21 June 2013

Society for General Microbiology Consultation Response

House of Lords Select Committee on Science and Technology – Call for Evidence on Scientific infrastructure

Introduction

We are pleased to respond to the House of Lords Select Committee on Science and Technology – Call for Evidence on Scientific Infrastructure.

We have divided our response into four sections: (1) key points; (2) the Society for General Microbiology and its role in UK microbiology; (3) the importance of microbiology research; and (4) consideration of the medium and large-scale infrastructural needs for such research.

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

- Infrastructure means both high-quality equipment and the skilled personnel to run it. It also includes the networks required to maximise effective use of scarce infrastructure resource.
- Open access national and/or regional centres for scaling-up fermentation processes will prove critical to the development of green biotechnology, and process improvement for the manufacture of bio-pharmaceuticals.
- Research in synthetic biology needs robots for screening experiments, coupled to high-throughput analytical equipment.
- Science is increasingly multidisciplinary and access to specialised equipment must be available irrespective of traditional specialities. Equipment for chemical analysis may need to be placed in bioscience or geoscience departments rather than in chemistry departments, for example.
- State-of-the-art bio-containment laboratories are central to research on dangerous pathogens.
- European-level coordination of research resources such as databases and culture collections is likely to become increasingly vital.

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. The importance of microbiology research

Microbiology research is concerned with advancing:

- Prevention and cure of infection in people, crops and livestock.
- Industrial fermentation processes to manufacture 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.
- Health of soils and ecosystems.

4. Medium- and large-scale scientific infrastructure in microbiology

Much microbiological research can be done in a "well-founded laboratory" environment, using small-scale equipment widely available in biochemistry and molecular biology laboratories, with small cabinets to provide a constant environment for growth of micro-organisms, cell cultures, etc. However, specialised equipment and expertise is required *inter alia* for developing industrial scale processes, for comparative analyses in systems microbiology, for high-throughput sample handling and for working with pathogenic micro-organisms in their host species.

4.1. Equipment and skilled staff for industrial biotechnology

Fermentation facilities are vital for microbiological research leading to the development of new biomaterials, biofuels, and biopharmaceuticals; and for basic research in the fields of systems biology, metabolomics, and microbial pathogenesis.

To succeed, these facilities need both high-quality physical plant; and skilled, well-trained personnel. Universities find these requirements hard to satisfy because of their dependency on project funding (leading to high staff turnover due to short-term contracts), and the lack of chemical engineering know-how within a purely science-based environment. We therefore consider important the establishment and maintenance of core-funded, open-access, interdisciplinary fermentation facilities on a national or regional level.

The UK currently hosts only one such facility: the National Industrial Biotechnology Facility at the Centre for Process Innovation, Wilton. This is backed by the Technology Strategy Board, and handles a mix of projects from SMEs, academia and (increasingly) larger corporations. The Wilton facility is used for producing chemicals and enzymes by growing micro-organisms in large stainless steel or

glass-lined reactor vessels supplied with nutrient solution (e.g., molasses). The enzymes and chemicals are then extracted and purified. The facility is used to design and develop profitable manufacturing processes that can be scaled-up in the commercial sector.

Universities additionally host a mix of smaller scale fermentation facilities. No national inventory is kept, but our combined experience indicates they are of variable quality. Multiple parallel fermenters are vital for comparative experiments but research fermenters are often assembled piecemeal over years, depending on the flow of grant money. This means that replicate experiments are hard to perform, particularly for systems biology, as the equipment does not match.

Large-scale equipment is increasingly needed to develop procedures for the manufacturing of chemicals and pharmaceuticals. It will also have value for making enzymes and plasmids for research. Photo-bioreactors for growing algae and cyanobacteria are becoming increasingly important for research on biofuels.

The UK infrastructure for fermentation could be strengthened by ensuring the Wilton facility, or a similar organisation, is open to academics (who need an appropriate scale of grant funding), as much as corporates – and advertises this fact to the academic community. There is also a need for multi-university or regional facilities with standardized parallel fermenters. But it should be recognised that all such facilities need both high-quality equipment, and skilled staff such as industrial scientists and technologists, process operators, and engineers; the two go hand-in-hand.

4.2. Robotic facilities

Robotic screening facilities are likely to prove important, particularly in the emerging field of synthetic biology and for high-throughput screening of candidate antimicrobial drugs. These need to be provided in the most cost-effective way for UK researchers.

In the case of synthetic biology, the aim is to develop new, sustainable ways to manufacture vital pharmaceuticals, industrial chemicals, and construction materials. This can be achieved by genetic modification of a micro-organism to produce economically-useful chemicals

Some compounds, such as benzene, cannot currently be synthesised enzymatically and major modifications to biochemical pathways may be required to achieve novel transformations. The prize is large – a green chemical industry – but to identify suitable candidate enzymes requires screening of hundreds of thousands of bacterial variants. This can only be done in expensive robotic systems coupled to automated analytical apparatus. Such systems also need skilled, long-term technical support.

