Joint response from the Society for General Microbiology and the Society for Applied Microbiology to the BBSRC/MRC Vulnerable Skills Consultation

The Biotechnology and Biological Sciences Research Council (BBSRC) and the Medical Research Council (MRC), in collaboration with the Society of Biology, held a consultation in summer 2014, which aimed to identify vulnerable capabilities and skills within the UK bioscience and biomedical research base.

The Society of General Microbiology and the Society for Applied Microbiology identified a number of areas which they considered to be vulnerable and submitted a joint response to the consultation. Details of the areas highlighted can be found below.

BBSRC and MRC have since published a report of the consultation.

1. Plant Pathology

Q1. What is the research area or discipline for which you wish to highlight a skills / capability vulnerability?

Plant pathology

Q2. To which funder(s) do you consider this research area relevant?

BBSRC

Q3. For the identified area, what is the evidence for its strategic importance?

If the area addresses known strategic research priorities, please describe how, highlighting interdisciplinarity where relevant.

Future food security depends on sustainable crop production. Plant pathology crosses plant science, microbiology, agronomy, mathematics, and bioinformatics disciplines.

What are the impacts (economic, social, health or academic) of this research skill in the UK?

Pathogens affecting crops, both pre- and post-harvest are a significant barrier, with around 25% of crops being lost to pests and diseases.

Q4. Please indicate at what level(s) and in what way(s) you have identified a vulnerability in the research area within the last 5 years.

A 2012 audit of plant pathology training and education in the UK by the British Society for Plant Pathology (http://www.bspp.org.uk/society/bspp_plant_pathology_audit_2012.php) found that plant pathology is dropping off the curriculum and even where it is taught, practical classes are not included in about three quarters of cases. The same report highlights a worrying age profile in the field.

These problems will only be compounded by the rate at which diseases of plants are emerging, spreading, and worsening due to environmental change and globalisation.

Q5. Why does this skill need to be enhanced in the UK, rather than by recruiting individuals from abroad? What would be the impact of losing UK expertise in this area?

Biosciences remain popular at undergraduate level, however, many graduates are not retained within the discipline. Whilst the transferable skills gained in such a course of study are clearly desirable to a range of employers, it seems that we are failing to capitalise on the specialist knowledge and training gained within the UK. The UK needs a long term solution to ensure a sustainable community of bioscience researchers across the breadth and depth of the discipline.

Mobility for UK bioscience researchers is beneficial. Working outside the UK helps researchers to build networks and identifying potential commercial applications linked to their work. We need to ensure however that the climate for carrying out research in the UK is such that these researchers return to the UK to work and share knowledge and experience. Likewise, the UK Research Base can benefit significantly from transitory researchers who are often highly productive during their stay. A balance needs to be found to provide the correct balance between UK and International Researchers, ensuring that UK researchers can have a sustainable research career.

Q6. Please tell us about any relevant interventions (that you are aware of) by institutions, companies or professional societies.

Please be as specific as possible and consider all appropriate intervention methods, including for example training courses and positions, workshops, networking events, Continuing Professional Development (CPD), summer schools, etc. Please indicate the scale of the intervention if possible (e.g. numbers of training positions available per annum).

The British Society for Plant Pathology has a small number of resources for primary, secondary, and university students. They also run an annual scientific meeting.

There is a five year fellowship in plant pathology, funded by the East Malling Trust, the Horticultural Development Company and the Horticultural Trades Association (http://www.hdc.org.uk/project/succession-planning-sustain-uks-expertise-field-and-laboratory-plant-pathology-research-an-4) This is due to end in 2016.

Q7. For the identified area, describe what actions could be taken forward by BBSRC / MRC (in partnership with others, where appropriate) to support the efforts identified in question 6.

- A survey of key roles in plant pathology in the UK, followed by support to the host organisations to ensure good practice in succession planning.
- It seems that, increasingly, students wish to undertake broad courses of study at undergraduate level. This means that the best hope for specialist training of plant pathologists comes at MSc level. In recent years, the money available to UK students to fund MSc studies has reduced to almost nothing. Overseas students tend to take up places on such courses and are self-funded or in receipt of European, Commonwealth, or other international bursaries that UK students are ineligible for. BBSRC and MRC could help reverse this trend by offering financial support to MSc students.
- Fellowships in plant pathology for early career researchers.

2. Plant Mycology

Q1. What is the research area or discipline for which you wish to highlight a skills / capability vulnerability?

Plant Mycology

Q2. To which funder(s) do you consider this research area relevant?

Q3. For the identified area, what is the evidence for its strategic importance?

If the area addresses known strategic research priorities, please describe how, highlighting interdisciplinarity where relevant.

