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Bringing medicines to life

Life Sciences R&D

Building the UK's international research collaborations

Contents

Executive summary & recommendations

To address the major health challenges of our time, the global pharmaceutical sector is pioneering cutting-edge science that can help develop new treatments and cures for diseases from cancer to dementia, as well as preventing disease through the latest generation of vaccines. These scientific breakthroughs are achieved through national and international collaborations across sectors and disciplines. **International research collaborations are fundamental to the discovery and early development of new medicines and vaccines.**

The UK has a strong history of scientific excellence, with a research ecosystem that has supported revolutionary research from the development of the smallpox vaccine and the discovery of penicillin, to advances in monoclonal antibody technology and gene therapies. As research has become increasingly international, we have also seen the UK develop a strong record in collaborative research, with 55% of recent UK research publications the result of an international collaboration – a figure that has doubled over the past two decades.[1]

The response to the COVID-19 pandemic has also demonstrated the success of international R&D collaborations, with partnerships between academia, industry and charities leading to the rapid repurposing of medicines to treat COVID-19 and the development of several vaccines and novel therapeutics.

Looking beyond the pandemic towards recovery and growth, the UK must proceed with open and collaborative research at the heart of its 'Global Britain' agenda. As the biopharmaceutical industry invests more in R&D than any other sector, spending £5bn on R&D in 2020[2] and directly employing 66,000 people across 930 sites in 2020,[3] the UK will see benefits to the wider economy through increased investment, job creation and expertise building, if it prioritises a research strategy that enhances international collaboration for pharmaceutical R&D.

The UK Government acknowledges that collaborative research is critical to the long-term prosperity of the country. Before the pandemic, this was made clear through the International Research & Innovation Strategy[4] which outlines how the UK will collaborate internationally to tackle global challenges and support economic growth. The Government continues to support this same ambition. In the Life Sciences Vision and R&D People and Culture Strategy, the government highlights that international research collaborations are fundamental in supporting innovation in life sciences, attracting further R&D investment to the UK, and achieving the government's ambition to be a global science superpower.

However, as research and innovation powerhouses across the globe are investing heavily in developing their research bases and international networks, the UK will have to review its strengths and identify new R&D partners to remain competitive. Failing to pursue deeper international collaboration risks the UK research ecosystem falling behind competitors such as the US, China, and South Korea, which are quickly becoming the destination of choice for global industry looking to anchor their discovery and early research programmes.[1] China, in particular, has grown its share of global research publications from 5% in 2008 to 20% in 2018.[1]

Key to the UK's continued success as an international research hub and partner in the discovery and early research space, is the development of two key foundations: frameworks and flows, underpinned by a collaborative research culture that brings together industry, academia, investors and others.

A collaborative culture is a positive, virtuous cycle of activity, relying on the development of deep networks, where research-intensive institutions and their partners from industry are more actively engaged with institutions in other countries, deepening the knowledge base and perpetuating an ever-deeper exchange of ideas. Furthermore, life sciences researchers benefit not only through links with their peers in other countries, but also from different research disciplines such as, data science, artificial intelligence (AI) and cutting-edge engineering techniques.

Creating a dynamic ecosystem which inspires innovation through collaboration, will in turn incentivise interest and investment for further international collaboration with the UK.

To capitalise on the strength of the domestic science base and incentivise international collaboration, effective frameworks for international collaboration are also needed. An effective framework is one that is underpinned by the principles of transparency, stability, and efficiency in its policy design. Such frameworks will, in turn, support the growth and maintenance of a collaborative culture, particularly between academia, SMEs, third sector and larger industry players. Three frameworks in particular are important in how they can incentivise or disincentivise collaboration:

- **Platforms: multilateral and bilateral platforms supported by governments.** Effective government-to-government agreements can build trust and facilitate platforms to set objectives, coordinate partners, and mobilise and allocate funding. At their best, these platforms can generate a shared risk appetite and goal alignment to foster innovation, as well as strengthen cultural ties that deepen the value gained from partnerships.
- **Administration: Efficient and collaborative research administration.** Reducing the time and resources required to negotiate contracts, licensing agreements and intellectual property (IP) sharing, particularly for multi-party collaborations or public-private partnerships which contribute to the attractiveness of countries as destinations for R&D activity.
- **Funding: flexible and transparent funding mechanisms.** Direct and indirect financial support for research from the public sector is vital for encouraging private sector investment. Increasing the level of this funding is important, but so too is the way funding is apportioned; multi-annual settlements provide certainty and stability for potential international collaborators. Funding programmes can also be targeted at incentivising public-private partnerships and international research mobility, or by actively stimulating and promoting international collaboration.

Finally, international research collaboration is also inherently dependent on the availability and cross-border flow of key inputs. This relies on boosting domestic capacity and quality, whilst reducing frictions for the international flow of:

- **Talent.** The availability of skilled researchers is fundamental to the life sciences sector. Ensuring investment in the domestic research talent base alongside supporting and incentivising the mobility of global talent is crucial for improving international research collaboration. Encouraging international movement of researchers from young academics to career professionals helps to embed scientists in the international networks that are crucial for successful collaborations.
- **Data.** High-quality, longitudinal and interoperable datasets are essential for modern scientific research. Alongside investment in data infrastructure, facilitating the safe and secure sharing of data with international research partners, underpinned by effective governance, is crucial for supporting an enhanced role for data analytics in the global research ecosystem.
- **Goods**. International research projects rely on the cross-border exchange of goods, whether medicinal products and their components or advanced lab equipment and materials, contributing to the stock of research infrastructure. Reducing friction in this process through mutual recognition of regulations and standards, minimisation of customs process and tariff-free access is crucial.

