Written evidence submitted by the Royal Society of Biology (GAP0022)

The Royal Society of Biology (RSB) is a single unified voice for biology: advising government and influencing policy; advancing education and professional development; supporting our members, and engaging and encouraging public interest in the life sciences.

The Society represents a diverse membership of individuals, learned societies and other organisations. Individual members include practising scientists, students at all levels, professionals in academia, industry and education, and non-professionals with an interest in biology. Our response focuses on some of the issues around uptake of STEM careers and cases where there are particular skills gaps in the biosciences and how they are being addressed.

Executive Summary

- Evidence indicates that we are facing a STEM skills shortage and the UK economy requires an additional 104,000 STEM graduates and 56,000 STEM technicians per year.
- To increase our pool of STEM talent we must increase diversity and attain gender balance across the STEM sector. In turn this will help create appropriate role models who can inspire young people from different backgrounds to enter a career in STEM.
- Raising the total number in our STEM workforce requires us to increase the number of students continuing to study STEM subjects on both academic and technical pathways. There is strong evidence that teaching by subject-specialist teachers (in biology, chemistry, physics, technology, engineering, maths) is key to inspiring and promoting student uptake in STEM subjects.
- There must be more opportunities to showcase the variety of careers available to students within the STEM sector, aimed at both primary and secondary students. Collaborations between schools and local STEM industry, universities and professional bodies can support this. The RSB is already active in such initiatives, which government should aim to expand and evaluate in order to develop a long-term strategy for teaching STEM subjects.
- Investment in training the current workforce can help to reduce the skills gap. Professional registration is helping to address shortages within the technical workforce through raising standards and expanding awareness and recognition of the technical professions. STEM employers should invest in the training of their technical staff and recognise the importance of professional development, encouraging employees to work towards professional registration.
- The Royal Society of Biology's degree accreditation programmes are raising the standards of bioscience education in higher education institutions, and enabling students to develop the skills needed by employers alongside strong academic knowledge and practical skills. Government support for the accreditation of Further Education bioscience programmes would help raise the standards of technical and profession education and training.
- There are many areas within the biosciences, including physiology, pharmacology/drug discovery, agriculture, forestry and food security, which face future shortages in skills and capability. Additional investment and expertise are required to support these vulnerable and vital areas of work.

Introduction

1. There is well documented evidence[1][2] that the UK is experiencing a shortage of skilled STEM workers to fulfil UK workforce requirements, and that those entering the sector do not always have the skills required by

[1] CBI/Pearson education and skills survey http://www.cbi.org.uk/cbi-prod/assets/File/pdf/cbi-education-and-skills-survey2016.pdf?mc_cid=dce980549f&mc_eid=6be1e9feb5
[2] Social Market Foundation (2013) In the balance: STEM human capital crunch http://www.smf.co.uk/wp-content/uploads/2013/03/Publication-In-The-Balance-The-STEM-human-capital-crunch.pdf

employers.[3] It is estimated that 20% of the UK workforce require scientific knowledge and skills in order to do their current jobs.[4]

2. The expected demand for STEM graduates could average 104,000 a year,[2] and the number of school leavers with relevant STEM skills falls short of current and future business needs.[5] In addition we also face long-term shortages of people with technician-level skills and it is estimated that we will need 56,000 STEM technicians each year by 2020.[6] Over 1.5 million technicians make up the UK STEM workforce, but we are not producing enough skilled individuals to fill these roles.[7]

Diversity within STEM

3. The underrepresentation of women, disabled people, and those from ethnic-minorities and low socio-economic backgrounds is a persistent phenonomen across the STEM workforce, particularly in senior roles.[8, 9] Barriers preventing groups of individuals entering in STEM careers must be removed so that we can help to address the shortfall of STEM talent across the sector, and existing stereotypes within STEM careers must be challenged. Equally, barriers preventing groups of individuals from staying within the STEM sector must be addressed, for example, women are less likely to remain in the STEM sector throughout their career, in the 'leaky pipeline' effect.[10] Appropriate role models are essential not only to inspire students, but to evidence the possibility of success demonstrating that STEM careers are open to everyone.

