Response from the Royal Society of Biology to the Science and Technology Committee (Commons) inquiry into a new research funding agency for the UK

July 2020

The Royal Society of Biology (RSB) is a single unified voice, representing a diverse membership of individuals, learned societies and other organisations. We are committed to ensuring that we provide Government and other policymakers, including funders of biological education and research, with a distinct point of access to authoritative, independent, and evidence-based opinion, representative of the widest range of bioscience disciplines.

The Society welcomes the opportunity to respond to this inquiry. We are pleased to offer these comments, which have been informed by specific input from our members and Member Organisations across the biological disciplines. Our Member Organisations are listed in the Appendix.

Summary

- Bioscience is a UK research strength, and includes many fields that could deliver revolutionary advances through an ARPA-like approach.
- The new agency should have a focus that extends beyond funding research, with emphasis on development and commercialisation to bring innovations into use – areas in which the UK has not been strong. Success will require investment to develop the necessary skills and capabilities, a strong pull-through strategy and a structure and atmosphere within the agency that encourages links between all elements of the R&D ecosystem.
- A UK ARPA will need to be agile and flexible, with structures that allow for and respond to failure, and can act on unexpected results that open up promising new avenues of innovation.
- International collaboration is vital for UK research and is essential to tackle global challenges. The new agency should facilitate this. There could be more vibrant investment and development in projects of potential wherever they occur throughout the UK, levelling opportunities.
- There should be a clear distinction between the agency and UKRI, and particularly Innovate UK, the Catapults and the Industrial Strategy Challenge Fund. This should avoid wasteful duplication of existing efforts, and support necessary communication.
- A UK ARPA will need to engage with and become a trusted focus for researchers so that they will seek to develop promising research with it.

Comment on ARPA as a model for a new UK funding agency

0.1   The ARPA approach focuses on opportunities for radical innovation, rather than gradual advances, addressing specific, hard-to-solve problems or responding to novel opportunities. Such research is high-risk, but can produce transformative advances with novel benefits.

0.2   Bioscience encompasses many fields that could deliver transformative innovation when visionary approaches receive the right level of backing. Examples include: synthetic biology, crop science, biomedical sciences, vaccinology, and advanced bio-manufacturing for greening the economy.

0.3   Transformative innovation often requires both large capital investment and a high tolerance for risk of failure. The private sector alone cannot provide the patient finance required.[1] However, a new funding agency could generate breakthroughs by allocating sizeable awards for research with clear objectives, targeting awards to areas of strategic need, and offering funding to bring innovations into socioeconomic use.

0.4   Funding, commitment and new ideas to support UK research are welcome, particularly with future access to European research programmes uncertain. This response highlights several issues that require careful consideration if a UK ARPA is created and is to succeed.

0.5   A key issue is whether and how the new agency will enable international collaborations. The US performs much of its innovative research within its borders, but its lesser size and access to research infrastructure makes this harder for the UK. Moreover, the UK has a long history of beneficial collaborative projects, particularly with EU researchers, but also with many other parts of the world. In 2015, over 58% of research papers by UK-based authors were the result of an international collaboration.[2] Working in isolation from other nations could be a less efficient use of public funds when collaboration is a possible alternative, and a research 'arms race' would harm UK interests if other countries pool resources, proceeding more quickly and sharing the benefits.

0.6   More broadly, with international collaboration needed more than ever to address numerous urgent and complex global challenges, those designing the agency should consider how this need can be met. UK research and development has much to contribute to the world, and there is much knowledge in other countries from which it can benefit. The UK should be outward-facing, and a leading partner in addressing global priorities.

0.7   Funding bodies have devised models to enable collaboration, while ensuring that international partners contribute fairly to costs and the UK benefits from public research spending. Careful thought is needed to design systems that allow efficient, effective international collaboration.

0.8   A UK ARPA should identify and deliver in the areas with the greatest need for innovation, where iterative approaches are not sufficient. One idea is a focus on addressing the key challenges facing society, such as health, pollution, biosecurity, food security, biodiversity loss, poverty, climate change and achieving net zero, and management of water systems. The UN Sustainable Development Goals (SDGs) list 17 challenges facing the world and the UK. The SDGs provide a common language for what are large-scale, complex and entrenched problems, which cannot be solved by the UK alone, and require global strategic and economic cooperation.

