Written submission by the British Pharmacological Society to The House of Lords Science and Technology Select Committee inquiry 'Life Sciences and the Industrial Strategy'.

Background

The British Pharmacological Society (BPS) is the primary UK learned society concerned with research into drugs and the way they work. The Society has around 4,000 members working in academia, industry, regulatory agencies and the health services, and many are medically qualified. The Society covers the whole spectrum of pharmacology, including laboratory, clinical, and toxicological aspects. Pharmacology is a key knowledge and skills base for drug development in the pharmaceutical and biotech industries, and is therefore fundamental to a thriving UK pharmaceutical and healthcare industry and the future of research and development. The Society publishes three scientific journals: the British Journal of Pharmacology, the British Journal of Clinical Pharmacology, and Pharmacology Research and Perspectives.

The Society is a stakeholder in the Life Sciences Sector deal as a point of contact, brokerage and support for pharmacologists across academia, the NHS and industry. Our response to this consultation is made in this context, and with a focus on the biopharmaceutical industry.

We have responded to all relevant questions where we believe our expertise best lies. In responding to the consultation, we have integrated many of the recommendations outlined in the "Life Sciences Industrial Strategy: a report to the Government from the life sciences sector"[1] in addition to our response[2] to the Industrial Strategy.

The Society would be happy to discuss our response in more detail. Please contact Dr Anna Zecharia (Director, Policy & Public Affairs) via anna.zecharia@bps.ac.uk

[1] Life Sciences Industrial Strategy-a report to the Government from the Life Sciences sector, 30 August 2017 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/640696/life-sciences-industrial-strategy.pdf ((accessed 15 September 2017).)

[2] Written submission by the British Pharmacological Society to the Industrial Strategy Green Paper, April 2017 https://www.bps.ac.uk/about/policy-positions-and-statements/consultation-responses/articles/response-to-industrial-strategy-green-paper (accessed 15 September 2017).

Executive Summary

A Throughout the response, we have aimed to emphasise that a thorough consideration of the impact of the UK exiting the EU is essential to any strategy which is to be produced. Although the impact is not yet known in parts, we have highlighted our key concerns over the number of top researchers from the EU who currently study and work in the UK. Further to this, we have highlighted the impact that this will have on the regulation of drugs in our response to questions seventeen and eighteen, with a recommendation to quickly identify the mechanisms by which the UK will collaborate with the EMA once the UK has exited the EU. Our key messages for this inquiry are:

B **The UK life sciences sector is complex and evolving.** Learned Societies like ours are valuable interfaces with researchers and professionals in industry, academia and the NHS. It is vital that an inclusive sector deal is reached, not just between industry and government – but to include those such as the charitable sector, academia, NHS, learned societies and academies as full partners. We would be keen to explore our role in supporting delivery of the strategy. We support the appointment of a Minister for Life Sciences. Appropriate leadership, coordination and communication will be significant challenges, and a central voice will be invaluable. The Minister should also be a champion for the sector in negotiations about the UK's exit from the EU, and the myriad of challenges this will bring.

C **The regulation of medicines and devices must be a high priority as the UK negotiates its exit from the EU.** The MHRA is one of the most innovative drug regulatory agencies in the world and has enormous expertise. Our response to Question 17 demonstrates how this expertise is of high value to the European Medicines Agency. There is a real risk that the MHRA may be relegated to observer status in the process of drug regulation, rather than taking an active part in the process. However, if the UK operates outside the EMA, then there is a danger that the UK public will miss out on early access to novel medicines, as companies will undoubtedly prioritise getting approvals from the big markets first (US, EU, Japan, and China). We cannot stress strongly enough the importance of getting this right.

D **Academia makes a significant contribution to drug discovery and development and should be recognised in the translational and commercial landscape – not just as a source of basic science.** We are currently undertaking original research looking at impact claims made in the 2014 Research Excellence Framework (REF2014). We argue that this data set could be a vital longitudinal tool in tracking and measuring academic contribution to the UK Life Sciences. We recommend that the next exercise (REF2021) should actively consider how data collection and subsequent analysis could support the Life Sciences sector deal and strategic approaches in the future. We also recommend raising the visibility of academic entrepreneurship, and providing support for following this path.

E **The British Pharmacological Society (and partners) should be asked to develop a skills action plan for clinical pharmacology.** We are currently working with organisations such as the Association of the British Pharmaceutical Industry (ABPI), the Faculty of Pharmaceutical Medicine and Health Education England on developing an action plan for clinical pharmacology and recommend that this work be developed in alignment with the life sciences sector deal.

F **The British Pharmacological Society (and partners) should be asked to develop a skills action plan for *in vivo* skills.** The Society has significant experience in managing a UK-wide fund for in vivo skills: the ten-year, £22m Integrative Pharmacology Fund (IPF), which was a joint investment by industry and public funders.

We have recently evaluated this work (see paragraph 29) and are currently working with partners in the sector on a strategic plan for these skills, which are critical to translational medicine and are recognised by industry as a skills gap.

G **The sector must strongly commit to equality, diversity and inclusion.** It is vital that the sector remove barriers to equality and diversity to gain access to all of its talent. We support efforts to focus attention on inclusion in research and innovation (e.g. the new Equality Diversity and Inclusion Network in Science and Health Research[3] launched by the Wellcome Trust, The Crick and GSK; BEIS Ministerial Diversity Steering Group for Research and Innovation) and that this work should be invested in - and embedded in the strategy.

Full response

1. How can investors be encouraged to invest in turning basic life science research into new innovations in treatment? Why has investment been lacking in this sector? Does the research base have the necessary infrastructure to be world-leading?

Key points:

- The UK life sciences ecosystem is evolving and the sector must work together to understand it, shape it, and communicate its value
    - Key value proposition: proximity to patients via NHS/NIHR should be a major factor for investors to choose to invest in UK life sciences.
- Academia plays an increasing role in life sciences innovation, and there is an opportunity to capitalise on this
- The Research Excellence Framework exercise offers a huge opportunity to gather data on academic contributions to impact in the life sciences. The next exercise (REF2021) should include data collection mechanisms that allow submissions to be used as both a research and assessment tool

1. The Society believes that the UK has the raw ingredients to be an attractive investment opportunity through its excellent science base[4], access to research partners through a high density research community and access to patients and real-world data through the NHS.

2. However, there has also been a fundamental shift in the UK pharmaceutical industry over the last decade and the sector is in the process of adjusting to and capitalising on this[5]. The landscape is fragmented with a reduced footprint of large multinational pharmaceutical companies, in favour of an increase in small and mid-sized companies, contract research organisations (CROs) and an increasing role of academia in the drug discovery and development process. A major challenge will be the sector working together to understand and shape the new ecosystem – and communicating the added value it offers to potential investors. This will require strong leadership from the sector, and a focus on how to align incentives and behaviours across its different parts. It is important that these conversations actively

[3] https://www.crick.ac.uk/research/seminars,-lectures-and-symposia/symposia/equality,-diversity-and-inclusion-in-science-and-health-research-(edis)-inaugural-symposium/ (accessed 15 September 2017).
[4]Elsevier, International Comparative Performance of the UK Research Base, 2013, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/263729/bis-13-1297-international-comparative-performance-of-the-UK-research-base-2013.pdf (accessed 11 April 2017).
[5]The Association of the British Pharmaceutical Industry, The Changing UK Drug Discovery Landscape, 15 August 2016, http://www.abpi.org.uk/our-work/library/industry/Documents/the-changing-UK-drug-discovery-landscape.pdf (accessed 11 April 2017).

include the academic community at institutional/organisational levels: a more effective strategic partnership is needed with this emerging - and leading - partner for the sector. We believe that a sector deal should be between government and the full sector, not just industry.

3. We would like to draw attention to original research we are undertaking to explore the academic contribution to drug discovery and development. We note that these data are historical by nature but note that a commitment to capturing and using this kind of information may be valuable for informing future innovation policy and industrial strategy in the long-term.

4. We have used the 2014 Research Excellence Framework (REF2014) impact case studies to examine academic contributions to drug discovery. We have extracted various potential KPIs, including information on investment sources and amounts. In the section below, we summarise the types of funder we have found, highlight the likely barriers to investment and suggest mitigations. We have outlined some relevant findings from our unpublished research, and would be happy to discuss this in more detail with the Committee. We recommend that the next exercise, REF2021, should include data collection mechanisms that allow submissions to be used as both a research and assessment tool, and have communicated this to HEFCE as part of their consultation.