Summary of recommendations:

Frameworks

- DIT and BEIS, with support of other key stakeholders, should produce a life sciences prospectus, describing and quantifying the UK's operational strengths and capabilities in early-stage research, showcasing its unique offer to international research collaborators in industry, academia and beyond.

a) Platforms

- The UK Science and Innovation Networks (UK SIN) should play an active role in supporting local research clusters within the UK to establish new links with international research consortia.
- The UK Government and EU Commission should work together to urgently finalise the UK's association to the Horizon Europe programme.
- As part of the UK's trade policy agenda, including the use of innovation chapters and initiatives such as the New Atlantic Charter, ensure that bilateral agreements with strategic R&D hubs facilitate research collaborations through innovative cooperation frameworks, funding arrangements and provisions that support innovation and partnership. Trade dialogues should also be used to promote research collaboration.

b) Research governance and administration

- Ensure that the Intellectual Property Office's International IP Service focuses on supporting commercialisation realised through international, cross-sector collaborations.
- The Intellectual Property Office should conduct a review of the Lambert Toolkit for academia-industry collaborations. This should include recommendations on how to work with other countries and multilateral organisations to improve international best practice in research administration.
- The Review of Research Bureaucracy should work with academia and industry to assess governance processes relating to domestic and international university-industry R&D collaborations, in order to identify ways to reduce contractual barriers and improve incentives for university-industry collaboration.
- The Government Office for Technology Transfer should work closely with industry to build better connections between life sciences innovators in the private sector, public sector, and academia and foster innovative, international technology transfer networks with domestic research institutions and innovation ecosystems.

c) Funding

- The Office for Science and Technology Strategy should undertake a formal horizon-scanning process with academia, industry and the third sector to anticipate and provide advice on which areas of early-stage research and discovery should be prioritised for funding.
- Building upon initiatives such as Royal Society Industry Fellowship, ensure funding is available to support international talent transfer between academia and private sector across borders.

Flows

a) Talent

- Building on the commitments of the R&D People and Culture strategy and as part of implementation and evaluation of the Life Sciences Vision, the government should establish a robust, bi-annual review process of human capital needs and policy challenges in the life sciences research ecosystem, incorporating feedback from academia, industry and the third sector.

b) Data

- The draft Healthcare Data Strategy (Data Saves Lives) and National Genomics Strategy (Genome UK) should be fully implemented to unlock the full potential of the UK's health data and genomics assets.
- The UK to take a leadership role in pursuing more common standards to data collection for international research purposes, via multilateral fora such as OECD and WHO.

c) Goods

Work through the WTO to secure commitments from Member States to:

- Eliminate tariffs on imports of all pharmaceuticals, vaccines, active pharmaceutical ingredients (APIs), raw materials, chemicals, other inputs and intermediaries, and specialty equipment used to invent, manufacture, and deploy these products.
- Encourage the development and maintenance of trade facilitation plans covering all inputs and goods in the R&D supply chain.

The world's largest research collaborators

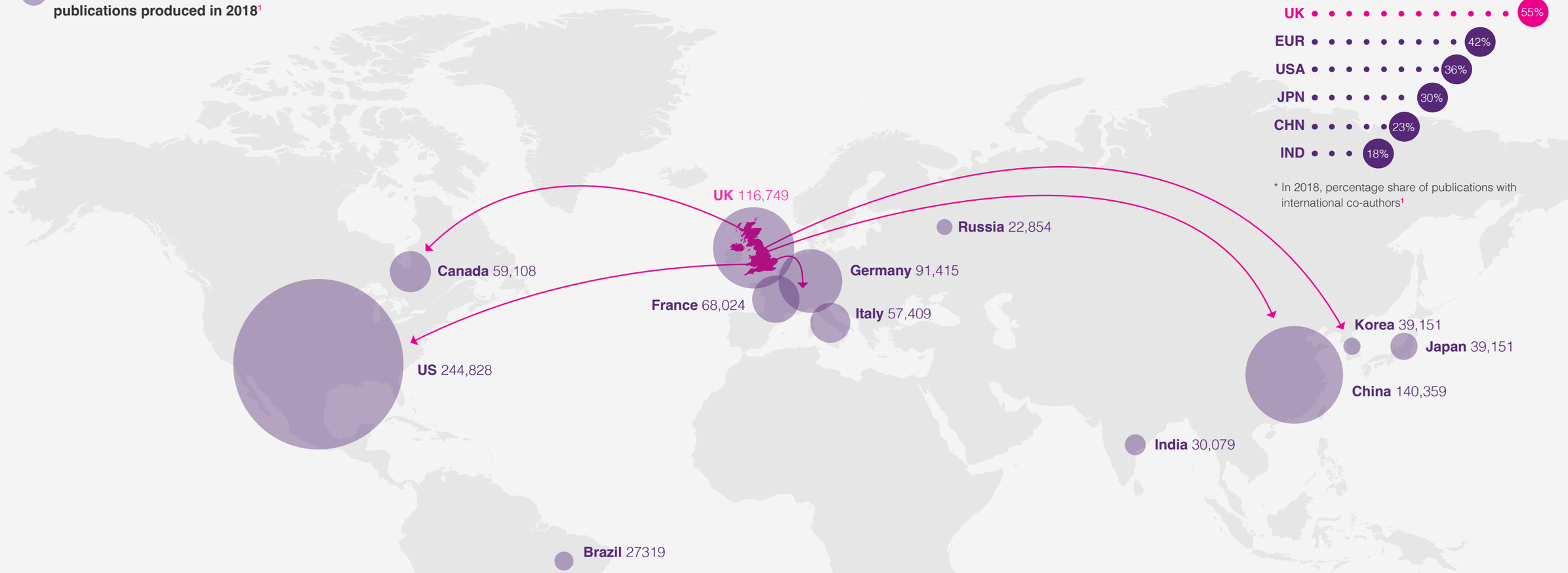
...and some of the vital work they have powered

Total number of international publications produced in 2018[1]

Share of publications which resulted from international collaboration (%)*

- UK 55%
- EUR 42%
- USA 36%
- JPN 30%
- CHN 23%
- IND 18%

* In 2018, percentage share of publications with international co-authors[1]



UK - Canada:

The Canada-UK Artificial Intelligence Initiative is an interdisciplinary programme seeking to maximise the social and health benefits of AI, including its contribution to personalised medicine, drug discovery and diagnostics.

https://cihr-irsc.gc.ca/e/51520.html

UK-Europe

The 3TR project is part of the Innovative Medicines Initiative. A pan-European consortium of universities and industrial partners is investigating the factors that determine patient responses to treatments for seven diseases, including asthma and multiple sclerosis.

https://www.imi.europa.eu/projects-results/project-factsheets/3tr

UK - Israel, China and US:

The Ecology and Evolution of Infectious Diseases programme is a partnership between the UK, the US-Israel Binational Science Foundation and the National Natural Science Foundation of China, seeking to increase the understand quantitative understanding of infectious disease transmission.