4. Initiatives to promote diversity within the STEM workforce, such as the Athena SWAN charter, are essential to ensure that diversity is supported and equal opportunities are provided when addressing the STEM skills gap. Existing initiatives must continue to be monitored to ensure that they are effective in promoting diversity within STEM careers.

Primary and secondary education

5. To begin to address the STEM Skills gap we must encourage more young people to continue to study STEM subjects and progress to STEM careers through both academic and technical pathways.

6. The King's College ASPIRES research suggests many young people, although they may enjoy STEM subjects, choose not to pursue STEM careers and very few aspire to become scientists.[11] The research shows that if 10 year olds cannot visualise themselves as a future scientist or engineer, they are unlikely to be able to do so by the time they are 14, and this self-perception influences subject choices by age 14 and beyond.[12]

7. In English schools there is a statutory requirement that all pupils are provided with independent careers guidance from year 8 to year 13.[13] Alongside this, Ofsted guidance states that outstanding schools will

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[3] UK Commission for Employment and Skills (2015) Reviewing the requirement for high level STEM Skills https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/444048/High_level_STEM_skills_requirements_in_the_UK_labour_market_FINAL.pdf
[4] The Royal Society (2014) A picture of the UK scientific workforce https://royalsociety.org/~/media/Royal_Society_Content/policy/projects/leading-way-diversity/picture-uk-scientific-workforce/070314-diversity-report-executive-summary.pdf?la=en-GB
[5]CBI/Pearson education and skills survey http://www.cbi.org.uk/cbi-prod/assets/File/pdf/cbi-education-and-skills-survey2016.pdf?mc_cid=dce980549f&mc_eid=6be1e9feb5
[6] Social Market Foundation (2013) In the balance: STEM human capital crunch http://www.smf.co.uk/wp-content/uploads/2013/03/Publication-In-The-Balance-The-STEM-human-capital-crunch.pdf
[7] Technicians: the backbone of our economy http://www.gatsby.org.uk/uploads/education/links-6838-gatsby-a5-technicians-brochure-2016-digital-aw-1.pdf
[8] http://www.sciencecampaign.org.uk/asset/7E74D16B%2D9412%2D4FA7%2D9CD361C8371DBD02/
[9] UKCES Reviewing the requirement for high level STEM skills. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/444052/stem_review_evidence_report_final.pdf
[10] Tapping all our talents http://www.raeng.org.uk/publications/other/tapping-all-our-talents
[11]King's College London (2013) ASPIRES Young people's science and career aspirations, age 10-14 http://www.kcl.ac.uk/sspp/departments/education/research/ASPIRES/ASPIRES-final-report-December-2013.pdf
[12] http://www.kcl.ac.uk/sspp/departments/education/research/ASPIRES/ASPIRES-final-report-December-2013.pdf
[13] Careers guidance and inspiration for young people in schools https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/440795/Careers_Guidance_Schools_Guidance.pdf

provide "*high quality, impartial careers guidance [that] helps pupils to make informed choices about which courses suit their academic needs and aspirations*."[14] However, recent reviews of career provisions in schools have established that for many, excellent quality career provisions are not in place.[15] Research completed by Sir John Holman on behalf of the Gatsby Foundation, identified eight Career Benchmarks that described what good career guidance looks like in schools and colleges. These benchmarks state that schools need a whole school strategy, 1:1 student support, high quality information about the labour market incorporated into the curriculum, and encounters with education institutions and employers.[16]

8. If more students are to pursue STEM subjects, they must be better informed of the careers within the STEM sector. Interventions must start early and be sustained. Career opportunities should be showcased to primary students, as well as those in secondary school, to encourage future participation in STEM subjects.[17] The Government should support teachers in delivering career provisions and ensuring that both academic and technical pathways are promoted to students.

9. There needs to be appropriate role models to demonstrate that all young people can work within the STEM sector. An excellent source of role models is the STEM ambassador scheme.[18] The scheme enables schools to invite ambassadors to run workshops to engage with their students. The STEM ambassadors work across different STEM sectors, at different career stages, and come from a diverse range of backgrounds.

