PN Physiology News

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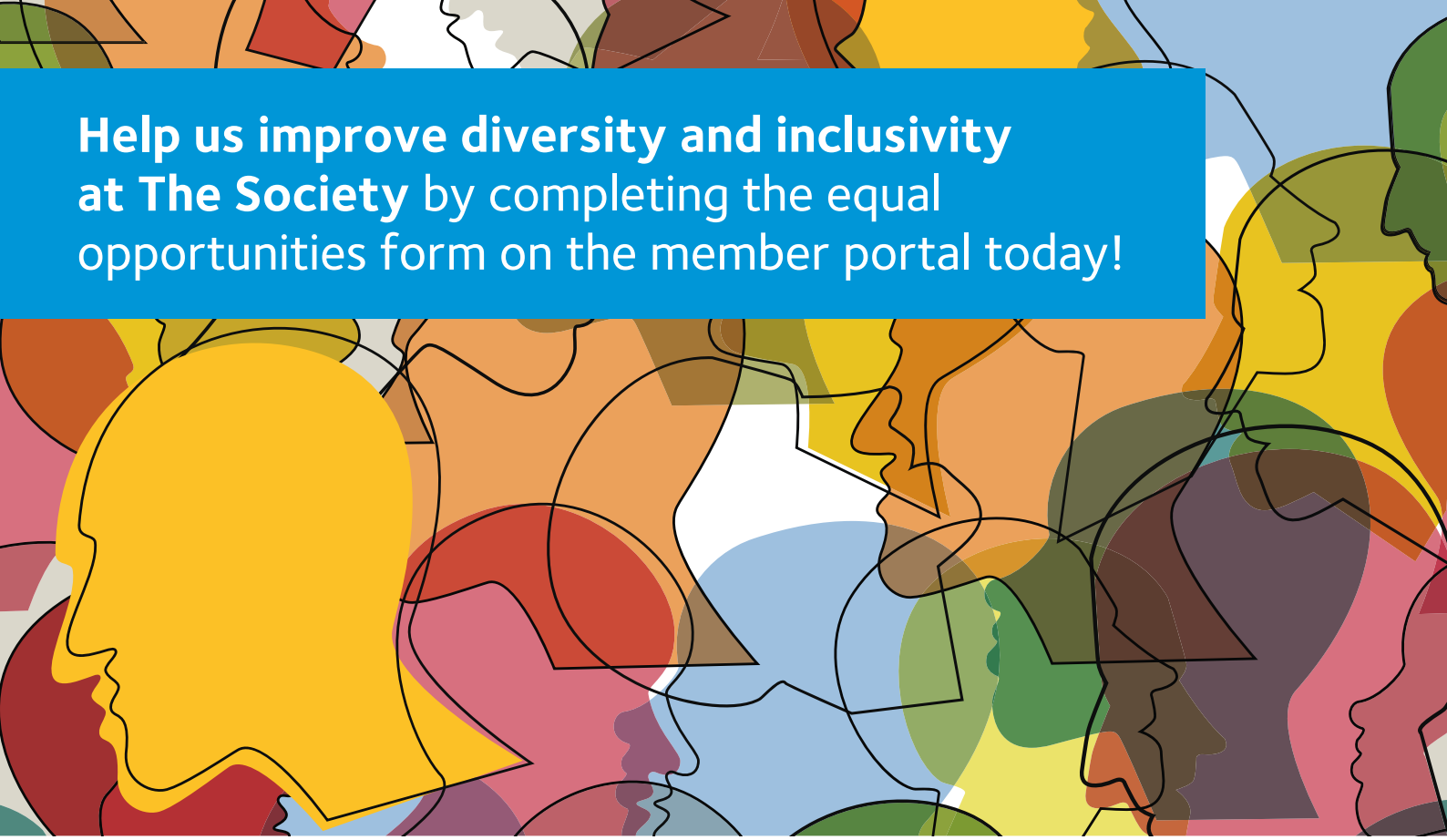
Diversity Special Issue

The Physiological Society



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The Physiological Society

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Physiology News

We welcome feedback on our membership magazine, or letters and suggestions for articles for publication, including book reviews, from our Members.
Please email Julia Turan at **magazine@physoc.org**.

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Welcome to the Summer 2019 edition of *Physiology News*

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The Physiological Society

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Diversity Special Issue

Julia Turan

Managing Editor

One of the most important lessons I learned during my undergraduate in neurobiology, was recognising just how little we know. I've carried this sentiment with me as I moved into a career in science communication, a profession similar to science in the importance it places on asking the right questions. And when I sat down to write for this issue, I had to ask myself, what does diversity mean to me?

Diversity can sometimes feel like it's not for everyone: even when we may fit one or two "protected characteristics," the feeling of privilege might stop us from feeling like we can be part of certain communities. It was hard not to feel an ironic sense of "imposter syndrome," for lack of a better term, like all of a sudden it was a competition, and I wasn't ticking the right boxes. It took me a while to realise my lived experience is unique to me: a busy intersection of traits that impact how the world treats me. I'm an American-born Hungarian-Jewish, bisexual, cis-woman who experiences mental health issues from time to time and I'm proud. And while recognising intersectionality is important, it's not about arguing over who is more discriminated against.

Nowadays, I think many people would say that diversity is important. However, even with the best of intentions, it's easy for this to be an empty statement, and we can easily forget the importance of knowing the specific struggles and needs of various communities different to our own: without concrete knowledge, we cannot take firm steps to help.

Given the overwhelming scope of diversity issues, we decided to focus on the immutable characteristics of sex/gender, ethnicity/race, age, disability and LGBTQI+ within the STEM community and scientific research. By commissioning articles on a broad mix of science, the experiences of scientists/educators/students, as well as covering issues and policy around diversity and inclusion in STEM, we hoped this issue would allow everyone to feel part of the conversation, by either relating to some of the experiences of the authors or by stepping outside of comfort zones to confront our own actions and those of our colleagues and institutes. And while the areas covered are by no means exhaustive, it is our hope that this Diversity Special Issue will be the start of a move to include more diversity content in the coming years.

Keith Siew

Scientific Editor

Who am I? I'm a physiologist who also happens to be a half-Irish, half-Chinese, gay, cis-male, dyslexic first-generaton PhD who's had a sojourn or two with depression. While these traits don't define who I am, they are undeniably important aspects of me which have shaped my experience of the world.

I recall the subtle feelings of otherness at a mostly white university, the constant struggle to pronounce my name and inevitable "but where are you really from?", or awkward moments in the labs when it came time to tick the ethnicity box for spirometry results (when, like always, there was no box between Asian and Caucasian). As a dyslexic student, I've had to endlessly explain myself and fight for supports from those who simply didn't "believe in it." I've felt embarrassed about lulls in my career during periods of depression, unsure of how to ask for help from colleagues or friends who only saw my "happy side". I've struggled to manage the stress of my studies with that of having to hide a part of myself from classmates for fear of rejection, when socialising is meant to help us unwind. To dealing with the daunting realisation that coming out doesn't just happen once, but is a calculated decision with every new colleague and collaborator, whereby choosing to live openly may not be entirely without professional consequences.

Before starting this journey we thought we knew what diversity looks like. We thought it looked like the cover image of this magazine, a place where people felt represented and seen. We wanted to showcase the diversity of scientists, the research we do and the policies we write. We thought our own experiences gave us adequate insight to put this issue together.

Having read the contributions of our authors, we were instead left feeling a mix of shock, shame and anger for our ignorance of the sheer magnitude of the issues many underrepresented and discriminated communities face. Even those we identify with. It made us question what we had been doing to make a difference, and we came to feel that the answer was: not enough!

While it is not possible to cover every aspect of diversity, it is our hope that by the end of this issue, you too will have walked a few steps in someone else's shoes and realised there is much left to do. We need to be more visible, we need to be more active, and we need to be better allies.

A home for all physiologists

Bridget Lumb

President, The Physiological Society

I am one of the generation of scientists who have experienced significant advances in the representation of women scientists on decision-making bodies. As an undergraduate student I was taught by very few female scientists. As a Council member of The Physiological Society in the 1990s I was often the only female member on committees and one of the few women to chair committees. Science benefits from diversity and inclusivity. Not only should we encourage this in our physiology community, and the scientific community at large, because it's the right thing to do morally, but also because it will further our research. There should be no barriers to participation nor to prevent anyone from having a fulfilling career in science. Scientific research is at its best when we have a diverse range of views around the table, drawing on the broadest range of experience and knowledge.

The articles in this issue present reason after reason to support diversity and inclusivity: allowing individuals to fulfil their ambitions, and science to progress. As a home for physiology and physiologists, we must raise the profile of much-needed role models, encouraging and facilitating participation in physiology, regardless of background or circumstance, and leading by example. I was very proud to become President of The Physiological Society but, at the same time, shocked that I was the first woman to hold this role. All of us must reflect on why it took more than 140 years for this to happen. Through the measures The Society is putting in place to improve diversity and inclusion, I am confident many more will follow.

The Society took an important step in promoting diversity and inclusivity in 2014 when it signed the Science Council's Declaration on Diversity, Equality and Inclusion, and later sat on the steering group that developed the Diversity and Inclusion Progression Framework for scientific bodies. This framework provided us with a benchmark for measuring the impact of our diversity and inclusion work, and we now have a strategy that will guide our future work.

Unfortunately there is no "one size fits all" approach, nor are there simple "tick boxes" for working towards diversity; every organisation has its individual challenges that must be addressed. However, while gender equality does remain a significant challenge we must move to encompass all areas of inclusion and diversity. Our work will continue, and must evolve as we learn more about what our Members and the physiology community need, and about what we can do to reach meaningful levels of diversity and inclusion in terms of The Society and its activities. We are prepared for a bumpy journey and we hope that you will stick with us; we must continue to advocate for and build on support, by both sharing our progress but also welcoming challenge and criticism.

Recognising one's own ignorance and unconscious bias is a good first step to making positive change, and we have worked with other organisations to learn more about what we should and could be doing. The Society is connected with and supports many other organisations that are also working in this area; for example the All Party Parliamentary Group on Diversity, LGBTQ STEM Day and Stonewall.

Whilst looking to our Members and other organisations for support, we are also continuing to challenge ourselves. We have made changes to ensure that diversity is high on the agenda at Council, on committees and with the staff; importantly Diversity Champions are appointed at every level. We have undertaken a Governance Review that has specifically looked at the diversity of our Council and our committees. We have introduced minimal and aspirational targets for gender representation at scientific meetings. We also have funding available for those that have caring needs or responsibilities that may prevent them from attending our meetings. While we recognise the importance of acknowledging the progress we have made, we are also not afraid to say that we must do more, both individually and as a community. We appreciate there is a long way to go to ensure that we provide greater inclusivity. The Society is a home for physiologists, full stop, and we are ready to work to make sure everyone feels welcome. We welcome your feedback and views on how we can accomplish this.

"Unfortunately there is no 'one size fits all' approach, nor are there simple 'tick boxes' for working towards diversity; every organisation has its individual challenges that must be addressed"

The Physiological Society

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Reports of The Society's recent committee meetings

The purpose of these short updates is to keep you informed about the work of our committees. The following summaries detail the meetings of the past few months.

Conferences Committee

The recent Meetings Committee, now Conferences Committee, meeting was held on 8 April and was chaired by Sue Deuchars, University of Leeds, UK. This year's Future Physiology was confirmed as being held in Liverpool in December at Liverpool John Moores University. The broad topic is "Translating Cellular Mechanisms into Lifelong Health Strategies" but abstracts would be welcome from all topics in physiology. Hosting the 2020 Future Physiology meeting was awarded to a group of early career physiologists from Norway, but the meeting itself will be held in the UK, in the summer of 2020.

The Committee noted plans for other 2020 meetings, including Europhysiology 2020 in Berlin and potential meetings on regeneration and on neural circuits and complex behaviour, whose programmes are being developed.

Physiology 2021 will be held at the ICC in Birmingham, 12 – 14 July. Other meetings for 2021 are in the early decision phase. Much of the discussion concerned the revised Society Themes. The Themes focus on individual areas of research in physiology. They provide Members with networks that share their immediate interests and allow opportunities to discuss their latest findings and forge new collaborations.

Council

Council discussed the President's Lecture which had been scheduled for 7 September 2019. American researcher of physiology, James Anthony "Jim" Pawelczyk, who flew aboard the NASA STS-90 Space Shuttle mission as a Payload Specialist will give the President's Lecture: *What Price a Martian? Human Limits to Exploring the Red Planet*, as part of a wider public engagement day hosted by The Society at the Royal Institution's prestigious Faraday Lecture theatre. This flagship event aims to enthuse the next generation of space medicine physiologists and consequently the target audience should be families and young people. Council also agreed they would seek out Members to volunteer to run space-related outreach activities that would engage young people and their families in discussions about physiology. The Head of Professional Development and Engagement (Chrissy Stokes) in conjunction with Sarah Hall, Chair of Education and Outreach Committee presented information about the schools competition which had been designed to accompany the President's Lecture.

The Head of Policy and Communications (Andrew Mackenzie) reported that one of The Society's strategic objectives was to increase the breadth of its membership from sub-disciplines currently underrepresented in The Society. The collaboration with GuildHE entitled "Sports and Exercise Science: Impact on the UK economy" enabled The Society to form collaborations with Sports and Exercise Science (SES) departments around the country. Around 25 SES departments provided data and case studies, which would be combined with national economic and destination data to produce an assessment of the economic contribution of the subject. Mike Tipton (University of Portsmouth) and Jamie McPhee (Manchester Metropolitan University) played an integral role in the development of the report providing both expertise and review. The report was going to be launched in the Houses of Parliament on 15 May at a reception hosted by the Shadow Minister for Higher Education, Further Education and Skills.

The Chief Executive (Dariel Burdass) reported that Fiecon Ltd had moved into the third and fourth floors of the building and incorporated into the facilities management structure, including all service charge elements. This meant that all three floors of Hodgkin Huxley House had now been successfully tenanted. She also updated Council that the administration of the deregistration of The Benevolent Fund and transfer of the balance of the money to The Physiological Society was underway. It was noted that the website project was in its final stages of development and Trustees, Committee Members and key stakeholders would have the opportunity to review the functionality, prior to launch.

Council resolved that the 2019 AGM would be held on Wednesday 10 July 2019, between 12 and 1:30pm at Aberdeen Conference Centre. Guy Bewick (Trustee) would chair.

The Honorary Treasurer (Frank Sengpiel) presented a paper on the proposed new Reserves Policy which linked to The Society's strategic planning and risk management to ensure it served both current and future beneficiaries and, as required by the Charity Commission, clearly communicated and justified how the reserves were laid out. He noted that in reviewing the policy, Finance Committee had taken external advice from John Speed (Js2) and Tom Wilson (haysmacintyre). He explained the premise of the draft policy which included a strategic investment fund for any new strategic projects, income diversification and innovation scoping for future projects. However these funds would appear in the accounts as designations for particular purposes rather than restricted funds and therefore provided an indication of the Trustees' intentions to satisfy the policy guidance but provided flexibility. Trustees discussed that the policy allowed for the principle of releasing money for strategic purposes but did not define what those projects might be and agreed that Chairs would discuss with their Committees and this would be fed back to Council in September to enable any decisions taken to feed into the annual budget-setting process in October. Trustees approved the policy for adoption and the specific designations for reporting in the 2018 Trustee Annual Report.

The Chair of Publications (Debbie Baines) and the Director of Scientific Programmes (Simon Rallison) presented a paper on the potential impact of Plan S. The key issue for The Society was that Plan S detailed that hybrid journals such as *The Journal of Physiology* (JP) and *Experimental Physiology* (EP) were not considered acceptable and although Plan S signatories only funded about 5% of the articles published in JP and EP, the fact that Research England came under UKRI meant that all UK universities would indirectly be affected by it. The Director of Scientific Programmes reported that The Society had contributed to the UKRI consultation via the Royal Society of Biology (RSB) and to the cOAlition S consultation via its own submission and through the RSB, ALPSP (the scholarly journal publishers' trade association) and the Society Publishers Coalition. Many submissions pushed back against the tight timetable, the barring of hybrid journals and the likely cap on article processing charges, although almost all were broadly supportive of Open Access. Trustees suggested a session be organised at P19 to share information on Plan S, its impacts

on researchers, authors and publishers and how The Society is responding. Trustees also approved the implementation of a Task and Finish group to look at the impact of Plan S in further detail.

Education and Outreach Committee

The final meeting of the Education and Outreach (E&O) Committee took place in May 2019. In light of The Society's recent Governance Review, it is proposed that oversight of education, outreach and policy activities will be joined in future under the remit of one Education, Public Engagement and Policy Committee (EPEP). The E&O Committee learned that various smaller, focused "Task and Finish Groups" and "Task Forces" will be set up to oversee specific ongoing education and outreach projects, as well as new initiatives; these groups will report to the new EPEP Committee. Further details on the new committee structure will be announced in the months after the AGM on 10 July, when such changes will come into effect.

The final E&O Committee meeting focused on a small number of current activities that required immediate input. These included a review of the Royal Society of Biology's accreditation criteria for degrees using "Physiology" in their title; a discussion on proposals for outreach activities that will take place alongside the upcoming President's Lecture by NASA astronaut/physiologist James Pawelczyk in London on 7 September 2019; an update regarding the new Outreach Grant Scheme, which now offers a wider range of funding streams (including up to £20,000 for high-impact projects), with the first large grant having recently been awarded to Simon Watt for his "Level Up Human" science comedy panel shows; and a review of proposals submitted for the Techniques Workshop Grant Scheme, which included one on "Molecular and Synthetic Biology for Bio-medical Research" in Nigeria during July 2019.

The Chair closed the meeting by thanking all members of the Committee and Society staff for their invaluable contributions to the many activities developed and delivered by the Committee over recent years.

Finance Committee

We welcomed our latest external member Tony Silcock (Director of Finance and People, Victim Support) and said goodbye and thanks to Lucia Sivilotti after four years' service.

A large part of the meeting was spent discussing the 2018 financial statements and the corresponding audit by haysmacintyre. The Committee is pleased to report that the finances are in very good shape with a "clean" audit report from haysmacintyre. I will be delighted to take any questions on the financial statements at the Annual General Meeting on 10 July 2019. In addition to this substantive business, we discussed the Q119 management accounts and the process for auditor reappointment.

Publications Committee

The Publications Committee met in May 2019, chaired by Deborah Baines. The Editors-in-Chief of *The Journal of Physiology, Experimental Physiology* and *Physiological Reports* presented their respective Editorial Reports. Plan S and its mandate for Open Access publishing remains a concern for The Physiological Society's journals as we eagerly await a more concrete outline of the cOAlition's mandates for a move toward Open Access. Despite this, all three journals have maintained healthy numbers of submissions, citations and social media impact.

Wiley's transformative "Publish and Read" deals with institutions in numerous European countries make it more important than ever to encourage high-quality submissions from not only these regions, but also further afield. The Committee agreed that The Society's journals should not "lower the bar" to publish more material, but need to focus more on innovative author messaging strategies to promote the thoroughness of their peer review, and subsequent longevity of the research they publish. The Committee also discussed how The Society's journals can look to be flagships for the physiology community. A new cross-journal statistics and data presentation policy, and the imminent addition of Registered Reports articles in *Experimental Physiology* are both indicators of a tangible commitment to transparent and open research practices.

Read the latest press releases from our journals at **physoc.org/news**

The limit of human physical endurance

Previous studies have suggested that maximum sustained energy expenditure in humans is capped at ~4x to 5x basal metabolic rate (BMR). However, new research has revealed an alimentary limit which places the cap at ~2.5x BMR. There is a limit to the amount of calories we can absorb per day, and beyond this point the body begins to draw on energy reserves and would not be sustainable indefinitely. Interestingly, energy expenditure during pregnancy and lactation peaks at ~2.2x BMR, which might explain the constraints on human gestation length and fetal growth.

DOI: 10.1126/sciadv.aaw0341

Changing blood types to increase supply

Type O "universal donor" red blood cells are the most critical for emergency medical procedures. Previous attempts to convert the A antigen of type blood A (2nd most common) to the H antigen of type O have been limited by enzyme efficiency and specific buffer requirements. However, by studying human fecal bacteria, which are regularly exposed to type A and B antigens present within the mucins lining the gut, a Canadian team have identified a pair of enzymes capable of converting type A to O (with the same +/- rhesus) at very low concentrations in whole blood.

DOI: 10.1038/s41564-019-0469-7

Nearly 400 medical devices, procedures and practices found to be ineffective

A study analysing over 3000 randomised controlled trials over 15 years found that 13% of trials resulted in medical reversals (i.e. no better than previous or lesser standards of care). When it came to the breakdown of results, cardiovascular diseases represented 20% of all reversals by medical discipline, while medications accounted for a third of all reversals by intervention type. In particular the study emphasised the importance of independent non-conflicted funding of clinical research, as the majority of reversal studies were funded by such sources (63.9%), with a minority funded solely by the industry (9.1%).

