











Anti-racist interventions to transform ecology, evolution and conservation biology departments

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Racial and ethnic discrimination persist in science, technology, engineering and mathematics fields, including ecology, evolution and conservation biology (EECB) and related disciplines. Marginalization and oppression as a result of institutional and structural racism continue to create barriers to inclusion for Black people, Indigenous people and people of colour (BIPOC), and remnants of historic racist policies and pseudoscientific theories continue to plague these fields. Many academic EECB departments seek concrete ways to improve the climate and implement anti-racist policies in their teaching, training and research activities. We present a toolkit of evidence-based interventions for academic EECB departments to foster anti-racism in three areas: in the classroom; within research laboratories; and department wide. To spark restorative discussion and action in these areas, we summarize EECB's racist and ethnocentric histories, as well as current systemic problems that marginalize non-white groups. Finally, we present ways that EECB departments can collectively address shortcomings in equity and inclusion by implementing anti-racism, and provide a positive model for other departments and disciplines.

Recent global attention towards the Black Lives Matter movement has provided opportunities for both critical self-reflection and progress in the academy—a transformation that has long been called for by under-represented faculty members, students and staff. Members of ecology, evolution and conservation biology (EECB) fields have recently called for acknowledgment of, and action to address, long-standing barriers to inclusion and equity for Black people, Indigenous people and people of colour (BIPOC)^{2–4} (Box 1, Supplementary Table 1). These calls have focused not only on recognizing racism, but on actively implementing anti-racism: actionable practices and policies to identify, challenge and change values, structures and behaviours that perpetuate systemic racism^{5,6}. While diversity and inclusion initiatives seek to increase representation of BIPOC and other marginalized groups, anti-racism initiatives seek to stimulate advocacy and direct action for organizational, social, economic and political changes at scales from the individual to the institution and society⁷. Anti-racism has been proposed as a solution to address both historic and present marginalization, bias and racism, as well as a mechanism to correct substantial under-representation of BIPOC in EECB^{4,8}.

Racial and ethnic inequities remain ubiquitous in science, technology, engineering and mathematics (STEM), and specifically in EECB. EECB students and faculty members of colour remain under-represented. This is largely due to financial and social barriers, including inadequate financial compensation, a lack of recognition of achievements due to implicit bias, and disproportionate representation on selection committees (for example, refs. 9–11). For example, in the United States, representation of BIPOC is generally low across STEM fields, and this problem is exaggerated in EECB^{12,13}. In 2018, non-white students—especially Black

and Asian students—were more under-represented among EECB PhD recipients than other STEM fields (Fig. 1). From 2014–2018, only 0.2% of US PhD graduates in ecology and evolutionary biology were American Indian or Alaska Native, and 1% were Black¹⁴. Furthermore, Black scientists make up just 0.7% of biology faculty members at large public universities¹⁵. Similarly, in the United Kingdom from 2016–2017, only 0.6% of university professors were Black¹⁶. In many countries, representation of Indigenous groups is low in STEM fields. For instance, in Australia in 2015, Indigenous student enrolment in STEM programmes was fewer than 1,000 individuals—far lower than for other fields of study¹⁷. While much of the research on this problem has focused on a handful of countries, patterns of racial and ethnic under-representation in STEM persist globally, as well as within international settings. Non-white groups are also under-represented among recipients of funding and awards, and as members of professional ecological societies^{13,18–20}. This lack of representation leads to a self-fulfilling prophecy, where members of under-represented groups may experience barriers to their important contributions²¹.

These statistics underscore the opportunity and obligation of EECB and related disciplines to increase racial and ethnic diversity and advance social justice in education and research. Increased visibility of the challenges faced by Black naturalists, students, staff, faculty members and researchers in field and academic settings^{21–24} has led many EECB departments to seek resources to implement inclusion and anti-racism. Concrete, research-driven actions are critical for change, but dismantling racism in EECB also requires understanding and acknowledgement of its origins and sources. In this Perspective, we present the historical context of racism in EECB and follow with actionable practices drawn from the literature and

