UKRI Biotechnology and Biological Sciences Research Council

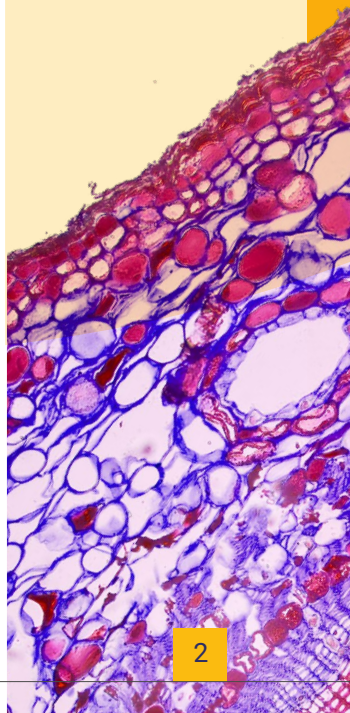
BBSRC

Infrastructure Strategic Framework

BBSRC Infrastructure Strategic Framework

Our approach to ensuring UK bioscience, including academic researchers, innovators and industrialists, can access cutting-edge, sustainable research and innovation infrastructures.

Contents



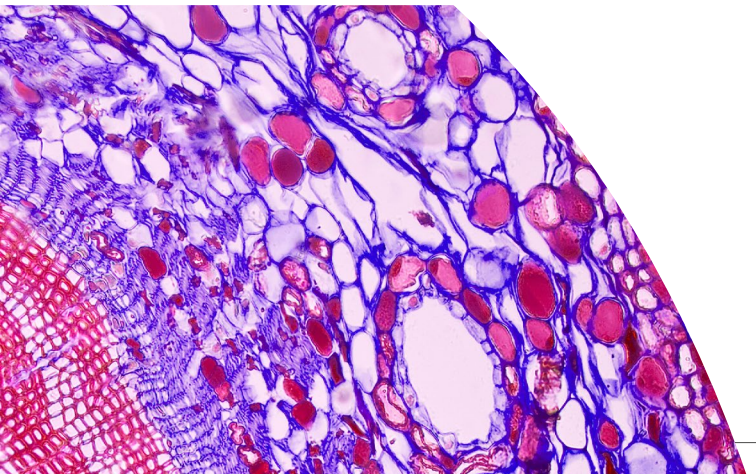
Cover image: Uromyces beticola pustule on the surface of a sugar beet leaf (1000x magnification). Seen using the scanning electron microscope at the John Innes Centre. Credit: Michelle Grey/Earlham Institute

1 Executive Summary

Infrastructure is a fundamental enabler of research and innovation. In recent years, an evolving strategic landscape and the establishment of new infrastructure-specific programmes across UKRI have placed infrastructure in new context. Against this background, BBSRC set out to develop a strategic framework to guide the forward planning of its infrastructure portfolio for the benefit of the UK bioscience research and innovation community.

In 2022, BBSRC initiated a strategic analysis of its infrastructure portfolio, informed by targeted engagement with internal and external stakeholders. An expert Task and Finish group, made up primarily of BBSRC Council members, was convened for guidance and advice during the analysis, engagement and development process.

The resulting framework summarises the current drivers in bioscience research and innovation. It then outlines: the seven strategic key principles guiding infrastructure development, the emerging priorities BBSRC intends to address, and the steps it will take going forward.



The key principles are:

1. Support a balanced portfolio of bioscience research and innovation infrastructures, from individual items of laboratory-based equipment to strategic investments that build regional, national and international capability.
2. Active engagement in forward planning to maximise the alignment of infrastructure with user needs and wider government research and innovation priorities.
3. Recognition of the importance of the broad, diverse, and highly skilled community that supports bioscience infrastructures, including its key role in managing infrastructure and delivering training, and the need to support continuing professional development, retention, and career pathways.
4. Support for state-of-the-art emerging technology and methods in infrastructure development, and their use to advance research capability and discovery.
5. Collaboration with partners in UKRI, the UK, and internationally to foster the networks and linkages that maximise the value of investments and enable access for bioscience user communities.
6. Responsible factoring of resource requirements, longevity, efficiency, and sustainability in managing the portfolio.
7. Embedding consideration of environmental impact in our approach.

BBSRC extends its sincere thanks to the research and innovation community for the inputs provided and to the Task and Finish Group who guided and advised throughout the process. The key principles provide a clear framework around which BBSRC will shape its current and future infrastructure portfolio, supported by BBSRC Council. The next steps will take forward these principles through an implementation plan, continued stakeholder engagement, a route for the community to feed ideas into BBSRC, and periodic review of the principles above.

With this document, BBSRC reaffirms its commitment to a holistic approach to infrastructure that encompasses a diverse range of capabilities, from equipment and facilities to resources and services, across all scales. We also recognise the vital contribution of skilled people in the design, operation and maintenance of a well-balanced, sustainable research and innovation ecosystem.

2 Introduction

A key component underpinning the success of UK bioscience research and innovation is access to a diverse range of infrastructures that enable discovery and foster innovation. These resources and facilities allow the frontiers in our understanding of plants, animals, microbes, and human biology to be explored, and bio-based solutions to critical societal needs such as food security, clean growth, lifelong health, and climate change to be developed.

As the main public funder of bioscience research in the UK, BBSRC plays an important role in ensuring that infrastructure provision addresses the long-term needs of our communities. This strategic framework sets out, for the first time, a consolidated articulation of BBSRC's role, portfolio, and future approach to infrastructure.

Publication of this framework is timely following UKRI's strategy, BBSRC's Strategic Delivery Plan and the UK Government's Science and Technology Framework, as well as developments in the wider research policy environment. It builds on the insights presented in the 2019 cross-UKRI Infrastructure Landscape Analysis and Opportunities to Grow Our Capability, with updated and additional perspectives obtained through a targeted stakeholder consultation (see Appendix 1). The framework brings together relevant aspects of BBSRC's Institute Strategy and considers the recommendations set out in BBSRC's strategic reviews of Bioimaging, Data-Intensive Bioscience, and Technology Development.

The framework will provide a reference for our strategic planning and decision making for the years to come.

Field Scanalyzer at Rothamsted Research's Harpenden site for agricultural research
Credit: Rothamsted Research

3 Aims and Scope

The strategic framework aims to provide a holistic overview of BBSRC's infrastructure investments, highlight the opportunities infrastructure provides to advance bioscience research and innovation, and establish a set of principles to guide our future strategy and investments. It also outlines the areas in which BBSRC can evolve its approaches, maximise the benefits of cross-disciplinary working within UKRI, and exert broader influence to foster an interconnected and resilient national and international infrastructure landscape.

This framework encompasses infrastructure across a spectrum of capabilities – from smaller-scale, fundamental equipment commonly found in laboratories to increasingly sophisticated multi-user platforms, translational and scale-up facilities, and specialised facilities that operate on a regional, national, and international level. Beyond the facilities and equipment, we also consider the Research Technical Professionals (RTPs) who enable the operation of infrastructure, as well as the skills, training, and knowledge-exchange that support users across both academia and industry and allow infrastructure impact to be fully realised. While BBSRC's focus is on bioscience, we also recognise the importance of interdisciplinary connections to other scientific domains.

Our intention is that this document provides insight into the multi-faceted role BBSRC plays in the wider national and international infrastructure landscape and acts as a platform for engagement with stakeholders.