Multinational companies (MNC): pharma & biotech

5. We found a dramatic variation in the number of case studies which attracted MNC investment. In particular, foreign direct investment by MNCs without a UK base or R&D facility appears to be underdeveloped. In terms of how to increase MNC investment, we recommend a multi-pronged approach. First, academics should be encouraged to collaborate with industry through the design of HEI reward & recognition systems. Hybrid approaches, balancing the imperatives of REF and revenue generation with the need to maintain academics' intrinsic motivation for knowledge creation and curiosity, have been shown to be most effective[6].

6. Secondly, HEIs will naturally seek to derive revenue from collaborations and may subsequently introduce procedures which actually impede industry collaboration. There must therefore be an appropriate balance between centralisation (e.g. value capture) and decentralisation (e.g. knowledge dissemination) within HEIs, with Technology Transfer Offices acting as brokers.

7. Our third suggestion concerns the strategies and practices adopted by MNCs. There are a range of options for increasing sophistication and commitment among life science firms wishing to engage in collaborations, ranging from patent licencing to consultancy, contract research, joint research, joint ventures and substitution of a commercial R&D function by an academic group[7] but there is little empirical research on this. The sector could undertake research to identify both how and why MNCs adopt specific strategies and collaboration models, and what works.

8. Finally, noting the comparative lack of foreign direct investment from MNCs, the role of both BEIS and the DIT in facilitating new collaborative links between UK HEIs

[6] Franco-Santos et al., 2014. Performance management in UK Higher education institutions: the need for a hybrid approach http://www.som.cranfield.ac.uk/som/dinamic-content/news/documents/PerformanceManagementinUKHigherEducationInstitutions.pdf. (accessed 15 September 2017).

7 Kleyn et al, 2007, Partnership and innovation in the life sciences, International Journal of Innovation Management Vol. 11, No. 2 (June 2007) pp. 323–347.

and MNCs is obviously important. However, we would argue that this is likely to be insufficient as the majority of academics will not be aware of potential opportunities. This is referred to as a network failure. Ultimately, as the academic community absorbs the concept of research impact, it must also develop an understanding of the economic and social context in which it is embedded. The learned societies are probably best placed to play a role in developing this understanding and disseminating it within their communities through extensive links to foreign-based partner societies and international membership body.

Foreign new technology based firms and small-medium enterprises

9. A new technology-based firm (NTBF) is defined as a firm recently (<25 yr) established by a group of entrepreneurs, based on exploitation of an invention or technological innovation and which employ a high proportion of qualified employees. Domestic NTBFs we found in REF case studies were invariably academic ventures which maintained strong collaborative links to their home HEIs. However, we also found a small number of foreign NTBFs as well as small-medium enterprises (SMEs) who funded UK research within single case studies or single projects discussed in multiple case studies, known as 'born-global' companies.

10. We know little about how these partnerships formed, but the fact that they exist suggests that this is an area that could be further developed. Furthermore, it is interesting that we see no collaborations with TBFs and SMEs in developing countries that are now strategically investing in their universities while shifting towards knowledge economies, such as China, India and Brazil. For instance, Singapore's Smart Nation strategy is actively seeking to develop partnerships with UK academics, offering the city state as a field laboratory for new technologies [8].

Technology or service suppliers

11. We found evidence of technology and service suppliers funding UK research & innovation, generally after proof of concept of a new technology. Technology firms such as MDS Sciex, 3M Healthcare; Bruker and Waters, CROs including Covance CR and Piramal Healthcare UK, and even companies outside the life sciences sector such as Unilever, Danone, Jaguar and Ford Motor Co, have all supported research which contributed to drug discovery and development, generally in single case studies.

12. The low incidence of collaborations with these companies suggests that they are less engaged in open innovation than pharma/biotech MNCs. This could be explored to determine the potential opportunities.

Non-profit sector

13.The contribution of the UK non-profit sector to medical research has been well documented elsewhere [9]. We found that non-UK based charities play a relatively small part in funding UK drug discovery & development research, suggesting that this is an area that could be developed further.

14. Additionally, we found that discounting the Wellcome Trust, which funds research across a range of medical issues, cancer is by far the largest cause advocated by charities. This suggests that the establishment of new charities to advocate for less

[8] http://insight.jbs.cam.ac.uk/2016/what-singapore-can-learn-from-the-cambridge-phenomenon/ (accessed 15 September 2017).
[9] AMRC, Charities' contribution to UK medical research, http://www.amrc.org.uk/sites/default/files/doc_lib/Charities-contribution-to-UK-medical-research-v2.1.pdf (accessed 15 September 2017).

supported causes may be a potential route of additional research funding. We found one example of this in our case studies, a patient group engaging in venture philanthropy (adopting the techniques of venture capital finance and the strategies of business management to build networks of scientists to work through early findings and develop promising ideas for new experiments) to fund research once the reversibility of Rett syndrome was demonstrated.

EU funded research

15. There was sufficient data available in both case studies and in the Cordis database to quantify EU contributions to UK research. We were able to attribute £114 million of EU funding plus £52.3 million in public-private partnerships to UK drug discovery and development. It is imperative that access to this funding remain a high priority in Brexit negotiations.

Academic venturing

16. A total of 96 academic ventures were established within our case studies, with 91 of these being based either partly or wholly in the UK. These UK based NTBFs have shown relatively good resilience, with just 11 (12%) ceasing trading. Two main types were discernible, ventures established as going concerns (e.g. contract research organisations, combined CRO/in-house discovery, technology suppliers) or ventures established as a channel for research funding. A total of 56 remain in operation today, while 26 have been acquired and 3 have merged. All maintained research links with their home HEIs.

17. However, only three of these NTBFs can be regarded as scale-ups, which we measured as having average annualised growth in profit or loss greater than 20% per annum over a three-year period, and with more than 10 employees at the beginning of the observation period. This finding is supported by a recent Royal Society study [10] of UK fast-growth science-based companies which found a low representation of life sciences companies (3) in the top 50. This suggests that there may be impediments to scale-up in the life sciences sector not experienced elsewhere. These should be identified and mitigated, where possible, in order to increase the potential of NTBFs as a source of research funding and a channel of knowledge diffusion.

Equity finance

18. While few case studies discussed finance sources for academic ventures, those that did predominantly employed venture capital to fund activities. HEIs have been found to overestimate the value of research-derived technology and this overvaluation can create difficulties in attracting private sector venture capital [11].

19. This issue should be addressed by the HEI in building the business development capabilities of TTOs. For example, the ability to conduct due diligence on intellectual property rights, the creation of spin-out companies and the availability of adequately trained staff are important determinants of a university's success in creating equity backed spin-outs [12,13].

[10] Royal Society, 2014, The Royal Society Science 50 Index <http://www.svc2uk.com/the-royal-society-science-50-index/> (accessed 15 September 2017).
[11] Clarysse et al., 2007, Academic spin-offs, formal technology transfer and capital raising'. *Industrial and Corporate Change*, **16**, 609–40.
[12] Lockett & Wright,2005, Resources, capabilities, risk capital and the creation of university spin-out companies, Research Policy 34, 1043–1057
[13] Wright, 2006, University spin-out companies and venture capital, Research Policy, 35, 481–501.

20. Additionally, we noted a number of instances of seed funding provided by universities to bridge a gap between public or charity research funding and venture capital funding. Organisations such as the Wyvern fund (Bristol & Southampton universities), Bloomsbury Bioseed University Challenge Fund (UCL), White Rose Seedcorn Fund (Leeds, Sheffield and York universities) and Isis University Innovation Fund (Oxford) all offered this facility. This is important as it can attract equity finance from private providers.

Research consortia

21. Our research found a number of examples of pre-competitive research consortia consisting of industry firms, leading global academic institutions and key regulatory bodies that acted as sources of research funding and channels of knowledge diffusion. To date, there has been little research into how these consortia operate, the barriers they face and the mitigation of these barriers.

National, regional and devolved government

22.Our research also found that there are only isolated examples of regional and devolved governments acting as 'Regional Innovation Organisers' in designing initiatives to foster economic and social development. This suggests that the strategic capabilities, e.g. strategic posture and financial resources, of regional and devolved government is underdeveloped with respect to drug discovery & development.

23. There are only isolated examples of national government departments funding research activities. These are important because they often indicate a successful linking between supply of new innovations and demand for these innovations. The relative low incidence of these funding events is indicative of a heavy supply-side policy focus.

