



28 August 2013

Society for General Microbiology Consultation Response

Science and Technology Committee (Commons) – Research and Development funding for science and technology in the UK

Introduction

We are pleased to respond to the House of Commons Select Committee on Science and Technology – Research and Development funding for science and technology in the UK.

The National Audit Office (NAO) memorandum on R&D funding is excellent, and we thank the Committee, and the NAO, for producing it.¹

We have divided our response into five sections: (1) key points; (2) the Society for General Microbiology and its role in UK microbiology; (3) overview of microbiology R&D; (4) the UK's R&D landscape in microbiology; and (5) suggestions for future inquiries on UK R&D funding.

We hope this information is useful to you as you work on your review. With our national reach, and deep knowledge of our discipline, we can provide further information as needed.

1. Key points

- Microbiological research has a long tradition of innovation, driven by new knowledge, new technology, and the supply of skilled, motivated, imaginative and well-trained scientists. The discipline presents opportunities to tackle major societal challenges such as infectious disease, climate change, and sustainable economic growth.
- Universities and public sector research establishments form a vital part of the microbiology research infrastructure driving forward innovation across the UK.
- New funding of 'discovery' or 'blue skies' research is imperative to feed the translational research agenda.
- Innovative microbiological work is growing rapidly in the private sector and is concerned with (i) antimicrobial therapies, diagnostic devices, monoclonal antibodies and vaccines to prevent, detect and treat infectious disease (anti-infectives technology), degenerative diseases and cancer; and (ii) sustainable, green chemicals and fuels manufacturing.
- Microbiology lies at the heart of the pharmaceuticals industry. For example, microbial fermentations are used to manufacture antibiotics and other anti-infectives, recombinant

¹ National Audit Office, 2013, *Research and Development funding for science and technology in the UK*; <http://www.nao.org.uk/wp-content/uploads/2013/07/Research-and-development-funding-for-science-and-technology-in-the-UK1.pdf>

human insulin, and monoclonal antibodies; and used increasingly to treat degenerative diseases and some types of cancer.

- Microbial processes contribute significantly to the food and drink industry, for example in brewing, and cheese and yogurt manufacturing.
- In the last few years, large scale microbial processes have been developed by fuels and chemicals manufacturers to produce biofuels, pharmaceutical intermediates, biopolymers and, increasingly, bulk industrial chemicals.
- The Science and Technology Committee could investigate the value of a coordinated national strategy committed to developing new anti-infectives technology. The ultimate objective would be to create an Anti-infectives Technology Catalyst Fund, with core funding drawn from the Biotechnology and Biological Sciences Research Council, Medical Research Council, Technology Strategy Board, National Institute for Health Research, European Union, plus other relevant non-governmental funders such as the Wellcome Trust and the Bill and Melinda Gates Foundation.
- The UK Chemicals Industry is one of the leading contributors to UK GDP. The Science and Technology Committee could inquire into the best ways to build on the relatively modest UK investments to date in the area of Industrial Biotechnology (compared with, for example, the USA, the Benelux countries and Germany), to further stimulate growth in bio-based chemicals and fuels manufacturing.

2. About the Society for General Microbiology

The Society for General Microbiology (SGM) is a membership organisation for scientists who work in all areas of microbiology. It is the largest learned microbiological society in Europe with a worldwide membership based in universities, industry, hospitals, research institutes and schools. The SGM publishes key academic journals in microbiology and virology, organises international scientific conferences and provides an international forum for communication among microbiologists and supports their professional development. The Society promotes the understanding of microbiology to a diverse range of stakeholders, including policy-makers, students, teachers, journalists and the wider public, through a comprehensive framework of communication activities and resources. Further information about SGM is provided in Appendix 1.

3. Overview of microbiology R&D

- ‘Blue-skies’ research on the basic biology of micro-organisms (viruses, bacteria, fungi and protozoa).
- Identification, prevention and cure of infection in people, crops and livestock.
- Industrial biotechnology including design, discovery, development, and manufacture through fermentation processes of chemicals, biofuels, pharmaceuticals and bio-therapeutics.
- Safe and efficient food production; food and drink manufacturing.
- Responsible innovation in frontier fields such as synthetic biology, industrial biotechnology, bio-nanotechnology and green energy.
- Pollution control and the safeguarding of water quality; waste treatment.
- Research on micro-organisms with the aim of improving soil and ecosystem health.