The National Plant Phenomics Centre, hosted at Aberystwyth University's Institute of Biological, Environmental and Rural Sciences (IBERS)
Credit: Prifysgol Aberystwyth University

4 Definition of Research and Innovation Infrastructure for Bioscience

BBSRC adopts the general definition for research and innovation infrastructure adopted by UKRI in its "Opportunities to Grow Our Capability" report:

"Facilities, resources, and services used by the research and innovation communities to conduct research and foster innovation in their fields. They include: major scientific equipment (or sets of instruments), knowledge-based resources such as collections, archives and scientific data, digital infrastructures, such as data, computing systems, and communication networks, and any other tools that are essential to achieve excellence in research and innovation."

Within the biosciences, these capabilities include technical platforms and resources such as:

- Equipment, for example high throughput 'omics platforms and bioimaging technologies
- Bioinformatics resources; for example, software and data services
- Biological resources and culture collections
- Computing systems and related hardware capabilities
- Laboratories and specialist facilities, for example field scale platforms and phenotyping capabilities
- Scale-up facilities to help de-risk product development, for example biorefining centres.

Bioscience research and innovation stakeholder communities comprise individuals, teams, and institutions across academia; users in industry sectors such as agriculture, pharmaceuticals, biotechnology, and health; as well as users outside these core communities who may engage with, and benefit from, bioscience infrastructures.

The Hamilton platform at Earlham Institute's Biofoundry provides automation for a wide range of powerful workflows. Credit: Earlham Institute

5 BBSRC's role and strategic objectives

As part of UKRI, BBSRC holds a unique position in driving bioscience discoveries, innovation, and impact across a diverse range of disciplines, organisations, and locations. Many other organisations also contribute towards infrastructure for the biosciences, including:

- Higher Education Providers (HEPs) and Research Institutes
- Other funding agencies and research charities
- UK Government and devolved administrations
- UKRI Research and Innovation Campuses
- Public Sector Research Establishments
- Bio-based industries and commercial service providers
- Intergovernmental Organisations such as the European Molecular Biology Laboratory (EMBL), and other international infrastructure programmes.

In the context of this wider landscape, BBSRC's strategic support for bioscience infrastructure reflects the multiple facets of our role: as an investor, convener, partner, and leader.

As an investor

Our role

We provide direct investment in bioscience infrastructure across a range of scales to strengthen provision within HEPs and research institutes, and contribute to institutional, regional, national, and international resources that are beyond the scope of a single organisation or nation to support. These investments provide enhanced scale, efficiency, and coordination for research, such as through sharing of open biodata, and provide space for new companies to establish themselves and thrive. Our investments in people and skills are also vital to the operation of infrastructure.

Our strategic objective

Building on a robust and successful portfolio of activities, we will continue to invest in the fundamental capabilities that underpin the field across a range of scales, from laboratory-based equipment to large-scale capabilities, and from discovery research to scale-up and translation. We will carefully consider the evidence base for our investments, the outcomes they aim to achieve and their potential for impact on a local, regional or national scale. We will ensure good practice is embedded and undertake regular monitoring and evaluation of our infrastructure portfolio.

Quadram Institute's rapid whole genome sequencing platform
Credit: Quadram Institute

As a convener

Our role

We are uniquely placed to convene stakeholders across bioscience disciplines but we also forge cross-disciplinary links with adjacent fields. We engage with researchers, innovators, entrepreneurs and technical experts across both academia and industry, investors, and other funding bodies to understand diverse needs and future opportunities for the bioscience community, at both national and international level.

Our strategic objective

We will drive connections across people, sectors, organisations, facilities and regions, including bringing together novel communities without established requirements. Working with other UKRI Councils, we will identify synergies where bioscience can benefit from and contribute to infrastructures developed for or with other disciplines, and identify ways to strengthen and coordinate infrastructure provision so it can connect across disciplines.

As a partner

Our role

BBSRC acts as a key national and international partner, working with wider UKRI Councils (including Research England and Innovate UK) and with other organisations to share intelligence, understand cross-cutting needs, tackle common issues, and make strategic investments in infrastructure. We collaborate and contribute towards a range of international infrastructure activities: coordinated funding programs, UK-based nodes of international infrastructures, funding subscriptions to international bodies such as EMBL, and providing mechanisms that promote access to overseas capabilities for our community.

Our strategic objective

We will build on past successes and develop new relationships to remain a partner of choice at both national and international scale and meet increasingly complex needs as the field develops. We will promote a sustainable, resilient, and integrated infrastructure ecosystem: for example, by continuing our work with the Global Biodata Coalition on the worldwide coordination of biodata resources.

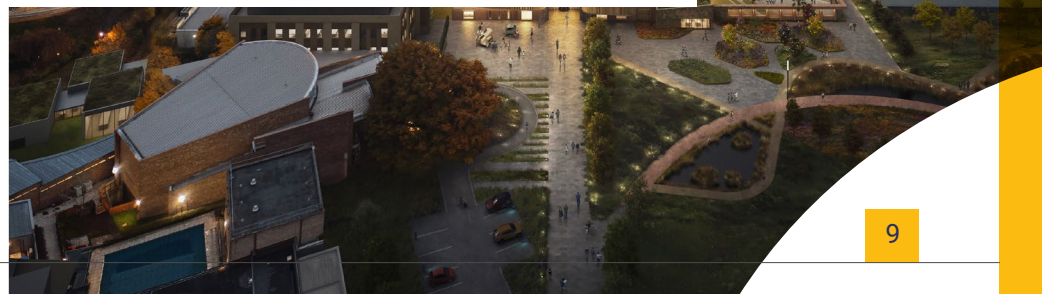
As a leader

Our role

Working with our stakeholders, we define key requirements, we lead the development of cases for investment through the UKRI Infrastructure Fund, and we represent UK bioscience in UKRI's Digital Research Infrastructure programme. In addition, we work closely with our partner UKRI Councils and with other funding bodies to secure funding that supports research and innovation infrastructure needs, and we advocate for bioscience communities in the broader landscape.

Our strategic objective

We will ensure that bioscience remains at the forefront of emerging technical developments. We will drive an inclusive research and innovation culture that recognises the needs, contributions and diversity of our communities. We will capture the impacts of bioscience infrastructure and showcase its scientific and socioeconomic value to help secure future investment.



CGI aerial view of John Innes Centre and The Sainsbury Laboratory
Credit: BDP - Secchi Smith

6 Current BBSRC infrastructure investments

BBSRC contributes towards a wide range of bioscience infrastructures operating at local, regional, national, and international scales.

Project-level support, support for projects that address focused research questions:

- Through research grants, for example responsive mode, funding for
  - New infrastructure and equipment requests
  - Access to facilities, resources, and services
- Technology development, for example through the Transformative Research Technologies (TRT) fund
- Aligned capital funding in major calls, for example the Engineering Biology Missions Hubs and Mission Awards supported through the Technology Missions Fund.

Multi-user equipment and resources, addressing shared needs of research organisations, industry and end user communities:

- ALERT: Mid-range equipment for biosciences research
- Support for the development of community databases, tools and resources, for example the Bioinformatics and Biological Resources (BBR) fund
- National Bioscience Research Infrastructures (NBRIs) and other capabilities at the BBSRC strategically supported institutes, for example the Flow Cytometry suite at the Babraham Institute
- Network development, training, and summer schools.