The skills required to study basic fungal biology, and relationships between fungi and other organisms in the context of a changing environment, are vital to future food security. Work in this area often crosses over with plant sciences and agronomy.

What are the impacts (economic, social, health or academic) of this research skill in the UK?

Many of the important pre- and post-harvest pathogens of crops are fungi. For example, in a bad year (e.g. 2007) annual losses to wheat brown rust can reach a cost of over £20 million to the industry, and this does not take account of the cost of control measures. (http://www.hgca.com/media/176809/ts120_wheat_brown_rust_management.pdf)

Fungi are ubiquitous in the environment and play vital roles in nutrient cycling. However, there are likely to be many more species in the environment which are so far undescribed..

Q4. Please indicate at what level(s) and in what way(s) you have identified a vulnerability in the research area within the last 5 years.

The demand for plant mycologists remains fairly small but there have been difficulties in filling roles as incumbents retire or leave the field.

Mycology is not always offered as an option within microbiology or botany undergraduate programmes.

Where there is considerable activity and expertise, particularly in identification and taxonomy, is in the amateur arena, where there are many local groups of enthusiasts. Without formal qualifications, however, these people are unlikely to ever transition into a professional role as a mycologist.

Q5. Why does this skill need to be enhanced in the UK, rather than by recruiting individuals from abroad? What would be the impact of losing UK expertise in this area?

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The British Mycological Society has a small number of guides to practicals in mycology for primary, secondary, and university students. They also run scientific meetings on various topics in mycology.

The Wellcome Trust has given a strategic award to the Medical Mycology and Fungal Immunology Consortium to promote medical mycology research and increase public understanding of the clinical importance of fungal infections. The other aims of the Consortium, led by the Aberdeen Fungal Group at the University of Aberdeen and funded by a Wellcome Trust Strategic Award, are to promote cross disciplinary research across the UK, to build capacity in the medical mycology sector and to train a new generation of scientists from countries of low- and middle- income with high endemic burdens of fungal disease.

Q7. For the identified area, describe what actions could be taken forward by BBSRC / MRC (in partnership with others, where appropriate) to support the efforts identified in question 6.

- A survey of key roles in mycology in the UK followed by support to the host organisations to ensure good practice in succession planning.
- It seems that, increasingly, students wish to undertake broad courses of study at undergraduate level. This means that the best hope for specialist training of mycologists comes at MSc level. In recent years, the money available to UK students to fund MSc studies has reduced to almost nothing. Overseas students tend to take up places on such courses and are self-funded or in receipt of European, Commonwealth, or other international bursaries that UK students are ineligible for. BBSRC and MRC could help reverse this trend by offering financial support to MSc students.
- Fellowships in Mycology for early career researchers.

3. Microbial Physiology

Q1. What is the research area or discipline for which you wish to highlight a skills / capability vulnerability?

Microbial Physiology

Q2. To which funder(s) do you consider this research area relevant?

BBSRC

Q3. For the identified area, what is the evidence for its strategic importance?

If the area addresses known strategic research priorities, please describe how, highlighting interdisciplinarity where relevant.

This relates strongly to the Industrial Biotechnology and Bioenergy (IBBE) strategic research priority of BBSRC

What are the impacts (economic, social, health or academic) of this research skill in the UK?

Microbial physiology has traditionally played a very important role in both fundamental research and in industrial applications of microorganisms. It therefore has a very wide range of social, economic and health impacts and impacts on many areas of academic research.

Q4. Please indicate at what level(s) and in what way(s) you have identified a vulnerability in the research area within the last 5 years.

Currently, there is a view that genomic techniques are all that are required for microbial physiology experiments. One specific focus within the microbial physiology area that is disappearing is microbial genetics i.e. plasmid and phage biology. It may be the case that people believe they know it all from

the genome sequence. Linking genotype to phenotype is of major importance and this requires experiments to understand fundamental cell biology and biochemistry of microbes.

It is essential that within the microbial physiology skill set there is an understanding of how microbes grow, how to measure growth, how to get reproducible growth, how to compare growth on different media, what metabolites they are using/making, flux through metabolic pathways and how to determine this, how to measure enzyme activity under physiological conditions, The list is endless and applies to pathogens – it is important to know what metabolism the microbes are using to grow in the host environment.

It is also important that microbial physiology covers what metabolism is in mixed populations such as anaerobic digesters, gut environment, soils, etc. It is easy to see what genes are expressed but hard to ascertain the metabolic pathways and exchange of metabolites - how is making/using what (again).

Q5. Why does this skill need to be enhanced in the UK, rather than by recruiting individuals from abroad? What would be the impact of losing UK expertise in this area?

