In vivo sciences in the UK: sustaining the supply of skills in the 21st century

abpi

BIOSCIENCES FEDERATION

This investigation was led by the ABPI and the Biosciences Federation but the following organisations are thanked for their support throughout the project:

This report reflects the broad consensus of members of the ABPI, BIA and the Biosciences Federation, though it is not necessarily those of the individual members. It is a report to government, its relevant agencies, employers, education providers and wider community interested in biomedical research. Government and relevant stakeholders, including industry, may not be able to implement all the recommendations immediately, but the positive engagement during the investigation of this important skills concern has been encouraging.

Contents

Foreword

Historically the UK has been a global leader in biomedical sciences both in the academic and private sector. Our university research groups punch well above their weight in terms of significant citations of research papers and the UK has been able to attract between 9 and 10% of global pharmaceutical and biopharmaceutical investment over several decades. Yet this leading position is under threat.

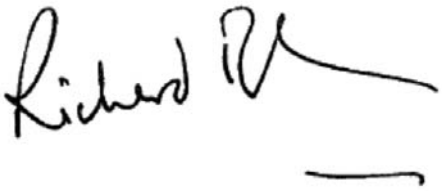
The ABPI's 2005 report *Sustaining the skills pipeline in the pharmaceutical and biopharmaceutical industry*, found significant skills supply deficits in the UK, especially in areas that were critical in sustaining biomedical research, at the same time as competitors were enhancing their skills provision. The supply of individuals in sufficient numbers and with the appropriate practical competence has been well known as an issue in chemistry, but the ABPI report noted that there were also substantive issues about the quality and number of appropriately qualified individuals in biological and biomedical sciences.

In particular, *in vivo* sciences – those where live animals are used in research projects – were reported to be in short supply. These include toxicology, pre-clinical pharmacology, pathology and *in vivo* physiology; all core disciplines essential for the successful development of new medicines and for fundamental research into disease and disease pathways. *In vivo* skills will not become redundant as science progresses, indeed quite the reverse. In order for the potential of the genomic and proteomic revolution to be realised, we need to move away from a reductionist approach to an integrative approach, moving from gene, to protein, to cell, to organ and up to whole organism.

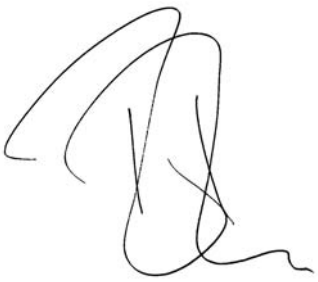
Animal research is not and must not be considered a research end in itself; rather it is a means to an end. The use of animals in research must be driven by scientific need and only used where there is no alternative. Furthermore there is good evidence that better welfare does not simply benefit the laboratory animal, but leads to better scientific results. Inculcating good welfare practices and developing a 3Rs approach – the replacement, refinement and reduction of animals in research – early in a student's career is therefore critical.

If the UK is going to sustain its competitiveness in attracting global biomedical research we must address the *in vivo* skills supply. China, India and Singapore are all striving to create the pools of skills required in modern day drug discovery and biomedical research. Several major employers have set up animal facilities in these countries. We cannot let a shortage of *in vivo* skills be a reason for disinvestment from the UK. Animal welfare will certainly not benefit, since the UK is rightly regarded as a leader in this area.

In line with the Government's vision for skills, as set out in its response to Lord Leitch's skills report, employers, providers and funders are already working in partnership to address the skills deficit. The Integrative Mammalian Biology Initiative, *in vivo* summer schools run by the learned societies and revamped curriculum for animal technologists are significant improvements. The recommendations laid out in this report require more action by all stakeholders. Our recommendations mainly address short-term issues, so Government, industry and academe, including the research and funding agencies, must continue to work together to build long-term sustainability. We should capitalise on the opportunities to carry our historical strengths well into the 21st century.



Richard Barker,
Director General of the ABPI



Dr Richard Dyer, OBE,
Chief Executive of the Biosciences Federation

Executive summary

Skills for a world-class sector

1. Historically the UK is a world leader in biomedical sciences, with 18 of the world's top 100 best selling medicines originating from industry R&D facilities located here. This strength has been built on a good supply of high quality skills and excellence in discovery research and drug development from pre-clinical to early clinical research. The UK currently attracts around 9% of global R&D investment, yet its market represents only 3% of world sales. Furthermore the pharmaceutical sector R&D investment in the UK accounts for nearly 24% of all private sector R&D investment[1].
2. This position is under threat both because of increased global competition for investment and, as evidenced in the ABPI report *Sustaining the skills pipeline in the pharmaceutical and biopharmaceutical industry*[2], because of a decline in the quality and quantity of skills, notably in those sciences requiring *in vivo* practical experience and knowledge.
3. To maintain the UK's position as a world leader in biomedical and pharmaceutical research and sustain inward investment, a supply of world-class skills and expertise is needed to drive and implement new scientific discoveries. The importance of translational biomedical science is recognised by the UK Government; and the Cooksey Report (2006)[3] focused both upon the transformation of laboratory-based discoveries into clinical benefit and/or commercial products and upon a research approach which is dependent upon skills to investigate intermediate scientific models in animals or animal organs/tissues.
4. Without high quality scientists with *in vivo* skills, the UK will be unable to either attract new pharmaceutical or biopharmaceutical R&D investment, or to sustain the higher education capability that will expand basic knowledge and train the next generation of scientists. Success is dependent upon a critical group of persons with high quality training and expertise in pharmacology, physiology, toxicology and histopathology. All of these sciences not only require in-depth knowledge of mammalian biology, but also a high standard of practical competence in research that involves living animals (*in vivo* skills) and in the use of isolated functioning organs. Without these skills to design, carry out and interpret pre-clinical research on animals (particularly safety research), the entire drug development process, from academic biomedical bench research through to the discovery of new effective medicines, cannot proceed.

   The supply of a relatively small cadre of individuals with these skills therefore has a potentially large impact on UK productivity, biomedical science, competitiveness and health.

Tackling concerns about the supply of *in vivo* skills

5. The ABPI's 2005 report entitled "*Sustaining the Skills Pipeline*[1]" identified a variety of skills concerns for the pharmaceutical and biopharmaceutical industries with the supply of *in vivo* skills the number one priority. The current report, arising out of Recommendation 1 of "Sustaining the Skills Pipeline", outlines the results of ABPI and the Biosciences Federation work, which was facilitated by the former Department of Trade and Industry, to analyse the concerns, identify potential blockages in the skills supply chain and propose actions to improve supply. Many stakeholders were engaged or consulted in this process, including Government departments and their advisory groups, Sector Skills Councils, providers, learned societies and a number of independent experts.

Research findings

6. This report is based on a number of surveys and studies to test the findings of the November 2005 ABPI report, and provides more detail on the issues to help identify potential short to medium-term solutions.
7. About 75%[4] of relevant employers (industry, universities, public sector and charity research organisations) report finding it "difficult" or "very difficult" to hire staff with appropriate *in vivo* skills. Most are managing the difficulties by recruiting people with higher degrees or investing heavily in training, with about 70% of employers believing the difficulties have had a negative impact on their productivity. Employers echoed the findings of the Bioscience Innovation and Growth Team (BIGT) report[5] of 2003, which warned that key aspects of the drug discovery process would, in the long-term, transfer to other countries that have the appropriate skills, if action by the UK were not forthcoming. Increasingly we are seeing investment in animal research facilities in emerging countries such as China, India and Singapore.
8. Employer demand for the skills has been stable over the past 10 years, but supply has declined. Fewer students[6] now study the practical aspects of whole animal physiology and pharmacology, and those who do, spend

1 Source: MA14 Research & Development in UK Business ONS
2 ABPI report, November 2005, http://www.abpi.org.uk//publications/pdfs/2005-STEM-Ed-skills-TF-Report.pdf
3 http://www.hm-treasury.gov.uk/pre_budget_report/prebud_pbr06/other_docs/prebud_pbr06_odcooksey.cfm
4 ABPI report on demand for *in vivo* skills
5 http://www.bioindustry.org/bigtreport/
6 According to research conducted for the Bioscience Federation and ABPI under this project.

a much smaller proportion of time on *in vivo* work than was the case historically. Shifts within curricula, regulatory bureaucracy, changes in societal values on using animals, high costs and the doubling in student: staff ratios within universities have driven the decline. The high cost associated with supporting vivarium in academic institutes makes provision of both undergraduate and postgraduate training economically difficult. Industry is providing significant financial support for the remaining training, but is concerned that the decline may be part of a wider trend of reduced practical time in many undergraduate bioscience courses: this it is unable to address.

9. Significant action has already been taken by private sector employers and Government funding agencies to support long term capacity building through the £12million Integrative Mammalian Biology Initiative (IMBI). Learned societies have developed *in vivo* summer schools for students without access to the learning in their own institutions and the Institute of Animal Technology (IAT) has revamped its training offer so that it is fit for the 21st century. UCAS and HESA data show student interest in the subjects that tend to include exposure to *in vivo* work (pharmacology, physiology, toxicology and pathology) is on the rise, but more needs to be done to create a sufficient pool of talent and skills to attract and retain new UK R&D investment.

10. Improved public acceptance of the use of animals in research and healthy student interest in the sub-disciplines should be built on to give more undergraduate students an understanding of the importance and complexities of *in vivo* work and, for those who need the skills for future work or studies, opportunities for gaining hands-on exposure under Home Office licences. This in turn requires support for the reduced numbers of academic staff with the skills to provide such training.
11. Of course animal research should be limited to where no alternative exists and, when it is required, good welfare practices and the concept of the 3Rs (the replacement, refinement and reduction of the use of animals in research) must be central to developing a sound basis for the relevant skills. This is important not only to ensure that animals are used only when there are no alternatives to achieve the research objectives, but also because good welfare and experimental design leads to better scientific outcomes. These principles are widely accepted by both the industrial and academic communities, but suitably educated and skilled scientists, animal technicians and laboratory animal veterinarians are required for effective delivery.

Delivering world-class skills and expertise

12. We believe that the package of relatively small scale, targeted short-term actions recommended in this report should help overcome the immediate recruitment problems that employers are facing in the short-term. But the UK must also develop and implement a long-term strategy in line with its ambitions – namely, to sustain and enhance long-term its position as a world leader in both fundamental biomedical research and the pharmaceutical development that delivers not only real patient benefit, as outlined in the Cooksey report, but also major commercial benefit.
13. This package will have limited impact on the long-term sustainability of *in vivo* sciences and it is essential that the need for more capacity-building be considered during future reviews of the IMBI and STEM skills supply. Progress on the implementation of this report's recommendations should be considered at the same time as those reviews.
14. The short-term challenge for Government funders and industry is to refocus a small amount of existing resource on targeted action so as to deliver sufficient numbers of graduates and postgraduates skilled in this specialised area: the challenge for industry and universities is to ensure that the product suits the needs of both industry and academic employers. Most of the action proposed in this report is focused on overcoming the graduate skills gap, but sustained effort is also needed at PhD level, due to the difficulty all employers have in finding suitably experienced PhDs. Support for the action must be sustained long-term by Government both with appropriate support for the strategically important and vunerable sub-disciplines that include *in vivo* work and through improving the regulatory framework for the use of animals in science.
15. A common theme in most of the recommendations is that students (undergraduates, taught Masters students, and PhDs) should spend sufficient periods of their training within industry to expose them to the cultures and practices of industrial research. This strategy, which builds on the success of current programmes, has the important added benefit for industry and the student that the companies can identify potential recruits and academic collaborators. There is, however, limited capacity in UK companies to extend these schemes. Charities, public sector research units and the NHS are also employers of science graduates with *in vivo* skills, and must also be included in any initiatives.
16. Employers are encouraged by the Government to take advantage of the demand-led approach to skills provision. This applies at all levels, from clarifying demand for animal technologists, through to harnessing Research Council PhD funding that is available to industry through Cooperative Awards in Science and Engineering awards, to flexible allocations of funds to universities for *in vivo* research.
17. Academia is a significant employer of *in vivo* skills – this cadre of scientists also needs to be replenished and enhanced to sustain basic biological research, undergraduate teaching and advanced training. Systems

biology, the challenge of relating changes in whole body function to those in whole organs, cells, proteins and subsequently genes, and the conveying of those concepts to undergraduates, requires *in vivo* skills in academia just as much as in industry. Many leading academic groups are also dependent on recruiting new graduates who have gained practical experience through employer placements.Government agencies also require skilled scientific reviewsrs to enable appropriate regulation.

18. Employers, learned societies and other relevant experts are urged to work with providers, to ensure course curricula better meet employers' needs and that they maximise learning opportunities, including those which do not require Home Office personal licences. All of the *in vivo* community needs to ensure learning incorporates modern approaches to *in vivo* work that draw on molecular biology and transgenic technologies. Key to success is achieving a cultural shift, so that *in vivo* techniques are seen as part of multidisciplinary solutions to problems. All stakeholders will need to work together to help achieve this cultural shift, so that *in vivo* work is seen as core to biomedical science and not just as an add-on at the end of a scientific process.

The recommendations

19. This report recommends a package of mainly user-driven actions that could be implemented rapidly by better targeting of existing resources. There are important recommendations on: supporting *in vivo* summer schools for undergraduates; increasing the number of *in vivo* employer placements; mapping the stage and means of exposure to *in vivo* work to increase the number of learning opportunities on offer; addressing concerns around the supply of animal technologists and veterinarian pathologists, and academic teaching and advanced training capacity. Critical factors of success will be:
    - raising student interest in developing *in vivo* skills (employers have a role in this through demonstrating their needs for the skills)
    - employers, funders and providers providing employer focused taught Masters degrees that target "hands-on" learning to those most likely to use the skills in future courses or careers
    - continued priority support for PhD level training, ideally through CASE style programmes
    - the Government improving the regulatory environment and protecting the sub-disciplines that include *in vivo* work through its support for Strategically Important and Vulnerable Subjects

Conclusions

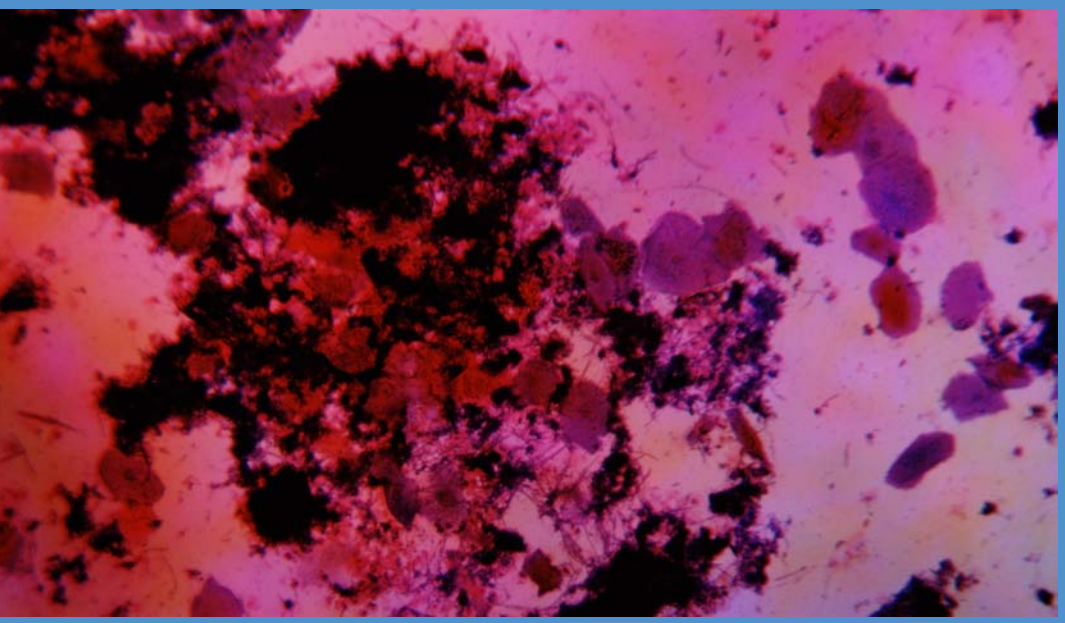
20. The UK must invest in skills upon which the biomedical sector, in both industry and academia depends if the country is to sustain its global leadership position in pharmaceutical and biomedical R&D. The shortage of *in vivo* skills is placing this leadership under threat and is also a blockage to increasing productivity in drug discovery and development.
21. The IMBI has started to turn the tide of decline of *in vivo* sciences, but further action is needed by all stakeholders to sustain the UK as a world-class centre for biomedical research. Issues affecting long-term sustainability will need to be monitored and addressed but, at a relatively small cost, the UK could in the short-term produce the skilled scientists and technicians needed to address the decline. The cost of not acting could be disproportionably high and ultimately lead to the UK's highest value-added sector relocating to countries that not only have the skills available but are also willing to provide backing to develop and sustain a commercially important biomedical and biopharmaceutical research base.
22. Employers, providers and funders are already working together to try to prevent inadequate biomedical skills being a reason for investments being made outside the UK. We believe there is a real opportunity for more partnership working to support this effort and thereby improve UK productivity, biomedical science, competitiveness and health.

Recommendations

Short-term recommendations	For	Outcome
1. Industry and other employers should work with universities, learned societies and careers services to communicate employer demand for students with *in vivo* skills and expertise.	Industry, other employers and relevant stakeholders	Increased student and university interest in *in vivo* work
2. Employers to work with academics to increase the overall number of employer placements that involve *in vivo* work by at least 50%.	Employers and universities	More skilled graduates at Bachelor's level
3. The Biosciences Federation should lead discussions between university departments providing undergraduate courses in the relevant disciplines, the learned societies (e.g. The Physiology Society and the British Pharmacological Society (BPS), and employers to set out the type and means of exposure to *in vivo* work that should occur at each stage of education. Universities should then support the learning recommended, as far as reasonably possible, subject to resource and regulatory constraints.	Biosciences Federation and relevant learned societies with employers and universities	Clarity on what and how BSc students should learn about *in vivo* work; more better-trained Bachelors graduates
4. Industry and other funders of *in vivo* work should continue supporting BPS/Physiological Society *in vivo* summer courses and if appropriate, increase funding to increase capacity of the courses.	Learned societies and relevant funders	Continued *in vivo* training opportunities
5. Develop a small number of programmes at a taught Masters level (one year) that are focused upon *in vivo* skills. 36 studentships should be provided in each of the next three years to make a substantial step towards solving industry recruitment problems.	IMBI funders	More skilled graduates, who are more likely to use the skills in future
6. Research Councils and industry should work together to increase the number of CASE PhD awards that use modern *in vivo* techniques. These additional CASE studentships should be linked to the proposed MSc programmes that are to be developed with industry input. Research Councils should continue to encourage the take up of PhDs that involve modern *in vivo* skills.	Research funders and employers	Maintained *in vivo* capacity and continued flow of PhD level expertise
7.1 Employers of toxicologists and research funders should work together to support the Medical Research Council's proposed toxicology/drug safety training programme so that it has capacity to meet the needs of more toxicology users. 7.2 The British Toxicological Society should continue to work with Government funding agencies and employers to help ensure the UK has a joined-up approach to maintaining its world-class toxicology expertise and, in particular, consider how to revamp the image of toxicology.	Toxicology employers, research funders and universities	More skilled graduates
8. Lantra, through the action plan for animal technology should: • help employers communicate demand for animal technology roles • improve knowledge and understanding of animal technology and related careers • set up an animal technology training providers forum and support development of a national network of providers to deliver training that meets their needs • help employers leverage funding to support animal technology training that is likely to have a low student/teacher ratio • maximise the potential of the EU labour market.	Lantra, colleges and employers	More and better trained animal technologists

Short-term recommendations	For	Outcome
9. Industry, academia and other stakeholders should explore mechanisms by which interchange programmes could occur readily to increase the pool of individuals who mutually support research, undergraduate teaching and advanced training involving *in vivo* techniques. Options for incentivising such interchange to be discussed with education and research funders and the supply of experienced teachers should be reconsidered alongside reviews of the IMBI.	Industry, other employers, universities and education & research funders	More teaching and research capacity
Long-term recommendations 10. The sub-disciplines that underpin *in vivo* skills (e.g. pharmacology, physiology, toxicology and pathology) are vulnerable in various ways. HEFCE should ask their advisory group on Strategically Important and Vulnerable Subjects to consider whether these subjects require some particular protection and support.	HEFCE	Monitoring of critical subjects and action to protect them
11. IMBI funders, at the 2009/10 mid-term review, to consider the impact of the IMBI when addressing the broad concerns about long-term capacity, both in the institutions that won the awards and nationally. The results of the review should be shared with the wider academic community to help assess and respond to long-term capacity concerns.	IMBI funders	Better informed analysis of long-term sustainability issues
12. Industry, veterinary schools and relevant funders should develop a structured national programme to support veterinary pathologist training at graduate and intern levels.	ABPI, British Society of Toxicological Pathologists, veterinary schools and the Royal College of Pathologists	Better trained specialists
Regulation 13. The Home Office should fully implement those parts of its simplification plan that relate to operation of the Animals (Scientific Procedures) Act 1986 and deliver an efficient and effective regulatory environment for the use of animals in science.	The Home Office	Better regulatory environment

1 Context to the use of *in vivo* skills: The Biomedical sector



This chapter outlines the importance of the biomedical sector to the UK, its needs for *in vivo* skills and the challenge of the sector maintaining its competitive advantage.

1.1 A successful biomedical sector[7], with a thriving pharmaceutical industry, is exactly the sort of high value added, knowledge-based activity the UK should be well placed to maintain in a knowledge-intensive global economy. The UK's biomedical science sector is already a British success story and Britain's academic and research scientists remain amongst the best and most productive in the world.

1.2 The sector is key to the UK in terms of its economic value. The pharmaceutical industry alone employs around 70,000 people[8], is the largest corporate investor of research and development funding[9], and provides a £4.3 billion trade surplus[10]. The UK biotechnology sector is second only to that in the United States and the Contract Research Organisation (CRO) sector also makes a significant economic contribution.

1.3 The pharmaceutical and biotech sectors, along with others involved in biomedical research, have developed and introduced many new medicines in the UK, and have led the way in disease diagnosis and the development of preventive medicines. In 2005, 15 of the world's top 75 prescription medicines originated in the UK and there are another 640 medicines currently in the UK pharmaceutical pipeline[11].

1.4 The UK's ability to continue to receive the wealth and health benefits of the sector depends on the UK remaining a competitive location for biomedical research. Increased global competition for biomedical investment is causing those responsible for research and development to look much more closely at what other locations offer in terms of access to skills, proximity to technical partners, attractiveness of local market conditions, operational costs and taxation rates. Globalisation is giving scientists and business a real choice as to where they are located. The UK can no longer count on remaining a choice location because of its past historical strengths.

1.5 This report concerns itself with one of the most important factors that governs whether the UK is an attractive location: the ability of the education system to continue its tradition of producing world-class scientists to drive the sector's growth. The Pharmaceutical Industry Competitiveness Task Force (PICTF) of 2001[12] and the Bioscience Innovation and Growth Team (BIGT)[13] of 2003 both highlighted the importance of skills and expertise to the sector. The BIGT report, *Bioscience 2015*, identified concerns around the sector being able to attract and retain the best talent, and highlighted concerns about the lack of scientists trained to conduct research using living animals.

1.6 Skills in whole animal research (*in vivo* skills) are key for regulatory compliance under the Animals (Scientific Procedures) Act 1986 (which governs the use of animals in research), so as to ensure humane use of animals and good scientific technique. The skills are also important for future advances in developing alternatives to the use of animals. It will be more experienced confident researchers who identify further means through better considered, better conducted and better designed experiments. Fundamentally, the sector needs the skills to design, manage and interpret preclinical safety and efficacy research on animals. Without these skills, the entire drug development process and translation of opportunities from the human genome project cannot proceed.

1.7 Although the importance of a relatively small number of experienced individuals with these skills is widely recognised, the BIGT report stated that there were reduced training opportunities for acquiring the skills and warned that, if action by the UK was not forthcoming, key aspects of drug discovery and development would be transferred to other countries.

1.8 Four years on from the report, it is clear that this risk remains significant. The UK's historical strength in scientific areas, such as integrative mammalian biology, is quickly being matched by new expertise in countries like China, India and Singapore. Potential investors are being tempted by governments eager to develop their own bio-economies with packages which include laboratories and even scientists[14]. This 'home grown' talent is often fostered by funding suitable candidates to work and study overseas (often in the UK) to help build their knowledge base.

1.9 The UK's science and associated knowledge and skills base is still internationally competitive, but the shortages of *in vivo* skills is a major concern, regarded by many employers as a blockage to increased productivity. It is for this reason that the sector is working in partnership with the Government and the education sector to analyse the causes of the skills concerns and to identify actions to overcome them. The cost of tackling the concerns may be relatively small, but the cost of not acting could be disproportionately high for the biomedical sector and in turn UK productivity, biomedical science, competitiveness and health.

7 For the purposes of this report the term "biomedical sector" covers the work of biotechnology companies, the pharmaceutical industry and other public, private and charity organisations involved with biomedical research, including academia.

8 Source: ONS Annual Business Inquiry

9 Source: Investment in R&D MA14 Research & Development UK Business ONS

10 Data source: UK Revenue and Customs

11 Data source: IMS

12 http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4008696

13 http://www.bioindustry.org/bigtreport/

14 The Singaporean Economic Development Board funds Singaporean students to work in companies locally or overseas for 12-18 months to upgrade their skills or capabilities. Upon completion of training, the employer has first right to employ trainees, subject to approval & payment of 30% training fee to the EDB. GSK has employed 58 Singaporean students through this programme since 2001, 25 of them in the UK.

2 Defining *in vivo* skills

This chapter explains what this report considers *in vivo* skills to be, who needs the skills, how regulations control their use and the limits of this report's consideration of *in vivo* techniques.

2.1 *In vivo* is Latin for (with)in the living and means that which takes place inside an organism. For the purpose of this report *in vivo* refers to experimentation done in or on the living tissue of a whole living organism, as opposed to on dead animals or parts thereof. Such procedures are regulated by law (see below). Considerable research involves isolated tissues and cells from recently killed animals, often under conditions requiring similar skills and similar regulatory control, and is therefore relevant to this report. *In vitro* (Latin: (with) in the glass) refers to the technique of performing a given experiment in a test tube, or, generally, in a controlled environment outside a living organism.

2.2 An understanding of *in vivo* research is needed by individuals involved in the translation of laboratory-based discoveries into clinical benefit and/or commercial products. An additional range of individuals, including those involved in licensing new medicines need some insight into *in vivo* research, in terms of its uses, limitations, implications for animal welfare and the associated regulation that governs it. Those funding, regulating or considering the results of biomedical research involving *in vivo* techniques, need some basic understanding of the complexities of the research that uses these techniques.

2.3 A relatively small number of individuals also require a high standard of practical competence in *in vivo* research. The Animals (Scientific Procedures) Act 1986 (ASPA) sets strict rules around who, where and for what purpose *in vivo* work can take place. In addition to requiring establishments intending to undertake *in vivo* work to be designated as 'scientific procedure establishments' and requiring project licences to cover *in vivo* work, the Act also requires all those undertaking the research (whether undertaking many aspects of animal husbandry or the experimental procedures themselves) to hold a personal licence. Personal and project holders licences are required to successfully complete an accredited training programme as set out by the Home Office[15].

2.4 This report does not consider in detail the type or means of *in vivo* exposure students should receive. It considers demand for *in vivo* skills and expertise against levels of supply and demand. For the purposes of this report, employers and academics participating in its preparation considered *in vivo* skills to be the skills and expertise required to undertake work under ASPA.

2.5 Modules 1-4 of the Home Office training, plus knowledge of experimental design, form an essential part of *in vivo* skills. This report does not attempt to redefine what should be in the modular training, but does suggest more individuals be exposed to the content of the modules. It must be recognised that the modules are intended to establish a sound foundation upon which further training can be more effectively built. They represent the first step that people needing or intending to work with animals must take; it is accepted that they must be built on through Continued Professional Development activity. This report strongly endorses the work of the education and training sub committee of the Animals Procedures Committee in its role advising on the requirements for training and education of those who hold responsibilities under the ASPA.