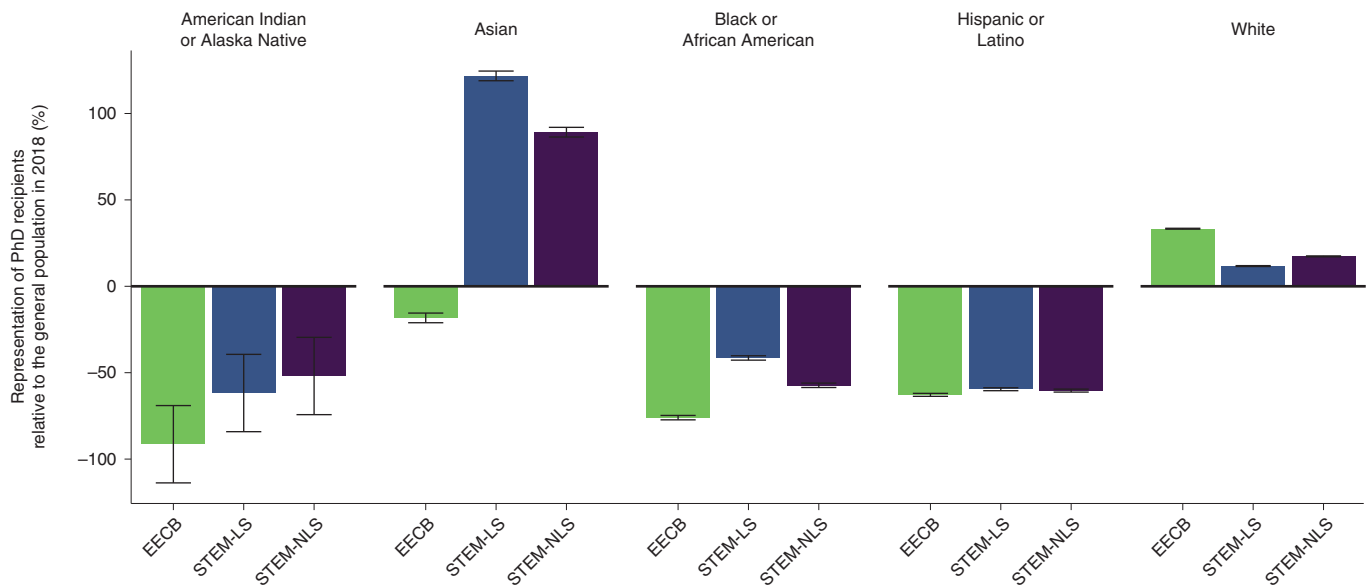


Fig. 1 | Representation of BIPOC among students in EECB, other life science fields and non-life science STEM fields in the United States. Bar graph of the representation of people of different ethnicities among students of EECB ($n=1,661$), STEM-LS ($n=7,473$; includes all five fields under the National Science Foundation (NSF) subfield of life sciences that we did not categorize as EECB) or STEM-NLS ($n=16,339$; includes all other (non-life science) STEM fields, as defined by the NSF Survey of Earned Doctorates¹⁵⁹). The percentage of PhD recipients of each racial or ethnic group¹⁵⁹ was subtracted from the estimated percentage of each group in the United States then divided by the percentage of each race or ethnicity in the United States (American Indian or Alaska Native = 0.7%; Asian = 5.6%; Black or African American = 12.3%; Hispanic or Latino = 18.3%; white = 60.2%)¹⁶⁰. Positive values indicate over-representation and negative values indicate under-representation relative to the US population. The racial categories in this figure are those used by the NSF and US Census Bureau and differ slightly from those used elsewhere in this paper (for example, Hispanic or Latino instead of Latin). The error bars represent 99% confidence intervals from the US Census Bureau. The data from the NSF were from a complete census and contained no sampling error. See the Supplementary Information for more details on data collection.

policies for implementing anti-racism in three areas: (1) classes; (2) laboratories and research groups; and (3) departments. To support instructors, laboratories and departments wishing to adapt these recommendations, we have also produced the following resources: (1) a glossary of important terms (Box 2); (2) an anti-racism checklist for departments (Supplementary Data 1); and (3) a resource list of anti-racist practices and pedagogy for EECB departments (Supplementary Table 1).

Racism and EECB: a difficult history

EECB disciplines have problematic social and political histories (Table 1). One of the earliest contributions to modern ecology was the development of taxonomic nomenclature, led by the Swedish botanist Carl Linnaeus. This original nomenclature codified the pseudoscientific theory of varieties of humans, which were based on skin colour and placed white Europeans above all other races²⁵. More than two centuries later, many scientific practices and terms still reflect this Eurocentric and racist legacy. For instance, many species carry scientific and common names that commemorate eugenics proponents, Confederate generals, slave owners and even Adolf Hitler²⁶. Seldom do taxonomy and natural history nomenclature reflect local knowledge predating species discovery by Euro-American naturalists. Beyond naming, Western scientists have engaged in colonial or parachute research, travelling to low-income countries to conduct ecological research that excludes local and Indigenous people²⁷. Some contemporary ecologists have pushed theories based on simplistic narratives of resource exploitation and overpopulation^{28,29}, which have been used to justify compulsory sterilization and even genocide, almost exclusively in poor communities within developing countries³⁰.

The discipline of evolutionary biology has also been used at times to advance racist ideology³¹. In fact, the writings of Charles Darwin,

who is widely considered the father of evolutionary thought, contained racist ideas, including the belief that white Europeans were evolutionarily more advanced than the so-called savage races they colonized³². Beginning in the late 1800s, the theory of natural selection was also misinterpreted in some intellectual circles to advance eugenics and social Darwinism, as well as to make apocryphal claims about race and gender³². Since its publication, evolutionary theory has been distorted to fuel false claims of scientific racism in modern social and scientific literature^{33–35}, despite widespread and explicit scientific consensus to refute these ideas^{36–38}.

In many ways, modern practices of conservation biology are similar to those of early Western ecology and natural history, in which Europeans led expeditions to foreign countries to collect and ‘discover’ taxa often already long-known to Indigenous peoples³⁹. Just as ecologists have been criticized for colonial fieldwork, modern conservation biologists, practitioners and policymakers have too often marginalized local communities^{40,41}. Conservation practice and research have been used to justify displacement, ethnic cleansing and marginalization of Indigenous peoples in many countries to create national parks and protected lands^{42,43}. As an example, our university, the University of California, Santa Cruz (UCSC)—a leader in conservation research—sits on stolen land of the Awawas-speaking Yypi Tribe, a theft that was financed by other land grabs from Indigenous people across the country⁴⁴. Finally, several modern-day conservation organizations and agencies still uncritically idolize their racist founders, including Theodore Roosevelt (US National Park Service), John Muir (Sierra Club) and Madison Grant (Save the Redwoods), and have only just begun to reckon with their disturbing racist histories^{45–47}.