4. The UK's R&D landscape in microbiology

4.1. Microbiology's UK-wide reach



Microbiological research is UK-wide. The Google Map on the left gives a snapshot of where microbiology research occurs (red is for universities, green for public sector research establishments, and blue for companies). The map is best viewed online.²

Universities strong in microbiology are distributed throughout the country (see section 4.2). Looking at the private sector, firms conducting microbiology R&D are also found throughout the UK: some are associated with former ICI or Big Pharma sites, such as Billingham in County Durham or Alderley Edge in Cheshire; others co-locate with universities; others still locate in science parks, or strike out on their own.

In July, the Sheffield-based vaccine discovery start-up Absynth received £850k funding from Fusion IP, The North West Fund (European Union-backed), and the Technology Strategy Board.³ In the chemicals and fuels sector, large enterprises with microbiology activities are based in Teesside; and microbiology-based small and medium-sized enterprises (SMEs) in Oxford, Guildford, Hertfordshire, Edinburgh, inter alia. Increasingly, traditional chemical companies (e.g., INEOS at Grangemouth) are becoming interested in the applications of Synthetic Biology to create “microbiological factories” (see section 4.4).

There is a real possibility of growing significant research, development, and production processes across the country, with clear translation of benefits to the economy, environment, and public health.

4.2. Microbiology's vitality in the universities

We live in exhilarating times, in terms of research and innovation in microbiology. Genomics, the metagenome, the microbiome, microbial ecology, synthetic biology, industrial biocatalysis, fermentation technology, biochemical engineering and new developments in bioinformatics, all imply a range of opportunities that have emerged from microbiological research in universities, or are having significant impacts upon the productivity and inventiveness of university research. These present opportunities to tackle wider problems such as climate change, biofuels and chemicals, food and water security, infectious disease, and antibiotic resistance.

The universities have particular strengths for effective R&D, notably:

² <https://mapsengine.google.com/map/viewer?mid=zwNbpN4FzNro.kexdTsv5eHOY>

³ <http://www.growingbusiness.co.uk/absynth-biologics-secures-850-000-investment-from-the-north-west-fund-for-biomedical.html>

- National capacity – around 60% of research output in microbiology (scientific publications) comes from universities outside London and the South East of England, with strength in the North and West of England, the Midlands, Scotland, Wales and Northern Ireland.⁴
- Remit to conduct both ‘blue-skies’ and applied research. Without blue-skies work, there will be little innovative science to translate, nor the expertise to understand fundamental research conducted overseas, recognise its significance, and translate it for the benefit of the UK economy.
- Broad-based, with strengths in most key sub-disciplines of microbiology and related disciplines unavailable in other research establishments, such as medicine and veterinary medicine, chemistry and engineering. This lends university research the resilience to respond in an expert way to unforeseen, emerging threats, such as new infectious diseases; and to identify, and exploit new discoveries for the benefit of the UK economy.
- Strong international networks with established and emerging research communities overseas.
- Research governance infrastructure including Open Access, Research Excellence Framework (REF), and peer-review that makes university research accessible to investors and policy-makers, and ensures research takes place under public (democratic) sight.

4.3. Emerging opportunities to fight infectious disease

Microbiology research concerned with ‘anti-infectives’ technology (to detect, prevent, and treat infectious disease) is an emerging source of private sector innovation. There are critical developments across three areas, namely (1) antimicrobial drugs aimed at bacterial and fungal infections (particularly vital due to the rise of antibiotic resistance in bacteria); (2) diagnostic devices; and (3) vaccines. Collectively, these measures have the potential to solve infectious diseases, such as those in the globally-important aged care sector (e.g., hospital-acquired infections), and also represent significant opportunities in the global healthcare market.

The Chief Medical Officer has drawn attention to the problem of antibiotic resistance. We welcome wider government moves on this topic, such as recent investments made by the Technology Strategy Board (via the Biomedical Catalyst), and the Ministry of Defence.⁵ There is significant potential in an emerging commercial sector: our own survey indicates that there are now at least 20 small firms across the UK actively involved in research on antimicrobial resistance (see the Microbiology Research Map, online⁶). These firms deploy a range of different approaches, from investigation of natural products, to development of vaccines, and other methods. Diverse approaches represent a richness of endeavour.

But further commitment is critical if we want take-off for a wider range of measures including antimicrobial therapies, diagnostic devices, and vaccines (as is support for skilled, motivated,

⁴ Based on Society for General Microbiology survey of microbiology papers published in the past decade by researchers at the UK’s universities.