2.6 Some of the skills and expertise employers refer to as *in vivo* skills do not require the holding of a personal licence, for example basic handling of animals or analysis of study results. This report makes clear when referring to *in vivo* skills, whether the skills being considered are those that are regulated under a Home Office licence. It is likely that MSc and PhD level training would require the holding of Home Office licences.

2.7 Where is not clear that all types of graduates need exposure to *in vivo* techniques under a licence (for example, some biology graduates need to understand the complexities of *in vivo* techniques, but this understanding can generally be developed without a licence by watching demonstrations, undertaking cadaver work or analysing the results of studies) the report and recommendations makes this clear. A list of skills and expertise that would provide enough exposure to *in vivo* techniques in BSc courses is noted provided in this report as the investigation was unable to produce one. Recommendation 3 of this report, therefore, suggests further work to clarify what exposure (and by what means of delivery) is required.

15 Further information about training and education can be found in the Home Office Statement on Education and Training, published as part of the 1992 Report of the Animal Procedures Committee and also in Appendix F of the Guidance to the Act. Available at http://www.archive.official-documents.co.uk/document/hoc/321/321-xf.htm

3 Origins of concerns and investigation methodology

This chapter outlines the origins of concerns about supply of the skills, research that prompted this investigation and the methodology used to investigate the concerns and reach consensus on solutions.

3.1 The PICTF and BIGT reports identified general concerns about the availability of the skills, but it was the British Pharmacological Society (BPS) and the Physiological Society Survey of Heads of Department Committees in 2004 which provided the first data on levels of *in vivo* exposure. It captured concerns about several courses stopping in the previous 10 years and found that of the 8,000 graduates of physiology, pharmacology, biomedical and biological sciences graduates completing their studies every year, only about 120-150 per year graduate with hands-on *in vivo* skills. In addition, some exposure, either through demonstration classes, research projects that require students to obtain a personal licence or industrial placements were available but the latter two options were only available to a small subset of graduates, and the number taking these options varied annually. **The overall conclusion was that the overwhelming majority of graduates in pharmacology, physiology or related subjects receive no direct exposure to *in vivo* techniques and, of key concern, the situation could deteriorate over the next years with a decreasing pool of academics with the required skills being available to train the next generation of researchers.**

3.2 The Association of the British Pharmaceutical Industry (ABPI) identified concerns about the supply of *in vivo* skills as the number one skills concern of the pharmaceutical industry, (November 2005 Sustaining the Skills Pipeline report[16]). The report considered the range of graduate disciplines and skills required by the pharmaceutical industry, whether enough graduates had the skills, whether their experience was of sufficient quality and whether they as employers would need the skills in the future. Scientists with *in vivo* skills (pharmacologists, toxicologists and pathologists) were considered to be lacking in quantity and quality. Employers thought these skills would continue to be important in future. The report also identified concerns about the supply of animal technologists.

Clarifying the concerns and agreeing action to tackle them

3.3 In December 2006 the ABPI and Biosciences Federation, with the support of the former Department of Trade and Industry facilitating discussions within Government, began a full investigation into concerns around the skills shortages. The work had the objective of developing an action plan that would ensure a coherent strategy to deliver the skills and expertise.

3.4 A group of experts and the relevant Sector Skills Councils, (the Science Engineering Manufacturing Technologies Alliance (SEMTA) and the Sector Skills Council for the environment and land-based sector (Lantra)), oversaw evidence-gathering of employer demand for the skills and UK universities' capacity to supply them. The skills concerns were already identified in SEMTA's draft Sector Skills Agreement (SSA) for the bioscience sector[17] and Lantra's action plan for animal technologists[18]. This work therefore built on the existing information gathered and provided a means for employers and providers to identify skills and productivity needs, the action they could take to meet those needs, and how further collaboration could help shape the nature of supply. This work was in effect much like trying to create a SSA for *in vivo* skills.

3.5 Since the ABPI skills report was published nearly two years ago, it was felt important to ensure the picture in terms of skills provision had not changed. Therefore a key part of the present investigation was to map current initiatives, such as the Integrative Mammalian Biology Initiative (IMBI)[19]. At the same time it was felt important to elaborate means for supporting good welfare practices and applying the principles of the Reduction Replacement and Refinement of the use of animals in Science (3Rs).

3.6 The programme of work involved:

- surveys of employers who need staff with *in vivo* skills and expertise
- surveys of higher education institutions identified by learned societies as providing exposure to *in vivo* skills
- focus groups with employers and training providers at relevant levels
- meetings with research and education funders
- a workshop with over 40 relevant stakeholders that considered research findings and potential action to help improve UK capacity to supply *in vivo* skills
- bilaterals with key stakeholders identified to take forward recommendations to help ensure the recommendations are appropriate and can be implemented in the timescales suggested.

3.7 The initial analysis and recommendations in this report were also presented to the Science Technology Engineering and Mathematics (STEM) High Level Strategy Group in May 2007. The group of senior representatives from relevant Government Departments and external stakeholders provides strategic advice to help the Government to drive forward its commitments for improving the supply of STEM skills and to increase scientific literacy. The detail of the work was not considered, but the partnership approach to tackling the concerns and package of recommendations being developed was broadly welcomed. The group emphasised the importance of employers communicating demand for the skills and industry continuing to work with universities, learned societies and funders of research and education, in particular the Learning Skills Council (LSC), to ensure the recommendations were appropriate and implementable.

3.8 This report summarises key findings from the programme of work, and outlines suggestions to help ensure the UK retains sufficient *in vivo* capacity to remain a competitive location for the biomedical sector. A list of organisations consulted as part of this work is at annex A.

16 http://www.abpi.org.uk/Details.asp?ProductID=285
17 http://www.semta.org.uk/semta.nsf/?Open
18 http://www.Lantra.co.uk/AnimalTech/
19 http://www.bbsrc.ac.uk/media/pressreleases/05_06_17_capacity_build_int_mammalian.html

4 Key findings

This chapter outlines the key findings of research in three parts:

4.1 Employer demand for *in vivo* skills

4.2 UK capacity to supply them

4.3 Action already being taken to support the skills and tackle the concerns

4.1 Employer demand for *in vivo* skills:

The data in this section is derived from an online survey of employers who need staff with in vivo skills, unless stated otherwise. The online survey, commissioned by the ABPI, ran in February 2007[20].

4.1.1 The Home Office Animals (Scientific Procedures) Inspectorate Annual Report 2005[21] highlighted that there are about 220 'scientific procedure establishments' which are legally permitted to undertake research under the A(SP)A.

4.1.2 The main types of employers that have licences or need to have *in vivo* expertise are:

- large and medium-sized multinational pharmaceutical companies
- contract research organisations (CROs)
- biotechnology companies
- biomedical research organisations outside the private sector, including universities, public sector research organisations and charities
- regulators and those funding biomedical research.

4.1.3 The majority of employers are based in the South East of England, the East of England, London and Scotland, though there are some major *in vivo* employers in the North West, North East and Yorkshire and the Humber[22]. Scotland has a thriving bioscience sector and was recently identified as one of the global top five innovative regions for biotech[23].

4.1.4 The research underpinning this report had input from the main types of *in vivo* employers. The BioIndustry Association (BIA) inputted to the initial stages of the work to ensure representation from the SME sector[24]. The research and the views contained in this report were tested by focus groups to help ensure they are representative of the different types of employers requiring *in vivo* skills.

Size of the research and development workforce that requires *in vivo* skills

4.1.5 There are about 14,000 Home Office personal licence holders in the UK[25]. In addition to these people legally permitted to conduct regulated procedures under ASPA, there are also significant numbers of people who have knowledge and understanding of *in vivo* work who do not hold personal licences. These people could have been licence holders in the past or may have been closely involved with the analysis and interpretation of the results of *in vivo* work.

4.1.6 Research for this report, identified about 6,300 *in vivo* scientists (employees whose major role is in the design, conducting and interpretation of *in vivo* experiments) and 2,700 animal technologists (employees whose primary role is in conducting studies, performing simple procedures and animal husbandry) in the UK. These people were mainly licence holders, though a proportion of non-licence holders were regarded as employees whose role required *in vivo* knowledge and expertise.

4.1.7 The employers participating in research for this report thought the number of staff employed with the skills had not changed substantially over the past ten years. The number employed in the education sector had decreased slightly, due to the closure and down-sizing of some teaching and research operations, at the same time numbers employed by the CRO sector have increased.

Future demand for the skills

4.1.8 No decrease in workforce sizes is expected over the next five to ten years. About 70% of employers expect their *in vivo* workforce will either increase by at least 5% or remain stable in this period. The education sector is the exception, in that it is less clear about its staffing needs. Academics report staff turnover will be higher than normal as significant numbers of staff close to retirement need to be replaced.

4.1.9 It was suggested by some participants in the research that the number of people requiring the skills could decrease due to development of alternatives to *in vivo* techniques. Employers and academics concluded that, if anything, the need for suitably-qualified medical researchers with *in vivo* skills will become more important in future for developing and implementing further alternatives to animals for pharmacological and toxicological screening of new chemicals and drugs. It will be the more experienced and confident researchers who are able to help identify means to further reduce suffering or waste of animals through better-considered, better-conducted and better-designed experiments.

4.1.10 Over the next five to ten years industrial employers expect to need to recruit annually:

- 100-320 BSc or MSc qualified people
- 20-50 with PhDs
- 30-60 with relevant post doctoral experience
- 140-280 animal technologists.

4.1.11 Apart from the animal technologists, all the recruits will need to be trained in universities to have some form of *in vivo* experience, either to work hands-on under a Home Office Licence with the animals, or to undertake work associated with *in vivo* studies. The

20 Further information on the survey is available from the ABPI.
21 http://scienceandresearch.homeoffice.gov.uk/animal-research/publications-and-reference/publications/reports-and-reviews/annual-report05?view=Binary
22 ABPI survey of *in vivo* employers.
23 Source: Young Company Finance Special Report: Life sciences in Scotland.
24 Most small biotech companies also need staff with an understanding of *in vivo* work to commission and interpret *in vivo* studies, which CROs generally undertake on their behalf.
25 Source: Home Office's Animals (Scientific Procedures) Inspectorate's Annual Report 2005

majority of recruits will have pharmacology, physiology, toxicology and pathology backgrounds, while some will have specialised in anatomy, neuroscience, biochemistry or veterinary science. Employers will generally be looking for graduates with first or upper second class Honours[26].

Employers experience of recruiting new *in vivo* employees

Engaging potential applicants

4.1.12 Recruitment of staff with *in vivo* experience has never been easy, due to the sensitivities of the work involved. Concerns about intimidation by animal rights extremists encourage some employers (including some universities) to advertise vague job descriptions. Some have tended to rely on informal networks to advertise vacancies. Increased public acceptance of working with animals and the Government's successful crackdown on the extremists is starting to give employers increased confidence in their communications, but it is nonetheless likely that employers will have to continue to think creatively about how to engage potential applicants.

4.1.13 Employers find the best way to reach those with the skills is by working with universities to promote opportunities and identify potential recruits. Relevant learned societies such as the BPS and The Physiology Society play an important role linking the trainers of potential employees with employers. This report commends the annual BPS recruitment days hosted at industrial research and development facilities. The opportunity for graduates to hear career talks, meet industry experts and showcase their own research is valued by both the employers and the graduates.

Securing the right employees to fill vacancies

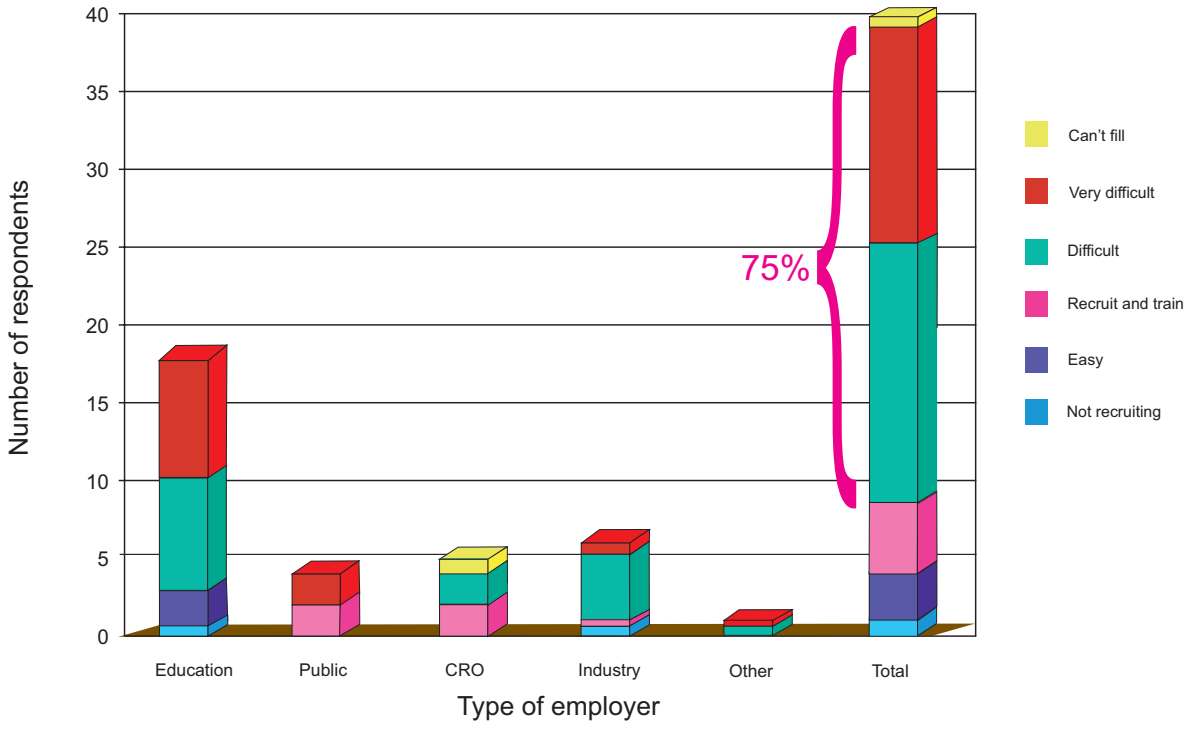
4.1.14 Setting aside the complications of trying to reach a limited group of potential applicants, it is clear that few employers find recruiting new staff with *in vivo* skills and expertise easy. Chart 1 below shows that 75% of relevant employers find it difficult, or very difficult, to recruit suitably qualified or experienced *in vivo* scientists. About 13% of employers report being able to recruit staff easily, but this is with the caveat of then having to train them up.

4.1.15 Chart 1 shows that one CRO has been unable to fill vacancies, but employer focus groups identified several other examples of employers being unable to fill vacancies. The recruitment difficulties seem to be an acute version of wider recruitment challenges the bioscience sector faces. The wider difficulties are being considered by SEMTA. The Sector Skills Council is urgently trying to complete an SSA for the bioscience sector to deal with the recruitment difficulties which it estimates to be five times higher than the average for all firms in the UK.

Reasons for recruitment difficulties

4.1.16 Employers participating in the project were asked why they were experiencing recruitment difficulties. Just under half of the employers cited applicants lacking the required level of experience as a reason. Insufficient basic practical experience was also a major concern for many employers. A lack of

Chart 1: Employers' experience of recruiting scientists with *in vivo* expertise



26 SEMTA Bioscience Sector Skills Agreement: Stage 2 Assessment of current provision. http://www.semta.org.uk/public_bodies/research/labour_market_information/pharma__bioscience_survey.aspx

applicants was an issue for some public sector, CRO and pharmaceutical employers (paragraph 4.1.19 has more detail on a lack of applicants for *in vivo* positions).

4.1.17 Focus groups found that employers think the recruitment difficulties are partly due to the changes in the education system's modes of delivery, rather than employers requiring significantly different types of skills and expertise. The majority participating in research for this project thought that in comparison to graduates from the 1990s, recent graduates from *in vivo* related courses, such as pharmacology or physiology, have:

- generally less exposure, knowledge and understanding of *in vivo* work
- significantly reduced levels of practical hands-on *in vivo* experience gained under Home Office licences
- generally less basic practical laboratory skills.

4.1.18 Employers also find that students from courses that would not provide significant *in vivo* exposure, such as biology, have less knowledge of the basic principles and complexities of *in vivo* work and few have seen animal units. In a few severe instances, industrial placement students and new recruits to research and development facilities have resigned or had to be moved to new departments when they became aware of *in vivo* work taking place close to where they worked. This lack of basic insight into *in vivo* work and its complexities could limit the employability of new biomedical research candidates, who may need the skills and knowledge later in their careers. Employers want general biologists to be exposed to the ethics around the use of animals, what the techniques involve, welfare issues, focus on reduction, replacement and refinement of the use of animals in science and the regulatory environments that both governs it and require it. This would help new recruits understand the complexity, cost and timescales involved in drug and device development.

Employer image

4.1.19 Para 4.1.16 noted that some employers find it hard to attract applicants. This is partly due to there being an insufficient number of skilled graduates, but also due to some employers trying to overcome image problems. Several employers report having to manage the impact of being targeted by animal rights activity. CROs are also having to manage the challenge of client confidentiality preventing them from advertising the type of research they are involved with.

4.1.20 Academics participating in focus groups reported that a minority of students prefer to stay in academia, as they view joining the private sector as "selling out" on the autonomy offered through managing their own research in academia. Historical perceptions that industrial science is not as good as that in academia seem to have been overcome. Academics think the pharmaceutical industry has improved its image through more effectively highlighting how its research directly benefits patients. Academics report private sector employers' favourable image is contributing to significant numbers of graduates, PhDs and postdoctoral scientists applying for jobs in industry. However, these views are considered as optimistic by a number of UK-based companies.

Remuneration and career progression

4.1.21 Salary and potential for career progression are both important factors that may affect graduate employment preferences. Employers and academics think these are significant factors which improve the attractiveness of private sector positions, rather than factors which have led to the recruitment difficulties.

Animal technologists

4.1.22 Animal technologists (laboratory technicians who specialise in working in research animal care units or in laboratories using animals) are key to the drug development process looking after the animals, reflecting modern approaches/technology, maintaining focus on the 3Rs and thereby helping to meet Home Office requirements. Typical turnover in these roles is around 5-10%, with many going on to other roles within the company. Employers have found it increasingly hard to identify suitable candidates over the last few years, as demand for animal technologists, particularly from CROs, has increased.

4.1.23 About 71% of employers find it difficult or very difficult to hire animal technologists. A lack of suitable applicants, lack of basic skills and lack of research animal experience are the main reasons. There are no strict entry requirements for animal technology positions, and employers are generally looking for persons who have an interest in caring for animals and a willingness/ability to learn. Despite this flexibility, 25% of employers report a lack of applicants. CROs and educational employers have the most difficulty in attracting applicants. Traditionally, the South of England, and particularly London, have faced problems, partly due to modest starting pay[27]. The physical nature of animal technology is also a key factor affecting the attractiveness of animal technology roles.

Specialist skills sets:

Toxicology

4.1.24 Toxicology has always been a niche area of expertise taught to relatively small cohorts of students at a few universities across the UK, but the growth of CROs means demand for experienced toxicologists is rising sharply. CROs need increased numbers of toxicologists to work on safety assessment studies as study directors leading studies on testing of pharmaceuticals, agrochemicals, industrial chemicals, food additives and veterinary products. Many employers are finding it hard to find toxicologists with *in vivo* experience. Employer concern about the shortage of toxicologists is growing now the Registration, Evaluation and Authorisation of Chemicals Directive[28] (REACH), is being implemented by EU member states, which they think could increase the need for toxicological studies.

Veterinary laboratory medicine

4.1.25 Employers do not report difficulties recruiting veterinarians to work in animal units, but veterinarians who specialise in laboratory animal medicine are in very short supply. Veterinarians with such experience are needed to fulfil the core roles to sustain animal health and welfare in laboratories and to contribute to the development of more effective and refined animal models of normal and abnormal physiology. The existing UK veterinary schools do not provide formal support for education in laboratory animal medicine at either the undergraduate or postgraduate level, although the Royal College of Veterinary Surgeons does have a postgraduate qualification in laboratory animal science that candidates can enter for. In contrast, the rest of Europe and the US veterinary and medical schools provide formal courses such as MSc and/or Residencies (European/American College of Laboratory Animal Medicine). Employers have been working with UK veterinary schools and funders to find ways of combining employer resources and knowledge, with veterinarian school education experience. Access to qualified veterinary skills with specialism in laboratory medicines is critical to the support of A(SP)A and the ability to fulfil regulation requirements.

Veterinary pathology

4.1.26 Several employers report difficulties attracting veterinarian and toxicological pathologists with sufficient experience. A recent demographic survey conducted by the British Society of Toxicological Pathologists (BSTP) indicates that there will be a shortfall of around 50 new pathologists over the next ten years. This figure may be an underestimate, as a survey conducted in the US indicates that there would be 350 vacant positions in veterinary pathology in the US by the end of 2007. The shortage in the US could lead to UK expertise being drawn to America. Industry has attempted to fund training in toxicological pathology but this has proven unsustainable.

How employers are managing recruitment problems and overall impact on productivity

In vivo scientists

Employing people with higher degrees

4.1.27 Employers are responding to the recruitment difficulties in a variety of ways. Many employers report hiring people with higher degrees, mainly PhDs, thus limiting the availability of candidates with this qualification. This results in increasing levels of cost, and sometimes frustration for the PhDs, where the roles do not meet the expectations of the individual.

Investing more in training

4.1.28 About 90% of employers report providing more training now than 10 years ago. Meeting regulatory requirements and new ways of working are significant reasons for the increase, but employers cite graduates not having the experience of previous generations as an important factor.

4.1.29 Many employers train up existing staff to manage recruitment difficulties. This strategy can be time-consuming and creates vacancies elsewhere which can also be difficult to fill. Employers report continually having to choose between this internal training solution and training up new recruits they would not have hired in the past.

4.1.30 Several employers have developed bespoke training programmes for new entrants to work in drug discovery, involving rotating entrants between different research groups, so that they gain experience of different departments and techniques. These programmes have included learning that involves the use of *in vivo* models.

4.1.31 Costs of providing *in vivo* related training are not available, but the Sector Skills Agreement for Bioscience estimated that a sample of Bioscience Employers spend almost £11million per annum on training, and this in expected to increase in future[29].

Working better with providers

4.1.32 Several employers have developed strategic relationships with key providers. Several sponsor courses though providing finances to courses, input to curricula through steering committees, provision of course speakers, visits for students to industrial laboratories and opportunities for them to work on industrial projects. Some employers value the interaction, but find it hard to meet demand for finance from an increasing number of providers.

28 The REACH directive will set further requirements for the testing and registering of chemicals. Further information is available at: http://www.defra.gov.uk/environment/chemicals/reach/pdf/reach-summary070214.pdf

29 Page 19, SEMTA, Bioscience Sector Skills Agreement, Stage 2: Assessment of current provision.

Accessing the global jobs market

4.1.33 More employers are seeking people educated outside the UK. Most teams within the large pharmaceutical employers are international in their personnel make up, comprising EU, American and Asian scientists. Smaller employers also seem to be harnessing the benefits of international employment markets. One CRO has recruited and successfully trained up several scientists from Zimbabwe, while others report targeting lucrative talent pools in new EU accession countries. China is an increasing source for academia. Most employers think they will hire more scientists who have been educated outside the UK.

Recruitment consultants

4.1.34 The use of recruitment consultants and head hunters to identify experienced staff is increasing, but chart 2 below shows that the vast majority of employers still tend to employ routine recruitment methods to find staff. Employers report scientists are more mobile and willing to relocate to where work is offered, so the opportunities for recruitment consultants and head hunters is likely to increase. Smaller employers have noticed the increased use of such headhunting and are trying to manage this threat through more generous employment packages.

4.1.35 Chart 2 shows that a few employers are not able to recruit staff and that vacancies are being left unfilled. Focus groups thought vacancies being left unfilled is more common than chart 2 suggests. In extreme cases, employers report the difficulties hiring scientists have led to work being delayed, increased training costs and increased pressure on existing staff.

Animal Technologists

European labour Market

4.1.36 Employer strategies for managing shortages of animal technologists vary according to the type and location of employers. Most employers are recruiting increasing numbers of willing and able applicants from Poland and other new EU accession countries. Employers have found the new recruits have excellent motivation, good basic scientific understanding and are able to pick up procedures and animal welfare requirements quickly. In the current climate of limited UK applicants, employers have found that these benefits outweigh the twin challenges arising from language barriers and staff returning to their country of origin after a few years service.

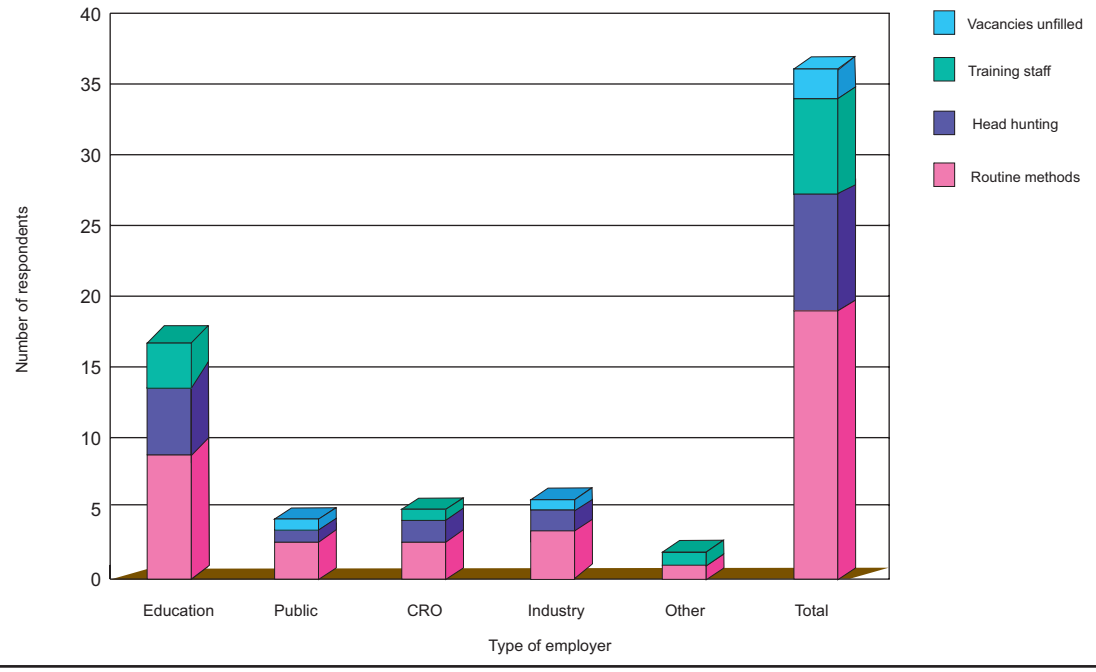
Enhancing the skills of the existing workforce

4.1.37 Degree-level animal technologists are becoming more common in CROs and large pharmaceutical companies, who have taken the strategic decision to pay higher salaries for technologists capable of fast-tracking into managerial positions. Degree-level animal technologists are also becoming more common in geographical areas where there are many employers and competition means that people with lower levels of qualifications are unavailable.

Working better with the Further Education sector

4.1.38 Most employers are working more closely with local colleges in attempts to improve careers advice and understanding of animal research. The majority of employers offer talks to local schools and colleges, but there have been a few instances of teachers and principals being reluctant to find time for such talks.

Chart 2: Methods employers use to manage recruitment



Improved public acceptance of the use of animals in science more generally and reduction of activity by animal rights extremist seems to be encouraging a more positive response from local colleges.

