cultures with similar values), which requires widespread PD for practitioners and the buy-in of internal and external funding groups.

All stakeholders, from affiliate faculty to accreditation agencies, must understand that marginalized students do not necessarily experience greater learning or social-emotional gains than nonmarginalized students if the content of learning or research is not specifically developed with their background, experiences, or needs in mind (see references 67 and 74–76 for examples). Cultural incongruity in science education is an important factor in understanding the “imbalance” that occurs when our students’ values are in conflict with the expectations of their academic environment (17, 20). Dewsbury et al. (20) recount the internal conflict that Hispanic students felt when listening to seminars about Hispanic scientists’ journey to success. Some students, particularly female students, felt that the culturally responsive activity highlighted the conflict between their identity and STEM rather than mitigated it. Meaning, while

the intent of an activity may be to validate perspectives rather than resolve inequities, an equally important consideration in CRP that can be liberating, it is not safe to assume that active learning or authentic research experiences create inclusion. While learning experiences are often faculty driven, these efforts are not without the approval and support (even if passive approval and support) of more powerful stakeholders, like department administrators. Johnson and Elliot (24) propose a model to guide culturally responsive transformation in STEM departments and advocate for a group focus on academic success, cultural competence, and critical consciousness. To align further with Kendi's anti-racist framework (3), institutions, accreditation agencies, grant-funding agencies, and journals can consider the programs and scholarship that they support, fund, and publish.

Language and communication matter

In other instances, studies have an appropriate scope that might lead to anti-racist systemic change but fall short in the communication of findings. Nuhfer and colleagues (77) developed a measure for citizen science literacy using more than 17,000 students in the hopes of improving citizen science initiatives, an inclusive model of science reform. They disaggregated assessment data based on gender and race to check for instrument bias, a common psychometric analysis. However, the authors concluded that "every ethnic group seems equally capable of achieving higher-level reasoning afforded by understanding science's evidence-based way of knowing" (77). The use of the word "capable" in this context suggests that certain ethnic groups might differ from one another in demonstrated reasoning ability. This is an example of problematic science communication. Biologists have long argued that every ethnic group is equally capable of reasoning at high levels, but measures are often biased toward the success of certain demographic groups (78). Understanding and acknowledging this bias in our assessment structures represent a liberating practice.

As advocated by many JMBE scholars (Table 1, Language and communication), broader conversations about how we communicate science may increase DEI. Some papers talk about the history of oppression in science neutrally (79), which buries the struggles that certain groups, such as women, have faced in our field (a subjugating practice). On the other hand, Malotky et al. (29) increased students' awareness of oppression, privilege, and cultural differences through explicit instruction about systemic racism during collaborative course-based undergraduate research experiences (CUREs) involving community stakeholders (a liberating practice). Taylor and Dewsbury (80) argue that normalized but violent language in biology curricula subjugates by reinforcing war norms and xenophobia, such as the use of the terms "invasive species" and "hijacked." A different paper refers to students' family and employment status as "risk factors" for academic success (70), an unfortunate label considering that low-income and first-generation students are pursuing college at increasing rates

(26). As shared by Martinez, students of color enter educational systems and learn about entirely new words to describe them, like "underrepresented," "underprepared," and "under-achieved" (17). As a community, we need to critically examine our language across contexts and how it might subjugate or liberate. Words matter (81).

Individuals and institutions can shift the narrative in unique but collaborative ways. For example, educators and researchers could use PD opportunities and introspection to challenge their language and communication practices, while conference organizers might promote PD and meta-cognitive practices, and journals may have the opportunity to encourage widespread changes through the review-and-editing process (17, 80).

Summaries of and references for conceptual categories

Summaries of the conceptual categories discussed above and references that informed the category are outlined in Table 1.

NEXT STEPS

Dismantle elitism in science

JMBE published a special issue on citizen science in 2016, and many authors contributed their ideas about informal science citizenship (77, 82–93). While the topic was not situated in anti-racism, and there is a need to increase diverse engagement with citizen science, as with all areas of science (87, 91), I argue that it has the potential to further anti-racism by challenging what it means to do science and who is a scientist. Not only do citizen science projects encourage young scholars to engage with and learn science, help tackle global issues like climate change, and increase our capacity to collect data (86), citizen science projects may also have the power to change how professional scientists perceive who is a scientist and what it looks like to make meaningful scientific contributions. In particular, I hope that this includes those who are currently excluded from higher education altogether, which is similar to Sprowls' sentiment that scientist experts conducting K-12 outreach "need to purposefully recognize students as competent makers of scientific knowledge and position them as participatory members of a scientific community" (94).

Citizen science encourages informally trained people to do legitimate science in their own communities (85). Before science became a professional career, informally trained scientists such as van Leeuwenhoek and Pasteur were contributing knowledge that is foundational to our field today (92). Yet PD outside the laboratory is often discouraged by academics, which can create a divide between scientists and society (66). As Begley notes, "you do not need a well-funded lab, a doctorate degree, or even a background in science to contribute to scientific progress in important ways" (82). While we have pockets of scholars who embrace this idea,

we need more widespread reach. Burnett and colleagues (83) explore gamified research as a method to utilize the “collective intelligence” of citizen scientists in unique ways. In other words, people played games to produce scientific data. Swift and colleagues (95) promoted science participation through social media like Twitter and TikTok. Opposite of tradition, citizen science actively leverages the talents and interests of informal scientists (85, 92). The idea gains traction when we also consider the dissemination of novice research, such as with undergraduate research journals (96). The *Undergraduate Journal of Experimental Microbiology and Immunology* (UJEMI) is informed by novice researchers and overseen by early-career scientists (graduate students and postdocs) (96). This system legitimizes the idea that science can be done by junior academics and does not require constant oversight by highly experienced Ph.D.’s to be trustworthy and valuable (96).