10. There is a shortage of STEM graduates across a wide range of sectors, including science teaching.[19] Increasing the recruitment, retention and support of subject specialist science teachers can help raise the number of students carrying on their study of STEM subjects. The importance of subject specialist teachers is recognised by the Department for Education (DfE) as a key determinant of student success, especially in science and maths subjects.[20] The Government should support primary teachers to enhance their STEM subject knowledge and confidence, through professional development opportunities and during Initial Teacher Training (ITT).Without subject specialist teachers to inspire and promote a love of the subject, as well as increase attainment, the cycle of persistent STEM skills shortages will be difficult to address.[21]

11. It is important that industry, universities and professional bodies work with teachers to support the delivery of STEM careers guidance. The RSB and its member organisations have been working together to help provide this support to teachers. With our careers committee[22] the RSB have developed a range of resources[23] that demonstrate the variety of bioscience careers that students can enter, this material is available free for teachers to use with their students. Our most frequently visited pages of the website are our careers and placement support pages.

12. We have recently commenced a project[24] facilitated through grant funding from the Biochemical Society, which involves visiting new science teachers on PGCE courses to discuss careers provision and developing resources to integrate STEM careers into lessons. So far 65 university based initial teacher training providers have been contacted to provide their trainee science teachers with careers resources. To date 6 visits have taken place which has enabled us to directly engage with 389 science teachers, 9 further visits are scheduled to take place this academic year. As the scheme is in its first year, a full evaluation has not yet taken place.

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[14] School inspection handbook https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/553942/School_inspection_handbook-section_5.pdf
[15] Careers education, information, advice and guidance https://www.publications.parliament.uk/pa/cm201617/cmselect/cmese/205/205.pdf
[16] Holman, J. *Good Career Guidance,* Gatsby Foundation (2014) http://www.gatsby.org.uk/uploads/education/reports/pdf/gatsby-sir-john-holman-good-career-guidance-2014.pdf
[17] Reiss M & Mujtaba T (2016): Should we embed careers education in STEM lessons?, The Curriculum Journal http://www.tandfonline.com/doi/full/10.1080/09585176.2016.1261718
[18] http://www.stemnet.org.uk/ambassadors/
[19] http://www.gatsby.org.uk/uploads/education/reports/pdf/key-indicators-in-stem-education-gatsby.pdf
[20] https://www.rsb.org.uk/images/ASE_IOP_RSB_RSC_RS_Teacher_Supply_Response.pdf
[21] Migratory Advisory Committee Teacher Supply Response https://www.rsb.org.uk/images/16-09-2016-MAC-teacher-supply-response.pdf
[22] Royal Society of Biology Careers Committee https://www.rsb.org.uk/about-us/committees/careers-committee
[23] RSB Careers Resources https://www.rsb.org.uk/careers-and-cpd/careers/career-resources
[24] Biology Careers, Teachers Resources https://www.rsb.org.uk/careers-and-cpd/careers/career-resources/resources-for-teachers

13. The Biochemical Society is supporting the STEM Insight[25] programme which enables teachers to gain a wider experience of the STEM sector through placements in universities or in industry. The first bioscience placements took place in February 2016 and 16 bioscience placements have been funded so far, with a wide range of hosts including Syngenta, the Babraham Institute, University of Cambridge and University of Liverpool. The feedback received so far suggests the placements are already having a lasting impact:

    "*We see the week as a big success since firm plans have been made involving: staff visits to talk at the College; a visit of Sixth Form students to the University of Liverpool, and a visit by a current undergraduate student to the College, sharing her university experience with the student body there"*. Dr Luciane Mello, University of Liverpool

    "*I am looking forward to implementing my findings about careers, subject knowledge and techniques into my teaching and sharing with the other biology staff in my department and then more widely within Colchester*." Teacher participant, Babraham Institute 2016

14. The Microbiology Society facilitate interactions between schools, colleges and universities through their Antibiotics Unearthed programme[26] where groups of students do real research, hoping to find the next new antibiotic. University partners will provide support for the school students and invite the students and relevant staff into their department to do further, more detailed analysis on any compounds isolated. The aim is that through engaging through real research, young people will be inspired to enter a career in science. This experience gives students the opportunity to familiarise themselves with a university or professional environment and engage with researchers.