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Q6. Please tell us about any relevant interventions (that you are aware of) by institutions, companies or professional societies.

Professional societies are aware that there is an issue in this area and try to incorporate into scientific meetings and conferences where appropriate.

Q7. For the identified area, describe what actions could be taken forward by BBSRC / MRC (in partnership with others, where appropriate) to support the efforts identified in question 6.

A specific call for grant applications in microbial physiology as part of IBBE (BBSRC) and of microbial pathogenesis (MRC) would go some way towards addressing the issue. There also needs to be opportunity for experienced researchers to retrain in microbial physiology due to the dearth of principal investigators in this area.

4. Industrial Biotechnology and Bioenergy (IBBE)

Q1. What is the research area or discipline for which you wish to highlight a skills / capability vulnerability?

Industrial biotechnology and bioenergy (IBBE)

Q2. To which funder(s) do you consider this research area relevant?

BBSRC

Q3. For the identified area, what is the evidence for its strategic importance?

If the area addresses known strategic research priorities, please describe how, highlighting interdisciplinarity where relevant.

This fits in with the BBSRC strategic research priority on industrial biotechnology. Industrial biotechnology and bioenergy research is inherently interdisciplinary

What are the impacts (economic, social, health or academic) of this research skill in the UK?

Energy, industrial materials and biopharmaceuticals, developed and produced using biological processes, reduce dependency on fossil fuels and help drive the UK bioeconomy.

Q4. Please indicate at what level(s) and in what way(s) you have identified a vulnerability in the research area within the last 5 years.

Industrial biotechnology and bioenergy research is inherently interdisciplinary. Current degrees in Biotechnology tend to be very broad, at the expense of the underpinning science/engineering needed to provide the best graduates. An exception is the well-regarded Biochemical Engineering degree at UCL, which provides an effective balance between in-depth engineering training and an appropriate level of science training. In addition, there are a small number of degrees in Biotechnology which do provide significant training in underpinning topics, such as microbiology. A potential solution to this problem would be to establish complementary Natural Sciences degrees, which would allow students to specialize in areas of their choice after initial training in the life and physical sciences.

The main single discipline subject of relevance to IBBE is Microbiology. Unfortunately, the status of Microbiology as a discipline has changed dramatically, and there are few Microbiology degrees on offer in the UK. Most focus primarily on medical microbiology. The emphasis has shifted away from teaching microbial physiology, enzymology, metabolism, and fermentation technology (all quantitative areas), towards more qualitative molecular biology. There is an increasing emphasis on basic maths, physics and chemistry training for biological scientists, but still insufficient to underpin IBBE.

A further problem concerns laboratory training for IBBE. IBBE requires skills in microbiology, biochemistry and molecular biology, all well provided for in current undergraduate lab classes. Unfortunately, training in IBBE-related fermentation technology is not well covered because of the high cost and lab footprint of the equipment and the requirement for skilled technical support. Where this is possible, it is supported by industry investment, such as the SAB Miller funded research and facilities at The University of Nottingham. Biological analysis is also well covered by existing degree courses, but the chemical analyses needed for IBBE (GC, HPLC, GPC, MS, NMR) are not taught in depth because the equipment is expensive and mainly located in Chemistry departments. Therefore, investment in IBBE teaching facilities is needed.

Company contacts have indicated that recruiting trained personnel is challenging at all levels.

Q5. Why does this skill need to be enhanced in the UK, rather than by recruiting individuals from abroad? What would be the impact of losing UK expertise in this area?

Overall, there is a serious shortage of UK undergraduates with the skills to undertake careers or PhD studies in IBBE. It is equally difficult to recruit high quality UK postdocs for projects in IBBE. Anecdotally, it is frequently necessary to recruit from the EU, USSR or N. America to find people with the right combinations of skills. Similarly, lectureship and higher-grade appointments in IBBE frequently rely on recruitment outside the UK. There is a similar skills shortage in synthetic biology. Part of the problem may be that there are few iconic, world-leading IBBE academics in the UK who can act as champions for IBBE training and research.

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Q6. Please tell us about any relevant interventions (that you are aware of) by institutions, companies or professional societies.

BBSRC has been addressing funding for IBBE through the IB catalyst and prioritizing IBBE for PhD studentships available through DTPs and Industrial CASE. Both EPSRC and BBSRC have been providing increasing support for Synthetic Biology by establishing IKCs and Research Centres, but much less funding seems to be available for institutions outside the centres. These centres do, however, work well, which supports a view that having a greater number of foci for IBBE encourages MSc training in the specialist disciplines, required for the UK to become strong in this area.