Rothamsted Research's North Wyke agricultural research facility in Devon
Credit: Rothamsted Research

Large-scale national infrastructure, strategically important facilities underpinning national capability and delivering priority step-changes

- John Innes Centre and The Sainsbury Laboratory Next Generation Infrastructure
- The Pirbright Campus redevelopment
- AberInnovation Biorefining Centre
- EMBL-EBI's Data Resources for the Life Sciences and the Thornton Building (with MRC)
- BioFAIR (with MRC)
- PhenomUK Research Infrastructure (scoping activity)
- Diamond Light Source and other facilities based at the Harwell Campus.

International cooperation, contributing to the international infrastructure landscape, promoting coordination, and securing access to unique infrastructure for UK researchers

- Participation in ELIXIR, including funding for the UK-based ELIXIR Hub and ELIXIR-UK node
- Establishment of a UK node for EuroBioimaging
- Participation in the development of EMPHASIS
- Participation in the Global Biodata Coalition
- Collaboration with US National Science Foundation in bioinformatics
- Engagement in the OECD's Global Science Forum.

Current BBSRC routes to support infrastructure include core research and World-Class Labs budgets, as well as the UKRI Infrastructure Fund and the UKRI Digital Research Infrastructure programme.

The National Plant Phenomics Centre, hosted at Aberystwyth University's Institute of Biological, Environmental and Rural Sciences (IBERS)
Credit: Prifysgol Aberystwyth University

7 Key bioscience areas

Overview of the field

In 2019, BBSRC engaged in a comprehensive Infrastructure Roadmap programme to identify infrastructure needs across UKRI and Public Sector Research Environments. We investigated opportunities and synergies with disciplines and sectors such as biological, medical, environmental, physical, and computational sciences. Further information on these themes can be found in the 2019 UKRI Opportunities to Grow our Capabilities report.

Research areas discussed in this report of particular interest to bioscience are:

- Multi-scale biology: the convergence of multi-modal data-gathering, integration, and mathematical modelling
- Biological imaging, structural biology and 'omics technologies
- Biosecurity for the life sciences
- Food safety and nutrition
- Advanced animal genomics, developmental biology, and breeding infrastructures
- Plant genetics, pathology, phenotyping, and agri-technology
- Synthetic biology and industrial biotechnology
- Human phenotyping.

The report also identified two cross-cutting themes, e-infrastructures (now referred to by UKRI as digital research infrastructures) and innovation infrastructures.

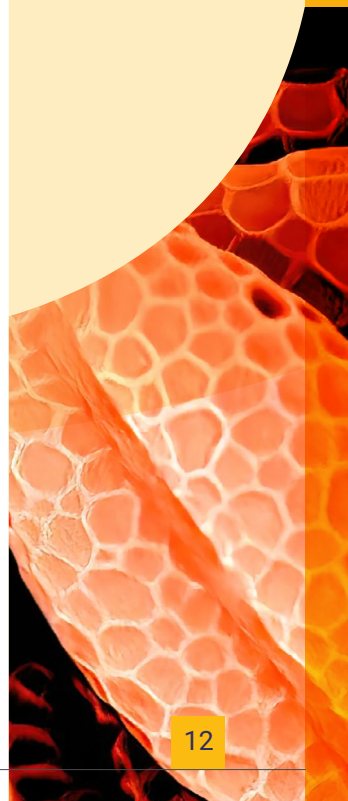
- Digital research infrastructures

The BBSRC strategic review of data-intensive bioscience highlighted the increasing importance of data-driven approaches in modern bioscience and recommended BBSRC take the lead in building a coherent ecosystem of digital research infrastructures for the biosciences. These infrastructures include high-performance computing (HPC), high-throughput computing (HTC) and cloud computing, integration of Artificial Intelligence (AI) tools and access to software and data analysis pipelines, as well repositories where data can be securely stored and accessed by other researchers. Equally important are the RTPs who design, operate and maintain the hardware, software and services, and provide guidance and support to the user communities. These roles include but are not limited to research software engineers (RSEs), bioinformaticians, system architects, data scientists, data curators and data stewards.

- Innovation infrastructures

BBSRC innovation infrastructure supports business and economic growth, promoting collaborative research and development between academia and businesses, and encouraging partnerships between scientists at research organizations and businesses to stimulate innovation. Such collaborations allow industry to benefit from research capabilities in academia and conversely can afford academics access to unique industrial infrastructure capabilities.

We also invest in Research and Innovation Campuses and scale-up facilities to foster innovations and support research and innovation communities, including emerging and established bioscience companies, de-risking the translational pathway from discovery science to industrial application.



8 Trends and Drivers

BBSRC's approach to infrastructure balances established technology platforms with opportunities to benefit from technological advances. Through regular engagement with stakeholders and partners, we continually seek feedback on emerging technical trends and broader issues in the landscape which help inform our forward priorities. Recent stakeholder insights have reinforced themes highlighted in the UKRI landscape analysis and BBSRC strategic reviews of Data-Intensive Bioscience, Bioimaging, and Technology Development.

Key trends include:

- Importance of digital and data-driven capabilities, including HPC, HTC and cloud computing, analysis of complex multi-modal datasets, application of AI powered tools and widespread adoption of FAIR data principles
- Increasing prevalence, sophistication and throughput of 'omics, imaging, and structural biology technologies
- Automation and increased coupling between physical, software and computational infrastructure
- Coordinated infrastructure platforms and pipelines that combine multiple modalities
- Approaches that bridge laboratory and field studies, and that allow data capture in realistic or 'real world' environmental settings
- Interdisciplinary working and "edge-of-discipline innovation" between bioscience and other domains
- A lack of dedicated industrial scale infrastructure to support the development of emerging technologies, products, and services and an interest in developing scale-up centres at facilities, along with the access mechanisms and networks of people to sustain them.

The following emerged as areas to strengthen:

- Support for Research Technical Professionals (RTPs) and career pathways
- Skills and training across all career stages and role types
- Access models
- Networking and connectivity
- Sustaining capabilities
- Benefits of international collaboration

In situ instrumentation at Rothamsted Research's North Wyke Farm Platform helps monitor the complete flow of nutrients from soil to food
Credit: Rothamsted Research

9 Strategic Framework Key Principles

BBSRC-supported research and innovation relies on high quality infrastructure, whether purposed for the sector or multidisciplinary in nature. Central to our strategy is a set of principles that will guide how BBSRC ensures the UK bioscience research and innovation ccommunity can access the infrastructures needed to deliver world class research and impact.

BBSRC will:

1. Support a balanced portfolio of bioscience research and innovation infrastructures, from individual items of laboratory-based equipment to strategic investments that build regional, national, and international capability.
2. Actively engage in forward planning to maximise the alignment of infrastructure with user needs and wider government research and innovation priorities.
3. Recognise the importance of the broad, diverse, and highly skilled community that supports bioscience infrastructures, including its key role in managing infrastructure and delivering training, and the need to support continuing professional development, retention, and career pathways.
4. Support state-of-the-art emerging technology and methods in infrastructure development and their use to advance research capability and discovery.
5. Work with partners in UKRI, the UK, and internationally to foster the networks and linkages that maximise the value of investments and enable access for bioscience user communities.
6. Responsibly factor resource requirements, longevity, efficiency, and sustainability in managing the portfolio.
7. Embed consideration of environmental impact in our approach.