15. Over recent years we have seen a decline in the number of students taking plant sciences and a fall in the number of specialist courses available.[27] The Science and Plants for Schools, in collaboration with the University of Cambridge, have produced resources to support students and teachers to increase awareness of the career options available within the plant sciences. The IntoBiology[28,29] website provides careers resources as well as support for students conducting extended investigative projects.

16. It is important that positive relationships are built between schools and STEM employers, to demonstrate the variety of careers available to students within the STEM sector. STEM businesses should be encouraging their staff to become mentors or Enterprise Advisors and be part of Local Enterprise Partnerships that are facilitated by The Careers and Enterprise Company.[30] Local Enterprise Partnerships create a coalition of local businesses that can engage with schools and support students to develop skills required for employment. To invest effectively in the future of STEM, staff should also be encouraged to become STEM ambassadors, with employers allowing them time to take part in outreach events with schools.

17. There have been and there continues to be a huge variety of initiatives implemented to facilitate better careers support within schools. These initiatives and partnerships must be evaluated, promoted and their long term impact assessed to better help us understand if they are making a positive difference.

Transition from school

18. It is vital that students develop the skills and competencies needed to support them to progress to further study or work once they have finished school. The RSB curriculum committee[31] is working on the development of core content, concepts, practical and transferable skills that should be developed during the study of school biology. The RSB curriculum committee have worked to open up dialogue between school teachers and academics teaching in higher education to discuss the skills that students need to progress in biology hosting an event on the transition from school to higher education.[32] We are also monitoring the

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[25] STEM Insight programme https://www.stem.org.uk/stem-insight
[26] Antibiotics unearthed http://www.microbiologysociety.org/outreach/antibiotics-unearthed/
[27] http://www.gatsby.org.uk/uploads/plant-science/reports/pdf/cei-uptake-of-plant-science-in-uk-feb-09.pdf
[28] IntoBiology http://intobiology.org.uk/
[29] IntoBiology review https://www.publicengagement.ac.uk/case-studies/intobiology-website
[30] The Careers and Enterprise Company https://www.careersandenterprise.co.uk/enterprise-adviser-network
[31] RSB Curriculum Committee https://www.rsb.org.uk/about-us/committees/biology-curriculum-committee

impact that curriculum reform is having on students confidence at understanding key areas of biology and self-assessment of their practical and transferable skills, through our online survey on 'Post 16 Biology Education in Schools and Colleges.' There have been over 1,300 responses to the survey. The responses will inform the curriculum committee's work and these finding will be shared with universities who have taken part and other interested stakeholders.

19. The 2014 Audit of Practical Work Undertaken by Undergraduate Bioscience Students across the UK Higher Education Sector suggests that many students come to university underprepared for the practical aspects of bioscience degrees.[33] With the changes to the assessment of practical work at A level we will be interested to see what impact this has on student's practical skills upon starting undergraduate courses. We hope this will result in increases in the practical ability of students.

Technical education and technical skills

20. The Government Post-16 Skills plan[34] recommends that our technical education undergoes reform. We agree that for technical education to be successful, the academic and technical pathways must have equal standing and there must be a means of switching between both pathways. We are positive about the 15 technical routes having a common core, developing key skills in literacy, numeracy and digital skills as well other transferable skills. It is important that the 'Agriculture, Environmental and Animal Care' and 'Health and Science' routes facilitate students and apprentices to develop the skills that are required to continue further study in the biosciences or progress into bioscience workforce.

21. Within the STEM sector we face long-term shortages of people with technician-level skills. It is estimated that we will need 56,000 STEM technicians each year from now until 2020[35]. Professional registration is helping to raise standards within technical professions and address shortages within the technical workforce.[36] A number of STEM employers already support their employees to become professionally registered and many professional bodies offer professional development opportunities and professional registration. STEM employers must invest in the training of their technical staff and recognise the importance of professional development, encouraging employees to work towards professional registration.

