Why we need to decolonize the biosciences curriculum

Lovleen Tina Joshi (University of Plymouth, UK)
Catherine Mansfield (Imperial College London, UK)
Isaiah J. Ting (University of Surrey, UK)
Katharine Hubbard (University of Hull, UK)

Bioscience has a history linked to exploitation, colonialism and marginalization. Biology has been dominated by white European perspectives, and pseudoscientific 'biological' arguments have been used to justify discrimination and oppression, particularly on the basis of disability and ethnicity. Addressing this legacy within bioscience education is challenging, particularly as many bioscientists are unaware of this history and its on-going influence on the discipline. In this article, we explore what decolonization of the curriculum means within the context of bioscience. To demystify terminology for those new to the subject, we first consider the differences between diversification and decolonization. We then explore the historical connections between colonial activity and bioscience, including scientific racism, bioprospecting and eugenics. Additionally, we highlight where white western biases are still present in bioscience, from the dominance of European samples in genomic studies to the lack of Black and Asian academics in UK bioscience. Multiple barriers to decolonization are also considered, from individual lack of knowledge to structural and societal issues. We call on bioscience educators to actively decolonize their curricula, ensuring the discipline is presented in its appropriate historical and cultural context and is inclusive for all.

All scientific disciplines are a product of their history. Who is included and excluded from a discipline shapes the type of knowledge that is generated and creates the research and educational culture for the future. Bioscience is no exception to this, being dominated by white European perspectives through much of its history. Biology has also been actively used as a tool of oppression. Pseudoscientific 'biological' arguments have been used to justify racism and ableism, underpinned the practice of eugenics and resulted in human rights abuses.

We need to confront this history and how it impacts on our discipline to this day. We need to create more inclusive curricula that actively confront the legacies of colonialism, eugenics and exploitation in the name of biology. This is known as decolonization of the curriculum.[i] While decolonization is usually associated with the arts and humanities, it is equally relevant for biosciences and other scientific disciplines. Here, we explore some of these concepts, give examples of relevant topics and consider the barriers to decolonization and diversification. We write mainly from the perspective of UK higher education, but these topics are also relevant and important for international and school-level audiences.

Let's start with some terminology. Diversification is the process of embedding a greater diversity of perspectives, including disability, ethnicity, nationality, sexuality and gender identity. Decolonization requires actively confronting the legacy of colonization, typically through scrutiny or rejection of western-centric ways of thinking and by re-imagining power dynamics between former oppressors and the oppressed. Decolonization arose from the work of Latin American scholars challenging narratives of colonization by the Spanish, but has grown to be a diverse field that considers multiple systems of historic and contemporary cultural dominance. Decolonial theories propose that the influence of colonialism on knowledge, economic and power structures continues long after political independence, and we cannot understand the modern world without understanding the on-going coloniality. While diversification and decolonization are related, they are distinct and it is possible to do one without the other. For example, you could revise your

[i]We acknowledge that the term decolonisation can be controversial in its own right, particularly in communities directly affected by the intergenerational trauma of colonial exploitation. We write from the perspective of UK Higher Education, where decolonisation is a commonly used term, but recognise that this language is not universal. Our UK lens means we primarily focus on the historical impact of the British Empire on our discipline. This narrative will differ for readers impacted by colonial activity of other European powers. We recognise that our thinking is shaped from the perspective of the colonisers, not the colonised. Many current global conflicts can also be seen as colonial in nature, so we also acknowledge that for many these issues represent current trauma and lived experience, not historical legacies. Our intention is to provide a practical introduction to this topic for bioscience educators. We do not imply that our article represents a complete guide to this complex and difficult subject, or that actions we propose are enough to genuinely decolonise the biosciences.

curriculum to ensure that diverse LGBTQ+ perspectives were represented without having done any decolonial work.