In employing these principles, BBSRC will monitor, manage, and evaluate its infrastructure portfolio to ensure the benefits of investment are fully realised.

LED and sodium lighting in a Rothamsted Research glasshouse
Credit: Rothamsted Research

10 Our Approach

Our infrastructure strategic framework builds on strong foundations: a diverse portfolio of activities and considerable corporate experience in infrastructure planning, underpinned by a broad network of strategic and policy engagement (figure 1). Drawing from the insights of the UKRI Landscape Analysis and our stakeholder engagement, we outline below the areas in which we will strengthen or evolve our approach.

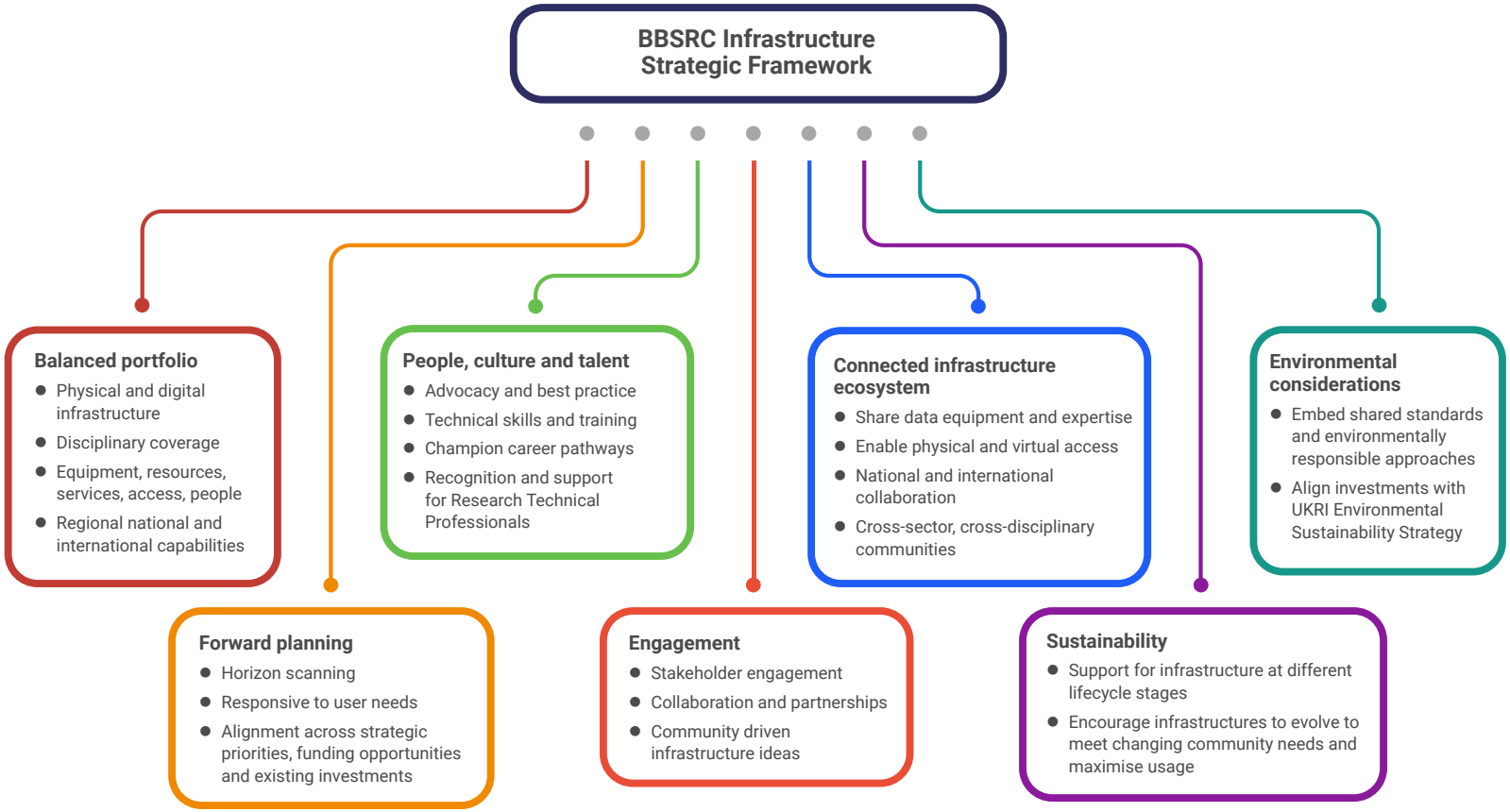


Figure 1: Diagram of Infrastructure Strategic Framework Principles, Approaches, and Next Steps

Addressing emerging priorities

We will:

- Take a systematic approach to identifying evolving trends, challenges, and opportunities across the breadth of our communities, making use of strategic stakeholder engagement and bottom-up mechanisms such as a channel for community infrastructure ideas. Through horizon-scanning, engagement, and co-development with the full breadth of our diverse community, we will enhance our infrastructure planning and, where relevant, the initiatives that address them.
- Embed environmental sustainability considerations in line with the UKRI Environmental Sustainability Strategy and wider national policies into our infrastructure activities.
- Support more sustainable approaches to investments and developing guidelines for sustainability of infrastructures at all lifecycle stages, from start-up to decommissioning and downsizing when demand has decreased, or technology has moved on.
- Respond to our community's growing needs for digital infrastructure by evolving existing infrastructures to support new communities of practice and, subject to funding, by investing in new capabilities in data infrastructure, large-scale computing, software infrastructure, networking and skills and career pathways.
- Harness the full range of opportunities offered by the UKRI Digital Research Infrastructure (DRI) programme's vision for a coherent state-of-the-art national digital research infrastructure to grow the breadth and depth of skills and capabilities. We will ensure these efforts strengthen a federated DRI system whose long-term vision and priorities align with government strategies and investments.
- Strengthen our support for infrastructures at different stages of their lifecycle, recognising that extending infrastructures' longevity and capabilities can increase both community usage, and sometimes offer greater value for money.

Working across the infrastructure landscape

We will:

- Continue to work with the cross-UKRI Infrastructure Fund to support step changes in capability and capacity that enable ambitious, multi-disciplinary research and innovation in bioscience.
- Work with other UKRI research councils to map synergies, leverage expertise, and better understand needs across sectors and disciplinary communities; for example, using workshops and exploring feasibility and pilot studies where appropriate to better scope new infrastructure concepts.
- Deepen our work to explore synergies in infrastructure provision between academia and industry through continued stakeholder engagement and the incorporation of commercial perspectives in infrastructure planning. Throughout, we will remain alert to mutual benefits and the potential for accelerating impact by fostering environments that promote cooperative research and innovation, and porosity between sectors.

Rothamsted Research glasshouses
Credit: Rothamsted Research

- Continue to ensure the bioscience community benefits from infrastructure in an international context, including access, resource sharing, strategic engagement, networking, and partnership building. We will work to foster a joined-up infrastructure ecosystem that maximises opportunities for UK bioscience and beyond.

Driving culture change

We will:

- Advocate for the crucial role people play in sustaining infrastructure, championing the role of Research Technical Professionals (RTPs) and embedding the "Visibility, Recognition, Career Development and Sustainability pillars of the Technician Commitment[1] in our policies and activities.
- Expect institutions to embed equality, diversity and inclusivity across infrastructure lifecycle planning, ensuring infrastructures are as accessible as possible to all researchers and can accommodate a range of access needs.
- Work to maximise the value and benefits that infrastructure provides, improving visibility, coordination and networking across facilities through engagement and outreach.
- Promote greater infrastructure sustainability and access by convening the community around these issues and identifying good practice in operational models and planning.

