Response from the Royal Society of Biology (RSB) to the call for evidence on the UK's Biological Security Strategy

March 2022

The Royal Society of Biology (RSB) is a single unified voice, representing a diverse membership of individuals, learned societies and other organisations. Our world-leading biosciences sector contributes strongly to the economy, and to society. 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 RSB welcomes the Cabinet Office's call for evidence on the UK's biological security strategy. We are pleased to provide comments informed by our membership of individuals and organisations with expert interests across the biosciences. Our Member Organisations are listed in Appendix 1.

Summary

Our response to this call for evidence advises that a renewed Biological Security Strategy should mainstream, support and integrate the following summary points. A single accountable body could ensure a clear line of reporting from risk owners across different Government departments and bodies, also enabling efficient and effective evidence gathering, policymaking, incentives and system design in collaboration with the biosciences sector, including representative organisations such as the RSB:

- Assist development and upholding of relevant community agreed standards and best practice, for example in research integrity, and biosecurity in laboratories, farming and trade, through appropriate governance, training and increasing awareness.
- Advance and refine forms of evidence gathering activity and infrastructure, such as vital surveillance, including through increased official development assistance to low and middle income countries, and building on successful systems assembled to tackle the COVID-19 pandemic; ensuring policy-making capacity to respond appropriately to evidence gathered.
- Enable transparent, efficient and effective routes for continuous, strategic information flow across sectors and disciplines, to ensure systems to anticipate, assess and respond to biological threats integrate the appropriate scientific evidence base – including One Health principles and approaches.
- Improve relevant (current and future) risk assessment and response capability through workforce capacity, training and skills acquisition, and resourcing, working closely with employers and professional associations.
- Bring a strategic focus to countering the spread of misinformation and disinformation related to biosecurity.
- Recognize both biodiversity loss, and chemicals and waste pollution, as priority challenges alongside climate change. Tackle these three complex threats together by advancing technologies alongside risk-benefit analysis, informed public debate and fit-for-purpose regulation, and by delivering well-integrated policies through cross-departmental, inter-sector, local, national, and international co-ordination.
- Act to make swifter progress and deliver positive change through international, national and regional leadership, to tackle and prevent a pandemic of AMR.
- Consider food production and security as a key system at risk from many of the threats listed in our full response.

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About the RSB response
All questions are shown below as they appear on the consultation document. The RSB responses to each question are in blue text.

Call for evidence questions

1: What are the key biological security opportunities, challenges, threats and vulnerabilities facing the UK:

a. now?

Opportunities:

- secure global leadership and resilience to future biological challenges, threats and vulnerabilities, e.g. in antimicrobial resistance (AMR) policy through One Health (OH) stewardship, and innovative antimicrobials[1]
- international collaboration: research, knowledge exchange, data share, surveillance
- international leadership: research standards and evidence-based policymaking on global challenges
- bio-technological advances e.g. artificial intelligence (AI) and machine learning; combination technologies to improve predictions[2]; automated sensors for detection and monitoring; engineering biology[3] and the use of genetic knowledge
- opportunities for bespoke UK policy, e.g. managing import conditions to eliminate the risk of carrying plant diseases such as Xylella, from the EU and elsewhere
- informed public dialogue and debate on the use of technological innovations to feed into democratic and evidence-based policymaking

Challenges[4]:

- continued COVID-19 pandemic
- limited pandemic preparedness and lack of full implementation of recommendations of Exercise Cygnus[5] and other such exercises
- high cost of biosecurity monitoring for private industry, also some technologies for biosecurity are unsuitable e.g. for farmers or agronomists without further streamlining and training. Lack of standards and interoperability between surveillance and biosecurity technologies/platforms may also hinder adoption.
- limited UK production, e.g. for horticultural plants, leading to greater reliance on imports
- strained resources for the screening required to trade plant and animal products following EU exit

Threats:

- socioeconomic and political instability affecting e.g.: international relations; research, surveillance, and risk analysis collaboration and funding agreements (latter e.g. association to Horizon Europe); food security; preparedness and response to global threats

[1] In-draft response (as of 18/03/2022) from the UK BioIndustry Association (BIA) to the call for evidence on the UK's Biological Security Strategy. https://www.bioindustry.org/ Final response: https://www.bioindustry.org/resource-listing/bia-response-to-biological-security-strategy-call-for-evidence-2022-docx.html

[2] Royal Society of Biology response to Defra on the GB plant biosecurity strategy; November 2021: https://www.rsb.org.uk/images/RSB_response_to_GB_plant_biosecurity_strategy_consultation-submitted.pdf

[3] UK BioIndustry Association information webpage on engineering biology https://www.bioindustry.org/policy/strategic-technologies/engineering-biology.html

[4] Royal Society of Biology response to Defra on the GB plant biosecurity strategy; November 2021: https://www.rsb.org.uk/images/RSB_response_to_GB_plant_biosecurity_strategy_consultation-submitted.pdf

[5] Annex B: Exercise Cygnus Report (accessible) - GOV.UK (www.gov.uk): https://www.gov.uk/government/publications/uk-pandemic-preparedness/exercise-cygnus-report-accessible-report

- the spread of misinformation and disinformation, hampering informed decision-making
- climate change
- biodiversity loss
- chemicals and waste pollution
- generation and spread of antimicrobial resistance (AMR) increasing the risk from pathogens across species and ecosystems. Related, the risk that drug-resistant pathogens, such as anthrax, will be deliberately spread as a weapon.
- future pandemics, e.g. public health risk from emerging zoonoses[6]. Pandemics in livestock or crop species risk our food security. Pandemics in wild species risk damage to ecosystems and the ecosystem services on which we rely.
- third party manufacturing and release of human pathogens
- animal and crop production systems which have little resilience to pathogens and act to promote epidemics, due to inappropriate agricultural practices. Market efficiency is often counter to disease resilience - markets need to be proactively managed and, if necessary, regulated.
- reductions in long-term Official Development Assistance (ODA) affecting research of benefit
- invasive species
- illegal import of cheaper, non-biosecure ornamentals

Vulnerabilities:

- in structures for timely information flow from expert research base to policy advisors and policymakers
- lack of surge capacity, through organisation of laboratory capability, to cope with emergencies
- small number of established companies and facilities for viral vectors, sub-unit proteins and whole virus vaccine manufacturing[7]
- lack of awareness of notifiable diseases, pests and other relevant threats across public and policymakers[8]
- lack of awareness among innovation and technology communities of key Government questions, challenges and opportunities[9]
- gain-of-function research (GOF) entails potential risks (e.g. escape through laboratory incident and outbreak of disease) and benefits (e.g. new research insights to help tackle infectious diseases)
- lack of contingency planning and supply, or reliance on overseas suppliers, leading to low stocks and shortages of essential mitigation equipment if supply chains are stretched

b. in 5 years?