Biology and the colonial world

We cannot decolonize before we understand what it means to be colonized. Most bioscientists (ourselves included) do not get any formal education in the historical, social, economic and political context in which scientific discoveries were made. This leads to a lack of expertise and confidence when discussing these topics. The history of colonialism and its relationship to bioscience is vast and an area of research requiring specialist expertise in its own right. Below we give a brief introduction to the field, but this should be viewed as a starting point for further reading rather than an exhaustive account.

Colonial exploitation of natural resources

Science was actively used as a tool of empire building. For example, the 1768 Pacific voyage of James Cook was primarily a scientific expedition to record the transit of Venus funded by the Royal Navy and Royal Society (England's most prestigious scientific organization). Cook collected biological, zoological and geological specimens from many Pacific Islands, and made the first contact between Europeans with both the Māori of Aotearoa (New Zealand) and the indigenous Australian peoples. Cook named his landing place in Australia 'Botany Bay' due to the local plant biodiversity; this was the home of the Gameygal people who called it Kamay. Cook's voyages were precursors to British colonization of New Zealand and Australia, involving devastating impact on indigenous peoples that continues to this day.

Botanical knowledge in particular was intimately associated with colonialism. Economically valuable plants were a key trading commodity. The spice trade was the driving force behind early colonial expansion through the activities of the Dutch and British East India Companies. Many naturalists travelled through the colonies exploring and describing the natural world they encountered and identifying plants with medicinal or commercial value, known as bioprospecting. Species were given Latin binomial names that often included names of colonial Europeans, excluding local traditional naming conventions. For example, the plant genus *Hibbertia* is named after George Hibbert, a slave plantation owner. Plant collectors often relied on local knowledge, which was sometimes shared with Europeans, but was often forcibly obtained. Botanical cures for tropical diseases were particularly highly sought after. European explorers assumed that cures for the deadly new diseases they encountered would be growing nearby, so bioprospecting was often one of the first activities in colonial settlement. No such consideration was given to the deaths of countless indigenous peoples from novel European diseases.

The colonial naturalists also collected specimens for European museums, often shipped back on slave ships or via colonial trade routes. For example, Hans Slone was a physician on slave plantations in the Caribbean. He also curated an extensive herbarium from plants collected by Ghanian slaves, which is now owned by the British Museum. Museum descriptions were (and often still are) highly colonial, and the substantial contributions of enslaved and indigenous peoples who supported these expeditions have usually gone undocumented.

Western exploitation of natural resources continues to this day. 'Parachute science', where western researchers conduct field work in less economically developed countries and publish without including local experts, is widespread. Western-centric bioprospecting is riddled with examples where natural resources and knowledge are taken from indigenous communities with little or no recognition or compensation. Biotechnology companies may use indigenous knowledge to identify plants with medicinal or other useful properties, extract the active compound, protect 'their' intellectual property via patents and then sell the product for profit. The medicinal plant couachi (scientific name *Quassia amara*) is an example of this 'biopiracy'. The genus itself was named by Linneas after the physician and botanist Graman Quassi (other spellings: Quacy, Kwasi and Quasi), an emancipated West African slave in the South American colony of Suriname, who learned of the plant's antimalarial properties from local people. In 2005, French researchers 'discovered' the potential of *Quassia* after interviewing local traditional medicine experts during a research trip to French Guiana. They then obtained a patent for extracting the compound simalikalactone E through the European Patent Agency without acknowledging the indigenous experts or granting them rights to its use. A subsequent agreement was reached between the French researchers and Guianian authorities to share the patent benefits, but the practice was widely criticized as unethical and colonial in its exploitation of natural resources and indigenous knowledge.