1 BBSRC, through UKRI, is a signatory to the Technician Commitment and is working with UKRI to deliver the UKRI Action Plan

IBERS aerial view
Credit: Prifysgol Aberystwyth University

11 Next Steps

To ensure we can fulfil our goals and take forward the objectives laid out above, we will:

- Embed this Strategic Framework's key principles across our infrastructure portfolio, use them to guide our portfolio monitoring and evaluation activities to understand their effectiveness, and identify ways to promote their adoption in the wider infrastructure landscape – for instance through stakeholder engagement and research assessment and policy activities.
- Continue to foster a connected infrastructure ecosystem that bridges gaps and addresses needs across bioscience-related disciplines and sectors, shares resources and capabilities, and strengthens international collaboration.
- Maintain regular engagement with our diverse stakeholder groups to ensure we remain at the forefront of community needs and emerging opportunities, and remain responsive to changes within the wider landscape.
- Implement a process for identifying, developing and prioritising new community-driven infrastructure opportunities, providing support and guidance to the community to establish their need, user base, and potential impacts. Prioritisation of new opportunities will be transparent and rigorously evaluated to ensure future investments are aligned with BBSRC strategy and the key principles presented above.
- Periodically review the framework to ensure it continues to deliver its goals and remains in line with BBSRC and UKRI priorities, those of the broader research and innovation policy landscape, and the diverse needs of our stakeholders.

Case Studies

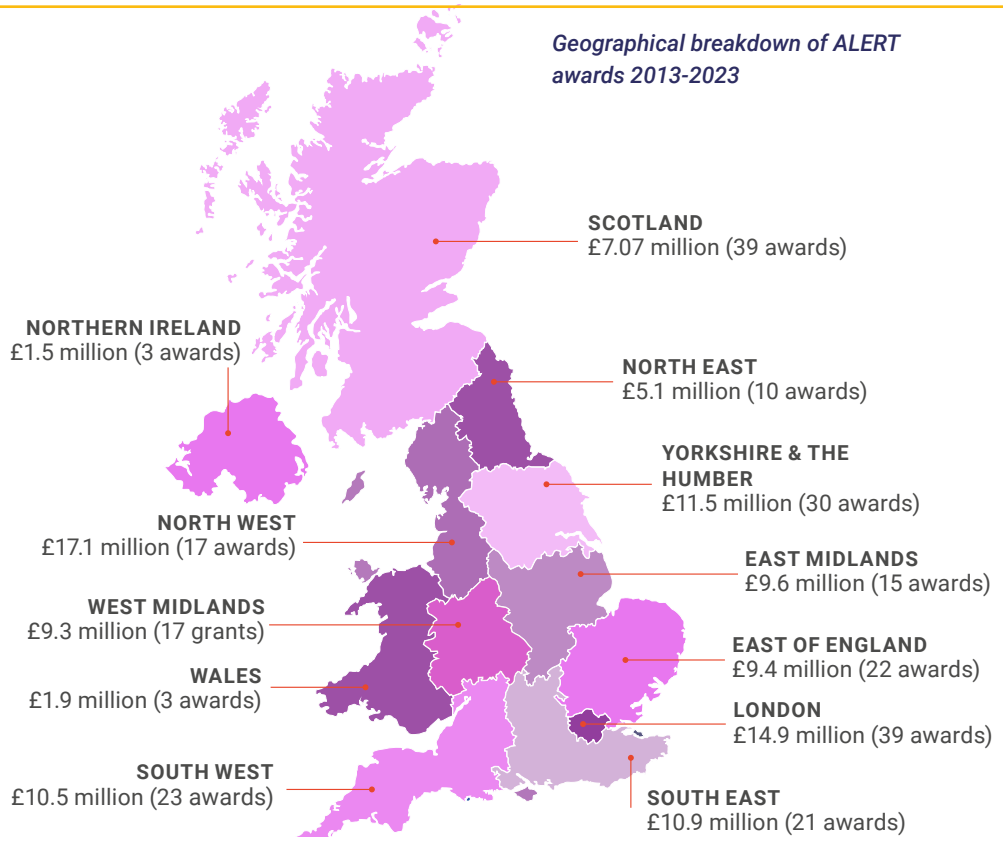
Case study 1

ALERT

The Advanced Life Sciences Research Technologies (ALERT) fund provides targeted support for mid-range equipment for bioscience research, ranging from widely used, underpinning so-called 'workhorse' equipment to cutting edge technologies and lab-to-field platforms, with the goal of enhancing institutional and regional capabilities. Since its introduction in 2013, BBSRC has invested £120 million in 258 ALERT awards across 51 research organisations.

In addition to supporting the community's equipment needs, ALERT has enabled BBSRC to highlight the vital role of research technical professionals (RTPs) in enabling research, such as facility managers, technologists, data stewards, research software engineers, trainers and other infrastructure staff. In recent years, BBSRC has increasingly sought to raise the profile of RTPs through representation on assessment panels and as panel chairs.

Geographical breakdown of ALERT awards 2013-2023



The number of applications from eligible technical staff as either principal investigator or co-investigator has grown over the years: in the 2022-23 round, 43% of proposals included RTPs, and in both 2021 and 2022, the top proposals were led by RTPs.

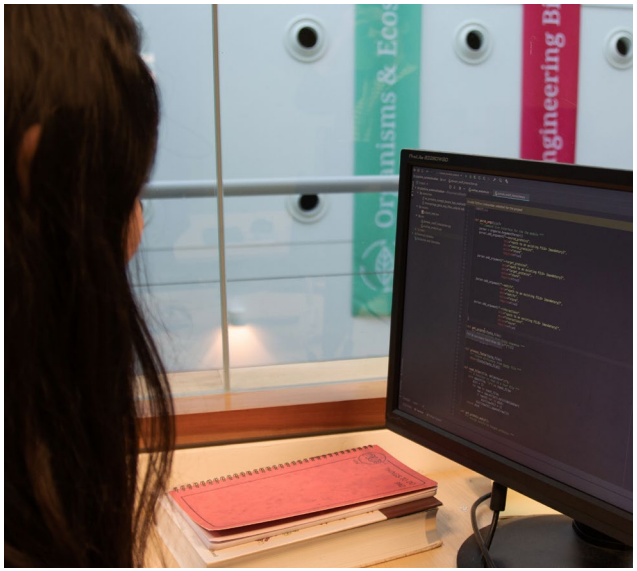
Case study 2

BioFAIR: a data commons infrastructure for biological and biomedical sciences

BioFAIR is a new digital infrastructure that will deliver a step-change for UK life sciences-related data. It will widen access to existing data processing, analysis, and repository infrastructures to maximise the findability, accessibility, interoperability, reusability (FAIR) and reproducibility of researchers' data.

The concept was originally submitted by groups within the data-intensive bioscience community to BBSRC's own Bioscience Big Ideas Pipeline. BBSRC and MRC collaborated on a full proposal to the UKRI Infrastructure Fund (IF) and Digital Research Infrastructure (DRI) programme, which was awarded £34 million (subject to Full Business Case approval).