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[1] HM Treasury, 2017. Patient Capital Review
[2] Royal Society 2015. UK research and the European Union: the role of the EU in international research collaboration and researcher mobility.

0.9   A new funding agency could support and advance UK interests, prioritising research on the challenges with the biggest impact on the UK, but with a remit to act globally, contributing to the UK's soft power.[3] A part of the agency's role could be to address problems that require supra-national coordination, resources and cooperation, bringing together individuals and organisations to form new collaborations that cross disciplines, sectors and national borders.

Question 1. What gaps in the current UK research and development system might be addressed by an ARPA style approach?

1.1   The UK has a gap in funding for late stage research and development for new and improved technologies.[4,5] Findings from early stage research cannot easily be taken forward. For example, agricultural research at universities has not always met the needs of end-users, while applied areas have sometimes been seen as the responsibility of those supplying farmers; resulting in missed opportunities to develop products that improve yields, quality and revenue. In medicine, development of new products and anti-bacterial agents can be delayed, for example where market size appears small, until a crisis occurs creating a "pull through" for development.

1.2   To bridge this gap and provide pathways to commercialisation, focus is needed on technology development and bringing innovations into use, as well as research. The agency will need to cultivate effective links between academia, research institutes and industry, creating a structure and atmosphere in which interactions and relationships can develop between sectors. This could include industry exchanges and apprenticeships. Collaboration and co-development with industry (and other research users) is essential to ensure work is focused in the right areas and discoveries can deliver benefits to end-users and impacted communities. Business insight on global market relevance and feasibility of commercialisation could also be considered at the outset (though longer term ambitions should not be hampered by short-term income horizons). Proposals could include market intelligence assessments, rather than impact statements that might be less clear or realistic. The transition from R&D to product and application should be "built in", with end-goals envisaged at the outset, including steps necessary for commercialisation, production to scale, procurement and/or market uptake. Development, innovation and commercialisation are areas in which the UK has historically not been strong; investment is required to build these skills and capabilities, which are broader than academic skills. Technology transfer needs to be adequately resourced to provide attractive, sustainable careers for bright and competent individuals.

1.3   Many areas of bioscience require longer funding periods to accomplish full projects than typical DARPA programmes – for instance research with generation times and cycles, like plant breeding. Development from concept to commercialisation usually takes many years, with continuous funding needed to bridge the 'valley of death'. The new agency could, where necessary, fund projects longer than other funders (e.g. BBSRC's Strategic Longer and Larger [sLoLa] grants of up to five years[6]), or renew funding for successful projects. Programmes could be planned for periods on at least the

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[3] Royal Society 2010, New frontiers in science diplomacy: Navigating the changing balance of power.
[4] Campaign for Science and Engineering, 2018. CaSE Member & HM Treasury Roundtable: R&D investment.
[5] Royal Academy of Engineering, 2018. Increasing R&D investment: business perspectives.
[6] BBSRC, 2020. Strategic Longer and Larger grants: Frontier bioscience 2020/21

timescale of the EU Framework Programmes (currently seven years). Adaptability and flexibility could be a strength, when there is active funder engagement with research as it progresses.

1.4 There is a need for a rapid scientific response to emerging infectious diseases and other threats to human, animal and plant health, highlighted by the COVID-19 pandemic.

1.5 There remains a huge appetite and need for more discovery research funding in the UK research community, and so the new agency should not detract from continued enhanced support for UKRI. There is also uncertainty about future access to EU grants; should access be lost, impacts should be managed through enhanced funding delivered by UKRI. A UK ARPA should not aim to replace European funding, but to offer something different.

Question 2. What are the implications of the new funding agency for existing funding bodies and their approach?

2.1 A UK ARPA would identify and fund high-risk, high-reward ideas that would not be funded by other bodies. Its approach should contrast with other public funders, which broadly support basic and applied research with lower risk. Existing funders must continue to support work on basic and applied science, the UK's excellence in which provides the underpinning necessary to make a success of an ARPA-style agency.

2.2 While the new agency will need distinct aims, processes and purpose to avoid competing with existing funding bodies, areas of research will inevitably overlap. The agency could therefore free up existing funding bodies to concentrate on their core strengths.

2.3 Clarity will be needed about how the new agency will complement and link with Innovate UK, Catapults and the Industrial Strategy Challenge Fund, without duplicating their efforts, to make best use of limited resources.

