Biochemical Society Response: APPG in Diversity and Inclusion in STEM's inquiry into *Inequity in access in STEM Education*

1 Introduction

1.1.1 Every student deserves an equal opportunity and access necessary to pursue STEM subjects. As well as being imperative for equality in society as a whole, access to STEM education is crucial to maintain the UK's position at the forefront of STEM research and development and can help equip students with the skills necessary to navigate our current, and future society. STEM professions, including those working in the molecular biosciences represented by the Biochemical Society, should reflect our societal demographic, and ensuring equal access to education and opportunities across minoritized groups is essential to achieve this.

1.1.2 The scope of this inquiry is broad, and the issues affecting access to education for different minoritized groups are not all the same. This response has been drawn from comments provided by our Policy Network of members and advisory panels of the Biochemical Society. We are focussing in this response on key issues raised by these groups and acknowledge that this by no means covers the entirety of the education system, nor all groups affected by unequal access to education across the UK. The issues discussed include the impact of socio-economic background on access to further education in STEM, importance of consistent access to careers information, and disparity between gender and Black Asian and Minority Ethnic (BAME) students within the STEM education system, and ultimately pursuing STEM careers. Where relevant, we have included examples from work and programmes supported by the Biochemical Society which exemplify measures to reduce inequality in STEM education.

1.1.3 It is imperative to recognise that those students who identify as belonging to more than one minority group are likely to experience any resultant inequity in access to STEM education individually, sometimes with compounded effects. Therefore, an intersectional approach to policy making will be required when looking to increase access to STEM education across all of society.

1.1.4 The Biochemical Society believes that diversity needs to be a central consideration in the development and implementation of all government policymaking for STEM. This includes teacher training, careers advice, curriculum reform, and university and further education (FE) funding. Solving disparity in access to STEM education will involve the breakdown of wider societal STEM stereotypes as well as addressing issues systemic within the education system.

2 Where is there inequity across different characteristics within the STEM education system in the UK, at any age?

2.1 Socio-economic background and increasing widening participation

2.1.1 It is widely accepted that socio-economic background influences likelihood of attending university and therefore impacts on access to a major route into STEM careers. For example, the Department for Education report on Widening Participation in Higher

Education 2018 (looking at the 2016/17 student cohort)[1] found that only 26% of students eligible for free school meals progress to university, compared to 43% of students not receiving free school meals. There is a gap of 17 percentage points between the proportion of students in state schools attending university compared to independent schools. This gap increases to 39% for students progressing to the top-third tier universities (as ranked by UCAS). Students within state education from a wealthier background may be in a position to supplement school education with tutoring, increasing their chance of getting better grades and attending university.

2.1.2 A lack of funding in schools can lead to disparity in the provision of extra-curricular services such as science clubs, as well as facilities for practical experiments, which can impact on students' enthusiasm and engagement for science and ultimately on attainment.

2.1.3 One of the results of this inequity in STEM education is a lack of diversity within the STEM work-force. For example, the Social Mobility Commission in 2017 found that under 10% of life science professionals are from a working-class background.

2.2 Inequitable access to progression opportunities

2.2.1 The opportunity to take triple rather than double science is not available to all students across the country. There is some evidence to suggest that schools not offering triple science tend to be in less affluent areas. For example, the Association for Science Education's 'Education in Science magazine' in 2018[2] suggested that the average school with more than a third of its students as Pupil Premium (PPM) in 2017 entered less than 10% of students for separate science GCSEs. This was compared to schools with less than 10% of students as PPM, where 60-100% of students were entered for separate sciences. Whilst taking double science GCSEs is not always prohibitive for continuing into STEM, the different double or triple science routes may risk inequalities being reinforced, with a resulting disadvantage in post-16 progression for those who have taken double science.

2.2.2 The UK Education system post-16 presently requires students to specialise in their choice of subjects earlier than many counterparts in, for example, Europe, where a Baccalaureate model is often followed. The result of this is that children as young as 15-16 may be making choices which can limit their later options, including in STEM subjects. This is not desirable for any group and may lead to a disproportionate number of girls dropping from STEM subjects, particularly chemistry and physics, as the "STEM stereotype" is learned young and is indeed mirrored in the STEM workforce demographics.

2.3 Gender differences in STEM reflect societal stereotypes

2.3.1 The uneven gender divide throughout the science pipeline (including within education) is well evidenced, and remains an issue despite being increasingly discussed. This manifests in post-16 education, and across higher education (HE), although formative experience at lower education stages will certainly be involved in the cause of this.