Slated to begin in summer 2024 with a five year timeline, BioFAIR will establish a national data and methods commons, develop communities of practice, and provide training resources to drive culture change towards the widespread adoption of FAIR principles in the UK life sciences.



BioFAIR will enhance the sharing, management, and reuse of life sciences data.

Case study 3

The Pirbright Institute: understanding, predicting, detecting, and responding to viral disease outbreaks

BBSRC invests approximately £75 million per annum in eight specialist institutes that provide national capability for the UK in strategically important research fields.

The Pirbright Institute is a unique capability in the UK to support national and international responses to high-consequence viruses that cause animal and zoonotic diseases. Those include diseases identified as highest-priority by the UK Government, such as foot-and-mouth disease, African swine fever, bluetongue virus, and African horse sickness. Most recently, the Institute's dedicated facilities were used during the SARS-CoV-2 pandemic and the monkeypox outbreak.

Pirbright's science expertise and physical infrastructure, including the BBSRC National Virology Centre: the Plowright Building, the BBSRC National Vaccinology Centre: the Jenner Building, high containment large animal and extensive insectary facilities, are complemented by its leading high biosecurity facilities and expertise in biocontainment engineering and bio-risk management. Indeed, the Institute's impact extends beyond its campus: its research partnerships with national and international research programmes – for example, Diamond Light Source, the One Health Poultry Hub and its World reference laboratories -- makes it a leading global contributor to disease control and food security.

Top, The Jenner Laboratory at the Pirbright Institute. Bottom, the Pirbright campus building.

Case study 4

Bioscience Research and Innovation Campuses

BBSRC's Research and Innovation Campuses form a vital component of the UK innovation ecosystem. Each of the five campuses (Aberystwyth Innovation and Enterprise Campus, Babraham Research Campus, Easter Bush Campus, Norwich Research Park, and Rothamsted Enterprise Ltd) is centred on world leading bioscience, strategically funded by BBSRC.

They aim to:

- Nucleate regional clusters and work with key stakeholders to deliver benefit for the UK by attracting and nurturing highly innovative businesses, creating high-value jobs, attracting inward investment, enhancing collaboration, and accelerating impact
- Add significant value to the local, national, and international innovation ecosystem
- Create research and innovation opportunities catalysed by a critical mass of world-leading science, talented people, national capability, and specialist research-led facilities / infrastructures at each location.

The campuses provide a unique environment where companies can access specialist facilities and exchange ideas with leading researchers.

Exemplar infrastructure:

Food biotechnology and manufacturing is one of the largest industrial sectors in the UK. AberInnovation hosts a dedicated biorefining pilot facility (and technical expertise) for extracting, analysing and optimising chemicals from biomass and process side-streams with integral industrial biotechnology and a food grade environment; helping emerging and established companies to grow and scale.

State-of-the-art scale-up and process development facilities at AberInnovation.

Case study 5

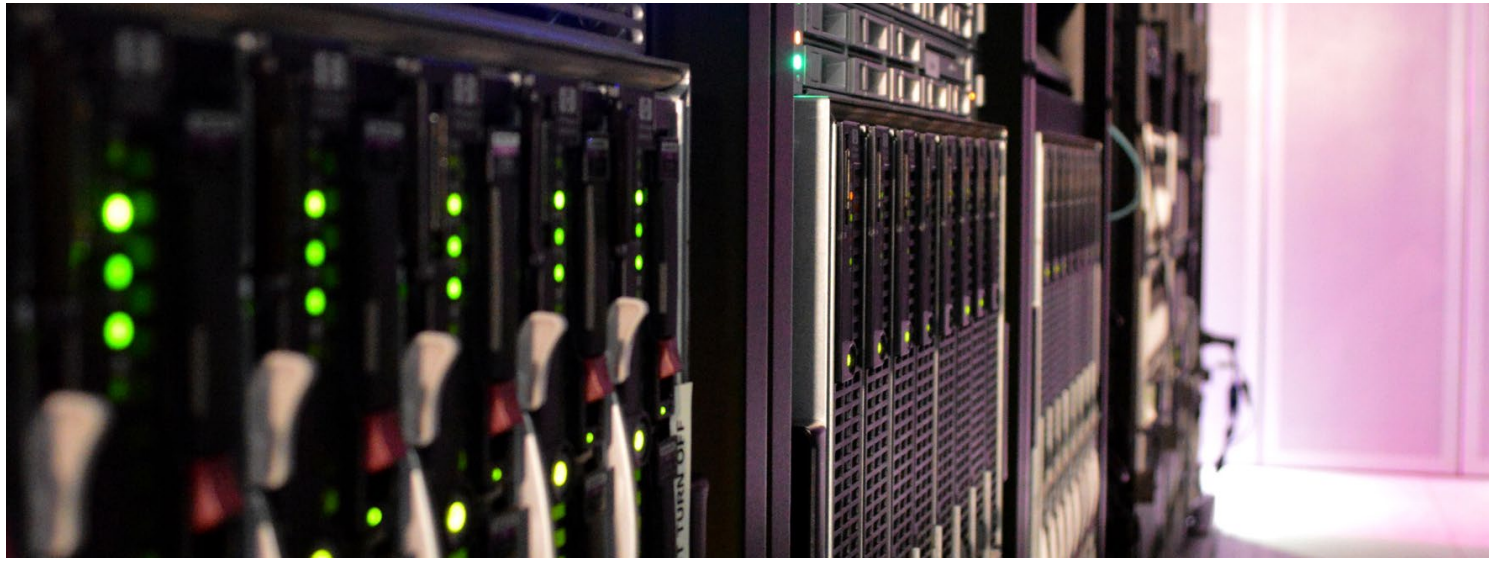
EMBL-EBI

BBSRC is a key supporter of international infrastructures, such as the European Molecular Biology Laboratory (EMBL) - European Bioinformatics Institute (EBI).

EMBL-EBI provides the world's most comprehensive range of open and interconnected biological data resources. By enabling this open data approach, it increases the accessibility and utility of existing data, thus reducing the need for researchers to re-run experiments. EMBL-EBI co-hosted resources also play a key role in the increasing application of artificial intelligence (AI), such as the development of DeepMind's AlphaFold protein structure prediction tool.

From its base in Hinxton, Cambridgeshire, EMBL-EBI enjoys a truly global reach: over the course of 2022, its resources were accessed by users in almost every country in the world and, with web requests equivalent to 107 million hits every day.

Closer to home, EMBL-EBI has strengthened the UK's leading position in European and global bioscience, specifically in bioinformatics and data-led bioscience research, by attracting more companies to invest and innovate on the Wellcome Genome Campus.



EMBL-EBI data centre. Credit: EMBL-EBI

Case study 6

John Innes Centre and The Sainsbury Laboratory Next Generation Infrastructure

The John Innes Centre (JIC) and The Sainsbury Laboratory (TSL) are both internationally recognised centres of excellence in plant and microbial sciences.

In line with its principles of environmental impact and sustainability, BBSRC is working with regional, national, and charitable partners to deliver the transformational JIC TSL Next Generation Infrastructure programme. The £317.7 million BBSRC secured through the UKRI Infrastructure Fund is a significant part of the overall investment (approximately £390 million) to establish a global interdisciplinary hub for plant and microbial sciences that will be energy self-sufficient and carbon net zero.

The hub will integrate capabilities for plant genetics, genomics, pathology, and phenotyping alongside field trial facilities. It represents a real opportunity to establish a world-leading global interdisciplinary hub for plant and microbial sciences that will help deliver the bio-based solutions needed to address global challenges around sustainable agriculture, food, nutrition and health.