Health authorities and NIHR

24. NIHR provides funding to support research in health, public health and social care via Biomedical Research Centres or Clinical Trials Units or through partnerships with academia. Our research found that they were one of the single largest contributors to UK academic research. Indeed, the Life Sciences Industrial Strategy notes the following figures:

- In 2016/17, over 660,000 patients were recruited through the NIHR Clinical Research Networks to research studies and clinical trials in the NHS.
- Around 35,000 patients were enrolled on commercial trials in 2016/17.[14]

25. In addition, the NHS, HPSS (now Dept of Health, N.I) and the Wales Centre for Health provide isolated examples of research funding. This connection between basic research and translational research through NIHR (in particular BRUs and BRCs) has not been developed/emphasised as much as it could/should be. As noted in the Life Sciences Industrial Strategy report[15], a funding stream was established by NIHR (based in the Department of Health) which focuses on creating a strong environment for translational research within the UK and the NHS. The Society believes that the funding scheme is therefore extremely valuable and thoroughly agrees with the

[14] Life Sciences Industrial Strategy-a report to the Government from the Life Sciences sector, 30 August 2017 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/640696/life-sciences-industrial-strategy.pdf pg 24 (accessed 15 September 2017).
[15] Life Sciences Industrial Strategy-a report to the Government from the Life Sciences sector, 30 August 2017 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/640696/life-sciences-industrial-strategy.pdf (accessed 15 September 2017).

report[16] which notes that improving translational science to enhance the UK's ability to attract more clinical trials from industry is essential.

2. Why has the UK underperformed in turning basic research in the life sciences into intellectual property? What needs to be done to address this historic weakness in the UK and grow new companies to commercialise new research and related technologies in the life sciences?

Key points:

- A more fragmented system has more players that need to interact. These interfaces can be a source of weakness if incentives and approaches are not aligned – and if networks and relationships do not function across them.
- Academia is playing an increasing role in innovation and support for academic entrepreneurship should be a priority.

26. The UK life sciences sector is likely to have a number of market and system failures which impede the diffusion of new knowledge created by research to innovation. A typology of these failures was published in 2014[17] and we would like to note the following key failures that are expected to be present within UK drug discovery and development, particularly in light of the evolution to a more fragmented ecosystem.

- **Institutional failure**: The rules, regulations, policies, habits and conventions of institutions may conflict and contradict. In related research exploring research impact in general, we have identified at least 8 institutional conflicts which arise between actors in triple helix innovation systems [18]. With initiatives such as the REF, the advent of open innovation business models and the greater acceptance of knowledge commercialisation within certain academic communities, it is difficult to know which of these conflicts constitute the greatest impediments within the life sciences sector. One implication of institutional failures is that the assumption [19] that the sector will follow changes in public health spending designed to meet the challenges of and aging population and the prevalence of chronic and communicable diseases may be proved false. The way in which finance affects the direction of innovation is not well understood [20].
- **Network failure:** One of the biggest difficulties associated with university-industry collaboration, from both perspectives, is identifying potential partners. The life sciences sector has fragmented in recent years, with the vertically integrated Big Pharma business model considered unsustainable. Open innovation models are emerging as an alternative, based on increasingly sophisticated and prolonged partnerships with academia, academic spin-offs, suppliers and competitors. Within this shifting landscape, difficulties associated with identifying collaboration partners is likely to increase. This failure is at its most extreme in cases of foreign direct investment, as we have noted in

[16] Life Sciences Industrial Strategy-a report to the Government from the Life Sciences sector, 30 August 2017 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/640696/life-sciences-industrial-strategy.pdf (accessed 15 September 2017).
17 Arnold et al., 2014, The Case for Public Support for Innovation, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/334369/BIS_14_852_The_Case_for_Public_Support_of_Innovation.pdf (accessed 15 September 2017).
[18] Kelleher et al., *Research Policy*, in press.
19 Deloitte, 2017 Global life sciences outlook.
[20] Mazzucato, M, 2017, Financing innovation: Creative destruction vs. destructive creation Industrial and Corporate Change, pp. 1–17. (accessed 15 September 2017).

paragraph 8. ***We recommend active collaboration between learned societies such as ours and organisations such as Innovate UK to help bridge the communication gap to academia***. It is not only partnerships with industry that are needed, but also with clinical teams to focus on the challenges of translational research and access to patients.

- **Information asymmetry:** Economic actors lack access to the high levels of technical and market knowledge involved in scientific innovation and must make decisions based on incomplete or flawed knowledge. We have discussed previously how this is an issue particularly for equity finance. It may also occur in academic-industry collaborations.
- **Infrastructural failure**: Insufficient human and capital investment in state infrastructure critical to innovation. UK science & innovation policy is currently based on "smart specialisation" strategies, identifying emerging technologies and supporting investment in these areas to develop national capabilities. However, recent work [21,22] on public financing of innovation has argued that the industry strategy should also concentrate on large mission-oriented policies, such as those identified by the World Health Organisation [23]. The purpose of these policies would be to increase spillover both within the life sciences sector as well as between it and other sectors through both cooperation and competition, to increase the global competitiveness of the UK life sciences and to encourage creation of new technological landscapes. Such policies might include the establishment of mission-oriented agencies to facilitate horizontal knowledge diffusion, public investment along the entire innovation chain (rather than just research) and increased risk-sharing between public and private sectors. We have also noted earlier how there is a lack of FDI for UK research, which is concerning at a time where a number of countries, such as China, India, Brazil and Singapore, are strategically developing their universities as they shift towards knowledge economies. This suggests an infrastructural failure in how potential sources of FDI are identified and how information is communicated to UK-based academics. We suggest this is a failure that should be addressed not only by BEIS and DIT, but also by learned societies.
- **Capability failure**: Actors may have deficiencies in skills, resources, ability to learn, absorptive and analytic capacity which affect the ability to capture innovation opportunities. For example, in paragraph 28 we discuss the need to embed educational awareness of entrepreneurship and associated skills to ensure the smooth transition from academic teams to spin-off companies.
- **Character of science and technology**: The size of scientific or technological problems is too great for individual private actors to tackle if markets are competitive, and the returns uncertain, discouraging private investment. We have seen how public-private research consortia are beginning to emerge in response to this failure.

3. What can be done to ensure the UK has the necessary skills and manpower to build a world class life sciences sector, both within the research base and the NHS?

Key points:

[21] Jacobs & Mazzucato, 2016. *Rethinking capitalism: Economics and policy for sustainable and inclusive growth*, Wiley-Blackwell.

[22] Mazzucato & Semieniuk, 2017, Public financing of innovation: new questions. *Oxford Rev. Econ. Policy* **33,** 24–48.

23 WHO. Health in 2015: from MDGs to SDGs. (2015).

- We support the production of targeted skills action plans, as recommended on page 62 of the Life Sciences Industrial Strategy[24]
    - The strategy notes that clinical pharmacology is expected to be a skills area in which an action plan is needed.
    - We have already begun work with ABPI, the Faculty of Pharmaceutical Medicine and Health Education England to create a skills plan for clinical pharmacology across academia, industry and the NHS.
    - We recommend that our group be tasked with leading on a skills action plan for clinical pharmacology.
    - We recommend that in vivo skills should be considered as a key skills area with regard to delivering the strategy
- It is vital the sector commits to equality, diversity and inclusion. This is a pressing business need if we are to unlock the full talent pool for UK life sciences.
- Strategic coordination between educators and employers can help raise awareness of career pathways and help meet skills needs in a targeted way
- Support for core skills is fundamental

Skills action plan for targeted skills needs: clinical pharmacology and in vivo sciences

27. We discussed the needs for investment in key skills areas (clinical pharmacology and in vivo sciences) in detail in our response to the Industrial Strategy Green paper.

28. Regarding clinical pharmacology, the Society has been working with the Faculty of Pharmaceutical Medicine (pharmaceutical medicine is another medical specialty concerned with the discovery, delivery and regulation of medicines) and together we recommended the following to Sir John Bell, and we are pleased to see this recognised in the final report:

- a new dual training certificate in clinical pharmacology and pharmaceutical medicine would offer a clear training route for this important role, and support permeability across the sector
- a focused appraisal of career pathways, and education and training requirements.