DOI: 10.7554/eLife.4518

Disobedience is a mandate, not an award

BethAnn McLaughlin

Vanderbilt University Medical Center, Nashville, Tennessee, USA

Sharona Gordon (left), Dana Miller (centre) and BethAnn McLaughlin (right) meeting at the University of Washington for the first time as a group

In November I sat surrounded by friends at my house shaking and crying. I had received a call telling me that I was a recipient of the MIT Disobedience Award. Endowed by philanthropist Reid Hoffman, the $250,000 unrestricted cash prize gave immediate moral clarity and authenticity to work of the #MeTooSTEM movement.

Five years before that phone call, things were far murkier. The #MeToo movement hadn't caused the worldwide culture shift we see now. Five years ago, I did the bravest thing I had done professionally up until that point. I decided to stand firmly behind University of Washington scientist Dana Miller, and backed her report describing an evening in which we witnessed retaliatory threats against a student that were both serious and frightening. I remember with great clarity realizing that this choice would almost certainly end my career.

Dana decided to protect a student she had never met. I spoke my truth to support both of them, and there were consequences. The tables were turned and I was investigated. I had to retain my own counsel. I endured internal and external investigations that spanned years. These investigations also stalled my up-until-then successful bid for tenure at an institution I love and helped grow. Countless lost hours, friends and opportunities later, part of my story was reported in February by Meredith Wadman in Science magazine. In response, a scientist I had never met, Sharona Gordon, rallied much-needed support to save my job. She gathered over 11,000 signatures from scientists, students and science allies supporting my bid for tenure. Undergraduates brought that petition and the signatures to my Chancellor's Office.

Two months later, when Dana, Sharona and I met at the University of Washington for the first time as a group, there were no victory laps or sense of accomplishment. There were only apologies on how we had failed each other. We knew that the bravest thing each of us had ever done professionally was still not enough to protect the person we had tried to help.

"...students around them cry because someone is finally telling them the truth they knew already. These are my lectures"

The student was never notified of the threats against her. The retaliation against those who reported escalated. Some of us would learn new and painful lessons about how helpless we all are in protecting our families and students even when we were "experts".

The joy that I took in running my own lab studying cell chaperones, neural metabolism and neurodegeneration is, to this day, overshadowed by the very real likelihood I will never be employable at a research institution again. I have said too much. What I have said is true, but it is too much. I have been too disobedient. Too disrespectful of the systems which are designed to silence and shame us. I save my respect for the thousands of students, faculty and staff, the concerned advisors and frightened spouses who have called, emailed and come to see me speak asking for help and validation since I founded #MeTooSTEM. You can read many of their heartbreaking stories of careers ended too soon on our website **metoostem.com**.

I am greeted on campuses with hugs, presents and so many tears by amazing women so grateful to be heard, and I am tolerated by men who have sat with crossed arms while students around them cry because someone is finally telling them the truth they knew already. These are my lectures.

Women and other minority voices too often lack the support to speak their truth. No one living this reality considers themselves to be heroic, tireless or fearless. What the three of us share is an aspirational goal of academic decency and relentless dedication to the truth. Dana, Sharona and so many other brave people have formed a foundation of #MeTooSTEM decency and civil disobedience that paves our path forward. It allows us to forge ahead with the moral certainty knowing success is inevitable. I take strength from the knowledge that when the textbooks are written, the pursuit of equity and safety spawned by #MeToo and #MeTooSTEM will be valued more than any gel being run or bit of DNA being manipulated.

History will reveal that women, minorities, LGBTQ family and those with disabilities are neither helped nor honored in any meaningful way in our jobs. We are in STEM, as physician and #MeTooSTEM advocate Eunice Neeley says, not because of institutional commitment to diversity and equity, but in spite of their notable absence of support.

I look at Eunice and am keenly aware that if we want black women in science, and we should, we need to recognize 60% of women from that demographic have been sexually assaulted before the age of 18. That is unacceptable, but pretending that is not their lived experience, a source of vulnerability and wisdom is nothing short of willful ignorance.

We navel gaze, have special lectures and pontificate about "equity and diversity" and fail to recognise showing up at work in academia is unsafe for too many people. Pettiness, fear and prejudice are only unsolvable problems if you refuse to spend real money on solving them. All these problems will persist until we refuse to reward those individuals and institutions that violate our shared belief that we do better science by having better humans as scientists.

It is my sincere hope that we become deeply uncomfortable that we fail to expect great things from our STEM administrators and scientific society leaders. That we vote too many people into positions of power and influence as rewards for their publications instead of as endorsements for their principled stances. I hope that those who hear conversation around #MeTooSTEM and feel uncomfortable realize they should. I mean to make you uncomfortable. You have likely been comfortable at some else's expense for far too long. I was.

If you've read this far, I ask you honour the people who have sacrificed so you can be in your space. Do the bravest moral thing you can do in your job today. Then do a slightly braver one tomorrow. I will forever be grateful that a woman, Tarana Burke, who had no great power saw her community devastated by silence and despair and spoke her truth, founding #MeToo. I will forever be grateful one man in particular with great power, Reid Hoffman, shared his moral authority on what is decent and forever changed my life and immediately empowered us to speak our truth more bravely.

"All these problems will persist until we refuse to reward those individuals and institutions that violate our shared belief that we do better science by having better humans as scientists"

The Disobedience Prize was not an award, it is a mandate. It is a mandate that men believe women. That women refuse to publicly drag and diminish each other. It is a statement that we honor those like Dana, Sharona, Eunice and those that have supported us and a reminder that you never have enough power, money or friends to be decent.

Go forward and be disobedient, friends. Don't believe administrators that tell you "they have it". You have it. Disobey anyone that tries to silence you when you speak out about safety. You are the hero someone needs and trainee eyes are fixed on you at this moment. Believe women. Protect minorities. Fail epically and share your failures. It's how we learn things in academia. And we still have a lot to learn.

Smelling with your tongue

The perception of flavour is an integrated sensory experience combining inputs from gustatory receptors on the tongue and olfactory receptors in the nose and in the brain. However, recent evidence has demonstrated the presence of physiologically functional olfactory receptors in the taste cells of transgenic fluorescent reporter mice and in cultured human fungiform taste papilla cells. These findings imply the first cross-talk between taste and smell may occur in the periphery before signals are integrated centrally in the insular cortex of the brain.

DOI: 10.1093/chemse/bjz019

Restoring partial brain function hours after death

Using a newly developed extracorporeal pulsatile-perfusion system named BrainEx, researchers supplied pig brains with a mixture of oxygen carriers and agents that protect and stabilise the cells. Over the six-hour experiment, they observed a slowing of cell death, restoration of vascular dilatory and glial inflammatory responses, spontaneous synaptic activity and active cerebral metabolism despite the brains being harvested 4 hours postmortem. The team's findings call into question the time-course and cessation of molecular and cellular brain functions following global anoxia or ischemia, but they state that no evidence of organised global electrical activity or higher-order brain function was found.

DOI: 10.1038/s41586-019-1099-1

Many Alzheimer's patients may in fact have a different disease

A definitive diagnosis of Alzheimer's disease requires postmortem microscopic brain examination to detect the presence of amyloid-β plaques and tau neurofibrillary tangles. Recently a newly-recognised disease, limbic-predominant age-related TDP-43 encephalopathy (LATE) was reported to associate with an amnestic dementia syndrome that mimics Alzheimer's-type dementia. Surprisingly, retrospective diagnostic autopsies of elderly patients with a premortem diagnosis of dementia of the Alzheimer's type revealed 17.3% of cases could be attributed to LATE vs 39.4% for Alzheimer's disease. Therefore Alzheimer clinical trials must be powered to account for LATE given the differing disease mechanisms and difficulty of accurate premortem diagnosis.

DOI: 10.1093/brain/awz099

Specific learning disabilities and me

Specific learning disabilities, or specific learning differences (SLDs) are neurological (rather than psychological) differences that affect the way a person learns and processes information that usually run in families and are independent of intelligence. They can have a significant impact on learning and the acquisition of skills many of us take for granted. SLDs cover a range of difficulties that often co-occur including dyslexia (literacy), dyspraxia (coordination), dyscalculia (numeracy) and ADD/ADHD (focus). To understand SLDs more fully, Rhys Jones, now a Lecturer, tells the story of his own dyslexia, and from her own experience Louise Robson advises educators on how to support students with SLDs.

Louise Robson

Department of Biomedical Science,
University of Sheffield

Supporting SLD students – an academic perspective

As an academic with over 25 years of experience teaching physiology, one of the biggest changes I have seen over the years is the recognition of, and subsequent support for, students with SLD. At the very start of my career I would say there was very little recognition of this in higher education (HE), and such students had to identify (through a process of trial and elimination) what worked for them. Of course, this also meant that some students would not go to university, as they had not been able to identify their own way of working, and so they didn't meet the entry criteria (i.e. get the right grades). Thankfully, over the years support for students has improved dramatically. Many HE institutions now have dedicated professional support teams, whose role is to assess what additional support is needed by a student, provide information to academic departments on what is needed (e.g. extra time for examinations), and provide support directly (e.g. providing mentors, notetakers, specific tutorial support, etc.). The amount of support available to students is probably at an all-time high. However, while this is a positive step forward, it brings other challenges for academic staff.

> "The key point is to recognise that students learn in different ways, and you can facilitate this learning by making some fairly straightforward changes to your teaching"

The first challenge is, given the wide range of specific learning support differences, how can academics ensure they are supporting their students effectively. After all, each student has a different set of support needs! This is where specific training for staff becomes important, particularly less experienced staff. Attending a session on the types of specific learning differences, how students can be supported, and how to make your teaching more inclusive is critical to being an effective teacher. The learning support needs for many students are very similar, so consider a policy of releasing teaching materials (e.g. Powerpoint files) to all students in advance of sessions. If this is then matched with lecture capture, so that students can revisit the lecture afterwards, then you are supporting a wide range of students with learning support differences. In your teaching, be as inclusive as possible. Use a range of teaching and assessment methods, so that students are not disadvantaged by having the same types of approaches over and over in their degree programmes. The key point is to recognise that students learn in different ways, and you can facilitate this learning by making some fairly straightforward changes to your teaching.

Finally, never assume that because a student is at university and has not been identified as needing support, that they don't need any. Over the years I have identified several students who were subsequently diagnosed with specific learning differences. Identifying such students is tough, as there are often just subtle differences in work that flag a student needs additional support. These small differences are often not apparent in just one piece of work, but it takes several pieces for you to recognise a pattern of activity. Oh, and it's not only the struggling students you should look at. I once had a very high achieving student get the highest level of support in the third year of her studies, after a throwaway comment in a one-to-one meeting around struggling with writing essays.

Overall, while there are challenges to helping students with specific learning differences, recognising that there are many different ways students learn and adapting your teaching accordingly can bring huge benefits to the student cohort as a whole.

Rhys Jones
Cardiff University

Dyslexia – a personal perspective

I am a Senior Lecturer of Evolutionary Biology at a Russell Group University, and I am dyslexic.

I left high school after a teacher took me to one side and enquired, "Why are you in my class?" I replied that I was excited at the future application of the technology they had been talking about, but before I was able to finish my sentence, he interrupted to inform me, "All you will be doing when you leave school Jones is stacking shelves."

It was a crushing blow to my confidence by a figure of authority who, as a teacher, had failed to live up to his responsibilities not only in terms of student engagement in the subject, but of student wellbeing too. I promptly left school with no qualifications and a hatred of education.

It is a story I hear all too often, where daydreaming, struggling dyslexic students are often perceived as timewasters or troublemakers. This was certainly the case for me growing up in the seventies when diagnoses of dyslexia were all but unheard of.

Fortunately, there have been significant advances in diagnosing and supporting students with dyslexia in recent years. It is now commonplace for lectures and accompanying PowerPoint presentations to be released several days in advance of a session being delivered. Cardiff University goes one step further by employing Panopto, a state-of-the-art video capture system that allows students to play back recorded lectures as revision aids on their own laptops.

As with releasing lecture material early, Panopto technology benefits all students, not just those with dyslexia. Removing the need to undertake comprehensive note-taking during a lecture not only facilitates more effective knowledge transfer but presents a more enjoyable learning experience for the student.

Although it certainly bucks the trend, students that achieve poor grades at school can often go on to excel within a university setting. It is an environment that appreciates that not all students learn in the same way, where dyslexic students can flourish just as well as all other students.

I was not diagnosed with dyslexia until I was 34 years old and reading my third degree. During my PhD study, a colleague looked over to my work station and exclaimed, "Wow, you're dyslexic!"

I can remember initially being quite shocked at the accusation, but then something about his statement rang true. He was also dyslexic and had noticed distinct similarities between the way our seemingly chaotically cluttered desks were organised.

I approached Cardiff University's Disability and Dyslexia Service, where a team of specialists put me through a series of tests in order to assess my condition. Despite establishing a high IQ, my reading age was found to be consistent with that of an eleven-year-old child, and within a matter of hours they were confidently able to diagnose me as dyslexic.

If I am completely honest, the diagnosis came as a relief. At last I had a label for my condition. At last I was able to understand why I had to work twice as hard as my colleagues to achieve a similar standard of reading and writing. Finally, I could feel at peace with who I was and how my brain worked, instead of constantly being stressed, worried and frustrated. I could now develop the coping mechanisms I needed to compensate for my disability.

Although dyslexia is widely considered to be a highly debilitating condition, there are situations when it can be extremely advantageous. Part of the test involved solving three-dimensional puzzles presented on a two-dimensional plane. At first viewing, I was able to answer each of the puzzles in little over 2-3 seconds. This elicited a smile from the Educational Psychologist who then informed me I had been allocated a full minute for each one. Such is the enhanced ability of a dyslexic's spatial awareness and three-dimensional mapping.

In fact, nowadays I do not think of my dyslexia as a disability. There have been many circumstances where my "disability" has been an advantage in problem solving at work. It has been especially beneficial when discovering camouflaged animals during field work or reading small behavioural cues of study species. As a Lecturer, it helps me to identify and support members of our student cohort facing the challenges of study with specific learning disabilities.

Although many organisations are now understanding the true value of incorporating dyslexics and people with other specific learning disabilities into workplace teams, there is still a stigma surrounding these conditions. Many of those diagnosed hide their condition, fearing they will be looked down upon by their work colleagues or that it will present a barrier to promotion.

We need to recognise and embrace the qualities of dyslexia and see them as an opportunity to excel. Only then will we see many more of our brilliant colleagues feeling confident enough to step forward and admit that they too are dyslexic.

"In fact, nowadays I do not think of my dyslexia as a disability"

LGBTSTEM Day: The importance of community and visibility

On any given day, a scientist, somewhere, is speaking to a group of young people, encouraging them to consider a career in science. We tell them how exciting it is to be part of that process of discovery, and how fulfilling it is to be in a line of work that is driven by curiosity and questions. But we don't always ask ourselves if every young person in that room will feel welcome in their first lecture, in their first lab, at their first conference. And I think we should.

Shaun O'Boyle

Founder, House of STEM, Ireland
& LGBTSTEM Day co-organiser
shaunoboyle.org

During my PhD, I began the challenging and never-ending process of "coming out" and telling people I'm gay. That didn't always go well, and I didn't always feel welcome in my department, but I was lucky to have the support and love of my lab group. I completed my PhD four years later, and I spent one more year at the bench as a postdoctoral researcher. My postdoc was in a new city, and I hid the fact that I was gay from most of my colleagues. That was exhausting.

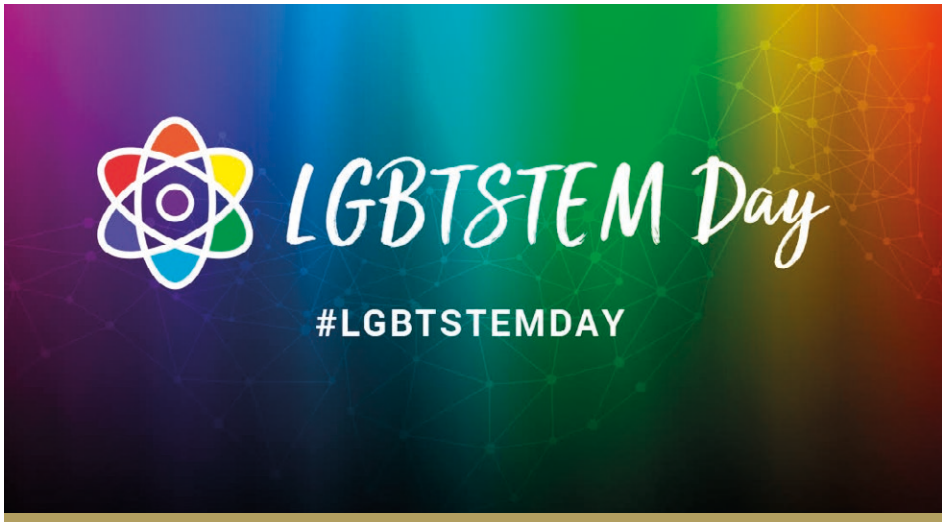
While the scientific process does its best to eliminate human bias, scientific careers happen in offices, in labs, in meeting rooms, and in lecture theatres filled with humans and our biases. Like any other job, science happens in buildings and societies where sexism, racism, ableism, homophobia, transphobia, biphobia and classism exist. It takes a lot more energy to do your science when you also have to deal any of these, and even more energy when you have to deal with more than one of them.

Not surprisingly, 29% of LGBTQ young people avoid careers in STEM because they fear discrimination, and those who do enrol are more likely to drop out (Hughes, 2018). 40% of LGBTQ people in STEM are not "out" at work (Yoder & Mattheis, 2016), and there are significant risks faced by LGBTQ researchers who are required to do fieldwork in regions where it is dangerous or illegal for them to exist.

Something I've learned over the years is that scientists are very good at forming communities. When I did my PhD on early zebrafish development, I discovered that there is a "zebrafish community" full of helpful and friendly people who like to dance at conferences, and who will share all of their plasmids with you if you ask them. After my postdoc, I moved into a career in science communication, and began to spend more time on Twitter. One day, I followed @PrideinSTEM, and in doing so I discovered an incredible international network of LGBTQ scientists and science communicators that would eventually feel like my extended family. This sense of community is important, because it gives us a stronger voice and it serves as an important support, particularly for new students and early career scientists.

Like many minorities in science, we find each other online and through social media. We also work hard to improve the experiences of current and future LGBTQ scientists. The first LGBTSTEMDay was organised last year, on 5 July, by a small team, but supported by 48 scientific organisations including The Physiological Society. It brought people together all around the world for events that ranged from coffee mornings to exhibitions, and panel discussions. It sparked important conversations, strengthened peer support, and improved visibility. Online, the #LGBTSTEMDay hashtag reached 11 million people on Twitter and 64 million people on Facebook. Visibility like this is important, because it makes LGBTQ scientists feel less alone, less isolated, and it helps connects us to a supportive community.

This year, nine groups will join forces to organise LGBTSTEMDay 2019, and to help spark more conversations, more get-togethers, and even better representation of the diversity of LGBTQ people who work in STEM. We will offer support to anyone who'd like to organise an event or initiative to showcase LGBTQ talent in STEM, to highlight the challenges faced by the community, and to show support and solidarity.



Visit **prideinstem.org** to learn more about this year's LGBTSTEM Day, happening 5 July 2019.

"Online, the #LGBTSTEMDay hashtag reached 11 million people on Twitter and 64 million people on Facebook"

In an initiative supported by The Physiological Society, I'm excited to be teaming up with Alfredo Carpineti to put together a collection of stories from LGBTQ scientists around the world. We hope that these stories will be a source of support, advice, and insight into what it's like to be LGBTQ in STEM, and we will be sharing them as a free e-book this year.

Science can be an incredible career, and an incredible journey. It benefits from having a diverse workforce, with a range of perspectives and experiences, but there are aspects of working in science that can hinder that diversity. Conferences, for example, are held in locations that are unsafe for LGBTQ people, or where people can be denied accommodation or service based on sexual orientation or gender identity (e.g. USA, Singapore, Russia). We talk about science's "leaky pipeline" for talent, but I think it's more like a pipeline with a series of selective filters that allow some people through while holding others back. My hope is that we will continue to work together to change that, so that when we speak to that room full of young people, we can confidently recommend a career in science, knowing they will all be respected equally.

#LGBTSTEMDay Organisers on Twitter:

- LGBTSTEMDay *@LGBTSTEMDay*
- Pride in STEM *@PrideinSTEM*
- House of STEM *@HouseofSTEM*
- Out in STEM *@OUTinSTEM*
- Inter Engineering *@InterEngLGBT*
- Queers in STEM *@QueersInSTEM*
- LGBTSTEM *@LGBTSTEM*
- 500 Queer Scientists *@500QueerSci*
- Queers in Science *@QueersInScience*
- LGBT+ Physics *@LGBT_Physics*

For more information, visit **lgbtstemday.org**. If you would like to get involved, email **lgbtstemday@gmail.com**.

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The only one in the room – why I set up BBSTEM

Kayisha Payne

Founder, BBSTEM
bbstem.co.uk

Kayisha Payne describes her experience as a black woman in STEM and how it led her to set up a non-profit organisation, BBSTEM, Black British Professionals in STEM.

I had a "random" encounter with a family friend. In February 2017, I met someone I consider to be a very successful young black chemical engineer. After the conversation I felt so inspired and privileged to hear of a young black man in the same career field, with a similar Caribbean upbringing, having "made it". I felt so enthused, and I wanted to create a platform where these "accidental" meetings are made deliberate and intentional, a place where young black people feel comfortable to reach out for support and can be given it. It was after this that I launched BBSTEM, which stands for Black British Professionals in STEM.