4.1.39 Employers are also working with local colleges to set up day release courses, which over the last 15 years the majority of relevant colleges have largely ceased to run due to changing employer preferences and colleges reprioritising their training portfolios. Employers find good quality day release training can provide an excellent means of meeting training needs, improving staff retention and the spreading of information about animal technology careers. There are some signs of local colleges engaging more positively with employers to support day release courses, which add to internal training programmes. One college in the North West has developed bespoke training options for a local employer and providers in the Cambridgeshire area continue to work with employers to help meet training needs. This engagement is starting to be replicated in other regions where there are further opportunities for training to be tailored to employer needs.

4.1.40 There has also been positive engagement with the new Department of Innovation, Universities and Skills (DIUS), which has offered to help Lantra bring together relevant organisations, such as the Association of Colleges, to help ensure employers have access to high quality training. The Institute of Animal Technology has increased its efforts to support Lantra and help employers find providers to deliver its training.

Recruitment agencies

4.1.41 The use of recruitment consultants has become common in the last decade and a number of agencies provide contract or temporary agency staff who already have completed security checks and hold Home Office personal licences. Although the use of contract staff can be expensive, employers have found the specific skills offered by these employees invaluable, given the overall skills shortage.

Internal training programmes

4.1.42 An interesting response from one public sector employer has been the development of bespoke internal training programmes. The MRC's Mary Lyon Centre has internal training but also encourages staff to attend external courses to help develop skills and experience useful for other animal work careers. Annual turnover of animal technicians fell from 20% in 2003/4 to 10% in 2005/6. The Centre has enabled many husbandry/procedure technicians with aptitude for bench work to move into archiving, in vitro fertilisation, transgenic or clinical pathology roles, which has enabled the centres to fill vacancies that it would not be able to fill with external recruits.

Remuneration packages

4.1.43 Remuneration packages have also been changing to help attract and retain animal technologists. A number of companies have introduced a menu of benefits, which might top up basic salary with non-cash benefits such as travel loans, pensions, computer equipment, crèche and additional holiday entitlement, all of which can be taken as straight forward bonus. This gives employees a number of choices and opportunities, although is still too early to judge whether or not these remuneration packages will become the norm[30].

Specialist skills set

Toxicology and veterinary pathologists

4.1.44 Concerns about supply of toxicologists and veterinary pathologists are being partly addressed by employers funding training in these specialist areas (with a degree of hope that the recipients will join the respective funders after graduation/qualification) and through making better links with training providers. Collaboration with veterinary schools, however, remains an area for further work, as discussions to date have been unable to produce a plan for better collaboration on the provision on veterinary pathology training.

4.1.45 Significant resources are also being used to train-up existing staff. Poaching of staff with these highly-prized skills is also common. Despite these actions, employers remain concerned about the vulnerability of toxicology expertise, due to toxicology expertise being taught in only a small number of institutions.

Summary of impact of skills shortages

4.1.46 Overall, employers seem to date to have found ways around the skills shortages, but there are concerns about their ability to continue finding solutions as significant numbers of skilled staff approach retirement.

4.1.47 About 70% of employers participating in research for this project think the recruitment difficulties caused by shortages of *in vivo* skills have had a negative impact on their productivity. The reported impact of the recruitment difficulties of hiring employees with *in vivo* skills and expertise ranges from unfilled positions in a few employers (leading to stress on existing staff) to one industrial employer transferring animal work outside the UK.

4.1.48 The biggest and most common impact for employers is increased training costs, which are significant in terms of the costs of senior managers' time overseeing new recruits and the need for close supervision. These combined impacts have led to many employers regarding *in vivo* skills as a blocker to enhanced productivity.

4.2 UK capacity to supply *in vivo* skills and expertise

This section considers levels of exposure to in vivo work, how and to what extent the exposure has changed over the past 10-15 years and why the changes have occurred. Factors affecting the UK's capacity to continue to supply the skills are also considered. The data and views contained in this section are from research conducted for the Biosciences Federation in February 2007, unless stated otherwise[31].

Student interest in subjects that include exposure to *in vivo* work

4.2.1 Scoping work for this investigation suggested there had been a decline in the student interest in subjects that are likely to include exposure to *in vivo* work. Higher Education Statistics Agency (HESA) data shows this is not the case. Interest in subjects aligned to medicine, which traditionally have provided the most in-depth exposure to *in vivo* work, has increased. Student interest in biological sciences, which may introduce students to the concept of the use of animals in science, has also increased slightly. There also continues to be strong student demand for medicine and veterinary science, both of which provide significant learning about physiology and how drugs interact with biological systems.

4.2.2 Box 1 outlines changes in the number of student places between 2002/03 and 2005/06 for higher education courses (mainly pharmacology, physiology, pathology and toxicology) most likely to provide exposure to *in vivo* work. Annex B shows more detail on these figures. Some basic data is also provided for biological sciences subjects (biochemistry in particular). Analysis of the data found:

Numbers graduating with some knowledge and experience of in vivo work

4.2.3 HESA data[32] shows that just under 2,000 (1940) students complete BSc and MSc courses in sub-disciplines likely to include at least some theoretical exposure to *in vivo* work and over a thousand students graduate from biology based courses that may give some basic introduction to the concept or ethics around the use of animals in science.

4.2.4 Current practice seems to be that during a first degree in the biomedical sciences, students from many of these courses will have:

- been introduced to the concept of the 'use of animals in medical research'
- attended ethics sessions
- considered alternative research approaches.

4.2.5 In many cases, they will also have also carried out *in vitro* techniques (e.g. studied tissues or isolated cells) after the animal has been killed by a schedule 1 method (i.e. a method of humane killing not regulated under ASPA). This report fully recognises that *in vitro* techniques are powerful in biomedical research and development, but for the foreseeable future, there will continue to be limitations that preclude complete replacement of studies on living animals. For a sustainable research base in the UK both aspects are required.

4.2.6 Biomedical research requires individual scientists to be trained in multiple technical approaches. In physiology, the translation of gene expression into functional activity requires integration of knowledge from the molecular to the cellular to the whole organism level. In pharmacology, there is a need to understand the many facets of drug action, development and use (e.g. the interface between mechanistic efficacy studies at a cellular or tissue level both with those concerned with metabolism and toxicology at a systems level, and clinical areas) rather than narrowly in a particular technology. The ability to generate knowledge at the level of the gene (e.g. from gene array studies) and translate it into organ-relevant function is a prerequisite for successful medical research. There is today a substantial need for scientists to be able to integrate knowledge of *in vitro* and *in vivo* systems, but only a small proportion of the education establishments offering the student places captured by HESA data are capable of offering education and training involving *in vivo* techniques.

Box 1
Changes in number of student places in disciplines that are likely to provide exposure to *in vivo* work between 2002/03 and 2005/06

Level	Change	BScs	MScs	Post graduate level study
Change	↑	26% physiology 15% pharmacology	29% physiology 94% pharmacology 20% toxicology	120% toxicology
	↓	37% pathology toxicology*		7% pharmacology 20% physiology

Data source: HESA
* Toxicology continues to be mainly a postgraduate level discipline

31 The Biosciences Federation commissioned a survey of universities identified by the BPS and The Physiology Society as most likely to provide exposure to *in vivo* work and verified the results through focus group with academics in February and March 2007. Further information is available from the Biosciences Federation.

32 See annex B.

The number of students being exposed to *in vivo* work

4.2.7 Academics from UK universities identified by the BPS and The Physiology Society as *most likely* to provide exposure to *in vivo* work were asked to consider the provision of *in vivo* exposure through means other than theory-based lectures. The three charts opposite (3a, 3b, 3c) show the results. The number of students receiving the type of learning is indicated on the top of each bar. The height of the bars indicate the percentage of students receiving each type of learning as a percentage of the total student cohort in question. Annex F has more detail on these figures. Key findings were:

- About 9% of the BSc graduates covered by the survey gain any significant amount of the hands-on *in vivo* experience valued most by employers (this is about 100[33] BSc students graduating each year who have held a Home Office personal licence)
- About 500 gain valuable insight into the theory and complexities of *in vivo* work through training using cadavers or demonstrations
- The majority of PhD work is "hands-on" and therefore likely to be under a personal licence
- The data found that between 40 and 60 gain experience on industrial placements.

How current levels have changed since the 1990s

4.2.8 A significant number of students are gaining exposure to *in vivo* work through non-theory means, but overall, the learned societies think fewer students are exposed than 10-15 years ago. Historical data is not available for comparison, but chart 4 below shows academics' views on how the amount of exposure has changed on the courses in which they are involved.
Key findings are:

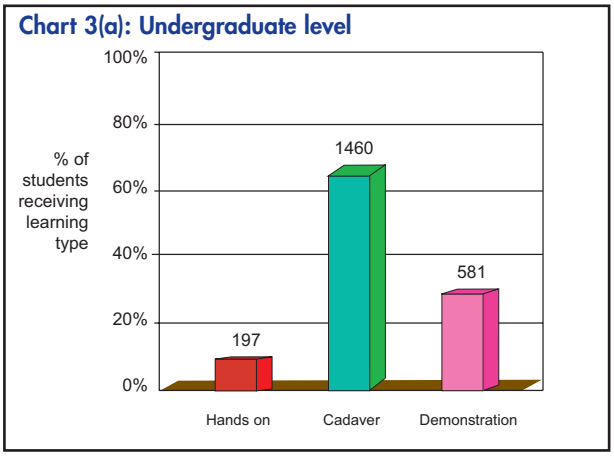
- About 40% of relevant academics think the amount of *exposure* offered has declined on their courses compared with ten years ago
- In the most extreme case, 9% of academics report courses dropping it altogether
- 21% of academics think the delivery of the exposure has been maintained
- Some new courses are emerging that offer it (9% cited this)
- 11% of academics think there has been an increase in the amount of exposure.

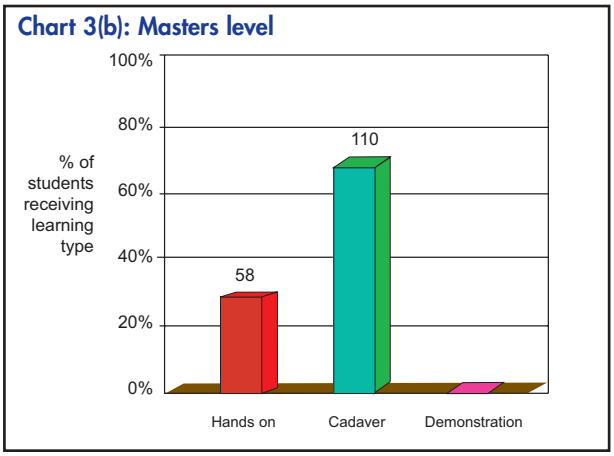
Reasons for the decline in exposure

4.2.9 Employers and academics argue the decline of *in vivo* exposure is due to various reasons associated with:

- shifts within the curricula towards molecular biology
- changes in societal values on using animals
- doubling student/staff ratios within universities
- especially high costs of training that involves

Chart 3: Type of *in vivo* teaching delivered at different degree levels





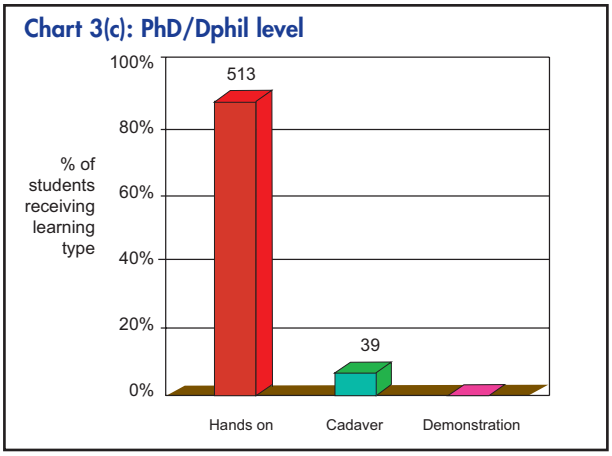
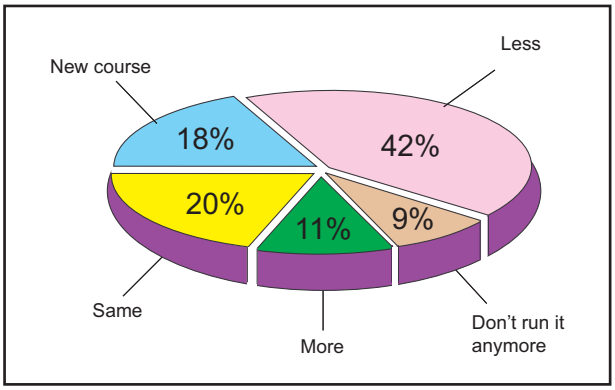


Chart 4: Academics views on how the amount of *exposure* offered has declined



animals (this includes the cost of the animals, security costs for some facilities and particularly the demands of staff time because of the close supervision that is required by law).

4.2.10 The survey of academics and focus group discussions with academics found that a significant number of academics think the decline in exposure at undergraduate level has been appropriate, as the learning is better targeted and focused at postgraduate level. Academics cited this as the fourth most significant reason for the decline (of a choice of 14 options) in exposure at undergraduate level. The top three reasons, in order of most votes received were: costs, regulation and students not approving of the use of animals. Teachers' ability to teach the work was a significant factor at MSc level. Insufficient laboratory space and difficulties sourcing animals were factors in relation to PhD level exposure. Regulation was also an important factor, which is considered in more detail in paragraphs 4.2.24-4.2.27.

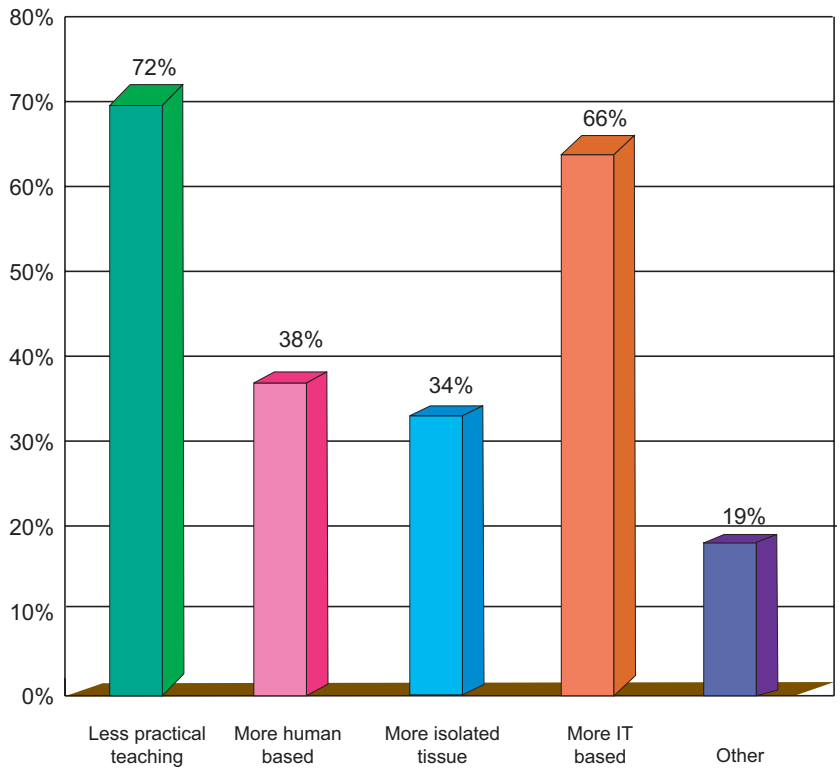
How exposure to *in vivo* work has been replaced

4.2.11 Chart 5 shows what academics think *in vivo* work has been replaced with. Key points are:

- 66% think it has been replaced by more IT based learning
- 38% think there has been an increase in human based learning
- 34% more isolated tissue work
- 72% think there is more generally less practical teaching
- Focus groups considering these findings emphasised that demonstrations, rather than students getting hands-on experience, have become a common means of handling expanded class numbers.

4.2.12 The decline in practical teaching and the associated rise in IT-based learning pose particular opportunities and challenges. Academics need to find the means and teaching time for newer techniques which are not subject to the A(SP)A, such as cellular and molecular biology. These are an important component of biomedical sciences research, and universities need to strike a balance between the subjects and techniques on offer. However, academics argue the newer ways of learning should enhance rather than replace classical *in vitro* and *in vivo* experimentation[33]. In teaching, computer-assisted learning (CAL) is used, but it has been found not to be able to replace the experience gained in a practical class. It can act as a useful complementary instructional tool[34]. Academics participating in focus groups recognised that striking a balance between new IT methods and being able to provide stimulating learning that provides graduates with the skills required by employers will need further consideration: it seems that at present the balance is not meeting employers' needs.

Chart 5: What teaching of *in vivo* skills has been replaced by



Data source: Bioscience Federation report on UK capacity to supply *in vivo* skills

33 Page, C.P., Sutter, M.C. & Walker M.J.A. (1994). Whither, whether and whither pharmacology. Trends in Pharmacological Sciences, 5, 17-19.
34 Mottram, D. & Nicholls, P. (1994). Computer assisted learning versus laboratory practicals – is there a conflict? The Pharmaceutical Journal, 253, E15-E16.

Factors affecting the UK's capacity to continue to supply the skills

4.2.13 Para 4.2.8 highlighted factors that academics think led to the decline of *in vivo* work. Chart 6 shows academics views on the key factors that would affect their ability to increase exposure to *in vivo* work in future. The key three reasons identified in the survey of academics and focus groups are indicated below:

Costs

Cost of facilities

4.2.14 Academics think costs are the biggest factor affecting their ability to continue to provide education and training. Many universities have taken the strategic decision to invest several millions of pounds to upgrade animal units and to continue meeting the costs of running the units. Several academics are concerned that universities may decide not to continue doing this as the Full Economic Costs (FECs) of running the units become clear. Several have been told their individual departments must meet the FEC of the units without subsidy from central university funds. This makes provision of education and training exceedingly difficult, if not impossible.

4.2.15 Academics are generating income to maintain animal units through prioritising income-generating activity, such as contract research, but companies are finding the prices charged are sometimes uncompetitive (some report the prices are higher than those charged by CROs and non UK universities). Academics are concerned that there is a gradual decline in contract research and collaboration with industry, at a time when they are becoming more reliant on industry income to help meet infrastructure costs for the provision of core research and education training. The ABPI is examining data on industrial collaboration with academia to help clarify what has driven the decline, with a view to agreeing with Government and relevant funding agencies action to help stem the decline.

Education and training

4.2.16 The majority of academics are dependent on funding administered by the BPS and/or The Physiological Society to provide undergraduates with exposure to animal research undertaken under Home Office personal licences. The support meets the costs of the mandatory Home Office module training (approx £300 per place) and for Home Office personal licences (£255 or £505 per annum[35] plus overheads) and contributes to consumables used in teaching and undergraduate projects. Academics from several Russell Group universities report an annual budget of £400 per project to meet the costs of undergraduate final year research projects, which is significantly less than the costs of undergraduates gaining exposure to *in vivo* work. Academics have relied on contributions from industrial employers to help fund the several thousand pounds for final year *in vivo* projects, but this continued subsidy from industry is unsustainable. IMBI funding is significantly helping one university increase its *in vivo* training at undergraduate level, but it is considered unlikely that other universities, particularly those that have not received extra support for *in vivo* training, will provide much more than the standard £400 for supporting final-year undergraduate projects.

4.2.17 Difficulties funding education and training are not restricted to undergraduate provision. Some academics report relying on funding from charity and other research funders to subsidise PhD training, as the funding for consumables often does not meet the high costs of *in vivo* research. BBSRC studentships provide £1,000 towards consumables costs, whereas some charity funders will provide the full costs, which have been suggested to be as high as £10,000. Academics report insufficient funding for consumables as a key barrier to training increased numbers of PhDs in *in vivo* research. Industrial employers have helped to subsidise the training at this level as well, but remain concerned that they have to provide such support to UK education and training, when this is not required in other countries offering them a world-class biomedical research environment.

Working with FEC and high costs of in vivo work

4.2.18 It is clear that the introduction of FEC has been challenging for many universities, but its introduction is generally welcomed. FEC is improving the transparency of education and training costs and encouraging universities as businesses to develop better financial management systems. The challenge is for universities and funders to find ways of ensuring the costs can be met, even for subject areas with above-average training costs.

Raising course fees

4.2.19 In some instances, universities are considering whether they could increase fees for courses to meet the costs. This is consistent with the Government's response to Lord Leitch's review of skills, which suggested those benefiting from training to improve skills at a higher level (the customers, be they individuals or employers) should share the costs of education and training. Some universities are already working with employers to show how courses can improve employability, which in turn will help them justify increasing fees. However, many academics remain concerned that increasing fees could reduce the attractiveness of courses, and the number and quality of applicants, as they believe the best students are influenced by both short and long-term financial incentives.

4.2.20 Raising fees is not possible at undergraduate level, so Government funders need to work with providers to help ensure a strategy is in place to protect

35 The cost can be twice that of a licence as the licences follow the financial year and not the academic year.

subjects where the high cost of practical provision is significantly higher than the unit of resource offered through the teaching funding method[36]. Universities taking a hard-nosed approach to balancing their books risk further reducing the provision of practical work in the courses concerned. Some pharmaceutical employers have helped struggling departments with enforced cost cutting, but they should not be relied on to help bridge funding gaps for the basic infrastructure used for core education and training that benefits a range of employers. Employers are already part of the short-term strategy for supporting costs of *in vivo* training, but a longer-term sustainable solution is needed. Recommendation 10 suggests how the Government's existing mechanisms could be used to protect the sub-disciplines within which *in vivo* work takes place, these being vulnerable due to the high costs involved with practical work, and *in vivo* practical work in particular.

Teaching capacity

4.2.21 The second biggest concern after costs is academics' ability to teach and supervise those undertaking *in vivo* work. Academics report a serve shortage of experienced teachers (about 15% of experienced academics are due to retire in the next five years and a further 5% in the following five years; this follows a significant (but unquantified) rate of retirement over the last decade. Home Office legislation sets strict requirements around the supervision of *in vivo* work which make a supply of experienced teachers essential.

4.2.22 To maintain *in vivo* provision, universities will need to manage staff recruitment, but the current shortage of experienced teachers, heavy competition from industry for experienced scientists and the Research Assessment Exercise (RAE) reportedly[37] favouring non *in vivo* scientists with better publication records seem to be making recruitment exceedingly difficult.

4.2.23 Recommendation 9 in chapter 7 suggests a number of measures to help improve teaching capacity, but the number of barriers to universities being able to recruit experienced teachers (as discussed above) suggests further action may be required. The supply of technical staff is also an issue affecting the capacity of education and training at all levels, and which will need careful monitoring.

Regulation

4.2.24 The third key concern affecting UK capacity is the strict regulatory environment governing the use of animals in science under the A(SP)A. The *in vivo* community strongly supports regulation that helps ensure there is a highly-skilled and competent workforce, with an appropriate focus on excellent science and animal welfare. There is belief across the sector, however, that the time and costs involved in meeting the current regulatory requirements have been partly responsible for the decline in levels of *in vivo* exposure, that some of the requirements have not served best animal welfare, and that better regulation would therefore be in order.

4.2.25 Regulation is likely to continue to be a key factor affecting future UK *in vivo* capacity and this report welcomes the acceptance of the Home Office and other relevant stakeholders that there are opportunities for regulatory improvements. The Home Office Better Regulation Simplification Plan contains a series of actions relating to better regulation under the A(SP)A. However, the community has been disappointed that some of the regulatory benefits have not been delivered yet. Recommendation 13 in chapter 7 has more detail on how the plans should help reduce time-consuming bureaucracy, while not undermining animal welfare.

4.2.26 One issue that is unlikely to be addressed in the simplification work is the legal requirement for students undertaking *in vivo* techniques to be constantly supervised. This increases the importance of universities and relevant stakeholders continuing to work together to esnsure that there are enough experienced people to supervise and provide education and training.

4.2.27 Research for this report identified 14 universities hold Home Office Project Licences for education and training purposes and a further seven provide exposure to *in vivo* work without requiring teaching licences. The exposure without teaching licences could be watching personal licence holders working under research project licences designated for the purposes of advancement of science, or limited exposure not requiring a personal licence, such as: basic handling or cadaver work; and learning about how to design, run and analyse experiments. A number of universities who used to provide exposure said they would be willing to provide exposure again, but only if the they could obtain the relevant licences, the extra teaching staff required, and support with costs.

Other issues

Student Demand

4.2.28 The rush to molecular level biology, increased choice due to the modularisation of learning and changes to societal values over the use of animals have all affected student demand. About 10% of academics think student demand for *in vivo* work was a factor that led to the decline in the amount of exposure at undergraduate level and 14% think more effort is needed at undergraduate level to clarify the reasons for the use of animals in research.

4.2.29 Despite these concerns, the majority of academics think there is sufficient student demand for *in vivo* work. Progressive acceptance that genomic, molecular and cellular information needs to be translated into functional studies has helped raise student demand

36 Detail about the teaching funding method is available at: http://www.hefce.ac.uk/learning/funding/fundmethod/
37 Academics participating in the project believed that the applied in vivo research tends to fair less well in terms of contributing to research star ratings.

for *in vivo* work. Many academics report being unable to meet student demand for Home Office licence training and final-year projects, and the BPS/the Physiology Society has put on *in vivo* summer schools for students whose institutions do not provide *in vivo* training, which are significantly oversubscribed. Universities that do provide *in vivo* work are finding they are unable to meet student demand for final-year projects (mainly due to costs and teaching capacity) or demand for PhDs involving *in vivo* techniques (due to lack of funding opportunities). Provision of *in vivo* PhD opportunities is generally problematic, as many of the graduates applying for opportunities lack the basic *in vivo* experience required both to make an informed choice of appropriate projects and to become effective researchers quickly.

4.2.30 Although demand for *in vivo* work and perhaps more importantly, demand for the sub-disciplines within which *in vivo* work takes place seem healthy, it is important this is not taken for granted as there is always the risk that societal attitudes and/or scientific advances could reduce demand for these vital sub-disciplines and techniques. If demand for *in vivo* work and the sub-disciplines becomes a problem again, employers will have an important role to help raise demand through demonstrating the opportunities and need for people with the skills.

Allergies

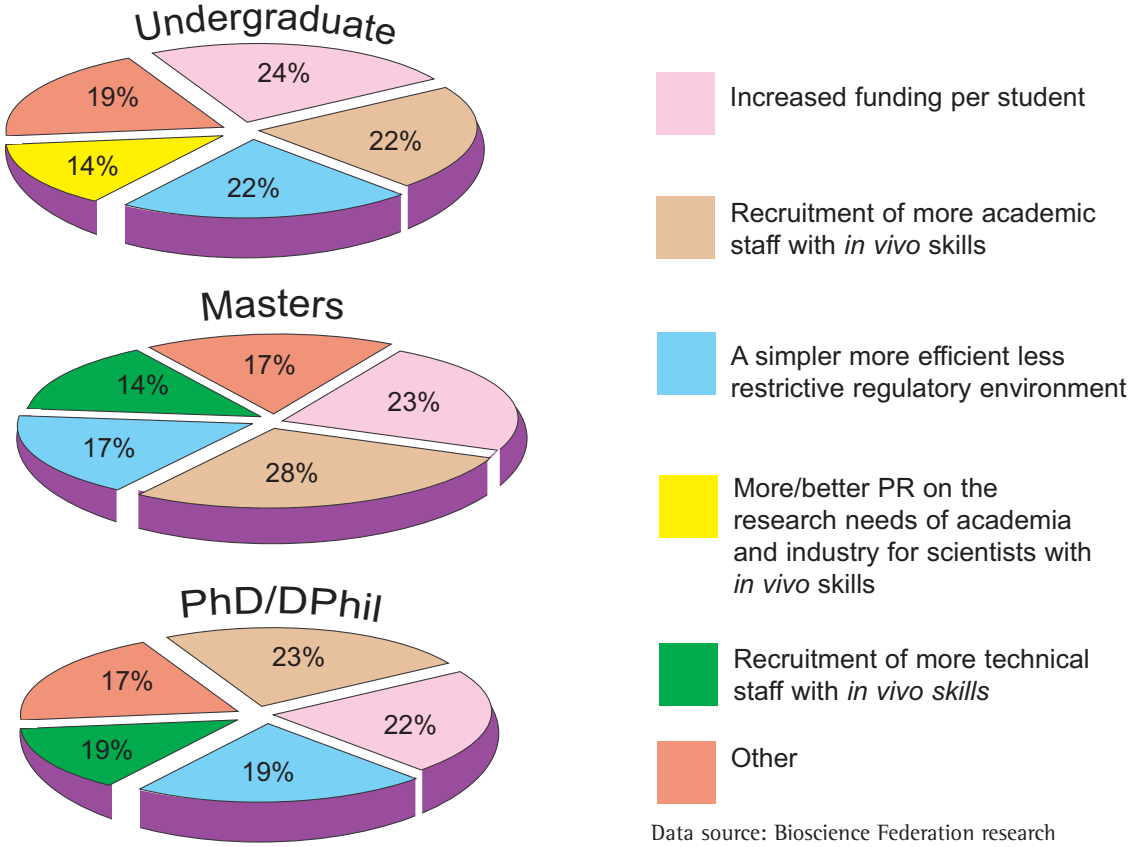
4.2.31 Academics emphasise that one irresolvable issue is individuals' allergies to animals. The increase in students reporting allergies is forcing academics to consider how to encourage students to have early contact with animals, so that they can assess at an early stage their suitability for a career in this area.