Scientific racism and eugenics

The biosciences has a unique need to confront the legacy of scientific racism, the pseudoscience of classifying distinct 'superior' or 'inferior' groups on a 'biological' basis. Linnaeus developed classification systems for humans as well as plants and animals that were widely used and underpinned much of scientific racism (Figure 1). He described four human 'variants': *Europaeus albus* (European white), *Americanus rubescens* (American reddish), *Asiaticus fuscus* (Asian tawny) and *Africanus niger* (African black). Linneas and others always positioned African Black humans as the lowest category and described them as inherently 'lazy',

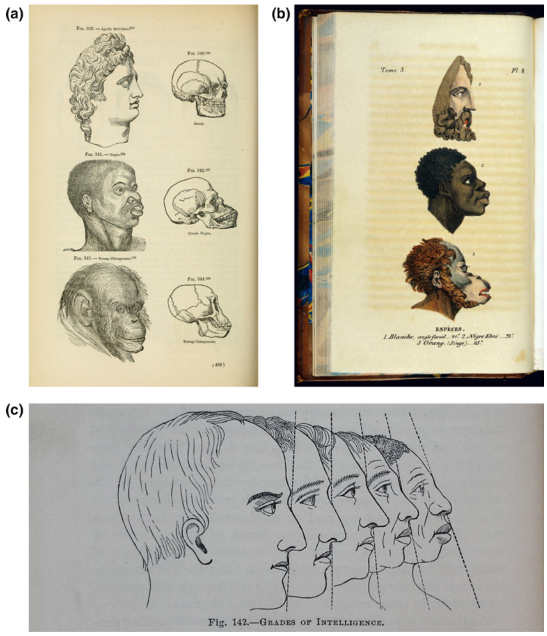

Figure 1. Examples of scientific racism. A: Illustration from the 19th-century textbook *Indigenous Races of the Earth*, presenting 'evidence' that African people were as closely related to chimpanzees as they were to European people. B: Plate from Virey's *Histoire Naturelle* (1826) positioning Black Africans as a separate species. C: Illustration from Wells (1868) depicting the assumed relationship between race and intelligence.

'sly' and 'neglectful'. Black African people were routinely assumed to have lower intelligence, with some not even considering Black people as fully human on this basis.

Modern genetic analysis confirms that commonly used racial categories (e.g., Black, Asian, and white) have no biological basis, and there is more genetic variation within these groups than between them. Race is therefore a social construct, not a biological reality. Discredited biological arguments have been used to perpetuate false groupings and stereotypes that persist to this day. For example, many clinicians still believe that Black people are less affected by pain, and they are less likely to prescribe pain relief medication to Black patients. Racial categories are still used widely within biomedical research to explain differences in physiology and pharmacological responses, despite no consistent genetic association between these traits and ethnicity.

Scientific racism also underpins the discredited field of eugenics, the selective breeding of humans to remove 'undesirable traits' from the population. Eugenics was developed as an academic discipline, but directly influenced social and healthcare policy around the globe in the mid-20th century. As a result of eugenic policies, hundreds of thousands of people classed as 'inferior' were denied reproductive autonomy or forcibly sterilized on the basis of disability or ethnicity, particularly in indigenous populations. The Nazis took eugenics to its horrific extreme through mass murder in the Holocaust, justifying their actions as 'applied biology' (Rudolf Hess, 1938).

Bioscientists such as Ronald A. Fisher and Karl Pearson were prominent advocates of eugenics on both racial and disability grounds. Both made key breakthroughs in bioscience that we still teach today; Pearson developed statistical concepts such as standard deviation, the chi-square test and both correlation and regression coefficients. Fisher developed the concepts of variance and $p = 0.05$ as a threshold for statistical significance and was a key figure in modern evolutionary synthesis of Darwinian and Mendelian models of inheritance. Their work was not tangentially connected to eugenics; they were leading figures in establishing a 'scientific' basis for identifying 'undesirable traits'. Both were heads of the eugenics department at University College London (UCL). Charles Davenport held an equivalent position at Cold Spring Harbour (CSH), establishing the Eugenics Record Office which influenced eugenic policy and legislation in most US states. UCL and CSH have publicly acknowledged their role in the history of eugenics. However, due to a lack of knowledge or a reluctance to introduce historical perspectives into the curriculum, most bioscientists continue to teach the works of Pearson, Fisher and others without confronting their legacies.