2.4 A UK ARPA could be formed within UKRI or as an independent body. Views are mixed and there are benefits and risks to both options that will require different mitigating action. Close links with UKRI would facilitate collaboration and sharing of knowledge and facilities, but might preclude a distinct approach and focus. An independent agency risks creating silos and duplicating some functions, but would give more flexibility in creating new processes.

2.5 On balance, the best option appears to be establishing ARPA as a separate entity, clearly distinct from UKRI, but with good lines of communication. This will allow clear assessment of the success of the ARPA approach, which should be assessed in a future review to ensure the agency is meeting its objectives, operating effectively and not overlapping with other bodies.

2.6 The roles and interactivity of Innovate UK and a UK ARPA should be carefully considered to achieve the ambitions for both investments.

Question 3. What should be the focus of the new research funding agency and how should it be structured?

3.1 A new funder distributing public money should focus on innovation for societal and global benefit – for instance aligned with the UN SDGs, climate and biodiversity targets – harnessing opportunities in research (both within and across disciplines).

3.2 A UK ARPA should be nimble, with a shorter lead time between concept and implementation than existing funders. Its operations must accept the potential for failure and have the ability to monitor and scale back projects (and sometimes programmes) if key milestones or developments are not achieved, with agreed options for agile directional change and redeployment of funds. Failure, in this context, includes loss of potential market advantage/benefit as well as technical failure. Good governance and fair judgements are needed to make such assessments, recognising the benefits of halting unsuccessful programmes early, so that resources can be reallocated. Within MRC, oversight of translational projects follows a process that could provide lessons. Milestones must be impact- and success-related, with the final objective clearly in mind. Abruptly halting research projects could create challenges for universities and other institutions in retaining staff on stable contracts. Research organisations should seek to develop flexible models for consortia working, permitting agility in adjusting research direction and for staff postings at different sites where necessary.

3.3 The agency must have the agility and flexibility to act on unexpected results or promising avenues of innovation when they arise. The US DARPA has successfully developed applications of technology outside their envisaged uses, underscoring the importance of cross-disciplinarity, lateral thinking and creative approaches. Mechanisms should be in place to learn from failure, or to adapt failures in one sector into potential advances in another. While milestones should be set out, it may become apparent that different approaches or even endpoints are preferable, particularly for longer-term projects.

3.4 The agency should select the problems on which to focus, setting a range of bold, ambitious, concrete missions, which, if successful, offer a high chance of creating UK and global societal benefit. This should aim to engage communities across disciplines and sectors. These exciting, relevant questions can inspire public interest. A parallel open process would allow consideration of novel ideas that a mission-selecting committee may not think of.

3.5 The agency's structure should be as accessible as possible, open to researchers, innovators and industry. To be open to unanticipated or mission-blind opportunities, but true novel innovation, the agency needs to develop a reputation and mechanism as an open listener, inviting of approach from promising researchers with promising ideas.

3.6 The insights of social scientists, practitioners and end-users are important in instigating innovations with benefits "on the ground". End-users should take active roles in shaping projects at the outset, and maintain links with researchers during projects to ensure that innovations are relevant and useful, and after completion to inform impact assessments.

3.7 DARPA finds and empowers 'thought leaders' to act as programme managers. These appointments are 'term-limited to ensure a constant infusion of fresh thinking and new perspectives', typically lasting four or five years.[7] The system has worked well for DARPA, providing programme managers with

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[7] DARPA, 2020. Employment at DARPA - Recruitment Information

autonomy and authority to test and enact their visionary ideas. However, there is little oversight or scrutiny, and a high degree of trust in the programme managers is needed. To command public confidence and the best outcomes for society, decisions must be made fairly and transparently, with a demonstrable process open to scrutiny. The appointment of programme managers must accord with best practice (and employment law) with respect to diversity and inclusion. These individuals will need broad and relevant experience, expertise and networks, and the roles must be sufficiently rewarding to attract the best candidates, appropriately valuing their expertise and experience.

3.8   The agency would also require capable IP professionals to undertake and advise on licensing and negotiations. This could be delivered by a unit, or with a hub-and-spoke model to spread knowledge to funding recipient institutions.

Question 4. What funding should ARPA receive, and how should it distribute this funding to maximise effectiveness?

4.1   A UK ARPA would need significant funding to deliver on its potential. Funding should not be spread too thinly across many projects, and the agency may need to focus on fewer, well-resourced programmes to derive the most value from each. It may be pragmatic to build on areas where the UK is world-leading. Funding should be sufficient to attract highly skilled individuals.