- All of the above are likely to be relevant in 5 years, dependant on near-term change.
- However, potentially these factors will be exacerbated by a projected financial recession affecting the UK (and other countries) post-pandemic, post-EU exit and post-war in Ukraine (geo-political instability).
- The threat posed by specific drug-resistant infections has the potential to change rapidly. The threats and challenges posed by AMR will increase over time unless significant action is taken to address it.
- Advances in use of genetic knowledge include genomic epidemiology techniques which can track outbreaks in great detail and monitor a range of environments from farms to hospitals. This

[6] British Society for Immunology response to the Government's Consultation on a Biological Security strategy. https://www.immunology.org/

[7] In-draft response (as of 18/03/2022) from the UK BioIndustry Association (BIA) to the call for evidence on the UK's Biological Security Strategy

[8] Royal Society of Biology response to Defra on the GB plant biosecurity strategy; November 2021: https://www.rsb.org.uk/images/RSB_response_to_GB_plant_biosecurity_strategy_consultation-submitted.pdf

[9] Royal Society of Biology response to Defra on the GB plant biosecurity strategy; November 2021: https://www.rsb.org.uk/images/RSB_response_to_GB_plant_biosecurity_strategy_consultation-submitted.pdf

sequencing capacity is vital in defence against COVID-19 and AMR through detecting outbreaks, to developing prophylaxis and treatments. Use of genomics surveillance techniques will become even more important in detecting, understanding and responding to these threats[10]. Another use of genetic knowledge involves genetic engineering technologies where applications could reduce risks to food security.

c. in 10 years?

All of the above are likely to be relevant in 10 years, dependant on near-term change. Further impact of climate change could mean the UK faces increased threats from tropical diseases and disease vectors[11].

2: How can the UK capitalise on the identified opportunities?

a. What are the key global, regional and domestic trends affecting UK biological security out to 2030?

- Climate change[12] is arguably now the major driver evolving the risk landscape, for reasons the 2018 Biological Security Strategy (the 2018 Strategy) makes limited note of (p.12). Despite UK leadership, predictions and calls for fast action are stark[13]. Timely action is imperative to prevent further climate change and mitigate related changes in habitat and species distribution. However, in case the UK and international community fail to prevent and where necessary adapt to this threat (some changes could be irreversible in the medium term) additional planning should identify related risks and response strategies under adaptive scenarios and with sustainable technologies.
- Despite the appropriate level of importance and focus warranted to the threat of antimicrobial resistance (AMR) in the 2018 Strategy (e.g. p.11), including OH approaches which are key, there is growing evidence of the increasing risk[14],[15]. This review should carefully assess the approaches described to tackle AMR in the 2018 Strategy, implementing lessons learned to prevent a pandemic of AMR.
- Biodiversity loss[16],[17]. The 2018 Strategy fails to mention this threat at all, which should be remedied. Halting and reversing biodiversity loss and habitat encroachment could limit spread of disease and conditions for emergence of new pathogens, or increase the success of existing disease control programmes. However, in case the UK and international community fail to halt and reverse biodiversity loss, there needs to be additional scenario planning.

[10] In-draft response (as of 18/03/2022) from the UK BioIndustry Association (BIA) to the call for evidence on the UK's Biological Security Strategy
[11] In-draft response (as of 18/03/2022) from the UK BioIndustry Association (BIA) to the call for evidence on the UK's Biological Security Strategy
[12] The Intergovernmental Panel on Climate Change (IPCC) home webpage: https://www.ipcc.ch/
[13] IPCC Sixth Assessment Report press release published 28 February 2022: https://www.ipcc.ch/report/ar6/wg2/resources/press/press-release/
[14] Government press release published 18 November 2020: https://www.gov.uk/government/news/new-antibiotic-resistant-infections-rise-to-178-per-day-in-england
[15] University of Oxford News published 20 January 2022: https://www.ox.ac.uk/news/2022-01-20-estimated-12-million-people-died-2019-antibiotic-resistant-bacterial-infections
[16] Convention on Biological Diversity home webpage: https://www.cbd.int/
[17] The RSB science policy team described these risks in detail in a note via email to the Cabinet Office private sector engagement team in January 2022, following a request for information.

- Chemicals and waste pollution[18],[19],[20]. The threat to the health and wellbeing of all life on Earth through chemicals and waste pollution is also a major omission from the 2018 Strategy. Examples include river contamination globally with a range of chemical pollutants including pharmaceutical pollution[21], providing a route for development and spread of AMR, among other risks e.g. unknown consequences on the microbial ecology of water.
- Another example is the need to include broader consideration of pesticide pharmacology and toxicology in evidence-based plans for safer legal limits and more sustainable use of pesticides (plant protection products)[22]. The effect on our environment, health and ecosystems from combinations of chemicals in waste released to mix uncontrolled in the environment, must also be further investigated. The international community must do more, fast, to assess this threat, and prevent and mitigate associated risks, especially through regulatory systems which optimize human, animal, plant and ecosystem health.
- As noted in the 2018 Strategy (p.11) technological advances, for example in use of genetic knowledge, alongside an evidence-based regulatory system also developed through informed public debate, hold the potential to mitigate some threats, e.g. through reducing disease risks to livestock and crop populations by genetically engineering their disease resistance. Recent policy changes on gene-editing for plant research and field trials in England is a step in the right direction. (Also see answer 1. b.)
- There is global recognition by governments of the importance of onshoring the life sciences supply chain, where possible, to secure resilience to health emergencies and contribute to the global biosecurity response[23].
- The UK requires standards to be sustained in food products and live imports; this can be managed through rules-based trading.
- Open science communication and dissemination, including open access research publications, enables rapid information share internationally, engendering efficiency benefits for research communities. Ethical, peer review and security standards should be integrated and transparently reviewed ongoing[24]

b. How should the government prioritise its efforts to identify and respond to these?