https://www.ukri.org/opportunity/ecology-and-evolution-of-infectious-diseases-2020/

UK-Korea:

The UK-Korea multi-omics based precision medicine research initiative supports the development of multi-ethnic precision medical technology to develop new therapies and deepen understanding of disease, backed by Egm of public funding,

https://www.cambridgenetwork.co.uk/news/uk-and-south-korea-collaboration-tackles-severe-asthma

1 Introduction

A policy framework for enabling new medicine discovery and early-stage research through international collaborations

Early-stage research, examining the cause and understanding the course of disease in patients, happens to a greater or lesser extent all over the world. International collaboration is a fundamental component of medicines discovery and early-stage research; the exchange of talent, ideas and ways of working is fundamental to achieving scientific breakthroughs that lead to innovative, life-saving therapies and vaccines. The goal of the policy framework surrounding international research collaborations in the medicines discovery and early-stage research space is to create a virtuous circle of activity, building an ecosystem where the government, industry, academia and the third sector work together. Creating this collaborative culture will help maintain the UK's prominence in life sciences research so that our scientists, clinicians and companies can be quick to build on and contribute to new ideas that inform medicine discovery and development.

Creating and maintaining a collaborative ecosystem also acts as a cornerstone incentive for industry, investors and talent to seek out a country as a place to conduct research. The attractiveness of a research ecosystem to global pharmaceutical companies is grounded on taking an integrated, strategic approach to two 'foundations': the supporting frameworks that provide effective administration, funding and platforms for research activity, and the flows of talent, data and goods between global research hubs (see Figure 1). These frameworks and flows interact to determine the extent to which a collaborative culture emerges, which in turn sets the tone for how global pharmaceutical companies and other institutions see countries as prospective partners; it is crucial for building and maintaining a country's reputation as a global leader in scientific research.

Figure 1: The elements of a policy framework to support a collaborative research culture

2 A collaborative research culture

A collaborative culture is a positive, virtuous circle of activity, relying on the development of deep networks, where research-intensive institutions and their partners from industry are more actively engaged with institutions in other countries, deepening the knowledge base and perpetuating an ever-deeper exchange of ideas between industry, academia and other partners. In turn this stimulates innovation and creativity which ultimately translates into the quicker development of cutting-edge therapies for patients. A collaborative research culture emerges where individuals and institutions have the resources, opportunities and incentives to exchange knowledge and talent.

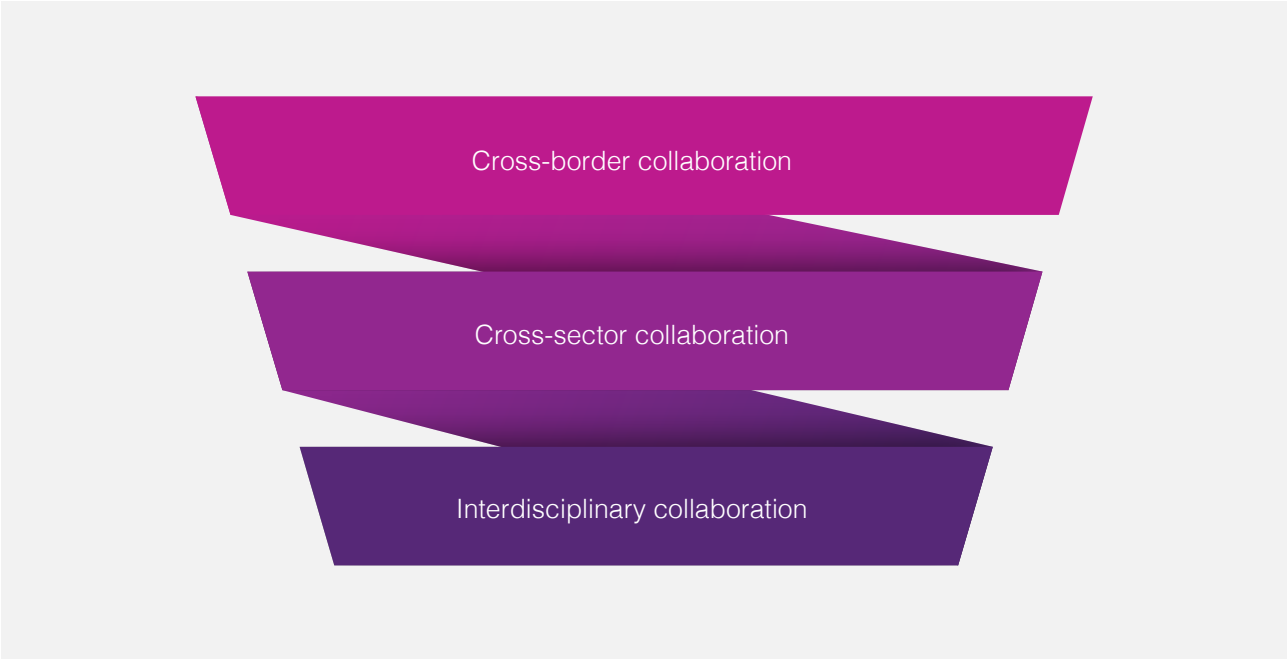
Life sciences researchers benefit not only through links with their peers in other countries, but also from different research disciplines. Life sciences research is becoming increasingly interdisciplinary, with data science, AI and cutting-edge engineering techniques unlocking new opportunities in medicines discovery and development. Understanding and incorporating approaches from these diverse viewpoints can prompt creative responses to scientific problems.

Successful research ecosystems needs to be **seen to be open and collaborative.** Trade policy and regulatory diplomacy strategies will be key mechanisms for implementing the UK's offer and choices for developing a collaborative research culture, but also for signalling to the global pharmaceutical industry and other international partners that the UK is a place of research excellence.

Policymakers in the UK recognise that a positive, open and inclusive culture is crucial for a healthy research ecosystem. The R&D People and Culture Strategy,[6] underpinned by research conducted by the Royal Society, the Wellcome Trust and the Russell Group, highlights this and identifies collaboration as a crucial aspect of research culture and a key factor in incentivising global investment.

As such, the UK is developing initiatives to improve the wider culture in research, including through the Review of Research Bureaucracy.[7] By ensuring future policy interventions consider three key strands of collaboration, **inter-disciplinary, cross-sector and cross-border** (Figure 2), the UK can grow its attractiveness and reputation as a world-leading location for collaboration and innovation.