29. In terms of the in vivo sciences, we would like to reference our response to the Industrial Strategy Green paper and recommend that the in vivo sciences are considered as a key skill with regard to development of skills action plans:

> *"58. For example, the Society recently released an evaluation of the Integrative Pharmacology Fund (IPF) in December 2016[25], which shows the potential of leveraging funding across sectors. The fund was originally a £4million investment from AstraZeneca, GlaxoSmithKline and Pfizer for education and training in the use of animals in research. This fund was leveraged to £22million through coordination of public funding. The holistic approach to education and training, serving both academic and industry interests was successful.*
>
> *"64. Following the intervention of the IPF as mentioned above, and also likely due to outsourcing and fragmentation in the sector, industry is less concerned about recruiting individuals with the skills to use animals in research than in previous*

[24] Life Sciences Industrial Strategy-a report to the Government from the Life Sciences sector, 30 August 2017 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/640696/life-sciences-industrial-strategy.pdf (accessed 15 September 2017).
[25] Lowe JWE, Collis M, Davies G, Leonelli S, Lewis DI and Zecharia AY (2016) An evaluation of the Integrative Pharmacology Fund: Lessons for the future of in vivo education and training. London: British Pharmacological Society. Available online at: www.bps.ac.uk/futureinvivo (accessed 11 April 2017).

years. Recent discussions between the Society and ABPI indicate that the main need is around translation. That is, the creation and use of reproducible models and the ability to work with clinicians to refine models and identify biomarkers. As mentioned in our response to Question 1, it is crucial to create a research environment that supports target identification. This requires support for bringing together scientists across disciplines and the sector. Whilst the sector is looking to move away from the use of animals in the long-term, animals in research are still a key part of the drug discovery and development process. It is essential that such studies should generate the highest quality, translatable data. ***The Society recommends a focus on supporting education and training in translation and reproducibility of studies."***

30. We are also keen to explore sector-led Trailblazer apprenticeships as a means of addressing high level skills in a targeted way e.g. levels 7 and 8 pathways to meet clinical pharmacology skills needs.

Please see question six for further comment on our approach to a focus on skills which refers to the Life Sciences Industrial Strategy.[26]

Accessing the full talent pool

31. The life sciences sector is not reaching the full talent pool. The Society believes that removing barriers to participation and progression (from the perspective of gender, other protected characteristics and socioeconomic background) is vital. Research commissioned by the Society indicated that only 5% of students accepted onto pharmacology courses are from the lowest socioeconomic bracket. This is reflective of comparable subjects. King's College London noted that building 'science capital' through awareness and experience of a pathway, and engagement with role models within it, are pre-requisites to following any career path, as shown at a school level by the ASPIRES project.

32. Unconscious messaging that the sector is 'not for me' can also stand in the way of access and progression. We recommend careful use of language and suggest 'manpower' as used in the text to this question be replaced by 'capability' in future reports and discussions.

33. The sector must strongly commit to equality, diversity and inclusion**.** It is vital that the sector remove barriers to equality and diversity to gain access to all of its talent. We support efforts to focus attention on inclusion in research and innovation (e.g. the new Equality Diversity and Inclusion Network in Science and Health Research[27] launched by the Wellcome Trust, The Crick and GSK; BEIS Ministerial Diversity Steering Group for Research and Innovation) and that this work should be invested in - and embedded in the strategy.

Co-ordination between educators and employers

34. The Society supports a coordinated national strategy for the life sciences that enables educators to build networks and partnerships between academia and industry. These relationships should facilitate responsive integration of needs into education and training programmes and enhances opportunities for work experience and placements as well as building trusted relationships across the sector. CPD opportunities for teachers

[26] Life Sciences Industrial Strategy-a report to the Government from the Life Sciences sector, 30 August 2017 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/640696/life-sciences-industrial-strategy.pdf (accessed 15 September 2017).

[27] https://www.crick.ac.uk/research/seminars,-lectures-and-symposia/symposia/equality,-diversity-and-inclusion-in-science-and-health-research-(edis)-inaugural-symposium/ (accessed 15 September 2017).

must be developed further (for example, an extension of Teacher Industrial Partnership Scheme) in order to improve links with industry, bring in additional teaching resources/contextualisation and help maintain teachers' engagement/retention.

35. It is also important to note that future skills needs, particularly as those around disruptive technologies may be areas which industries are reluctant to explore. It is vital that there are established and agreed ways of responding to this, through effective links to global innovation clusters as a source of knowledge and foreign direct investment (FDI), for example.

36. The Society believes that an approach to supporting STEM skills in the next generation should focus on embedding awareness of what is involved in these careers from an early stage, ensuring there are appropriate role models and giving opportunities to embody these behaviours. We discuss some notable schemes in our response to the Industrial Strategy Green paper.[28] We also recommend exploration of Trailblazer apprenticeships backed by key life sciences employers as a potential way to meet key skills needs through development of clear employment pathways in collaboration with the higher education sector.

Support for core skills

37. We strongly support efforts to improve basic numeracy and literacy. We would also support investment in recognised tools that support the development of self-driven learning, collaboration and critical thinking – all of which underpin successful research and innovation. For example, the British Science Association's CREST Award Scheme[29] is already supported by BEIS and focused industry/academia investment and engagement could help scale a well-regarded programme.

38. While our research into the REF impact case studies (see paragraph 53) found a relatively high level of academic venturing as a knowledge diffusion route to innovation, it must be remembered that the overall rates of venturing among academics are generally low. One possible reason for this is that academics may need support in this regard, both in terms of awareness and skills. In order to improve venturing levels, there should be greater personal development opportunities regarding competencies, identified in the literature as being associated with academic entrepreneurship [30].

5. What can be learnt from the impact of the 2011 UK Life Sciences Strategy? What evidence is there that a strategy will work for the life sciences sector? How can its success be measured against its stated objectives?

39. The 2011 Life Sciences Strategy was a welcome initiative from Government and broadly supported by the industry. We have outlined below where we believe the strategy was not successful and would need to be improved:

- The uptake of Early Access Schemes has not been as positive as expected. This is deemed to mainly be due to the fact that there was a lack of credible criteria for how it might work and no link to reimbursement. The associated concern that patients would receive access to a promising innovation but that this may not be

[28] Written submission by the British Pharmacological Society to the Industrial Strategy Green Paper, April 2017 https://www.bps.ac.uk/about/policy-positions-and-statements/consultation-responses/articles/response-to-industrial-strategy-green-paper (paragraph 21) (accessed 15 September 2017).
[29] CREST Awards, http://www.crestawards.org/ (accessed 11 April 2017).
[30] Rasmussen et al., 2011, The Evolution of Entrepreneurial Competencies: A Longitudinal Study of University Spin-Off Venture Emergence *Journal of Management Studies,* 48:6

ultimately available on the NHS also resulted in the creation of problems for industry, NHS and regulators.

- The Strategy recognised that medicines are changing rapidly and the focus on genomics was welcome. However, appraisal methodology from NICE and NHSE was not addressed by the strategy. This was a significant strategic error given that all new innovations would have to be appraised by the NHS or NICE before being made available to patients. Key issues around this include the lack of variability on thresholds, criteria for entry into HTA being inflexible leaving some medicines without appropriate methodology for appraisal, different methods of entry of innovation into the NHS confusing patients and the clinical community, and the strategy not being linked to the overall medicines budget within the NHS.

40. The Society also wishes to note that there is mixed evidence that an industry strategy approach will work. Issues relating to such strategies are that Government is relied on to choose who is 'leading' in terms of emerging technologies, and the UK's previous attempt to develop an industry strategy in the 1970's was unsuccessful. Nonetheless, industry strategies are becoming increasingly popular globally following some successful examples in the Far East and the imperative to restructure economies following the financial crisis of 2007/08. The Society believes that in order to be successful the industrial strategy must be long term in its outlook, measure progress against clear key performance indicators and be independently monitored to help ensure that it survives changes of Government. It should balance a supply-side perspective with building demand for new products and services. It should specifically take account of knowledge spill overs, particularly cross-sectoral spill overs, to derive greater benefits from financial spend. In addition to this, it must balance the demands of smart innovation and national growth with inclusive innovation and regional growth. The Society does not therefore believe that its success should be measured in terms of supply-side metrics, such as the number of new ventures or innovations. Instead, it is suggested that measures should be based on national and regional-level indicators, such as GDP per capita and labour productivity.

6. (If published) Does the strategy contain the right recommendations? What should it contain/what is missing? How will the life sciences strategy interact with the wider industrial strategy, including regional and devolved administration strategies? How will the strategies be coordinated so that they don't operate in 'silos'?