Putting the decline of in vivo skills into the context of declining HE practical skills

4.2.32 The decline in practical *in vivo* experience seems to be part of a wider trend of reduced practical time in many undergraduate bioscience courses (Chart 5 showed that 72% of academics think less *in vivo* experience work has been accommodated by less practical work). Many employers find graduates have less practical experience and are unable to perform even basic laboratory procedures such as calculating concentrations, performing basic pipetting and dilutions. Employers report graduate confidence in undertaking practical work seems lower than ever before, despite graduates' giving more confident performances in interviews. Biomedical employers find hiring people with higher degrees, most notably PhDs, is sometimes the only means of obtaining practical (as opposed to theoretical) skills.

4.2.33 Academics report that the RAE, increased student numbers and pressure to reduce unit costs all discourage the provision of practical classes. Student preferences for non-practical learning are also relevant, but institutional efficiency drives, involving maximising teaching to large student numbers and in turn offering less practical time seem to be the key

Chart 6: What would enable increased provision of *in vivo* skills



Data source: Bioscience Federation research

driver. Furthermore, students who might be encouraged to take up research careers by a wider exposure to practical science frequently do not get the opportunity. One Russell Group university participating in this project reported the operation of a system that rewards provision of lectures to large number of students over other learning means such as practical laboratory work.

4.2.34 The concerns about declining levels of practical work are not specific to *in vivo* skills concerns and this report does not make any recommendations to address them. The authors of this report would, however, welcome the opportunity to work with Government to find ways of further promoting and enhancing the practical skills of graduates from UK universities. The Higher Education Subject Centre for Bioscience has already been contacted about further activity to help teaching of practicals.

4.3 Action already taken to tackle the concerns around the UK capacity to supply the skills

This section outlines the significant action which has already been taken to help rebuild in vivo capacity.

Long-term capacity building

4.3.1 In addition to routine employer support for this area of science, AstraZeneca, GlaxoSmithKline and Pfizer collectively contributed £4million over four years to create the British Pharmacological Society's Integrative Pharmacology Fund in 2004. The fund, which aims to enhance *in vivo* training at higher education centres of excellence, has helped support academic fellowships, PhD studentships and teaching of *in vivo* work at undergraduate level through subsidising the cost of training, Home Office licences and project costs.

4.3.2 About £2million of the IPF was used to catalyse the development of the Integrative Mammalian Biology Initiative, which is a multi-funded partnership helping to address the capacity concerns. The IMBI is supported by a unique consortium: the Higher Education Funding Council for England (HEFCE), the former Scottish Higher Education Funding Council (SHEFC), the Biotechnology and Biological Sciences Research Council (BBSRC), the Medical Research Council (MRC) and the former DTI.

4.3.3 Following an open competition administered by the BBSRC, £12million of funding was allocated in May 2006 to regenerate training in animal research skills at all student levels. Four awards were made to two London universities, Imperial College London and King's College London, and two jointly-led consortia between the universities of Manchester and Liverpool, and the universities of Glasgow and Strathclyde. The capacity-building awards will help the four centres offer training opportunities in research areas including heart disease, neuroscience, reproduction and metabolism. Box 2 has details of how the IMBI will help rebuild *in vivo* capacity.

Box 2

LIKELY IMPACT OF THE IMBI

£12M to four universities over 2006-2011 to fund:

- **14 faculty staff who will increase significantly the exposure of undergraduates in those four institutions to *in vivo* skills**
- **90 MRes places**
- **80 associated PhD places**
- **Limited equipment and contributions to FEC of teaching**
- **Outreach activity**

Support from Research councils

4.3.4 The BBSRC supports a broad research base in microbial, plant and animal sciences, ranging between studies at the molecular organismal and population level. Some examples of how BBSRC activities have or are supporting *in vivo* sciences, are:

- 12 of the 50 Targeted Priority Studentships in 2006 were in the area of Integrative Mammalian Physiology and 10 in the 2005 competition. In 2004 18 studentships were awarded to the area of whole-animal physiology through the Strategic Research Studentship Competition.
- In addition to these specific competitions prioritising *in vivo* related disciplines, BBSRC CASE studentship awards and Doctoral Training Accounts (DTAs)[38] were, and continue to be, available for *in vivo* research. The CASE Studentships and DTAs provide flexibility for university departments to seek joint funding of studentships with industry. This flexibility also enables industry to contribute to project costs or match fund costs to increase the number of studentships in any area.
- BBSRC supports a number of research institutes[39], such as the Institute of Animal Health, which have *in vivo* expertise.
- BBSRC's Technology Strategy: *Underpinning Industrial Needs* also highlights *in vivo* pharmacology and physiology as a priority area.

4.3.5 The MRC is the UK's largest public funder of biomedical research, funded by the UK taxpayer. Its mission is to encourage and support high-quality research with the aim of improving human health and training a cadre of researchers to help deliver this aim. The MRC has 29 Units and three Institutes in the UK which carry out research across the biomedical research spectrum, from fundamental science at the molecular level to large-scale epidemiological studies. There are also 15 MRC Centres, which are long-term partnerships between the MRC and UK universities intended to help universities develop and sustain

38 http://www.bbsrc.as.uk/media/pressreleases/05_05_19_new_studentship_competitions.html
39 Information about BBSRC sponsored institutes is available at: http://www.bbsrc.ac.uk/about/centres/Welcome.html

centres of scientific excellence. Key points relating to MRC support for *in vivo* sciences are:

- Around 30% of the research MRC funds involves animals.
- Many of the Units, Institutes and Centres compliment or use *in vivo* expertise and part of their mission is to train new experts in this area. MRC's Mammalian Genetics Unit at Harwell, for example, uses a wide range of approaches to investigate mouse models of human genetic disease and has one of the largest mouse banks in Europe.
- MRC support for studentships has included a focus on supporting *in vivo* expertise. Whole animal physiology was a priority capacity building area in 2004/05 and 2005/06 competitions and 15 and five studentships were awarded respectively in each year.
- MRC Industrial Collaborative and Doctoral Training Account Studentships may also be used for this area.
- The MRC plays an active role in developing and disseminating the principles of the 3Rs. It was instrumental in setting up the National Centre for the Replacement, Refinement and Reduction of Animals in Research (NC3Rs), and is the largest funder of the Centre.

Medical charity support

4.3.6 The 100 medical research charities which are represented through the Association of Medical Research Charities (AMRC) have a combined annual UK medical research expenditure exceeding £600million. The research is undertaken in hospitals, universities and institutes. Most of the medical research involves techniques such as test-tube and cell culture work, computer simulations, clinical trials, human tissue analyses and epidemiological surveys, but some major advances rely on animal-based studies. In parallel, some new medicines are required by law to use animals during development and safety-testing. Below are examples from some of the charities that use research involving *in vivo* techniques, either through their own research or through partnering with UK universities on research projects:

- The Parkinson's Disease Society has funded a significant number of *in vivo* studies as part of a multidisciplinary programme aimed at understanding Parkinson's and developing new treatments.
- The Wellcome Trust, in particular, supports biomedical science and has recognised integrative physiology as a strategic priority following concerns about UK capacity in this area[40]. The Trust has funded large-scale capacity building awards in the past under its £15million Integrative Animal and Human Physiology Initiative. The programmes were awarded funding over five years and all three contained large elements of *in vivo* work. The Trust's responsive mode funding schemes, such as long-term Programme Grants (five years), shorter 1-3 year project grants, fellowship grants for all career stages of researchers and PhD studentships can all be used in open competition for *in vivo* sciences. The Trust has also been working with veterinary schools to help support training of veterinarians in laboratory animal medicine.
- The British Heart Foundation, as the major funder of cardiovascular research in the UK, is committed to funding basic and applied biomedical research at all levels from studentships and fellowships to project grants, programme grants and chairs. The BHF recognises that *in vivo* experiments are necessary for some of the preclinical projects it funds, and a significant fraction of BHF awards supports personnel who carry out *in vivo* studies.

Universities

4.3.7 Data on investment by universities is not available but academics report significant ongoing investment by universities into existing animal facilities, which is critical for future UK *in vivo* capacity. Universities have also committed to recruiting new staff to ensure they have the staff needed to remain world leaders in biomedical research. On the other hand, universities driving forward FEC in both research and teaching (without any flexibility for subsidising expensive animal units) puts severe pressures on the use of animals. The impact of FEC on animal work will need careful monitoring.

Support for undergraduate training

4.3.8 Since 2002 the BPS and The Physiological Society have helped run summer schools that provide important, cost effective exposure to *in vivo* work to students whose universities are unable to provide such exposure. The societies thought this important due to a number of universities deciding to close animal units or stop educating and training undergraduates in *in vivo* techniques. The courses, which have capacity up to 40 places per annum, have been funded by industry, the BBSRC and Wellcome Trust. Students attend a Home Office Modules 1-4 training course during the Easter vacation and then the *in vivo* course during the summer. The places are delivered at a cost of about £2,000 per student. This per student cost relies on courses providers administering the courses, without their own Department receiving any recompense for the considerable staff time input required.

40 http://www.wellcome.ac.uk/node2149.html

5 Clarifying further priority action

This chapter clarifies at what level of education more *in vivo* skills are needed and the scale of action needed to overcome the recruitment difficulties employers face.

Clarifying where the need for further action is

5.1 Chapter 4 outlined the recruitment difficulties of employers, and academics' view that they are unlikely to be able to increase supply of the skills without further support. Before considering the type of support needed, clarity is needed on where and how large the gap between supply and demand is.

Understanding supply, demand and numbers entering industrial employers

5.2 The first column in box 2 shows the number of graduate level appointments industrial employers make each year, the middle three columns the numbers of students graduating with different levels of *in vivo* skills (based on comparisons of Bioscience Federation data on numbers with *in vivo* experience and HESA data for the number of places in the sub-disciplines that include *in vivo* work) and the end column on the right, estimated numbers of graduates likely to join industrial employers (based on destination trends identified by the Biosciences Federation). The figures are based on the best available sources, but all of the sources relied on individuals interpreting questions and providing data. In light of this risk of human error, the real figures could be higher or lower.

Box 3

CALCULATING THE NUMBER OF EXTRA GRADUATES NEEDED WITH *IN VIVO* SKILLS AND EXPERTISE

Level	Estimated annual demand for staff with *in vivo* skills (a)	Annual supply of pharmacology, physiology, toxicology and pathology graduates with exposure to *in vivo* techniques			Number of graduates with basic and significant exposure of *in vivo* work that are likely to join industrial employers each year (d)
		Some exposure to *in vivo* theory	Basic exposure to *in vivo* work through demonstrations and cadaver work	Significant exposure to *in vivo* work up to and including that requiring a Home Office licence	
BSc/MSc/MRes	100-320 (median **230)**	1282 (b)	497 (c)	158 (c)	**112**
PhD	20-50 (median **35**)	47 (b)	3 (c)	170 (c)	**51**

DATA SOURCES:

a) Estimated industrial demand: ABPI statistics. (see annex C)
b) Graduates with some exposure to *in vivo* theory: HESA 2005/06 places for subjects B210, B120, B220 and B130, minus the number of graduates being exposed to *in vivo* work according to Biosciences Federation data (c)
c) Estimated graduates with non-theory based exposure according to Biosciences Federation data (detail at annex F)
d) Estimated number of graduates likely to join industry: Biosciences Federation data (detail at annex D)

NOTES ON BOX 3 DATA:

- BSc, MSc and MRes appointments are grouped together, as most employers tend not to differentiate between these levels of qualifications.
- The range of employees needed with the different level of qualifications are broad because employers use the skills and expertise in different ways. Some employers have small *in vivo* teams, as they draw heavily on the expertise of CROs, while others have larger teams spread across several research units. Annex C has more detail on the methodology used to reach industrial demand figures.
- Demand figures for more senior scientists with post-doctoral experience are not included in the table, as most employers think action should be prioritised on supporting BSc, MSc and PhD level training. Some are, however, finding recruitment of these scientists difficult. This is concerning academics who need to hold on to a significant proportion of their experienced post-doctoral scientists with a view to both supporting ongoing research and replacing impending retirements of *in vivo* staff.
- Supply of animal technologists and other specialist skills concerns, such as veterinary pathology, are not considered, as there are no courses to enable easy comparison of supply and demand. It should be noted that some of the 100-320 BSc or MSc positions could be for graduate-level animal technology roles.
- Needs of academia and other public sector and charity employers are not considered as the necessary data was unavailable. Recommendation 9 in chapter 7 considers how to address academia's problems in recruiting teaching staff, and increased levels of training should help academia fill PhD and post-doctorate positions, as not all of the extra people trained will join industry. Public sector and charity employers could help ease their recruitment difficulties by taking on industrial placement students and supporting MSc and PhD provision in a manor equivalent to industrial employers.

Destination of graduates with exposure to *in vivo* work

Graduates with the skills most valued by employers

5.3 Box 3 shows that the majority of BSc, MSc and MRes graduates with basic (demonstrations and/or cadaver work) and significant (work including that requiring a Home Office licence) exposure to *in vivo* work are thought unlikely to join industrial employers. Academics report that many of the most able and experienced graduates use the *in vivo* experience to help enter medicine or dentistry, and a significant proportion continue using the skills and knowledge in non-industrial employers or in education. Of the 650 graduates, only 112 are estimated to be likely to join industrial employers and these will not all be entering research and development positions (many enter as clinical research associates).

Graduates with only exposure to the theory of in vivo work

5.4 Just under 1,300 BSc and MSc graduates have some exposure to *in vivo* theory, but this is likely to be limited and involve little in-depth consideration of the challenges of *in vivo* work, which can span ethical, animal welfare, scientific or practical issues. Employers recruit some of these graduates, but the number is not likely to be significant and employers emphasise they only recruit such people when more experienced applicants are not available.

Scope for reducing the number of graduates who decide to stop using the skills altogether

5.5 The assumptions about the destinations of students with the different levels of skills are based on research with academics (more detail at annex D), and while they may be on the optimistic side, provide a reasonable basis for considering the gap between employer demand and supply from universities. HESA destination data (annex E) shows that about 25% of the graduates from the sub-disciplines likely to include some introduction to *in vivo* work end up working for biomedical industrial employers. This destination data and the destination trends for those with the skills seem to indicate there is some scope for all employers (not just industrial ones) to better target those who have had some basic exposure to *in vivo* work, though it is unclear whether better targeting is likely to help significantly increase the number of graduates who continue to use the skills.

PhD graduates with in vivo exposure

5.6 PhD level supply versus demand seems healthier, with 51 of the 173 PhDs estimated to be undertaking research that includes *in vivo* work thought likely to join industrial employers at graduation. Employers and some academics participating in focus groups were surprised that the number of PhDs involving *in vivo* was so high, but agreed with the assumption that about half of the PhD graduates stop using their *in vivo* skills, and of those who continue to use the skills, about half do so in industry. Reasons for the 50% attrition at PhD graduation include laboratory animal allergies, ethical concerns with animal research, switching to enter medical training, and a desire to broaden the research portfolio. It is therefore unlikely that this attrition rate can be reduced substantially.

5.7 The figures superficially suggest that PhD supply is exceeding the demand, but both industrial and academic employers report difficulties recruiting PhD level scientists, prehaps due to many employers hiring PhDs to do work previously undertaken by BSc graduates (see paragraph 4.1.27).

5.8 Successful implementation of this report's recommendations to boost supply of *in vivo* skilled graduates, should help reduce the need for PhDs to be used this way. This and the IMBI's injection of significant numbers of PhDs should also, to some extent, help improve PhD supply and ease the recruitment difficulties. It will be important that some of the new IMBI PhDs join academia or other non-industrial employers who also have difficulties recruiting PhDs as academic employers need to have access to a sufficient supply of PhDs to take forward their own research and manage the loss of significant numbers of postdoctoral scientists who join industry. This report was unable to clarify whether PhD supply was sufficient for these services and thus there continues to be a need for sustained support of PhD level *in vivo* training.

Understanding the scale and means of action needed

5.9 This report uses the median figure for industrial employer demand from column one of box 3 as the indicator of industrial demand. Comparison of this figure with the number of graduates likely to join industry indicates at least 120 more BSc or MSc graduates with basic or significant skills and expertise are needed to meet industrial employer recruitment needs. Continued support for PhD level training will also be important (to meet all employers' needs and help produce a pool of people with experience who may, in future, decide to become trainers) but the gap between supply and demand is most pronounced at graduate level.

5.10 Box 3 does not consider the impact of the IMBI and other factors that may affect how many positions are likely to need to be filled by UK graduates. Key factors to consider in assessing the appropriateness of the training of 120 extra BSc or MSc graduates are:

- The likely impact of the IMBI on the graduate shortage: the investment should reduce the size of the gap, as it increases supply of the skills
- Recruitment of people educated outside the UK: about 15% of existing *in vivo* scientists were educated outside the UK and employers think more of their recruitment needs will be met this

way[41]. This should reduce the size of the supply shortfall

- Internal staff filling vacancies: many vacancies are filled by internal staff who have been promoted or relocated from operations at different sites. These recruits fill positions, but create vacancies else where, so overall, are neutral on the skills gap[41]
- Unknown potential workforce: significant numbers of UK graduates gain exposure to *in vivo* work through employer placements or PhD training outside the UK. The return of these graduates reduces the supply gap.

5.11 Box 4 shows that applying the above factors (detail under calculation 1) reduces the need for extra UK *in vivo* trained graduates by at least 60 graduates.

However, calculation 2 shows that since not all trained graduates will join industrial employers, at least twice the remaining 60 graduates need to be trained up to Home Office personal license level[42], and more likely three times unless the current percentage of experienced graduates who join industry can be improved. This report takes the optimistic estimation that at least an extra 120 graduates per year need to be educated and trained in basic *in vivo* skills to ensure employers' needs are met. The figure could be higher or lower, but provides a useful basis for considering the scale of the action needed. Effective targeting of action in recommendations 1, 2, 3, 4, 5 and 7 should help increase the likelihood of graduates joining industrial employers and reduce the need for greater numbers to be trained.

Box 4

CALCULATING THE NUMBER OF EXTRA GRADUATES NEEDED WITH *IN VIVO* SKILLS AND EXPERTISE

SKILLS AND EXPERTISE

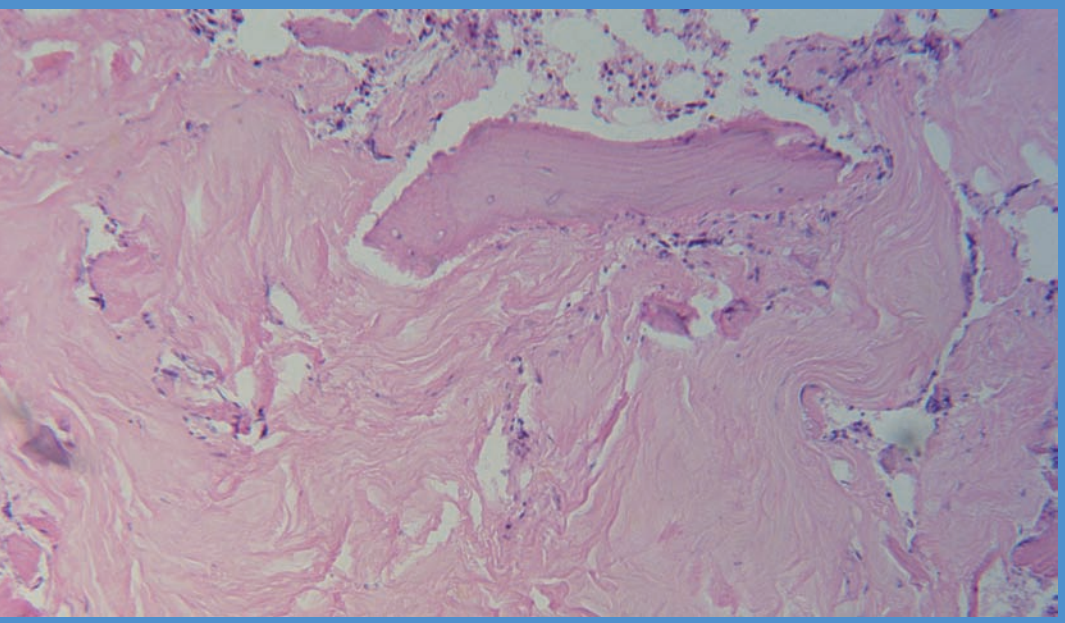
Number of graduates industrial employers need above existing numbers	Impact	120 extra needed
Calculation 1		
Factors to consider a) IMBI supported graduates likely to join industry	30[43]	–30
b) Recruits educated outside the UK likely to join industry (15% of median demand figure)	30	–30
c) Internal promotions	neutral	neutral
d) Unknown UK experts returning from overseas	unknown	unknown
Total extra graduates needing to be recruited pa		**60**
Calculation 2		
Graduates not directly joining industrial employers	Multiply gap X 2	+ 120
Total extra graduates needed based on median employment needs		**+ 120**

41 In addition to UK graduates returning to work in the UK. *In vivo* experts educated outside the UK often return to their country of origin to create new vacancies. This occurrence is included in the employer demand figures.

42 The type and level of training students receive seems to affect the proportion of graduates who join different types of employers. For example, students that undertake some training in industrial employment are more likely to return to them after graduation. Destination trends for students taking different MRes or MSc courses, seem to reflect whether courses are designed for preparing students for PhDs or employment. Courses designed with direct employer input and opportunities for interaction with employers during the courses are thought to significantly increase the likelihood of graduates joining industrial employers.

43 Based on the assumption that each year half of the IMBI MRes may join industry and each of the successful IMBI grant winners trains at least an extra 15 BSc graduates to basic or significant levels of *in vivo* exposure.

6 Principles underlining further action recommended in this report



This chapter set sets out principles that were considered when examining measures to:

- expose an extra 120 graduates to basic or significant *in vivo* work to fill the skills gap
- help ensure the UK has sufficient capacity to produce enough skilled persons with *in vivo* skills to join employers
- ensure long-term international competitiveness in this area.

It also considers:

- the importance of employers communicating demand for the skills
- finding ways to encourage universities to respond to the skills shortage
- the need to mainstream into eduation and training the importance of excellent animal welfare, teaching ethical issues around the use of animals in science, excellent experimental design and continued progress in the 3Rs.

6.1 The principles are that all of the recommended actions in the following chapter should be:

- employer (demand) led so that they reflect employer needs[44]
- effective in producing skills and expertise that will address short- and medium-term recruitment difficulties but be sustainable in the long-term
- targeted only at those whom it is essential have the skills in future[45]
- consistent and beneficial to better animal welfare and the reduction, replacement and refinement of the use of animals
- complementary to the IMBI and other capacity-building work
- taken forward though existing partnership approaches, such as the IMBI, rather than inventing new models
- consistent with existing Government policy frameworks
- shared between employers, providers, individuals and Government.

The importance and practicalities of employer (demand) led action

6.2 This first principle is critical. As it was industrial employers concerns about insufficient skilled staff that initiated this investigation, many of the recommendations aim to ensure that industrial employers get the skills they need. It has been recognised that attempts to organise the supply side of education and training to deliver other workplace skills that employers need have had mixed levels of effectiveness, sometimes training too many people or not enough, or mismatching the skills provided with the expectations of employers[46]. Industrial and non-industrial employers, need to engage with universities both to convey the skills and expertise they need and to discuss the incentives that will ensure those needs are achieved.

Effective dialogue about employer needs

6.3 Employers input to skills development needs to be an ongoing process. Employers should regularly discuss their needs with providers (just as they would discuss needs with other suppliers) to ensure their requirements are up-to-date and do not overstate demand (this last point is key, as graduates unable to use the skills will spread the message that the skills are not needed). Practically, this means employers need to try to be clear about whether they need providers to expand provision or maintain training at existing levels.

Better collaboration between providers and employers

6.4 A key means for ensuring that training is demand led is by finding ways for students to spend time with employers. A focus of the recommendations in this report is to shift the balance of training so that it provides this group of students with far more industrial experience. Increasing the amount of time students spend in industry will allow them to experience life within industry (in far more areas than only the utilisation of *in vivo* skills), enable them to learn about the latest industrial techniques, and see how the skills are used. Perhaps most importantly, experience shows that it increases the likelihood of the student taking a post with the industrial employer.

The need to further encourage universities to respond to the challenge

6.5 While not listed as a principle in considering the appropriateness of actions, a key factor that will determine whether or not they are implemented is how universities are encouraged to take action. Universities are independent businesses that are free to decide their own business models, products and services within a very broad remit of developing the education of young people. Finding an effective means for encouraging universities to provide very specific learning experiences, such as expensive and sensitive *in vivo* education and training, is therefore challenging. It is, however, essential, if the other recommendations proposed in this report are to be successful.

6.6 Continued employer dialogue with universities on the importance of skills is already happening in relation to *in vivo* skills, and some major industrial employers are providing limited numbers of universities with funds that enable some *in vivo* training to be provided. Most universities are not in a position to respond to the demand unless extra finance is provided, given that increasing the provision of high-cost training to meet specific employer requirements is inconsistent with drives to reduce unit costs of BSc training within universities. Where such specific training is provided, as with medical training, the government's unit of resource is very substantially higher. The situation is exacerbated by the split time pressures on the dwindling number of academic staff who are fully skilled in *in vivo* theory and practice (see section 4.2.20 above) and by the high levels of supervision required by legislation.

6.7 The Government is using a number of means both to support Strategically Important and Vulnerable Subjects (SIVS) and to strengthen the emphasis on universities meeting employer demand, as set out in

44 Which employer leads the action will depend on which of the skills shortages is being addressed. Industrial employers need to help ensure graduate training produces the skilled people they need, whereas academia needs to help ensure any action to support teaching meets their needs.

45 The A(SP)A states that education and training should only be provided to those who will ultimately be responsible for the design, conduct or analysis of scientific work involving the use of living animals, and for whom an understanding of in vivo biological phenomena in protected animals is essential.

46 http://www.hm-treasury.gov.uk/media/6/4/leitch_finalreport051206.pdf

World-Class Skills: Implementing the Leitch Review of Skills in England. This should help encourage universities to deliver the training employers need. This report therefore sets out a package of actions to help universities deliver training (including some staffing support and contributions to costs), but it relies on universities responding more effectively to employer demand without further significant cash injections from industry at undergraduate level. If universities do not or cannot (for financial reasons) respond, then the Government and relevant stakeholders will need to consider how to alleviate the situation. Unless this succeeds there is a risk that parts of the UK's biomedical and pharmaceutical research (within both industry and academia) could move to other countries that provide better support for *in vivo* research.