Top picture, hub technician at work. Image courtesy of John Innes Centre. Bottom picture, an artist's impression of the future John Innes Centre and The Sainsbury Laboratory campus. Image courtesy of BDP.

Appendix 1: Insights from 2022 stakeholder consultation

Over summer 2022, BBSRC's Research Infrastructure Team conducted a series of engagement consultations with key BBSRC stakeholders, including Strategic Partner Universities, BBSRC's Strategically Supported Institutes, UK nodes of international infrastructures, and the former UK Government Department of Business, Energy and Industrial Strategy (BEIS). A full list of stakeholders is provided below.

The consultations engagement aimed to address the following points:

- An understanding of the targeted community's perspectives
- A consideration of how BBSRC might address community needs in prioritising investments and developing capabilities
- Risk identification and management
- A light-touch review and forward-look of the bioscience infrastructure landscape.

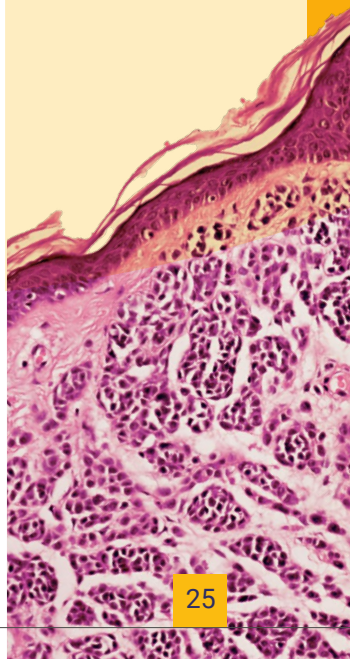
The summary of these insights, below, highlights their common themes.

Research and technology trends

The emerging trends identified by respondents included advances in widely used technologies such as 'omics, imaging, and structural biology, and the increased uptake of machine learning and artificial intelligence (AI). A key area is the need for alignment and synergy between physical and digital technologies to maximise the benefits of experimental platforms, manage data, and guide experimentation. Regular advances in imaging technologies have resulted in the need for hardware and software updates to keep pace with the increased sensitivity, speed, and resolution available.

Technologies that were highly specialized a few years ago are becoming commonplace, with an increase in demand for cryo-EM and cryo-ET to 'see' molecules in action. 'Omics technologies (genomics, proteomics, and metabolomics most frequently) also continue to evolve, particularly with regard to throughput and scale (including miniaturisation). Interdisciplinary working and "edge-of-discipline innovation" were cited as important developments that allow researchers to take advantage of diverse infrastructure technologies from other domains, but present additional challenges in relation to access, collaboration, and training.

Increasingly, coordinated platforms or pipelines of equipment are required for the integration of multiple technologies (multi-omics), or for example, cryo-EM with mass spectrometry and Alphafold modelling for structural biology, or 'omics with imaging technologies for single cell spatial applications. The integration of technologies, when coordinated in physical proximity as a platform or pipeline, lends itself well to automation and the deployment of robotics technologies; developments that go hand in hand with the increased data accuracy and reproducibility, which provide the robust and consistent datasets required for AI. Such trends are also apparent in technologies deployed in the field, with a need to find ways to effectively bridge, compare and integrate quantitative insights gathered across infrastructures between laboratory and 'real world' settings.



Data, along with the tools and methods to analyse it, emerged as the outstanding trend. In this field, digital infrastructure and the full range of capabilities to operationalise it (services, staff, skills and training, connectivity, computation and storage, and access) were mentioned as most in need of support. Key messages included the need to invest in the software and hardware to enable data storage, analysis and sharing, and in skilled staff (for example data scientists, data stewards, research software engineers, IT staff) and training for both staff and users to maximise the application (curation and FAIRification) of that data to address research goals. The revolution in data-intensive bioscience is driving changing infrastructure needs, with increasing demand for high-throughput, high-performance computing, and a robust cloud computing framework.

Access

Access to infrastructure can present challenges for users and infrastructure providers. Infrastructure access models and contexts vary widely, from in-lab equipment through to local facilities including spaces for innovation; high-end equipment in national and international centres and remote access. It is also crucial to ensure that facilities are open to a range of physical abilities. Stakeholders highlighted the need to establish operational and financial models that better support broadened access for a diverse range of users. They mentioned issues including access costs, which can create obstacles for PhD students, as well as the need for sufficient staff and funding resources to support access. Equipment-sharing and open access, while positive developments, have increased pressure on infrastructures.

Improving access allows researchers to use the latest technologies, share best practice and training, establish collaborations, innovation, and maximise the efficiency and impact of infrastructure investments. Consultations offered up suggestions to facilitate access and manage costs, including paid access to industry, the join-up and consolidation of national assets and, for users, subsidised access schemes. They also pointed to international access schemes as a valuable resource that promotes cooperation and knowledge-exchange.

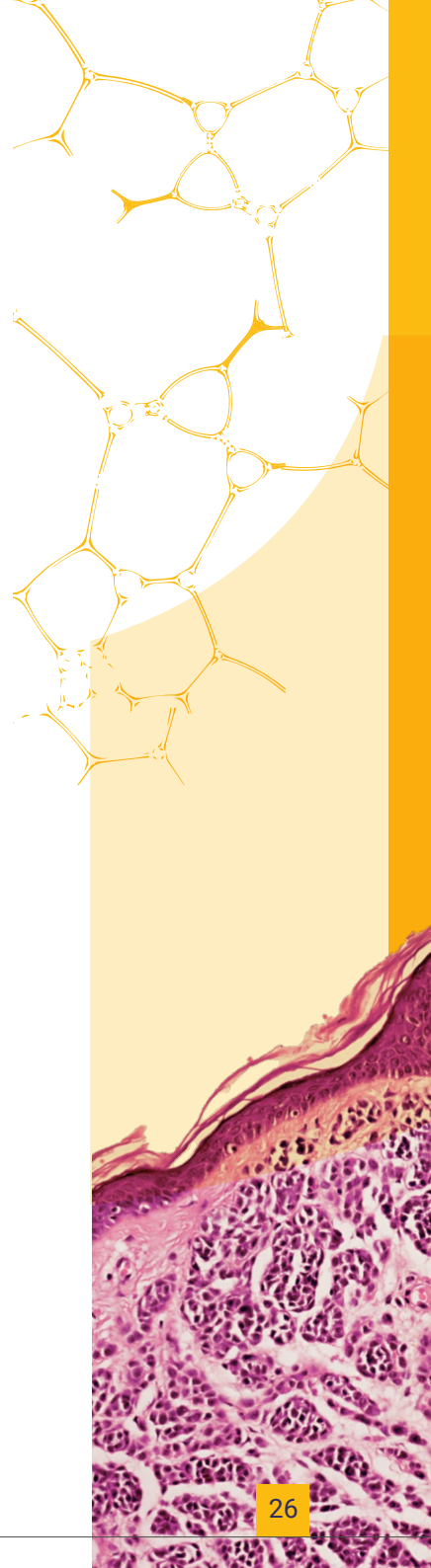
People and talent, including career paths

The sustainability of the infrastructure ecosystem relies on a well-trained, well-supported, highly skilled community of managers, researchers and other users. Equally important are the technical staff who operate equipment, run experiments, provide training, manage facilities, analyse data, and generally support day-to-day operation of infrastructures.