41. The Society is pleased to see that the recommendations outlined in the Life Sciences Industrial Strategy[31] incorporate many of the issues and challenges noted in the Society's response to the Industrial Strategy[32]. We have outlined below the recommendations along with strategic goals which we deem to be of particular importance in this response and we have also commented on those which we believe need further development.

42. The Society believes that any strategy must include a thorough consideration of the impact of the UK exiting the EU and more specifically, suggest an approach to

[31] Life Sciences Industrial Strategy-a report to the Government from the Life Sciences sector, 30 August 2017 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/640696/life-sciences-industrial-strategy.pdf (accessed 15 September 2017).

[32] Written submission by the British Pharmacological Society to the Industrial Strategy Green Paper, April 2017 https://www.bps.ac.uk/about/policy-positions-and-statements/consultation-responses/articles/response-to-industrial-strategy-green-paper (accessed 15 September 2017).

minimising this. The Society therefore agrees with the recommendation and strategic goal outlined below:

Reinforcing UK Science Offer[33]

"Reinforcing UK Science Offer (Discovery Science): The UK should attract 2000 new discovery scientists from around the globe."

The Society equally agrees that Government should improve the UK's clinical trial capabilities in order to compete globally and supports the recommendation below:

"Reinforcing UK Science Offer (Translational Science): "To support a 50% increase in the number of clinical trials over the next 5 years and a growing proportion of change of practice and trials with novel methodology over the next 5 years."

43. **Growth and Infrastructure**

The Society's response to the Industrial Strategy[34] outlined the utility of clusters and the Society therefore agrees with the recommendation below:

"Government, local partners and industry should work together to ensure the right infrastructure is in place to support the growth of life sciences clusters and networks."[35]

The Society's response to the Industrial Strategy considered research by the OECD regarding the approach to Industry in other countries. It noted that most OECD countries promote a cluster-based approach to innovation.

Argentina, Belgium, France and Portugal have made cluster policies an integral element of their national innovation strategies or plans and other countries have programmes to promote the creation of new clusters or to strengthen existing clusters. The Society suggested that government consider this report in detail.[36]

44. **NHS Collaboration**

The strategy[37] notes that it compliments much of the NHS five-year forward and that these opportunities could only be realised with the NHS as a healthcare system. The Society agrees with the following recommendation that the Accelerated Access Review should be adopted:

"Utilise and broaden the Accelerated Access Review to encourage UK investment in clinical and real world studies. Deliver a conditional reimbursement approval, for

[33] Life Sciences Industrial Strategy-a report to the Government from the Life Sciences sector, 30 August 2017 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/640696/life-sciences-industrial-strategy.pdf p.5 (accessed 15 September 2017).
[34] Written submission by the British Pharmacological Society to the Industrial Strategy Green Paper, April 2017 https://www.bps.ac.uk/about/policy-positions-and-statements/consultation-responses/articles/response-to-industrial-strategy-green-paper (accessed 15 September 2017).
[35] Life Sciences Industrial Strategy-a report to the Government from the Life Sciences sector, 30 August 2017 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/640696/life-sciences-industrial-strategy.pdf p.5 (accessed 15 September 2017).
[36] OECD, 2012 https://www.oecd.org/sti/outlook/e-outlook/stipolicyprofiles/interactionsforinnovation/clusterpolicyandsmartspecialisation.htm (accessed 15 September 2017).
[37] Life Sciences Industrial Strategy-a report to the Government from the Life Sciences sector, 30 August 2017 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/640696/life-sciences-industrial-strategy.pdf (accessed 15 September 2017).

implementation as soon as licensing and value milestones are delivered so that patients can benefit sooner."[38] Please see our response to Question 11 for more detail.

Skills

45. Our response to the Industrial Strategy[39] outlined our concerns over the migration of a skilled workforce due the UK exiting the EU and called for Government to clarify the situation regarding movement and provide certainty to EEA nationals which will ensure that the skills of such individuals are not 'lost'. Additionally, removing students from being counted in official immigration figures was also proposed in our response. The Society therefore agrees with the focus of the Life Sciences Industrial Strategy on skills and highlights the following recommendations as particularly significant:

"A migration system should be established that allows recruitment and retention of highly skilled workers from the EU and beyond, and does not impede intra-company transfers."[40]

The Society agrees with the recommendation that we must

"Develop and deliver a reinforced skills action plan across the NHS, commercial and academic sectors based on a gap analysis of key skills for science."[41]

The Society does however wish to clarify the situation in regards to the clinical pharmacology skills as the report notes that

"A UK strength has historically been the training of individuals in clinical pharmacology. Although this specialty has almost disappeared there remains a need for training in therapeutics, particularly with a wealth of new types of advanced therapies appearing."[42]

46. The Society wishes to add that although it agrees that there is a critical need to focus on clinical pharmacology skills, the specialty is neither larger nor smaller than it has been over the past twenty years: it has not grown in line with other specialties. By 2012 the overall UK consultant workforce had increased by 62% (representing 4,636 extra consultants), but with only a 4% increase for clinical pharmacology (equivalent to 3 extra consultants – 77 in total; Royal College of Physicians 2014). The Society believes that the reasons for this are complex and that achieving a more vibrant specialty will require raising the visibility of clinical pharmacology as a specialty, reviewing training pathways and outputs into different parts of the sector, assessing clinical pharmacology competencies and potential amplification through other healthcare professionals and scientists, reassessment of workforce planning – and most importantly, doing this through a coordinated cross-sector approach. As we have previously mentioned in this

[38] Life Sciences Industrial Strategy-a report to the Government from the Life Sciences sector, 30 August 2017 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/640696/life-sciences-industrial-strategy.pdf p.6 (accessed 15 September 2017).
[39] Written submission by the British Pharmacological Society to the Industrial Strategy Green Paper, April 2017 https://www.bps.ac.uk/about/policy-positions-and-statements/consultation-responses/articles/response-to-industrial-strategy-green-paper (accessed 15 September 2017).
[40] Life Sciences Industrial Strategy-a report to the Government from the Life Sciences sector, 30 August 2017 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/640696/life-sciences-industrial-strategy.pdf p.6 (accessed 15 September 2017).
[41] Life Sciences Industrial Strategy-a report to the Government from the Life Sciences sector, 30 August 2017 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/640696/life-sciences-industrial-strategy.pdf p.6 (accessed 15 September 2017).
[42] Life Sciences Industrial Strategy-a report to the Government from the Life Sciences sector, 30 August 2017 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/640696/life-sciences-industrial-strategy.pdf p.6 (accessed 15 September 2017).

submission, we have begun this work and would recommend it is developed in line with the strategy and supported by the sector deal.

47. The Society believes that continuous professional development (CPD) is essential to ensuring that the skills required continue to be developed and are transferred between industry and academia and agrees with the following statement in the report[43]:

"There should be support for entrepreneur training at all levels, incentivising varied careers and migration of academic scientists into industry and back to academia to increase influx of talented scientists and entrepreneurs in the public and private sectors."

48. The Society equally agrees that developing STEM education is essential:

"High quality STEM education should be provided for all, and the government should evaluate and implement additional steps to increase the number of students studying maths to level 3 and beyond."[44]

49. Indeed, it is noted in our response to the Industrial Strategy consultation that including support for teachers, practical skills, work experience and careers advice is essential**.** Many of the recommendation for skills development at secondary school are outlined in the Society's response to the Industrial Strategy. [45]

50. The Society wishes to clarify that although it is developing a new convergent training program with the Faculty of Pharmaceutical Medicine which seeks to provide the mechanism for such training schemes, this has not yet been established as noted in the strategy, but is under consideration.

51. Overall, the Society agrees with the suggested approach to a sector deal outlined in the Life Sciences Industrial Strategy[46]. Our specific comments on the key principles it suggests following are outlined below:

- Clear, identifiable leadership of a self-defined sector
- Implementation Planning
- Oversight of delivery by senior, accountable leaders
- Success metrics

52. The Society would like to see strong leadership from a Minister for Life Sciences, and a commitment from this Minister and the Office for Life Sciences to lead implementation, transparently and with support and engagement from the full sector – not just industry. It is essential that there is sufficient resource both from central government and the sector itself to enable this.