- We fully support the positioning of a One Health (OH) approach at the heart of the 2018 Strategy (p.16); this should be carried forward and strengthened. We welcome commitments made[25] by UK and international ministers at G7 meetings in 2021. Government must coordinate with funders and other stakeholders to enhance and incentivise OH research and education; and integrate the OH evidence base, approaches and principles into policymaking, as part of systems-based and long-term strategies to tackle current and future threats. OH principles include sustainable practice and implementation to

[18] International Panel on Chemical Pollution (IPCP) Declaration: https://www.ipcp.ch/ipcp-declaration
[19] Government press release published 2 March 2022: https://www.gov.uk/government/news/uk-backs-ambitious-global-action-to-tackle-plastic-pollution
[20] IPCP News published 7 March 2022: https://www.ipcp.ch/news/celebrating-the-first-milestone-towards-establishing-a-global-science-policy-panel
[21] University of York News published 14 February 2022: https://www.york.ac.uk/news-and-events/news/2022/research/global-study-pharmaceutical-pollution-rivers/
[22] Written submission from the British Pharmacological Society to the Defra consultation on the revised national action plan for the sustainable use of pesticides (plant protection products). https://www.bps.ac.uk/
[23] In-draft response (as of 18/03/2022) from the UK BioIndustry Association (BIA) to the call for evidence on the UK's Biological Security Strategy
[24] Royal Society of Biology response to the UK Research and Innovation (UKRI) Open Access Review consultation; May 2020: https://www.rsb.org.uk/images/Policy/RSB_response_to_UKRI_Open_Access_Review.pdf
[25] G7 UK 2021 News published 3 November 2021: https://www.g7uk.org/uk-presidency-celebrates-g7-one-health-approach/

ensure ongoing productivity, for example in food production, where the health of our crop pollinator populations is as important as the health of the crops themselves.

- Support and incentivise a well-integrated and comprehensive framework for research funding under this strategy. Funding should balance discovery, translational and applied forms of research – which are of equal importance. Many of the advances made during the COVID-19 pandemic, e.g. development and delivery of novel vaccines, were made possible due to many years of discovery research and international movement and collaboration between researchers, in addition to unprecedented levels of funding, and scaling up of manufacturing processes, plus appropriate acceleration of regulatory bodies' approval processes[26]. Preservation of the research and public health infrastructure we have built up is important to prevent opportunity cost in future. Other funding bodies with a role include Innovate UK, UKRI/BBSRC, potentially ARIA, and other specific programmes for example aimed at increasing access to finance for start-ups and scale-ups[27]. (Also see answer to question 3. a.)
- Support well integrated, responsive and resilient infrastructure (including through expert advisory committees) for knowledge exchange, expert analysis, horizon scanning, and scenario and contingency planning. This is imperative to enable transferrable capability and capacity to prepare for and pivot response to the unexpected (e.g. a pandemic of coronavirus rather than influenza). (Also see answer to questions 2. h. and 3. b.).
- Maintain and join efforts to develop global-scale surveillance systems, including biosurveillance for emerging health threats. Recent research has discussed establishing global surveillance systems for plant health[28] and proposed a research agenda for plant disease pandemics[29].
- Rules-based trading and biosecurity checks at the borders. The UK has greater capacity to control the passage of dangerous pathogens across its borders than many countries but it does relatively little at the border to protect the UK. Compare with Australia or New Zealand as examples where high levels of biosecurity are applied. However, the UK also needs to take a risk-based approach to biosecurity checking, using for example AI to help identify where the greatest risks lie.
- Consider additional ways to bolster the expert workforce required across research, surveillance, inspectorate and policymakers (and other relevant roles) for example through apprenticeship routes, promoting career opportunities in relevant bodies widely e.g. to undergraduates, and sufficient staffing with appropriate remuneration and career development.
- Engage with groups likely to first encounter new threats such as plant diseases or invasive alien species (e.g. gardeners, farmers, land managers).

c. How do new mitigations which emerged through the COVID-19 pandemic (such as mRNA vaccines) alter the risk landscape?

- During the Covid-19 pandemic, close working of scientists with the regulators (MHRA) led to accelerated development pathways to the clinic for vaccines and therapeutics. This momentum should be exploited in response to other emerging and current pathogens for which there are no effective vaccines currently and which could pose a future threat e.g. Lassa fever, Nipah virus, the filoviruses, dengue fever; whilst also maintaining a high standard of independent regulatory review and maintaining the UK vaccine network to support this interaction.
- The speedy development of effective mRNA vaccines against SARS-CoV-2 sets a precedent for the utilisation of this technology in future pandemics that may arise, toward the goal set out by

[26] British Society for Immunology response to the Government's Consultation on a Biological Security strategy
[27] In-draft response (as of 18/03/2022) from the UK BioIndustry Association (BIA) to the call for evidence on the UK's Biological Security Strategy
[28] Carvajal-Yepes et al. (2019) Science 364 (6447), 1237-1239, https://doi.org/10.1126/science.aaw1572; Giovani et al. (2020) Nature Plants 6, 902-905, https://doi.org/10.1038/s41477-020-0744-x
[29] Ristaino et al. (2021) PNAS 118 (23), e2022239118, https://doi.org/10.1073/pnas.2022239118

the Coalition for Epidemic Preparedness Innovations (CEPI) to create an effective vaccine against the next 'Disease X' in 100 days. Although highly positive developments have been – and continue to be – made, the presence of vaccine technologies alone does not necessarily diminish risk from future pathogens. Key factors that affect the risk profile presented by a new pathogen include: rate of mutation of the pathogen in question; availability of raw materials for vaccine manufacture; availability of funding for simultaneous large-scale trials; stability and storage requirements of the relevant vaccine, together with distribution and logistics of vaccine delivery; and the extent to which vaccine delivery is on a global scale, including Low and Middle Income Countries (LMICs).[30]