Why should we decolonize and diversify biosciences education?

Students and staff from all cultures should feel welcomed, respected and able to achieve their full potential within educational institutions and bioscience as a discipline. Sadly, many are marginalized and excluded. How would you feel if your culture was repeatedly disrespected by your lecturers or you never saw anyone that looked like you in teaching materials? Data from the UK Higher Education Statistics Authority (HESA) shows that Black and Asian students are less likely to obtain higher degree classifications and are less likely to progress to postgraduate study (Figure 2B). HESA data also demonstrates that Black academic staff in particular are significantly under-represented in bioscience departments, and white staff are more likely to be in highly paid positions (Figure 2C). A recent UK parliamentary inquiry identified a wide range of significant issues related to diversity and inclusion in Science Technology Engineering and Maths (STEM), including research funding being consistently biased towards white male researchers. This is against a backdrop of wider society that can be deeply prejudiced and even hostile to minority groups through populist rhetoric, discrimination in legal, healthcare and educational spaces

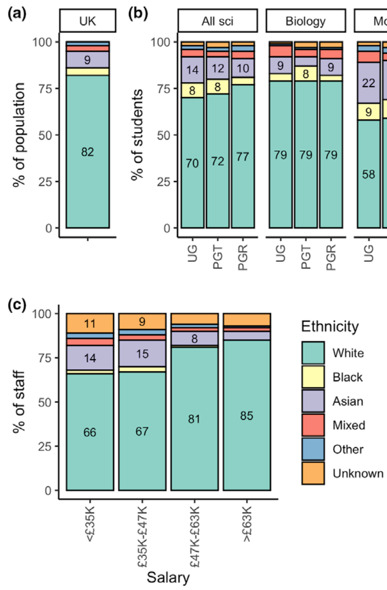

Figure 2. Ethnicity statistics for UK Bioscience students and staff. A: UK population from the 2021 census for reference. B: Ethnicity of UK home students (excludes international students). UG = undergraduate; PGT = postgraduate taught (e.g., MSc); PGR = postgraduate research (e.g., PhD). For most bioscience disciplines, the proportion of white students increases for higher level qualifications, even for disciplines that attract large numbers of Black and Asian students at undergraduate level.[i] C: UK bioscience staff salaries by ethnicity; the proportion of non-white staff decreases for higher salary bands. Bars labelled if they represent 7% or more. All Sci = all sciences; Mol Bio = molecular biology, biophysics and biochemistry; Biomed = biomedical sciences; Eco Env = ecology and environmental biology. Data from Higher Education Statistics Authority combined for years 2019–2020, 2020–2021 and 2021–2022.

and immigration policies. It can be difficult for people from majority groups to understand the lived experience of those from minoritized groups and the profound impact that this has on well-being, belonging and success.

A lack of diversity in biosciences education and research has real societal consequences. For example, over 95% of Genome Wide Association Study participants have European ancestry (https://gwasdiversitymonitor.com/). Limited diversity of such datasets results in incomplete disease understanding and fewer treatment options being developed. Clinical trials are disproportionately conducted on able-bodied white men, ultimately contributing to unequal health outcomes (NIHMD, 2024). Students entering into biomedical fields need an awareness of these issues in order to diversify research and clinical practice. Those going into ecological careers should be aware of exploitative research practices and be prepared to engage in ethically designed fieldwork. Biology students also go on to roles in policy, science communication, teaching and public engagement, so they should be equipped to engage with diverse perspectives and able to challenge incorrect or overly simplistic 'scientific' narratives.