8. Where should the funding come from to support the implementation of the strategy?

53. In our analysis of REF impact case studies, we noted the importance of joint funding across government, industry and charities and suggest that this is considered when

[43] Life Sciences Industrial Strategy-a report to the Government from the Life Sciences sector, 30 August 2017 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/640696/life-sciences-industrial-strategy.pdf (accessed 15 September 2017).
[44] Life Sciences Industrial Strategy-a report to the Government from the Life Sciences sector, 30 August 2017 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/640696/life-sciences-industrial-strategy.pdf p.6 (accessed 15 September 2017).
[45] Written submission by the British Pharmacological Society to the Industrial Strategy Green Paper, April 2017 https://www.bps.ac.uk/about/policy-positions-and-statements/consultation-responses/articles/response-to-industrial-strategy-green-paper (accessed 15 September 2017).
[46] [46] Life Sciences Industrial Strategy-a report to the Government from the Life Sciences sector, 30 August 2017 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/640696/life-sciences-industrial-strategy.pdf (accessed 15 September 2017).

considering where funding can be obtained. The Society released an evaluation of the Integrative Pharmacology Fund (IPF) in December 2016[47], which shows the potential of leveraging funding across sectors. In our response to the Industrial Strategy the following figures were noted:

"The fund was originally a £4million investment from AstraZeneca, GlaxoSmithKline and Pfizer for education and training in the use of animals in research. This fund was leveraged to £22million through coordination of public funding. The holistic approach to education and training, serving both academic and industry interests was successful."

The report focused on the principles of success which were:

- Open pathways
- Networked communities
- Embedded partnerships
- Responsive leadership

54. Our response also noted that it is essential to consider the significant role that EU based initiatives such as FP7[48] and the Innovative Medicines Initiative have had in regards to funding of academia and SMEs in the life sciences sector. If a Brexit deal does not enable continued participation in such schemes, the Society believes that it is crucial to consider alternative funding schemes for international collaborations in the future. We believe that central government, UKRI, Innovate UK and industry all have a foundational role to play in funding the strategy. We also advise leveraging additional funds from other organisations (e.g. medical charities) on a project-by-project basis. Success in leveraging funding will depend on the extent to which the strategy feels co-owned by the sector, as noted in our response to question one.

11. How can the recommendations of the Accelerated Access Review be taken forward alongside the strategy? Will the recent changes to the NHS England approval process for drugs have a positive or negative effect on the availability of new and innovative treatments in the NHS? How can quick access to new treatments and the need to provide value for money be reconciled?

<u>How can the recommendations of the Accelerated Access Review be taken forward alongside the strategy?</u>

55. It is clear that exiting the EMA will require a significant investment at the MHRA to maintain its standard regulatory responsibilities. As some of these (such as pharmacovigilance) are crucial for the safety of UK patients, this will likely take priority over establishing new accelerated access paths.

56. It is our belief that the Government needs to respond to the AAR to understand how they are proceeding before this question can be answered comprehensively.

- It is not appropriate to use cost-per QALY thresholds as an over-arching criteria to evaluate ultra-orphan medicines.
- The recent changes introduced by NICE and NHS England to the Highly Specialised Technology (HST) evaluation process will effectively stop the flow of new treatments for ultra-rare conditions.

[47] Lowe JWE, Collis M, Davies G, Leonelli S, Lewis DI and Zecharia AY (2016) An evaluation of the Integrative Pharmacology Fund: Lessons for the future of in vivo education and training. London: British Pharmacological Society. Available online at: www.bps.ac.uk/futureinvivo (accessed 11 April 2017).
[48] https://ec.europa.eu/research/fp7/index_en.cfm (accessed 15 September 2017).

- These changes in England will create inequalities within the UK regarding patients' ability to access treatments.
- There is strong public support for treating patients with ultra-rare diseases as part of the comprehensive offer of the NHS.
- Universal access to healthcare and equity, including for patients with an ultra-rare disease, are core tenants of the NHS.
- The changes to the HST programme run counter to the Government's focus on building a competitive life science sector and positively showcasing the UK during Brexit.
- The NHS should reintroduce a fit-for-purpose process to evaluate ultra-orphan medicines that is not reliant on cost-per QALY thresholds.

Will the recent changes to the NHS England approval process for drugs have a positive or negative effect on the availability of new and innovative treatments in the NHS?

57. It is essential to consider that the present NHS budgets are inflexible and the potential to draw from one strand to offset increased costs in another are limited – although Vanguards may provide a partial solution in time. At present most hospitals are largely dependent on tariff based clinical activity and that is based on a calculated average cost to treat an episode of care. The only financial incentive for hospitals to consider adopting an innovative approach (e.g. introducing a new medicine or device) is if that development leads to a saving within that episode of care through for example reducing average length of stay. Conversely for commissioners and primary care the only real financial incentive for adopting innovation is to reduce risk and/or length of hospitalisation beyond tariff cut-offs. In each case the cash saved is only of the order of hundreds of £ per hospital bed day avoided in the patients it actually works in. Unfortunately, there are very few innovations marketed that have that type of evidence available to make an economic case for investment and for commissioners it is probably true to say that that bed will be filled straight away with another patient and therefore regardless of this, it does not lead to a tangible reduction in overheads.

58. Although it can be difficult to determine value for money from innovative medicines – it is still years ahead of where we stand with devices, dressings, apps and procedures because of the need for licensing and thus RCT-based evidence to satisfy the regulator. It could be argued that instead of working with industry to promote uptake of innovative medicines the NHS should focus its resources in terms of working with the life sciences industry on the non-medicine developments to work through developing an evaluation programme which could include NHS evaluation of impact on patient outcomes. However, the NHS does need greater clarity on governance and liability when supporting development of these potentially innovative products as it is very unclear where liability lies.

59. At the moment, the NHS drives down cost by using its bulk purchasing power to deliver drug costs which are amongst the lowest in the developed world (the most recent OPEC data show that we spend ~£250 per head on medicines per year compared with ~£350 for our closest European counterparts). Again, this has a knock on effect for uptake on innovation in that the monies to be saved on offsetting the use of other medicines are much less than is the case in other countries, e.g. Germany and the US where health service costs are higher so it is easier to make the case for investing in innovation.

60. The NHS does not really operate as a single entity either as a supplier of services or as a commissioner. Individual NHS Trusts could choose to partner with a commercial

company to develop particular innovative products but even if that leads to commercial success the IP and commercial benefit lie with that Trust (assuming it has the commercial acumen) and that could ultimately be at the expense of other NHS Trusts.

61. The impact of AHSNs to provide a more co-ordinated approach to the roll-out of innovation and best practice has been disappointing and limited in terms of impact on daily practice in the NHS.

62. Although the removal of the Cancer Drugs Fund (CDF), will or may reduce access to 'new and innovative' treatments, it appears that the effect will be on those with very limited clinical value. The Society therefore believes that the changes to the approval process are positive for the NHS and the country as a whole.

63. The accelerated medicines scheme seems to be largely limited to high-tech medicines predominantly used for cancer (except sacubitril/valsartan for heart failure). This is disappointing as we already have the CDF for cancer and this would seem to be an opportunity to create a system for patients with other serious chronic diseases who have limited access to newer treatments. From a Trust perspective however it would also be helpful to have a national view on where liability lies with patients started on these treatments and whether NICE/ NHS England should decline funding in the longer term. The revised PPRS scheme was meant to create an environment whereby the NHS would not be financially disadvantaged by increasing use of new medicines (pharmaceutical companies underwrite any increase in budget over 1-2%). However, in reality the money paid back by pharmaceutical companies to NHS England in recognition of an increase in expenditure over that cap has not found its way back to NHS Trusts in a tangible sense – instead NHS England has stated that money was taken into account in calculating Tariffs. By adopting this approach neither the NHS providers or industry feel that PPRS has delivered its objective.

64. Overall, for the NHS to support more rapid uptake of innovation requires a partnership approach which acknowledges these factors and accepts that the focus of the NHS should remain on delivering high quality clinical care within a tightly controlled and limited budget. However, if additional innovation funds could be identified (for example by ring-fencing PPRS payments when it is updated) the NHS would be an ideal test bed for quantifying the impact of particular innovations on health service utilisation and patient outcomes. This might take the form of an extended CDF-type arrangement whereby NICE assess the evidence (not necessarily at the point of licence) and have the option of recommending funding for a limited time to generate real-life clinical outcome data to inform a final NICE decision in the future. Given NICE's worldwide credibility, companies may be more willing to share financial risk in the UK during this phase to acquire evidence which will have a credibility across the world. However, to make this efficient also requires significant investment in IT and coding to enable patients to be followed across healthcare settings in the NHS without the need for manual data collection.