These historic legacies contribute to racial gaps in EECB because they influence norms and popular perceptions today in ways that discourage participation by BIPOC in EECB fields. Examples

Box 1 | Positionality of the authors

This work was authored by a diverse group of EECB faculty members, staff and students of multiple racial and ethnic identities at UCSC. As such, we recognize that these recommendations are the product of our survey of the literature, but are also informed by the experiences, backgrounds and intersectional identities of the authors—natural scientists belonging to a single department at a single university—and therefore cannot be interpreted as universal¹⁶¹. We draw on the foundational contributions of many BIPOC scholars whose work confronting the colonial and racist histories of academia, science and EECB has informed this Perspective (for example, refs. 4,14,84,87,162,163), and as members of the EECB academic community, we are invested in the outcome of this work¹⁶⁴. However, the process of implementing effective anti-racist practices is linked to the unique socio-geographic histories of colonization and racism at different institutions. Therefore, we see that this is not a one-size-fits-all approach; rather, we aim to stand with and aid our own and other EECB departments in adopting and adapting these recommendations to implement anti-racism as a requisite to a justice-centred praxis in EECB⁸⁷. We envision the implementation of these anti-racist practices as one step in a larger process that extends beyond the academy¹⁶². Furthermore, in this work, we focus on anti-racism in particular, and we use the term BIPOC to refer to multiple groups of non-white racial and ethnic identities that have been historically marginalized in multiple countries, acknowledging that it (and any term that groups people as a monolith) is inherently divisive and risks eliding the complex, heterogeneous experiences of these groups. We recognize that academic and STEM fields have also imposed intersectional barriers for women, individuals who identify as lesbian, gay, bisexual, transgender, queer and intersex (LGBTQI+), individuals with disabilities and many others^{165,166}. Anti-racist practices frequently have manifold benefits for other identity groups^{7,167}. Where appropriate, we use BIPOC to represent multiple racially marginalized groups, while acknowledging that it has problems, limitations and risks, and encourage future research that further explores these areas of friction and how to tailor recommendations to best support the unique needs of intersecting identity groups¹⁶³.

include: ideas about social Darwinism in school curricula and the popular press; lists of famous scientists that lack racial and ethnic representation and idolize racists; and conceptions of conservation scientists as experts who deliver knowledge to poor communities, rather than working with or consulting local stakeholders. These intersectional histories of racism and colonization have led to an EECB discipline that manifests systemic racism and oppression.

To overcome these legacies, the field will need to acknowledge its history and the limitations of a Eurocentric view; anti-racism is one important step towards disrupting these forms of oppression. Addressing these limitations is just one part of adopting an anti-racist institutional strategy for EECB departments.

Anti-racist practices in teaching

Incorporating anti-racist pedagogy into course content and delivery can reduce barriers to inclusion, remedy academic inequities and strengthen anti-racism across academic culture. In this section, we review evidence-based reforms for course content and design to increase undergraduate and graduate retention and inclusion in EECB fields⁴⁸. Building an inclusive classroom climate fosters STEM identity and increases retention for students from under-represented groups^{12,49,50}. This is particularly important in the first two years of undergraduate study, which are critical for the

retention of under-represented students in STEM⁵¹. Instructors can improve the climate by including diversity statements on course syllabi, explicitly discussing departmental anti-racist values on the first day of class (for example, by reading aloud and discussing departmental anti-racism statements), providing protocols for anonymous reporting of hate or bias, and acknowledging the value of diversifying STEM⁵².

Beyond the classroom climate, incorporating equity-based pedagogical modifications in course design can narrow achievement gaps for students from racially marginalized groups. Many current STEM teaching practices, such as large, lecture-only courses with high-stakes exams to weed out students (for example, organic chemistry) disproportionately exclude students of colour from STEM and hamper efforts to increase diversity⁵³. Alternatively, cohesive learning communities and active learning, in which students interact with each other to learn materials rather than passively attend lectures, offers immense benefits for students from under-represented groups⁵⁴. Field courses and well-planned group activities in which students practice scientific skills increase student interest, content retention and performance while building confidence and positive STEM identity^{55–57}. Forums led by faculty members to share inclusive teaching practices can help spread pedagogical knowledge through courses and departments⁵⁸. These interventions need to be continuously evaluated to avoid unintended consequences that amplify inequities, such as increased course fees.

In addition to these equity-based modifications of course design, instructors can incorporate wise interventions. Wise interventions are low-investment, high-impact classroom actions that improve academic achievement and educational outcomes⁵⁹ (Table 2). These interventions disproportionately improve educational outcomes for BIPOC^{60,61} and increase persistence, retention and achievement in a range of STEM settings⁶².