Respondents highlighted the clear need for training across fields and career stages to support current and future capacity, particularly in data skills training for staff and researchers. Attracting and retaining highly skilled people, particularly in the in-demand field of data analysis, requires support for salaries, well-delineated and supported career progression, and professional development opportunities (for example eligibility for grants and conference attendance), support at all career stages, and recognition of the value and essential nature of their inputs.

Innovation

Innovation infrastructures include facilities that enable the development, demonstration, and delivery of new-to-market products, services, or processes. Infrastructures that facilitate innovation operate across a range of technical, societal, and regulatory readiness levels, providing access to scientific and



market knowledge, as well as to potential customers and investors.

Building on the model of the UKRI Campuses, research and innovation infrastructures have the potential to support these early-stage capabilities by enabling access to a wider user base, thus de-risking access for companies. Indeed, there is an opportunity for infrastructures to support bioscience across the entire research and innovation spectrum. This not only enables wider strategic alignment with the aims of BBSRC and UKRI, but also provides an opportunity to diversify the infrastructures' funding sources and maximise their capacity to support early to late-stage commercialisation, and applied uses.

Furthermore, by investing in dedicated scale-up infrastructure, there are opportunities to further de-risk innovation development and encourage economic growth within the bioscience sector overall. Stakeholder engagement highlighted that there is a clear gap in the support available for projects at the pilot/demonstration level, which are looking to scale and become market ready.

Networking and Connectivity

The networking of infrastructures plays a vital role in sharing best practice, training, data, equipment, resources, and other capabilities. Both in terms of policy and sustainability, connecting resources and services optimizes their use and promotes a cooperative, joined-up landscape.

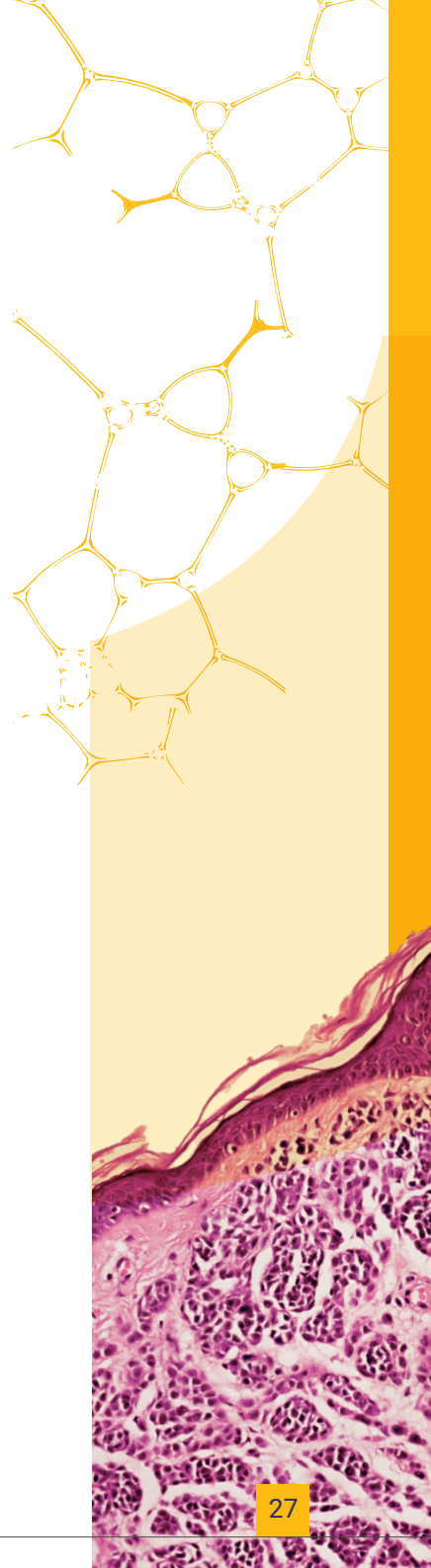
Consultations revealed broad support for institutional interconnectivity and improved networking of resources and facilities. Nevertheless, stakeholders recognised that these capabilities require robust and sustained support (data infrastructure, staff resource) to harness the potential of an integrated ecosystem.

Increased support for multidisciplinary and multisectoral networking activities would offer users the opportunity to co-design, test and adopt new technologies. Respondents expressed enthusiasm for increased coordination across UKRI's Research Councils on cross-disciplinary infrastructures, as well as better coordination with other funders on shared infrastructure investment. UKRI-wide doctoral training programs focusing on instrument and software development and data-driven science, for instance, would bolster both the bioscience and infrastructure skills and knowledge ecosystems.

Sustainability

Sustainability has long been recognised as a critical factor in infrastructure development and a consideration that must be embedded into financial and human resources planning. Responses pointed to the challenges of long-term sustainable operational management. While funds exist to set up pilot projects or new equipment and facilities, fewer sources of external funding to support their longer-term maintenance and ongoing costs exist. Stakeholders suggested better-aligned capital and operational expenditure funding lines to provide ongoing support for staffing and operational costs,equipment maintenance and warranties, access, and other capability costs.

They also addressed the importance of environmental sustainability in this issue, which is particularly relevant in digital research infrastructure, since newer equipment is much more energy-efficient in terms of power consumption and cooling technologies.



Appendix 2: Acknowledgements

List of stakeholders who provided input to consultation

Strategic Partner Universities	BBSRC-Supported Strategic Institutes
University of Bristol	Babraham Institute
University of Cambridge	Earlham Institute
University of Edinburgh	Institute of Biological, Environmental and Rural Sciences
University of Glasgow	Rothamstead Research Institute
Imperial College London	Quadram Institute
University of Leeds	The Pirbright Institute
University of Liverpool	
University of Manchester	
University of Oxford	
University of Southampton	
University of Warwick	
University of York	

ESFRI Infrastructures	UK Government Departments
ELIXIR-UK	BEIS
EMPHASIS-UK	
EuroBioimaging-UK	

Members of the Task and Finish Group

Steve Bagshaw CBE FIChemE CEng,
Centre for Process Innovation,
BBSRC Council

Professor Kathryn Lilley,
University of Cambridge;
Chair Transformative Technologies Strategy

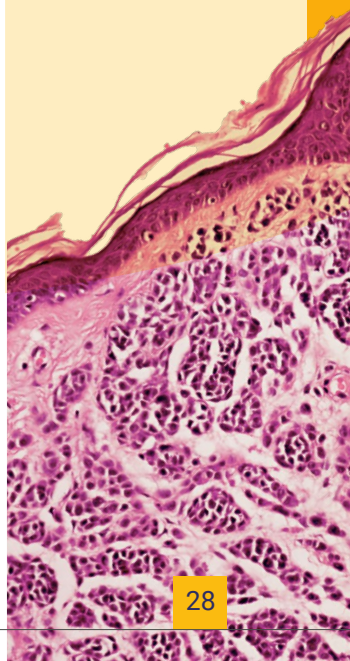
Professor Andrew Millar FRS, RSE,
University of Edinburgh,
BBSRC Council

Professor Christine Orengo FRS, OBE,
University College London,
BBSRC Council

Professor Malcolm Skingle FRS, GSK,
BBSRC Council

Professor David Stephens FRSB,
University of Bristol

The Group was chaired by
Dr Amanda Collis FRSB, BBSRC



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