Excellent animal welfare, ethical use of animals in science and continued progress in reducing, refining and replacing the use of animals in science

6.8 One of the objectives of this project has been to ensure that action supports good welfare practices and the application of the 3Rs. Employers expressed a strong desire for providers to ensure they mainstream substantial teaching about good animal welfare, different ethical issues (such as harm benefit assessments, ethical reviews and the many different perspectives on animal use in science), excellent experimental design and the 3Rs into education and training. In considering ways to sustain and enhance the supply of *in vivo* skills to support UK biomedical sciences, these points were carefully considered.

6.9 At all stages, learning needs to be structured so that the scientific, as well as ethical, advantages of these approaches are recognised. This report aims to increase the pool of people with an understanding of *in vivo* work, achieved by providers maximising opportunities for students to acquire the knowledge and skills through *in vitro* methods, witnessing procedures or supporting existing research, thus minimising the need for more animals to be used for education and training purposes. Opportunities for hands-on exposure to animals will be largely restricted to those with a high likelihood of using the skills in their future careers. Another important component of this will be ensuring veterinarians are able to advise on animal welfare and appropriate animal models.

6.10 Implicit to all recommendations is the need for academics regularly to consider the learning objectives of education and training to ensure they are fit for purpose. Academics, learned societies and employers need to work together to find ways of providing the training with minimal adverse impact on animal welfare and as appropriate, fewer number of animals. The work of the education and training sub-committee of the Animals Procedures Committee (APC) in its role advising on the requirements for training and education of those who hold responsibilities under the A(SP)A is strongly endorsed. It will be important that work on mapping the stages and means of exposure to *in vivo* work (recommendation 3) draws on the expertise of the training and education sub committee of the APC.

7 Action to tackle the skills supply gap

This chapter sets out a package of 13 recommendations to address the skills shortages and notes key milestones and opportunities within the frameworks governing this area of education, as follows:

- 7.1 Context to the recommendations
- 7.2 Short- and medium-term recommendations
- 7.3 Recommendations to support long-term sustainability of *in vivo* sciences
- 7.4 Important factors to be monitored.

7.1 Context to the action

7.1.1 Chapter 4 indicated that employers are finding it difficult to hire skilled people and that universities are concerned about their long-term capacity to supply the skills[47], despite having already reduced their supply capacity significantly. This report strongly welcomes the IMBI initiative, but suggests a second phase of user-driven action to ensure industry and other employers obtain the skills they need in the short- and medium-term.

7.1.2 This second phase of action will only be a success, however, if employers, academia and research and education funding bodies work together to understand each other's concerns and agree how to overcome them. The focus of action should be targeted at the graduate level problem, but key to tackling this is the need to ensure that there is a healthy long-term skills pipeline at all levels of training. Academics report many hurdles to further action, so it will be important that HEFCE's Advisory Group on Strategically Important and Vulnerable Subjects finds suitable means of protecting those sub-disciplines that provide exposure to *in vivo* work. Support under the SIVS programme of work will help ensure actions recommended in this report are prioritised by providers and other education and research funders so that *in vivo* capacity can be improved.

7.2 Short- and medium-term recommendations

Recommendation 1: Creating a pull for the skills through more effective communication of employer needs

Rationale

7.2.1 Employers have already undertaken much work to help clarify their needs, but more effective communication of employer needs for scientists to work in research careers and acquire *in vivo* skills and expertise in particular is key to:

- encouraging young people to invest time and resources in studying
- encouraging education providers to provide the necessary education and training
- ensuring that those who have the skills are aware of and motivated to apply for positions.

The opportunities/action required

Inspiring the next generation of research scientists

7.2.2 Education providers need to continue to work with employers to convey the opportunities in research careers. Increasing the pool of people interested in research careers will increase the number of people who could be interested in research careers involving *in vivo* work. Improved promotion of general research careers through careers advice needs to start with children in schools. All employers of research scientists have a role in this by creating case studies of the opportunities they can provide.

Tapping into the more economically-minded learners of today

7.2.3 Research careers in industry or academia do not offer the high salaries of some professions, so research scientists are unlikely to be motivated by purely financial gains. However, academics report students interested in research careers are increasingly seeing the costs of university as an investment towards future earnings potential. Students are becoming more economically minded, so further action is needed to promote research careers and the different employment opportunities and benefits on offer. Students need to know how many opportunities are available (so they can assess their chances of using the skills they invest in) and how skills and expertise will improve their employability and earning potential.

Tackling misconceptions around employer demand

7.2.4 Focus groups involving academics, employers and relevant experts uncovered anecdotal evidence of students thinking *in vivo* skills will become obsolete because of advances in molecular biology. This misconception needs to be addressed urgently. Huge advances in molecular biology have been made, but *in vivo* skills are needed, as it is not possible to replicate via in vitro or molecular methods the complex workings of physiological systems.

7.2.5 Employers report that many biosciences graduates seem unaware that senior management positions within research and development facilities often require people who understand the challenges of *in vivo* work. Employers and academics should work together to emphasise that biology graduates need a basic understanding of *in vivo* sciences, if they want to work in biomedical sciences, as they could end up working in units that commission or interpret results of *in vivo* work.

Demonstrating successful deployment of the skills

7.2.6 All universities now collect destination data which aids marketing of courses. It would be helpful if academics were to find ways of capturing data on where graduates with *in vivo* skills go, to develop case studies of the success of those who invested time and resource into learning about *in vivo* techniques. These case studies would form part of improved careers information about the jobs available to those who invest in learning *in vivo* techniques.

Ensuring strategic decision makers in training providers understand demand

7.2.7 Implementation of the above points will help increase student demand for *in vivo* work, which universities as providers should then try to meet. Employers have a role to help clarify their needs (as explained in paragraph 6.3) and where these needs have not been

47 Academics are particulary concerned about supplying skills aquired under Home Office licence

met seek discussions with key decision-makers in universities, just as they would with other suppliers who were not producing products and services to their requirements. This dialogue should help encourage universities to respond more to employer demand, as advocated by the Government.

7.2.8 If this dialogue does not deliver the results, then the Government, with other relevant stakeholders, will need to consider how it can further incentivise universities to respond to employer demand. Recommendation 10 on SIVS provides the means by which delivery of education in Strategically Important and Vulnerable Subjects (SIVS) can be incentivised.

The steps of action needed

Step 1: Providing students with fuller information

7.2.9 Employers to consider what specific detailed information they already provide and how this could be enhanced for particular target audiences. Attention should focus on looking at what key messages are given about work opportunities (numbers of positions, career options and pay), misconceptions around the skills and evidences of success for those with the skills.

Step 2: Using a range of communication vehicles to communicate demand for research careers and in vivo skills in particular

7.2.10 Employers communicate to students and potential job applicants through a number of means, but more direct targeting of undergraduates could help encourage both more students to learn about *in vivo* work and more of those with the skills to use them in employment. Examples of further activities could include:

- more career conventions (ideally like BPS ones in industrial facilities)
- more articles in specialist journals
- better use of relevant websites highlighting PhD opportunities
- more "a day in the life of" talks
- targeting job advertisements directly to course tutors, to share with students.

Step 3: Employers discuss needs with universities not meeting their demand

7.2.11 Employers should try to develop relationships with key universities that they recruit graduates from and support academics in their efforts change/increase learning so that it meets their needs. Where academics report being unsuccessful in gaining extra resources, employers should seek discussions with universities at higher levels. The ABPI should be made aware of successes/failures, to help clarify the extent to which universities are responding to employers' needs.

Cost of no action

7.2.12 The recommendations in this report are unlikely to be effective unless employers more effectively communicate demand for the skills. Particular costs of not acting would be:

- students will continue not to choose units that involve *in vivo* work
- those with the skills will not seek to use them again in future
- universities will have even less incentive to provide staff intensive training at undergraduate level.

Recommendation 1:

1 Employers work with universities, learned societies and career services to communicate demand for graduates with in vivo skills and expertise

Targets:

- By Jan 2008 employers to have analysed and agreed action to improve how they communicate demand for *in vivo* skills
- Academics to begin collecting and sharing specific destination data for graduates with the skills from June 2008
- Updated materials (including references to the revamped ABPI careers website) to be disseminated to careers advisors and others identified as requiring the information by September 2008.

Increasing exposure at undergraduate level

RECOMMENDATION 2: MORE EMPLOYER PLACEMENTS

Rationale

7.2.13 Employer placements provide some of the best means of exposure to modern *in vivo* work, but currently, student demand for *in vivo* placements outstrips supply, the student selection process does not always provide the option of *in vivo* project choice and some students are not given the opportunity to gain the basic skills they need to be effective on a placement. Industry has limited capacity to significantly increase placement provision, as it already provides such opportunities to many students and skills shortages and further industry consolidation could reduce further opportunities. Industry cannot cover the whole of the UK's needs, but individual employers could look at incremental increases to help ensure more students gain *in vivo* experience in the UK, rather than doing so overseas[48].

48 Several academics report students really keen to gain exposure to *in vivo* work are having to take overseas placements as there are insufficient opportunities in the UK.

The opportunities/action required

Employer capacity

7.2.14 Employers report that well-managed placement students can provide valuable contributions to research teams that outweigh the significant costs of paying fair salaries and supervision of training.

7.2.15 Several large pharmaceutical companies and some CROs (most of whom do not currently take placement students) have capacity to offer more *in vivo* placement opportunities. Other employers, such as public research organisations, should be able to do so as well. In all cases such placements depend on the ability to identify skilled staff to supervise the students.

Clarifying the different benefits of placements

7.2.16 A few employers do not realise that much of the value of industrial placements is providing employers with the combined advantages of screening potential employees and addressing research topics that otherwise may not be a priority. A sometimes unrecognised benefit for students is enabling them to gain the prized practical experience they have little exposure to on their BSc course. Academics could explain to employers, such as CROs who are not used to having placement students, what they think good placements can and should offer, and clarify that placements do not need to involve participating in blue skies research. Given that the work undertaken contributes to the student's BSc degree, it is however important that the experience covers the scientific process rather than purely technical procedures; placement students need to be seen as budding scientists.

Clarifying the level of experience placement students should have

7.2.17 An informal framework could be developed between universities and employers to set out what employers expect students to have in terms of general background insight, practical skills and direct exposure to *in vivo* work. This could reassure employers who are concerned about the level of skills undergraduates have upon arrival. Such training (including provision of Home Office module training) would however be a significant additional cost to Universities that many academics feel the standard biomedical HEFCE unit of resource does not incentivise the provision of.

Clarifying whether placements offer in vivo exposure

7.2.18 Some employers could amend their online application forms and promotional material to clarify whether *in vivo* work is included in placements offered. This could increase the take-up of *in vivo* work. Amending forms to show whether *in vivo* work takes place on site, even if *in vivo* placements are not on offer, could help show that *in vivo* skills and knowledge are used by employers.

Enabling students to decide whether they want to do placements providing in vivo exposure

7.2.19 Courses could expose students to more *in vivo* work before they are asked to apply for a placement. Currently most students are asked to apply at the end of their first year of study before they have considered what *in vivo* work involves. This is thought to reduce the probability of students choosing placements with *in vivo* work. As it is unlikely that employer timescales for placements (which are the same for all disciplines) will be amended, it would be helpful if first year undergraduate courses could provide some exposure. The mapping work proposed in recommendation 3 should consider what exposure, in addition to visits to animal units, could be provided. Hands-on exposure is not likely to be appropriate.

Student costs

7.2.20 Academics raised the concern that the cost students incur on placements sometimes discourages placement take up. From September 2007 universities will no longer have to charge half fees for students on placements, so universities could, in theory, decide to waive fees for placement take up. Enabling students to gain significant exposure to *in vivo* work (which employers and potential PhD supervisors want) this way would avoid universities having to finance a final year *in vivo* project, so providing a cost-effective way of universities exposing students to *in vivo* work[49]. However, academics are sceptical whether universities would agree to such special arrangements for this small group of placement students.

Filling the skills gap

7.2.21 Placements provide an excellent means of linking skilled students to employers. The University of Surrey estimates that overall 40% of its students return to their placement employer after graduation. For industrial employers the figure is 80%.

An ambitious drive to encourage more placements

7.2.22 The success of the placements depends on the willingness of employers, universities and students deciding to invest in them. The Government could decide to proactively promote placement activity in this strategically important and vulnerable area, by developing a scheme similar to that run by the Singaporean Economic Development Board (EBD). This scheme is focused on a number of skills areas and funds Singaporean students to work in companies locally or overseas for 12-18 months to upgrade their skills or capabilities. Upon completion of training, the employer has first right to employ trainees, subject to approval and payment of 30% of the training costs to the EDB. GSK has employed 58 Singaporean students (25 of them in the UK) through this programme since 2001. If the 50% increase in placements proposed in recommendation 2 below is not achieved, the Government should consider the scope for similar interventions.

49 Data on the cost of administering an industrial placement was not collected but it is assumed this is lower than the cost of a final year *in vivo* project.

The steps of action needed

Step 1: Clarifying skills and experience needed

- Academics to consider what exposure they can realistically provide to first-year students to enable them to decide on and then take up a placement.

Step 2: Identifying the new opportunities

- Employers and academics to discuss new capacity and agree how to screen students to ensure they are genuinely interested in *in vivo* work (some employers are concerned that students deeply opposed to animal work could try to disrupt research).

Cost of no action

- Not increasing the number of places could mean that the most effective way of helping employers fill their skills shortages is not utilised. Employers could miss out on good value work and on potential employees; students could miss out on excellent experience and job opportunities; and universities could miss out on better collaboration with employers.

Recommendation 2:

2.1 Employers to work with academics to increase the overall number of employer placements that involve in vivo work by at least 50% by 2010

Targets:

- 15 more *in vivo* employer placements to start in September 2009
- Another 15 more to start in September 2010.

RECOMMENDATION 3: CLARIFYING WHAT IS MEANT BY *IN VIVO* EXPOSURE AND MAPPING THE STAGES AND MEANS OF LEARNING

Rationale

7.2.23 In order to ensure that employers have access to the skills they need, it is important they and skills providers (universities) are clear on the competencies required, and at what level they should be acquired. Currently, there are inconsistencies between employer expectations and academic provision. The only way to overcome this is through action to articulate needs and balance them against limitations over provision. Clarification of the requirements and limitations would then enable funding councils and universities to ensure they can and will provide the recommended education and training.

The opportunities/action required

7.2.24 Academics and the learned societies are aware of the different expectations employers and academics have in this area, and think there is an opportunity to agree definitions of what *in vivo* skills are and when these should be introduced in education and training. Such interactions over the content of undergraduate curricula are mandatory in most professional areas, but can be equally valuable in a more informal setting, e.g. learned societies working with universities. An informal partnership approach to clarifying when and how these sensitive skills are required could provide an opportunity to clarify:

- What type of practical work requiring Home Office personal licences employers value most and at what point in education they should be taught
- The range of modern teaching techniques that can be used to help expose students to *in vivo* work that do not involve the holding of a Home Office personal licence
- How learning about animal welfare, excellent experimental design, understanding of ethical issues around use of animals and the benefits of the 3Rs can be further main streamed into courses to ensure continued improvements in these areas[50]
- How much exposure and type of exposure general biologists need to help them appreciate why *in vivo* work is still essential in biological science
- How to provide students with enough exposure to *in vivo* work to enable them to decide whether they would like to do *in vivo* work in an employer placement
- Whether and when academics should be recommending students participate in summer *in vivo* projects or attend the BPS/The Physiological Society summer schools which provide exposure to *in vivo* work
- Whether those universities that do not have animal units should be asked to pay for a selection of their students to attend BPS/The Physiology Society summer courses (cost is £2,000 per place)
- How much *in vivo* exposure is needed by future research scientists who end up commissioning, interpreting or regulating *in vivo* studies
- Options for providing and funding the teaching received under modules 1-4 of the Home Office licences (plus experimental design)
- How much exposure is needed to allow students the opportunity to (fully) consider whether they would want to enrol for an MSc or PhD
- Who can or should teach or supervise the learning that is recommended
- How this extra training can be funded and the role and responsibilities of funding councils in this.

50 The University of Newcastle, the new Veterinary school in Nottingham and University of Leeds are some of the institutions with a range of experience teaching about the ethical issues around the use of animals in science, the roles of scientists and veterinarians in maintaining excellent animal welfare and the provision of excellent learning that does not involve the holding of Home Office licences.

Continued improvement to animal welfare and reducing, replacing and refining the use of animals

7.2.25 Throughout the work programme looking at BSc level learning, there will be opportunities to share teaching practice and consider how the skills and teaching objectives could be delivered without compromising animal welfare and, if carefully handled, indeed enhancing it. The education and training group of the Animal Scientific Procedures Committee and welfare groups could be invited to participate in the discussions. The examples of best practice should be shared widely and acted upon by those providing training.

The steps of action needed

Step 1: Convening the experts and agreeing a work plan

- The Biosciences Federation should identify a group of relevant experts who between them have detailed knowledge of employers' needs, the challenges of providing *in vivo* education and training, learners' preferences, regulatory matters and the latest advice on animal welfare, ethical issues, experimental design and the 3Rs. The group should draw both on the experience of the BPS and the Physiological Society, who run *in vivo* summer schools, and on representatives from institutions who received IMBI capacity-building grants. The group should invite the AIMS (Applied and Integrated Medical Sciences) Centre for Excellence in Teaching and Learning at Bristol University and the Higher Education Academy Subject Centre for Bioscience, based at Leeds University, to advise on best teaching practice and on how to disseminate the findings.

Step 2: Helping universities implement the recommendations

- The Biosciences Federation and employers should discuss the suggested learning enhancements with universities so as to identify the realistic costs of supplying them, in terms of both direct costs (e.g. paying for Home Office licence training, final year BSc projects) and the indirect costs in academic staff time (eg close student supervision of *in vivo* projects, processing of licence applications). Options for achieving the required funding need to be identified.

Step 3: Monitoring of implementation

- The Biosciences Federation and ABPI (through discussions with their members) and SEMTA should monitor implementation of the agreed learning to help clarify if universities are responding more to employer demand for improving undergraduate learning.

Cost of no action

Without this dialogue, there will continue to be a piecemeal approach to:

- Ensuring undergraduate courses meet employer needs for *in vivo* training
- Demonstrating the value of specialist and perhaps more expensive ways of practical teaching
- Sharing best practice on teaching methods that do not require personal licences
- The significant benefits offered through increased opportunities for employer placements would not be realised, as employers will not be clear on what experience students should have, and students will not have had enough *in vivo* exposure to decide whether they would like to do a placement with *in vivo* elements.

Recommendation 3:

3 The Bioscience Federation should lead discussions between university departments providing undergraduate courses in the relevant disciplines, the learned societies (e.g. The Physiology Society and the BPS) and employers to set out the type and means of exposure to in vivo work that should occur at each stage of education. Universities should then support the learning recommended, as far as reasonably possible, subject to resource and regulatory constraints

Targets:

- Guidelines on requirements and stages of undergraduate *in vivo* learning, and costs that would be incurred, to be published by May 2008
- Modifications of undertgraduate courses which do not have prohibitive cost implications to start being implemented from September 2008
- Progress on achieving new funding and thereby full implementation of the recommended undergraduate experience to be reviewed in May 2010.

RECOMMENDATION 4: BPS/PHYSIOLOGICAL SOCIETY SPONSORED SUMMER SCHOOLS

Rationale

7.2.26 The BPS/The Physiological Society summer schools provide important, cost-effective exposure to *in vivo* work to students whose universities are unable to provide such exposure. Funding continues to remain uncertain, despite student feedback on the courses being excellent and demand outstripping supply.

Opportunities/action required

Harnessing more funding

7.2.27 The courses have been funded by industry, the BBSRC and Wellcome Trust, but the BPS and The Physiological Society have found it difficult to maintain funding for these schools. The societies should continue to work with these and other funders, such as HEFCE, to try to ensure these highly valuable courses continue.

Increasing capacity

7.2.28 Current capacity for the three courses is for up to 40 places per annum, but demand for places outstrips supply. The course managers could consider opportunities for increasing capacity if there were more funding available. If significant funding were available, then perhaps other summer courses could be set up at different centres.

The steps of action required

Step 1: Harnessing funding

- The BPS and The Physiological Society to continue discussing funding needs with potential funders.

Step 2: Link the summer schools to wider action to improve in vivo capacity

- Data on course satisfaction, funding situation and potential for increased capacity should be prepared for discussion alongside the mid-term review of the IMBI, as part of wider discussions about long-term sustainability issues relating to the supply of *in vivo* skills.

Cost of no action

- Closure or decreased capacity would remove from many undergraduates their only opportunity to participate in non-theory based *in vivo* work
- Further reduction to the pool of undergraduates capable of objectively considering careers involving *in vivo* techniques
- End of a highly successful scheme that delivered well-received training at a relatively low cost (course places cost about £2,000 per student).

Recommendation 4:

4.1 Industry and other funders of in vivo work should continue supporting BPS/ Physiological Society in vivo summer courses and if appropriate, increase funding to increase capacity of the courses.

Targets:

- BPS/The Physiological Society summer courses to maintain existing capacity until 2009/10, when summer courses funding and capacity should be reviewed alongside the mid-term review of the IMBI.

RECOMMENDATION 5: INCREASING OPPORTUNITIES FOR GRADUATE EXPOSURE TO IN VIVO WORK THROUGH MSC/MRES COURSES

Rationale

7.2.29 Most students can gain significant in-depth experience in any given subject through final year projects and/or employer placements. Many subject areas, ranging from economics through to teacher training, also encourage or require specialisation through graduate level training. Unlike most physical science degrees, biomedical degrees (including physiology, pharmacology and other subjects which are likely to contain *in vivo* work), tend to be mostly three-year rather than four-year degrees. The challenges of providing hands-on *in vivo* exposure within three year undergraduate programmes and of directing it to those likely to need the skills in future, makes a strong case for targeting the major emphasis and resources for hands-on training at postgraduate level.

Opportunities/action required

More employer collaboration

7.2.30 Employers are already working closely with several universities, such as Birmingham, Liverpool, Surrey, King's College London and Oxford, which provide one year masters level courses with some *in vivo* exposure. Several employers are keen to see more such courses because graduates from these courses are more committed to *in vivo* work and have received more exposure than students completing three years BSc courses.

Potential provision by universities

7.2.31 There are a limited number of one-year taught MSc courses that involve *in vivo* work, but academics report potential to expand the number of course places or even refocus existing courses to include exposure *in vivo* to work, if funding were available to make such courses attractive to UK applicants. Several universtities have expressed interest in establishing such extra course provison.

New industrially-focused courses

7.2.32 Employers could work with universities to help tailor existing or new course content, so that it has a stronger industrial focus. Some courses could allow students to spend significant amounts of time in industry (preferably students would spend up to four months with employers[51]), but where this is not possible, familiarisation visits and contact with employers could be provided.

51 It is not clear what capacity other employers have but this should be investigated further.

Review of course emphasis

7.2.33 The courses could be reviewed to ensure appropriate emphasis on the benefits of experimental design, ethical issues around animal use in science, excellent animal welfare and a 3Rs approach to research involving the use of animals, which employers think there is demand for. Best practice in these areas, to be gathered through mapping work (recommendation 3), could be drawn on to give the courses a focus that is suited to modern employment requirements.

Consideration of teaching capacity

7.2.34 Although several universities have expressed interest in running the courses, careful consideration will need to be given to how scarce resources will be used to help provide the training. Academics will need to look at how they can draw on the opportunities outlined in recommendation 9 on teaching capacity. Academics also need to think about whether they can encourage applicants from within the EU, over non-EU applicants, as academics find EU applicants are more likely to deploy the skills they have acquired in the UK after graduation.

Financial sustainablity

7.2.35 An added advantage of targeting resources at MSc courses would be the potential to recruit full fee-paying international students. This might increase financial sustainability, but would be subject to capacity constraints, both of the academic staff time required to supervise practical training and of employers to provide placements. Industry could also promote sustainability if companies partnered CASE PhD studentships with the research staff providing the MSc courses. Some international students might enter UK industry, which would be a further advantage.

Improving the pool of graduates available to undertake PhDs with in vivo content

7.2.36 Several universities report difficulties attracting UK applicants with sufficient *in vivo* experience and insight to undertake *in vivo* PhDs. While the masters courses would primarily be designed to prepare graduates for jobs in industry, they would also provide an excellent grounding for graduates who decide to take up PhDs instead (particularly important for three-year as opposed to the less usual four-year PhD programmes).

Increased UK in vivo capacity through linking PhDs to MSc places

7.2.37 Linking a CASE PhD to every three MSc places would improve the attractiveness of the MScs both to potential UK applicants and to the academics whose time is required to train and supervise the MSc students.

Further targeting of the use of animals

7.2.38 Encouraging more *in vivo* MSc places could further focus the training of skills, and therefore the use of animals on the subset of graduates most committed to *in vivo* careers, thereby improving the likelihood of the animals used being limited to trainees who will use the skills in future.

The steps of action required

Step 1: The funding package

- To help universities provide the places and attract high quality UK applicants, each MSc/MRes place should be accompanied by a bursary for the student and adequate support to cover the high costs of supervision, training and consumables involved. Up to £25,000 per place would cover all the costs. Industry and existing MSc funders should discuss how to fund the places and ensure that a significant proportion of the funding would be directed to the department running the courses so as to address their direct and indirect (salary) costs.

Step 2: Course content and providers

- Universities with capacity for *in vivo* MSc/MRes places should discuss with employers and learned societies: course content; opportunities for short four-month employer placements; and how the increased number of CASE PhDs proposed in recommendation 5, could most effectively be linked to the MScs.

Step 3: Competition for MSc funding

- MSc funders will need to consider options for holding an appropriate competition for the MSc places. To make a substantial step towards solving industry recruitment problems up to 36 places, to be shared between 4-6 universities, will be needed.

Step 4: Consideration of long-term sustainability

- Successful bidders for the Master level places to discuss with MSc funders a sliding scale[52] of support needed to make the courses sustainable after the initially fully funded three years. Funding and research councils to consider how they fit this into a long-term strategy for SIVS.

Cost of no action

- Many graduates would continue to have no opportunity to gain significant hands-on exposure to *in vivo* work under Home Office licences, even if they planned to use the skills and knowledge in future
- Employers would not be able to recruit graduates with significant *in vivo* expertise from these courses
- Universities would continue to have difficulty in recruiting PhD students with appropriate insight into and training of *in vivo* skills

52 Smaller units of resource should be required as international students contribute higher fees and UK students begin to pay fees for the courses. However, it is likely that the courses will always need some subsidy, as it is unlikely UK students will pay costs that cover the FEC of the course despite the course directly improving their employment prospects. Oxford University has found it difficult to attract UK applicants to its *in vivo* MSc course with fees that cover the FEC of the course.

- Universities would not gain new resource that they need to help increase their *in vivo* training capacity be that through more demonstrations or Home Office license training at undergraduate, MSc and PhD levels.

Recommendation 5:

5.1 Develop a small number of programmes at a taught Masters level (one year) that are focused upon in vivo skills. 36 studentships should be provided in each of the next three years to make a substantial step towards solving industry recruitment problems

Targets:

- 36 new course places with *in vivo* content to be in place by September 2009.

RECOMMENDATION 6: INCREASING PHD LEVEL EXPOSURE

Rationale

7.2.39 This report does not recommend significant increases in the number of PhDs involving *in vivo* work, but it strongly supports continued focus on prioritising *in vivo* research at this level. This is needed to help rebuild capacity and provide the skilled post doctoral scientists that employers in both industry and academia are finding difficult to recruit. The rationale for supporting 3Rs PhDs is made in (7.2.43).