BBSTEM is dedicated to introducing, inspiring and supporting black youth who would like to enter into rewarding STEM careers, an area where they are currently underrepresented. Our mission is to create a balanced representation of black people in STEM from education to industry. One way we aim to achieve this is by increasing commitment to diversity and inclusion within organisations by partnering with them to execute programmes, workshops, networking events and mentoring schemes that teach young black students about STEM opportunities. These efforts remove the element of chance from these encounters and foster attitudes that allow marginalised youth to aim higher when choosing their career paths.

Growing up, becoming a scientist was never something that came to mind. Was it because it didn't seem like a "real job normal people do"? Was it too hard? Was it because there wasn't anyone in my immediate family or social group that was in a scientific profession or industry? Or maybe because I'd never seen or heard of a black scientist? It could be all of the above. To think that I have received a Masters in Chemical Engineering from Imperial College London, contributed to the advancement of being able to model and simulate the thermodynamic behaviour of active pharmaceutical ingredients and bio-pharmaceutical products and am now a scientist at a global pharmaceutical organisation exceeds my expectations!

The nature of science and knowledge sharing is paramount for science to advance. For this reason, I, like many other scientists and engineers, attend numerous industry events, workshops and conferences, and I am constantly reminded by the stark lack of representation of black scientists. I have yet to attend a conference where there was a black speaker, or facilitator and I often find that I'm the only black person in the room. When attending events, should I even be thinking about race? It's almost impossible. Race inevitably defines the experiences of who I am, how society identifies me and how society interacts with me. I can't help but be distracted by these thoughts when I find that people shy away from interacting with me at the break or lunch hour. Is it because I'm younger than most, a woman, and black?

It's important to motivate young people to see that embarking on a STEM career is an option, that it's something that they can progress in and be successful in. Without obvious representation it might not seem possible. Aside from my own observations of lack of role models and visible representation, I read a publication by The Royal Academy of Engineering which stated that, "There are a number of programmes designed to support and encourage girls into STEM, but there are fewer supporting BAME students." This statement was supported by statistics showing that the number of black UK students residing in the UK enrolled onto a STEM-related course was only 6%.

I wanted to use the small platform I have to create change. It's a known fact we have a STEM skills shortage in the UK, which is costing us a substantial amount of money (Stem.org.uk, 2019). Diversity initiatives pop up all over the place, but do not address the needs of black people. How can we encourage and inspire younger generations to aspire to be something they cannot see themselves reflected in?

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The cost of coming out in biomedicine

Bryce Hughes

Department of Education,
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National efforts across the United States, United Kingdom and the rest of Europe have taken aim at reducing social inequality through widening participation in undergraduate STEM (science, technology, engineering, and mathematics) fields. These efforts typically focus on redressing the underrepresentation of women, ethnic minorities, people with disabilities, and people from other groups underserved by these fields (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2011; Thompson, 2019). An emerging body of research has shown that members of the lesbian, gay, bisexual, transgender, and queer[1] (LGBTQ) community are also being systematically excluded from full participation in STEM, though limitations in the data collected on participation in STEM until recently has obscured the scope of this problem. Using longitudinal, national data on college students in the United States[2], I was able to show that sexual minority (LGBTQ) students are retained in STEM degrees at a significantly lower rate than their heterosexual peers (Hughes, 2018).

Overall, I estimated the retention rate for sexual minority students in STEM to be about 7% lower than that for heterosexual students. What was somewhat surprising was that sexual minority students were more likely to leave STEM despite being about 10% more likely to participate in undergraduate research, one of the most effective experiences to promote persistence to STEM degrees (Graham *et al.*, 2013). This difference persisted even when talent, ability, and interest were accounted for.

Physiology and other medical fields should be especially concerned about LGBTQ participation given how the healthcare system underserves these communities. Negative experiences with providers lead to LGBTQ people not being appropriately evaluated for various diseases, or to avoid seeking healthcare altogether (Parameshwaran *et al.*, 2013). In disaggregating my data to students who majored in the biomedical sciences, I found a starker difference than for STEM overall: 52% of the heterosexual, but only 41% LGBTQ, students were retained in the biomedical sciences after four years. As seen in Table 1, most of the difference appears to be LGBTQ students who switched from the biomedical sciences to other STEM fields, though more than one-third of students in both groups left STEM altogether. About two-thirds of the original LGBTQ biomedicine undergraduate population who remain in STEM keep on track to complete a degree in biomedicine, while the other third may be attracted to other STEM fields offering more task independence for LGBTQ people concerned about disclosing their sexual or gender identity to colleagues (Tilcsik *et al.*, 2015).

What then could be done to bring these numbers closer to parity? It is unclear that undergraduate research experiences make a difference for LGBTQ students in STEM, which could reflect the environment and support established by the faculty mentor. One important recommendation, then, is to provide professional development opportunities to help faculty who would like to be better mentors to feel empowered to do so. Alternatively, it could mean that LGBTQ students may be even less likely to persist in STEM without these undergraduate research experiences. Controlling for other factors, like undergraduate research participation, my estimate of the difference in retention by sexual orientation expanded to 9.5% from 7% (Hughes, 2018). LGBTQ students also continue to experience isolation in STEM, and transgender, nonbinary, and gender nonconforming students face direct stigma when the wrong names or pronouns are used, or when peers express discomfort with their gender expression (Duncan *et al.*, 2018). Organisations like House of STEM in Ireland, oSTEM and NOGLSTP in the United States, and InterEngineering in the United Kingdom are developing networks for LGBTQ STEM students and professionals to find community. Connecting students, faculty, and staff to these organisations, or hosting these types of organisations in academic faculties, can help diminish these feelings of isolation.

	LGBTQ (n = 170)	Heterosexual (n = 1932)
BioMed major	41%	52%
Other STEM major	21%	13%
Non-STEM major	38%	35%

Table 1. Biomedical sciences aspirants who after 4 years (2011 – 2015) were retained in the biomedical sciences, had switched to another STEM major, or left for a non-STEM major. $\chi^2(2) = 10.93$, $p < 0.01$.

[1] Queer is a formerly derogatory term that has been reclaimed by academics and activists to describe being a sexual or gender minority; academics use it most frequently in reference to queer theory whereas activists tend to use it in political organising.

[2] The sources for these data are the 2011 Freshman Survey and the 2015 College Senior Survey, both administered by the Cooperative Institutional Research Program within the Higher Education Research Institute at UCLA.

Finally, addressing the disparity in retention between LGBTQ and cisgender/heterosexual STEM students has implications for representation in the workplace and in academia. By addressing the climate in STEM and empowering more LGBTQ students to persist in their plans to enter the STEM workforce, future generations of LGBTQ STEM students will have an increased number of role models to look up to as they pursue their own career plans. LGBTQ clients will have access to LGBTQ health providers who can create a more comfortable environment for accessing sensitive and competent health care. I came to this research having been an openly gay engineering undergraduate myself, and I have felt especially encouraged by visibility efforts like 500 Queer Scientists and #LGBTSTEMDay. Society may have shifted rapidly in terms of attitudes toward the LGBTQ community, but the work has not yet finished.

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Policy focus: APPG on Diversity and Inclusion in STEM

Chi Onwurah, MP

Chair of APPG on Diversity and Inclusion in STEM, Member of Parliament for Newcastle Central

As Shadow Minister for Industrial Strategy, Science and Innovation I'm proud to have put science and innovation at the centre of my work. Britain's future prosperity and social cohesion depends on delivering high-wage, high-skill, high-productivity jobs for everyone, and science and innovation are a central part of achieving that. I am enormously pleased therefore, to see that The Physiological Society has dedicated this entire issue of *Physiology News* to hear from different voices and perspectives within the community itself and hope that by doing so, The Society sparks new conversations and ideas.

In my life before entering Parliament, I spent twenty years as a telecommunications engineer. In this role, I attended many conferences and would present to around 2,000 people in a room. Very often, I would be the only black engineer. If this wasn't the case, I would be the only woman, the only working-class person, the only Northerner. While this made me unique, ultimately it was a very isolating and exclusive environment and each aspect faced stereotypes and barriers to inclusion.

Diversity is not a "nice to have"; it is a moral and economic imperative. Without it, innovation is limited and valuable talent is excluded from the workforce. That was true throughout my twenty-year career outside Parliament. It is even truer now that technology has become such an everyday part of everyone's lives. We need to ensure as representative a STEM community as possible so that scientists can get on with what they do best – using rigorous scientific processes to meet the major challenges facing all of us.

My constituency of Newcastle upon Tyne Central includes Newcastle University and so I am aware that diversity in STEM includes ensuring that science and innovation is the foundation of wealth generation beyond the traditional boundaries of the Golden Triangle. There is cutting-edge research occurring throughout the UK and we must not allow the research or development aspects of R&D to suffer because of where they are proposed, or by whom.

This is why the work of the All-Party Parliamentary Group (APPG) on Diversity and Inclusion in STEM is so important. It has already attracted a huge amount of interest from parliamentarians because colleagues from both Houses value the opportunity to engage directly with the STEM community to understand the barriers to a more diverse scientific workforce. The APPG will help put diversity and inclusion in STEM high on the agenda, to move the sector in the right direction. This means all kinds of diversity – not only gender, but also race, religion, sexual orientation, disability, socio-economic status and age. That is why this year, the APPG is exploring inquiries focusing on promoting diversity in the STEM education, careers, government funding and tech sectors, and I would encourage the learned society sector to play an active role in providing evidence and recommendations to shape the inquiry's outcomes.

In summary, I hope that this edition of *Physiology News* contributes to constructive conversations within the physiological community about how best to encourage diversity within the discipline. I also hope that by promoting the work of the APPG on Diversity and Inclusion in STEM in this issue, members of The Society will engage with our future work to ensure diversity of thought too!

A decade of diversity – the Institute of Physics' journey in diversity and inclusion

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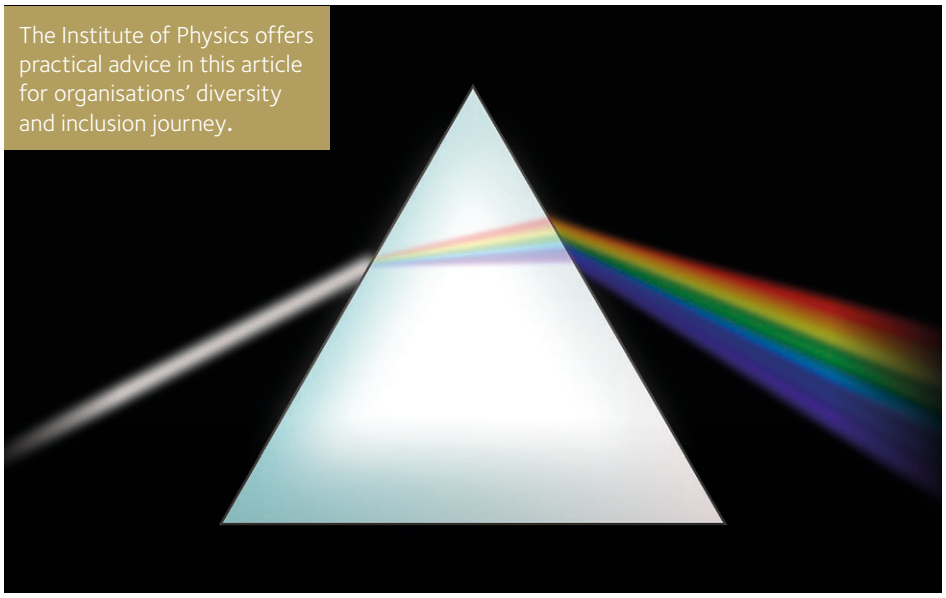


The Institute of Physics offers practical advice in this article for organisations' diversity and inclusion journey.

The Institute of Physics established our Diversity Programme, our Diversity Team (originally 1.6 FTE, now 2.9 FTE) and Diversity & Inclusion (D&I) Committee (which reports to our Council) in 2004, after pressure from our members, especially our Women in Physics Group, to "do something" about the issues for women in physics.

Following a member-led project visiting UK academic physics departments to talk about women's progression, we established our gender equality award scheme, Project Juno, in 2007. The original aim of Juno was to support women in academic physics but over the past decade, Juno has evolved beyond academia, has introduced an additional principle on professional conduct (covering harassment and bullying) and a new level, Juno Excellence, to encourage community ownership and engagement on gender equality. Our members are the lifeblood of Project Juno, helping us with visits to departments, assessing applications and giving feedback on progress. Currently we have 21 Juno Champions and 16 Juno Practitioners, demonstrating how well-regarded the scheme has become amongst the physics community.

In 2011, we carried out our first Member Diversity Survey, an anonymous survey of UK & Ireland members, to obtain a snapshot of their diversity profiles. We repeated the survey in 2015 and this year, 2019, we will be repeating the survey with expanded questions on workplace culture to start a new focus on tackling bullying and harassment.

Following our 2015 survey, members from our LGBT+ community encouraged us to establish an LGBT+ network initially with the Royal Astronomical Society (RAS) and, from 2017, with the Royal Society of Chemistry (RSC). This has culminated in our three organisations running the first UK climate survey for LGBT+ physical scientists, the results of which will be launched in June this year.

The diversity team has always faced the challenge of being both inward and outward looking – tackling barriers to diversity in our own internal practices, operations and governance as well as among our much wider membership and community. This year we are submitting our own application to Project Juno, demonstrating our commitment to embedding diversity across all that we do.

"...we hope to ensure we continue to make a constructive contribution to culture change"

And, looking to the future, we hope to ensure we continue to make a constructive contribution to culture change within the Institute, ensuring that all members and staff understand and respect the value of diversity and inclusion in their working lives. We hope that our 2019 member diversity survey shows that we continue to make improvements in the diversity of our membership. We hope to continue to be a champion in the STEM community on diversity. All of this takes resource, passion, commitment from the top and the willingness for change, both bottom up and top down. We know we're not there yet but we are positive about the changes we know we can make.

As for advice after a decade of diversity work:

- It takes time and resource; there is no getting away from that. But you don't have to tackle everything at once. Decide on a few priorities and start on them.
- Gathering data, so you know where the issues are, is vital. Looking at the different stages of your own pipeline enables you to address intrinsic barriers in employment, membership, governance, etc.
- Members can really help drive change. Most of our D&I programme has arisen from our members being willing to be involved in initiatives for change.
- Commitment from the top is fundamental, and so is the appetite for change. There's no point rushing into an action plan, if there isn't any willingness to address issues that are found. Developing an inclusive culture takes time.
- It's a continuous cycle of review, re-evaluation, seeking constructive feedback, and improving. It's only by identifying why things aren't working that you can look to change.

For all our diversity information and publications, see our web pages **iop.org/diversity**

Diversity and inclusion at Wellcome: What we are learning

Gemma Tracey

Wellcome Trust,
London, UK

Wellcome's diversity and inclusion work is underpinned by the philosophy that a greater diversity of ideas will improve human health for everyone. It is well-documented that we are losing out on some of these great ideas because of the barriers that some people face to building a career in research, especially Black and Minority Ethnic (BME) and disabled researchers, and women at later career stages.

How we work

We try to ensure that this philosophy informs all the projects we do as a team. For example, we have an external diversity and inclusion advisory group that we recruited through an open call, and which includes members from a range of backgrounds, sectors and career stages. Our quarterly meetings with the group are robust and challenging – as they should be. Something I have learned as a diversity and inclusion (D&I) practitioner is that you must remain in an ongoing cycle of reflecting on your views and practice, and be open to feedback from others. Wellcome does not have all the answers, and our steering group is just one way we try to work in an open and inclusive way.

Supporting others

In some ways Wellcome has engaged with the D&I agenda later than others – the funding for our team was approved in late 2016. But that has enabled us to build on the experiences of others. There are so many people and organisations dedicated to creating a more inclusive science and research community. Much of this work is done by grassroots groups, led by people who have themselves faced barriers. We have provided funding for events like the BME Early Career Researcher Conference, we have hosted meetups in our building, and we want to continue to use our resource and convening power to elevate the voices of those most aware of the barriers that some groups face.

Sometimes it comes down to resource

Something I observe when I attend Wellcome researcher meetings, is the high level of enthusiasm and commitment to creating a more diverse scientific community. But there is a funding gap – busy researchers often lack the time and the financial resource to implement their ideas for creating a more inclusive research environment, or to remove barriers that certain groups face. That is why Wellcome runs the Research Enrichment scheme – which offers dedicated funding to Wellcome grant holders to do D&I projects. It's worth noting that since the scheme launched in 2017 we have received fewer applications than we hoped and we didn't always receive the type of proposals we are willing to fund.

So what type of application do we want to see? Firstly, it's really important that any project be informed by existing data and research – whether this be data from HESA about the diversity of a specific field or institution, or anecdotal feedback gathered through conversations or staff surveys. It's also important that projects are designed to remove barriers, rather than taking a deficit model approach (a term which describes projects aimed at "fixing" individuals from an under-represented or marginalised group). An example of a successfully funded project that took this evidence-informed approach will look at developing a diversity and inclusion training programme and toolkit for senior researchers to empower them to lead on D&I issues.

Genuine leadership on diversity and inclusion

It is noteworthy that the monitoring and evaluation work we are conducting as a team highlights that genuine commitment from senior leaders is key to progress on D&I – both internally within Wellcome, as an employer of 800 staff, and externally within the institutes we fund.

So what makes the difference between vocal commitment to D&I and genuine leadership, and what enables someone to step into leadership on D&I? Something that we are currently exploring at Wellcome is reverse-diverse mentorship for our senior leaders, offering them the opportunity to meet with a group of staff from one of our staff networks, and be mentored on the issues and challenges faced by that group – in relation to race, disability, gender and LGBTQ+ identities. We are still in the early stages of this work and plan to build in evaluation to ensure we have robust insights we can share with the sector. But initial feedback is that mentors and mentees have valued the opportunity to share and discuss real issues, while deepening their knowledge and understanding. It's noteworthy that a number of universities are piloting similar programmes through the Engineering and Physical Sciences Research Council's (EPSRC) Inclusion Matters funding stream.

What's next?

We are also a founder member of EDIS (Equality and Diversity and Inclusion in Science and Health), a coalition established by Wellcome, Francis Crick Institute and GSK to draw together organisations across the science and health field to influence and drive evidence-based change. EDIS is currently engaging new members, as well as organising a symposium in September dedicated to the concept of inclusive research and experimental design.

Working in diversity and inclusion can be challenging, not least because the rate of progress can feel far too slow. But within Wellcome I sense an increased appetite and willingness for change, and our team is looking forward to engaging with our staff, the people and institutions we fund, as well as those we don't yet fund, to hopefully speed up the rate of change.

"It is noteworthy that the monitoring and evaluation work we are conducting as a team highlights that genuine commitment from senior leaders is key to progress on diversity and inclusion"

Launching The Society's new Themes

Susan Deuchars
University of Leeds, UK

The Society has been internationally recognised over many years for its diverse conferences that bring together researchers from across the world to celebrate the top findings in physiology research.

With our focus on activities around diversity and inclusivity, we have ensured that our conferences foster new opportunities for early career scientists to be involved. Our Annual Conference runs parallel sessions of symposia, organised into Themes that enable scientists to focus more on specific hot topics in their fields. We have also reintroduced many more oral communications that are delivered in Theme sessions. In poster sessions focused around a Theme, individuals can disseminate their research to experts in their field and have in-depth discussions that may open new avenues for future collaborations. We are also introducing poster prizes within Themes for early career scientists – these will be judged by experts in each Theme.

Each of these Themes is associated with a number of Specialities, thus enabling scientists to align their abstracts or presentations according to both a Theme and Speciality. The attached matrix gives an idea of how this flexibility works. As you can see, all of the Specialities are associated with at least one Theme and each Theme has at least seven Specialities to draw from.

Following feedback from Members of The Society and Theme Leads, a decision has been made to slightly alter the Themes and look at the affiliation of the different Specialities. This should resolve issues with researchers feeling somewhat isolated in their Themes or wanting to be more involved with a number of Themes. Please choose your Speciality and Theme on the Member Portal; these can be as extensive as you wish. You can be involved with any activity of The Society, regardless of Theme or Speciality. We have a fantastic group of Theme Leads, who are chosen due to their passion for physiology and their wish to provide relevant, topical symposia and meetings that suit their Themes. They are working hard in tandem with the Conferences Committee to shape future events and would love to hear from you!

We want to foster the values of local support and interactions with well-matched physiologists and would like you to have a sense of belonging within the wider, diverse physiology community. Therefore, we would like you to be more aware of who your Theme Leads are and what activities are associated with different Themes.

We have taken the opportunity to announce new Theme Leads here in *Physiology News*, and on the new website we have a more detailed introduction to each Theme. This should help when it comes to choosing a Theme or Speciality for your abstract. I am particularly grateful for the input from all the Theme Leads, their support of meetings and endless enthusiasm.

Epithelia and Membrane Transport (EMT)
Mike Althaus
Lecturer in Animal Physiology, Newcastle University

Becoming a Theme Lead in Epithelia and Membrane Transport (EMT) is a great chance to shape our vibrant EMT research community and I am particularly enthusiastic to promote EMT to the next generation of physiologists.