- The interaction between political leaders, chief medical officers and scientific advisers (including the Scientific Advisory Committee on Emergencies) and public presentations and advice by the Government CMO and CSA was immensely valuable in the early part of the pandemic in reducing risk.
- Enacting the scientific advice on mitigation in law ensured public compliance in 2020.
- The rapid genetic testing of coronavirus infections helped identify new variants quickly, allowing measures on mitigation to be modified, if required.
- The development of novel vaccines and their rapid testing allowed rapid vaccination of the population.
- The availability of large scale diagnostic tests (Lateral Flow and PCR tests) enabled quick diagnosis and isolation of infected individuals
- A study has found that COVID-19 control measures are likely to have led to substantial changes in risk from other disease threats such as dengue fever, lessons learned should be considered for integration into control strategies longer term[31].
- Irrespective of any (specific) technology, the pandemic has demonstrated how underprepared most countries were for the scenario, including the UK. There is enormous potential for lessons learned from the pandemic with regard to public health, preparedness among industry, etc. more widely.
- New vaccine technologies have the potential to mitigate the risks from some of the most problematic animal diseases. However, harmonising trade and food standards in ways which incentivise animal growers to vaccinate is essential. Often, it is easier to vaccinate humans, rather than animals which might enter the food chain. Animal growers may often choose not to vaccinate when the risks of not doing so are borne by the state through compensation.

d. How might surveillance tools[footnote 5] and capabilities enhance our resilience to natural hazards and malicious biological threats?

- Surveillance is vital. It should be risk-based. Government should take care not to undervalue surveillance despite the difficulty in quantifying the benefits of avoiding negative impacts through surveillance and response activity. The 2018 Strategy appears to achieve necessary clarity of purpose whereby surveillance is an integral part of the system for developing and maintaining prevention, preparedness, detection and response strategies and processes which are fit for purpose. The biggest surveillance operation in the UK monitors bovine tuberculosis, lessons learned from this programme over the years could pay dividends through consideration in the context of other or new surveillance programmes. Surveillance and health systems should be set up with the appropriate data flows to enable sharing and real time monitoring, insights and responses[32].
- Population level studies should be supported and developed as a primary focus[33] but recent cuts in funding bring an opportunity cost to the enormous potential of such technologies to monitor, at a

[30] Nature News Feature published 18 December 2020: https://www.nature.com/articles/d41586-020-03626-1; Nature Review published 11 February 2022: https://www.nature.com/articles/d41573-022-00035-z; CEPI news published 29 November 2021: https://100days.cepi.net/100-days/

[31] Science Daily Science News published March 3 2022: https://www.sciencedaily.com/releases/2022/03/220302190011.htm

[32] In-draft response (as of 18/03/2022) from the UK BioIndustry Association (BIA) to the call for evidence on the UK's Biological Security Strategy

[33] Zoe COVID Study home webpage: https://covid.joinzoe.com/

population level, human and animal health and the environment. It's notable that such studies can track and report virtually in real time, unlike most surveys. Rigorous programmes of surveillance, including appropriate systems for sample collection and clinical studies, will be highly important to implement a proactive vaccinology model to address the challenge posed by SARS-CoV-2[34]

- As indicated in the 2018 Strategy (p.16), surveillance should also combine information from multiple relevant data sources in real time for best effect, e.g. wildlife movement and pathology reporting, livestock and crop disease notification, sentinel populations surveillance, meteorological surveillance, etc.
- Ongoing long-term support to appropriate surveillance systems, and systems evaluation, is absolutely imperative to inform our understanding of the right data to collect in terms of priority, reliability and timeliness. An important part of this evaluation is support, capacity and capability to continually improve and update these systems as appropriate, based on knowledge exchange between sectors, and incentives to promote ongoing research and development on surveillance methods themselves. Honing of evidence-based surveillance strategy, infrastructure and processes, is also important e.g. to avoid excessive expenditure on contingencies.
- Surveillance vulnerabilities include EU Exit which has, by some accounts, lead to a dearth of experienced applicants for roles in animal and plant health and food standards inspectorate and surveillance e.g. at farm and abattoir level; this is projected to worsen with gradual retirement of the current workforce. Horizon Europe association delays may also impact on UK's interaction and exchange with international research and surveillance schemes.

e. Are there successful examples of surveillance and/or wider approaches and capabilities for mitigating biological risks in other countries that we can learn from?

- The speed of information on incidence and symptoms provided by for example the Zoe COVID study[35], the REACT Study[36], and the COVID-19 Infection Survey[37] should be built on ongoing.
- There are additional opportunities in surveillance, e.g. greater use of aerial or remote monitoring, involvement in citizen science programmes, like Observatree[38], or potential extension of current programmes such as the Wellcome Sanger Institute COVID-19 Genomics UK (COG-UK) Consortium[39], which could potentially be applied to other pathogens and risk factors that can be mapped through genomic sequencing. The genomics surveillance networks and data flows established during the pandemic illustrate what can be achieved when the government, academia, industry and the NHS work together[40].
- Innovation in surveillance methodology, in some cases brought about by the COVID-19 pandemic, such as sampling of air and water, shows increasing promise and could contribute to surveillance meaningfully to inform risk analysis and early warning response and control systems against a range of specific threats.
- Development of new processes to monitor environmental DNA could be applied for other communicable diseases and biosecurity risks, e.g. the techniques pioneered to monitor SARS-CoV-2 infections at sewage treatment works have the potential to be used for environmental surveillance and monitoring of AMR as well.

[34] British Society for Immunology response to the Government's Consultation on a Biological Security strategy
[35] Zoe COVID Study home webpage: https://covid.joinzoe.com/
[36] REACT Study home webpage: https://www.reactstudy.org/
[37] COVID-19 Infection Survey home webpage: https://www.ons.gov.uk/surveys/informationforhouseholdsandindividuals/householdandindividualsurveys/covid19infectionsurvey
[38] Observatree home webpage: https://www.observatree.org.uk/
[39] COVID-19 Genomics UK (COG-UK) Consortium home webpage: https://www.sanger.ac.uk/collaboration/covid-19-genomics-uk-cog-uk-consortium/
[40] In-draft response (as of 18/03/2022) from the UK BioIndustry Association (BIA) to the call for evidence on the UK's Biological Security Strategy

- UK Government is funding international biosurveillance, this needs careful co-ordination across government to get best value. There needs to be sufficient and consistent practical support in LMIC's in which biosurveillance is conducted to engage at a local and national level, to achieve best results.
- Despite the well-integrated UK risk assessment systems described in the 2018 Strategy (p.15), there is concern that the UK's response to COVID-19 in early 2020 was delayed, considering the threat indicated by early research emerging from China on the burgeoning SARS-CoV-2 outbreak. In light of this, Government should carefully re-assess these systems across departments and bodies, and the current routes available for timely international knowledge exchange and information flow, providing evidence to policy.
- The Government's Chief Plant Health Officer highlights the example of New Zealand as a country where greater public awareness and education about plant health reduces risks of personal imports of potential threats.
- EU avian influenza surveillance and reporting system[41] is a successful international exemplar.

f. What further steps should the UK take to maximise our resilience to and preparedness for natural hazards, accidental release, malicious biological threats, and emerging zoonotic pathogens?