<u>How can quick access to new treatments and the need to provide value for money be reconciled?</u>

65. In some ways, this is irreconcilable, since value for money in terms of health benefits (e.g. 'quality-adjusted life years'—QALYs) requires good data on outcomes such as mortality, which inevitably take time to accrue. The global pharmaceutical industry remains extremely profitable, with especially high profits going to innovators. Indeed, it may be the case that the NHS should not sacrifice resources that would bring substantial health benefits using established technologies simply in the interests of 'innovation.' However, the issue might be lessened by a form of continuous appraisal. A new

treatment would be adopted through the current NICE process or an accelerated version of it. The Society believes that continuous assessment of the real data accrued in clinical use against the postulated benefit at adoption would allow the NHS price to be adjusted according to true outcomes and therefore believes this approach should be considered

66. It was hoped that the <£10,000 QALY threshold would speed NHS uptake of low budget impact innovations, but it appears that it is only likely to reduce the NICE implementation period by one month at the very most. For this to have a significant impact, it would require NICE to highlight these innovations at an earlier stage (i.e. in advance of the full publication of the technology appraisal) so the NHS could work to support prioritisation. The ability to delay implementation of medicines that have a significant budget impact will lead to delays in those medicines affected. We hope that pharmaceutical companies would review their pricing strategies for those medicines affected - and recognise the pressures on NHS budgets during prolonged financial austerity.

13. Who should take responsibility for the implementation of the Life Sciences Industrial Strategy and to whom should they be accountable? What should the UK Government's role be? What should the role of the academic, charitable and business sectors be?

Key points:

- How responsibility should and can be shared and how to ensure strong and trusted relationships are built which take into account expertise of business sector, academia and industry etc.
- A successful strategy will depend on effective representative of the entire sector (charities, CROs, SMEs as well as large pharma) and needs to report into a minister with specific responsibility for life sciences. An accountable Minister must be appointed to lead the implementation of the Strategy.

67. The Society believes that the Life Sciences industrial strategy should have three main considerations: pace of innovation, direction of innovation and accessibility of the resulting medical products. The approach of UK government has up to now resulted in limiting its role to market fixing through public funding of research including smart specialisation, regulation of the HE sector and ensuring enforcement of property rights. It is the Society's view that this approach has focused on innovation pace while neglecting direction and accessibility. Recent work in the area of innovation enterprise has argued that the role of government should move beyond market fixing to "opportunity creation" , in terms of making and shaping markets [49]. In particular, this would involve direct government investment in 'riskier', long term innovation that private capital is unwilling to invest in. As we have discussed previously, this should include both smart specialization and mission-oriented initiatives.

68. The post-war roles of academia included the selection of elites, generation of new knowledge, and training of the bureaucracy [50]. By the 1990s, its roles included production of human capital and innovation as a basis for economic growth and competitiveness. In the future, its roles should include regional development and growth, co-development of new knowledge with societal partners, mission-oriented innovation and disruptive innovation. It should also serve as a link to both developing

[49] Lazonick & Mazzucato, 2017, The risk-reward nexus in the innovation-inequality relationship: who takes the risks? Who gets the rewards? Industrial and Corporate Change, 22, 4, 1093–1128
[50] Maassen & Stensaker, 2011, The knowledge triangle, European higher education policy logics and policy implications, High Educ, 61:757–769.

and advanced economies through transnational research, internationalisation and mobility.

69. The charitable sector's current role is to provide research funding and to influence policy. These roles are critical because they provide a mechanism which links academia to society, in addition to markets, public funding and research consortia. However, the charitable sector is dominated by incumbent organisations and it is questionable how quickly the sector would be able to reflect the needs of an ageing population with more chronic conditions. The sectoral deal should therefore explore ways of encouraging philanthropic venturing as a means of disrupting the charitable sector.

70. The role of the business sector has traditionally been seen as the primary means of commercialisation of goods and services. While the vertically integrated Big Pharma business model was common, the high costs of drugs were justified on the basis of high attrition rates of new molecular entities. However, it has been argued that the pharmaceutical industry has become excessively commercialised, with many MNCs spending an increasing proportion of their net income on share buybacks (to boost stock prices and stock options) [50, 51]. In an age of increasingly open innovation, this is difficult to justify. In the future, this would mean that it will be incumbent on business to improve R&D productivity, reduce costs, develop new markets in emerging economies, and shift to managing patient outcomes [52].

14. What is the role of companies within the sector, particularly the large pharmaceutical companies, in the implementation of the strategy? How are they accountable for its success?

Key points:

- Ensure strong and trusted relationships are built and that good communications between all involved. (including academia and schools etc to ensure fair access and that relevant skills are targeted etc.)
- Increase visibility of partnerships

71. The Society believes that although large pharmaceutical companies are a key part of this, they should no longer be the dominant voice. We suggest a focus on greater mobility/knowledge exchange across the large companies, SMEs and academia in order to build trust, mutual understanding and help identify partnership opportunities. In addition, sharing of platform technologies and, where possible, data will help make research more cost-effective and successful. There must be greater incentives (at an individual level) for researchers in large pharmaceutical companies to engage in such schemes. It is clear that schemes such as the Royal Society Industry Fellowship scheme[53] are undersubscribed for exchanges out of large companies, and this trend must therefore be reversed.

72. The Society believes that the role of MNCs in the implementation of the strategy should include the following:

- Encourage relevant skills development, not only for students but also for current academics through secondments, joint appointments, joint research projects etc.
- Develop new markets in emerging economies and facilitate links between UK academics and these economies

[51] Mazzucato, M. High cost of new drugs: Why government must negotiate a better deal for publicly funded research. BMJ 354, 4136 (2016).
[52] Deloitte, 2017 Global life sciences outlook : Thriving in today's uncertain market.
[53] https://royalsociety.org/grants-schemes-awards/grants/industry-fellowship/ (accessed 15 September 2017).

- Contribute to improving UK labour productivity, not only through its own efficiency but by sharing know-how with other businesses throughout its value and innovation chains, its competitors and businesses outside the sector
- Shape research direction, e.g. through research consortia, to ensure that changing societal needs are met
- Support the emergence of new ventures through reducing market knowledge asymmetry and potentially even venture capital
- Driving new training pathways to support pressing skills needs e.g. sector-led Trailblazer apprenticeships

15. Does the Government have the right structures in place to support the life science sector? Is the Office of Life Sciences effective? Should the Government appoint a dedicated Life Sciences Minister? If so, should that Minister have UK-wide or England-only responsibilities?

73. Overall, for the life sciences sector to be fully supported, there is a need for more joined up thinking within Government and the Society is concerned that competing priorities within individual Government departments could prevent this from occurring as effectively as possible. We are concerned that Government's 'capacity' with be strained due to the UK exiting the EU and this must be considered in detail and all steps to avoid this having an impact must be taken.

74. The Society believes that a Life Sciences Minister and a well-resourced Office for Life sciences would have a significantly positive impact on the Life Sciences sector and thoroughly supports this. A Minister for the Life Sciences with a cross-departmental remit in the Department for Health and the Department for Business, Energy and Industrial Strategy would be particularly beneficial. A focus on considering how to create sector engagement and coordination has the potential for being particularly beneficial, perhaps though a sector board with broad representation (e.g. UKRI, BIA, ABPI, CROs, Treasury, Charities, Learned Societies, Academies)

16. What impact will Brexit have on the Life Sciences sector? Will the strategy help the sector to mitigate the risks and take advantage of the opportunities of Brexit? Page 4 of 5

75. **Key points:**

- We have commented extensively on the effects of Brexit on the Life Sciences sector along with suggestions of reducing such impact in our responses to the Industrial Strategy and the Leaving the EU inquiry[54]. We wish to draw particular attention to:
    - Significant impact on the regulation of medicines, medical devices and *in vitro* diagnostic products within the UK. The worst case scenario would be that on leaving the EU the UK would be unable to participate in the European wide approval system via the European Medicines Agency (EMA), and this could be a major deterrent for pharmaceutical companies and delay access to medicines for patients. It is vital that a regulatory solution is found. Please see our response to Question 17.
    - Vital role of international research consortia, particularly in the life sciences, e.g. under FP7 or IMI.