2.3.2 This may be a particularly difficult issue to resolve as it is, in part, the result of wider societal stereotypes resulting in both explicit and implicit perpetuation of gender

[1] Department for Education, Widening Participation in Higher Education, England, 2016/2017 age cohort – Official Statistics, 2018

[2] 'Education in Science, Association of Science Education, September 2018

stereotyped participation within the classroom, which can be perpetuated by teachers and parents[3].

2.3.3 A-levels followed by university remains one of the major routes into STEM careers in England, Wales and Northern Ireland. Gender participation in the sciences differs and can be evidenced at A-level. In general, gender bias is seen earlier for physical sciences than life sciences as students move through this path of the education system. For example, in 2018 the proportion of girls taking biology A-level was higher than boys, with 63% of the cohort female in 2018. However, in physics, the proportion of girls taking A-level was only 22% and in computer science, females made up only 11.8% of entrants[4].

2.3.4 At HE, the number of women taking science (again, most notably the physical sciences) is lower than men, although is slowly improving. Chemistry (including some biochemistry courses) had 44% female intake in 2016, whilst geology and physics were lower still (36 and 23% respectively)[5,6]. Moving to the next stage in this STEM education pipe-line to post-graduate level and the proportion of females drops to 39% for chemistry post-graduate (35 for UK domiciled)[7].

2.3.5 Ultimately, these figures begin to allude to the well-documented “leaky pipeline” of women in academic STEM careers. For example, according to 2018 report by the Royal Society of Chemistry (RSC) “Breaking the Barriers”[8], 99% of female chemists can evidence lack of retention and progression of women. This results in a noticeable lack of leading female academic staff. For example, the School of Life Sciences in the University of Glasgow currently evidence 1 female of 10 professors, in line with a 2016 survey from the Royal Society of Chemistry (RSC) documenting 9% of chemistry professors were women[7]. Not only is this symptomatic of issues earlier in the academic STEM pipeline (including contributing influences from STEM education), but also results in a lack of female role-models, particularly for undergraduate and postgraduate students within the HE system, thus perpetuating the stereotypes already learnt in school.

2.4 Ethnic Diversity in STEM

2.4.1 Black Asian Minority Ethnic (BAME) groups are statistically well-represented in taking STEM A-levels and STEM subjects at higher education[4,9], and have been reported in showing a greater interest in STEM subjects at school than their white peers[10]. However, there is clear inequity in attainment at all educational levels for BAME groups[8]. This is not restricted to STEM, but is manifest in these subjects as in others. In addition, it has been found that BAME students are less likely than white

[3] UNESCO, Cracking the code: girls’ and women’s education in STEM, 2017

[4] Institute of Physics, Analysis of UK physics A-level entrants, http://www.iop.org/policy/statistics/uk-a-levels/page_67953.html

[5] Diversity landscape of the chemical sciences, Royal Society of Chemistry, 2018

[6] UCAS 2016 end of cycle data resources, National level table set, 2016

[7] Higher education student and staff records, HESA, 2017

[8] Breaking the Barriers, Royal Society of Chemistry, 2018

[9] Improving Diversity in STEM, Campaign for Science and Engineering, 2014 (and references within)

[10] STEM subjects and jobs: A longitudinal perspective of attitudes among KS3 2008-10, Hutchinson and Bentley, 2011

students to attend higher-tariff universities[11] and the minority of students from a BAME background attending Oxbridge has featured in the media frequently over the last year.

2.4.2 It's important when looking into these statistics to acknowledge the shortcomings in assessing at "BAME" level. When data are further broken down into individual ethnic groups, they present a more nuanced environment[10]. For example, as reported in 2014 report on Diversity in STEM by the Campaign for Science and Engineering[8] [original data from London Mathematical Society], whilst British staff of Chinese heritage make up 0.7% of the UK population, but account for 1.9% of researchers, Black academics account for 0.4% of researchers, despite making up 3.3% of the UK population[12]. This example serves to highlight the simplification of grouping minority ethnic experiences of the STEM workforce and education system together. Furthermore, intersections with gender and socioeconomic background (and other minoritized groupings) must also be considered, with, for example Black women more likely to pursue STEM than Black men, which is the converse for White men and women[13]. Again, socioeconomic factors affecting access to STEM education discussed in section 2.1 will also have an influence here, with little evidence reported for social mobility in HE within BAME groups.