- All of the threats identified in this question have the potential to result in people requiring hospital care, likely of high level. Following from the traumatic couple of years in the NHS, the staffing issues are more acute than ever. 1 in 10 nurses' posts are unfilled. A key aspect of preparation for health hazards is addressing the staffing crisis in the NHS.
- It is unwise to consider the UK in isolation and also impossible to isolate the health and security aspects from wider environmental aspects, e.g. habitat disturbance is known to be an important factor in the emergence of new zoonoses, and in the general resilience of ecosystems and the health and wellbeing services they provide.
- Given the lessons learned through the COVID-19 pandemic thus far, Government should evaluate the effectiveness of the information sharing and risk assessment systems described in the 2018 Strategy (e.g. p. 15-17), in order to continue to develop and improve approaches for strategic information flow, collaboration and capability building. For example, p.17 identifies the 'USA, Australia, Canada and others' as partners in risk identification, however, partners should include the widest range of countries including across Asia, Africa and South America, perhaps especially focusing on collaboration with those countries enclosing regions identified as at increased risk of emerging infectious disease events, with the caveat that research to understand the complex mechanisms behind such emergence is ongoing and new findings are likely[42],[43]. Surveillance is the first line of defence in identifying diseases with conceivable risk of pandemic effect. USAID's PREDICT[44] programme is a proactive, outward-facing approach proven to be effective in the past,[45] as an example. The Fleming Fund[46] has proved crucial in tackling AMR[47]. A strategy to track emerging pathogen infections should be built on the existing expertise and networks of public health and environmental health professionals.

[41] The EU Member states, Iceland, Norway Switzerland and the UK are all reporting countries to the EU surveillance programme: Avian influenza overview May – September 2021 | EFSA (europa.eu): https://www.efsa.europa.eu/en/efsajournal/pub/7122 ; Great Britain avian quarterly report Disease surveillance and emerging threats (publishing.service.gov.uk): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1042114/Great_Britain_avian_quarterly_disease_surveillance_and_emerging_threats_report_for_quarter_3_2021.pdf

[42] Nature communications published 24 October 2017: https://www.nature.com/articles/s41467-017-00923-8

[43] Nature scientific reports published 23 February 2022: https://www.nature.com/articles/s41598-022-06932-y

[44] USAID PREDICT home webpage: https://p2.predict.global/

[45] British Society for Immunology response to the Government's Consultation on a Biological Security strategy

[46] The Fleming Fund home webpage: https://www.flemingfund.org/

[47] In-draft response (as of 18/03/2022) from the UK BioIndustry Association (BIA) to the call for evidence on the UK's Biological Security Strategy

- EU Exit alters trading relationships, and allows UK-focused policy to reduce specific risks, with effective monitoring at new border control points, along with pre- and post- border checks, so long as sufficient expert workforce is available. Until departure from the EU, the UK was not among the risk-averse nations of the world, with trade often taking priority over biosecurity, this balance should be reviewed. Any post-EU exit relaxation of trading rules and standards increases the likelihood of accidental importation of animal and plant pathogens, so high standards must be maintained in this area. Certain key areas have been reliant on access to an EU workforce and need additional support to maintain capacity over time, e.g. in the meat hygiene sector[48].
- GOF research must be assessed carefully and clearly through expert and in-depth risk-benefit analysis (including informed public debate where societal risks and benefits are involved), and controlled through appropriate biosecurity, biorisk management, biocontainment and data security protocols. In this manner, benefits can be brought and risks avoided.
- The 2018 Strategy notes the importance of a common understanding within and across Government departments (p.31), it should be assessed to what extent has this been achieved, for efficiency, accountability and strategic information flow, etc., implementing lessons learned.

g. What role would health systems overseas (including in Low and Middle Income Countries) and their resilience play?

- The 2018 strategy (p.5) rightly states that biological threats are generally 'not constrained by international borders', and thus the UK must work 'with international partners to tackle such threats at source' – COVID-19 is a prime example.
- Essential to our ability to tackle many biological threats, and an imperative area for positive change, is UK's investment in international development (ODA). The 2018 Strategy notes the then-commitment to this investment at the level of 0.7% as 'in line with the UK's aid strategy to tackle the global challenges of our time', and 'enables us to shape the world around us rather than be shaped by it'. Of course, in 2022, this is not the case. Much reduced UK spending on ODA has proved a weakening blow to OH and other R&D areas imperative to the UK's biological security. The key roles played by DFID and ODA funding in UK biological security are indicated on p.10 of the 2018 Strategy. Therefore, it may also be prudent to assess what impact the 2020 merger of DFID and the FCO to form DIDFO has had on delivery on the 2018 Strategy's aims. Impact on long-term projects initially set-up by DFID to meet 2018 Strategy-related objectives, in addition to capacity and capability to meet future biological security requirements, should also be assessed. The recent announcement of allocated funding to support all 12 GCRF hubs until 2024, is exceptionally welcome, as per RSB's calls earlier in 2021[49]. However, the impact caused by the non-reinstateable funds cut from the 2020 – 2022 budgets has and will have lasting negative effects, through disruption caused to international collaboration and abandoned projects[50]. The overall reduction in ODA spending has ended important projects, damaged relationships, and prevented approval of new grants for innovative new research. Many areas funded by this budget are highly important for the UK's biological security[51]; the need for funding reinstatement (with statutory duty) is urgent, as is a commitment to strengthen ring-fencing of ODA spending in future for long-term sustainability and security.