Decolonizing the curriculum is one way that we can address the culture of exclusion and make people feel 'seen'. It should be seen as part of broader efforts to create inclusive and diverse communities; decolonization alone will not solve systemic discrimination within our discipline. Students have been at the forefront of the movement to design and teach inclusive and diverse curricula, for example, leading the Alternative Reading List project at Oxford University and UCL's 'Why is my curriculum white' initiative. Professional bodies, learned societies, funders and scientific journals are also increasingly putting equality, diversity and inclusion at the heart of their activities. In the UK, the most recent Quality Assurance Agency (QAA) benchmark statements for biosciences and biomedical science explicitly state that degree programmes should '*critically engage with how the subject has contributed to and benefited from social injustice, for example presenting a balanced and informed history of the field and acknowledging that influential scientists might have benefited from and perpetuated misogyny, racism, homophobia, ableism and other prejudices*'.

It is important to decolonize within a relevant disciplinary context. Biologists are not social scientists or

[i] These graphs present data using ethnicity categories (Black, Asian) commonly used in UK Higher Education. It should be noted that these groupings represent a social construction of race, not a biological reality, and have been used to justify historical and contemporary racial oppression.

Table 1. Barriers and enablers to decolonization of the curriculum

Personal	► Awareness, knowledge and training ► Individual beliefs, attitudes and values ► Time, capacity, workload and resources ► Communication and language use ► Personal characteristics and experiences
Disciplinary	► Disciplinary cultures, beliefs, attitudes and values ► Curriculum and assessment norms for discipline ► Time, capacity and resources for curriculum change ► Communication and language use ► Professional, Statutory and Regulatory Bodies (PSRBs)
Institutional	► Leadership, culture, values and strategic priorities ► Capacity, workload allocation and resources ► Communication and language use ► Diversity and inclusiveness of community ► Legal and regulatory context
Societal	► Conscious and unconscious biases, attitudes and values ► Cultural and historical discrimination and oppression ► Diversity and inclusiveness of society ► Communication and language use ► Legal and regulatory context

historians and they should not pretend to be. However, we can provide context to the biological examples we include. For example, studies using HeLa cells can be used to highlight Henrietta Lacks as the source of this material and to discuss the ethics of research participation and consent. Genetics teaching can be revised to ensure that we don't use the language of 'defects' and 'low quality of life' about genetic disease, and can challenge binary assumptions around sex and gender by including exploring the complexity of sex determination. Case studies of gene editing in crops can highlight diverse scientists who are working to solve agricultural issues in their own countries and the importance of involving local farming expertise in achieving food security. We can choose to include research from non-western scientists and to view inclusion as integral to ethical and sustainable bioscience.

Barriers to diversification and decolonization

Decolonization and diversification should be met with open arms. So, why is there resistance to it? Progress can be frustratingly slow, and there is active hostility towards inclusivity-related work from some. The reasons for this are multifaceted and complex, ranging from cultural and social factors to personal beliefs (Table 1). However, without understanding these barriers, we cannot make progress.

Decolonization can and should make us feel uncomfortable. How did you feel looking at Figure 1? Shocked? Angry? Challenging power dynamics and norms is integral to decolonization, but it can be unsettling and threatening to do so. It is difficult to learn that your scientific heroes held views that would be unpalatable today or that your specialist area relies on the products of exploitation. Critical race theory proposes that race and racism are social constructs that are embedded within political, legal and educational structures. Addressing these issues therefore requires fundamentally questioning those structures and finding new ways of working. Those who have historically held power within those structures may be unwilling to democratize or to acknowledge the harm that respected institutions have caused.

Finding space within the packed curriculum to decolonize and diversify can be difficult. Many scientists worry that they are being asked to teach social science or history, not their areas of expertise. Decolonization is more complex than simply offering a more diverse reading list. It requires us to have open and frank conversations about difficult and sensitive topics. Fear of getting it wrong or causing offence is very real. Lack of appropriate training can cause confusion and resistance from staff, particularly if they are not supported by colleagues and senior leaders.