22. The RSB, licensed by the Science Council, offers Registered Science Technician (RSciTech) status. This award offers recognition for the technical profession and demonstrates individuals meet and maintain the high standards expected our organisation as a professional body. The RSB also provide progression to higher awards through Registered Scientist (RSci), Chartered Scientist (CSci), and our own professional register Chartered Biologist (CBiol). For our membership to achieve registration status they must demonstrate evidence of meeting the standard for key competencies as well as a commitment to undergo continuing professional development.

23. In 2016 the RSB launched a new professional register, the Plant Health Professional Register, in response to the Department of Environment, Food and Rural Affairs (Defra) and Government of Science reports, which recommended the development of plant health skills and creating opportunities for a wide community of trained plant health professionals.[37,38] A 2014 report by the Plant Science Federation[39] indicated that

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[32] Transition from schools to higher education https://www.rsb.org.uk/about-us/committees/biology-curriculum-committee/curriculum-committee-supporting-transition-from-school-to-higher-education
[33] Audit of Practical Work Undertaken by Undergraduate Bioscience Students across the UK Higher Education Sector https://www.rsb.org.uk/images/SB/UG-Practical-Work-Report-Web.pdf
[34] Post-16 Skills Plan https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/536068/56259_Cm_9280_print.pdf
[35] Social Market Foundation (2013) In the balance: STEM human capital crunch http://www.smf.co.uk/wp-content/uploads/2013/03/Publication-In-The-Balance-The-STEM-human-capital-crunch.pdf
[36] http://www.gatsby.org.uk/uploads/education/reports/pdf/gatsbyprofessionalregistrationleaflet.pdf
[37] Defra/GoS (Dec 2014) Animal and Plant Health in the UK: Building our science capability https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/388571/14-1293-animal-plant-health-capability.pdf
[38] Defra (April 2014) Protecting Plant Health-a Plant Biosecurity Strategy for Great Britain https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/307355/pb14168-plant-health-strategy.pdf
[39] UK Plant Science Federation (2014) UK Plant Science – Current status and future challenges https://www.rsb.org.uk/images/pdf/UK_Plant_Science-Current_status_and_future_challenges.pdf

shortages of plant scientists and an inadequate skills base were the greatest barriers to meeting future challenges in UK plant science. Particular shortages of UK expertise in identification specialists, taxonomists, and plant pathologists, were identified.

Higher Education

24. In 2009 the Office for Life Sciences released the Life Sciences Blueprint[40] which identified the support that was required within the life sciences sector. The (Royal) Society of Biology initiated the development for accreditation of bioscience degrees in 2010, following recommendations from this report. The 2016 Wakeham Review of STEM Degree Provision and Graduate Employability also recommended that there be further support for accreditation and that it can strengthen the links between higher education and employers.

25. The RSB launched Advanced Accreditation October 2012, supported by Government funding from the UK Commission for Employment and Skills (UKCES). The RSB Advanced Accreditation scheme rigorously and independently assess programmes to ensure that degree courses have a solid academic foundation in biological knowledge and skills, as well as preparing graduates for the needs of employers.[41] The Advanced Accreditation criteria requires evidence that graduates from Advanced Accreditation programmes meet defined sets of learning outcomes, including substantial research experience.[42] In December 2016, 213 degree programmes at 22 universities had achieved Advanced Accreditation through the RSB.

26. Due to the success of Advanced Accreditation and requests from the wider community, the Society developed Degree Accreditation,[43] addressing the skills gaps identified by employers for graduates from traditional bachelor's degrees, launched in March 2015. To achieve Degree Accreditation, universities must provide evidence that meets six overarching learning outcomes, including demonstrating transferable and technical skills. In December 2016, there were 175 degree programmes at 25 universities that achieved Accreditation.

27. As part of the accreditation process, feedback is provided to the higher education institutions. This includes conditions that must be met before accreditation can be awarded and recommendations for enhancement of programmes. For example, from the launch of accreditation until June 2016 approximately 130 programmes had conditions set around final year projects, approximately 70 programmes had conditions related to technical skills, approximately 30 programmes received conditions on transferable skills, approximately 50 programmes were required to enhance the physical sciences and maths content, and approximately 70 programmes received conditions on some aspects of the bioscience curriculum. These conditions were all met, raising the standards of bioscience degree programmes and improving the skills and employability outcomes for bioscience students.