[48] Royal Society of Biology provided evidence to the EU Energy and Environment Sub-Committee of the House of Lords, in response to its inquiry on Brexit: plant and animal biosecurity; April 2018: https://www.rsb.org.uk/images/RSB_response_to_the_HoL_EU_EESC_inquiry_Brexit_plant_and_animal_biosecurity_for_submission.pdf

[49] RSB News March 2021: https://www.rsb.org.uk/news/rsb-urges-pm-to-reconsider-research-funding-cuts-reduction-could-leave-a-lasting-scar-on-uk-science

[50] Times Higher Education article published November 2021: https://www.timeshighereducation.com/news/relief-uks-very-high-quality-global-research-hubs-saved

[51] British Society for Immunology response to the Government's Consultation on a Biological Security strategy

- Further to this, despite the commitment noted in the 2018 Strategy on spending to develop vaccines for diseases with epidemic potential in LMICs, the UK has fallen short of expectations and the necessity to support COVID-19 vaccination programmes in LMICs, through programmes such as COVAX[52]. It is absolutely imperative that LMICs are given the support they need to rapidly access, and where necessary efficiently develop, and distribute effective vaccines to their populations. It is a risky strategy to focus too heavily on levels of vaccination in the UK's population, given that in this pandemic scenario, new SARS-CoV-2 variants have and could arise at any time in any country, and spread globally. These variants may exhibit greater virulence, pathogenicity, transmissibility and escape natural immune responses, vaccine driven immunity, and current treatment methodologies. It is therefore imperative that the UK does more to appropriately finance, engage with and support LMICs in their biological security approaches now and in the long-term, through at least a reinstatement of ODA support back to 0.7% of gross national income, and further and faster engagement with programmes such as COVAX.

h. Should research and laboratory standards, safety and security play more of a role (domestic and international), and what else should we be doing?

- The UK's laboratories for animal pathogens have seen underinvestment for a long time. This has changed relatively recently with new investments promised for Weybridge, but there is a lack of coherence in the UKs approach to laboratory capability for the management of pathogens. For example, laboratories which should be collaborating are often in competition with each other for key technical skills to operate high containment facilities.
- Recognising the risk of laboratory accidents and concomitant threats is an important aspect to address through training and facility investment where needed at commissioning, upkeep and decommission stages.
- These areas are a key part of risk mitigation, dependant on the scenario. International knowledge exchange and standards development through training is being significantly contributed to by bodies such as the UK Reproducibility Network (UKRN)[53], and professional associations such as the RSB and other learned societies. Collaboration with policymakers to identify needs and incentives to meet them in real time and with foresight, will be highly beneficial.
- Responsive and resilient infrastructure should also include 'governance and oversight frameworks to manage [bio-risks] posed by science and technologies and their applications'[54], which are fit for purpose and up to date. Lack of structures for biorisk governance in institutions, and the increasing convergence of life sciences with other fields e.g. AI (where risks can emerge at the interfaces and slip between biorisk frameworks) contribute to governance lagging behind innovation. 'International organisations [e.g. UN, and initiatives like the Global Health Security Agenda[55]] have a role in providing guidance for developing international standards, metrics, regulations, and reinforcing global best practice within their boundaries of governance'[56]. Appropriate governance is also key to develop and streamline standards and processes, e.g. for collaboration, or prevention/mitigation of risk, within and between research institutions[57]. Awareness of biorisks (e.g. how research could be misused) and incentives to mitigate these, among the scientific and R&D management and funding workforce is also

[52] Gavi COVAX update webpage last updated 17 January 2022: https://www.gavi.org/covax-vaccine-roll-out
[53] UK Reproducibility Network (UKRN) home webpage https://www.ukrn.org/
[54] Version in draft, open for public consultation: WHO Global guidance framework on responsible use of life sciences. Mitigating biorisks and governing dual-use research; https://www.who.int/news-room/articles-detail/call-for-comments---who-global-guidance-framework-for-the-responsible-use-of-the-life-sciences; accessed 24/03/2022.
[55] Global Health Security Agenda home webpage: https://ghsagenda.org/
[56] Version in draft, open for public consultation: WHO Global guidance framework on responsible use of life sciences. Mitigating biorisks and governing dual-use research; https://www.who.int/news-room/articles-detail/call-for-comments---who-global-guidance-framework-for-the-responsible-use-of-the-life-sciences; accessed 24/03/2022.
[57] British Society for Immunology response to the Government's Consultation on a Biological Security strategy

key. Access to information is central to improving these aspects, international bodies, academic scientific institutions, and professional associations such as the RSB can facilitate knowledge exchange across disciplines, through 'responsible science concepts, including biosafety, biosecurity and dual-use'[58] in education and continuing professional development (CPD) curricula (including laboratory/ practical training), and in development and dissemination of standards through degree accreditation. See answer to 3.b; RSB is also investigating developing a newly proposed biorisk and bio-containment professionals register with relevant partners.

- Assisting with development of assays and methods that can be used in different settings, including climatic extremes and resource-poor settings, will be useful in real-time and in scenario and contingency planning.

3. What lessons can we learn from the UK's biological security delivery since 2018, including but not limited to COVID-19?

a. Which are the key successes we should look to develop and build on, and where are areas for development?

- Successes in the UK's biological security delivery since 2018 have been the COVID-19 vaccine programme (built upon historic Innovate UK investments and the strategic decisions taken by the Vaccine Taskforce) and the COG-UK consortium. As well as providing the genomic data that informed public health actions and policy decisions, the COG-UK network has now amassed a unique dataset that can be used to study COVID-19. The model of combining long term and rapid response funds and investments is something that could be developed in future. Through Vaccines Taskforce and other investments, the UK has put in place the foundations for a prosperous and robust mRNA sector, including strategic leadership and investment in critical technology areas and opportunities for international collaboration, information sharing and training[59].
- The UK Coronavirus Immunology Consortium (UK-CIC) has proven to be a successful funding model through the challenge of the pandemic, where research groups collaborate rather than compete - coordinating their efforts on priorities. Strengths of this model include research efficiency, standardisation, more robust findings, and scientific camaraderie spurring productivity[60].
- Lessons from the pandemic – more will emerge from the forthcoming inquiry – also include the importance of epidemiology and surveillance and that public mobilisation to assist with response is possible with good messaging, based on social sciences expertise and evidence base.
- The Zoe COVID study is a success in terms of size, speed and efficacy. The model is widely applicable across all areas that the public has an interest in. For full benefit derived for cost, Government must make capacity to consider the evidence generated from these efforts, in timely decision and policy-making.
- Weaknesses have also been exposed by the pandemic, such as pandemic preparedness being focussed too closely on influenza and not coronavirus, despite the recent overseas outbreaks of SARS and MERS[61].
- The UK has so far achieved relative success in tackling AMR, including by drawing international attention to the issue, supporting healthcare systems in LMICs, and by supporting the development of innovative antimicrobials. It is important that the UK builds on this success in the coming years. If