Beyond modifying course delivery, instructors can incorporate anti-racist materials into their curricula. Curricular content in EECB should reflect the realities of the field's past and present, including racism, colonialism and displacement (see Table 1). For example, a lesson on human genetics that discusses the contributions of Ronald Fisher and James Watson can also address the history of eugenics⁶³ and the population genetics research that refuted eugenicists' pseudoscientific claims³⁰. It is also important for curricula to acknowledge historically ignored, local and traditional ecological knowledge and resources and the ways they were and are degraded or exploited during EECB research⁶⁴. For instance, curricula on protected area design can include consideration of Indigenous communities, equitable management and colonialist histories of land conservation^{65,66}. Building on this, instructors can include in lessons on biodiversity and conservation the acknowledgement of multiple ways of understanding and valuing nature, including cultural, aesthetic and spiritual values, as well as non-Western valuation of ecosystems and biodiversity^{67,68}. To connect this content to immediate societal issues, curricula can also include modern examples of the ecological and evolutionary consequences of systemic racism on human communities^{66,69,70}, as well as themes of environmental justice and contemporary efforts to address these issues^{4,71,72}. Instructors can additionally highlight examples of notable research by scientists of colour and explicitly discuss societal and institutional barriers they overcame and highlight barriers that continue to hamper representation of BIPOC in STEM^{12,31,73}. Highlighting past and current work by scientists of colour with whom students can identify is a crucial way to build science identity in students from racially marginalized groups^{12,31,74}.

Finally, gaining access to STEM careers requires more than high achievement in courses. Instructors can explain the importance of academic and professional opportunities outside of the formal STEM curriculum that confer access to careers in academia and industry⁷⁵. Students from under-represented groups are less likely to be informed

Box 2 | Glossary of key terms

Anti-racism. Practices and policies that identify, challenge and change the implicit and explicit values, structures and behaviours that perpetuate racism^{6,7}.

BIPOC. An acronym that stands for ‘Black people, Indigenous people and people of colour’. BIPOC is used to refer to multiple historically racially marginalized non-white identity groups, with particular focus on the experiences of Black and Indigenous peoples (<https://www.thebipocproject.org/>).

Implicit bias. Unconscious attitudes, stereotypes and/or negative associations that can affect an individual’s understanding and actions towards people or identity groups¹⁶⁸.

Prejudice. Preconceived opinions about an identity group based on generalizations or stereotypes that are usually, but not always, negative¹⁶⁹.

Racial discrimination. An action or actions that treat individuals or groups differently due to their race or ethnicity¹⁷⁰.

Racial microaggressions. Brief actions that communicate hostile or derogatory messages based on racial or ethnic stereotypes; these can be verbal, non-verbal or environmental (that is, in a social or physical context)¹⁷¹.

Racism. The belief that race is a determinant of human capacities, justifying contempt for and perceived superiority over racial and ethnic identity groups¹⁷².

Stereotype. An often erroneous oversimplified and generalized belief about members of an identity group or group of people¹⁷³.

Stereotype threat. The fear an individual feels of confirming negative stereotypes about an identity group to which they belong or with which they associate. This threat can impact an individual’s performance or can cause them to act differently to avoid confirming a stereotype¹⁷⁴.

White privilege. Unearned and often unconscious advantages and benefits available to people who are perceived as white¹⁷⁵.

about the hidden curriculum: unspoken norms, behaviours, etiquette and implicit expectations around seeking and effectively gaining access to scientific careers⁷⁶. To teach these, instructors can explain how to access (and fund) institutional research opportunities, work-study programmes, graduate school and internships both inside and outside of academia⁷⁷. Cohort-based mentoring programmes can also transmit institutional, social and cultural capital and improve access to funded opportunities, particularly for BIPOC^{57,76}.

Through modified pedagogy and curricula, wise interventions, greater representation of BIPOC in course content and incorporation of hidden curriculum, courses can provide actionable, high-impact arenas to practice anti-racism and widen the participation of under-represented students in EECB fields.

Anti-racist practices in laboratories and research groups

Best practices for anti-racism in the laboratory can have an immediate impact on the career trajectories of students from racially marginalized groups⁵. Principal investigators and laboratory members can show support for diversity, equity and inclusion through their actions in the laboratory, which will help to create a laboratory environment where diversity is expected and respected.

First, principal investigators can make recruitment of BIPOC a priority by focusing on prospective student potential as well as past achievement, and by including recruitment and support for

BIPOC at graduate and undergraduate levels in grant proposals. When reading and writing reference letters, principal investigators should be aware of unconscious (or implicit) biases associated with race and ethnicity and of whether applicants come from a research or non-research institution⁷⁸.

Once BIPOC have joined the laboratory, research laboratories are the daily environments where the great majority of mentor-mentee and peer-peer interactions take place in science. Therefore, it is essential that laboratories host open conversations about diversity, equity and inclusion, as well as how racism manifests in macro- and microaggressions, unspoken expectations, routines and wealth disparities⁷². Discussing and formalizing goals and actions helps to set expectations for promoting anti-racism. As a first step, laboratories and field teams can build and sign a code of conduct and community agreement. These community agreements set shared norms of respect and communication and delineate unacceptable behaviours, their consequences and the institutional policies that dictate them⁷⁹. They can also include goals and anti-racist actions to promote equity and inclusion in the future. Comprehensive examples of these documents exist and can serve as models⁸⁰, and many laboratories host public-facing versions of these or similar values statements on their websites (Supplementary Table 1).

In addition to community agreements and similar pledges, principal investigators can set aside laboratory meeting times to discuss non-academic topics that are important for career success, such as professional communication, finances during graduate school, cultural values and networking. In particular, principal investigators should acknowledge and confront the toxic normalization of workaholicism among academic trainees, which can lead to unrealistic work expectations and exploitative conditions in the classroom, laboratory and field. Work cultures that pressure or reward trainees to sacrifice personal time in order to advance in science have been identified as a conduit for exploitation and an obstacle to inclusion⁸¹. Principal investigators and supervisors can assess organizational culture in their laboratory group, set realistic and healthy expectations and discuss effective time management skills that do not induce burnout. Mentees from racially marginalized groups also report that individual mentors open doors to professional networks and academic success⁸². Establishing diverse, multi-mentor networks among laboratory members at different professional levels can help all students—especially under-represented students—to navigate barriers to career success⁸³. These mentors can communicate strategies for under-represented students to succeed in academia as well as in potentially high-risk settings for incidents of racism and harassment, such as during fieldwork^{14,84}. Students can also be strong agents of change, and several universities have developed successful workshops focused on mentoring up, which guide mentees to take engaged roles in their own mentoring relationships⁸⁵ (Supplementary Table 1).