[54] Written submission by the British Pharmacological Society to the Leaving the EU inquiry of the Science and Technology Committee, House of Commons, 22 August 2016, https://www.bps.ac.uk/getattachment/About/Policy-positions/Consultation-responses/Articles/Response-toLeaving-the-EU-inquiry/Leaving-the-EU-inquiry-response-(1).pdf.aspx?lang=en-GB (accessed 6 September 2017)

- It's crucial that the UK maintains and improves connections with scientists on a global scale (including free movement of researchers, scientists and students) as it is essential to secure the UK's access to talent and world-class research collaborations.

17. How should the regulatory framework be changed or improved after Brexit to support the sector?

Key points:

- The MHRA is one of the most innovative drug regulatory agencies in the world and has enormous expertise. The loss of UK input in EMA evaluation processes, would lead to reduced regulatory capacity of the EMA.
- There is a real risk that the MHRA may be relegated to observer status in the process of drug regulation, rather than taking an active part in the process.
- If the UK operates outside the EMA, then there is a danger that the UK public will miss out on early access to novel medicines: the increased costs and regulatory burden is likely to mean that companies will undoubtedly prioritise getting approvals from the big markets first (US, EU, Japan, and China).
- It is vital for patients and the success of the Life Sciences Industrial Strategy that a regulatory solution is found.

76. We discussed the implications for the regulation of medicines, medical devices and *in vitro* diagnostics in detail in our response to the government's Industrial Strategy Green Paper. We reference this response here:

> "41. Leaving the EU could have a significant impact on the regulation of medicines, medical devices and *in vitro* diagnostic products within the UK. The regulation of such medicinal products, both for those under development and as approved products in the UK, is heavily reliant on the Regulations and Directives that come from the EC via the European Medicines Agency (EMA). The EMA is a decentralised agency of the European Union (EU) which was created in 1995. Its creation followed the decision by the EU Heads of State and Government in 1993, choosing London as the location for EMA's premises. Since the inception of the EMA, the majority of the regulatory processes that are now utilised to regulate medicines in the UK have originated from within the EC as developed by the EMA. When the UK leaves the EU, much of our own legislation to cover the activities that utilised the EU medicines regulatory legislation will have to be re-written.
>
> "42. In addition, the MHRA has an internationally recognised reputation due to the contribution it makes to the global regulation of medicines and devices. In our response to the House of Commons Science and Technology inquiry on Leaving the EU,[55] the Society noted:
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> > *"Located in London, the EMA is responsible for the scientific evaluation, supervision and safety monitoring of medicines developed by pharmaceutical companies for use in the EU (since 1995)[56]. It is the largest EU body in the*

[55] Written submission by the British Pharmacological Society to the Leaving the EU inquiry of the Science and Technology Committee, House of Commons, 22 August, 2016,https://www.bps.ac.uk/getattachment/About/Policy-positions/Consultation-responses/Articles/Response-to-Leaving-the-EU-inquiry/Leaving-the-EU-inquiry-response-(1).pdf.aspx?lang=en-GB (Accessed 10 April 2017).

[56] EMA (2016) About us, 29 June 2016. Available from: http://www.ema.europa.eu/docs/en_GB/document_library/Other/2016/08/WC500211862.pdf (Accessed 22 August 2016).

United Kingdom with a full-time staff of more than 600 people. British experts were leaders or co-leaders in examining 27 new drug applications in 2014[57]. The EMA ensures a 'centralised authorisation procedure' allowing a single marketing authorisation application to make a medicine available to all EU member states and the European Economic Area (EEA) countries Iceland, Liechtenstein and Norway[58]. The UK's Medicines and Healthcare Products Regulatory Agency (MHRA) works closely to support the EMA, for example it[59]:

- *led a third of all EU-wide safety reviews since legislation was introduced in 2012*
- *was a rapporteur or co-rapporteur in 20 centralised procedures that led to granting of a Marketing Authorisation*
- *was appointed Reference Member States (RMS) in 43% of procedures where a UK licence was sought*
- *held 319 regulatory or advisory meetings to help applicants*
- *helped shape regulation and approvals through 96 European Scientific Advice meetings*

The level of work undertaken on behalf of the EMA is considerable, representing 6.4% of total gross income in 2015/6[60]. This indicates that loss of MHRA expertise would put a considerable burden on EMA processes. This influence is expanded upon in the House of Commons Science and Technology Committee report "EU regulation of the life sciences"[61], where evidence from the Bioindustry Association stated that "the MHRA has been able to exploit its reputation, leadership and expertise to positively influence the EU medicines regulatory regime."[62] The report also discusses several instances of how MHRA has influenced EU regulation, for example Clinical Trials Regulation and Pharmacovigilance legislation."

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[57] Hirschler, B. (2016) Brexit threat hangs over London-based EU medicines agency, *Reuters*, 29 January 2016. Available from: http://uk.reuters.com/article/us-britain-eu-medicines-idUKKCN0V71AS (Accessed 22 August 2016).

[58] EMA (2016) Authorisation of medicines. Available from: http://www.ema.europa.eu/ema/index.jsp?curl=pages/about_us/general/general_content_000109.jsp (Accessed 22 August 2016).

[59] MHRA (2016) Medicines and Healthcare products Regulatory Agency Annual Report and Accounts 2015/16. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/539679/MHRA_annual_report_and_accounts_2015_to_2016.pdf (Accessed 22 August 2016).

[60] MHRA (2016) Medicines and Healthcare products Regulatory Agency Annual Report and Accounts 2015/16. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/539679/MHRA_annual_report_and _accounts_2015_to_2016.pdf [Accessed 22 August 2016]

[61] Great Britain, Parliament, House of Commons, Science and Technology Committee (2016) *EU regulation of life sciences,* HC 158, 11 June 2016. Available from: http://www.publications.parliament.uk/pa/cm201617/cmselect/cmsctech/158/158.pdf (Accessed 22 August 2016).

[62] BioIndustry Association (2016) Written evidence submitted by the BioIndustry Association (UKL0022), EU regulation of the life sciences inquiry, the Science and Technology Select Committee, House of Commons. Available from: http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/science-and-technology-committee/impact-of-european-regulation-on-uk-life-sciences/written/30086.html (Accessed 22 August 2016).

"43. As things stand, on leaving the EU the UK would be unable to participate in the European wide approval system for new medicines and the revisions to already approved products, to participate in the Orphan Drug Designation and the Small to Medium Sized Enterprise schemes that the EMA operate. In addition, we would be unable to participate in the centralised approval process for paediatric drugs and the process that supports new medicines development for children. We would also lose access to the EU wide Pharmacovigilance networks and the EU Clinical Trials Database. Not participating in such regulatory activities and processes could have serious implications from the public health perspective in the UK and in particular for patient safety.

"44. At present, it is not at all clear whether the UK could continue to collaborate with the EMA in some way relating to medicinal product regulation and pharmacovigilance activities. If possible, some form of collaboration would be beneficial to both parties and should help avoid the possible impacts on public health.

"45. However, being outside the EMA could also have its own benefits. For example, it could be easier to implement the outcomes of the Accelerated Access Review and introduce new and innovative medicines into the UK earlier than other countries and include the other benefits of the review, if we so desired. We could also focus much more than we currently do on utilising the NHS clinical facilities and patients for new drug research, development and evaluation.

"46. The Medical Research debate at the House of Commons which took place on Tuesday 28 March 2017[63] highlighted similar concerns in regards to regulation. It noted that the new regime on approving drugs would mean that the NHS may not supply some newly approved drugs for up to three years. It is therefore necessary to consider how this would impact on research and industry as it is likely to result in investment in research in the UK being viewed as less attractive."

18. To what extent should the UK remain involved with and contribute to agencies such as the EMA post Brexit?

77. In addition to the above considerations, the Society also believes that it is essential to consider that in order to cover any previous EMA capacity in drug approval processes, the number of staff at the MHRA would need to triple. Even if the funds for this were made available, the Society has concerns over the amount of time it is likely to take to recruit and train suitable talent. The lack of involvement in the EMA could therefore result in major adverse consequences for the approval of new drugs and the monitoring of the safety of existing drugs several years after Brexit. Overall, a major part of regulatory functions of the MHRA has been filled by the EMA which applies both to the approval process but also to pharmacovigilance. The Society therefore believes that it is essential that the impact of this is considered in detail and that alternative processes are established in order to lessen these effects.

[63] Medical Research, House of Lords debate, 28th March 2017 https://hansard.parliament.uk/lords/2017-03-28/debates/56D4E574-0641-4358-A69D-69B99F7DA30D/MedicalResearch (accessed 11 April 2017).