[58] Version in draft, open for public consultation: WHO Global guidance framework on responsible use of life sciences. Mitigating biorisks and governing dual-use research; https://www.who.int/news-room/articles-detail/call-for-comments---who-global-guidance-framework-for-the-responsible-use-of-the-life-sciences; accessed 24/03/2022.

[59] In-draft response (as of 18/03/2022) from the UK BioIndustry Association (BIA) to the call for evidence on the UK's Biological Security Strategy

[60] British Society for Immunology response to the Government's Consultation on a Biological Security strategy

[61] In-draft response (as of 18/03/2022) from the UK BioIndustry Association (BIA) to the call for evidence on the UK's Biological Security Strategy

successful, the National Institute for Health and Care Excellence (NICE) pilot scheme will help to incentivise the UK life sciences sector to increase commercial investment into innovative antimicrobials (as part of the toolbox for tackling AMR, alongside stewardship in antimicrobial use (AMU))[62].

- The 2018 Strategy notes (p.16) that Government will 'improve our communication with the private, academic and third sectors, to enhance biological risk awareness and to drive innovation in addressing that risk […] [building] on work already undertaken such as the UK Plant Health Risk Register'. The RSB has an ongoing collaboration with funding from Defra to deliver our Plant Health Undergraduate Studentships[63], our Plant Health Professional Register[64] and a further three year programme of further professional development deliverables in the plant health sciences, for example to further engage early career researchers with Defra's plant health priorities. This program and engagement with Defra on this front has been successful and very promising for the future.

b. How can the future development and delivery of the strategy be improved by adjustments to UK systems, capabilities and the UK life sciences industry?

- The RSB uses the term 'life sciences' to describe all areas of the science of life, from molecules through whole organisms to ecosystems, and across all biological specialisms.[65] Under this definition, the life sciences extend far beyond healthcare, pharmaceuticals and treatment.[66]
- To improve workforce capability and capacity:
    - enhance university and continuing professional development course content – including on research standards such as in ethics, reproducibility, integrity, communication and dissemination of results, proactive self-governance and best practice in biosecurity, biorisk management, biocontainment and data security protocols, and dual-use biosecurity issues. RSB programmes support enhancing the 5-19 biology curricula[67] and building the plant health profession, and degree accreditation[68] .
    - promote careers in relevant areas, including risk analysis; and skills in analysis of population level data including and beyond modelling
- To ensure systems for strategic information flow are fit for purpose so policies and processes are evidence-informed and equipped to tackle abrupt surges[69], all personnel and bodies involved (including external experts) should receive clarity and understanding on the routes, and their responsibility, for efficient and effective knowledge exchange and reporting. Expert advisors including researchers, analysts and professional education specialists need to know how to effectively and efficiently channel their expertise to policymakers, with incentives to do so. Policy makers also need clarity on effective and efficient links, and incentives to use them, with researchers and other experts, so they know where to go for balanced advice across disciplines, and consensus where possible e.g. across ecological, veterinary, plant health, social sciences and public health fields; and across sectors including clinical and pre-clinical, academia and industry, discovery, translational and applied research fields. The 2018 Strategy appears to cover these aspects well, with ambitions to improve and enhance

[62] In-draft response (as of 18/03/2022) from the UK BioIndustry Association (BIA) to the call for evidence on the UK's Biological Security Strategy
[63] RSB Plant Health Undergraduate Studentships https://www.rsb.org.uk/get-involved/grants/plant-health-ug-studentships
[64] RSB Plant Health Professional Register https://www.rsb.org.uk/careers-and-cpd/registers/plant-health-register
[65] Royal Society of Biology. https://www.rsb.org.uk/index.php/about-us
[66] The Royal Society of Biology responded to Life Sciences Industrial Strategy inquiry; September 2017: https://www.rsb.org.uk/images/RSB_response_Life_Sciences_Industrial_Strategy_inquiry_submitted.pdf
[67] RSB Evolving 5-19 Biology: recommendations and framework for 5-19 curricula: https://www.rsb.org.uk/policy/education-policy/school-policy/curriculum
[68] Royal Society of Biology response to Defra on the GB plant biosecurity strategy; November 2021: https://www.rsb.org.uk/images/RSB_response_to_GB_plant_biosecurity_strategy_consultation-submitted.pdf
[69] British Society for Immunology response to the Government's Consultation on a Biological Security strategy

data capture and sharing. However, evaluation and review of approaches since 2018 should be undertaken, for refinement. Government should consider the merit of an overt formal requirement for policymakers on soliciting and timely response to expert advice, accordingly. Surveillance and reporting also need to track through to action both for purpose and community incentive. As the 2018 Strategy notes (p. 31-33) good interactions between policymakers, academia and industry can help to highlight needs and enable collaboration on research and development, as well as implementation steps. Assessment of biosecurity threats should be well communicated by Government to other sectors, including industry and academia, to ensure appropriate prioritisation of efforts and investment[70]. The RSB hosts several advisory committees and special interest groups, bringing together stakeholders and expertise of relevance across the biosciences[71].

- The 2018 Strategy also notes (p.32) an aim for better communication with the biosciences community on Government requirements and problems, particularly in those areas (such as deliberate biological threats) where communication from Government have traditionally been more cautious, an assessment with community consultation on achievements and lessons learned on this since 2018 could be beneficial.
- Maintaining and enhancing research links, collaboration, and ease of movement for researchers, with EU partners and beyond, is important, as noted in the 2018 Strategy (p.11), e.g. links with European Reference Networks.

c. Should the UK have a single accountable role or body responsible for meeting the full range of biological threats?