Beyond day-to-day laboratory activities, demonstrating ongoing commitment to anti-racist practices is important for retention. When setting laboratory research agendas and priorities, EECB scientists can avoid traditional research approaches that contribute to the problem of colonial science in fieldwork⁸⁶. EECB scientists can commit to decolonizing fieldwork: collecting data only in places where they have been invited; recruiting local students and technicians; including a land acknowledgement in publications and presentations; and consulting with and collaborating in people-centred partnerships with local scientists and communities to produce participatory, reciprocal research that meets the needs of community stakeholders^{39,87–92} (Supplementary Table 1). For instance, the Amah Mutsun Relearning Program at UCSC is one example of a research and conservation project that involves participation and collaboration with local Indigenous stakeholders⁹². Laboratory members can make research findings accessible by translating papers and communication materials into local and Indigenous languages to ensure

Table 1 | A subset of historic examples of racism and ethnocentrism across disciplines within EECB

Field	Discipline	Historical examples of racism and ethnocentrism
Ecology	Natural history	Expeditions and so-called discoveries in occupied lands; specimens collected by slaves for their owners ³⁹ A Congolese man, Ota Benga, on display alongside animals at the Bronx Zoo, by eugenicist Madison Grant, among others ¹³⁵
	Taxonomy	Species named after slave owners, Confederate generals, eugenicists and derogatory terms for racial groups ^{26,136} Awards, scientific buildings and journals named after racists and eugenicists ¹³⁶
Evolutionary biology	Population genetics and genomics	Eugenics used to justify white supremacy and compulsory sterilization of patients based on inaccurate gender and racial biases ¹³⁷ Co-discoverer of the DNA double helix, James Watson, used genetics to defend racist beliefs ⁶³
	Human evolution	Social Darwinism drew on the theory of natural selection to legitimize imperialism and racism ^{138,139} Human evolution used to justify the concept of scientific or biological race, leading to the pseudoscientific manipulation of evolutionary theory to argue that some races are inferior to others ⁴⁵
Conservation biology	Protected area designation	Displacement of Indigenous communities to create national parks, leading to conservation refugees ¹⁴⁰ Notable land preservationists, including Theodore Roosevelt, Madison Grant, Gifford Pinchot, and John Muir were proponents or supporters of racism and eugenics ^{46,141}
	Conservation and development	Colonialist or parachute conservation practices carried out by researchers from wealthy countries in poor countries without inclusion of local stakeholders, values and cultures ¹⁴² Loss of indigenous culture, knowledge and autonomy following colonial displacement for conservation lands ¹⁴³ Militarization of conservation, contributing to violence, death, displacement and other unjust outcomes ¹⁴⁴

This table does not include issues related to under-representation of racial and ethnic groups, as research on representation is rarely categorized by sub-discipline.

that the products of the research are accessible. Many countries now have rules in place to safeguard native biodiversity, genetic resources and local Indigenous knowledge^{93,94}. Rather than resisting them, EECB scientists should openly embrace these rules and share with their students and colleagues why they are important⁸⁷.

In summary, laboratories and research groups are directly positioned to build a culture of anti-racism and equity. They provide small-group settings in which to discuss expectations in science, which can be leveraged to create healthy research environments, build mentoring networks and set positive fieldwork and ethical norms, with the ultimate goal of producing the best scientific knowledge and professional development for the next generation of scientists.

Anti-racist practices in departments

EECB departments are broad but like-minded academic communities within which meaningful structural changes can cultivate an anti-racist culture. These changes should come from inclusive departmental discussions, advocating within the university and partnering with university administration to make lasting change.

Creating internal departmental structures to combat racism builds a permanent foundation of continuous support for faculty members, students and staff from racially marginalized and under-represented groups. Departments can start by collectively developing a diversity vision statement and code of conduct that include both rules and norms for behaviour, as well as aspirations, goals and concrete actions to achieve equity⁹⁵. Departments can also foster community growth by actively and transparently addressing barriers to progress. For example, departments can host forums for the productive discussion of racist language and behaviour, and provide tools for bystander intervention; create and publicize safe reporting channels for harassment,

bias and discrimination; and sustain mutual support networks for students, postdoctoral researchers, staff and faculty members. Social events enriched by diverse input from across department constituents offer a low-stakes way to build community and respect, paving the way for deeper conversations; these events can be open to all professional levels, or alternatively closed to faculty members or supervisors to provide a safe space for students and trainees to discuss these issues in without superiors present. Departments can also spark discussions about race in academia and in EECB, such as through #ShutDownAcademia, #ShutDownSTEM and the Strike for Black Lives. Anti-racism competence can be built through well-designed, evidence-based interactive trainings that allow participants to hone professional skills through an equity lens, such as effective hierarchical mentoring⁹⁶ and inclusive teaching practices. Diversity, equity and inclusion committees can provide leadership that cuts across departmental hierarchies, gathering collective insight across career levels to set agendas and achieve goals (for example, see the Ecology and Evolutionary Biology Department's Inclusion, Diversity, Equity, and Action (IDEA) Committee at UCSC⁹⁷). These committees can serve as springboards for assessing the departmental climate, addressing department-specific needs and ensuring accountability. Providing monetary support or other concrete career incentives for participation on such committees can help to avoid diversity fatigue and signal the value of such work to the institution⁹⁸.