Figure 2: The three dimensions of collaboration



Cross-border collaborations

Collaborating internationally, across sectors and disciplines, is a vital element of building a world-leading collaborative culture. As outlined in this report, supporting frameworks and the flows of talent, data and goods are needed for an open and collaborative research culture, but the UK must also present a coherent narrative to prospective international partners to describe existing opportunities and demonstrate value in collaborating and investing in the UK ecosystem.

The 2019 International Research and Innovation Strategy presented such a case, but there have been several subsequent developments, including the COVID-19 pandemic, that require this strategy to be refreshed. The UK Government has outlined its ambitions across recent publications, such as the Integrated Review, which sets out ambitions for what the UK country aims to achieve on a global platform by 2030. This should be followed by the development of a life sciences prospectus describing and quantifying the UK's operational strengths and capabilities and showcasing its unique offer to international research collaborators in industry, academia and beyond.

Quantifying the extent and quality of domestic and international research collaboration is challenging, with the number of academic papers co-authored by researchers in different countries, and the number of these that are in the top 1% of cited publications, often used as proxy measures. Such a prospectus would therefore need to include more robust metrics, building on approaches such as those used to measure the collaborative benefits of the Horizon 2020 programme, in order to articulate the quality and depth of UK research collaborations.

Cross-sector collaborations

The most effective research clusters in the world, such as Boston in the United States, and Israel, have developed **a culture where researchers and practitioners across sectors network and collaborate regularly to share perspectives and refine ideas.** It is not unusual for top researchers to simultaneously hold positions at a leading academic institution, a hospital and a global pharmaceutical company. The UK has yet to embed this strand of collaboration to such an extent and, as the R&D People and Culture Strategy highlights, more needs to be done to encourage collaboration between academia, industry and the third sector.

Interdisciplinary collaborations

Researchers across disciplines are keen to learn from each other and work together, understanding how distinct areas of scientific research can relate to each other and generate exciting breakthroughs. The UK has a good track record in supporting interdisciplinary collaboration, which has, for example, brought perspectives from engineering and computer science into the field of genomics research, but more can be done to structure and incentivise these collaborations. **The R&D People and Culture Strategy's proposal to pilot ways to support researchers to learn skills from outside their discipline is welcome and should be pursued as a priority.** It is vital that this encompasses researchers in industry and the third sector.

Recommendations to the UK Government:

- DIT and BEIS, with support of other key stakeholders, should produce a life sciences prospectus, describing and quantifying the UK's operational strengths and capabilities in early-stage research, showcasing its unique offer to international research collaborators in industry, academia and beyond.

3 Frameworks

To capitalise on the strength of the domestic science base and incentivise international collaboration, effective frameworks are vital.

An effective framework is one that is underpinned by the principles of transparency, stability, and efficiency in its policy design. Such frameworks will, in turn, support the growth and maintenance of a collaborative culture, particularly between academia, SMEs, third sector and larger industry players. Three frameworks are important in how they can incentivise or disincentivise collaboration:

- **Platforms** that set objectives, coordinate partners, and mobilise and allocate funding via effective government-to-government agreements.
- **Research governance and administration** processes that are efficient and collaborative for multi-party collaborations or public-private partnerships.
- **Funding** mechanisms that are flexible and transparent to encourage private sector engagement and investment.

Platforms

National and international research collaboration can take a number of forms, and a mix of platforms and mechanisms is essential as the nature of research is itself diverse with collaborations ranging from short-term projects involving two universities to multi-annual, multi-country partnerships involving large numbers of industry, academic, government and health system organisations. Vibrant local research clusters, with diverse pools of research expertise and built upon reputations for scientific excellence, can act as a magnet for international researchers seeking collaborators.

For organisations within these clusters to attract, or seek out international collaborators, involvement in **partnership programmes and networking mechanisms** which support, incentivise and showcase opportunities for international collaboration is key. For example, Singapore's Agency for Science, Technology and Research, A*STAR, coordinates activity through a range of flexible collaboration models, working with industry and research institutes to determine priorities and drive research into advanced, innovative areas of science that are vital to underpin the later stage work of global pharmaceutical companies (Box 1).

Local research clusters underpin the most productive international medical research hubs, such as Boston, Israel, or Singapore, and are built on **deep networks between industry, universities, health systems and investors, creating an environment that fosters innovation and commercialisation**. These hubs, attract global capital and talent, which in turn enhance and project the reputation of the cluster, serving as a strong pull for international collaboration and investment. This can help unlock greater potential and economic growth in local clusters, helping to address regional inequalities in research investment.

For example, 33 Israeli MedTech and life sciences firms established a research presence in the North of England, bringing with it investment and collaborative opportunities for UK-based researchers, in the 12 months following a Memorandum of Understanding being signed between the Northern Health Science Alliance and the UK-Israel Tech Hub.[8]

The UK could use similar approaches and leverage assets such as the Cell and Gene Therapy Catapult[9] to level-up R&D activity and investment across the UK.

This could be supported by the UK Science and Innovation Network (UK SIN),[10] which plays an important role in enhancing UK growth across key innovation sectors, including health and life sciences, by connecting UK industries and expertise with international opportunities.

Box 1: Singapore and ETC-159

Singapore's Agency for Science, Technology and Research (A*STAR) has harnessed its deep connections within academia and industry to underpin the discovery of novel cancer therapies. One recent example is the cancer drug ETC-159, which looks to treat previously drug resistant colorectal, ovarian, endometrial and pancreatic cancers.

ETC-159, which has now progressed to a clinical trial, was jointly developed with Duke-NUS Medical School (a collaboration between Duke University in the USA and the National University of Singapore) and A*STAR's Experimental Drug Development Centre (EDDC), harnesses a novel approach which allows immune cells to infiltrate cancerous tumours. Researchers collaborated to investigate the process of Wnt signalling in certain cancers, and how interfering with this process through treatments like ETC-159 could improve immunotherapy outcomes in previously unresponsive patients.