⁵ Technology Strategy Board/Medical Research Council, Biomedical Catalyst (Round 3) Awards, undated; <https://www.innovateuk.org/documents/1524978/1866952/Biomedical+Catalyst+-+Round+3+Awards/1743b16c-c324-443c-81c6-ab2672136460>

⁶ <https://mapsengine.google.com/map/viewer?mid=zwNbpN4FzNro.kexdTsv5eHOY>

imaginative and well-trained scientists in this field). Different, but complementary, approaches could usefully be driven forward by a new Catalyst Fund focused on Anti-infectives Technology.

4.4. Biotechnology in the green economy – opportunities, and challenges

It is estimated that over 30,000 different chemicals are now in commercial use. Unstable oil prices – and emerging green technologies – are prompting a transition from oil-based chemistry towards alternative, renewable starting materials. Firms involved range from the very large, to SMEs. Microbiological research plays a pivotal role, as the yet-to-be-developed production processes depend on bacteria and fungi to convert sugars into useful chemicals.

There are two interrelated aspects to government support for science in this area. The first concerns research and development to establish viable production processes using pre-existing knowledge (knowledge translation); good progress is being made here. The second concerns basic research on the microbial physiology needed to operate these processes on an industrial scale; in this area there is significant weakness.

Government support for knowledge translation has helped the UK into the top five of EU countries for commercialisation of research in this field. Government recently expanded its backing for applied research through the Biological Sciences and Biotechnology Research Council (BBSRC)/Technology Strategy Board (TSB)-funded Industrial Biotechnology Catalyst.⁷ This scheme, which launches in 2014, should be encouraged.

On the second aspect, however, there appears to be less progress. One significant scientific issue for R&D expenditure is scaling-up production. When moved to large scale – as is needed for industry – useful end products kill the micro-organisms producing them. Yields are therefore too low. We are yet to develop an ‘off-the shelf’ industrial biotechnology.

As noted in a policy research paper from NESTA – and widely acknowledged elsewhere – creative solutions will emerge from greater collaboration between chemical engineering *and* microbiology.⁸

The Engineering and Physical Sciences Research Council (EPSRC) supports relevant research but the funding is targeted at the engineering side. The BBSRC is the major Research Council of relevance to the microbiological side; BBSRC funding for ‘industrial biotechnology and bioenergy’ amounts to £26.2m in 2012/13, but this is split between 18 often eclectic areas ranging from tissue engineering to biomass crops.⁹ The focus is therefore diffuse, with relatively little opportunity for the scientific committees that allocate research funds to make major investment in one area.

⁷ <http://www.bbsrc.ac.uk/news/industrial-biotechnology/2013/130125-n-industrial-biotechnology-catalyst.aspx>; <https://connect.innovateuk.org/web/bbsrc-nibb>

⁸ NESTA, 2011, *Financing Industrial Biotechnology in the UK*, p. 54 (recommendation 7); <http://www.nesta.org.uk/library/documents/FinancingIndBioTechv12.pdf>

⁹ Overall figure supplied to SGM by Dr Sharon Fortune (BBSRC). The relative funding allocations for the 18 topic areas were not given.

There is, as a consequence, a huge funding gap for applied microbiological research in technology readiness levels 1-4 (discovery, research, and proof of concept) for key areas of basic science underlying industrial biotechnology.¹⁰ The BBSRC Networks in Industrial Biotechnology and Bioenergy (NIBB) will usefully link together interested researchers for the purpose of knowledge exchange, but they are not a research funding mechanism.¹¹ It would therefore be worth examining the value of a ring-fenced *funding* pathway for synthetic biology, targeted at microbial physiology for industrial application. This could go some way to supply the research needed in terms of scaling-up production processes.

4.5. The importance of Public Sector Research Establishments (PRSEs)

We looked at the Chief Scientific Advisor (CSO)'s recent list of PSREs to determine where microbiological research concentrates.¹² The CSO does not make the conventional distinction between 'PSREs' (taken to mean institutions directly under a ministerial department), and 'research institutes' (government-funded, but held at arm's length through the Research Councils).

In our analysis, there are a total of about 30 research establishments and research institutes with significant microbiological interests (see map¹³; detailed list available on request from the Society for General Microbiology). The majority are located in England; one is in Northern Ireland (not included on the CSO's list); and two in Scotland.

These institutions cover the gamut of microbiological research, from the most applied, to the bluest skies; but sharing a clear focus on (i) infectious disease; and (ii) agriculture. With their specialist infrastructures, they support significant research strengths in UK microbiology, covering vital topics for future public health, food production, and the agricultural economy. They provide essential frontline services, such as predicting and controlling disease outbreaks. They have potentially enormous value in linking basic, strategic and applied research, with a longer time-horizon than the shorter-term grants offered to universities, and acting as nuclei for innovation. Developing more effective synergistic relationships between researchers in universities and public sector research establishments should be a future goal.