Hiring, promotion, tenure and retention processes are critical tools for building equity, as well as inclusion, in departments. Recruitment of under-represented faculty members requires a commitment to anti-racism at all stages of the process, from drafting the job description and outreach to qualified candidates to evaluating candidates, interviewing and negotiation⁹⁹. Departments

Table 2 | Examples of wise interventions and how they work

Wise intervention	Explanation	How it works	Why it is anti-racist	Examples for the classroom
Growth mindset	Intellectual abilities are malleable, not fixed, and can be developed with effort and guidance ^{145,146}	When a topic is challenging, a fixed mindset might lead to viewing the topic as beyond the student's ability; conversely, a growth mindset facilitates the belief that struggle is normal and can ultimately lead to mastery ^{146,147}	Growth mindsets can create inclusion, curb racial bias, remove stereotypic beliefs and narrow achievement gaps between URM students and their peers ^{148,149}	Explicitly discuss intelligence as a learnable trait; highlight, praise and value effort rather than just correct answers; and explain that challenges and mistakes are excellent learning opportunities ¹⁴⁵
Utility value	Exercises that increase the perceived value and importance of a given topic for students' lived experiences ¹⁵⁰	Highlighting STEM knowledge's short-term relevance to students' personal values increases interest, ownership and commitment to lesson content ¹⁵⁰	Utility-value interventions lead to engagement and active thinking, which can improve academic performance, particularly for URM and first-generation students ⁵⁰	Ask students to write an essay about the usefulness or personal value of a scientific study to their lives ¹⁵¹
Values affirmation	Affirmation of personal core values and belonging in a previously threatening academic environment ¹⁵²	Values affirmation interventions can ameliorate psychological threat and stress to directly increase academic performance ^{5,153–156}	Values affirmation disproportionately helps students who are targets of negative stereotypes by shifting the focus away from stereotype threat (Supplementary Table 1) and towards belonging, experience and perspectives ¹⁵¹	Assign writing prompts where students identify personal values and explain their role in overcoming academic obstacles ^{157,158}

URM, under-represented minority.

can aggressively pursue a diverse pool of applicants by advertising through diverse networks, writing job advertisements in inclusive ways, describing a welcoming climate and identifying a more diverse faculty as a departmental goal^{100,101}. Faculty recruitments should require diversity statements and can use them as an initial filter rather than as supplementary information; this approach has been used successfully in several recent, high-profile recruitments^{101,102}. By centring diversity as a department value, the hiring process can also be an opportunity to expand and communicate an anti-racist department culture. The norms of academic freedom and the First Amendment usually preclude removing individuals who persist in racist speech and behaviours¹⁰³; this highlights the critical importance of identifying a candidate's commitment to anti-racism before bringing them into the community. Offer letters and contracts communicate standards for conduct, discipline and reporting and are therefore an early opportunity to enhance an inclusive culture.

Beyond hiring, the tenure and promotion process is crucial to both advance equity in the assessment of faculty members of colour and to recognize, incentivize and reward faculty members who work to implement anti-racist practices. Faculty members of colour commit disproportionately more time and effort towards diversity initiatives⁹⁹ and often bear a cost (that is, a time tax taken away from research) for the additional diversity-supporting service they are asked to perform⁶. They may even be penalized for engaging in diversity-valuing behaviour and activities by colleagues who perceive these activities as excessive or unimportant¹⁰⁴. Departments can ensure diverse representation on promotion and tenure committees, evaluate candidates using transparent rubrics, communicate expectations openly and provide mentoring to help candidates meet those expectations, and explicitly recognize contributions to hidden work, including diversity and equity programming, committee work, emotional labour, mentoring and accessibility to undergraduates, all of which are often disproportionately performed by members of under-represented groups^{105,106}.

To more broadly address discrepancies in who takes on the labour of diversity-supporting services, department members—particularly those from well-represented racial and ethnic groups who have benefited from academic and personal privileges under

current societal and academic reward systems—can take the lead in implementing anti-racist practices. These members can devote time, resources and effort to ensure that departmental dedication to diversity is equitably upheld.

An easy and immediate department-level intervention is to highlight the work of scientists from racially marginalized groups in weekly seminars and reading groups. Departments now widely attend to gender balance in speaker series and readings, and should also include racial and ethnic diversity in these considerations¹⁰⁷. Seminar speakers provide students of colour with key opportunities to interact with same-race or culturally similar faculty members within predominantly white institutions¹⁰⁸, while also promoting exposure and networking for speakers from under-represented groups⁸⁹. Departments can invite speakers to highlight their social justice work and personal experiences in science, as well as their scientific contributions (and the intersections of these spheres) as a way to place value on different types of contributions and highlight social responsibility. Reimagining these existing forums, rather than creating new ones, does not require extra time and normalizes anti-racism in ongoing departmental activities.