As well as leveraging local research clusters to drive collaborations, international research programmes and initiatives such as the EU's Horizon 2020 or the US Critical Path Institute, have succeeded in supporting long-term, multi-party collaborations that help to address strategic health system challenges. Public-private partnerships have also demonstrated great value, such as the EU's Innovative Medicines Initiative (IMI) under Horizon 2020 (Box 2). This initiative has delivered substantial benefits to the pharmaceutical industry, enabling researchers to pool data and resources in pre-competitive environments and share skills and expertise in order to address challenges and bottlenecks in the drug discovery process.[11]

The UK's participation in the €95.5bn Horizon Europe 2021-2027 programme,[12] and accompanying Innovative Health Initiative (IHI), is critical for the maintenance of the UK and EU's long-standing collaboration in research and innovation, helping to support and deepen a wide range of scientific collaborations.

ABPI welcomes the agreement in principle which was reached in 2020 for full UK association to Horizon Europe, and the commitment to fully fund association,[13] as well as support new international partnerships. **The UK Government and EU Commission should work together to urgently finalise the UK's association to the Horizon Europe programme.**

Box 2: European Innovative Medicines Initiative: U-BIOPRED

As a public-private partnership, the European Innovative Medicines Initiative (IMI) brought together pharmaceutical companies, academic institutions and SMEs to tackle Europe's biggest health challenges.

The U-BIOPRED project, which ran from 2009 to 2016, brought together 12 pharmaceutical companies, researchers from the University of Amsterdam and a range patient groups to research severe asthma, a condition which has seen few ground-breaking treatments since the 1940s.

The project focused on identifying the subtypes (or 'handprints') of the condition to enable therapies to more accurately target different presentations of the disease. Using a biobank of 50,000 severe asthma patent samples from over 1,000 patients, the results from the U-BIOPRED study have helped companies develop more effective asthma treatments, improve investment decisions, and ensure currently-available drugs are delivered to the right patients.

In addition to finalising UK association with Horizon Europe, **the UK Government and UKRI should learn from the positive aspects of established international research programmes to support in building deeper collaborations between the UK and other advanced economies** such as Japan, South Korea, Canada, Australia and the United States, where industry and the public sector are engaged in cutting-edge life sciences research.

In particular, the government should use the potential of **'innovation chapters' in trade deals,** as announced in the Innovation Strategy[14] to build funding collaboration agreements with countries with a substantial pharmaceutical industry presence, further encouraging investment into the UK and economic growth. This could build on the successful support for research enabled by initiatives such as the Global Anti-Microbial Resistance Innovation Fund[15] and the Pandemic Preparedness Partnership,[16] and would focus on continuing to deliver the greatest possible impact for the benefit of humanity.

The UK should also seek government-to-government agreements to provide structure, funding, and leadership to life sciences research endeavours. Initiatives such as the US-Israel Binational Science Foundation, stemming from diplomatic agreement between the two states, which has financed $700m of R&D activity since its inception. The Foundation's work was crucial in, for example, achieving breakthroughs in the study of cell degradation, deepening understanding of diseases such as cystic fibrosis and earning the investigation team the 2004 Nobel Chemistry Prize.[17]

The UK has made substantial recent progress in leading bilateral and multilateral research partnerships. The Research Compact, Carbis Bay Declaration and Pandemic Preparedness Partnership agreed at the 2021 G7 meeting were important statements of intent in which the UK took the lead. The Compact highlighted the benefits of international collaboration in tackling the COVID-19 pandemic and pledged to 'maintain policies, legal frameworks and programmes' to incentivise collaboration.

The ambition for 'more flexible and agile research collaborations facilitating rapid, interdisciplinary, and evidence-based responses to future systemic crises is fundamental. The UK must continue to support this endeavour and commit the requisite resources to ensure the G7 Working Group on the Security and Integrity of the Research Ecosystem is a success.[18]

Similarly, the New Atlantic Charter agreed between the US and UK in June 2021 provides a basis for the development of a deep and commercially beneficial bilateral agreement on R&D co-operation. By working with industry and the academic sector to refine its priorities as it develops the technology partnership intended to deliver the goals of the Charter, the UK Government can ensure it maximises the economic benefits for the UK.[19]

But this is just one part of a wider challenge. The goals of these international commitments and investment in cross-border platforms need to be linked to the development of the UK's domestic research ecosystem to attract collaboration from international academic and industry researchers. Signalling to global pharmaceutical companies and other research collaborators how the UK's headline ambitions translate into tangible opportunities within the UK, will be essential.

Recommendations to the UK Government:

- The UK Science and Innovation Networks (UK SIN) should play an active role in supporting local research clusters within the UK to establish new links with international research consortia.
- The UK Government and EU Commission should work together to urgently finalise the UK's association to the Horizon Europe programme.
- As part of the UK's trade policy agenda, including the use of innovation chapters and initiatives such as the New Atlantic Charter, ensure that bilateral agreements with strategic R&D hubs facilitate research collaborations through innovative cooperation frameworks, funding arrangements and provisions that support innovation and partnership. Trade dialogues should also be used to promote research collaboration.

Research governance and administration

One of the building blocks of research collaboration is good governance, provided through streamlined administrative procedures and managed through trust, shared risk appetite and shared objectives. For global innovators, the ease of doing business is a critical part of the decision on where to pursue a research collaboration; fewer administrative hurdles can go some way to encouraging collaboration and can be a source of differentiation with competitor systems.

In the UK, however, there are some time-consuming bureaucratic procedures in areas such as contracting, licencing and establishing IP arrangements – a point acknowledged by the R&D Roadmap. This is particularly the case where more than two parties are involved, which is a common feature of cutting-edge research in the life sciences. This deters international partners from seeking to collaborate with organisations in the UK.

The commitments in the Innovation Strategy to expand the Intellectual Property Office's IP education programme for researchers, and to launch an International IP Service, are welcome.[14]

It is crucial that the Intellectual Property Office's International IP Service in particular supports academic, industry and third sector researchers in the commercialisation of work produced through international collaboration.

UKRI has begun the process of reducing bureaucracy in the grant system, providing academic institutions in particular with streamlined application processes, simplified outcomes reporting and the introduction of a digital portal. The complexity of the process itself is often daunting for potential industry partners and particularly for SMEs, while the time taken to prepare grant applications and receive a decision can often be too slow for industry partners, resulting in the prospective project being superseded by funding opportunities pursued by competitor firms in other countries.