Opportunities/action required

CASE PhDs

7.2.40 Research Council PhD funding, allocated directly to industry under the CASE studentship scheme, provides industry with the opportunity to create a demand-led approach both to the allocation of PhDs and to the level of *in vivo* content of the projects.

7.2.41 Research councils and some other funders also provide universities with flexible training accounts. However, the focus for many universities is on maximising the number of studentships, rather than the funding for lower numbers of more expensive specialised studentship projects. Industry could, at limited cost, incentivise universities to use some of this funding to support *in vivo* PhD projects. Industry could also promote the viability of the proposed MSc programmes that involve *in vivo* work (as per recommendation 5) by organising CASE PhD studentships with the relevant university departments.

PhDs

7.2.42 In addition to increasing the number of CASE PhDs that involve *in vivo* work, it is important that there continue to be opportunities for academics and universities to carry out fundamental *in vivo* research independently of industry. Research councils should continue to encourage the supply and take up of PhDs that involve modern *in vivo* skill (ideally through ring-fencing or other means, including the re-introduction of schemes that have been dropped (e.g. BBSRCs). Continued promotion of *in vivo* PhDs will increase *in vivo* capacity, will help academics drive forward new research, and will help to promote the next generation of academic staff able to provide *in vivo* training.

PhDs with a 3Rs focus

7.2.43 The development, promotion and implementation of the 3Rs is considered to be of major importance to future research developments. Discussions about the 3Rs during this project highlighted a need not only for learning about the 3Rs to be mainstreamed into biomedical courses that cover translational science, but also for more 3Rs research to be undertaken. There is an opportunity for the NC3Rs and other research funders to support collaborative PhD studentships that relate to the 3Rs. This could help develop not only new 3Rs research output but also a new generation of scientists who have a deep understanding of strategies for promoting alternatives and technical enhancements that advance the 3Rs.

PhDs that encourage time in industry

7.2.44 Even for non-CASE studentships, particularly in four year PhD programmes, up to one year of the training programme could profitably be spent with a relevant commercial employer, to help expose students to different ways of working and life outside academia. As indicated elsewhere, this would also significantly increase the likelihood of the PhD student returning to the employer after graduation.

The steps of action needed

Step1: Considering scope for employer/academia collaboration

- Employers should consider how many more *in vivo* CASE PhDs they could support and discuss this with academics they could partner with.

Step 2: Work with PhD funders

- Employers and academia should work with PhD funders to ensure new calls for PhDs prioritise bids that include *in vivo* techniques.

Step 3: Linking PhDs to new MScs

- Employers and CASE funders should discuss how to link PhDs with the providers who are keen to expand/develop MSc places with *in vivo* content. Linking CASE PhDs is an important way of incentivising academics to set up the new courses.

Cost of no action

- A failure to continue prioritising *in vivo* PhDs will undermine progress made in boosting UK *in vivo*-capacity by halting the flow of experienced PhDs being produced

- A failure to link PhDs to MScs will seriously reduce both the attractiveness of the MSc places to students and the incentive for providers to offer them
- A failure to support 3Rs PhDs will not promote progress with the 3Rs.

Recommendation 6:

6.1 Research Councils and industry should increase the number of CASE PhD awards that use modern in vivo techniques. Industry should work with academics to link additional CASE studentships to the MSc programmes proposed in recommendation 5

6.2 Research Councils should also continue to encourage (ideally through ring-fencing but if not ring-fencing then other means) the take up of non-CASE PhDs that involve modern in vivo techniques

6.3 NC3Rs, industry and research funders should consider providing additional funding for PhD studentships to promote research that directly supports the 3Rs

Targets:

- Additional CASE awards with *in vivo* content to start by 2009
- Research councils to have found means of continuing to promote PhDs with *in vivo* content with calls for bids for PhDs starting in 2008 onwards
- New 3Rs PhDs to start by September 2009.

Recommendation 7: INCREASING CAPACITY OF TOXICOLOGY INVOLVING IN VIVO TECHNIQUES

Rationale

7.2.45 *In vivo* work spans several sub-disciplines, but academics and industry think toxicology is particularly vulnerable. Increased demand for experienced toxicologists makes action to address this vulnerability urgent.

Opportunities/action required

Undergraduate employer placements

7.2.46 A number of the employer placements to be introduced from recommendation 2 should be in CROs. Part of the training on these placements should expose students to the vital role of toxicologists in drug discovery.

MSc level training

7.2.47 The number of the new MSc course places from recommendation 5 could be made available for toxicology places that include *in vivo* work. The BBSRC already supports a number of such places, but encouraging bids for some of the new MSc places to have a toxicology focus could further boost toxicology capacity.

MRC training programme

7.2.48 The MRC's toxicology unit at Leicester is taking forward a new national toxicology/drug safety training programme. The £2.25million of MRC funding for the programme could be matched by other funders to enhance the programme's capacity to meet UK needs. The training programme could also be structured to include one-year training placements with industrial employers. The steering committee driving the overall programme could also have industrial representation.

British Toxicological Society work

7.2.49 Toxicologists, through the British Toxicological Society (BTS), have been starting to consider UK toxicology capacity in terms of its strengths, opportunities for growth, teaching capacity and success in accessing funding. The BTS is reviewing what funding is available from the Research Councils and industry, and how they can maximise the funding to enhance UK toxicology. One of the key aims of the work is to consider how academia meets the needs of industry through training and research. This bottom-up approach has been widely welcomed. A key strand of any strategy the BTS produces could focus on revamping the image of toxicology, which is currently considered to be a weakness.

The steps of action needed

Step1: Linking toxicologists into the discussions over in vivo MSc places

- Toxicology departments should participate in discussions about content of MSc courses to be supported.

Step 2: Leveraging support of multiple funders for new toxicology programme

- The MRC should invite other research and higher education funders to discuss how they could help add to the capacity of the toxicology training programme.

Step3: Linking up BTS and other plans

- The BTS should continue to discuss its work plan with the MRC and other funders to deliver the biggest impact.

Cost of no action

- Not supporting toxicology through more MScs and PhDs will mean toxicology does not get the boost that it requires to meet the current deficit being experienced by employers.

Recommendation 7:

7.1 Employers of toxicologists and research funders should work together to support the Medical Research Council's proposed toxicology/drug safety training programme so that it has capacity to meet the needs of more toxicology users

7.2 The British Toxicological Society should continue its work to with Government funding agencies and employers to ensure the UK has a joined-up approach to maintaining its world-class toxicology expertise and, in particular, consider how to revamp the image of toxicology

Targets:

- Industrial representative to be included on new toxicology programme board by November 2007
- New toxicology programme's capacity to be reviewed in September 2009 against all toxicology users' needs
- British Toxicological Society to have decided on need for a strategy for toxicology by May 2008.

Recommendation 8: SUPPLY AND TRAINING OF ANIMAL TECHNOLOGISTS

Rationale

7.2.50 A critical part of UK *in vivo* capacity is the supply of skilled animal technologists. The IAT and Lantra (the Sector Skills Council responsible for animal technology) have made considerable progress to overcome employer concerns about inadequate quantity and quality of training, but there is much work needed to:

- increase the pool of individuals interested in animal technology roles
- find colleges to help provide appropriate training
- find a mechanism for sharing training costs better between providers and customers
- improve retention of trained staff through better HR strategies and employment packages
- improve technologist status.

Opportunities/action required

The IAT as an awarding body

7.2.51 A positive development in June 2007 was the IAT receiving Awarding Body status from the Quality and Curriculum Authority (QCA). This has paved the way for IAT courses and qualifications to become part of the national curriculum framework, and for IAT to work with Lantra and the Learning and Skills Council (LSC) to secure funding for animal technologist training. IAT training will also be considered during Lantra's work with employers to develop a sector qualification strategy for animal technology.

Better understanding of perceptions of animal technology/more interest in animal technology roles

7.2.52 To help improve interest in animal technology, Lantra has undertaken a survey to understand perceptions of animal technology work in land-based colleges[53]. The results of the survey will be used to help plan better engagement with colleges with the aims of raising both student and lecturer interest and understanding of animal technology work, and of increasing the pool of people likely to apply for animal technology roles.

Network of regional providers to deliver animal technology training

7.2.53 Lantra has agreed to help establish a forum for providers to discuss training needs with animal technology employers. The forum could be used to develop a network of training providers across the UK, ideally with a centre of expertise in each region. Given the nature of students on such courses, course provision generally needs to within commuting distance of employers. The centres of expertise could help share information about animal technology work, and help bring together providers within each region to whom employers can direct information about vacancies, and provide opportunities for work experience placements for students and site visits.

7.2.54 Key to making the network a success will be employers identifying local providers with whom they wish to work and thinking further about what type of training they would like to be delivered. The IAT has offered to look how it could provide further modules[54] to meet employer needs, but some employers may find they need to ask other providers for bespoke training. These developments will need more course providers to opt to become involved with the delivery of animal technology training provision.

Funding to support training

7.2.55 Currently employers meet all of the costs of animal technology training but there could be opportunities for employers to access public funding to support the provision of training. Employers need to discuss their needs with Lantra and the Learning and Skills Council at a regional level, to see what support could be provided. Financial support could be important where small numbers of employees make provision of training expensive per capita. Lantra will also approach the national LSC to discuss regional priorities and guidance on the funding available for animal technology.

53 Land based colleges tend to offer animal management and animal welfare courses which provide basic training for potential animal technologists. There is scope for these courses to include insight into the scientific and technological information required by animal technologists, and also how animals are used for scientific purposes in science.

54 The ABPI is working with the IAT to ensure IAT course content is up to date, appropriate prior learning is recognised (so that it counts towards IAT qualifications) and the courses are structured so new modules can be developed for staff who wish to specialise in different areas.

New EU labour market

7.2.56 A potential group of employees that has yet to be fully utilised are those from the new EU accession countries. Polish immigrants have helped several employers fill gaps, but there is probably more scope for harnessing these potential employees. Once Lantra and relevant animal technology stakeholders have succeeded in delivering the animal technology action plan and action recommended in this report, the sector could consider how to maximise international labour sources for animal technology roles. However, an uncertainty over this approach is the duration of employment. Employers need to ensure they do not become overly reliant on employees who are likely to return to their home country after completion of their training in the UK.

The steps of action needed

Step1: Agreeing how to develop further training capacity

- Lantra to: convene or follow up meetings with employers and providers to consider the results of the survey of perceptions of animal technology roles; set up a providers' forum; consider with employers the requirements for further training; and discuss action required with local Learning and Skills Councils to understand the scope for funding.

Step 2: Driving forward action

- Once a national network of regional providers has been identified, these provides can drive forward action in terms of promoting careers, delivering training and accessing funding.

Step 3: Updating the animal technology action plan

- Lantra should update the action plan for animal technology and consider how to incorporate the recommended work set out in this report into the action plan for animal technology.

Cost of no action

- Poor perceptions of animal technology careers will not be tackled and many employers will continue to suffer from a lack of applicants for animal technology roles
- Employers will continue to be raising level 2 skill standards for employees without any contribution from the public sector – this is contrary to the sharing of costs advocated by the Government
- There will continue to be a lack of training in animal technology that will continue to be a barrier to improved employer productivity.

Recommendation 8:

Lantra through the action plan for animal technology with the support of animal technology employers, training providers and IAT should continue to set out action to:

- help employers communicate demand for animal technology roles
- improve knowledge and understanding of animal technology and related careers
- set up an animal technology training providers' forum and support development of a national network of providers to deliver training that meets their needs
- help employers leverage funding to help support animal technology training that is likely to have a low student/teacher ratio
- maximise the potential of the EU labour market.

Targets:

- Lantra to set up an animal technology providers' forum by December 2007
- The action plan for animal technology to include all agreed work strands by March 2008, specifically with plans to raise interest in animal technology work and develop a network of regional providers.
- Lantra to have clarified options for harnessing new public funding to support expensive training by June 2008
- Regional providers to start delivering new training by September 2008.

Recommendation 9: MAINTAINING SUFFICIENT CAPACITY IN ACADEMIA FOR RESEARCH, TEACHING AND ADVANCED TRAINING

Rationale

7.2.57 Research for this report found that 15% of permanent *in vivo* teaching staff are due to retire in the next five years, and a further 5% in the five years following. This has the potential for a serious adverse impact on the capacity for both research and training in academia, particularly if current industry needs are met, at least in part, by recruitment from the academic sector. Universities promote world-class fundamental research into the integrative biomedical sciences that depend on animal use. The associated experienced academic researchers supervise not only *in vivo* research and undergraduate teaching, but also the supply of the next generation of trainers. Universities are responsible for managing their own recruitment, but there are opportunities to increase

teaching and advanced training capacity. If the opportunities do not deliver the training required, then academic fellowship schemes will need to be considered.

Opportunities/action required

Harnessing industry capacity

7.2.58 One opportunity to help teaching and advanced training capacity is for industrial and other employers to work with academia to develop mechanisms by which interchange programmes could occur more readily and easily. This is already happening to some extent, but employers think there may be scope for enhancing this. Employers find their staff value the opportunity to work with academics in educational settings. Industry needs to facilitate this, but a framework could be put in place with research councils, HEFCE and universities to incentivise a significant step change in such provision.

CPD for biomedical lecturers in in vivo techniques

7.2.59 An option that could be considered alongside the mid-term review of the IMBI is the scope for universities to consider investing in CPD of academics not previously trained in *in vivo* skills (such as *in vitro* physiologists or pharmacologists) to help supervise *in vivo* work at undergraduate level. Non *in vivo* specialists' appetite for this, and the actual means of delivering the CPD over several years, is not clear, but it could be worth investigating to help ease teaching capacity shortages. It would have the spin-off of helping align *in vivo* work more closely with modern genomic, molecular and cellular techniques in the eyes of the non-*in vivo* biomedical science community.

Targeting the next generation of trainers

7.2.60 Some researchers return from America, Canada and other countries having gained advance *in vivo* skills. They can and should continue to be captured through mechanisms such as the Academic Fellowships scheme. At the early career stage there are some 170 PhDs completing *in vivo* research each year who could, in theory, progress towards the skilled senior academic status that is currently in progressively shorter supply.

7.2.61 HR departments in universities need to consider how they can improve adverts for new positions so they attract these graduates who could be nurtured to help satisfy an expected shortage in teaching staff. Some universities may find they need to increase salaries, as anecdotal evidence suggests this has helped some universities attract experienced staff. More and better innovative HR practices, such as marketing the new posts as aligned with building strategic partnerships with industry, could also help.

Transferring in vivo expertise

7.2.62 One of the measures used under the programme of work to protect SIVS has been provision of support to help relocate academics from centres that have closed. The flurry of *in vivo* unit closures over the past 10 years seems to have halted, but the *in vivo* community should be prepared to act if closures are threatened. Awareness of centres seeking more teachers and openness about possible difficulties for *in vivo* units would help the community respond to closures and allow valuable skills in academia to be redirected. The addition of the sub-disciplines that include *in vivo* work to the list of SIVS would encourage universities to give early notice of closures and potentially open up support to relocate academics.

Challenging universities to ensure they have stable and secure in vivo units

7.2.63 Academics have also questioned whether the Research Assessment Exercise (RAE), adequately promotes high quality training. Many think there are opportunities for the new metrics-based system that is due to replace the RAE to help rebalance the focus between teaching and research, so that teaching becomes as prestigious as research. A number of metrics are under consideration, but it seems highly unlikely these will deliver such a dramatic shift in emphasis as to favour teaching and training in high cost areas which rely on *in vivo* techniques.

7.2.64 As the RAE is unlikely to incentivise teaching in any significant way (or single out research that has used *in vivo* techniques) universities will need to consider the importance of high quality teaching and research that involves *in vivo* techniques to their business. Universities need to recognise that the slow rate of progress with *in vivo* work and the staff-intensive nature of *in vivo* work research (compared with many semi-automated *in vitro* approaches) does not match well with the RAE system, but the significant income generated through teaching and research related to *in vivo* work means its in their interest to ensure they have sufficient levels of academic capacity. Continued concerns about succession plans not being in place for key academics is concerning employers who collaborate with the academics and uncertainty about staffing ultimately risks undermining research funders confidence in universities reliability as partners. Universities should adopt best practice in HR practices, especially around succession plans for key staff.

Learning from RCUK fellowships and IMBI appointments

7.2.65 The mid-term review of the IMBI in 2009/10 would provide useful information on the success universities have had recruiting, maintaining and promoting research and training capacity under the IMBI. Lessons learnt should be shared with other universities.

7.2.66 If the IMBI mid-term review finds that research and training capacity has not improved sufficiently, and universities are either not prioritising or succeeding in recruiting high class experienced *in vivo* staff, then the scope for further "Roberts" style targeted

academic fellowships[55] to further build *in vivo* capacity should be pursued.

The steps of action needed

Step1: Assessing the need/options for incentivising teaching

- Academics seeking teaching assistance should discuss their needs with relevant learned societies through the Biosciences Federation to begin discussions with the ABPI about how to gain further teaching support from employers. Discussions should take place with education and research funders about how such employer teaching support can be incentivised.

Step 2: Capturing evidence of difficulties in recruiting and retaining experienced staff

- Academics should collect and share information about their experience of recruiting and retaining *in vivo* staff at all levels, and the implications of that experience for academic research, undergraduate teaching and advanced training. Such information could be collated by the Bioscience Federation and submitted to the mid-term review of the IMBI, and, if appropriate, to the SIVS Advisory Group.

Step 3: Sharing concerns about academic succession plans

- Employers should raise concerns about a lack of succession plans for key academic positions both with the universities concerned and, via the ABPI, the IMBI steering group, and if appropriate, the SIVS Advisory Group. The outcomes of these discussions should be collected by the ABPI and the Biosciences Federation to help consider whether a case should be built for a new round of new blood fellowships.

Cost of no action

- Potential teaching and advanced training support from employers will not be harnessed.
- The case for further recruitment drives (such as RCUK fellowships) or other teaching support will not be based on a sound evidence base.
- The case for enhanced financial input to support *in vivo* science and promote sustainability will not gain the strong evidence base that would be needed to persuade relevant education and research funders that action was needed.

Recommendation 9:

9.1 Industry, academia and other stakeholders should explore mechanisms by which interchange programmes could occur more readily and easily to increase the pool of individuals who can mutually support research, undergraduate teaching and advance training involving in vivo skills

9.2 Industry and academia should collaborate in collating evidence of staffing problems for potential submission to the mid-term review of the IMBI, and if appropriate, the SIVS Advisory Group

Targets:

- By June 2008 options and timescale for greater employer support for teaching and incentivision of interchange between employers and universities to be agreed with relevant research and education funders
- The Biosciences Federation to work with the steering committee of the IMBI to complete analysis of recruitment of *in vivo* trainers and produce recommendations to ensure there are enough *in vivo* trainers by 2010.

7.3 Recommendations to support long-term sustainability of *in vivo* sciences

Recommendation 10: ROLE FOR HEFCE'S STRATEGICALLY IMPORTANT AND VULNERABLE SUBJECTS (SIVS) ADVISORY GROUP

Rationale

7.3.1 Since 2004 HEFCE has been taking forward a programme of work to protect those higher education subjects or courses deemed to be of national strategic importance. This report welcomes the £4million contributed under the SIVS programme towards the IMBI, and the inclusion of science as a broad SIVS area. More specifically, academics and employers both believe that particular action is needed in relation to pharmacology, physiology, toxicology and pathology because of the significant reduction in the practical content in these courses – and the reduction of *in vivo* content in particular. Further provision of those areas of quality practical learning that employers value most, is particularly vulnerable in that:

- Toxicology and pathology are taught in only a few centres across the UK. A closure of any centre would severely reduce the already limited supply of

55 Sir Gareth Roberts Review "Set for Success" recommended fellowships that offer a fast-track route to full academic appointments for outstanding researchers in the early stages of their career. The fellowship models offer opportunities for those with excellent research records to develop their research careers and gradually engage in teaching, project management and outreach activities. They have in recent years been used successfully by some universities to recruit promising staff skilled at *in vivo* techniques.

skilled pathologists and toxicologists;

- Significant numbers of academics with advanced *in vivo* skills have either retired in recent years or are due to retire within the next few years – but universities have been struggling for various reasons to find and fund adequately trained replacements; and
- All universities providing *in vivo* learning that requires students to hold Home Office personal licences report being dependent on financial support from external sources to meet the high costs of *in vivo* work. If this support discontinued academics believe the HEFCE unit of resource would not incentivise universities to provide a selection of undergraduates with sufficient exposure to *in vivo* techniques for them to be able to decide objectively whether they would want to pursue careers involving *in vivo* work. Any further reduction in the recruitment of *in vivo* trained graduates would seriously undermine UK competitiveness in biomedical science.

7.3.2 In light of the vulnerability in this area, and the current mismatch between supply and demand for *in vivo* skills, the sub-disciplines should be specifically recognised as SIVS and the SIVS Advisory Group could consider appropriate means of protecting the provision of scientific training involving *in vivo* techniques.

Opportunities/action required

Adding the sub-disciplines to the list of SIVS

Course vulnerability

7.3.3 In order for the subjects to be deemed SIVS, HEFCE's advisory group will need to consider the subjects as vulnerable and of strategic importance to the UK. In reaching a judgment on whether the subjects are vulnerable, the advisory group should consider the consistent view of academics administering relevant courses, to hear how pressures to reduce expensive *in vivo* training are reducing their ability to provide the practical education and training that employers particularly value (mainly Home Office license training and related learning). The impact of financial initiatives such as TRAC(T) must not be permitted to further threaten practical provision on these courses.

Recognising the economic importance of the sub-disciplines and the associated skills

7.3.4 The advisory group will also need to consider the strategic importance of the sub-disciplines to the UK's long-term science and technology objectives. If we are to compete, the UK must invest for the long-term in the centres of learning that provide courses that support SIVS. This report sets out a number of reasons why *in vivo* skills are vital to a significant number of key UK employers. In summary, the entire biomedical sector, including the drug development process, cannot proceed without these skills. A deficit in these skills therefore risks a significant part of the drug development process moving to overseas locations where government support has been maintained, or in some cases significantly expanded, so as to promote these skills with a view to maximising the commercial benefits.

SIVS status: Sending a signal to universities

7.3.5 Specifically highlighting the subjects from the broad category of science subjects would send a clear signal to universities that the subjects, and in particular the focus on *in vivo* work within them, are of strategic national importance.

SIVS status: Early notice of closures or course devaluation

7.3.6 Recognising the subjects in this way would encourage universities to give early notice to HEFCE should there be adverse changes affecting the courses that provide *in vivo* exposure. It would be particularly important to preserve both a cadre of skilled academic staff to undertake *in vivo* research and training, and activity under Home Office teaching licences for undergraduates.

SIVS status: Encouraging universities to take account of employer needs

7.3.7 Recognising the subjects in this way would also encourage the relevant universities to take account of the specific needs of employers when planning courses. The need for universities to do this is emphasised in the Government's response to the Leitch review of skills in England.

SIVS status: Potential for protection

7.3.8 The addition of the sub-disciplines gives the advisory group for SIVS the ability to recommend how to protect the sub-disciplines, within the boundaries of principles that govern the action for protecting SIVS[56]. One specific suggestion the advisory group could consider is scope for identifying a small number of final year undergraduate, and perhaps also MSc, places that warrant support at Band A rates, on the basis that the training and costs are equivalent to those incurred in the teaching of the only other group of undergraduates requiring extensive animal facilities and handling, namely veterinary students.

The steps of action needed

Step 1: Providing further information

- The Biosciences Federation to provide further detail to HEFCE's advisory group for SIVS on the vulnerability of the sub-disciplines that provide exposure to *in vivo* techniques and suggestions of how they could be protected.

Step 2:

- See Target below.

Cost of no action

- The only mechanism for protecting the sub-disciplines within the education framework is through the SIVS framework. Not taking action through this framework

56 The principles are set out on page 7 of the HEFCE October 2006 report on its support or SIVS.

would remove the only means available in the higher education framework for protecting the vulnerable teaching of *in vivo* skills.

- Not protecting the sub-disciplines could widen the gap between supply and demand, as the factors making the sub-disciplines vulnerable, such as retirement of skilled academic staff and the high cost if *in vivo* work are most likely to further reduce the number of graduates gaining exposure to *in vivo* work.

Recommendation 10:

10.1 HEFCE should ask their advisory group on Strategically Important and Vulnerable Subjects to consider whether the sub-disciplines that underpin in vivo skills (e.g. pharmacology, physiology, toxicology and pathology) require some particular protection and support

Target:

- HEFCE's Advisory Group to have considered whether the subjects need particular protection and support by February 2008.

Recommendation 11: USING THE MID-TERM REVIEW OF THE IMBI TO ASSESS LONG-TERM CAPACITY ISSUES

Rationale

7.3.9 Long-term sustainability of research and training in the *in vivo* sciences depends on:

- employers communicating demand for the skills (to shape student demand);
- universities being in a position to meet the high costs of *in vivo* work;
- the historic strength of the UK's basic research that requires *in vivo* approaches being maintained; and
- there being enough experienced trainers (there is an ageing cohort of *in vivo* academic staff) to revamp the image and role of *in vivo* sciences so that they are seen as part of fundamental biological research and as part of a package of scientific tools used both to generate laboratory-based discoveries and to aid their translation into clinical benefit and/or commercial products.

7.3.10 This report has recommendations to help with each of the above issues. Monitoring of implementation of the recommendations (to be taken forward by a joint Bioscience Federation ABPI led group) could be considered alongside the reviews of the IMBI, as these will involve the key stakeholders and provide new information from the IMBI to assess long-term sustainability issues.

Opportunities/action required

Assessing need for further capacity building

7.3.11 The IMBI was a unique and important step in tackling the declining *in vivo* capacity and changing the way that *in vivo* sciences are viewed. The IMBI put the emphasis on the *in vivo* community to develop novel proposals to combine different areas of expertise that are linked by the use of *in vivo* techniques. Academics consider that there is a need to build more capacity, and a window of opportunity to use ageing skilled staff to provide it. The mid-term review of the IMBI in 2009/10 provides an excellent opportunity for stakeholders to collectively review the initial results of the four capacity-building awards and to think about how new schemes could be developed to take to funders of research and teaching, including those who supported the current IMBI.

Encouraging academics to have a bottom-up approach

7.3.12 Research funders are keen that academics embrace a bottom-up approach to thinking about how *in vivo* techniques and training can be developed alongside the development of new techniques and technologies. The IMBI review provides a suitable focal point for academics to work together to present their vision of how *in vivo* skills can be better aligned with multidisciplinary approaches to answering scientific questions.

Assessing the success of the IMBI

7.3.13 The review will provide IMBI funders with an opportunity to reflect on how the capacity building awards have contributed towards meeting their original objectives and to what extent the award holders have managed to satisfy national training needs in supporting both industrial and academic research. The reviews can also assess whether these schemes and/or others would be most cost-effective for further developments.

Widening the IMBI reviews to relevant funders

7.3.14 The panel reviewing the IMBI should consider the potential for inviting other funders of biomedical research to review the progress of the capacity building awards. This will help other funders when considering how best to engage with academics seeking to enhance UK *in vivo* capacity.

Assessing whether the cultural change is happening

7.3.15 Trainers have a key role in revamping the image of *in vivo* techniques. The UK needs scientists who have the broad knowledge and understanding of *in vivo* work, thus enabling them to pull together expertise from multiple disciplines, translating *in vitro* research into knowledge of processes within complex living systems and, eventually, applying this knowledge to clinical situations in human beings. *In vivo* work needs to be seen as part of the wider scientific process rather than as a stand alone area of expertise. The IMBI has helped to start this cultural change and

the discussions of the results and witnessing how the new centres are integrating the new culture should help spread new ways of thinking about the skills. This IMBI reviews should also consider the extent to which the cultural change is occurring.