Decolonization work takes time and effort, and there is very little personal reward for it in the modern university environment. It might not be obvious to students and outsiders just how much pressure academic staff are under. They have to hit multiple key performance targets, often relating to research funding and publishing research papers. Academic staff therefore end up focusing on tasks that meet their individual goals. When education is under-resourced and workloads are high, staff can become burnt out or apathetic. In this climate, inclusion work can often become a 'tick box' exercise or is overlooked altogether. In a 'selfish academic' culture, even well-meaning academics may lack the capacity or motivation to revise teaching materials when they see little reward from their department or institution for doing so. The burden of this work disproportionately falls on those who are already minoritized, representing considerable emotional labour and another barrier to personal success in a system stacked against them. Changing this culture requires leadership and rethinking what activities are valued by institutions.

Conclusion

Decolonization is needed within bioscience as much as in any other discipline. Our subject has long and deep links with oppressive and exploitative practices that we should not ignore. Acknowledging this context within bioscience curricula and public engagement goes some way to redressing these structural biases. We provide some practical suggestions for decolonizing and diversifying the bioscience curriculum later in this issue.

It can be lonely to feel like you are the only person who cares about decolonization and inclusion. However, there are many scientists and academics who do care and are making positive change. There are communities coming together via social media to share experiences and build mutual support; BlackInNeuro and Black in Plant Science UK are just two examples. Researchers are engaging with politicians and governmental inquiries into the lack of diversity and systemic bias in scientific communities. Some departments and learned societies have led decolonization projects and provided funding for this work. Museums are re-evaluating the way they present their collections, and highlighting both the contributions of minoritized peoples and examples of prejudice. The more awareness we all have of the impact of colonialism and exploitation on our discipline, the better we are able to create a bioscience culture that is inclusive of everyone. ■

Further Reading

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Author information

Dr Tina L. Joshi is an Associate Professor of Molecular Microbiology at the University of Plymouth, where she specialises in Clinical Microbiology and Infectious Disease. She is Principal Investigator of the Molecular Microbiology Research Group. Her interdisciplinary research spans disinfectant resistance and novel diagnostics to tackle Anti-Microbial Resistance (AMR). Dr Joshi sits on international external advisory boards including Antibiotic Research UK's Science Committee, and the Microbiology Society Council where she Co-Chair's their Impact and Influence Committee, and the international Knocking Out AMR initiative. She is deputy Editor in Chief of the Journal of Medical Microbiology and holds two granted patents.

Dr Catherine Mansfield (she/her) is a Senior Strategic Teaching Fellow in the Department of Life Sciences at Imperial College London, teaching undergraduates across Biological Sciences and Biochemistry. Her scientific background is in plant developmental biology, and she completed her PhD at the John Innes Centre in Norwich before working for a widening access charity. She is interested in increasing diversity in and access to Life Sciences Higher Education. Dr Mansfield has completed a Masters in University Learning and Teaching, focusing on the role of enjoyment in Life Sciences, and is a Senior Fellow of the Higher Education Academy.

Isaiah Ting (he/him) is a PhD student at the University of Surrey, investigating the role of biological rhythms (ultradian and circadian) in metabolism. His scientific background is in cell biology and bioinformatics, and Isaiah has keen interest in raising awareness of EDI causes within his university. He has been a part of many schemes and events that celebrate and raise awareness of diversity within academia as well as highlighting inequity of certain groups within academia. Isaiah is originally from the Philippines, and grew up in London, and is the first in his family to be doing a doctorate.

Dr Katharine Hubbard (she/her) is a Reader in Bioscience Education at the University of Hull and Director of Studies for the School of Natural Sciences. She is a National Teaching Fellow, Senior Fellow of AdvanceHE and the Royal Society of Biology HE Teacher of the Year 2016. Her background is in plant physiology, and she currently teaches cell biology and biotechnology. Her research interests are around inclusive education, awarding gaps, and effective STEM pedagogies. She established the Royal Society of Biology Bioscience Educators Network, and has developed an Inclusive Education Framework for HE funded by the Quality Assurance Agency.