The Dowling Review[20] acknowledged in 2015 that the difficulty of completing Intellectual Property (IP) and contract negotiations, particularly where Technology Transfer Offices were involved, was the most prominent barrier for businesses when considering collaboration with academic institutions; it was the second most identified barrier for universities themselves. IP can be a contributor to university income and so there are often conflicting objectives between academic and industry partners in terms of negotiating its future use and the time horizon for realising revenue. **Standardised support mechanisms such as the model agreements for collaborative research**, known as the Lambert Toolkit,[21] have improved the time taken to reach agreement on IP, but more could be done to improve the uptake and use of the guidance.

Promisingly, the Mackintosh Report[22] and Innovation Strategy demonstrate that the government understands the need to establish and firmly embed a knowledge and technology transfer infrastructure into its fabric, through creation of The Government Office for Technology Transfer. This new unit will provide an opportunity for industry to better facilitate international research collaborations through improved networks and capacity-building with innovators in the public sector and academia; whilst also offering specialist support to realise the potential of successful collaborations through further opportunity development.

Furthermore, in 2021 the UK Government commissioned an independent review of research bureaucracy,[7] which commits to supporting the UK research system to work more productively.

As part of the Review's remit to explore university-business R&D interactions, it should assess governance processes relating to university-business collaborations, in order to identify ways to reduce contractual barriers and improve incentives for university-business collaboration.

Internationally, administrative barriers can be compounded by the cumulative effect of differences between domestic regimes.

The UK would benefit from working with global partners to develop the expertise of research administrators and establish internationally recognised guidance on best practice.

Recommendations to the UK Government:

- Ensure that the Intellectual Property Office's International IP Service focuses on supporting commercialisation realised through international, cross-sector collaborations.
- The Intellectual Property Office should conduct a review of the Lambert Toolkit for academia-industry collaborations. This should include recommendations on how to work with other countries and multilateral organisations to improve international best practice in research administration.
- The Review of Research Bureaucracy should work with academia and industry to assess governance processes relating to domestic and international university-industry R&D collaborations, in order to identify ways to reduce contractual barriers and improve incentives for university-industry collaboration.
- The Government Office for Technology Transfer should work closely with industry to build better connections between life sciences innovators in the private sector, public sector, and academia and foster innovative, international technology transfer networks with domestic research institutions and innovation ecosystems.

Funding

To achieve the UK's ambition of becoming a science superpower, the government's commitment to raise public R&D spending to £20bn by 2024/25 and £22bn by 2026/2027, to an investment of 2.4% of GDP by 2027 and continuing to 3% in the years afterwards, is critical. However, the UK must also decide **where to invest these resources in order to leverage the most private sector investment.**

In the UK, the private to public ratio of investment is currently 2:1 but countries with higher R&D spend are typically more successful in leveraging private sector contributions, such as South Korea, 3.5:1 and Japan, 3.9:1.[23] As the UK seeks to increase public sector R&D investment to record levels, bringing it more in line with other advanced economies, a goal should be set to increase the rate of leverage to a ratio of 3:1, **working with industry to structure funding programmes** so that they provide global pharmaceutical firms with the confidence to invest in early-stage research collaborations in the UK.

The pharmaceutical industry is consistently the number one private sector investor in UK R&D, accounting for £1 in every £5 invested by businesses. This means that with the right support, the sector is well placed to increase investment at a speed and scale greater than many other sectors, delivering for the UK's economic growth ambitions. Key to this is delivering on the Life Sciences Vision[24] which sets out broader ambitions for the sector, including how to attract further international investment.

The transparency, stability and efficiency of the frameworks and investments and incentives the government puts in place should be such that they leverage the greatest possible private sector contribution, as well as facilitating the exchange and networking of talent and ideas. Within this context, **it is important that the research funding system is geared towards maximising international collaboration.** This can be both through funding specific programmes, such as Horizon Europe, as well as in supporting initiatives and activities that enable international collaboration, such as ensuring grant funding for researchers includes provisions for international travel by default to attend conferences, develop overseas networks and undertake work in other countries.

To achieve the UK's ambition of becoming a science superpower, the government's commitment to raise public R&D spending to

£20bn

by 2024/25 and £22bn by 2026/2027

To encourage the greatest investment in R&D, and therefore a more substantial and immediate impact for patients and the public, **funding needs to be aligned with the strengths of the UK's science base and priorities of the global pharmaceutical sector**, reflecting both emerging research priorities such as functional genomics, but also industry's expectations on the timing, longevity and dynamism of funding schemes. An effective suite of funding schemes should ensure that large and small companies, academic institutions and other research organisations can collaborate through fair and equitable mechanisms and sharing of expertise and resources.

The UK has a strong foundation through the leadership of its funding bodies and the efforts of UKRI to develop a more integrated, cross-disciplinary approach to funding early-stage research, thus sending a clear signal to the global pharmaceutical industry that the UK's research ecosystem is world-leading and engaged in international collaborations. This is augmented through funding from industry, charitable foundations, national academies and other sources.

Policymakers should continue to work with industry to understand where these research priorities lie.

The newly established Office for Science and Technology Strategy should undertake a formal horizon-scanning process with academia, industry and the third sector to anticipate and provide advice on which areas of early-stage research and discovery should be prioritised for funding.

By doing so, the UK would gain a competitive edge by taking a strategic approach to the research sector and providing greater visibility and certainty to global investors.

The UK's domestic strengths can be further enhanced by ensuring funding programmes incorporate incentives and, where appropriate, requirements to pursue international collaboration. In particular, funding should be earmarked to support the international mobility of researchers, including between academic and industry settings.

The UK should explore expanding and internationalising programmes such as the Royal Society Industry Fellowship which supports inter-disciplinary and cross-sector exchange of talent.[25] Where appropriate, academic funding awards should permit and encourage the use of funding for international travel and accommodation for research purposes.

Recommendations to the UK Government:

- The Office for Science and Technology Strategy should undertake a formal horizon-scanning process with academia, industry and the third sector to anticipate and provide advice on which areas of early-stage research and discovery should be prioritised for funding.
- Building upon initiatives such as Royal Society Industry Fellowship, ensure funding is available to support international talent transfer between academia and private sector across borders.

4 Flows

International research collaboration is inherently dependent on the availability and cross-border flow of key inputs. This relies on boosting domestic capacity and quality, whilst reducing frictions for the international flow of talent, data and goods.