The steps of action needed

Step 1: Identifying who to involve and their role

- IMBI funders consider potential for inviting other relevant funders to help consider the mid-term results

Step 2: Agreeing what issues to asses alongside the IMBI mid-term review

- The IMBI steering group and Biosciences Federation to agree what long-term sustainability issues should be considered alongside the reviews (such as employer demand, research capacity throughout academia, teaching capacity, and costs) and how best to address them

Step 3: Disseminating results

- IMBI funders to share the results of their review with the *in vivo* community so as to maximise discussions of the lessons learned; in particular how best to use future resources when considering future needs, bearing in mind long-term sustainability issues.

Cost of no action

- Not using the IMBI to share lessons learnt, consider progress in changing the culture around *in vivo* work and wider long-term sustainability issues will not further current efforts to improve UK *in vivo* capacity
- Lessons learnt will not be shared and the opportunities could be lost.

Recommendation 11:

11.1 IMBI funders, at the 2009/10 mid-term review, to consider the impact of the IMBI when addressing the broad concerns about long-term capacity, both in the institutions that won the awards and nationally. The results of the review should be shared with the wider academic community to help assess and respond to long-term capacity concerns

Target:

- The mid-term review's results to be shared with the *in vivo* community by the end of 2010
- Academics to have agreed how to best collaborate with industry and funders to achieve the desired UK *in vivo* capacity through any further innovative capacity building schemes, by mid 2011.

Recommendation 12: VETERINARY PATHOLOGY

Rationale

7.3.16 Veterinary pathologists have a key role in the drug development process, but many employers are very concerned about their supply. A predicted shortage in the United States is expected to increase pressures on UK employers to hold on to experienced staff. Without some co-ordinated action, the UK is at risk of losing its historical competitive advantage.

Opportunities/action required

7.3.17 Training in veterinary and toxicological pathology has traditionally been on-the-job, with membership of the Royal College of Pathologists being obtained via examination. Teaching expertise is split between the different veterinary schools, and certain areas of expertise are held solely with industrial employers. A number of veterinary schools and industrial employers have agreed there is a need for greater collaboration if the UK is to remain a leader in veterinary pathology. The next generation of trainers needs to be identified to develop veterinary school and employer collaboration and to clarify UK future needs.

7.3.18 Some veterinary professionals participating in the project thought there could be an opportunity to attract veterinarians seeking a career change. These skilled people already have *in vivo* and post mortem skills plus training in anatomy, including histology, physiology, biochemistry, pharmacology, microbiology and pathology, and could help to fill the skills gap. This investigation was unable to consider the true potential of this opportunity but it is something which is worth further investigation.

The steps of action needed

Step 1: Clarifying demand and supply

- This report encourages the British Society of Toxicological Pathologists (BSTP), UK veterinary schools, and other relevant stakeholders to work in partnership in developing/researching these future needs.

Cost of no action

- Expertise in veterinary pathology will continue to remain spread across several veterinary schools, and

the UK will not have a strategy to deliver veterinary pathology training that meets the needs of employers

Recommendation 12

12.1 Industry, veterinary schools and relevant funders should develop a structured national programme to support veterinary pathologist training at graduate and intern levels.

Targets

- An agreed industry proposal for veterinary pathology training to have been produced by January 2008
- An updated proposal to have been agreed with veterinary schools by April 2008
- New veterinary pathology training to commence in September 2009.

Recommendation 13: THE BEST POSSIBLE REGULATORY ENVIRONMENT TO DELIVER ANIMAL WELFARE AND SCIENTIFIC EXCELLENCE

Rationale

7.3.19 The current legislation (the Animal (Scientific Procedures) Act 1986) and the high standards of animal welfare in the UK are valued by the *in vivo*-community. The expectation is that other EU countries will approach current UK regulation when the revision of Directive 86/609 is implemented. The UK biomedical sector would not wish to see a decline in welfare standards, but would welcome opportunities for significant improvements in regulation and reduction in bureaucracy. The sector believes that further welfare improvements could be made through better regulation.

Opportunities/action required

7.3.20 The regulatory framework that controls *in vivo* work has a crucial impact. It has long been the view of many in industry and academia that there are opportunities to:

- improve how research using animals is regulated, thus enabling, *inter alia*, improvements in animal welfare;
- strengthen UK science competitiveness by reducing the excessive bureaucracy that often leads to delays and significantly increased costs for research with no welfare or 3Rs benefit;
- enable greater consistency of how restrictions are imposed and regulations implemented; and
- reduce the administrative burden on the Home Office Inspectorate, thereby enabling them to use their time more effectively to enhance animal welfare.

7.3.21 To help realise the opportunities above, the following key detailed issues have over recent years been presented to the Home Office for their consideration:

- the regulation of personal licences;
- the level of detail in project licence applications;
- the detail included in certificates of designation;
- the complexity of reporting the use of genetically altered (GA) animals;
- the reporting of annual Home Office statistics; and
- making information technology (IT) work for animal welfare and research.

Overall compliance costs

7.3.22 This report welcomes that, as part of the Government's commitment to efficient and effective regulation, the Simplification Plan published by the Home Office[57] includes a target to reduce compliance costs arising from the regulation of animal experiments. To take this work forward the Home Office has set in motion a dedicated Animals Scientific Procedures Division Better Regulation programme, which has been examining a number of issues identified in recent reviews. For instance, the Davidson review reported on the transposition of EU legislation into the UK, and specific issues have been put forward by various groupings of stakeholders in industry and academia. An important objective of the programme is to simplify administrative processes and to reduce compliance costs by 25% by 2010, while maintaining proper provision for animal welfare.

EU developments

7.3.23 In addition to the programme of work on improving existing regulation, it will be vital that the UK Government works with European partners to ensure that revisions to the European Council Directive 86/609/EEC improve regulation, promote excellent animal welfare, promote EU research, and impact positively on the ability of those working in teaching and research to deliver effectively.

Steps of action

- A Steering Group, chaired by officials from the Better Regulation Executive, is already providing advice on strategic issues relating to the better regulation programme, and it will ensure that any changes to the regulatory system do not compromise animal welfare. The steering group has representatives from the Home Office, relevant Government Departments, industry, academia and other organisations focused on animal welfare and the 3Rs.

57 The Home Office Simplification plan can be found at: http://www.homeoffice.gov.uk/documents/ho-simplification-plan/ho-simp-plan?view=Binary

Cost of action

- Lost opportunity to improve the regulatory environment, which could prolong unnecessary bureaucratic costs to industry and academia with a serious detrimental effect on UK investment and an increased risk of transfer of animal based work overseas.

Recommendation 13:

13.1 The Home Office should fully implement those aspects of its Simplification Plan that relate to operation of the Animals (Scientific Procedures) Act 1986 and deliver an efficient and effective regulatory environment for the use of animals in science.

Target

- At least a 25% reduction in compliance costs by 2010, while maintaining proper provision for animal welfare.

7.4 Important factors to be monitored

The National Centre for the 3Rs

7.4.1 Important to the future provision of *in vivo* skills and expertise is ensuring that the focus on Reducing, Replacing and Refining the use of animals in science is further mainstreamed into education and training. This report strongly endorses the work of the NC3Rs and the positive contribution it is making to the 3Rs agenda. In 2006 the NCRs awarded nine research grants totalling £1.4million on 3Rs research, up from £1million in 2005. The ABPI currently funds a programme manager for the NC3Rs, an arrangement that has been very productive. The NC3Rs, in partnership with the Laboratory Animal Science Association (LASA), runs an annual Small Awards scheme specifically to support research (e.g. pilot studies) and training (e.g. new techniques, exchange visits) in the 3Rs and animal welfare. The centre has continued to raise awareness of recent developments in the 3Rs, in addition to working on specific projects with industry and the scientific community. The NC3Rs is still a relatively young organisation, but is has made a considerable impact to the 3Rs agenda, which the authors of this report hope will continue into the future. Sustaining this success will depend on the continued development of science-based products that are aligned with company and stakeholder needs.

7.4.2 It will be important that the Universities Federation for Animal welfare (UFAW), the Fund for the Replacement of Animals in Medical Experiments (FRAME) and the Royal Society of Prevention Cruelty of Animals (RSPCA) and other organisations that have also contributed to the 3Rs landscape over many years continue to fund research and contribute to discussions around the 3Rs. Employers, academics, learned societies and relevant stakeholders must continue to take a partnership approach to deliver sustained improvements.

Support for veterinary surgeons

7.4.3 An initiative which will help with niche specialist skills related to *in vivo* work is the recently agreed (but not yet announced) Wellcome Trust Strategic Award for Clinical Veterinary Research. The scheme will involve all UK veterinary schools and industry and university/research institutes in training veterinarians in laboratory medicine and animal welfare through better animal models. The scheme will provide further important training for veterinarians in their role assuring health and welfare of laboratory animals. It will be important that the veterinary community grasps this important opportunity and continues to look for innovative ways of providing veterinarians with training in laboratory medicine and animal welfare.

Providing a solid foundation for *in vivo* skills development in HE

Links to schools

7.4.4 The A(SP)A rightfully forbids *in vivo* work in primary and secondary schools. This project did not consider whether there are potential links between the decline of *in vivo* work in higher education and developments in schools. This report does acknowledge that it is essential for universities to continue to receive well educated, motivated students who have some insight into science as a career and are comfortable working in laboratory settings. The Government's recognises this in the 10 year Science and Innovation Investment Framework 2004-12[58] as well as the Next Steps document[59], published in March 2006. Both documents emphasise the need to improve Science Technology Engineering and Mathematics (STEM) skills. The STEM programme report[60] of October 2006 laid out a process by which this work will be taken forward. STEM programmes of activity (with the aim of rationalising, improving the effectiveness of STEM initiatives in schools, colleges and other learning providers) should be commended. The desire of STEM initiatives to enhance practical science in schools is strongly endorsed, and is supported by many stakeholders as central to achieving an undergraduate cohort in universities that is receptive to practical research in general.

58 http://www.hm-treasury.gov.uk./spending_review/spend_sr04/associated_documents/spending_sr04_science.cfm
59 http://www.hm-treasury.gov.uk/media/7/8/bud06_science_332v1.pdf
60 http://www.dfes.gov.uk/hegateway/uploads/STEM%20Programme%20Report.pdf

Specific schools issues

Careers advice

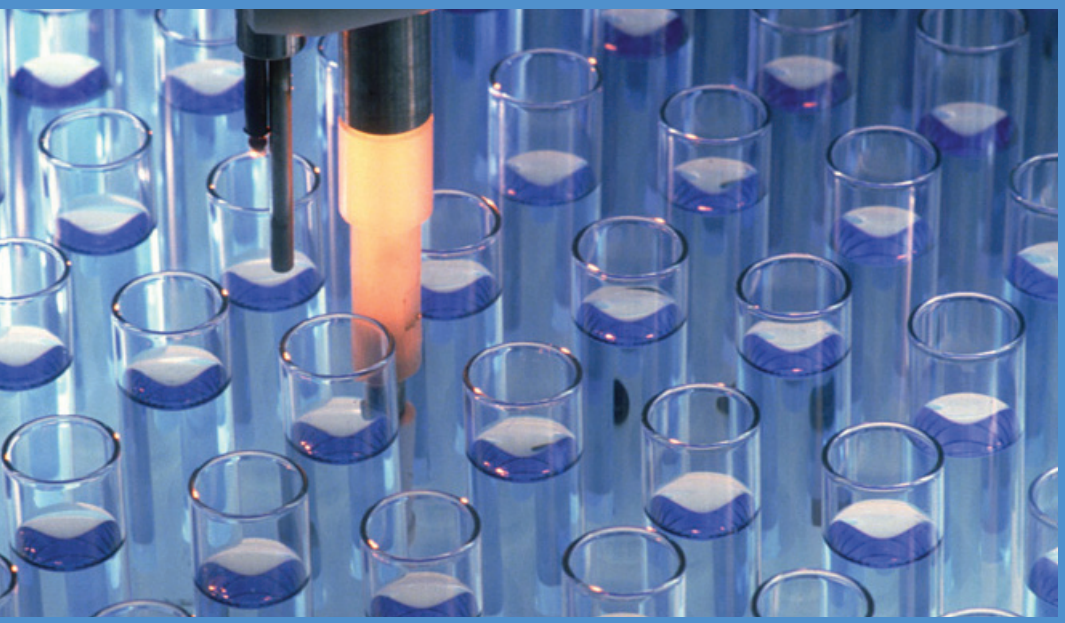
7.4.5 High quality, fit for purpose careers advice is important at all levels, but particularly so in schools, as it is at this age that young people often make key decisions about their future career or study direction, based on early concepts of their likely career. This report welcomes the Science Council's plan to launch a careers website and the ABPI's revamping of its careers site. It is unlikely that careers advice in schools would cover *in vivo* careers in any great detail, so it will be important that students, parents and careers advisors are aware of the new sites and other relevant careers information sources about the biomedical sector more generally.

Information about the use of animals in science

7.4.6 Student demand for *in vivo* work has been an issue in the past, but it seems students are becoming better informed and more able to make considered judgements about *in vivo* work. This report welcomes the requirement of the new science GCSEs to include ethical discussions about topical issues, which can include the use of animals in science. The April 2007 Physiological Society DVD resource for school (Make Up Your own Mind) is welcomed, as is the Coalition for Medical Progress's (CMP) decision to act in a leadership role for the provision of advice, materials and strategy for raising understanding and public debate on the use of animals in science, including that in schools. Discussions about the use of animals in science can have a large impact on the willingness of young students to consider courses that expose them to *in vivo* work. It is important there is a range of materials available highlighting different perspectives that exist. Continued open and transparent discussion of the pros and cons of such work, plus a focus on the 3Rs, will continue to be important. Last year's MORI survey[61] showed public acceptance continued to be high, but this platform needs to be built on.

61 http://www.ipsos-mori.com/polls/2006/dti.shtml

8 Impact of proposed actions on skills concerns



This chapter shows how recommendations could overcome the skills shortages and help long term sustainability

8.1 Chapter 5 concluded that an extra 120 graduates per year need to be exposed to basic or significant *in vivo* work. Box 5 below maps the impact of recommendations 1-13 against the need for both 120 more graduates and more PhDs, and against long-term sustainability concerns. It should be noted that the mapping of stages and means of *in vivo* work (recommendation 3) could significantly increase the pool of graduates with basic understanding of *in vivo* work but it is not possible to include a figure in the table. It is also likely that there could be an increase in the number of graduates who gain significant exposure under a Home Office personal licence, all of whom would be highly valuable for both employers and long-term *in vivo* science capacity. The package of measures in this report could therefore produce the skilled graduates needed to overcome the skills shortages and make significant contributions to long-term sustainability.

Box 5
Potential impact of recommendations on skills gap and long-term sustainability

Recommendations	Contributions to 120 more graduates needed	Impact on sustaining PhD supply	Long-term Impact
1. Employer demand	More graduates with skills apply for roles	More demand for *in vivo* PhDs and more apply for jobs in industry	Increased demand for learning encourages better supply from providers
2. Employer placements	At least an extra 30 skilled graduates are significantly more likely to join industry	Increased pool of experienced graduates available for PhDs	• Better provider/employer collaboration • Increased pool of people with *in vivo* experience
3. Mapping of stages and means of *in vivo* training	• More graduates with basic understanding of *in vivo* work • More graduates have significant exposure to *in vivo* work up to and including that requiring a Home Office licence	Increased pool of experienced graduates available for PhDs	• Larger pool of graduates understand *in vivo* work to undertake *in vivo* at higher levels • Better understanding of the importance of animal welfare, ethical issues around animal use in science, the 3Rs and experimental design to shape future education and training • Better provider/employer working to help support *in vivo* work
4. Continued support for BPS/The Physiology Society summer courses and potential expansion	• Continued demand for industrial posts from graduates who otherwise would not have basic exposure to *in vivo* work. • Potentially more graduates after 2009/10	Increased pool of experienced graduates available for PhDs	Continued supply of graduates with exposure to *in vivo* techniques
5. More MSc/MRes places	Significant chance many of the 36 graduates from funded places may join industry and some of the fee-paying international students could also join industry	Increased pool of experienced graduates available for PhDs	Providers offering courses can develop • Larger pool of graduates with significant *in vivo* experience • Potentially a sustainable model for courses by recruiting international students, subject to capacity constraints on training places • Better quality graduates applying for PhDs

Recommendations	Contributions to 120 more graduates needed	Impact on sustaining PhD supply	Long-term Impact
6. More *in vivo* CASE PhDs (some linked to MScs course places), continued PhD supply and 3Rs PhDs	More PhDs could be used to fill vacancies at graduate level	More trained PhDs available to *in vivo* research	• More experienced *in vivo* researchers • Strengthened capacity at *in vivo* centres • More 3Rs research and researchers capable of developing and spreading best practices
7. Increasing toxicology capacity	More PhDs could be used to fill vacancies at graduate level	More PhDs	Increased capacity at centres winning new PhDs
8. Action plan for animal technologist training	Increased awareness of *in vivo* technology work could increase demand for *in vivo* learning	Better animal technologist support for advanced animal management and bench research	Better technician support, improved productivity and better awareness of animal welfare and 3Rs
9. Teaching capacity	Better teaching capacity		
10. SIVS protection	Protection of undergraduate training of *in vivo* skills	Support for sub-disciplines within which PhD research is based	Could protect sub-disciplines that tend to include *in vivo* work and encourage better employer/provider collaboration
11. IMBI review	Assess progress to date and advise on future needs and solutions		
12. Veterinary pathology	NA		Improved *in vivo* research capability
13. Better regulation	Savings will support *in vivo* work		Better UK environment for science
Total impact	At least 100 more graduates have significant exposure to *in vivo* work plus unknown number as a result of implementation of curriculum work from recommendation 3	Improved PhD supply	Better *in vivo* capacity and improved focus on the 3Rs

9 Cost of implementing proposed recommendations

9.1 We believe the costs of implementing the short-term recommendations can be met by industry, providers and existing education and research funders reprioritising existing resources. The submission to the SIVS Advisory Group might, however, identify the need for additional funding. The key costs proposed here will be for the MSc places and linking a number of PhDs to these. Three years of adequately supported MScs could cost up to £2.7million. The cost implications of all recommendations are in box 6 below.

BOX 6: COST OF IMPLEMENTING PROPOSED RECOMMENDATIONS AND FUNDERS WHO COULD MEET THE COST

Short-term recommendations	Associated costs	Funders/recipients of savings
1. Employer demand	Minor costs producing new careers and marketing materials	Employers, providers and learned societies
2. Employer placements	Placement salary, training costs (including Home Office personal licence cost), student fees for the year	Employers, HEFCE and students (for fees)
3. Mapping of stages and means of *in vivo* work	Minor costs of facilitating the work and disseminating results Increased costs for providers implementing recommendations; some minor but some potentially substantial	Biosciences Federation, industry and providers to meet facilitation and review costs Providers to meet implementation costs where possible; some implementation may be dependent on SIVS support
4. Continued support for BPS/The Physiology Society summer courses and potential expansion	£2,000 per student place	Current industry and other funders of the courses in the short-term; long-term sustainability to be established
5. More MSc/MRes places	36 x £25,000 per annum. £2.7million over 3 years. Longer-term sustainability to be established	Education and research funders, industry for placements, students for fees
6. More *in vivo* CASE PhDs (some linked to MSc course places), continued PhD supply and 3Rs PhDs	Cost of PhDs and support for consumables	PhD funders, employers and providers
7. Increasing toxicology capacity	Cost of PhDs and support for consumables	PhD funders, employers
8. Action plan for animal technologist training	Cost of new training developed	Employers, providers and training funders
9. Teaching capacity	Cost of industrial staff supporting teaching and any means of incentivisation developed	Employers/education and research incentivising activity
10. SIVS protection	Costs of protection of the sub-disciplines that provide exposure to *in vivo* work not clear at this stage; To be considered	HEFCE
11. IMBI review	NA	IMBI funders
12. Veterinary pathology	Not clear at this stage	Employers, providers (veterinary schools) and possibly organisations interested in biomedical research
13. Better regulation	Ongoing administrative input	Home Office and stakeholders (industry and academia) Employers and education and training providers share at least 25% efficiency savings

10 Conclusion

10.1 The UK must invest in skills upon which industry, and academe, depend if it is to sustain its global leadership position in biomedical, pharmaceutical and biopharmaceutical R&D. The shortage of *in vivo* skills is placing this leadership under threat, particularly in view of attractive overseas relocation sites for such research. There is a need to further rebuild UK *in vivo* capacity to translate the benefits from the human genome project. Translating gene expression into functional activity requires and will continue to require integration of knowledge from the molecular to the cellular to the whole organism level.

10.2 Fewer graduates now leave UK universities with the *in vivo* skills and expertise that employers need to create the new medicines that patients and healthcare providers demand, and that Universities need to sustain current *in vivo* research capacity. This decline in skills availability is a barrier to enhanced productivity for many pharmaceutical and biopharmaceutical employers, as well as undermining the UK academic base in the long-term. A number of factors have contributed to the decline in the skills, some of which are specific to the challenges of using animals in science, but many simply caused by, or reflect, wider cost efficiencies and changes in higher education.

10.3 Employers and funders have already taken long-term action through the innovative Integrative Mammalian Biology capacity building Initiative, but this is only a start and a second phase of action is needed to help overcome the immediate skills shortage and support UK *in vivo* capability. Employers, academics and funders agree there is scope to address the short-term to medium-term supply issue and a consensus has been built on the factors affecting long-term sustainability, which will require monitoring by various sector and government groups, with further action as appropriate.

10.4 This report has illustrated in greater detail employer demands for *in vivo* skills and recommends a number of user-driven actions that depend upon employers and the education sector working in partnership with appropriate Government funding agencies. Considerable care needs to be exercised as many other countries do not expect funding or investment from companies to deliver these skills, seeing this as an opportunity to create the pool of scientific talent that will attract new investment. Skills supply is a core competitive factor and onerous requirements for further funding from industry to augment national supply could have a counter productive effect in helping to drive industry R&D overseas.

10.5 Nevertheless, in the short-term, demand-led responses to the skills concerns that apply are required at all levels and students (undergraduates, taught Master's students, and PhDs) should be encouraged to spend sufficient periods of their training with employers, so that they are exposed to the cultures and practices of industrial research. Universities will need to work further with employers to modify and develop courses to promote placements and to better reflect employers' needs. Some universities may need to be incentivised to do this. Employers are helping to do this and should make better use of flexible funding arrangements such as CASE PhDs to influence the allocation of research council funding. Responsibility for raising the skills standards is shared between employers, providers, funders and the relevant Sector Councils.

10.6 Central to the action required is achieving a cultural shift, so that *in vivo* techniques become seen, as an integral part of a multidisciplinary approach to solving biomedical problems. Currently *in vivo* research tends to be perceived as a separate add-on to basic research that some parties consider dispensable. This shift in perception needs to evolve, and the recommendations in this report should help initiate this. Only when this perceptual change occurs is there likely to be stronger demand on universities to provide the education and training that promotes *in vivo* techniques. Key to delivering increased capacity will be a combination of such stronger demand, willingness by universities to respond to customers demand (as the Government expects them to) and, where appropriate, financial incentives to encourage them to do so.

10.7 The impact of the IMBI should not be underestimated: it is starting to turn the tide of decline in *in vivo* sciences, and there is evidence that the universities that won the funding are becoming more responsive to employer needs. This is just the start of a cultural change in education, where employers and providers develop strategic partnerships to their mutual benefit. If the UK is to sustain its position as a global leader in biomedical and biopharmaceutical research, such innovations need to become more common and the Government must be prepared to use the tools at its disposal (such as the SIVS programme) to encourage investment in priming the key skills. As implied above, such further government investment is key to attracting new industrial investment and sustaining the UK's academic base.

10.8 With continued globalisation enabling companies to locate research anywhere in the world, the UK must be bold in its ambitions. While there will not be an exodus of UK research activities overnight, new investments are taking place in the emerging countries, especially in the Far East. The UK's competitors are thinking more creatively about how to build their capacity. This requires the UK to urgently grasp the available opportunities to remain globally competitive. With this in mind, this report therefore sets out a package of targeted action that will help improve UK biomedical science, productivity, competitiveness and health.