Considerations for developing antiracist policies and practices

As stated by MacDonald et al., “authentic changes in individual behavior are only maximally effective if they are contextualized within a system that communicates the value of equity through its incentive, evaluative, and support structures” (28). Classroom- and faculty-centered approaches are most often suggested in JMBE literature as methods to increase DEI (24), as validated by my literature review, where about 55% (42/76) of the papers were focused on classroom approaches or faculty development. However, department- and institution-wide approaches are more aligned with the antiracist framework described by Kendi (3).

There are notable policies and practices proposed in the JMBE literature that consider systemic challenges, as noted by the number of papers aimed at department or institutional change (34/76). Elliot (97) discusses the importance of journal fee waivers for “community colleges or minority-serving institutions,” “under-resourced countries,” and those holding “temporary positions” such as a graduate student, postdoctoral fellow, or adjunct, or “early-career faculty.” This thinking validates financial inequities. Martinez (17) suggests that all institutions and/or programs implement faculty training to address DEI, citing a free program offered by the ambassadors of the Partnership for Undergraduate Life Sciences Education (PULSE). This thinking validates resource inequities but also widespread mindset change. Ardisson et al. (15) propose laboratory boot camps for all biology programs to adhere to medical school admission requirements but increase accessibility for remote learners, which tend to include more underrepresented students and “education deserts.” This thinking validates access inequities. These three examples are all systemically focused and in alignment with antiracist philosophy. They also require buy-in from many types of stakeholders, including journal and financial stakeholders and institutional and faculty stakeholders.

As noted in the introduction, Schloss and colleagues (1) propose systemic changes for journals and academic communities.

Some of these changes include tracking the representation of Black microbiologists and calling for work that “impacts the Black community” (1). Additionally, Asai (2) and Sparks et al. (38) situate the need for faculty and curricular development in a sociohistorical context. These are important considerations. I offer additional considerations for the science education community based on my review and my familiarity with critical scholarship:

- a. Explore the various ways in which DEI is worthwhile, beyond financial or economic incentives. Consider factors like community, social-emotional wellness, or the social restoration of humanity and dignity (51).
- b. Tailor department and institutional curricula, active learning experiences, and authentic research to the needs of your immediate community (72). If you do not know the needs of your immediate community, consider conducting a needs assessment.
- c. Engage faculty and more powerful stakeholders in DEI plans and initiatives, including institutional administrators and leadership of conferences, academic journals, and grant-funding agencies.
- d. When suggesting a method that could reduce inequities, look further for the systemic cause. Create clear connections between the symptoms of oppression and the systems of oppression (4).
- e. Carefully consider academic and social language in verbal and written communication and the implied meaning of that language.
- f. When planning or disaggregating data for DEI, consider the range within demographics. For example, Asian students are often grouped with White students in analyses because certain Asian ethnicities tend to perform just as well as White students academically and professionally. Consequently, some Asian and Pacific Islander (API) communities remain unseen and underserved (23, 35, 68).
- g. Consider the many intersections of identities that exist beyond race or ethnicity (26). Develop the capacity for supporting multifaceted identities such as “Black female scientists” and “Latinx queer scientists” who continue to experience hardships beyond their White, male, or heterosexual counterparts (24, 38, 39; for more information on intersectionality, see references 98 and 99).
- h. Never pressure a person of color to educate others using their trauma and/or experiences (100). A list of diverse academic speakers was suggested by Hagan et al. (23) as an accessible tool to elevate marginalized voices in the field of biology, but the authors also stress the importance of self-nomination and willingness to speak to be on the list. This sentiment extends to other areas of DEI.
- i. Ensure accountability to antiracist initiatives through external evaluation. With all proposed actions for DEI, there must be robust evaluation plans to examine promising policies and practices. If the evaluation concludes

that the practice or policy does not result in antiracist outcomes, it should be revised or eliminated in a timely manner. For more information about equitable evaluation, visit the Equitable Evaluation Initiative website (<https://www.equitableeval.org/>).

CONCLUSION

The antiracist framework challenges us to examine subjugating practices and liberating practices in all aspects of science education and scholarship. There are opportunities for all stakeholders to get involved, from graduate teaching assistants to grant-funding agencies. Folks with relatively less power in post-secondary systems can more easily focus on mindset changes and small actionable goals, such as creating inclusive active learning strategies and multicultural science approaches. Ideally, this will lead to grassroots systemic change. On the other hand, powerful stakeholders are well positioned to challenge systemic issues like elitism in science and capitalist motivation. Systemic change leads to structural incentives for antiracism. With all pushes, critical reflection and equitable evaluation will be important to inform promising practices and to continue forward. JMBE has published work by powerful thought leaders in our field who clearly care about DEI, whether their proposed ideas align with Kendi's (3) version of antiracism or not. I am excited to see where our commitment to DEI takes us.

SUPPLEMENTAL MATERIAL

Supplemental material is available online only.

SUPPLEMENTAL FILE 1, DOCX file, 0.1 MB.

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