Talent

Successful R&D collaboration in the life sciences relies on skilled and talented researchers, and also on the opportunities and incentives for researchers to collaborate domestically and internationally. As outlined in the People and Culture Strategy, the whole R&D sector could create an additional 150,000 jobs by 2030.[6] Facilitating international talent flows and incentivising the international collaboration that necessitates them can help the UK address skills gap, allowing the pharmaceutical sector to invest in and create jobs.

There are two interlinked challenges for the UK, as identified by the R&D People and Culture Strategy that affect productivity, patient outcomes and health resilience. One is a **growing skills gap** in the life sciences sector where there is high emerging demand for skilled workers in genomics, engineering, informatics and computer science – with each discipline presenting its own challenges. For example, genomics is a very broad field encapsulating practical, analytical, and ethical elements - developing a genomics workforce with sufficient analytical capabilities requires high quality educational programmes which are tailored to each role and the demands of the current workforce. Second is **growing international competition for a finite pool of research expertise.** The UK must ensure it tackles both aspects – this involves demonstrating to global pharmaceutical companies and research institutions that the UK has a world-leading talent pool, while simultaneously indicating to global talent that the UK is seen by prestigious organisations as the most desired destination for collaboration.

The establishment of the Office for Talent and the commitment to establish an online portal and service to guide and facilitate overseas researchers to come to the UK is welcome.[6] Alongside the launch of the Global Talent Visa in 2020, the Graduate Route, offering skilled graduates the ability to stay in the UK without a job offer for up to three years, this provides a real opportunity for the UK to gain a competitive edge in attracting and retaining talent.[26]

A vital aspect of meeting the needs of the research sector includes ensuring the life sciences sector attracts and retains a diverse workforce. A 'best-in-class' approach to diversity and inclusion will not only ensure the sector can attract top talent, but it is also a key building block for supporting mobility between sectors.

Initiatives such as the UKRI's Future Leadership Fellowship, alongside grant support for international collaboration, are welcome investments. To keep pace with international competition, the UK should expand these programmes.

The commitment to review the UK's funding offer to globally mobile talent is also welcome. The government should ensure that stakeholders from across academia, industry and the third sector are involved in this review and consider going further, undertaking a wider human capital review to strengthen the evidence base on the barriers associated with moving to the UK.

Building on the commitments of the R&D People and Culture strategy, the government should establish a robust, bi-annual review process of human capital needs and policy challenges in the life sciences research ecosystem, incorporating feedback from academia, industry and the third sector.

The quality of domestic talent is undoubtedly a significant consideration for the global pharmaceutical industry's choice of the UK as a partner. Particularly for discovery and early-stage research, however, it is also the ways researchers work with others - building expertise through talent exchange across disciplinary and institutional lines - that marks a destination as attractive for collaboration. It is the quality of these domestic networks and inter-relationships that form the basis of the value within the UK's research ecosystem.

As outlined in the R&D People and Culture Strategy, a focus on interdisciplinary and cross-sector working can emerge through the provision of more robust continuing professional development, but it can also be supported through **innovative, agile career models in life sciences research which reward inter-disciplinary partnership-building and collaboration as much as specialist knowledge.**

An important aspect of this interdisciplinary approach is the transfer of research and commercial experience between academia, industry and the third sector. In advanced life sciences research ecosystems, such as Boston, the formal cross-working and career paths of researchers often involves a mixture of public and private sector experience, while informal networking and collaboration between the two realms is frequent, helping to develop trusted relationships and allowing for the exchange and development of ideas.

Greater incentives and clearer structures should be put in place to encourage and support researchers to pursue innovative career programmes, spending time in both industrial and academic organisations. Funding, accreditation, and structure for a large cohort of early to mid-stage researchers to work across this divide should be provided through a partnership between industry, funding bodies and universities.

Ensuring that researchers at all stages of their career have **exposure to international networking and partnership opportunities is fundamental to embedding a longer-term collaborative ethos and driving economic benefits.** This relies on efficient visa and administrative processes to facilitate access to conferences and events, funding to support researchers, especially from low and middle-income countries, and above all structures and governance to implement effective exchange programmes.

Building on the government's ambition of ensuring the UK secures its status as a science superpower, **a commitment should be made to develop international, interdisciplinary and cross-sectoral research talent at a level never seen in the UK before.** Building on the legacy of Newton International Fellowships, Chevening and Commonwealth Fellowships, the government should lead the design and funding of a scheme to support early-stage researchers in working with both industry and academic institutions.

Further support for access to global talent may come from the launch of a Global Talent Network (GTN) in 2022, as announced by the UK Government as part of the 2021 Spending Review – such a network is intended to complement immigration system reforms and result in bringing highly skilled people to the UK in key science and technology sectors. This network will work with businesses and research institutions to identify UK skills needs and source talent in overseas campuses, innovation hubs and research institutions to bring to the UK.

Currently, announcement of the launch of a GTN is met with cautious optimism as we look forward to further information in order to establish exactly how this network can benefit UK life sciences.

Recommendations to the UK Government:

- Building on the commitments of the R&D People and Culture strategy, and as part of implementation and evaluation of the Life Sciences Vision, the government should establish a robust, bi-annual review process of human capital needs and policy challenges in the life sciences research ecosystem, incorporating feedback from academia, industry and the third sector.

Data

Breakthroughs in life sciences are increasingly driven by data and digital technology. It is a fundamental component of the work undertaken by researchers and increasingly a point of competition for global pharmaceutical companies seeking to invest in R&D. Datasets such as molecule libraries and biobanks, the data infrastructure to manage them, and skilled practitioners to interpret and analyse data are all necessary to provide a valuable data ecosystem that can contribute to discovering life-saving medicines.

Technology companies are increasingly a fundamental piece of the puzzle for advanced life sciences research. Where they are integral parts of research clusters, working collaboratively with academics, the pharmaceutical industry and the third sector, they can contribute to pioneering breakthroughs, such as DeepMind's work on protein folding (Box 3).

To achieve this next generation of breakthroughs in partnership with technology firms, the life sciences sector requires four key inputs. One is **access to skills;** bioinformaticians and computer engineers are as critical to the future of the industry as immunologists and pharmacologists.

Second is **data** itself. The UK has already made strong progress through the establishment of the UK Biobank, HDR-UK and Health Data Research Hubs, however fragmentation and lack of interoperability remain key challenges. The commitments of the draft Healthcare Data Strategy (Data Saves Lives)[28] and National Genomics Strategy[29] (Genome UK) should be fully implemented if we are to unlock the full potential of the UK's health data and genomics assets.