2.4.3 Within higher education, research has shown that lack of cultural understanding by the (white) majority means that many BAME undergraduate students feel that they have to fight harder for the same opportunities, and that some of the opportunities offered to try to overcome barriers are "not for people like us". Furthermore, white students are slightly more likely to progress to post graduate study[4]. In fact, the proportion of BAME students moving from undergraduate to postgraduate study in the biological sciences shows a large decrease (21 to 13%)[14].

2.4.4 "Approaches in other nations

Australia, New Zealand, South Africa, and to some extent the USA and Canada, have made concerted efforts to address issues related to ethnicity and widening participation. Approaches are varied, but include using appropriate examples in class, contextualising to the lived experiences of a diverse population; giving individuals a forum to discuss their lived experience and its impact on how they expect to/would wish to study, and how this relates to their own career goals; ensuring cultural identity is understood by all pupils/students and all staff they come into contact with - this is now embedded in law in Australia. The University of Sydney have some on-line cultural awareness courses which are mandated for students and are also being rolled out to staff. In Australia, this relates specifically to indigenous aboriginal population, which will present different challenges to those across the UK with its multi-cultural demographic."

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[11] UCAS End of Cycle Report 2016, UCAS Analysis and Research, 2016

[12] Academic mathematical sciences staff in UK HEIs, London Mathematical Society, 2013

[13] Ethnic Minorities in STEM factsheet, Business in the Community: Race for Opportunity, 2015

[14] A picture of the UK scientific workforce, The Royal Society, (based on data 2011/12) https://royalsociety.org/topics-policy/diversity-in-science/uk-scientific-workforce-report/interactive-chart/

2.4.5 Across academia, there is an underrepresentation of professors of BAME background. For example, of the 19,000 professors in the UK, fewer than 150 are black[15]. In the biological sciences, there is a clear lack in progression for BAME academics, resulting in 7.6% of lecturers from a minority ethnic background which further drops to 4.4% at Professor level[13]. As described in paragraph 2.3.5, this resultant lack of role models is both symptomatic of inequity at earlier stages, including within the education system, and contributes to a lack of visibility and role-models for future students who may be dissuaded from pursuing further study towards academic research.

3 What policy change could alleviate this inequity?

3.1 Increasing science capital in widening participation schools

3.1.1 Lower entry grades for students from Widening Participation (WP) schools at university level are helping to increase access to HE but have not yet succeeded in alleviating the inequity in HE attendance (documented in section 2.1).

3.1.2 There are existing programmes aimed at increasing interest, skills and confidence of students from lower economic background into STEM which have been shown to have significant success. The Biochemical Society supports In2ScienceUK, a charity which empowers students from disadvantaged backgrounds to progress in STEM subjects through work placements and careers guidance. By pairing students with STEM professionals in both academia and industry, students have the opportunity to experience real-world STEM research. In addition, students receive careers advice, skills workshops and guidance for university admissions. These facilities are often available within independent schools but are inconsistent across the UK. In 2018, 69% of students taking part in in2ScienceUK schemes were receiving free school meals, and 91% had no family history of higher education. As a result of the scheme, 46% of In2scienceUK students have gone on to be offered a place at a 'high tariff' university, compared to 11% of their peers and 48% of students from independent schools[16].

3.1.3 Similar impacts can be found from facilitating encounters between school and further education teachers and higher education. Since 2015 the Biochemical Society has actively supported teacher placements in academia and industry, including the STEM Insight scheme provided by STEM Learning. An external evaluation of STEM Insight was carried out by the Careers Research & Advisory Centre (CRAC) in 2016-2017 and published in November 2017[17]. This found that 88% of teachers were using their STEM Insight experiences as teaching examples and 80% of participants reported improved STEM subject and pedagogical understanding, together with increased confidence and enthusiasm for STEM. Through schemes like STEM Insight and In2scienceUK it is clear that increasing links between WP schools and STEM professionals increases engagement and enjoyment in STEM, which ultimately can increase students' necessary science capital and motivation to pursue STEM beyond school. Since teachers will typically work with hundreds of young people over their career, the impact of effective continuing professional development (CPD) can potentially be huge. We urge the Government to increase its support for schemes that facilitate access to higher education for school and further education teachers and students, particularly in widening participation schools, and to increase funding and access more generally

[15] Leading Routes: Black in Academia, http://leadingroutes.org/bia

[16] In2Science Impact Report 2018, In2Science, 2018, https://drive.google.com/file/d/1HbXTNQwoRRJ4R00XfJLX2ZmgoVVEO67K/view

[17] Evaluation of STEM Insight programme, The Career Development Organisation, 2017

for subject-specific continuing professional development for science teachers throughout their career.