4.2   The Government will need to set out publicly and transparently how funding decisions will be made, by whom, and the degree to which these decisions will be made by Government or by independent scientists. Funding decisions should take into account other policy areas, such as supporting the 'levelling-up' agenda and the post-Covid economy.

4.3   Each project should be funded at the scale appropriate for the end-goal and stage of the R&D process, assessed when calls are created and at project selection.

4.4   If the agency is to be successful in the long-term, it will need cross-party support, to give adequate time to show its worth. The time-frame required to deliver radical innovation is longer than the political cycle, and patience and collaboration will be needed. However, as for other major funders, a review interval and mechanism should be incorporated to assess agency effectiveness and success.

4.5   Partnership working should be embedded in the agency, and it should leverage additional support from collaborations with industry, SMEs, NGOs, public sector research establishments (PSREs), and government laboratories, as well as from philanthropy. Organisations across these sectors could bid openly and jointly for funding, to maximise the gearing available from each sector.

4.6   ARPA's budget should always come in addition to (and not eclipse) other effective approaches to research funding – of value to the community and with positive impact for society – which would remain a vital part of the research and development ecosystem. Maintaining separate budgets for UKRI and ARPA would avoid competition over funding streams during budget-setting.

4.7   The US DARPA is able to fund risky research because its budget allows scope for failures, provided there are some successes. A UK ARPA should guard against being too risk averse with its smaller budget, lest it should fail to fund ideas sufficiently ambitious to create disruptive breakthroughs.

4.8 The agency should aim to stimulate growth and economic activity in ways that create societal benefits, for instance directed towards meeting global challenges (see section 0.9, above). When successful commercial ventures arise from publicly funded innovation and discovery, a fair and pre-agreed portion of the revenues should be returned to public finances, for instance by retaining a share of intellectual property rights or equity in new start-ups. However, sufficient IP protection and returns must be available to incentivise development and commercialisation of products.

4.9 The agency should aspire to a level of openness that inspires public trust, interest, engagement and feedback on the research undertaken. However, this must be balanced with the need to protect new intellectual property, necessary to incentivise industry involvement and the commercial development of innovations.

4.10 Government should set out how it will assess the success or failure of projects, and their impact. Funding would be needed to determine the attainment of goals (e.g. those of delivering societal benefit) over various timescales. Lessons should inform future funding decisions and evaluations.

4.11 The agency should set out how it will distribute funding for international collaborations, as discussed above (sections 0.6-0.8).

Question 5. What can be learned from ARPA equivalents in other countries?

5.1 DARPA research has led to significant civilian applications, but while it uses public funding to share the risks of research, it has not always sought to obtain a share of the rewards directly for the public. Meanwhile privatised innovation building on public research creates significant private wealth. A UK equivalent could greatly support our SMEs and biotech industry, but with appropriate sharing of risk and reward negotiated upfront.

5.2 DARPA has developed products and solutions for which the US Government was an early customer, such as the microchip. Public procurement encouraged private investment and created economies of scale, driving down prices. Lower priced microchips then enabled further applications and widespread adoption. This fly-wheel effect could drive the adoption of green technologies, contributing to progress towards net zero.

5.3 Without a clear customer of first resort, commercialising innovations is more difficult, and a focus on technology transition will be crucial. A stronger "innovation pull" could be provided by using public-sector procurement strategically, for instance encouraging procurement teams to spend on innovative ideas and linking them with ARPA programme managers and potential end-users from the start of projects. Lessons from SBRI, which attempts to create demand pull through procurement, could be instructive; feedback from users and industry has been mixed, and there is a perception that public procurement budget holders are risk averse.[8]

5.4 The selection of programme managers is vital to the DARPA's success. The skills and experience required for success are different from those in academic careers, and the search for programme

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[8] Rothwell and Gerghiou, 2020. Navigating high scientific risk and high innovation risk to reap the rewards of ARPA funding. In *Visions of ARPA: Embracing risk, transforming technology* (Eds Mansfield and Owen). Policy Exchange.

managers will need to consider a broader field than those with distinguished careers in research, if the agency is to foster truly revolutionary ideas, and ultimately create benefits.

Question 6. What benefits might be gained from basing UK ARPA outside of the 'Golden Triangle' (London, Oxford and Cambridge)?