Epithelia and Membrane Transport (EMT)
Morag Mansley
Research Fellow, University of Edinburgh

The EMT Theme has become a very important community and part of my research life: from the many scientific discussions over coffee (or a glass of wine) and the exciting collaborations that have developed, to the ongoing friendships I have made. I was delighted to take on the role of Theme Lead for the EMT Theme. I am enthusiastic to contribute to this community which I was welcomed into more than a decade ago, to ensure it flourishes, and to help promote it to our next generation of EMT scientists.

Human, Environmental and Exercise Physiology
Gladys Onambele-Pearson
Deputy Director Musculoskeletal Science, Manchester Metropolitan University

Human, Environmental, and Exercise Physiology is a very dynamic area of research and practice that links to clinical areas through sports medicine. It also leads our understanding of physical fitness and what factors govern it so that we can optimise habitual physical functioning and health through the lifespan. It is this wide range of often directly applicable findings to the end-users that attracted me to the topic. I remain as enthusiastic as I ever was from the beginning of my research journey, more than 15 years ago.

Human, Environmental and Exercise Physiology
Kostas Tsintzas
Associate Professor of Human Physiology, University of Nottingham

My involvement with the Human, Environmental and Exercise Theme allows me to champion the importance of human physiology, interact with other Theme Leads and colleagues throughout the country, help out with activities at Annual Conferences, and have input in the future direction of the Theme. Co-organising the highly successful "Experimental Models of Physiology" conference in Exeter in 2018 was a particular highlight.

Cardiac and Vascular Physiology
Sarah Calaghan
Associate Professor of Cardiac Physiology, University of Leeds

I've benefited from the activities of The Physiological Society, particularly the scientific meetings, since I was an early career scientist and I'm keen to contribute to The Society by acting as Theme Lead for Cardiac and Vascular Physiology.

Cardiac and Vascular Physiology
Chris Garland
Professor of Vascular Pharmacology, University of Oxford

As a long-term member of The Society, I was eager to take on the role of Theme Lead for Cardiac and Vascular Physiology, which has been my area of interest since my PhD studies in London.

Cardiac and Vascular Physiology
Andrew James
Senior Lecturer, University of Bristol

The Cardiac and Vascular Theme encompasses all aspects of this vast research field from cellular to organ level and the integration of functions to produce appropriate cardiovascular responses. With increasing access to gene editing and super-resolution imaging technologies, now is an exciting time to be a physiologist.

Endocrinology
Paul Le Tissier
Senior Lecturer, University of Edinburgh

My principal research interest looks at how the different cell populations of the anterior pituitary gland function to maintain and alter their output throughout life and how their dysregulation leads to pathology. I use an integrated approach, from the level of individual cells and their organisation to their secretory activity and its effect on whole animal physiology. Currently my research focuses on three main areas: (1) plasticity and organisation; (2) monitoring secretion; and (3) pathology.

Endocrinology
Tim Wells
Senior Lecturer, Cardiff University

I'm a metabolic neuroendocrinologist in the School of Biosciences at Cardiff University. I work at the interface between nutrition, hormones, neuroscience, physiology and connective tissue biology. Since joining Cardiff University, I've focused on generating novel rat models of altered neuroendocrine function, and on the activity of the gastric hormone, ghrelin.

Metabolic Physiology
Paul Meakin
Research Fellow, University of Leeds

I am indebted to the support that The Physiological Society has provided me by funding conference and training travel grants, as well as undergraduate studentships. These funds at key stages in my research career have proved vital in developing my skills (both research and supervisory) in order to allow me to establish my own research group. I am grateful for the opportunity to give back to The Society by becoming a Theme Lead for Metabolic Physiology. I plan to promote and integrate metabolic physiology with the other Themes within The Society.

Metabolic Physiology
Andrew Murray
Reader in Metabolic Physiology, University of Cambridge

I am a Reader in Metabolic Physiology at the University of Cambridge, where my group works on integrative mitochondrial physiology. We have broad interests in the factors that influence mitochondrial respiratory function in health and disease, and the impact this has in turn on the function of the cell, tissue, organ and organism. A major interest of ours lies in the response of mitochondria to hypoxia, and we have enjoyed many years of collaboration with the Xtreme Everest group investigating the metabolic response to high altitude and in disease states where hypoxia is an underlying factor.

Neuroscience
Mark Dallas
Associate Professor in Cellular Neuroscience, University of Reading

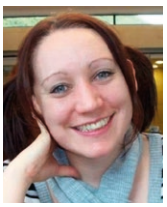
My research focuses on understanding cellular mechanisms of disease with a focus on neurodegeneration and the role glial cells play in disease processes. I wished to become Neuroscience Theme Lead for The Physiological Society to represent the neuroscience community and also to gain an insight into the world-leading research carried out by The Physiological Society's Members outside my area of expertise.

Neuroscience
Talitha Kerrigan
Honorary Research Fellow, University of Exeter

I am an applied neurophysiologist with a special interest in stem cell biology, in particular, the use of induced pluripotent stem cells as a model of neurodegenerative diseases. My research focuses on the role of neuroglia and neuroinflammation in diseases such as Alzheimer's and Parkinson's. I am also interested in the development of new technologies in stem cell research.

Neuroscience
David Menassa
Research Fellow, University of Southampton

As Theme Lead, I wanted to get involved in helping develop Topic Meetings that would allow cross-over between various fields to support neurophysiological research. Another reason for my interest was that I wanted to reach out to other Members under my Theme as well as funders and the public by writing short pieces on topical issues in neuroscience.



Education & Teaching
Sheila Amici-Dargan
Senior Lecturer, Cardiff University

I wanted to be an Education and Teaching Theme Lead to help The Physiological Society organise events and workshops to promote the sharing of best practice in teaching, learning and educational research.

Education & Teaching
Nicholas Freestone
Associate Professor, Kingston University

Since becoming a Theme Lead I have gained enormously from exposure to the best practices in the learning and teaching milieu in the UK and further afield. I have striven to raise the profile of learning and teaching as a pathway for career progression and promotion. The best thing about being a Theme Lead is the help and support one can provide to others in their day-to-day practice. I enjoy serving as a guide in the often bewildering and foreign world of pedagogy for those interested in examining more closely the learning and teaching parts of their academic lives.

Education & Teaching
Derek Scott
Senior Lecturer, University of Aberdeen

I wanted to become a Theme Lead to help colleagues share the excellent things they are doing to improve physiology teaching and to help them in their career progression. I also want to demonstrate how The Society's Members are improving the standard of physiological education globally.

Figure 1. Matrix of Themes and Specialities.

	Neuroscience	Endocrinology	Cardiac & Vascular Physiology	Metabolic Physiology	Human, Environment & Exercise Physiology	Epithelia & Membrane transport	Education & Teaching
CRAC	X	X	X	X	X		X
CN	X			X			X
CS	X	X	X	X	X	X	X
CP	X	X	X	X	X	X	X
EMT			X			X	X
GIT		X		X	X	X	X
HCM			X	X			X
HW	X		X				X
HP			X		X		X
IC	X		X	X		X	X
L	X				X		X
MEP		X	X	X		X	X
MC	X		X	X	X		X
NDP	X						X
NE	X	X		X		X	X
PP		X		X		X	X
RP		X	X	X	X	X	X
Resp	X			X	X	X	X
SMC	X				X		X
SF	X			X	X		X
SM		X	X	X	X	X	X
SSP	X				X		X

CRAC Cardiovascular, Respiratory & Autonomic; **CN** Cellular Neurophysiology; **CS** Cellular Signalling; **CP** Comparative Physiology; **EMT** Epithelia & Membrane Transport; **GIT** Gastrointestinal Tract; **HW** Health & Wellbeing; **HCM** Heart & Cardiac Muscle; **HP** Human Physiology; **IC** Ion Channels; **L** Locomotion; **MEP** Microvascular & Endothelial Physiology; **MC** Muscle Contraction; **NDP** Neural Development & Plasticity; **NE** Neuroendocrinology; **PP** Placental & Perinatal Physiology; **RP** Renal Physiology; **Resp** Respiratory Physiology; **SMC** Sensorimotor Control; **SF** Sensory Functions; **SM** Smooth Muscle; **SSP** Somatosensory Physiology; **TE** Teaching.

What price a Martian:
Human limits to exploring the red planet

With a human trip to Mars on the horizon, how can humans survive the journey and the planet?

Learn about visiting Mars at our fascinating talk

Get your questions answered by an astronaut

Roll up your sleeves at our hands-on activities

A great afternoon for all the family! Join us at our **free talk** by an astronaut, followed by hands-on activities to inspire children about space and science.

The Physiological Society's 2019 President's Lecture will be delivered by NASA astronaut and physiologist **James Pawelczyk.**

Book now for this **FREE** event: **physoc.org/presidentslecture**

The Physiological Society

Saturday 7 September, 1-4:30pm
The Royal Institution, London

Meeting preview

Equality, Diversity and Inclusion in Science and Health (EDIS) Symposium for 2019: The diversity problem goes far beyond the scientist

9 September 2019,
Francis Crick Institute,
London, UK

edisgroup.org/edis-symposium-2019/

Equality, Diversity and Inclusion in Science and Health

Lilian Hunt

Programme Manager at EDIS (Equality, Diversity and Inclusion in Science and Health), London, UK

Biomedical, medical and health research needs to represent the diversity of the population to be truly beneficial for everyone. When we talk about diversity and inclusion in science research, the focus tends to fall on researchers and scientists, but the unintended consequences of poorly designed studies and trials can be life-threatening.

The recent spotlight on clinical trials and drug responses is a powerful example of why trial design and research needs to be disrupted. Sex differences in drug responses, including adverse side effects, are now recognised (Carey *et al.*, 2017) and the historic exclusion of women from clinical trials and even the exclusion of female mice from pre-clinical research (Karp and Reavey, 2018) are known driving factors for why drugs fail. A study in 2001 found that of the 10 drugs withdrawn from the market since 1997, eight posed greater health risks for women than men (Heinrich, 2001). This is just one part of the diversity and inclusion problem within research (although possibly the aspect with the most traction and evidence at present).

Another important issue is increasing the diversity of patients and public members involved in health research (PPI) initiatives. The National Institute for Health Research (NIHR), supported by the Standards Development Partnership, has included "Inclusive Opportunities" in its National Standards for public involvement in research (NIHR, 2018). This was built on an understanding that diversity and inclusion is important for public involvement in research both for improving the research itself (Crocker *et al.*, 2018), and for improving health outcomes for all or for those at higher risk of health problems (Born in Bradford, 2018).

Improving the design of trials and who takes part in them can be resolved by a diverse workforce. Currently, black and minority ethnic individuals and people with disabilities remain underrepresented compared to the UK working population (Advance HE, 2018). A greater understanding of who is benefiting from research, and more importantly who isn't, needs to be developed by researchers and funders to redirect focus to those missing out.

So, what is the science community doing to ensure inclusive practices yield results that are truly representative of today's diverse society?

Challenging health inequalities underpins The Equality, Diversity and Inclusion in Science and Health (EDIS) Symposium for 2019. EDIS is a coalition of 14 organisations in the science and health sector working together to improve equality, diversity and inclusion. This year's focus is on research, with the symposium bringing together researchers and leaders in their fields with the aim to change the way we design and conduct our research. Inclusive research and experimental design is crucial for health equity, and systematically leaving any group behind in health advances is both poor practice and unethical.

The symposium (held on 9 September at The Francis Crick Institute, London) will explore several topics including sex as a biological variable, ethnicity and ancestry in genomics studies, diversity in clinical trials, the impact of diversity on the power of Artificial Intelligence in health, and BAME (Black, Asian and Minority Ethnic) participation in health research. The event will inform, inspire and give researchers, funders and policy-makers a chance to input on the future of how we acknowledge this problem and how we change it as a sector.

The exciting speaker line-up includes:

- Londa Schiebinger
  web.stanford.edu/dept/HPST/schiebinger.html
- Ewan Birney
  ebi.ac.uk/about/people/ewan-birney
- Robin Lovell-Badge
  crick.ac.uk/research/find-a-researcher/robin-lovell-badge
- Bella Starling
  research.cmft.nhs.uk/our-team/bella-starling
- James Wilsdon
  sheffield.ac.uk/politics/people/academic/james-wilsdon
- Peju Oshisanya
  wocip.org/wp-content/uploads/2018/09/Peju-Oshisanya-Bio_WOCIP2018.pdf

We hope you can join us! Sign up here:
eventbrite.com/e/edis-symposium-2019-inclusive-research-and-experimental-design-registration-57785996471

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Advance HE (2018). *Equality in Higher Education: Statistical Report 2018.*

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Crocker JC *et al.* (2018). Impact of patient and public involvement on enrolment and retention in clinical trials: systematic review and meta-analysis. *BMJ* **363**, k4738.

Heinrich J (2001). *Most Drugs Withdrawn in Recent Years had Greater Health Risks for Women.* General Accounting Office-01-286R.

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Meeting preview

Future Physiology 2019: Uniting early career researchers

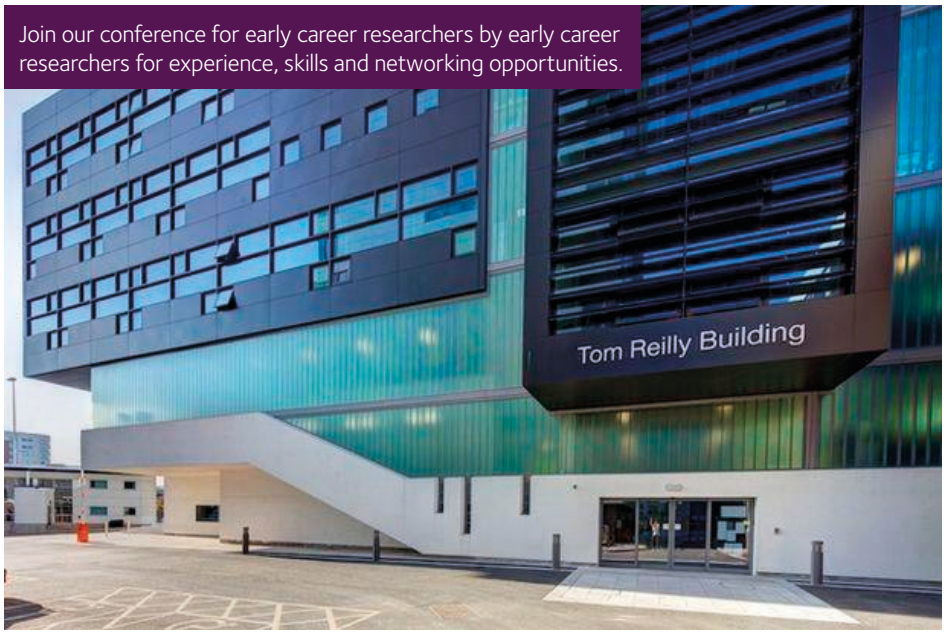
17 – 18 December 2019,
Liverpool John Moores University,
Liverpool, UK

physoc.org/events/future-physiology-2019/

Katie Hesketh & Mark Viggars

Liverpool John Moores University,
Liverpool, UK

Join our conference for early career researchers by early career researchers for experience, skills and networking opportunities.



In 2017, The Society's Affiliate Working Group organised a successful conference in Leeds, Future Physiology, bringing together over 200 early career physiologists and senior academics. As part of our commitment to early career researchers (ECRs), Council agreed to support an annual meeting organised by ECRs for ECRs as a place to share their research and meet with their peers and also senior academics. Liverpool John Moores University, led by Katie Hesketh and Mark Viggars, was selected as this year's hosts.

Future Physiology offers Undergraduates, and Affiliates of The Society the chance to organise an exciting two-day scientific meeting. We were excited by the opportunity because it allowed us to bring together other like-minded, early career researchers from different backgrounds to present on and discuss health and ageing, something that we are both extremely passionate about. Organising a large conference alongside PhD studies will also be a welcome challenge and a great learning opportunity for us both as we develop our research careers.

Future Physiology gives undergraduates, masters students, PhD students and postdocs a unique platform to share their research and collaborate with other leading researchers to raise their profile and build their scientific networks. We wanted the conference to be a place where the up-and-coming researchers, the future of physiology, could share their experiences and data with other like-minded students and academics.

The broad topic of our conference is Translating Cellular Mechanisms into Lifelong Health Strategies and the scientific programme promises a selection of exciting and current research on a wide variety of physiological topics. The keynote lectures will be delivered by both world-leading academics and early career researchers, giving insight into their current work and share information on their career path to inspire the next generation. The invited talks will be complemented by 16 oral communications selected from abstract submissions and a vibrant poster session. There is also time in the two-day programme for career development workshops that will be valuable for up-and-coming researchers such as "Translating Research into Public Knowledge" and "Publishing for the first time".

> "Future Physiology gives undergraduates, masters students, PhD students and postdocs a unique platform to share their research and collaborate with other leading researchers"

We felt that this is an important topic area for a conference as it covers all of The Society's Themes. Whilst modern science has gifted us with an increase in lifespan, we must now work harder than ever to extend health span. This will both increase quality of life in older age and reduce the increasing economic impact an ageing population has on our healthcare systems.

Our main scientific aim for this conference is to bring together researchers, early career and senior, to look at what ageing processes are across all systems and how they impact us on a cellular and whole-body level. It is also key to try and establish where the gaps in knowledge are and how we are best placed to investigate them. Lastly we hope to try and understand how future physiologists can collaborate with clinicians and policymakers to help prevent, intervene and treat these processes on an individual and population level.

Our speaker line-up includes:

- **Claire Stewart**
  Liverpool John Moores University, UK
- **Mats Nilsson**
  McMaster University, Canada
- **Karyn Esser**
  University of Florida, USA
- **Robert Seabourne**
  Queen Mary University of London, UK
- **Anton Roks**
  University of Rotterdam, Netherlands
- **Lasse Gliemann**
  University of Copenhagen, Denmark

Key information

Abstract submission: 1 - 30 September

Registration opens: 1 July

Travel grant deadline: 31 October

Learning the lingo

How deaf scientists create new technical terminology in British Sign Language

Rachel O'Neill

School of Education and Sport, University of Edinburgh, UK

Gary Quinn

Heriot-Watt University, Edinburgh, UK

Audrey Cameron

School of Education and Sport, University of Edinburgh, UK

Deaf students at school often do not use British Sign Language (BSL) because specialist teachers rarely have fluency in the language, and old views about using only speech with deaf children still dominate. In some local authorities a real choice is offered about communication approaches for deaf children, and increasingly deaf children with hearing aids and cochlear implants are using spoken English and BSL, or Sign Supported English (SSE). That is, if children are exposed to both English and BSL, they can choose the language and communication mode that suits the context. BSL is a language with its own grammar structures that are very different to English, whereas SSE follows English word order with clear visible pronunciation of speech, taking vocabulary from BSL.

Since 2007 the Scottish Sensory Centre (SSC), based in the School of Education and Sports at the University of Edinburgh, has been developing a project to support deaf children and their teachers by collecting and creating specialist BSL signs for scientific and mathematical concepts. The BSL Glossary project has focused so far on STEM subjects (SSC, 2019a). There are currently 1,500 signs and definitions for technical terms in biology, astronomy, physics, geography, chemistry and mathematics. The signs have been developed by a team of 24 deaf scientists, mathematicians and linguists fluent in BSL who have in-depth subject-specific knowledge. The aim is to develop signs, definitions and laboratory clips to illustrate the use of the BSL sign in a scientific discussion or experiment. The website had 151,000 hits over the last year and the associated app, BSL Education, had 6,420 downloads over the last 12 months (SSC, 2018). We know that both resources are used by deaf students, their teachers, and BSL / English interpreters and support workers in education. In addition, wider groups use the Glossary too: teachers of hearing children such as Professional Graduate Diploma in Education (PGDE) science students, deaf scientists working with interpreters, and people working on TV translating scientific or mathematical programmes. A recent addition has been interactive scientific images which take the user to the BSL sign for each label (SSC, 2019b).

The process of collecting and creating the technical signs is deaf-led, unlike earlier attempts by teachers which tried to make BSL more like English (Day, 2000). Audrey Cameron is a deaf BSL user who leads the Chemistry pathway on the School of Education's PGDE, which involves training hearing students how to teach chemistry for the Scottish education system. Audrey works in class and on placement visits with BSL / English interpreters. Her role has been crucial in the Glossary project in coordinating the intensive sign collection and creating

Figure 1. Still from the video of the sign for gas exchange, from the Scottish Sensory Centre

"For many of the signs we also produce a laboratory video or a clip of deaf BSL users signing about a group of scientific concepts in BSL, incorporating the new terms and actually teaching in the way an encyclopaedia does"

workshops. The project has raised money for particular projects. Working closely with Gary Quinn, a BSL sign linguist from Heriot-Watt University, and Rachel O'Neill, a lecturer in deaf education at the University of Edinburgh, Audrey uses contacts from the deaf BSL-using community in the UK to locate science graduates and scientists who are fluent in BSL. Since 1992, the Disabled Students Allowance (DSA) in the UK has enabled deaf BSL users to access university in much greater numbers; before that time BSL users were discouraged from progressing to higher education. Since the advent of DSA, there are now many deaf BSL users who have science degrees, sometimes working as scientists or as teachers or in science-related jobs.