3.2 Increasing access to career options

3.2.1 STEM stereotypes are learnt early, so concerted effort should be placed on showcasing the breadth of STEM career pathways throughout the education system.

3.2.2 Teachers and STEM professionals can work together, showing the diversity of, and within, STEM careers. As above, teacher placement schemes such STEM Learning's ENTHUSE Placements (formerly STEM Insight) and others provided by, for example the Scottish Schools Education Research Centre (SSERC) can widen the outlook of STEM subject teachers, ultimately benefitting teachers, their students and STEM professionals taking part. The 2017 evaluation of STEM Insight found that 100% of participants increased their understanding of current STEM jobs and career pathways and felt better informed to provide young people with personal advice on progression and potential career choices.

3.2.3 Teacher placement schemes can be particularly valuable for inter-disciplinary subjects taught at university, such as the molecular biosciences, which are not fully described within the traditional biology-chemistry-physics model of the curriculum as well as in helping teachers to support their students with the transition between school/college and higher education.

3.2.4 Supporting teachers' professional development, including their knowledge of the breadth of STEM pathways, will help to incorporate this into teaching at every level of education, further breaking down existing prohibitive STEM stereotypes. This aligns with the Gatsby Good Careers Guidance benchmarks[18].

3.2.5 Although existing third-party organisations such as non-governmental organisations (such as STEM Insight) and Learned Societies have a role in providing and supporting these activities, partnership and funding from government sources (to cover substitute teacher costs, for example) could further increase the availability of such schemes, particularly in hard to reach groups.

3.3 Role modelling

3.3.1 The importance of role-models in student participation and engagement is clear throughout the education system, be it scientific achievements celebrated and taught in school, or exposure to success in current research as an undergraduate, postgraduate or further education student.

3.3.2 Several studies have shown the positive impact of role models on girls' interest in STEM subjects. Building on the report by UNESCO[2], research by Microsoft[19] on the importance of role models within Europe showed a doubling of girls' interest in science with role models. Within the UK students, the proportion of girls who reported they could "imagine themselves working in STEM" rose from 32 to 52% following exposure to female role models as part of their education.

3.3.3 There are existing schemes in the UK aiming to highlight and incorporate female and other minority workers in STEM as role models into students' experience. For example, WISE's "People like me" resources aim to highlight the diversity of personalities and options in STEM and ultimately to degrade existing STEM stereotypes using role

[18] Good Career Guidance Report, Sir John Holman (on behalf of Gatsby Charitable Foundation), 2014, https://www.goodcareerguidance.org.uk/the-benchmarks

[18] How role models are changing the face of STEM in Europe, Microsoft and KRC Research, 2018

models. A 2018 evaluation of People Like Me conducted by the Open University[20] confirmed that this approach was well received and resulted in a more than 50% reduction in girls who reported they were not interested at all in pursuing STEM further into education.

3.3.4 Although it is by no means the only solution, increasing the representation and visibility of women scientists and scientists of other minority groups will help to break down societal stereotypes which result in an unequal perception of STEM options by young people. An increased incorporation of the achievements of female and other minoritized scientists should be recommended in teaching of STEM subjects at all stages of education within the UK STEM curricula.

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About the Biochemical Society:
The Biochemical Society promotes the future of molecular biosciences; facilitating the sharing of expertise, supporting the advancement of biochemistry and molecular biology, and raising awareness of their importance in addressing societal grand challenges.

We achieve our mission by:

• Supporting the next generation of biochemists; promoting the opportunities offered by biochemistry and molecular biology through education and training from age 15 upwards

• Bringing together molecular bioscientists; fostering connections and providing a platform for collaboration and networking across our membership and the wider community to ensure a strong future for molecular biosciences in both academia and industry

• Promoting and sharing knowledge; enabling the circulation of scientific information through meetings, publications and public engagement to support innovation, inform decision-making and advance biochemistry and molecular biology

• Promoting the importance of our discipline; highlighting the role of molecular biosciences in interdisciplinary and translational research, while supporting the fundamental research that underpins applied studies.

[19] People like me evaluation report, The Open University, 2018