Box 3: DeepMind and AlphaFold[27]

DeepMind's AlphaFold tool uses machine learning to predict protein structures, representing a substantial leap forward in structural biology. This, in turn, opens up a range of possibilities for pharmaceutical companies looking to develop new drugs, especially for rare genetic diseases.

DeepMind's work has generated a substantial, open access database of protein structures, which can be used by researchers from all sectors. It is hosted by the European Bioinformatics Institute, based in the Wellcome Genome Campus. The development of this database itself relied on easy access to existing protein datasets and biobanks.

Third is the **infrastructure and governance frameworks** to facilitate the use and international sharing of data. At its most acute, rapid international sharing and study of data has allowed for improved disease surveillance, control and research in (re-)emerging infectious diseases such as Ebola and more recently COVID-19. Initiatives like the UK's contribution[30] to GIS-AID,[31] a global database tracking COVID-19 variant sequences, points to the impact international data sharing can have on population health management. The newly created UK Health Security Agency provides a range of opportunities to deepen the UK's leadership here, given its mission to use world-class science and data analytics to monitor and mitigate threats.[32]

Data sharing also allows multiple groups of researchers to work concurrently towards the same goal and can broaden datasets where, as with rare diseases, patient populations may be too small in individual countries to allow for efficient research. Barriers to research here can most effectively be overcome where public and private institutions partner internationally to create datasets and their supporting infrastructure.

The UK already works with existing and emerging data research infrastructures such as ELIXIR, which develops standardised data sets across Europe,[33] or framework and standard-setting organisations such as the Global Alliance for Genomics and Health,[34] which provides tools, standards and technical advice on international genomic data-sharing.

The UK could go further by pursuing more common standards to data collection via multilateral fora, such as the OECD and WHO, to better support international research efforts.

Interoperable datasets that adhere to common standards and definitions, can magnify the utility of data for medical research. Similar approaches have been used for certain use cases, such as the Human Genome Project or the International Neuroinformatics Coordinating Facility.

Finally, international research collaboration can often be stimulated by **financial incentives**, especially for private sector partners. The Government's announcement to expand the scope of the R&D tax credit regime to include datasets, software and cloud computing services is welcomed and could help the UK capture a greater share of growth in technology-driven life sciences research.

Recommendations to the UK Government:

- The draft Healthcare Data Strategy (Data Saves Lives) and National Genomics Strategy (Genome UK) should be fully implemented to unlock the full potential of the UK's health data and genomics assets.
- The UK to take a leadership role in pursuing more common standards to data collection for international research purposes, via multilateral fora such as OECD and WHO.

Goods

As with the manufacture of licensed pharmaceutical products, **the inputs into the research and development process are dependent upon a global supply chain.** Cross-border transfer is often heavily regulated, with human tissue and cells, animals for use in medical research, Investigational Medicinal Products (IMPs), chemicals, other laboratory materials and equipment rightly subject to robust assurance processes. A range of trade policy measures can be used to reduce friction in this cross-border trade.

Although the 1994 WTO Pharmaceutical Agreement and the 1996 Information Technology Agreement eliminate tariffs on finished medicines and a wide range of precision equipment for signatory countries, R&D inputs and intermediaries can still be subject to tariffs.

An updated and expanded WTO Pharmaceutical Agreement would reduce tariff barriers further. Encouraging non-members such as China and India to accede to the agreement would expand its reach and encompass a greater proportion of supply chains. The pharmaceutical sector would also benefit from an expansion in its scope to explicitly include all R&D inputs, such as laboratory equipment, specialist transportation and storage machinery and consumables such as needles and test mediums. Pharmaceutical products, including research materials and inputs, attract one of the highest numbers of non-tariff measures (NTMs) across traded goods, requiring compliance with 38 NTMs on average. Key inputs such as organic chemicals and advanced machinery also attract a substantial number of regulatory checks to successfully facilitate cross-border trade.

The UK should work with other WTO members to **develop and share best practice in implementing common standards in domestic regulation.** This can be done via international fora and international summits, including through the International Organisation for Standardisation (ISO) and the International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use (ICH). We welcome steps the MHRA has taken to date to move towards full membership of ICH and encourage this ambition to be fully enacted in due course. This would provide the UK with an opportunity to further shape the global regulatory environment and reduce the burden of regulatory barriers to moving research material and equipment between countries.

The UK can ensure that it invests in sufficient capacity in border infrastructure and regulatory authorities to allow the prompt, accurate and effective movement of regulated goods across borders. It can also work through the WTO to encourage other members to do the same, including by encouraging the publication of national trade facilitation plans and adopting electronic pre-clearance procedures to reduce time and resource spent on navigating the customs clearance process.

Recommendations to the UK Government:

Work through the WTO to secure commitments from Member States to:

- Eliminate tariffs on imports of all pharmaceuticals, vaccines, active pharmaceutical ingredients (APIs), raw materials, chemicals, other inputs and intermediaries, and specialty equipment used to invent, manufacture, and deploy these products
- Encourage the development and maintenance of trade facilitation plans covering all inputs and goods in the R&D supply chain.

5 Conclusion

With its strong heritage in life sciences, wealth of academic and third sector expertise, and dynamic pharmaceutical industry, the UK is well positioned to grasp the opportunities afforded by international collaboration to enhance early-stage research and the opportunities of new medicine discovery.

This report identifies the importance of dynamic funding and governance structures, excellent skills and expertise, frictionless flows of talent and goods, and deep-networked research clusters to ensuring the UK fosters the most collaborative research culture in the world.

Policy and decision makers should take account of the vision set out in this report, using the opportunity of upcoming policy milestones to enhance the UK's offer to international research collaborators and ensure private and public funding flows are fully optimised.

The UK Government should also use the opportunity of forthcoming trade negotiations and dialogues to deepen collaboration with new and trusted partners, while ensuring that at a domestic level, academia, industry and the third sector are fully primed to take advantage of new horizons. Key to this will be ensuring that the life sciences workforce has the inter-disciplinary skills and opportunities it needs to remain at the cutting edge of research, along with enhancing the nation's strong research and data infrastructure.

As the UK explores a new global role, grasping these opportunities will help the country remain at the forefront of cutting-edge science, supporting the nation's economic recovery and ensuring patients can access innovative, life-changing treatments and vaccines.

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