A typical collection workshop will have eight members, including Gary Quinn as the BSL linguist who explains the process of collecting existing signs from specialists who sign about science concepts, and of creating signs for concepts where none are currently in use. Gary's input includes discussion of the fact that languages rarely map one to one: in one language there may be two terms and in another language one term for the same or closely related ideas.

Group members have been briefed in advance of the scientific terms in English and concepts we want to include in the Glossary based around a particular subject area. Members of the group compare existing online BSL signs, and also check the meaning of terms before the workshop. We discuss the concepts in BSL, often at a micro level, and make sure the science is clear. For some workshops we invite an illustrator, a hearing science educator or science communicator, which often aids the process.

When the group comes to a decision about a newly created sign or chooses to adopt an already established but lesser known sign, we first film it in draft. The draft signs are then put up on a closed Facebook site so that a wider group of fluent BSL users, mostly deaf, can comment on our work. Feedback on the draft signs is collated from this group and the workshop members over the next few weeks. There is then some discussion in BSL, for example via a Zoom meeting, to clarify or improve the draft signs. Sometimes group members try them out on the target audience, such as deaf children.

The revised signs are then filmed and a definition is added. We try to base the definition on the conceptual discussions from the workshop, rather than just translating from an English print textbook. The definitions often include other technical BSL terms.

An example is the sign for DIABETES **ssc.education.ed.ac.uk/bsl/biology/diabetesd.html**

For many of the signs we also produce a laboratory video or a clip of deaf BSL users signing about a group of scientific concepts in BSL, incorporating the new terms and actually teaching in the way an encyclopaedia does. An example is this clip about different products of volcanoes (**edin.ac/2PZAuuk**). When you view this, pay attention to how the camera spends a long time focusing on what things look like. This is an aspect of deaf pedagogy which deaf teachers bring to the creation of educational materials, though currently there are few qualified deaf science teachers (O'Neill, 2017).

In this definition of gas exchange (Figure 1, **edin.ac/2vSRXvt**), Gary uses placement, a grammatical feature of BSL, and many related technical terms in a short clip showing features seen in formal explanation in BSL. This includes "chaining", which you can see in the way he moves between English fingerspelling, the BSL sign, a BSL explanation and pointing to parts of the 3D model. This is an approach seen in sign bilingual education settings when deaf teachers give explanations.

The BSL Glossary project receives feedback from users in many ways: in emails and tweets, at science festival events we organise, and at workshops for deaf young people and teachers of deaf children. This has helped us to focus on new subject areas, and also encouraged us to produce more lab clips. Teachers have commented on how useful the definitions are for preparing to teach using BSL and to give complex explanations in a language they are learning.

To coincide with the diversity issue of this magazine, we have created a sign for physiology which you can now view on our website (**edin.ac/2QeXqpv**), but we hope to find funds to increase the number of biology definitions and add more physiology-related concepts on the Glossary website (SSC, 2019c). Each sign and definition takes about £200 to develop. This sounds expensive, but when the development processes of collecting and coining new terms is understood, it is evident that it is a complex undertaking. The terms and definitions are an important corpus in the educational use of BSL.

"To coincide with the diversity issue of this magazine, we have created a sign for physiology"

To find out more about how deaf students fare in studying physiology, we interviewed a deaf PhD student at Oxford Brookes University, Clare Halliday. Clare has used BSL more as a student than at school.

Q. At school, were there any challenges for you in learning biology as a deaf young person?

Clare: Learning biology at school was challenging but it wasn't due to lack of accessibility. I went to a deaf oral school, Mary Hare School. Small classrooms with low student numbers were specially adapted and teachers were specifically trained to teach deaf students. My biggest issue was that biology is a subject that contains lots of jargon with coursework and exams involving extensive writing. My English, like most deaf people is a bit weak, so processing information wasn't as straightforward. I didn't achieve high grades for my A-Levels.

Q. What about at university – what have been the positives and negatives in studying biology?

Clare: University was a further challenge as lack of accessibility was added to the mix! I was lucky to get the support I needed, e.g. notetakers in lectures and BSL interpreters in practical classes. It just wasn't enough, as I found myself over-compensating my time for the information that I didn't get first time round. It was a difficult balance: extra reading, longer time to process, trying to fit in with the working groups and getting a bit of my own "deaf time". University was a lesson about what my limitations are! Now, doing a PhD has the further challenge of needing to network!

Q. Do you think your concerns are similar to hearing students?

Clare: There are many similar concerns, but also I'm worrying about whether I'm pronouncing my words correctly when giving talks, whether I'll have enough time to get work done, whether I'll have enough DSA funding, whether I have missed anything that I didn't know about and hoping that my thesis supervisor is understanding and supportive enough of what I can do and what takes me longer to do and whether I'll be able to access the jobs market after graduating! There is one slight advantage – being deaf means that I use my eyes a lot more so I have a better visual memory when it comes to drawing life cycles or signalling pathways.

Q. What about careers – what are you thinking of doing with your biology degree?

Clare: At university, I thought about working in a diagnostic lab in hospitals but that was because I thought it would be an easier route – I don't have to talk as much or to engage too much. Over time I realised that research is a lot more interesting and that my brain is capable of coming up with ideas and analysing things.

Q. Have you used the BSL Glossary while at school or university?

Clare: I wasn't aware of this at the time of my school or undergraduate study, but it definitely would have been useful then. During my PhD I find that the words I use are very project-specific with terms such as kinetoplastids, promastigotes and the flagellar pocket.

In conclusion, the work of the BSL Glossary team is a never-ending one, as there are a huge number of concepts used in school and university which deaf students and the staff working with them need to grasp. Please contact us if you have any ideas for fundraising to collect and create more signs and definitions in the area of physiology!

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Do you see what I see?

Viewing the world through the prism of colour blindness

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Our experience of the world around us is filtered through our senses, making our interpretation of various stimuli uniquely subjective. When Claude Monet developed cataracts in his 60s, his paintings changed and reflected the world as he saw it. Those paintings from 1915 – 1923 were no longer light but rather duller with more reds and browns than before. In those paintings, we see the impact of the cataract on the artist's vision. This author does not have cataracts, but like ~8% of Western European men, and ~0.5% of Western European women, I have a colour vision deficiency and my experience of the world is different to many.

Colour vision appears to have evolved alongside light-sensitive photoreceptors. Vision appears to take off from around the time of the Cambrian explosion (~545 – 530 million years ago) and over those 15 million years, vision starts to appear with the huge increase in diversity of life. Strikingly, the structures for vision are well conserved. The photoreceptors in prokaryotes and eukaryotic protists, such as algae, are similar to our rods and cones (Williams, 2016).

The key family of proteins in rods and cones are called the opsins. These are part of the superfamily of G-protein coupled receptors as they have seven transmembrane domains and are associated to G-proteins. The opsins in cones and rods are different, with rods for low light (scotopic) and the cones for well-lit (photopic) and, crucially, colour vision. When unstimulated, cones and rods are depolarised, with cGMP bound to cyclic nucleotide-gated Na^+ channels, allowing Na^+ influx and the so-called "dark current". This "dark current" raises membrane potential and leads to glutamate release. In response to light stimulation at the appropriate wavelength, there is activation of the G protein leading to activation of phosphodiesterases and the decrease in cGMP. The subsequent closing of cyclic nucleotide-gated ion channels hyperpolarises the cell and decreases glutamate release (Kaupp and Koch, 1992).

What conveys the ability to see colour is the presence of opsins that are stimulated by different wavelengths of light. Very early in the evolution of vertebrates (~350 – 400 million years ago) four gene families of opsins in cones as well as the rod opsin were present allowing a spread of vision across a range of wavelengths (see Table 1). Indeed, there are some species of fish, birds and reptiles who are tetrachromatic and can see ultraviolet light. (As an aside, some snakes can "see" in infrared, but this is unrelated as it is not via the eye but rather the specialised pit organ that creates a separate thermal image in addition to an optic one.)

Mammals, having started off with the other vertebrates enjoying tetrachromacy, lost this along the way. Whether it is because early mammals were burrowing or nocturnal is unclear but most mammals are now dichromatic, having lost both the short-wave sensitive 1 (UV) and the medium-wave sensitive rhodopsin-like 2 (green). Interestingly, monotremes such as the platypus still have the remnant of the short-wave sensitive 1, suggesting UV sensitivity was still around in mammals at the time of monotreme divergence (~165 million years ago). While it is true that most mammals are dichromatic, primates are trichromatic, meaning we primates re-evolved trichromacy around 35 million years ago (see Table 2) (Jacobs, 2009).

"What conveys the ability to see colour is the presence of opsins that are stimulated by different wavelengths of light"

Opsin	Code	Wavelength (nm)	Receptor	Colour
Short-wave sensitive 1	SWS1	370 (355 – 445)	Cone	Violet – UV
Short-wave sensitive 2	SWS2	420 (400 – 500)	Cone	Blue – violet
Rhodopsin-like 2	Rh2	508 (450 – 530)	Cone	Green
Long-wave sensitive	LWS	570 (500 – 700)	Cone	Green, yellow, red
Rhodopsin-like 1	Rh1	500	Rod	Green – blue

Table 1. Five vertebrate families of opsins.

Opsin	Wavelength (nm)	Receptor	Colour
S-Cones (blue cone)	420 (400 – 500)	Cone	Violet
M-Cones (green cone)	540 (450 – 630)	Cone	Green
L-Cones (red cone)	570 (500 – 700)	Cone	Yellow
Rhodopsin-like 1	500	Rod	Green – blue

Table 2. Opsins in the human eye.

This is important for the development of colour vision deficiency. Having lost the medium-wave opsin (Rh2) millions of years previously, the re-emergence of the green sensitivity comes from a gene-duplication of the long-wave opsin which has two important impacts. Firstly, in primates the overlap of wavelength between the medium- and long-wave opsins is much more than in the other vertebrates with Rh2. Secondly, the gene encoding the long-wave opsin is located on the X chromosome and so now both the long-wave and the duplicated medium-wave opsins are on the X chromosome (Dulia *et al.*, 1999). As a result, colour vision deficiency is a recessive sex-linked trait, far more common in males (about 1 in 12) than in females (about 1 in 200; Figure 1). With both of these genes situated on the X chromosome, males only inherit one copy and consequently only need to inherit one defective copy to present with the symptoms. Since females have two X chromosomes, and because it is recessive, this would require the inheritance of two defective copies before presenting and so rates are far lower in females.

Colour vision deficiency is due to either missing or dysfunctional cones. Depending on how many and which ones are affected, colour vision deficiency can be split into either:

- Monochromatism: *either no cones at all or only one type available*
- Dichromatism: *only two different cone types, the third one is absent*
- Anomalous trichromatism: *all present but with altered sensitivity in one*

Depending on which cone is missing or dysfunctional, the latter two can be sub-classified based on the cone (and therefore colour) affected. If the L-Cone is affected, the ability to see red light is disrupted resulting in one form of red-green colour blindness. This is known as *protanopia* if the L-Cone is missing (as in *dichromatism*) or *protanomaly* if it is simply dysfunctional. If the M-Cone is affected, the ability to see green light is disrupted leading to the other form of red-green colour blindness. This is known as *deuteranopia* or *deuteranomaly* depending on whether or not the M-cone is missing or just dysfunctional. An abnormal M-cone is the most common problem leading to colour blindness and is identified in ~75% of cases.

An abnormality in either the L- or the M-cone does not simply result in deficiencies in picking up reds and greens. Since these work on a range of wavelengths (Figure 2), perception of all light within those wavelengths may be disrupted. Reds, browns, oranges, yellows and greens all fall within these wavelengths and are common problems. For my own perspective, this has limited impact on my day to day life and it is not considered a disability in the UK. That said, as a working physiologist there are considerable challenges to people with colour vision deficiency – particularly around imaging.

Given that the most common colour vision deficiency is red-green colour blindness, it is unfortunate that green and red stains predominate in microscopy. There is actually a good reason for this: while most people can distinguish between red and yellow as they are detected by the same opsin, the wavelengths are a little too close for a microscope to separate into different channels. So if you are looking for two proteins, one with a red stain and one with a yellow, you are liable to pick up some yellows in the red channel and some reds in the yellow due to the width of the emission spectra of the fluorophore. Red and green however are sufficiently far apart to allow them to be picked up in separate channels so that you can tell which of your two proteins is which. This seems fair enough, but it does not explain the lack of blue staining. Blue is further away again and would certainly be more specific as a second colour. While there are blue stains available, the vast majority appear to be red and green, which perhaps reflects a bit of historical convention (after early fluorophores, FITC and TRITC).

However, in this day and age and with such advanced digital systems, there is no reason to stick to the colours of recording channels. Software packages such as ImageJ and Adobe Photoshop have a number of functions that allow for different colour combinations to be presented. Indeed, the Color Universal Design Organization (CUDO) – a non-profit organization in Tokyo, Japan – has produced a handbook to provide the rationale and the means to make these changes (CUDO, 2006). One such idea is the replacement of red stains with magenta, easily achieved on free open-source imaging software such as ImageJ which provides step-by-step guides (Ferreira & Rasband, 2012). The advantage of magenta is that it is an equal mixture of red and blue, so that people who struggle with the red component can easily detect the blue hue, whilst the overlap of two positives appears as white.

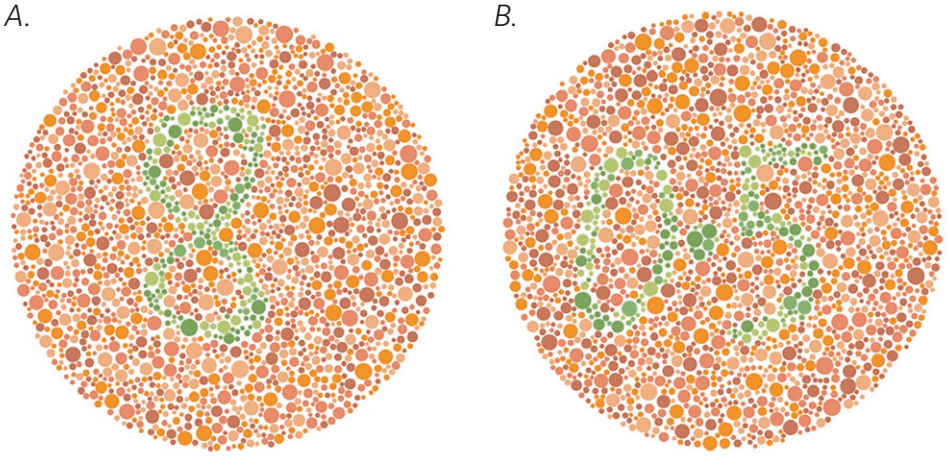

Figure 1. The percentage of *A.* male and *B.* female readers with colour vision deficiency who will not be able to read these.

Much of these ideas have been led from the ground up, with individuals blogging and presenting these alternatives (Cox, 2015; Keane, 2015). The journals themselves have a role to play in taking this further by including these ideas in their formatting guidelines. I shall see many images that are indecipherable to me, but there are changes beginning to creep in. *Nature Medicine* has the following on its instructions to authors:

"Authors are encouraged to consider the needs of colorblind readers (a substantial minority of the male population) when choosing colors for figures. Many colorblind readers cannot interpret visuals that rely on discrimination of green and red, for example. Thus, we ask authors to recolor green-and-red heatmaps, graphs and schematics for which colors are chosen arbitrarily. Recoloring primary data, such as fluorescence or rainbow pseudo-colored images, to color-safe combinations such as green and magenta, turquoise and red, yellow and blue or other accessible color palettes is strongly encouraged."

Such advances are useful and will make a big difference to work and science, but these are of limited value in life outside of work. There are now a range of glasses commercially available to improve colour vision. The problem with most colour vision deficiency is the overlap in the wavelengths between the M- and the L-cone. These glasses work by filtering out the light at those overlapping wavelengths, giving a more accurate interpretation of the colour. What this means is that people will not see any new colours, but rather perceive the same colours in a different way. Having tried some examples of these, I did see some numbers in the Ishihara plots, but everything else had a purplish hue that was similar to wearing sunglasses indoors.

As a young man, I was told that being colour blind meant that I could never be a pilot or an electrician (neither of which is actually true) but since I had no desire to be either, it had limited impact. Adoption of the ideas proposed by Color Universal Design Organisation would make a significant improvement in my working experience as someone with colour vision deficiency. That said, the single biggest improvement in my experience would come from not asking me "what colour is this?"

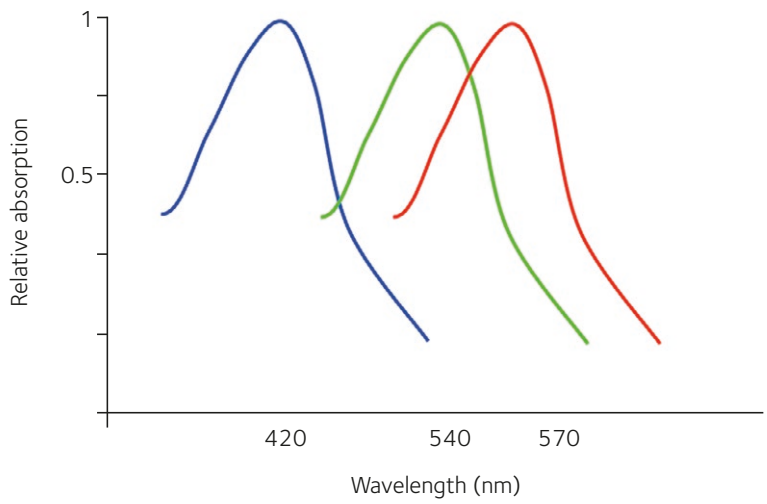

Figure 2. Cone wavelengths. The sensitivities of the long-wave, middle-wave and short-wave photopigments found in the human retina.

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Numbers in the Ishihara plates of Figure 1 are *A.* 8 for males and *B.* 0.5 for females.

Mental health in academia

An invisible crisis

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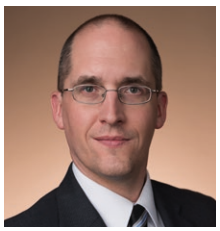

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Everyone has good and bad days. Life throws curve balls and we have quite dynamic responses to them, even when two individuals experience the same event. The diversity of our reactions is on a wide spectrum; depending on the situation and individual. This variation is normal and is driven by many factors. What is not normal is when our reactions become stuck within one of these extremes of unhelpful levels of reaction. When an event or a series of events begin to sequester our emotional real estate, the possibility of the onset or exacerbation of symptoms of anxiety and even depression increase. This is especially true in an already high-stress environment.

Mental health in graduate education is personal for us, as it is for so many who have been a part of academia. We have known faculty as well as trainees who have struggled with their mental health during graduate school, those who struggle currently in their careers, and even several who took their lives along the course of it all. In fact, we have struggled ourselves. We have firsthand experiences with the trials and tribulations of mental health issues, which fuels our passion to address the problem.

Over the last few years, the higher education community has built a better understanding of how impacted some faculty and graduate trainees are by mental health issues given the competitive academic environment. Understanding and addressing mental health in academia is vitally important to support the wellness of our current and future scientific leaders. The key is not crisis response, rather it is in creating a culture of support and prevention – and the time is now.

Mental health issues in faculty

Tragedies such as a suicide have far-reaching impacts, including sparking discussions about mental health. In the academic sphere, the suicides of professors Will Moore and Alan Krueger (Flaherty, 2017; Casselman and Tankersley, 2019) stirred this discussion and highlighted the need for an increased understanding of the impact of mental health on academics. The rates of suicide in academic populations are not clear and data on prevalence of mental health symptoms is limited. That said, Schindler *et al.* (2006) found that 20% of full-time academic physicians and basic science faculty had significant levels of depression. This was almost equal for males and females, and younger faculty were found to have more emotional distress than their older colleagues. Further, in a cross-institutional survey of 267 US faculty with mental disabilities, mental illness, or symptom histories, nearly 70% had no or limited familiarity with resources available to support their mental health needs, and even fewer used them (13%), mostly due to fear of stigma and professional risk.