Institutions are beginning to respond to the funding opportunities by building research and training capacity in IBBE and synthetic biology, but progress is painfully slow because of the scarcity of iconic leaders.

In industry, there is significant growth in IBBE. The turnover for bio-based chemicals manufacturing is expected to grow to ca. £4-12bn in the UK by 2025. Globally leading companies (Lucite International, DuPont, Mitsubishi, Unilever, Dow, Evonik, DSM are just a few examples) are investing significantly in development of bio-based manufacturing. The success of numerous UK biotech SMEs further underlines the importance of IBBE for the UK economy (e.g. Green Biologics, Ingenza, Novacta, Biosyntha, Algaecytes).

Bioscience KTN and the IChemE have investigated UK training provision for the bioindustries, and concluded that significant intervention is needed to provide the supply of trained manpower needed to drive future innovation in IBBE.

Q7. For the identified area, describe what actions could be taken forward by BBSRC / MRC (in partnership with others, where appropriate) to support the efforts identified in question 6.

Support for IBBE-related infrastructure and equipment is needed urgently to address the skills shortage in IBBE. Basic IBBE equipment (fermenters, complementary sterilization equipment and analytical equipment) and support technicians are needed to underpin the establishment of credible IBBE research and training activity across UK universities.

Reliance on the current, small population of IBBE academics is insufficient to develop the UK's capacity for innovation in bio-based manufacturing. The proportion of UK academics in IBBE and synthetic biology needs to be increased as a matter of urgency, to establish the UK as a global powerhouse for bio-based innovation. RCUK needs to entice leading UK academics to make the transition to IBBE research, since this would enhance the status of the subject and encourage others to follow. Current large scale funding schemes for IBBE (£2-5M) require a significant track record in the area, whilst small feasibility studies or proof of concept studies are too small to be attractive to the very best research leaders. Therefore, more attractive mid career and professorial fellowships (5 years) should be offered to provide a sufficient incentive for discipline hopping and for engagement in IBBE and synthetic biology research. The resulting increased pool of IBBE academics would then drive the necessary expansion of training at PDRA, PhD and undergraduate level.

The research councils should also consider funding MSc courses to enable science graduates to receive high quality training in IBBE. Current MSc courses tend to be under-resourced in terms of bespoke module provision and equipment provision for high quality laboratory training. The lack of funding available to students means that many of the courses that exist in this area are populated by overseas students – UK expertise is not being used to train UK scientists, which is a great shame

5. Food Microbiology

Q1. What is the research area or discipline for which you wish to highlight a skills / capability vulnerability?

Food Microbiology

Q2. To which funder(s) do you consider this research area relevant?

BBSRC

Q3. For the identified area, what is the evidence for its strategic importance?

Sustainable production of safe and nutritious food is key to food security. There are also specific aims of the food retail industry to be met by the application of food microbiology, including extending shelf life without compromising quality and thus reducing wastage – the ready meal that lasts past the weekend, being one of the holy grails! The increasingly popular ready-to-eat market also invites technological development in the packaging of foods for safety and shelf life.

Q4. Please indicate at what level(s) and in what way(s) you have identified a vulnerability in the research area within the last 5 years.

The last remaining BSc in Food Microbiology (The University of Nottingham) was withdrawn last year, due to low student numbers.

In the 2014 Denver Russell Memorial Lecture, Professor Colin Dennis – a well respected scientist in this field – cited a need for more food microbiologists in the UK.

There is further circumstantial evidence, such as the recent Food Microbiology 2014 conference, out of 49 talks, just 2 were from the UK. This is indicative of the fact that there are very few world leaders in food microbiology in the UK.

Q5. Why does this skill need to be enhanced in the UK, rather than by recruiting individuals from abroad? What would be the impact of losing UK expertise in this area?

Biosciences remain popular at undergraduate level; however, many graduates are not retained within the discipline. Whilst the transferable skills gained in such a course of study are clearly desirable to a range of employers, it seems that we are failing to capitalise on the specialist knowledge and training gained within the UK. The UK needs a long term solution to ensure a sustainable community of bioscience researchers across the breadth and depth of the discipline.

Mobility for UK bioscience researchers is beneficial. Working outside the UK helps researchers to build networks and identifying potential commercial applications linked to their work. We need to ensure however that the climate for carrying out research in the UK is such that these researchers return to the UK to work and share knowledge and experience. Likewise, the UK Research Base can benefit significantly from transitory researchers who are often highly productive during their stay. A balance needs to be found to provide the correct balance between UK and International Researchers, ensuring that UK researchers can have a sustainable research career.