11 *In Vivo* Sciences Action Plan

Short-term recommendations	**Milestones**	**For**	**Outcome** (Box 5 page 59 has more detail)
1. Industry and other employers should work with universities, learned societies *and* careers services to communicate employer demand for students with *in vivo* skills and expertise	• By January 2008 employers to haveanalysed and agreed action toimprove how they communicate for *in vivo* skills • Academics to start collecting specific destination data for graduates with the skills from June 2008 • Updated materials to be disseminated to careers advisors and others identified as requiring the information by September 2008	Industry, other employers and relevant stakeholders	Better employer pull for *in vivo* skills to incentivise student and university interest in *in vivo* work
2. Employers to work with academics to increase the overall number of employer placements that involve *in vivo* work by at least 50% by 2010	• 15 more IPs to start September 2009 • Another 15 more to start in 2010	Employers and universities	• More skilled graduates at Bachelor's level • Better provider/ employer collaboration
3. The Biosciences Federation should lead discussions between university departments providing undergraduate courses in the relevant disciplines, the learned societies (e.g. The Physiology Society and the BPS) and employers to set out the type and means of exposure to *in vivo* work that should occur at each stage of education. Universities should then support the learning recommended, as far as reasonably possible, subject to resource and regulatory constraints.	• Working group to take forward mapping work to be set up by January 2008 • Guidelines on stages of *in vivo* learning to be published by May 2008 • New ways of learning start being implemented from September 2008 • Progress implementing recommended ways of earning to be reviewed in May 2010	Biosciences Federation and relevant learned societies, employers and universities	Clarity on what students need to learn about *in vivo* work at Bachelors level and in turn better trained Bachelors graduates
4. Funders of *in vivo* work should continue supporting BPS/The Physiological Society *in vivo* summer courses and, if appropriate, increase funding to increase capacity of the courses.	Summer schools capacity and funding reviewed in 2009/10 to consider if existing capacity has been maintained, alongside mid-term review of the IMBI	Learned societies and relevant funders	Continued *in vivo* training opportunities
5. Develop a small number of programmes at a taught Masters level (one year) that are focused upon *in vivo* skills. 36 studentships should be provided in each of the next three years to make a substantial step towards solving industry recruitment problems	• 36 funded MSc places to commence in September 2009	BBSRC, MRC, HEFCE, Industry and universities	More skilled graduates who are more likely to use the skills in future and help fill the skills gap

Short-term recommendations	Milestones	For	Outcome (Box 5 page 59 has more detail)
6.1 Research Councils and industry should work together to increase the number of CASE PhD awards that use modern *in vivo* techniques. These additional CASE studentships should be linked to the proposed MSc programmes that are to be developed with industry input 6.2 Research Councils should continue to encourage (ideally through ring-fencing, but if not ring-fencing then another means) the take up of PhDs that involve modern *in vivo* techniques 6.3 Industry and research funders should consider providing funding for PhD studentships to investigating the 3Rs	• New CASE PhDs to start 2009 • PhDs to be linked to MSc courses to start in 2009 • From 2009 onwards, four 3Rs studentships per annum to be funded	Industry, universities and research funders	Maintained/ enhanced *in vivo* capacity and continued flow of PHD level expertise/better understanding of the 3Rs
7.1 Employers of toxicologists and research funders should work together to support the Medical Research Council's proposed toxicology/drug safety training programme so it has capacity to meet the needs of more toxicology users. To be developed with industry input. 7.2 The British toxicological society should continue its work with Government funding agencies and employers to ensure the UK has a joined-up approach to maintaining its world-class toxicology expertise and, in particular, how to revamp the image of toxicology.	• Industrial representative to be included on board by November 2007 • British Toxicology Society to have reached a decision on the need for a strategy for toxicology by May 2008 • New toxicology programme capacity to be reviewed in September 2009 against all toxicology users needs	Toxicology employers, research funders and universities	More skilled graduates
8. Lantra, through the action plan for animal technology, should continue to set out action to: • help employers communicate demand for animal technology roles • improve knowledge and understanding of animal technology and related careers • set up an animal technology training providers forum and support development of a national network of providers to deliver training that meets their needs • help employers leverage funding to help support animal technology training which may have a low student/teacher ratio • maximise the potential of the EU labour market	• Providers forum set up by December 2007 • Animal technology action plan to be revised to include all work strands by March 2008 • Lantra to have clarified options for harnessing new public funding to support expensive training by June 2008 • Providers to deliver new training by September 2008	Lantra, colleges and employers	More and better trained animal technologists

Short-term recommendations	**Milestones**	**For**	**Outcome** (Box 5 page 59 has more detail)
9. Industry, academia and other stakeholders should explore mechanisms by which interchange programmes could occur more readily and easily to increase the pool of individuals who can mutually support research, undergraduate teaching and advanced training in *in vivo* techniques. Options for incentivising such interchange to be discussed with education and research funders and the supply of experienced teachers should be reconsidered alongside reviews of the IMBI	• By June 2008 options and timescale for greater employer support for teaching and incentivision of interchange between employers and universities to be agreed with relevant research and education funders • The Biosciences Federation to work with the steering committee of the IMBI to complete analysis of recruitment of *in vivo* trainers and produce recommendations to ensure there are enough *in vivo* trainers by 2010	Industry, other employers, universities and education and research funders	More teaching and research capacity
Long-term recommendations	**Milestones**	**For**	**Outcome** (Box 5 page 55 has more detail)
10. The sub-disciplines that underpin *in vivo* skills (e.g. pharmacology, physiology, toxicology and pathology) are vulnerable in various ways. HEFCE should ask their advisory group on Strategically Important and Vulnerable Subjects to consider whether these subjects require some particular protection and support	To have considered subjects by February 2008	HEFCE	Monitoring of critical subjects and action to protect them
11. IMBI funders, at the 2009/10 mid-term review, to consider the impact of the IMBI when addressing the broad concerns about long-term capacity, both in the institutions that won the awards and nationally. The results of the review should be shared with the wider academic community to help assess and respond to long-term capacity concerns	• Mid-term review's results to be shared with the *in vivo* community by the end of 2010 • Academics to have agreed how to best collaborate with industry and funders to achieve the desired UK *in vivo* capacity through any further innovative capacity building schemes, by mid 2011	IMBI Funders	Provide further analysis of long-term sustainability issues
12. Industry, veterinary schools and relevant funders should develop a structured national programme to support veterinary pathologist training at graduate and intern levels	• Industry proposal produced by January 2008 • Version agreed with academia by April 2008 • New training to commence 2009	ABPI, BSTP, veterinary schools, Royal College of Pathologists and relevant funders	Better trained specialists
Regulation 13. The Home Office should fully implement those aspects of its simplification plan that relate to operation of the Animals (Scientific Procedures) Act and deliver an efficient and effective regulatory environment for the use of animals in science	• Simplify administrative processes and reduce compliance costs by at least 25% by 2010, while maintaining proper provision for animal welfare	Home Office	Better regulatory environment

Annexes

Annex A – Stakeholders Consulted

Academy of Medical Sciences
Association for Science Education (ASE)
Association of Medical Research Charities – (AMRC)
Association of Veterinarians in Industry
BioIndustry Association (BIA)
Biosciences Federation
Biotechnology and Biological Sciences Research Council (BBSRC)
British Association for Psychopharmacology
British Neuroscience Association
British Pharmacological Society (BPS)
British Society of Toxicological Pathologists (BSTP)
British Society of Veterinary Pathology
British Toxicology Society (BTS)
Chemical Industries Association (CIA)
Confederation of British Industry (CBI)
Cranfield University
Department for Children, Schools and Families (DCSF)
Department for Environment Food and Rural Affairs (DEFRA)
Department for Innovation, Universities and Skills (DIUS)
Department of Business, Enterprise and Regulatory Reform – (BERR)
Department of Health (DoH)
Eastern Region Biotechnology Initiative (ERBI)
Edinburgh University
European Society of Toxicologic Pathology
Fund for the Replacement of Animals in Medical Experiments (FRAME)
Higher Education Funding Council for England (HEFCE)
Imperial College London
Institute of Animal Technology (IAT)
Institute of Biology (IOB)
King's College London
Laboratory Animal Science Association (LASA)
Landex
Lantra
Learning and Skills Council (LSC)
Medical Research Council (MRC)
National Science Learning Centre
Office of Science and Technology (OST)
Qualifications and Curriculum Authority (QCA)
Research Councils UK (RCUK)
Royal College of Pathologists
Royal Society
Scottish Funding Council (SFC)
Sector Skills Council for Science, Engineering, Manufacturing Technologies (SEMTA)
The Higher Education Academy Subject Centre for Bioscience
The Home Office
The National Centre for the Replacement, Refinement and Reduction of the use of animals in science (NC3Rs)
The Physiological Society
The Royal Society for the Prevention of Cruelty to Animals (RSPCA)
The Royal Veterinary College
The Wellcome Trust
University College London
University of Aberdeen
University of Bath
University of Birmingham
University of Bristol
University of Leicester
University of Liverpool
University of Manchester
University of Newcastle
University of Nottingham
University of Oxford
University of Sheffield
University of Surrey
University of York

ANNEX B – STUDENT DEMAND FOR *IN VIVO* RELATED SUBJECTS

HESA data for subjects which may contain exposure to *in vivo* work.

The two tables below are based on data supplied by the Higher Education Statistics Agency. The tables show that there have been significant increases in the number of students enrolled on higher education courses most likely to introduce and expose students to *in vivo* work. Subjects like neuroscience and pathobiology, which may also include exposure to *in vivo* work, are contained in grouping B1, along with other subjects such as physiotherapy and cellular pathology. The grouping B2 includes pharmacy courses and pharmacology, toxicology and pharmacy course places that did not fit into other pharmacology, toxicology and pharmacy categories or were not classified elsewhere by the host institution.

MSc numbers may seem high as many students who study for a doctorate qualification will initially be enrolled on a masters course and will transfer to a doctorate course after a year or two. For this reason, the number of doctorate students may be under counted and the number of masters students may be over counted.

Table 1: Students studying specific subjects 2005/06 by Level and Mode of study

Subject	All Masters	Other PG	All First Degree	Estimated number graduating annually with First Degrees
(B100) Anatomy, physiology & pathology	248	288	2733	911
(B110) Anatomy	13	91	451	150
(B120) Physiology	49	192	1594	531
(B130) Pathology	4	122	154	51
Other (B1)	1478	531	8806	2935
(B200) Pharmacology, toxicology & pharmacy	302	692	645	215
(B210) Pharmacology	524	304	1779	593
(B220) Toxicology	168	51	51	17
Other (B2)	930	3876	10146	3382
Biochemistry	38	1	710	237
Other (C7)	894	1908	6290	2097

Table 2: Students studying specific subjects 2002/03 by Level and Mode of study

Subject	All Masters	Other PG	All first Degree	Estimated number graduating annually with First Degrees
(B100) Anatomy, physiology & pathology	248	336	2734	911
(B110) Anatomy	45	116	442	147
(B120) Physiology	38	231	1186	395
(B130) Pathology	11	125	245	82
Other (B1)	966	374	5265	1755
(B200) Pharmacology, toxicology & pharmacy	252	296	906	302
(B210) Pharmacology	271	328	1553	518
(B220) Toxicology	140	23	83	28
Other (B2)	983	2642	7863	2621
Biochemistry	14	0	532	177
Other (C7)	775	1497	6349	2116

The subjects in the tables are aligned to medicine, sparing biochemistry, which is aligned to biology. Some other biological sciences courses also introduce students to the use of animals, but biochemistry student numbers were identified as several employers highlighted these as sometimes having had some basic exposure to *in vivo* work. Data on overall student numbers for biological sciences courses are below.

Biological sciences courses

HESA data for HE qualifications obtained from 2000/01 to 2004/05 shows a 14.7% increase in the number of students graduating with biological sciences qualifications. The majority of this increase however, has been due to increased numbers of sports science and psychology students. The number of students on biology courses increased by 2.2%, genetics by 5.2%, and microbiology by 2.5%. This compares with sports science increasing by 13.2% and psychology by 9.9%. This trend has also been identified by SEMTA in its draft Sector Skills Agreement for the Biosciences Sector.

Table 3: Subject of HE Qualifications Obtained 2000/01 to 2004/05 (Source HESA)

	Total first degrees					% change on previous year			
	2000/01	**2001/02**	**—**	**2003/04**	**2004/05**	**2001/02**	**2002/03**	**2003/04**	**2004/05**
Biological sciences	**18890**	**18495**	**23725**	**25955**	**27200**	**–2.1%**	**28.3%**	**9.4%**	**4.8%**
Broadly-based programmes within biological sciences	680	520	240	230	200	–23.5%	–53.8%	-4.2%	-13.0%
Biology	4405	3915	4430	4485	4585	–11.1%	13.2%	1.2%	2.2%
Botany	85	80	55	80	60	–5.9%	–31.3%	45.5%	–25.0%
Zoology	890	910	825	895	895	2.2%	-9.3%	8.5%	0.0%
Genetics	500	510	575	580	550	2.0%	12.7%	0.9%	–5.2%
Microbiology	610	610	850	800	820	0.0%	39.3%	–5.9%	2.5%
Sports science			3745	4975	5630			32.8%	13.2%
Molecular biology, biophysics and biochemistry	1910	1905	1960	1785	1830	–0.3%	2.9%	–8.9%	2.5%
Psychology	6000	6085	8900	10405	11435	1.4%	46.3%	16.9%	9.9%
Others in biological sciences	3810	3965	2145	1725	1195	4.1%	-45.9%	-19.6%	-30.7%

ANNEX C – INDUSTRIAL EMPLOYER DEMAND FOR GRADUATES WITH BASIC OR SIGNIFICANT EXPOSURE TO *IN VIVO* WORK

Employer type	Level of qualification employers want			
	BScs and MScs	PhDs	Post Docs	Animal technologists
Pharmaceutical employers	(6-36) x 4 24-144	(4-5) x 4 16-20	(2-3) x 4 8-12	(6-20) X4 24-80
Contract Research Organisations	(8-32) x 4 36- 128	(2-2) x 4 8-8	(1-1) X4 4-4	(30-50) X4 120-200
Biotech	(0.2- 0.3) x200 40-60	(0.0- 0.1) X200 0-20	(0.1-0.2) X200 20-40	NA-negligible
Total	100-332	24-48	32-56	144-280
Median	232*	35	44	220

1. Chapter 4 highlighted that over the next 5-10 years industrial employers expect to annually need to recruit:
   - 100-232 BSc or MSc qualified people
   - 20-50 with PhDs
   - 30-60 with post doctoral experience
   - 140-280 animal technologists.

2. The table above shows the data upon which these figures were reached.

Methodology used

3. A selection of employers were asked to specify the number of positions requiring *in vivo* skills and expertise that they would need to fill each year. The positions could involve directly undertaking *in vivo* work or indirectly supporting *in vivo* work through experimentation on isolated organs or the interpretation or commissioning of *in vivo* studies. Employers were asked to differentiate between *in vivo* scientists and animal technologists, but some of the graduate level positions identified may have been for animal technologist roles which have a greater degree of specialisation.
4. The data was collected from employers through a questionnaire. The highest and lowest numbers provided by each type of employer were used to provide a range, which was then multiplied by the number of employers in that category. To ensure the total employer demand figures were representative of total employer need the range of demand was multiplied by a weighting. A multiple of 4 was used to reach an overall number for the pharmaceutical and CRO sectors, as there are 3 large employers of each type and it was assumed the combined recruitment needs of smaller and medium sized employers would be similar to that of a large employer. Data collected from medium sized employers indicated that this was a fair assumption.
5. The figures for biotech employers were obtained through the same questionnaire but discussed with the BioIndustry Association to help ensure they reflected the skills needs of the biotechnology sector. Reaching a figure is difficult as only a few employers run experiments in-house and is not clear how many of these companies will need *in vivo* expertise to help commission and interpret *in vivo* studies. The frequency of employment will therefore vary depending on the scale and age of the companies. The range in the table above shows that they are estimated to hire someone with the skills and knowledge only one or twice every five years. The range was multiplied by 200. This is under half the 450 bioscience employers estimated to be in the UK[61]. The BIA emphasised that the 450 figure will not capture new spin-outs from universities. In light of the uncertainty about biotech skills needs it was thought prudent to use a conservative estimate.
6. The figures for all types of employers are based on the best available sources, but all of the sources relied on individuals interpreting questions and providing data. In light of this risk of human error, the real figures could be higher or lower.

Notes on the data:

- BSc, MSc and MRes appointments are grouped together as most employers tend not to differentiate between these levels of qualifications.
- The range of employees needed with the different level of qualifications are broad because employers use the skills and

61 http://www.bioindustry.org/cgi-bin/contents_view.pl?SITE_ID=367&ID=376

expertise in different ways. Some employers have small *in vivo* teams as they draw heavily on the expertise CROs, while others have larger teams spread across several research units.

- Demand figures for more senior scientists with post-doctoral experience are not included in the table as most employers think action should be prioritised on supporting BSc, MSc and PhD level training. Some are finding recruitment of these scientists difficult. This is concerning employers and academics trying to hold onto their experienced post doctoral scientists.
- This data covers only industrial employer needs. Needs of academia and other public sector and charity employers are not considered as employment data for them was unavailable.
- Some of the 100-330 BSc or MSc positions could be for graduate level animal technology roles.

Type of people who fill the positions

Although the figures are grouped according to the level of education employers are looking for, the people who fill the vacancies will not necessarily be fresh from the education system. The positions are filled by a mixture of the following:

- Graduates from pharmacology, physiology, toxicology and pathology courses that may have involved basic (gained through demonstrations and cadaver work) or significant (work up to and including that requiring a Home Office licence) exposure to *in vivo* work
- Graduates educated outside the UK (could up as much as 15%)
- Graduates returning from completing studies or work outside the UK
- Graduate level scientists from other employers
- Internal employees.

Animal technology roles (some of which may have been classified as scientists roles requiring BSc/MSc, PhD or post doctoral qualifications) can generally be filled by any applicant interested in working with animals, though employers prefer people with relevant qualifications in subjects, such as animal care or veterinary nursing. The table suggests about (220) animal technologist posts need to be filled each year. This seems a reasonable number as an ABPI survey of *in vivo* employers found over half of the 2,700 estimated animal technologists in the UK are employed by industrial employers and while staff turnover was estimated to be about 10%, CROs report increased need for animal technologists.

ANNEX D – DESTINATION TRENDS FOR GRADUATES WITH *IN VIVO* SKILLS

Biosciences Federation destination trends

As part of Biosciences Federation research into UK capacity to supply *In vivo* skills, data on the destination of students with basic or significant exposure to *in vivo* skills was sought. The data was gathered during the production of case studies for students studying at four universities (based on real life experiences at the universities). The case studies were developed through interviews with academics and considered by focus groups. The trends suggested that:

- About 50% of BScs gaining significant "hands-on" *in vivo* experience with a Home Office licence continue doing further *in vivo* related study or work (about 50% do this in industry)
- About 25% of BScs who gain basic exposure through cadaver work or watching demonstrations continue doing further *in vivo* work (about 50% do this in industry)
- About 90% of MScs who gain *in vivo* experience continue doing further *in vivo* work (about 25% do this in industry) and about 50% of PhDs who gain *in vivo* experience continue doing further *in vivo* work (about 60% do this in industry).

These trends are not exact and there could be large variances in the trends depending on the nature of the courses, student interests of the student intake and employment opportunities at the time.

It can be assumed, however, that the trends are unlikely to have underestimated the numbers likely to join industry as:

- HESA data (see annex E) shows that overall 25% of the students join employers which could be the employers which need *in vivo* skills;
- The students may not necessarily be those with basic or significant *in vivo* skills which employers value; and
- The students could be entering positions which do not require *in vivo* skills.

There is the possibility that a significant number of the students who did not respond to the student destination survey did in fact join industrial employers and they did have *in vivo* skills but there is no evidence to back this assumption or clarify if these students had *in vivo* skills.

The Biosciences Federation research identified that many of the best graduates with *in vivo* skills use the skills to enter medicine or dentistry, in addition to the majority continuing with their studies.

In light of the complexity of trying to calculate destination data recommendation 1 of this report recommends *in vivo* departments try to monitor the destination of graduates who have obtained *in vivo* skills to help create a more accurate picture of how supply is meeting demand can be developed.

ANNEX E – HESA DESTINATION DATA FOR RELATED COURSES *IN VIVO* WORK

This report considers that physiology (B120), pathology (B130), pharmacology (B210) and toxicology (B220) are most likely to include exposure to *in vivo* work. Biochemistry and subjects aligned to biological sciences may also include some exposure but this is likely to be less in-depth than that offered in the four sub-disciplines above.

HESA first destination data on of leavers from higher education courses in the subjects concerned (JACs codes B120, B130, B210, B220) shows about a quarter of all graduates end up in full-time work which has Standard Industrial Classifications (SICs) that are likely to be biomedical industrial employers. The SICs used in the analysis were:

- Manufacturing of pharmaceuticals, medicinal chemicals and botanical products (2,440)
- Manufacture of chemicals and chemical products (other 24)
- Research and development activities (75).

Pharmacology graduates are the most likely to join industrial employers, followed by toxicology and physiology graduates. The pie charts (1, 2, 3 and 4) below show the percentages of graduates in full-time employment who are likely to join industrial employers. Pie charts (5, 6, 7) show overall destinations trends for the subjects concerned.

The Second most popular form of full-time work was health and social work (25% reported working in SIC 85). Other popular work destinations were retail sale of pharmaceutical and medical goods, cosmetics and toilet articles (SIC 52), education (SIC 80), other business activities (SIC 74) financial services related work (SIC 65,66 and 67) and public administration (SIC 75).

Chart 1

Percentage of First Degree and Msc Physiology graduates joining industrial employers

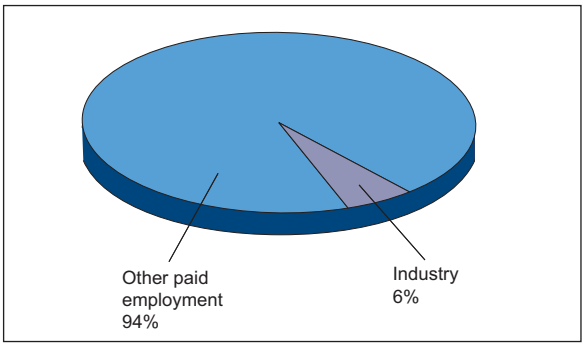


Chart 2

Percentage of First Degree and MSc Pharmacology graduates joining industrial employers

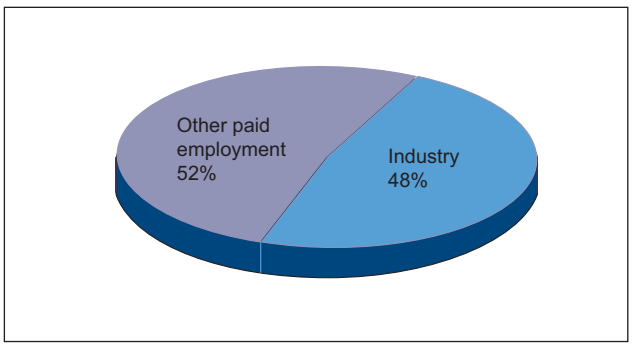


Chart 3

Percentage of First Degree and Msc toxicology graduates joining industrial employers

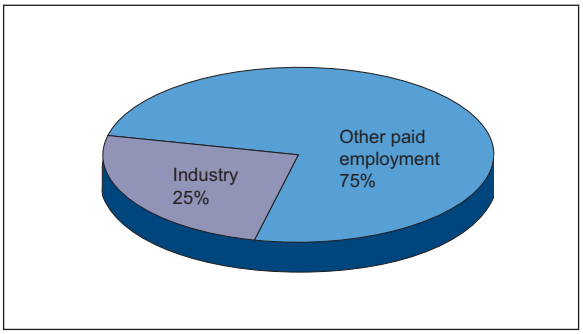


Chart 4

Percentage of First Degree and Msc Pharmacology, Toxicology, Physiology and Pathology graduates joining industrial employers

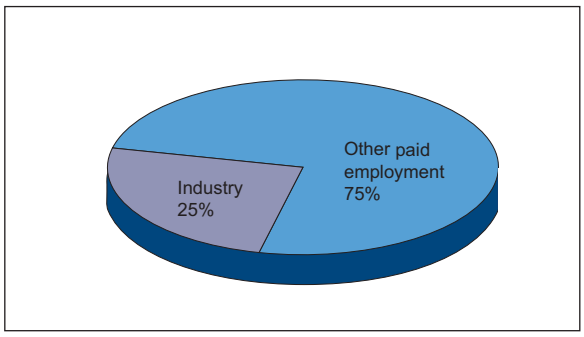


Chart 5

Destination of 2005/06 First Degree and MSc students studying Physiology

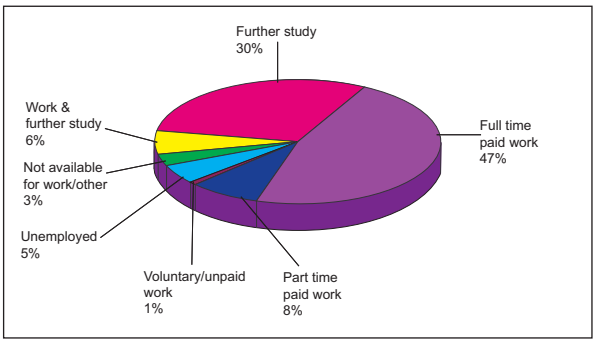


Chart 6

Destination of 2005/06 first Degree and Msc students studying Toxicology

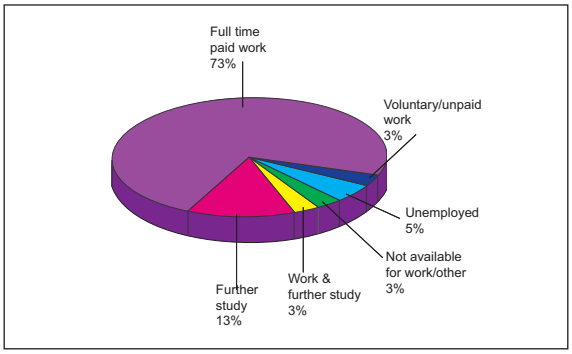
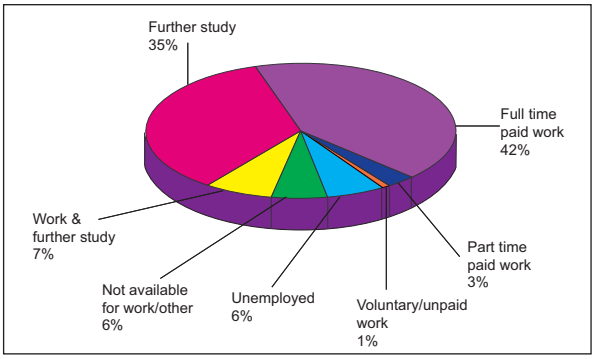


Chart 7

Destination of 2005/06 First Degree and MSc pharmacology students



Conclusions on student destinations and validity of destinations assumptions made in this report

The data shown above is for students from courses which are thought likely to provide some introduction to *in vivo* work. The conclusion from the data that about 25% of students end up in employment which could be with employers seeking *in vivo* skills is broadly consistent with the conclusions of research the Biosciences Federation conducted into the destinations of students that have basic or significant *in vivo* skills (annex D has more detail).

ANNEX F – STUDENT EXPOSURE TO *IN VIVO* TECHNIQUES

1 The British Pharmacological Society (BPS) and the Physiological Society survey of Heads of Department Committees in 2004 provided data on numbers of students who receive a "hands-on" education in animal research techniques. It found that of the 8,000 graduates of Physiology, Pharmacology, Biomedical and Biological Sciences completing their studies every year, only about 120-150 graduate had exposure to hands-on *in vivo* work. Hands-on skills are likely to be skills acquired under Home Office Licences. It identified that there is also likely to be some exposure, either through demonstration classes or employer placements, but this exposure was only available to a small subset of graduates, and the number taking these options varies annually.

2 To help clarify whether there had been a decline in the numbers graduating with the exposure since 2004 and to further clarify how many have gained exposure through demonstrations, cadaver work and employer placements, the Biosciences Federation (with the support of the ABPI) conducted a similar survey in February 2007. The survey asked heads of Pharmacology and Physiology Departments across the UK to identify how many graduates received exposure to *in vivo* work. The survey sample was identified by the British Pharmacology Society and The Physiology Society.

3 The 3 charts below show the number of students at different levels who receive exposure to in vivo work and related techniques through hands-on exposure, cadaver work or demonstrations. The number of students receiving each type of learning is marked on the top of each bar. The size of the bars show how the numbers equate to a percentage of the total number of students at the level in question receiving the learning this way.

4 The charts do not capture the considerable number of students who receive exposure to *in vivo* techniques through only theory-based means. This report estimates that just under 2,000 students complete BSc and MSc courses in sub-disciplines likely to include at least some theoretical exposure to in vivo work each year. Another 1,000 students graduate from biology based courses that may also give some basic introduction to the concept or ethics around the use of animals in science. This basic introduction is different from the more in-depth consideration of *in vivo* techniques and related complexities (in terms of the science, animal welfare, practical aspects and ethical issues around how to use animals) that students on the courses covered by the Biosciences Federation survey are likely to receive.

5 The figures in the charts do not necessarily represent the number of graduates to finish the courses with the skills each year. For example, the number of BSc level students is likely to include three intakes of students. Exposure to in vivo techniques and the complexities around it through cadavear or demonstrations could occur in any year, so the number should be divided by three to reach the number graduating from universities with this type of exposure each year. Only about half of the 197 estimated to receive hands-on exposure graduate each year as this exposure is gained in the second and final year of the courses. The number of MSc/MRes students graduating each year with the skills is likely to be the same as the number shown in the charts as the courses are generally one year in duration. About a third of the number of PhD students graduate each year, as the PhD training generally lasts three years.

6 The research also identified between 40-60 industrial placements which provide exposure to *in vivo* work and up to 40 students gaining exposure through attendance of the BPS and the Physiological society summer courses.

Chart 3(a): Undergraduate level

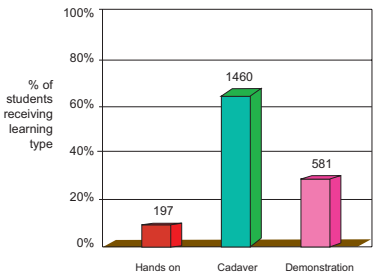


Chart 3(b): Masters level

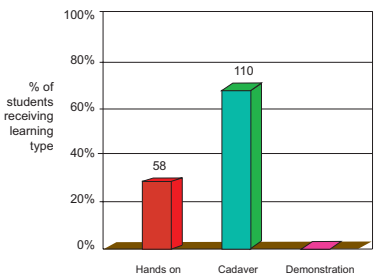
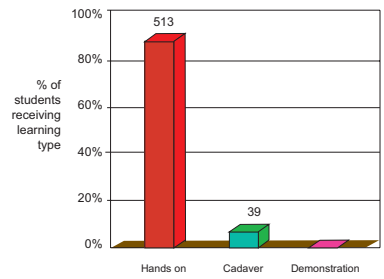


Chart 3(c): PhD/Dphil level



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The Association of the British Pharmaceutical Industry
12 Whitehall, London SW1A DY

Telephone: +44 (0)870 890 4333
Fax: +44 (0)20 7747 1411
Email: abpi@abpi.org.uk
Website: www.abpi.org.uk

Biosciences Federation
PO Box 502, Cambridge, CB1 0AL, United Kingdom

Telephone: +44 (0)1233 400189
Email: info@bsf.ac.uk
Website: www.bsf.ac.uk