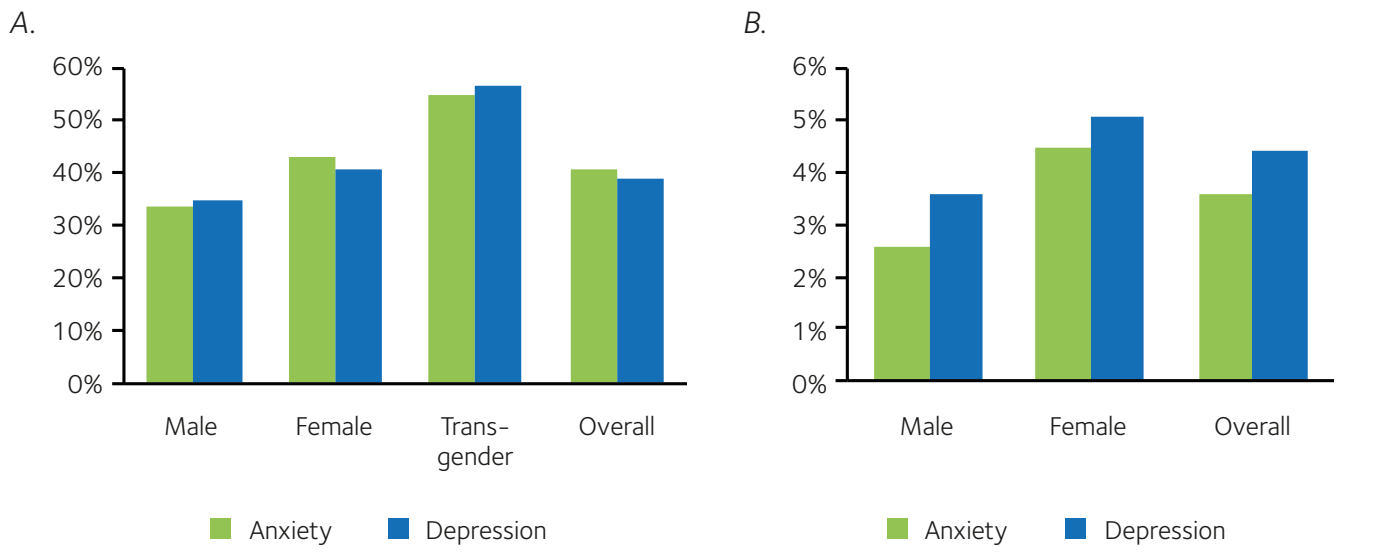

Figure 1. Prevalence of anxiety and depression in *A.* graduate trainees (Evans *et al.,* 2018) and *B.* the global population (WHO, 2017).

Respondents indicated that they felt most supported by their spouses or significant others (75% very or extremely supported) and friends (51%) rather than colleagues (29%) and supervisors (25%), though many had not disclosed their mental health needs to their supervisors (Price *et al.,* 2017).

Faculty often highlight the lack of support, high demands, and cut-throat mentalities that lay the groundwork for mental health struggles; they also point out the double-bind of pulling back on workloads or seeking help (e.g., disclosing symptoms or seeking therapy), as there may be personal and professional consequences of addressing the issue at hand. Consequences are a reality whether the decision is to take action or let it lie (Anonymous, 2018a, 2018b; Price *et al.,* 2017). In recent years, professors and academic administrators have used online platforms as well as opportunities to present at national meetings to openly discuss their mental health journeys and suicidal experiences to crack stigma and encourage support (Flaherty, 2015; Knight and Saker, 2016). This is encouraging, as these are essential steps toward building a culture of open discussion for both faculty and graduate students.

Mental health issues in graduate trainees

Mounting data support the fact that graduate trainees face serious mental health challenges. In 2014, the University of California *Berkeley Graduate Student Happiness and Well-being Report* demonstrated that 43 – 46% of graduate student respondents in the sciences at that institution were depressed (The Graduate Assembly, 2014). The following year, Smith and Brooks (2015), showed that at the University of Arizona, 50% of graduate students surveyed reported "more than average" stress and 23% reported "tremendous" amounts of stress. Levecque *et al.* (2017) found that 32% of responding Belgium PhD students were at risk of having or developing a common psychiatric disorder. Additionally, *Nature's* 2017 PhD survey showed that about 25% of respondents were concerned about mental health and 12% of all respondents sought help for anxiety and depression that was caused by their training program (Woolston, 2017). In these studies, students' concerns include advisor relationships, career prospects, personal finances, overall wellness (e.g., diet and sleeping issues), living conditions, and their sense of value and inclusion.

In March 2018, we published an article in *Nature Biotechnology* further highlighting the critical nature of the mental health issues faced by graduate students. Using the clinically validated scales to assess symptoms of anxiety and depression, General Anxiety Disorder-7 and Patient Health Questionnaire-9, we found that within the context of a cross-sectional, convenience sample of 2,279 graduate students from 26 countries and 234 institutions, 41% had moderate to severe symptoms of anxiety and 39% had moderate to severe symptoms of depression. Female and transgender students showed the highest levels of anxiety and depression symptoms in our study. Positive faculty mentor relationships and a healthy work-life balance were associated with lower symptoms of anxiety and depression (Evans *et al.,* 2018). To put this in context, by comparison the prevalence of anxiety and depression in graduate students is almost an order of magnitude greater than that observed in the general population (see Figure 1) (WHO, 2017).

"Mental health disorders have been called 'invisible wounds' as they are difficult to describe, understand, and see from the outside"

"Faculty and graduate trainees face a multitude of mental health issues. The shift toward more open discussion and limited research in this area are making this clear"

The stigma of mental health

Stigma around mental health issues is multidirectional, and though much progress toward increasing awareness and access to resources has been made in recent years, much more still needs to be understood and advanced, particularly in high-stress fields. Mental health disorders have been called "invisible wounds" as they are difficult to describe, understand, and see from the outside. They show themselves in disruptive emotional and behavioral patterns, which are unfortunately often attributed to personality flaws, work ethic deficits, underachievement, and health issues.

Misunderstanding and judgment not only come from those viewing the individual, but also from the individual experiencing the symptoms themselves, especially in academic populations. Rigorous training programs select top-tier students who have much of their identity tied up in high performance and achievement. Such identity is greatly challenged during the course of training and into the career span; the demands of academia consistently confront individuals with their own shortcomings, promote unrealistic upward social comparisons, and drive high standards of approval. This easily sets the stage for symptoms of burnout, anxiety, and depression, particularly for those with other known vulnerability factors (e.g., minority status, existing disability, low socioeconomic background, history of trauma or adverse childhood experiences) (Safran *et al.*, 2009; Felitti *et al.*, 1998). When mental health symptoms begin to surface, shame easily develops, particularly when environmental and social support are lacking. Shame drives hiding, denying, and social withdrawal, which complicates symptoms and prevents positive paths forward that could ameliorate mental health issues and their consequences over time.

It is important to note that symptoms do not have to reach the level of a "disorder" or complete dysfunction to be disruptive; many times, a person (especially an academic) is able to "white-knuckle" through symptoms to appear successful in demands and interactions while their internal experience is that of turmoil and exasperation.

If advisors, programs, and institutions do not have procedures in place to appropriately flag, assess, and address such issues using targeted, early-intervention roadmaps, struggling faculty and trainees will continue to fall through the cracks, which can exacerbate existing struggles and potentially build the psychological landscape for suicide risk.

Addressing mental health issues

An essential first step to addressing mental health issues is awareness. Knowing that rates are higher in certain populations gives light to an issue that has previously been undefined or swept aside. Creating more dialogue through research, written features, and social media movements serves to highlight the issue and gives voice to those who are struggling now or who have in the past. Individuals need to know that they are not alone and are valued; organizations need to know that compromised emotional wellness is an understandable reaction to a culture of high stress, and existing mental health disorders are disabilities that require diversity training and inclusion. Just as all entities in the United States are required to have Americans with Disabilities Act-compliant facilities for inclusion purposes, it is important to integrate consistent, accessible, and positively regarded resources for those who begin to suffer or for those with pre-existing mental health disabilities (e.g. major depressive disorder, bipolar disorder, anxiety disorders) to make the academic terrain easier to navigate.

In terms of resources, we propose several. First, training on mental health and emotional wellness should be made available via a variety of modalities for both trainees and faculty. This should focus not only on wellness for the individual but also on how to support others and how to respond to mental health-related events in the department. Second, given that mentorship is an important factor in trainee wellbeing, it is the institutions' responsibility to ensure that there is specific training focused on effective mentoring practices and modelling wellness for trainees. Third, institutions are at the foundation of establishing a culture that promotes both a sense of community beyond the laboratory or classroom and an expectation ofwellness. Establishing a community wellness culture begins by establishing a clear institutional vision and mission that aligns with the support of trainees, wellness, and community culture. Fourth, it is suggested that anonymous surveys be sent to trainees and faculty to assess mental health; following that, anonymous, digital counseling services should be offered to individuals who flag as symptomatic or at-risk as a gateway to engaging in more intensive counseling (this support model is seen in medical schools such as University of Texas Health San Antonio School of Medicine; Feist, 2018). Lastly, faculty and trainees should be rewarded not only for grants and manuscripts but also for their effective education, mentoring, and wellness practices. Initiatives such as student-driven faculty wellness awards can be a great way to showcase the positive role, modelling that faculty can do to support the institutional culture. Price and Kerschbaum (2017) discuss additional suggestions in their "Resource Guide for Promoting Supportive Academic Environments for Faculty with Mental Illness".

More research is needed

Research in this area is essential. We need additional data on the prevalence of the range of mental health issues in both faculty and trainees. We also need to understand the root causes of these issues at a much deeper level. There are likely unique and overlapping factors between faculty and trainees that contribute to mental health issues. For faculty, we have a sense that the pressure of winning grants, publishing papers, earning tenure, and promotion are contributing factors. For trainees, career outcome, mentor relationships, and many personal factors play a role. We also need to understand at what point mental health issues arise in faculty and trainees. Do trainees enter graduate school with already elevated rates of mental health issues? Do trainees' elevated rates of mental health issues carry over into the beginning of a faculty position? Do the rates increase at any particular point in a faculty position or graduate program? To address these questions, there is a clear need to conduct well-controlled population-based longitudinal studies in both faculty and trainees that would study the mental health issues in a cohort of faculty and trainees beginning before they matriculate into the faculty ranks or graduate school and then follow them for some long period of time. Evaluation within such studies should include measures of subjects' mental health and a multitude of factors that could contribute to changes in their mental health status.

Additionally, some institutions are probably already putting interventions into place that are aimed at addressing the high rates of mental health issues in faculty and trainees. These interventions need to be rigorously evaluated and the findings should be shared with the higher education community. We all need to understand what interventions are being tried and the level of their impact.

Conclusion

Faculty and graduate trainees face a multitude of mental health issues. The shift toward more open discussion and limited research in this area are making this clear. The higher education community needs to better understand the overall prevalence of these issues as well as their causes, and we need to create solutions to fix the problems that are plaguing so many of our current and future scientists. We can no longer stand by, letting this issue continue to cause individuals to suffer alone and be blunted in their personal and professional potential in our fields.

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Sex differences in pain across species

Both simple and complex

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It is widely recognised that there are sex differences in the prevalence of chronic pain conditions with females greatly outnumbering males in diagnosis and treatment. This justifies the mandatory inclusion of females in clinical trials from 1993. However, preclinical researchers have been neglectful and reluctant to include both sexes in their experimental design and analyses – despite glaring disparities in the respective clinical conditions. To that end, the bulk of preclinical investigations, across multiple disciplines, including pain, have primarily utilised male rodents. The reliance on male rodents may have spawned from inertia or incorrect assumptions regarding variability with respect to ovarian hormones. In any case, key differences between males and females have been observed forming a basis for equal inclusion among the sexes.

Biologically based sex differences

According to the biopsychosocial model, biological, psychological and social variables interact to alter an individual's health and well-being. With a phenomenon such as pain, the belief is often that injury to the body is reflected in a clear biological response and differences in the pain experience are underpinned by a sex-specific biological mechanism. Thus, animal models are employed to explore biologically based mechanisms, potentially simplifying the investigations. In rodents, female animals show more hypersensitivity after injury (Nicotra *et al.*, 2014) and more nociceptive behaviours across a host of inflammatory tests (Nasir *et al.*, 2016), suggesting that they experience more pain in a manner similar to human females. Additionally, primary afferent neurons from female rats were twice as likely to respond to mechanical stimulation than those from males (Ross *et al.*, 2018), suggesting fundamental differences in the pain-sensing system between males and females.

The immune system plays a key role in the mediation of chronic pain through direct interactions with neurons via inflammatory signals. While this integral role has been recognised for some time, we were the first to demonstrate that microglia, a type of neuro-immune cell, is critical for chronic pain hypersensitivity in male mice, but not females. In short, we demonstrated that inhibitors of microglial activation (or their receptors) could alleviate hypersensitivity in male mice when delivered into the spinal cord, but these treatments did not work in females. In contrast, females appear to utilize T cells. Consequently, removal of T cells or administration of testosterone shifts the balance to the "male" system (Sorge *et al.*, 2015). This work has been replicated with rats and other injury models to date (Mapplebeck *et al.*, 2018; Taves *et al.*, 2015). To support this work, there are clear sex

"Testosterone was required for male-specific 'pain memory' in mice, and testosterone administration to female mice evoked pain memory"

differences in immune cell responses (Wegner *et al.*, 2015) and proportion of immune cells (Abdullah *et al.*, 2012) in humans that resemble those seen in animal models. Interestingly, the sex differences in T cell populations seen in rodents and humans appear to be conserved across a wide range of species from fruit flies and sea urchins, to kestrels and macaques (Klein and Flanagan, 2016). There are clear biologically-based differences in the mechanism of pain sensation that is evident in animal models. However, the experience of pain is rarely simply biological.

Sex differences in learning mechanisms

Typically, the ability to predict the likelihood of pain or other unpleasant events by learning from prior experience is an important adaptive behaviour in healthy organisms (McNally and Westbrook, 2006) and can cause disabling fear and avoidance in patients with persistent pain states (Fritz *et al.*, 2001). Pain caused either by an injury or illness is suspected to leave a memory trace within brain and spinal structures (Ji *et al.*, 2003). In most cases this pain memory is implicit and not subject to conscious awareness, but may lead to behavioural and perceptual changes such as hypersensitivity. We have recently highlighted the importance of sex differences for learned pain responses by demonstrating that male mice and men exhibit more pain when returned to a location previously associated with pain, but females do not (Martin *et al.*, 2019). We serendipitously uncovered these responses by routinely testing males and females for pain sensitivity and stratifying our statistical analyses by sex. Testosterone was required for male-specific "*pain memory*" in mice, and testosterone administration to female mice evoked pain memory. Interestingly, an injection of zeta inhibitory peptide (ZIP), an inhibitor of atypical protein kinase C (aPKC), which has been shown to prevent long-lasting plasticity also prevented conditioned pain hypersensitivity in male mice but had no effect on female responses (Martin *et al.*, 2019). The ZIP findings are in line with sexual dimorphisms in aPKC action in mouse models of chronic pain (Nasir *et al.*, 2016) and open a wider debate on sex-specific plasticity mechanisms. In addition, since we developed parallel mouse and human procedures for testing the same phenomena, we assessed physiological similarities between the two species and corroborated that males – of both species – were stressed by the expectation of impending pain.

These findings were not expected and are even more intriguing when you consider that learned pain sensitivity was found only in males – of both species – but that learning mechanisms may contribute to pain chronicity (Apkarian, 2008) and chronic pain conditions are more prevalent in females (Berkley, 1997). There is also precedent to support the hypothesis that male and female subjects may use different learning strategies or incorporate the most salient features of stimuli to alter the expression of behaviour. For instance, in the fear conditioning literature, female rats express fear responses differently than male rats by engaging in darting and escape responses, whereas male rats display much higher levels of freezing behavior (Gruene *et al.*, 2015). Thus, an important consideration in sex-based comparisons is to include the observation of relevant behaviours during experimentation, such as facial expressions, licking and escape behaviour.

Sex differences in psychological variables affecting pain

There appear to be consistent and translatable sex differences in pain between males and females when examining biological underpinnings or innate learning mechanisms, but it is likely that there are human-specific psychological variables that play a significant role. Pain is a subjective experience and many non-drug strategies are employed to reduce pain. In humans, females are more likely to endorse rumination (Meints *et al.*, 2017) and rely on social support (Rovner *et al.*, 2017) than males. Perhaps these coping strategies are the result of female patients reporting greater levels of pain dismissal (Igler *et al.*, 2017) and perceived psychologically based pain (Miller *et al.*, 2018) than males. Unfortunately, despite repeated demonstrations that females are more sensitive to painful stimuli (Bartley and Fillingim, 2013), female pain is often discounted at the clinical level.

It is unfortunate that many researchers use "sex" and "gender" interchangeably. Sex is based on chromosomal biology and the result of hormones during development, while gender identity is individually determined and based on socially constructed roles. In preclinical models, sex is the variable of interest; it is easily determined by outward appearance and there is no evidence that rodents have a gender that is different from their natal sex. In humans, this assumption is woefully incorrect and invalid. In one of the only studies of its kind, gender role expectation of pain accounts for more variability in human pain sensation than genetic sex (Robinson *et al.,* 2001). Therefore, the strength of the belief in gender roles contributes more to an individual's pain expression than their genetic sex, suggesting that psychological variables play a much larger role than are given credit. Along a similar line, it has been reported that brain connectivity for transgender individuals matches more closely to that of their identified gender (Kruijver *et al.,* 2000), providing further support for an emphasis on psychological forces driving biological responses. However, it should be noted that a study of transgender adults with pain reported that transgender women reported pain following the start of hormone treatment, whereas transgender men were more likely to report pain reductions following hormone therapy (Aloisi *et al.,* 2007). Together, these data demonstrate the complicated interaction of psychology and biology.

"Sex" differences are simple and complicated

According to the model outlined above, experiences are the result of a variety of influences. When comparing sexes at the biological level, there are identified differences in neuronal function, immune cell reactivity and brain responses that appear to be greatly conserved across species and related to hormonal levels. For preclinical scientists, these similarities provide hope for translation of treatments from the bench to the bedside. However, this path becomes tenuous when one considers that the human experience of pain is rarely a pure biological phenomenon. Humans are highly social and cognitive, adding a complex layer to the perception of pain that is difficult to model at the preclinical level. Sex differences should continue to be studied in animals to further our understanding of the complex interaction of hormones and various physiological responses. In contrast, gender differences should be the focus of clinical investigations to emphasise the critical role that psychological and social processes play in perception. The use of more inclusive language as part of demographic information will permit researchers to explore many more aspects of the human experience and allow for more appropriate treatment recommendations.

"Gender differences should be the focus of clinical investigations to emphasise the critical role that psychological and social processes play in perception"

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Cardiac output diversity

Are children just small adults?

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Understanding the phenotypical differences between children and adults is uncomplicated. The changes children undergo in terms of growth, stature and higher functions are easily apparent. What is not so clearly visible, is their physiological differences. Even the micro-architecture of cells differs and an understanding of this diversity helps us to manage conditions which alter their physiology in a detrimental way (Vrancken *et al.*, 2018; Marijianowski *et al.*, 1994). In this article we will focus on how the physiology of cardiac output varies with age.

What is cardiac output?

Cardiac output is the volume of blood pumped from the left or right ventricle, per unit time. It is most commonly used to describe the left ventricular (LV) output to the systemic circulation, and is a product of the stroke volume and heart rate. Adequate LV cardiac output is important to ensure sufficient oxygen delivery to tissues, irrespective of age.

In order to alter the cardiac output to match the end organ demand during disease states, or increased metabolic demand, there are many factors which can be altered with the end effect of changing heart rate or stroke volume.

It would appear logical that if there is a greater demand for an end product (oxygen, glucose), both an increased supply and increased rate of delivery is required. However, there is distinct diversity between the response of the neonatal, infant and young children's cardiovascular system to demands on cardiac output, when compared to that of the adult.

How the neonatal heart differs

Newborn infants have a much higher metabolic rate and demand than adults, given their rate of growth, particularly in the first year of life. Their protein and glycogen stores are comparatively much less than adults.

When the neonatal heart is put under greater demand, the ability to increase cardiac output by increasing stroke volume is limited. This is because it has a relatively higher proportion of extracellular matrix (ECM), and a higher ratio of type I to type III collagen within the ECM. This lends it to being less compliant than the adult heart and thus, less accommodating of volume expansion with resultant increases in cardiac stroke volume (Marijianowski *et al.*, 1994). There is evidence that following a myocardial infarction, the deleterious remodelling that occurs and leads to a less complaint heart is in part owed to a similar increase in the ratio of type I to type III collagen fibres (Wei *et al.*, 1999). Therefore, given the relatively fixed stroke volume, the cardiac output of neonates and infants is very heart-rate dependant. This is a relatively unique difference in the age-dependent physiology.

Approximate age groups	Approximate normal range of observations			
	Heart rate *(Beats per min)*	**Respiratory rate** *(Breaths per min)*	**Blood pressure** *(mmHg)*	
			Systolic	**Diastolic**
Neonate *(up to 1 month)*	100 – 165	30 – 60	65 – 85	35 – 50
Infant *(1 month to 1 year)*	90 –160	25 – 50	70 – 105	35 – 55
Toddler *(1 – 2 years)*	85 – 140	20 – 40	85 – 105	40 – 60
Pre–school child *(2 – 5 years)*	80 – 120	20 – 30	90 – 115	45 – 70
School age *(5 – 9 years)*	75 – 110	18 – 25	95 – 115	55 – 75
Pre–adolescence *(9 – 11 years)*	70 – 110	15 – 20	100 – 120	60 – 80
Adolescence *(12 – 16 years)*	65 – 100	12 – 20	105 – 130	65 – 80
Adult *(Over 16 years)*	60 – 95	12 – 20	110 – 130	65 – 85

Figure 1. Normal reference ranges for common physiological variables.

The mechanics of cardiac output: Preload

The Frank–Starling curve represents changes in cardiac output for a given change in preload (or end diastolic volume). Such that, as end diastolic volume is increased (through increasing preload) this equates to a proportional increase in stroke volume, and therefore cardiac output. This is true to a point of optimal sarcomere stretch, after which further increases in preload do not equate to ongoing increases in cardiac output.