These efforts towards greater BIPOC representation are broadly beneficial, but the challenges faced by BIPOC international students deserve special attention. International students from racially marginalized groups have historically faced discrimination while studying or working in another country⁹⁰ and are especially under-represented in EECB departments^{12,96} (Fig. 1). For that matter, many under-represented students may face a similar problem of culture shock at majority-white institutions, even in their home country^{109–115}. These students may face additional and intersectional challenges at predominately white institutions, including cultural adaptation, language barriers, loneliness and even neo-racism^{90,94–96}. Departments can implement peer-to-peer mentoring systems⁷⁶, with mentoring structured beyond academic affairs to include advice on cultural adaptation and communication skills. Faculty members or staff who are educated on the unique challenges that international students face can advise and build support structures and community. All faculty members and staff can facilitate access

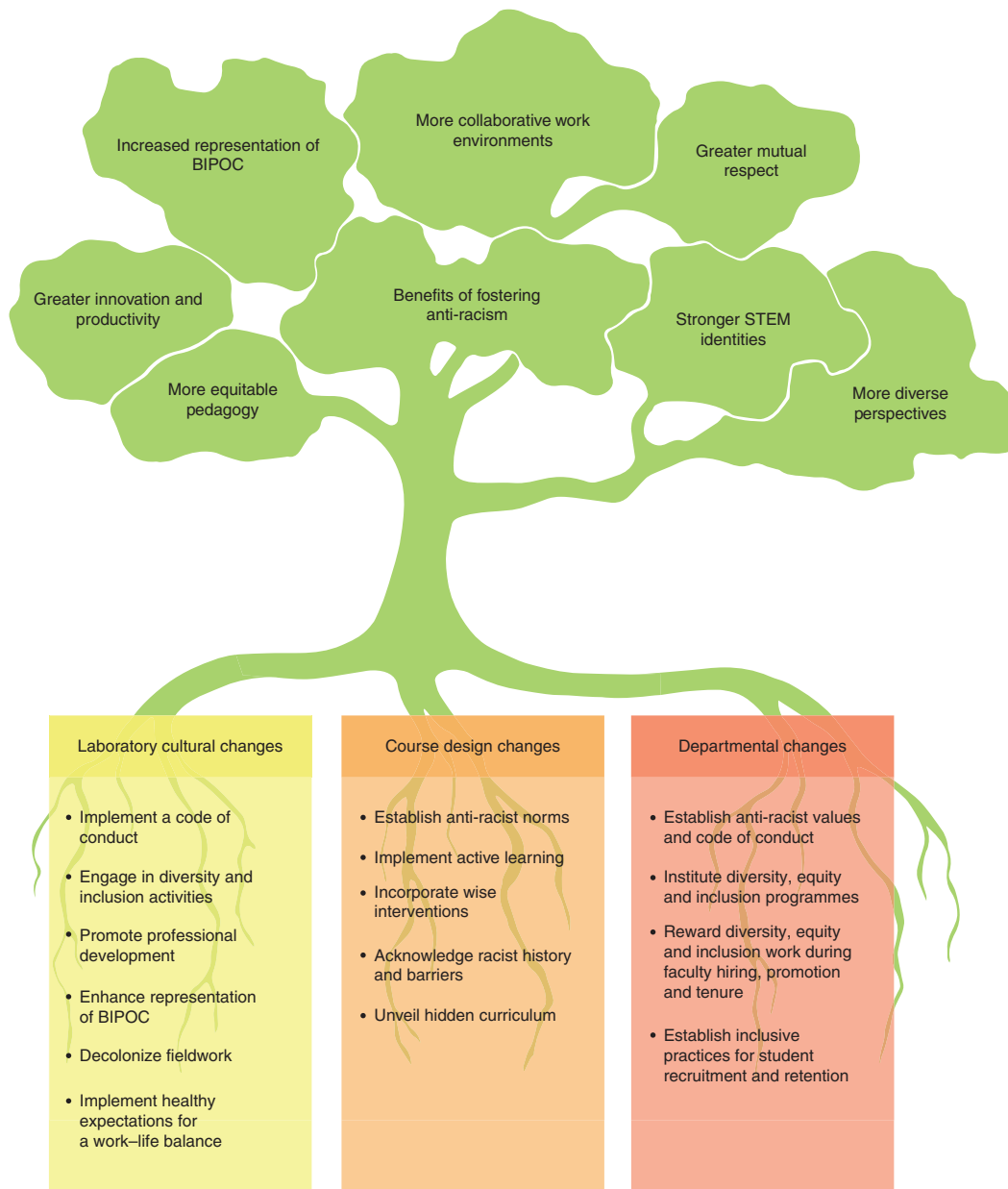


Fig. 2 | Fostering anti-racism through changes and actions at different scales, including curricula, laboratories and departments, will result in many benefits in EECB. The benefits presented in this figure are a small subset of the positive outcomes of fostering anti-racism in EECB. Illustration courtesy of Julie Johnson.

to existing resources, including mental health counselling and financial planning.

Finances are a challenge for many students, but may disproportionately impact students from low-income families with less accumulated wealth. Departments can address financial barriers to increase diversity and inclusion for students. Graduate programmes obstruct the enrolment and retention of BIPOC when stipends are too low relative to local costs of living¹¹⁶. Departments can ease financial burdens by including advance payments (rather than reimbursements) via direct deposit for travel and work- or field-related equipment, disbursing graduate support at the start of the month or academic quarter (rather than the end) and providing information on the availability of short-term loans, grants and other resources for students when needed¹¹⁷. Providing paid research opportunities and creating fellowships for undergraduates is another way to support BIPOC while

helping to prepare and recruit future graduate students. Ultimately, departments with strong commitment to increasing diversity can commit funds to this end, helping alleviate disproportionate economic barriers.