6.1   Opportunities for regeneration, increasing connectedness, and more equitable dissemination of research funds and outputs across the UK should be considered.[9] While there are strong clusters such as the 'Golden Triangle' spanning many capabilities, different regions and nations of the UK also have particular strengths. Centres of excellence for particular disciplines outside of the south-east should be recognised in decision-making, for instance, with capabilities in agriculture, food, advanced materials and the bioeconomy. Potential locations outside of the south-east will need good development of ongoing interaction (in both directions) with central Government to optimise policy relevance.

6.2   A distributed model, or hub-and-spoke model, could engage a wider range of stakeholders, encourage more inclusive and diverse recruitment, facilitate the agency in seeking new research and individuals with potential, and ensure related employment opportunities are distributed around the UK. Science parks could provide an option for locating regional offices.

6.3   A large headquarters should not be needed, as the agency should contract research to be performed elsewhere, rather than in its own facilities. Regardless of location, the agency should engage fully with the devolved administrations, regional partnerships and combined authorities. It should aim to form consortia that combine the best of academia, industry and other sectors, with the goal of producing research of real societal benefit across communities.

6.4   An equitable and sustainable system to develop current research and development infrastructure, skills and opportunities across the UK, via a distributed model for a UK ARPA, should be incorporated in planning from the outset. Current UK infrastructure standing to benefit from such a system of 'levelling-up' ranges from the web of SMEs in the Scottish Highlands to the Golden Triangle and all models in between. The potential benefits to be brought by supporting this diverse community – the power of place – would stretch across the equally broad set of citizen communities in the UK. CaSE's report on The Power of Place considers many of these issues.[10]

[9] UK Research & Innovation, 2020. Regional distribution of funding for research and business.
[10] CaSE, 2020. Power of place crucial to UK's Covid-19 economic recovery.

Appendix: Member Organisations of the Royal Society of Biology

Full Organisational Members
Agriculture and Horticulture Development Board
Anatomical Society
Association for the Study of Animal Behaviour
Association of Applied Biologists
Association of Reproductive and Clinical Scientists (ARCS)
Bat Conservation Trust
Biochemical Society
British Association for Lung Research
British Association for Psychopharmacology
British Biophysical Society
British Ecological Society
British Lichen Society
British Microcirculation Society
British Mycological Society
British Neuroscience Association
British Pharmacological Society
British Phycological Society
British Society for Cell Biology
British Society for Developmental Biology
British Society for Gene and Cell Therapy
British Society for Immunology
British Society for Matrix Biology
British Society for Neuroendocrinology
British Society for Parasitology
British Society for Plant Pathology
British Society for Proteome Research
British Society for Research on Ageing
British Society of Animal Science
British Society of Plant Breeders
British Society of Soil Science
British Society of Toxicological Pathology
British Toxicology Society
Daphne Jackson Trust
Drug Metabolism Discussion Group
Fisheries Society of the British Isles
Fondazione Guido Bernardini
GARNet
Gatsby Plant Science Education Programme (incl. Science and Plants for Schools)
Genetics Society
Heads of University Centres of Biomedical Science
Institute of Animal Technology
Laboratory Animal Science Association
Linnean Society of London
Marine Biological Association
Microbiology Society
MONOGRAM – Cereal and Grasses Research Community
Network of Researchers on the Chemical Evolution of Life
Nutrition Society
Quekett Microscopical Club
SCI Horticulture Group

Society for Applied Microbiology
Society for Experimental Biology
Society for Reproduction and Fertility
Society for the Study of Human Biology
South London Botanical Institute
The Field Studies Council
The Physiological Society
The Rosaceae Network
Tropical Agriculture Association
UK Brassica Research Community
UK Environmental Mutagen Society
University Bioscience Managers' Association
Zoological Society of London

Supporting Organisational Members
Affinity Water
Association of the British Pharmaceutical Industry (ABPI)
AstraZeneca
BioIndustry Association
Biotechnology and Biological Sciences Research Council (BBSRC)
British Science Association
Covance
Ethical Medicines Industry Group
Fera
Institute of Physics
Ipsen
Medical Research Council (MRC)
MedImmune
NNedPro Global Centre for Nutrition and Health
Northern Ireland Water
Porton Biopharma
Royal Society for Public Health
Severn Trent Water
Syngenta
Understanding Animal Research
Unilever UK Ltd
United Kingdom Science Park Association
Wellcome Trust
Wessex Water
Wiley Blackwell