However, we know that the neonatal myocardium is less compliant. It therefore sits on a flatter part of the Starling curve, and the same increases in preload do not result in increasing cardiac output to that which may be observed in an adult. As mentioned, neonates are heart-rate dependent for their cardiac output. However, when beating too fast there is then reduced diastolic filling time. The normal heart rates therefore vary with age (Figure 1).

The mechanics of cardiac output: Contractility

Calcium is essential for the unique narrative of the cardiac action potential and for the excitation–contraction coupling by which the electrical action potential is converted to muscle contraction.

There are a number of factors related to calcium delivery and use in the neonatal myocardium which impair contractile ability. The sarcoplasmic reticulum (SR), which senses and triggers calcium-induced calcium release (CICR) in order to potentiate contraction is immature, as well as the T-tubules which invaginate into the myocyte to bring L-type calcium channels into closer contact with the SR ryanodine receptors (Ikonnikov and Yelle, 2013; Breatnach *et al.*, 2017). There is evidence that these factors, alongside altered calcium handling, lead to generation of less force during contraction (Wiegerinck *et al.*, 2009).

> "The response of the neonatal, infant and young children's cardiovascular system to demands on cardiac output is distinctively different to that of an adult"

The pattern of LV contraction during systole differs between adults and neonates, with adult myocardial muscle fibres using optimal rotational physiology. Outflow from the adult ventricle is enhanced as the fibres of the apex move in a counter-clockwise direction with other fibres (basal) moving in the opposite direction (Vrancken *et al.*, 2018).

There is some evidence that preterm infants (those delivered prior to 36 weeks gestation) display more negative (clockwise) basal rotation than their term counterparts. Furthermore, infants who have been exposed to hypoxia in the perinatal period, have further deleterious properties of LV physiology, displaying reduced LV torsion, twist and untwist rates compared to controls (Breatnach *et al.*, 2017).

Diversity in maturity of autonomic innervation between the neonatal and adult heart also differs. Mature parasympathetic fibres predominate in the neonatal heart, leading to a more pronounced response of the vagal nerve (bradycardia). Given we have established the importance of heart rate in the control of cardiac output in neonates, one can understand the potential detrimental effects of this should the parasympathetic response be activated (a problem encountered in paediatric anaesthesia and critical care).

Beta-adrenergic receptor stimulation leads to increased inotropy, chronotropy and lusitropy in cardiac muscle. The neonatal heart has relatively less sympathetic

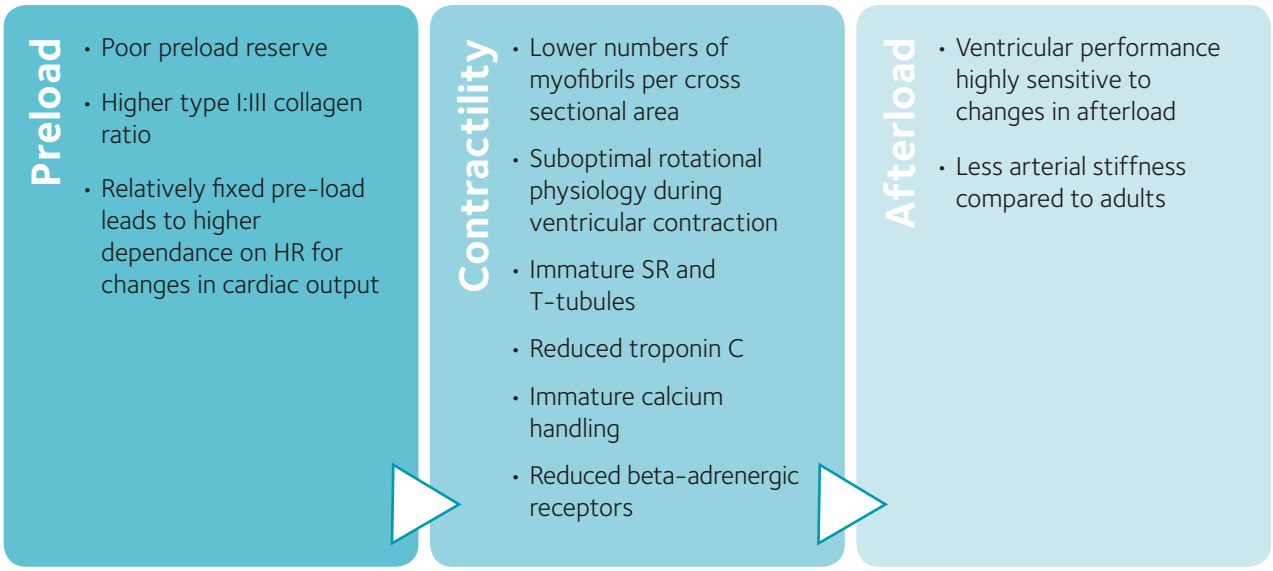

Figure 2. Ways in which the neonatal heart and cardiac output differ to that of an adult.

innervation and beta-adrenergic receptors compared to the adult heart, leading to impaired contractility.

The mechanics of cardiac output: Afterload

Afterload is the pressure against which the left ventricle ejects blood during systole. Afterload is often primarily considered to be that of systemic vascular resistance, but it is also dependent upon aortic pressure and vascular compliance. There is some evidence that the neonatal heart is more sensitive to changes in afterload than the adult heart, in terms of ventricular performance (Rowland and Gutgesell, 1995).

The effects of ageing and hypertension on the systemic vascular resistance are also an example of differences in afterload and therefore cardiac function between adults and infants. There is a natural increase in blood pressure with age (Figure 1).

Clinical applications of the physiological differences

An understanding of the variances in alteration of cardiac output between young children and adults enables us to tailor our practical management and anticipate causation of physiological decline.

There is evidence to show the haemodynamic response of young children to sepsis (overwhelming blood-borne infection) is commonly that of increased systemic vascular resistance and myocardial dysfunction. In contrast, adults more commonly present in a hyperdynamic state of reduced systemic vascular resistance (SVR) and increased cardiac output.

> "An understanding of this diversity helps us to manage conditions which alter their physiology in a detrimental way"

Understanding this, alongside the specific mechanisms which impair cardiac output in children, means we can counter them with our treatment.

For example, if we understand that the very young patient has a poor preload reserve and a limited ability to intrinsically improve cardiac output by improving contractility, the addition of medication to reduce afterload (reduce pressure against which the left ventricle needs to pump) is likely to be of significant benefit. Figure 2 summarises the differences between neonatal and adult cardiac output that have been discussed here.

Conclusion

There are physiological differences as described in the cardiovascular system of the neonate when compared to the adult. This diversity is important when considering the clinical implications of management of critical illness.

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Salt and blood pressure in Africans

Is it all down to the epithelial sodium channel (ENaC)?

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Salt they say adds spice to life, as well as to culinary tastes – hence the propensity to indulge in excessive salt consumption! However, high salt intake has been shown to be associated with high blood pressure (BP), as reported in the large world-wide INTERSALT study (Stamler, 1997). Hitherto, blood pressure values had been assumed to be similar across races, until studies began to emerge reporting that BP values were higher in black African-Americans compared to their Caucasian counterparts. Since then, the WHO has recognised and pegged salt intake to less than 5g (about one teaspoon) per day, while also acknowledging that high salt intake may result in higher BP increases in blacks than in Caucasians.

This seemingly innocuous observation ultimately led to the development of a controversial theory, which attributed the hereditary, salt-sensitive, higher blood pressure values observed in African Americans to the exertions of slavery on their ancestors. Today, shifting perspectives and new evidence from studies on the native African populations have begun to cast a cloud of doubt over the validity of this school of thought.

Salt dependency, blood pressure and global perspectives

In 2013 the incidences of hypertension in the United States were estimated to be 44% and 32% in blacks and whites, respectively (Go *et al.*, 2013). The explanations for this disparity in the prevalence of hypertension for blacks had been hinged on the possible mutation or modification of a "salt gene" in blacks following trans-shipment across the Atlantic during the slave trade era in the 16th to 19th centuries (Wilson and Grim, 1991). It was postulated that their sojourn in the hot environment of the ships' holds and subsequent forced labour in the searing heat of the agricultural fields of the southern states would have resulted in an increase in salt loss, primarily from diarrhoea and sweating and compounded by a low dietary intake of salt. These situations, it was argued, provided selection pressures for adaptations that enhanced sodium retention by the kidneys which may have been beneficial in this environment but would also result in elevated BP. This sodium conservation mechanism was then argued to pass down through generations following transmission of these supposedly "beneficial" genetic adaptations. However, in the more recent times, it has been reported that native blacks in their environment in Africa also have a high prevalence of hypertension (Amira *et al.*, 2014; Gomez-Olive *et al.*, 2017), and it has become necessary to revisit the "slave journey-hereditary sodium retention" theory to challenge it and if necessary, expunge it entirely (Lujan and DiCarlo, 2018).

Salt-sensitive status and β-ENaC polymorphism

Various methods have been developed to investigate and quantify an individual's tendency toward an increase in sodium retention. Traditionally the "Salt Sensitivity" testing technique has been most widely utilised. This test measures the rise in BP after a salt load with an elevation in BP above 5 mmHg considered salt-sensitive and anything less classified as salt-resistant. A study by Morris *et al.* (1999) indicated salt sensitivity rates of 73% and 36% in black Americans and Caucasians, respectively. Interestingly, native Nigerians were found to have salt sensitivity rates of approximately 56% in hypertensives versus 34% in normotensives, suggesting that hypertensive subjects tended to be more sensitive to salt ingestion (Elias *et al.,* 2014). This is particularly concerning when taken together with the finding that hypertensive Nigerian subjects have significantly higher sodium intakes than normotensive subjects, as measured by salt taste threshold testing and 24 hour urinary sodium excretion revealed (Azinge *et al.*, 2011).

Among the plausible explanations for the similarly high prevalence of hypertension in African Americans and native Africans are the genetic factors which affect the renal handling of sodium. Hence, a focus of research on the polymorphisms in the genes encoding the subunits of the heterotrimeric epithelial sodium channel (ENaC) that controls the final adjustments in renal sodium excretion. This is especially true of the T549M polymorphism in the beta subunit of ENaC (β-ENaC) which occurs in about 8% of blacks but is rarely present in Caucasians (Swift and MacGregor, 2004). Baker *et al.* (1998) also reported similar prevalence of the T594M polymorphism in hypertensive blacks living in the London area of the UK, but of particular note was the observation that these patients were more responsive to anti-hypertensive treatment with amiloride, a diuretic drug that promotes urinary salt and water loss through ENaC blockade. In our own work with native Nigerian subjects (Elias *et al.*, 2019), we found a 5% incidence of the β-ENaC T594M variant and discovered the presences of an additional five previously undescribed β-ENaC polymorphisms in the population. This brought the total prevalence of sequenced β-ENaC polymorphisms in our cohort to 13%, with hypertensive subjects being more than twice as likely to be a carrier of a β-ENaC variant than normotensive subjects.

Based on these observations, it is almost obvious that gene polymorphism in blacks, in addition to higher salt sensitivity may contribute to the greater incidence of high blood pressure in black Africans, as it is the case with African-Americans.

Low plasma renin, aldosterone and suggested treatment modality in black hypertensives:

We also know that hypertension in blacks is also often characterised by low levels of plasma renin activity, which is paradoxical considering high levels of renin are often associated with elevated BPs. Based on these observations, decision-making protocols for choosing appropriate anti-hypertensive strategies may need to be examined further. In particular it may be prudent to re-evaluate and redefine the first-line use of renin-angiotensin-aldosterone system (RAAS) pathway inhibitors such as angiotensin converting enzyme (ACE) inhibitors or angiotensin receptor blockers (ARBs) in treatment, in addition to the use of amlodipine, the calcium channel antagonist. A recent review looking in more detail at the therapeutic strategies involving RAAS has suggested that decisions be based on the phenotyping results of renin and/or aldosterone status, whereby amiloride can be used for low renin–low aldosterone subjects while aldosterone antagonists such as spironolactone be used for cases of primary aldosteronism (Spence and Rayner, 2018). In particular, the observation of a high percentage of gain-of-function β-ENaC gene mutations in Africans lends credence to the use of amiloride as an effective treatment as it directly counteracts the effects of the ENaC mutation (Baker *et al.*, 1998). It is our suggestion that amiloride or in combination with another thiazide diuretic will be useful in treating hypertensive blacks, especially those carrying the highly prevalent T594M β-ENaC mutation (Elias *et al.,* 2019).

Conclusion

Salt ingestion plays a crucial role in the elevation of blood pressure, especially in blacks. While this is entirely unrelated to the detrimental impact of slavery on humans as previously asserted, this may be caused by genetic polymorphisms that affect the renal handling of sodium ions, that are observed with similar prevalence in both native Africans and African Americans.

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Cardiac autonomic function in different ethnic groups

Is heart rate variability the same in different populations?

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It has become a well-documented fact that the normal heart does not beat like a Swiss watch. In other words, the time between successive beats is not exactly equal, but varies slightly from beat-to-beat and this apparent irregularity has turned out to be an indicator of how the healthy heart responds to the normal beat-to-beat sympatho-vagal interplay. Special computer software can provide quantitative indices of the magnitude of this variability. Indicators used can be analysed in either the time-domain such as the variance of the R-R interval in an ECG recording, or analysed in the frequency-domain by extraction of high-frequency and low-frequency components after appropriate processing of the data (e.g. Fourier transformation).

Although still somewhat controversial, absence or reduction of such physiological heart rate variability (HRV) has thus been suggested to indicate compromised or disturbed sympatho-vagal balance, with a greater dominance of the sympathetic component. This has been found to be a risk factor for cardiovascular morbidity, and a strong predictor of cardiac and all-cause mortality (Caetano & Delgado Alves, 2015). Because there are reported differences in the prevalence of cardiovascular diseases and in the number of deaths among various ethnic groups, it was rational to explore whether this was associated with differences in HRV.

Factors known to affect HRV

Many physiological and environmental factors as well as lifestyle habits are reported to affect HRV. Studies consistently agree that HRV exhibits more sympathetic dominance with advancing age and in male subjects as compared to pre-menopausal females of the same age groups (Voss *et al.*, 2015). Regular physical exercise is associated with higher vagal activity and higher HRV. Indeed, regular exercise improves vagal (i.e. parasympathetic) influence in cardiac patients with reduced HRV (Routledge *et al.*, 2010). On the other hand, chronic stress, smoking, obesity and diabetes are all associated with reduced HRV (Aeschbacher *et al.*, 2016).

Possible ethnic differences in HRV

The majority of studies on ethnic differences in HRV investigated the difference between Americans of African versus Caucasian origins, with controversial or inconclusive results. Studies which reported that African Americans have reduced HRV compared to European Americans, presented their findings as a plausible explanation of the epidemiological disparities in cardiovascular morbidity between the two ethnic groups (Choi *et al.*, 2006). In contrast, a recent meta-analysis analysed a total of 11,162 subjects in 17 studies, and reported a higher HRV in Americans of African origin as

"The prognostic value of HRV may need to be considered cautiously in some ethnic groups"

compared to those of European origin (Hill *et al.,* 2015). One study reported lower HRV in Indian Asians living in the UK as compared to Europeans, but the Indian Asian sample had a higher blood glucose level which could possibly explain the difference (Bathula *et al.*, 2010). Unlike other authors, Bathula *et al.* (2010) explicitly indicated a potential attribution of ethnic difference in HRV, at least partially, to health conditions and lifestyles that are more prevalent in certain ethnic groups. Something which is not always explored, reported or controlled for in other studies.

Studies on other ethnic groups such as original dwellers of Africa or Africans of European or Indian origins are still largely missing in the literature

Genetic basis of HRV

A large meta-analysis that involved over 70,000 subjects of European, Hispanic and African American descent identified a number of genetic polymorphisms which can affect acetylcholine release from vagal nerve endings in the sinoatrial node as well as the signaling pathways downstream of muscarinic acetylcholine receptors. These differences may partially account for inter-individual, inter-cohort and inter-ethnic HRV (Nolte *et al.*, 2017). Another study investigated HRV in 1,103 adult twins, and reported a high intra-couple correlation ranging from 0.4 to 0.71 in monozygotic twins and much less in dizygotic ones (0.11 to 0.42), which supports a hereditary origin of HRV (Golosheykin *et al.*, 2017). It thus seems that certain genes involved in the control of vagal cardiac function may account for the individual variations in HRV. Some of these genetic variations are more prevalent in certain ethnic groups and thus can partially account for ethnic variability.

Clinical implications

Although it is well agreed that increased vagal-originating parasympathetic influence in basal state HRV is associated with better health and less mortality, a few studies challenge this concept, among which is the meta-analysis of Hill *et al.* in 2015, which showed greater HRV in African Americans despite having greater cardiovascular morbidity and mortality. In another study, Hill *et al.*, showed that HRV was positively associated with left ventricular hypertrophy in African but not in European Americans (Hill *et al.,* 2017). Therefore, the prognostic value of HRV may need to be considered cautiously in some ethnic groups, specifically African Americans.

With respect to therapy, it is acknowledged that the clinical response to some classes of cardiovascular drugs varies among different populations. The most notable example is that African Americans show reduced anti-hypertensive response to beta-blockers compared to European Americans (Johnson, 2008). Taken together with the finding that pharmacological sympathetic inhibition enhances HRV in cardiac patients may highlight the need to investigate the effect of beta-blockers on HRV in African Americans compared to Europeans.

Conclusion

HRV is but one example of the many physiological variables whose interpretation needs to be contextualised according to the physiological, environmental, and disease conditions of the studied subjects.

Large-scale controlled studies that investigate ethnic differences in HRV are quite scarce, and therefore it is still too early to draw a solid conclusion in this field. However, given the reports that HRV is higher in Americans of African than of European descent, despite the former being known to have concurrently higher cardiovascular disease burden, undoubtedly raises questions about the prognostic impact of normal HRV among differing ethnic groups. Without more rigorous study of diverse populations that take these aspects into consideration, we cannot expect to increase the validity of interpretation of HRV for use as a diagnostic and prognostic indicator.

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Towards gender equality in scientific careers: Are we there yet? ... Are we there yet? ... Are we there yet?

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Many moons ago, when I was a PhD student at University College London, I was standing next to my Head of Department at a party. Somewhat in his cups, he turned to me and said, apropos of nothing, "Over my dead body will I ever appoint a woman to my academic staff". And indeed, there were no female faculty members in the department, and hardly any female students at either the undergraduate or postgraduate level. I still remember how shocked I was by his comment, as well as how determined I was to show him that I would succeed in an academic career. Thankfully, over the almost forty years that have elapsed since I heard those words, such overt sexism has largely vanished in most science, technology, engineering and mathematics (STEM) fields. And for much of the early part of my career I felt that being a female scientist often brought me advantages, such as when efforts by the US National Institutes of Health (NIH) to increase the representation of women brought me an earlier-than-usual appointment to a grant review panel. However, with the benefit of hindsight, as well as a growing body of research, I have come to believe that women are systematically disadvantaged as they seek to develop their careers in science, and this likely accounts for the fact that the overall representation of women in academia, and especially representation at the higher ranks, has stalled at a disappointingly low level despite parity in many fields amongst the numbers of men and women seeking STEM doctoral degrees.

Implicit bias – imposter syndrome – microaggressions. These terms from social science reflect the daily onslaught that taxes the efforts of minority groups, including women, in competitive fields such as research. I have lost count of the number of times I have been assumed to be "Professor Barrett's secretary" when making travel arrangements by phone. I once received an invitation to a reception for new faculty addressed to "Dr. and Mrs. Barrett" (my mum sent her regrets). And with a relatively gender-neutral first name, and before the days of Google Image, I was almost left behind at the airport when arriving to speak at a conference in Asia because the student sent to collect me assumed I would be a man. These relatively minor irritations nevertheless take a considerable collective toll over time. More importantly, moreover, there is significant evidence, both from STEM and other academic fields, that women (as well as other under-represented minorities) do not receive equal treatment in the activities vital for progression up the academic career ladder such as publishing, receiving invitations to speak at meetings, or obtaining research support – or in landing a faculty position in the first place. Women are consistently held to a higher standard to reap equivalent rewards, experience more delays in the acceptance of their papers, are paid less than their male counterparts with similar experience and accomplishments, and have their qualifications and abilities routinely under-estimated (Reuben *et al.*, 2014). For example, a study published earlier this year revealed that first-time female grant awardees received significantly lower amounts of funding, on average, from the NIH than their male counterparts (by almost 25%) despite no difference in their baseline publication or citation rates (Oliveira *et al.*, 2019). A working paper presented this year by Hengel at the meeting of the American Economic Association showed that papers written by women are delayed an extra 3 – 6 months in peer review despite being better written than those authored by men (Hengel, 2019); in addition to this women represent only ~25% of first authors and ~15% of senior/last authors in journals like *Nature* and *Science* (Shen *et al.*, 2018). Women physicians and basic scientists in US medical schools are paid 77 – 90 cents per $1 earned by men, even after accounting for age, experience, rank, specialty and research productivity and despite better outcomes and survival rates of their patients (Jena *et al.*, 2016; Tsugawa *et al.*, 2017; Wallis *et al.*, 2017; Paturel, 2019). These factors all contribute to a vicious cycle of structural sexism that limits opportunity for female scientists (Figure 1). Women are also more likely to be found amongst the ranks of non-tenure-track faculty or as full-time educators, or to exit employment in higher education altogether (for example, see van den Besselaar and Sandström, 2016). And lest anyone thinks that this is a male conspiracy to keep us down, women themselves also hold implicit biases that negatively impact their evaluation of more junior women in, for example, hiring decisions (Reuben *et al.*, 2014).