Q6. Please tell us about any relevant interventions (that you are aware of) by institutions, companies or professional societies.

Please be as specific as possible and consider all appropriate intervention methods, including for example training courses and positions, workshops, networking events, Continuing Professional Development (CPD), summer schools, etc. Please indicate the scale of the intervention if possible (e.g. numbers of training positions available per annum).

Whilst there are funding initiatives in this area, e.g. http://www.bbsrc.ac.uk/business/collaborative-research/programmes/tackling-campylobacter.aspx, they do not address lack of graduates with skills in this area.

Q7. For the identified area, describe what actions could be taken forward by BBSRC / MRC (in partnership with others, where appropriate) to support the efforts identified in question 6.

It seems that, increasingly, students wish to undertake broad courses of study at undergraduate level. This means that the best hope for specialist training of food microbiologists comes at MSc level. In recent years, the money available to UK students to fund MSc studies in Food Microbiology has reduced to almost nothing. Overseas students tend to take up places on such courses and are self-funded or in receipt of European, Commonwealth, or other international bursaries that UK students are ineligible for. BBSRC and MRC could help reverse this trend by offering financial support to MSc students.

BBSRC are funding Food Security Doctoral Training Programmes. It would be beneficial if the current or future DTPs include some form of microbiology training.

6. Bioinformatics

Q1. What is the research area or discipline for which you wish to highlight a skills / capability vulnerability?

Bioinformatics

Q2. To which funder(s) do you consider this research area relevant?

All

Q3. For the identified area, what is the evidence for its strategic importance?

Bioinformatics, as a technique, crosses most biosciences disciplines. Increasingly large data sets are being collected – the rise of genomics, proteomics, metabolomics, and other data rich tools, contributing most – and must be manipulated computationally in order to derive meaningful results.

Q4. Please indicate at what level(s) and in what way(s) you have identified a vulnerability in the research area within the last 5 years.

For bioinformatics, the problem is not of succession planning, rather the difficulty is in filling and supporting the large number of new posts being created in response to new techniques in bioscience that create enormous data sets.

There is a rapid decline in the number of MSc Courses in bioinformatics available in the UK and there are no universities offering bioinformatics as a major part of an undergraduate degree. It is important that students who use the outputs of bioinformatics are aware of how they are achieved. Conversely, Bioinformaticians need to have an understanding of fundamental aspects of the biosciences, including microbiology.

Major challenges to incorporating bioinformatics in education are, “required infrastructure and logistics; instructor knowledge of bioinformatics and continuing education; and the breadth of bioinformatics, and the diversity of students and educational objectives.” (http://bib.oxfordjournals.org/content/11/6/537.short)

Without sufficient new people entering the field, we will again be faced with a major skills shortage exactly at a time where new technologies are creating more data than ever.

Q5. Why does this skill need to be enhanced in the UK, rather than by recruiting individuals from abroad? What would be the impact of losing UK expertise in this area?

Biosciences remain popular at undergraduate level, however many graduates are not retained within the discipline. Whilst the transferable skills gained in such a course of study are clearly desirable to a range of employers, it seems that we are failing to capitalise on the specialist knowledge and training gained within the UK. The UK needs a long term solution to ensure a sustainable community of bioscience researchers across the breadth and depth of the discipline. As indicated above, bioinformatics is fundamental to research in many aspects of the biosciences.

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There are a number of high profile training centres in bioinformatics. Less is known about short courses on this topic for undergraduates and others who use the outputs of bioinformatics.

Q7. For the identified area, describe what actions could be taken forward by BBSRC / MRC (in partnership with others, where appropriate) to support the efforts identified in question 6.

There is a need to support training at undergraduate level and to maintain a pool of academic staff to teach at postgraduate level. BBSRC and MRC could support train-the-trainer programmes (if not doing so already) with organisations such as EMBL-EBI and The Genome Analysis Centre. There is also a need for training for molecular biologists / life scientists in using bioinformatics tools/methods so that they can incorporate these into their research.

It seems that, increasingly, students wish to undertake broad courses of study at undergraduate level. This means that the best hope for specialist training of bioinformaticians comes at MSc level. In recent years, the money available to UK students to fund MSc studies has reduced to almost nothing. Overseas students tend to take up places on such courses and are self-funded or in receipt of European, Commonwealth, or other international bursaries that UK students are ineligible for. BBSRC and MRC could help reverse this trend by offering financial support to MSc students. This could be particularly helpful in bringing Mathematics graduates into bioinformatics..

Bioinformatics Support Services in universities and research institutes need to be supported. These support academic groups. They need perpetual funding and excellent career development opportunities for career bioinformaticians acting in a technical/support role.