- The RSB would support a single accountable body approach. At present, there are many departments involved with special interests (e.g. BEIS, Defra, MoD, DHSC) and they could coordinate far more effectively. A single body could hold departments accountable for their core roles, alongside accountability for their part in a strategic, national role which at present does not exist. However, it must be understood that the 4 nations have different geographical and social landscapes, so flexibility will be required.
- A clear line of reporting from risk owners across different departments and bodies is imperative for appropriate oversight of surveillance and preparedness strategies, and coordination of response planning and implementation. This clarity should extend externally to enable information flow, knowledge exchange on priorities, and early warning from expert stakeholders and actors internationally. Clear structures are required for monitoring and evaluation of risk management systems, including comprehensive risk assessment capability and collaboration across risk owners in departments and agencies, with clear responsibility for real-time warning of changes.
- Of equal importance is that accountable bodies and roles have access to the full range of relevant expertise across disciplines, sectors etc., e.g. across human, ecosystem, animal and plant health, agriculture, aquaculture, fisheries and other forms of food production and supply, and epidemiological and environmental sciences, to name a few areas.

d. What can we learn from other countries' biological security practises and experiences?

[70] In-draft response (as of 18/03/2022) from the UK BioIndustry Association (BIA) to the call for evidence on the UK's Biological Security Strategy

[71] RSB policy webpages: https://www.rsb.org.uk/policy

- International development programmes of research such as the One Health Poultry hub[72], and OIE Collaborating Centres in Risk Analysis & Modelling[73] may well be in the position to provide extensive and detailed advice.
- Australia, New Zealand and Taiwan are examples of countries which have been more successful than others in controlling the spread, mortality and morbidity associated with COVID-19, and their approaches should be assessed. Australia and New Zealand also currently have effective risk based approaches to mitigating animal and plant disease threats, including from invasive species, following historical experience with current impacts.
- As the 2018 Strategy states frequently and throughout, engaging with other countries' biological security practises and experiences is imperative, for example to assist UK activity to:
    - ID and improve the range of diseases under surveillance
    - Improve our horizon scanning of potential pests, vectors and diseases with the risk of change or increase in range or host populations
    - Add to our capacity to detect, and act on, detected threats globally - in a timely manner
    - Collaborate on surveillance, detection and quarantine control measures regarding trade across borders

e. How should the UK engage with, support or influence, existing multilateral and other international collaborative efforts towards biological security to improve the impact of our strategy?

Optimize UK engagement with the upcoming UN Global Plan of Action for One Health[74]

4. How should progress be monitored and evaluated, and how often should the strategy be refreshed?

a. Are there successful approaches in other countries that we can learn from?

See answer to question 3.d.

b. How should UK collaborations, investments, and interventions be designed to assure the development and delivery of the strategy?

The strategy should undergo an annual system of rapid and efficient re-review against any changes to threats and risks identified e.g. through the National Risk Register (NRR), and to ensure that any decline in the UK's capabilities to predict, early-detect and respond are immediately acted upon[75].

Government should mainstream, support and integrate the following bullet points, through policymaking, incentives and design in collaboration with the biosciences sector including representative organisations such as the RSB:

- Assist development and upholding of community agreed standards in research integrity, and best practice in biosecurity, biorisk management, biocontainment and data security protocols.

[72] One Health Poultry Hub home webpage: https://www.onehealthpoultry.org/
[73] Royal Veterinary College research news published 7 June 2019: https://www.rvc.ac.uk/research/research-centres-and-facilities/veterinary-epidemiology-economics-and-public-health/news/rvc-and-the-animal-and-plant-health-agency-awarded-oie-collaborating-centre
[74] WHO News published 1 December 2021: https://www.who.int/news/item/01-12-2021-tripartite-and-unep-support-ohhlep-s-definition-of-one-health
[75] British Society for Immunology response to the Government's Consultation on a Biological Security strategy

- Advance and refine relevant collaborative research, development, surveillance and other forms of evidence gathering activity and infrastructure, including Government advisory and policymaking capacity to respond to evidence gathered.
- Improve relevant risk assessment capability through workforce capacity, training and skills acquisition, and resourcing. Government should work closely with employers in research institutes, industry, and with professional associations like the RSB to identify and address current and future skills shortages[76].
- Enable transparent, efficient and effective routes for continuous, strategic information flow to ensure systems to anticipate, assess and respond to biological risks and threats appropriately integrate scientific principles and evidence base – including OH principles and approaches. The RSB convenes, synthesizes and communicates evidence and expert advice direct to policymakers on behalf of our community.
- Bring a strategic focus to countering the spread of misinformation and disinformation related to biosecurity.
- Recognize both biodiversity loss, and chemicals and waste pollution, as priority challenges alongside climate change - tackling these three complex threats together, with well-integrated policies across departments and international and inter-sector co-ordination, collaboration and engagement, for example through regulation and incentives. This prioritization and action in response should absolutely be matched through enactment by local authorities' on-the-ground actions.
- Act to make swifter progress and deliver through international, national and regional leadership to tackle and prevent a pandemic of AMR.
- Consider food production and security as a key system at risk from many of the threats listed in this response.

[76] In-draft response (as of 18/03/2022) from the UK BioIndustry Association (BIA) to the call for evidence on the UK's Biological Security Strategy

Appendix 1: 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)
Biochemical Society
British Association for Lung Research
British Association for Psychopharmacology
British Biophysical Society
British Ecological Society
British Lichen Society
British Microcirculation and Vascular Biology 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 Soil Science
British Society of Toxicological Pathology
British Toxicology Society
Daphne Jackson Trust
Fisheries Society of the British Isles
Fondazione Guido Bernardini
GARNet
Gatsby Plant Science Education Programme
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
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
UK Environmental Mutagen Society
United Kingdom Society for Extracellular Vesicles
University Bioscience Managers' Association
Zoological Society of London

Supporting Organisational Members

Animal & Plant Health Agency (APHA)
Association of the British Pharmaceutical Industry (ABPI)
AstraZeneca
BioIndustry Association
Biotechnology and Biological Sciences Research Council (BBSRC)
British Science Association
Ethical Medicines Industry Group
Fera
Institute of Physics
Medical Research Council (MRC)
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
Wessex Water
Wiley Blackwell
Ecological Continuity Trust