"... with the benefit of hindsight, as well as a growing body of research, I have come to believe that women are systematically disadvantaged as they seek to develop their careers in science"

Women are also much more likely to be subjected to the spectrum of adverse behaviours that make up sexual harassment. A highly visible report recently published by the US National Academies of Science, Engineering and Medicine (NASEM, 2018) found that 58% of female academics reported being harassed, second only to harassment of women in the US military (69%). At the Experimental Biology meeting earlier this year where the NASEM report was discussed, none

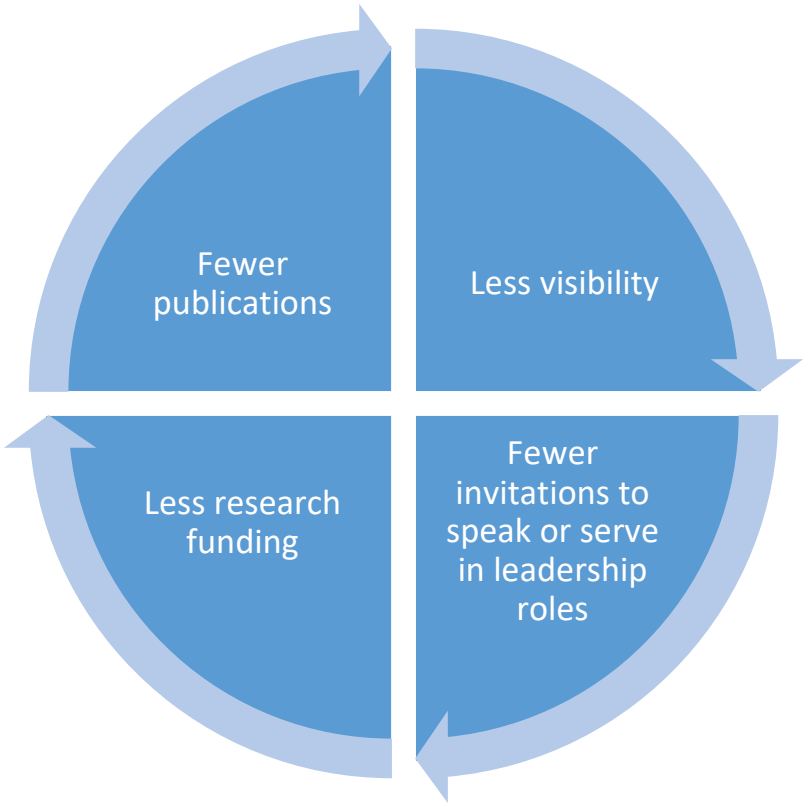

Figure 1. Schematic of how the known challenges that women face in getting their work published (fewer submissions to top tier journals [Shen *et al.*, 2018], publication delays and apparent higher standard required [Hengel, 2019]) set off a vicious cycle of impacts that stymie their progression in an academic career.

of the women present (but several of the men) were surprised by this statistic. In fact, I would venture the percentage is actually higher, because I don't think I know a single female colleague who doesn't have at least one war story to tell. Early in my own career, I experienced a number of such incidents that ranged from mildly amusing to downright scary. Women deserve to be able to do their work, as well as attend conferences, without having to fend off unwanted advances from colleagues. These situations are really all about upholding a power differential, and the psychological effort required to navigate them (or even to suffer the effects of retaliation should one be brave enough to report them) has been amply demonstrated by the recent #MeTooSTEM movement (visit metoostem.com for some sobering stories). They add yet another hurdle for the career success of many women.

So what is to be done? First, we need to be aware of the implicit biases we all hold as well as strategies to short-circuit them when serving on search committees or as the reviewers of manuscripts or grant proposals. I was pleased, upon getting involved with The Physiological Society in a leadership capacity, that I was required to complete implicit bias training – more societies should be doing this. We also need to be vigilant about ensuring representation of women as speakers at our meetings, members of committees, and in editorial roles, and in setting measurable goals for progress. In fact, a recent study showed that as more women rise to positions of journal leadership, editorial boards become more diverse (Ioannidou & Rosania, 2015) – a phenomenon we have also gladly experienced at *The Journal of Physiology*. It's also wonderful that we finally have our first female president in Bridget Lumb. Within our institutions, targeted interventions can improve the climate for, and retention of, women and other minorities (as shown recently at my own [Wingard *et al.*, 2019]). But we still need to ensure that women feel safe to conduct their work in laboratories, at meetings and in the field – and that perpetrators of sexual harassment are held accountable for their actions while their victims receive restitution from their employers, rather than retaliation, for the impacts on their lives and careers.

The outlook for women in STEM has changed over the course of my career, but I am far from sanguine about the prospects for equity any time soon. This is society's loss, given evidence that diverse teams have the greatest potential to deliver robust solutions to scientific problems. For this reason, I plan to redouble my commitment to work that boosts the status of women in all facets of academic life, and I hope that readers will join me.

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Access is everyone's business: Disabled students' experiences in higher education

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Vivian Rath

Trinity College Dublin, Ireland

Vivian Rath (front left), Amy Hassett (front right) and colleagues in University College Dublin at the Trinity College Dublin Equality Fund event in 2018.

Two students with disabilities who are blazing a trail in the fields of STEM, education, equality and diversity are Amy Hassett and Vivian Rath. Amy a founder of Disabled Women Ireland (**disabledwomenireland.org**) and Vivian a former director of the board of the Irish Association for Higher Education Access and Disability (**ahead.ie**), have been campaigning to ensure the rights and needs of those with disabilities remains top of the agenda in Ireland. Both with a background in STEM, these disability rights campaigners shared their stories with us and detailed several action points necessary to bring about meaningful change. Our discussion with them reflected the differences in experiences of people with disabilities, and emphasised the importance of not assuming everyone with a disability will have similar experiences or the same needs.

Amy Hassett is a physiologist undertaking a neuroscience masters at Erasmus University, Rotterdam where she is investigating the use of machine learning in characterising the behaviour of autism mouse models. As a person with a disability, namely osteogenesis imperfecta or brittle bone disease, she chose to engage in activism and served as the Student's Union Disability Rights Campaign Coordinator while studying for her BSc at University College Dublin. Her condition resulted in below average height, skeletal malformation and bones much more susceptible to fracture, which often necessitate the use of mobility aides such as an electric wheelchair.

Amy spoke to us about her experience in various labs, in particular about the barriers to access she's faced that many of us never have to consider. "In the past I've done cell culturing, western blots and all that stuff. In those [wet] labs it can be a little bit harder to get around... getting into a darkroom I had to get out of my wheelchair, you just had to... and for cell culture, you obviously cannot bring an electric wheelchair into a cell culture room." After humorously recounting the creative solutions she and her undergrad supervisor came up with to modify and make safe her "really frickin' massive" lab coat, Amy impressed upon us the importance of a supervisor's outlook on a disabled person's experience. "It all comes down to the attitude of the supervisor I think. There are some supervisors who just say 'look we'll work it out' and there are others that are just terrified! We had a lab technician, who was just petrified of someone with a physical disability and just thought anything that can go wrong, will go wrong, and 'well maybe she shouldn't be here'. When that's somebody's first response, it's really poor!"

Following a BSc in Pharmacology, Vivian Rath's experiences motivated him to shift his research interests from STEM to the inadequately addressed issues faced by students like himself. Continuing at University College Dublin, he went on to complete an MSc in Business Management where he researched the factors impacting the employment of graduates with disabilities. Now a PhD student at Trinity College Dublin he investigates the social involvement and sense of belonging experiences of students with disabilities in higher education. Vivian is also an appointee to the National Disability Stakeholders Group and Irish Human Rights and Equality Commission Disability Advisory Committee – the first ever statutory advisory committee in Ireland to support monitoring of the implementation of the United Nations Convention on the Rights of People with Disabilities (IHREC, 2019; UN, 2006).

Vivian has significant physical disability due to a spinal cord tumour he had removed when he was three years old. He typically uses a mobility scooter or two walking sticks. However, chronic ill-health, due to severe asthma continues to be one of his most significant medical issues which can affect all aspects of his life. Vivian recalls the challenges and help he received during his undergrad at University College Dublin. "I really enjoyed my time studying pharmacology and it has equipped me with a range of transferable skills that I have brought with me into my many roles including my PhD. I think what was most important was the supports that I received from the college disability support service and my department, this enabled me to succeed and enjoy the full college experience. Science is a demanding course in comparison to other disciplines and I spent a lot of time in the laboratory. And so, those academic supports that I received, for instance having a notetaker from time-to-time, or receiving notes in advance of lectures was really important! I faced many challenges in the lab, and I found the physical

aspect exhausting. However the staff in the department were extremely helpful; the difference between succeeding or failing for any student can often be the people you meet along the way, and that was certainly my experience."

Vivian's research aims to identify the barriers and enablers to the the social involvement experiences of students with disabilities. He notes, "that due to inclusive policies and greater supports there has been an increase in the number of students with disabilities attending higher education over the last decade but despite this there has been little focus on their experiences of their wider college student experience. Students still face a range of barriers including, inaccessible environments, lack of suitable supports, and outdated perceptions." Although thoroughly enjoying his PhD, Vivian highlights that the numbers of students with disabilities progressing onto postgraduate level is very small. He believes that this is due to a number of factors including the lack of funding streams, the culture and the highly competitive environment. "PhD researchers are expected to give so much of their time to academic activities outside their PhD. You need to organise conferences, seminars, give tutorials and lectures, attend international conferences, and that's all on top of your research... and of course publishing!" As someone with chronic asthma who often spends considerable time in hospital, it can be extremely challenging to balance these expectations. Vivian is often forced to focus on his PhD work only, and has felt under huge strain to meet the demand to build his academic CV whilst completing his research. Again he highlights the importance of his relationship with his supervisor and the support of his department the School of Education and the disability support services at Trinity College Dublin.

On a similar note, Amy highlighted that one of the most difficult things for her has always been how much to disclose on her CV directly or indirectly "... a lot of it was to do with disability. In my opinion that's a risk! All my volunteering and work experience, all my skills were related to campaigns I had done in relation to disability rights. You're kind of putting up a big flag saying 'hey, I'm disabled'! It's nerve-wracking to have to make that decision, but I did it and it worked in my favour, for the most part." Also when it came to the interviews for choosing the lab project in her Masters, she found the experience induced even more anxiety about future employment prospects. "Again that's pretty nerve-wracking. People have very expensive equipment, the labs can sometimes be small or not so small, and you're worried that they might say 'this is too much effort, this is too much hassle'. The one thing that I noticed was that every supervisor asked me 'how are your hands?' and I didn't even think of this, but [in hindsight] what they were really asking me about was my fine-motor control for doing things in the lab. I don't mind being asked that, but I think what it showed was that it was definitely in the back of their minds. You always take a gamble... there's always an extra hill you have to climb, and sometimes it doesn't pay off in your favour and sometimes it does."

Vivian and Amy noted people with disabilities are constantly having to be innovative and adapt to situations quickly. They believe that these problem-solving abilities make people with disabilities perfect candidates for careers in science. And while persons with disabilities are clearly drawn to science and mathematics undergraduate courses (12.3% of students with disabilities vs 9.5% of total student population in Ireland [AHEAD Ireland, 2018]), there is a worryingly low number of students with disabilities continuing on to postgraduate study (students with disabilities representing 7% and 2.8% of the total undergraduate and postgraduate students in Ireland, respectively (AHEAD Ireland, 2018), and disabled STEM students being 57% less likely to take up postgraduate STEM study than non-disabled students in the UK [CaSE, 2014]).

Five ways every organisation can better support people with disabilities

Rath and Hassett point out that everyone can be an ally and identified some key changes that could make a real difference in the laboratory and in college.

1. **Nothing about us, without us:** People with disabilities are not all the same; they have different needs, and different preferences. The easiest solution is to ask persons with a disability what they need (UN, 2006).

2. **Complete an access audit:** Undertake a review of the supports your organisation or institution currently offer.

3. **Make disability awareness training mandatory:** This involves understanding and appreciating the needs of people with disabilities including your legal obligations.

4. **Create a postgraduate-specific funding support programmes:** People with disabilities encounter many additional challenges in the college environment while undertaking a postgraduate course. In particular, the additional costs associated with having a disability. For instance, finding suitable accessible accommodation, medical bills, support assistants, extra travel costs associated with attending conferences, etc. There needs to be more financial supports for people with disabilities who want to take on a PhD, similar to dedicated schemes for increasing representation from other under-represented groups.

5. **Implement universal design (UD):** Universal design is a set of design principles whereby the environment should be designed in a way that meets the needs of all users (both in terms of structural aspects, but also ways of teaching) (CEUD, 2014).

In addition to implementing these five principles, Vivian highlighted that from his experience it is really important that students with disabilities feel like they belong and feel part of the wider college community. In order to achieve this goal, access must be everyone's business.

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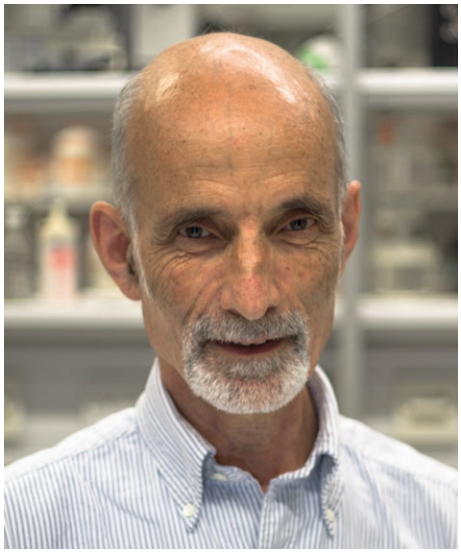
Confessions of an old lab rat



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"You mean to say you are still doing experiments?" As I "mature" I feel less self-conscious about revealing my failings but the number of people who seem to be poleaxed when they realise that I am still an active laboratory worker never ceases to surprise me. I see that flicker of astonishment, sometimes mild envy, cross my interlocutor's face. But I do not think I have ever considered being otherwise. My laboratory companions may be less than half my age but here I am, mixing solutions, patching cells, fixing equipment, and all the stuff that comes with being a highly qualified postdoctoral researcher.

I think this must have been a decision I made in my late 30s: that I would try to avoid being in a position of such responsibility that there would be no time for real bench work. I do not think this has soured my relations with administrations. One reason is that I continued to win grants in a research field that was, luckily, quite sparsely populated. Being associated with organisations and societies outside the university I was also seen as useful. Many of my contemporaries – and I don't in anyway judge them badly for this – found themselves promoted up to managerial positions so that it became increasingly difficult to return to being the laboratory scientist of their youth. You either get branded as a dinosaur, with out-of-date skills or, worse, fear of getting found out for having lost the few that you had. (Alan Hodgkin who, despite a large number of other commitments and even arthritic hands, admitted to being very pleased when he did a really botched dissection only to discover that this was the one that provided key data for one of his elegant papers on the retina (Simon *et al.*, 1975).

> "I hope that I can provide limited advice about what might and what might not work"

I always knew that I wanted to be a lab rat. It was called being a "back room boffin" when I was growing up. I went to a fine progressive school in North London (incidentally also the alma mater of John Nicholls [Nicholls, 2014]) which offered my 6-year-old self the option of either doing woodwork or reading. The choice was so blindingly clear that a few years later, barely reading, I had to be moved onto a more traditional educational path. But those workshop lessons started me off, migrating me through model airplanes to electronics and even to the temporary excursion of becoming a theoretical physicist with a doctorate in the arcane world of quantum field theory. But I found myself back in a lab in my mid-twenties, recording miniature endplate potentials from a neuromuscular junction under the tutelage of Paul Fatt and Gertrude Falk in the Biophysics Department at UCL. And I was hooked!

I suppose I have been lucky – every senior scientist says that – but physiology has always allowed the fortunate to take a random walk through a whole variety of different topics with so much to discover. Finding myself working in hearing was the indirect result of a chance encounter with Ian Russell, then pioneering the cellular physiology of the cochlea, in a corridor of UCSF in California.

Of course I started with an advantage. It was probably easier when I was a graduate not to have to plan a career trajectory and to stumble into various projects without real consideration for the step beyond that. It has also been helpful to think that one should never be dependent on too large a team: I like doing the work so much myself. Working in a laboratory on an equal footing with colleagues who may be students doing their first project or senior colleagues of a like-mind seems normal. This may be another dinosaur trait. Large collaborative groups in the life sciences are encouraged and I agree that certain sorts of science need to be done like that, but I can see it must be hard to step down from running a large laboratory. My inheritance from the world of mathematics and physics has been a belief in small groups, because that is how theoreticians work.

Any researcher will say they are driven by the highs from what they do (that is, when things go well). In my case there are still many interesting questions to answer about hearing and a clutch of new technical issues to grapple with. In the laboratory, I hope that I can provide limited advice about what might and what might not work to students and even to my academic colleagues. The important thing is try to avoid repeating too many mistakes. It is sometimes said that an expert is one who has made all possible mistakes, although most would agree with Richard Feynman that life is too short for that (Feynman, 1997). Nevertheless, the painful process of writing grants (even with others) or the stage nerves when giving a talk persist. The main concern for elderly scientists, past the normal retiring age, is to hope some of the accumulated wisdom (and I use the term guardedly) still trickles down. But I hope that I'll know when I've become a serious liability. Or perhaps, by writing this, I have become one already?

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Obituary: Saffron Whitehead 1948 – 2019

Saffron Whitehead

Emeritus Professor of Endocrinology Saffron Whitehead died on 18 February 2019. She will be remembered for raising the profile of endocrinology and women's health through her research, writing, media and public engagement activities. She was a happy person who lived life to the full and possessed the rare ability to infect those around her with a positive attitude to life. She will be greatly missed by all who knew her.

Saffron Whitehead was an eminent scientist with a passion for endocrinology and a real champion for women's health. She was a prolific author, and her latest book *Managing Obesity: a practical guide for clinicians* was published with co-author Gul Bano earlier this year. Across her academic career, she published 55 notable papers, five reviews and three endocrinology textbooks, which became definitive texts on many university degree courses. Saffron was a thoughtful and supportive colleague and supervisor, who gave willingly of her vast font of knowledge and wisdom.

Saffron graduated from University College London (1967 – 1970) with a BSc Physiology (Hons) and gained her PhD in 1974 at McMaster University in Canada, where she specialised in Medical Sciences (Neuroendocrinology). Long before it became mainstream, she was researching the interactions of endocrine disrupting chemicals (EDCs) and hormones and how they impact on fertility and cancer. Saffron joined St George's University of London in 1978 as lecturer in endocrinology and reproduction. She was responsible, along with Helen Mason, for creating the third year Science of Reproduction module for the BSc/iBSc in Biomedical Science, and will be remembered fondly by her students across the years.

To help advance the public discussion around better understanding of science, she wrote articles for the general media in publications such as *New Scientist* and *The Guardian*, under her married name, Saffron Davies. She was a constant advocate of women in science, having herself combined raising a family while maintaining a scientific career. She also contributed regularly to TV and radio shows, including appearances on BBC4's "The Fantastical World of Hormones" with John Wass and Radio 4's "Woman's Hour". She was the scientific advisor on *Tide Tables* a 2011 play supported by the Wellcome Trust and the Society for Endocrinology (SfE). The play centred on the challenges of midlife as a time of significant biological change.

Saffron contributed to her scientific field beyond her teaching and research responsibilities with active roles in both The Physiological Society and the Society for Endocrinology. She was a Member of The Physiological Society from 1980, edited *Physiology News* (1994 – 1998) and served on the Committee (1995 – 1999). On the Society's History & Archives Committee, Saffron could be relied on to lighten the mood with sometimes mischievous but always perceptive suggestions offered with her characteristic throaty chuckle. Saffron served on the editorial board of *The Endocrinologist* for many years and was its editor from 2004 – 2005. She was the Chair of the Public Engagement committee for the SfE, also managing press enquiries on publications and scientific breakthroughs for that society. Saffron was hard-working but always full of fun.

The lasting memory of Saffron is her resilience and tenacity. A memorable example occurred during a trip from St Petersburg to Moscow following the IUPS Congress in 1997. Saffron, together with Tilli Tansey and Bridget Lumb, spent a week living on a boat on the Neva river during the Congress and then headed off for a cultural trip to Moscow. Embarking on the overnight train for Moscow, Saffron was not intimidated by the request from a Kalashnikov-bearing official to pay a bribe before boarding the train. She confronted him and told him exactly where he could put the money. Needless to say all three boarded the train and arrived in Moscow the following morning.

Despite retiring several years ago, Saffron was still actively teaching and was a personal tutor at St George's. As well as these obligations, Saffron was a governor for Oak Lodge School for the deaf, and volunteered with the Shaw Trust, a charity helping people gain an education, enter work, develop their career, improve their wellbeing or rebuild their lives. She was an active tennis player and loved to play the piano. Saffron is survived by her husband John Davies, three sons, daughters-in-law and four grandchildren.

Written by Suman Rice, Dafydd Walters and Bridget Lumb.

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