5. Suggestions for future inquiries on UK R&D funding

- Investigate the potential for a national innovation strategy aimed at supporting the development of new technology to fight infectious disease (antimicrobial therapies, diagnostic devices, and vaccines). It could include discussion in the following areas:

¹⁰ <https://www.innovateuk.org/documents/1524978/2139688/High+Value+Manufacturing+Strategy+2012-15/>, p. 13

¹¹ Dr Saul Purton, 07/03/13 11:54, Establishing the network and putting together an application; https://connect.innovateuk.org/web/bbsrc-nibb/discussions/-/message_boards/message/7062630?p_p_auth=RmXyl7r9

¹² <http://www.parliament.uk/documents/commons-committees/science-technology/130516walportpsres.pdf>

¹³ <https://mapsengine.google.com/map/viewer?mid=zwNbpN4FzNro.kexdTsv5eHOY>

- Assessment of (i) the scale of potential markets; (ii) the societal benefits of cutting the rates of infectious disease; and (iii) where government funding could usefully intervene.
- Views from the relevant UK sector in antimicrobial therapies, diagnostic devices, and vaccines (firms and institutions involved in production, marketing, research and development, and regulation).
- Contribution of the EU's Innovative Medicines Initiative (and what else is needed in terms of targeted funding).¹⁴
- Relevant skills sets and career pathways in the universities.
- How to use limited financial resources most effectively. Extent of collaboration between the Technology Strategy Board, Research Councils, the universities, Department of Health, philanthropic funders, and private sector (including SMEs).
- The vital part played by the National Institute for Biological Standards and Control (a public sector research establishment) in setting safety standards for vaccines and biological therapies, and conducting research to streamline vaccine production processes.
- The possibility of an Anti-Infectives Technology Catalyst Fund ('Bug Busting Fund') backing technology to fight infectious disease.
- Potential linking role for the Office for Life Sciences (BIS).
- Inquire into best practice occurring in R&D associated with industrial biotechnology; identify gaps in the innovation system. While necessarily very broad in scope (economics, environmental benefits, engineering challenges), such an inquiry could include examination of the value of a ring-fenced funding pathway for synthetic biology, targeted at microbial physiology for industrial applications.

Society for General Microbiology – President & Chair of the Policy Committee:

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- Professor Colin Harwood, Newcastle University
- Mr Scott Nicholson, University of Leeds
- Professor Maggie Smith, University of York
- Professor Gill Stephens, University of Nottingham
- Dr Jeremy Webb, University of Southampton

The Policy Committee additionally sought the views of Dr Mike Dawson (Novacta Biosystems Ltd.), Professor Laura Piddock (University of Birmingham), Dr Malcolm Rhodes (University of Manchester), and Dr Rebecca Wood (Chemical Innovation Knowledge Transfer Network) in preparing this

¹⁴ http://europa.eu/rapid/press-release_IP-13-668_en.htm

response. Mr Jonathan Fuhrmann (Society for General Microbiology) contributed significantly to data gathering and analysis.

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Appendix 1: The Society for General Microbiology

Vision

A world in which the science of microbiology provides maximum benefit to society.

Mission

To promote high-quality microbiological science, both nationally and internationally, to a diverse range of stakeholders.

Rationale

The potential socio-economic benefits arising from microbiology are substantial. They include:

- A healthier future (for humans, animals and plants) and a better quality of life, within the context of a sustainable natural environment.
- The development of biotechnology products (such as food, drinks, biopesticides, biofuels and medicines), which generate wealth and employment, and so support growth and innovation.
- The advancement of scientific knowledge, as a benefit in its own right, and to allow us to plan for the future and contribute to international solutions for global challenges, such as climate change, the burden of disease and food security.

Strategic priorities

To achieve its Vision and Mission, the Society will work towards the strategic priorities below.

- Publishing: to contribute to the science of microbiology through high-quality publications.
- Scientific conferences: to hold international scientific conferences to disseminate research knowledge and provide a forum for communication between microbiologists and to grow and support communities among them.
- Raising awareness: to inspire and educate people about microbiology, and allow them to make informed decisions which recognize the importance of microbiology and its advances.
- Influencing policy: to ensure that appropriate scientific information and expert opinion are made available to policy- and decision-makers and that the improvement of resources and infrastructure for microbiology is supported.
- Professional development: to promote microbiology as a career from school level onwards and support career and professional development of microbiologists.

The Society is a Charity registered in England and Wales (No. 264017) and in Scotland (No. SC039250) and a Company Limited by Guarantee, registered in England and Wales (No. 1039582).

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