The shortage of antimicrobial drugs has been widely highlighted.[1] It is therefore timely to consider how the UK medium- and large-scale research infrastructure can be strengthened in this field. High-

[1] Society for General Microbiology, Note for Parliamentarians, 2013, *Responding to the challenge of antibiotic resistance,* 7 June 2013, http://www.sgm.ac.uk/en/policy/consultation-responses.cfm, and click on: Antimicrobial Resistance Policy.

throughput robotic drug screening will be important for screening candidate antimicrobials and antivirals, and for repurposing existing drugs. It would be useful to map fully our robotic capacity in the drug discovery field, ensure open access, and seek to maximise its use for antimicrobial discovery.

4.3. Analytical facilities in the biological sciences

Chemical analysis is found in chemistry departments of universities, but not often in the biological sciences departments where microbiologists work. There are, accordingly, issues relating to availability and long-term support of analytical equipment to support microbiology. Where grants provide equipment, there is no long-term funding for technical support, maintenance and replacement of dated machinery. This is an area for which capital and sustained recurrent funding is required, and it could be on a regional, rather than individual institutional, basis. The impact is on studies of microbial physiology, bio-catalysis and biotransformation, natural products chemistry, and metabolomics and proteomics – all essential areas for research on problems such as antimicrobial drug development, and industrial biotechnology.

4.4. Containment facilities for research on human, animal and crop disease

State-of-the-art bio-containment laboratories will be central to future research on dangerous pathogens. This research is critical if we are to tackle the most devastating infectious threats to public health; it also ensures we can respond to outbreaks of livestock and crop disease that menace our rural economy.

Plans made under Programme Chrysalis (Public Health England) must be designed to meet the UK's needs for research on dangerous human diseases in the most up-to-date way.[2] In addition to bio-containment capacity for *in vitro* experiments, planners should consider adequate provision of (1) facilities to conduct vital infectious disease research using model animals (e.g., the ferret model for influenza) in accordance with the latest animal welfare standards; and (2) specialised insectaries for the study of insect-borne viruses.

Researchers also require access to specialised containment facilities for studies of endemic disease of large livestock; these are limited at present and open access to facilities is required up to SAPO 3 containment. The Pirbright Institute (BBSRC) or the Roslin Institute (University of Edinburgh) are relevant locations outside Government Departments (which sponsor the Animal Health and Veterinary Laboratories Agency, Moredun Research Institute, and the Defence Science & Technology Laboratory).

We should consider how we can make all such sites available to legitimate academic and industrial researchers, so that they become true 'open access' facilities.

There is a need to implement quickly a One Health regulatory framework (combining the Control of Substances Hazardous to Health Regulations 2002, and the Specified Animal Pathogens Order 2008).

[2] George E. Griffin, 2012, *Programme Chrysalis Due Diligence Review,* pp. 32-34, http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1317137026275.

Animal infections such as bird flu can pass to humans. A combined approach will ensure our ability to conduct high-quality research to the appropriate standards of safety and bio-containment, and allow us to pool regulatory expertise.

4.5. International partnerships in microbiology

The European Strategy Forum on Research Infrastructures (ESFRI) has been good at organising and providing large single facilities that operate on a European Scale.[3] However, many infrastructure components for microbiology are dispersed but need international coordination. National culture collections of micro-organisms are a case in point. These are often funded in *ad hoc* ways and there has historically been little transnational coordination. More recently, coordination of biological information resource is being developed through the European Life Science Infrastructure for Biological Information (ELIXIR) and we envisage the need for more initiatives of this type.[4]

4.6. Other major facilities that should be strengthened

- Increasing requirement for big data (and therefore the bandwidth of the UK network). Existing centres for bioinformatics should be open to all UK researchers.
- Environmental observatories. These should include accredited access-managed land (farm-scale), natural environments, and historic trials (e.g. the Broadbalk Experiment at Rothamsted Research).
- Facilities for molecular studies (e.g. at Harwell). These can be shared with other molecular disciplines, including chemistry and physics.

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- Professor David Blackbourn, University of Birmingham
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- Professor Colin Harwood, Newcastle University
- 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 Steven Pearson (Centre for Process Innovation, Wilton) in preparing this response.

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[3] http://ec.europa.eu/research/infrastructures/pdf/esfri-strategy_report_and_roadmap.pdf#view=fit&pagemode=none
[4] http://www.elixir-europe.org/

Appendix 1

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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