In summary, departments can make concerted efforts to provide welcoming and supportive settings for current students, postdoctoral researchers, staff, researchers and faculty members from racially marginalized groups. While creating structures to recruit more under-represented candidates is essential, simply recruiting more under-represented individuals to assimilate into majority-white departments is not enough and can ultimately harm the retention and success of BIPOC in academia². To embrace an anti-racist agenda and create a more inclusive future, EECB departments can implement the best practices outlined here, and provide top-down models for laboratories, classes and other academic departments.

Anti-racist practices beyond the department

We have presented actionable practices for anti-racism at different academic scales, but these changes cannot and should not occur in isolation. Effective implementation requires concerted efforts at all organizational levels¹¹⁸. Departments can engage more broadly with racially marginalized communities beyond the confines of the academy. Many departments host education and early learning service programmes that have the capacity to increase future recruitment and retention for BIPOC in STEM and EECB. Such programmes prepare grade school and undergraduate students for STEM career advancement¹¹⁹. STEM recruitment programmes for younger students can take the form of summer science camps, community open house events or digital or active learning classroom materials for students and teachers. EECB departments can also collaborate with education departments to develop experiential education in and out of the classroom. It is also essential that individuals adopt anti-racist practices as they engage in other roles within their field (for example, as editors, reviewers and committee members) and in association with publishers, funding agencies and scientific societies.

At the university level, administrators can direct funding and establish incentives for departments to implement and maintain the practices described here. Physical spaces such as buildings and gathering places can be redesigned with equity in mind, including removing statues and honorifics that memorialize racists, as many institutions have begun to do¹²⁰. Departments and institutions can advocate for policing reforms that include ending the use of militarized and heavily armed on-campus police and re-evaluating contracts with local municipal police forces involved in police brutality¹²¹. Widespread inequity in criminal justice and law enforcement means that the presence of militarized campus police disproportionately threatens BIPOC on campus, thus counteracting attempts to create anti-racist campuses and departments^{121,122}.

Conclusion

The fields of EECB must experience great change to ensure meaningful and lasting equity for participants from diverse backgrounds. Anti-racist interventions and best practices benefit academic communities by fostering a diversity of perspectives and ideas that enriches research, teaching and learning^{123,124} (Fig. 2). When done effectively, anti-racist practices lead to greater equity, greater representation of BIPOC in academia and greater diversity among students, instructors and staff. These changes are self-reinforcing as the field shifts from the welcoming in of excluded groups to diverse co-leadership. For students, an education delivered by diverse instructors and surrounded by diverse peers promotes better performance on assessments¹²⁵, persistence and retention in academia^{126,127}, greater cognitive development and cultivation of critical thinking and complex problem-solving skills¹²⁸ and overall satisfaction with the university experience^{126,129}. Beyond individual students, greater diversity of racial and ethnic groups in academia benefits EECB as a field, as it fosters the generation of more novel, high-quality and complex ideas^{130,131}, as well as enriching scholarship and teaching by increasing productivity and collaboration^{132,133}.

Recent social media movements, such as #BlackInTheIvory and #BlackBirdersWeek, illustrate that microaggressions and overt racism persist globally in academia and in EECB^{22,23,134}. EECB departments must collaborate to implement anti-racist academic culture, particularly as these fields still carry a legacy of historic racism. At multiple scales, EECB departments can work collectively to build an anti-racist community based on mutually developed inclusive norms; decolonize teaching, research and fieldwork; incorporate best practices and wise interventions for more equitable pedagogy and classrooms; increase the representation of BIPOC through equitable admissions, hiring and tenure processes; and advocate for larger institutional policies that incentivize and support these efforts. While national movements ignite efforts to change the status

quo, a unified commitment to action, as well as to zero tolerance of racism and discrimination among faculty members, staff, students and institutional leaders, will be key to implementing this change. We envision an EECB academic community where persistent anti-racist structures support racially marginalized students, post-doctoral researchers, staff, researchers and faculty members and increase their representation in our field to the point that they can fully share in its leadership; where active community engagement promotes inclusion; and where all participants are welcome not only to belong, but also to reshape EECB in the image of all of us.

Received: 1 December 2020; Accepted: 24 June 2021;

Published online: 9 August 2021

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Acknowledgements

We acknowledge and thank T. M. L. Scholz, P. DeSalles, M. Carr and J. Straub for their review and insight into this work.

Author contributions

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Positionality statement The authors of this paper are all members of an academic department located on unceded and colonized land of the Awaswas-speaking Uypi Tribe. This institution was originally funded by the expropriation of 150,000 acres of land from Indigenous peoples. The authors' perspectives reflect their race, gender, class, access, ethnicity, religion, ability/disability and status as members of a higher education institution in the United States. This paper cannot therefore offer a complete or global understanding of the problem of racial inequity and discrimination in STEM, but it is hoped that it will contribute the authors' perspectives to an ongoing struggle for racial justice in academia.

Competing interests

The authors declare no competing interests.

Additional information

Supplementary information The online version contains supplementary material available at <https://doi.org/10.1038/s41559-021-01522-z>.

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Peer review information *Nature Ecology & Evolution* thanks Melanie Culver, Danielle Lee and Zoe Todd for their contribution to the peer review of this work.

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