28. The RSB Accreditation Committee review the degree programme criteria annually to ensure that they remain relevant, up-to-date and set the bar for a high standard of learning and teaching. In addition the Society aims to see an increase in the development of graduates' creativity and innovation and, although conditions in this area have not been set yet, we are expecting positive developments when higher education institutions seek re-accreditation.

29. The accreditation of bioscience programmes within the Further Education (FE) sector would help to raise the standards of technical and profession education and training. Whilst initial work is being done by the RSB in this area, the support of Government funds for the accreditation of FE bioscience programmes would enable accreditation processes to launch on a greater scale and have a wider impact.

Specific areas of vulnerability for the bioscience sector

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[40] Office for Life Sciences (2009) Life Sciences Blueprint https://www.biocity.co.uk/file-manager/Group/reports2009/2009-07-ols-life-science-blueprint.pdf

[41] https://www.rsb.org.uk/images/RSB_BIS_consultation_response_29.10.15.docx

[42] Royal Society of Biology Advanced Accreditation https://www.rsb.org.uk/education/accreditation/Advanced-Degree-Accreditation-Assessment-Criteria

[43] Royal Society of Biology Degree Accreditation https://www.rsb.org.uk/education/accreditation/Degree-Accreditation

30. In 2014 the Biotechnology and Biological Sciences Research Council and Medical Research Council, in collaboration with the then Society of Biology, held a consultation to identify vulnerable skills within the biosciences.[44] Responses were received from academic research organisations, BBSRC and MRC institutes, centres and units, businesses, professional societies and other organisations with an interest in research skills. Many areas of vulnerability were highlighted, and were grouped into the following categories:

- Interdisciplinarity
- Maths, Statistics and Computation
- Physiology and Pathology
- Agriculture and Food Security
- Core Research and Subject Specific Skills

31. Skills that enable interdisciplinary research to take place are vital, they require in-depth knowledge and understanding of more than one discipline. Support is needed for those working across the interface of bioscience, chemical and physical sciences, this has significant impacts upon the biotechnology sector. Mathematical skills, data analysis and computational skills are required to facilitate working with large data sets, and modelling within bioinformatics. Additional expertise is required to cover whole organism biology, and particular niche areas within pathology, taxonomy and microbiology. There is additional investment required to support the development of *in vivo* skill relevant to pharmacology and drug discovery at undergraduate level, as costs associated with the implementation of infrastructure are high. In regard to agriculture and food security there are particular shortages in areas focusing on plant breeding, entomology and forestry skills.

32. The Association for British Pharmaceutical Industry 2015 report[45] identified: *"Many of the areas of highest concern relate to* ***mathematical and computational skills****, including* ***bioinformatics, statistics, data mining, health informatics, and health economics and outcomes****."*

33. We are seeing initiatives being developed to help support the development of mathematical skills, this includes recent funding being offered by the Heads of University Biosciences (HUBS), Heads of University Centres of Biomedical Sciences (HUCBMS) and Institute of Biomedical Sciences (IBMS) to support a workshop on improving the teaching of mathematical skills and physical sciences within bioscience courses.

34. We would like to highlight that the British Pharmacological Society (BPS) and APBI are submitting their own responses to this inquiry. The BPS have also recently launched an evaluation of the Integrative Pharmacology Fund (IPF), identifying outcomes of the IPF and the extent which it has supported sustainable solutions to the *in vivo* skills gap.[46]

January 2017

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[44] BBSRC and MRC (2015) BBSRC and MRC review of vulnerable skills and capabilities http://www.bbsrc.ac.uk/documents/1501-vulnerable-capabilties-report-pdf/

[45]Bridging the skills gap in the biopharmaceutical industry http://www.abpi.org.uk/our-work/library/industry/Documents/Skills_Gap_Industry.pdf

[46] An evaluation of the integrative pharmacology fund: lessons for the future of *in vivo* education and training https://www.bps.ac.uk/BPSMemberPortal/media/BPSWebsite/Assets/Evaluation-IPF-report.pdf