The logo has been developed to reflect the wider remit of the fdf organisation as a national body that supports employer engagement across higher education programmes. This has been reflected in both the changes made to the fdf logo itself and through the introduction of the new strap line “Innovating workforce development”.

The fdf logo consists of:

1. The icon or flag
2. The typography
3. The strapline

In the majority of cases the logo should always appear in its entirety, for further information on how to use the logo please progress to section 03.1 and 03.2.

There may be some occasions when it may not be appropriate to use the logo with the line and strap. To use the logo without the line and strap, permission needs to be sought from the Director of Communications. To obtain artwork please contact the Director of Communications:
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Foreword

The University of Reading is pleased to have enabled the SE Universities Biopharma Skills Consortium Project to produce this Report. The detailed investigation that led to the Report has not only brought to the fore the challenges facing the universities, but also identified ways in which they might work better together and with the industry to implement change for the benefit of all parties.

As the Report reveals, it has become increasingly clear over the past five years that, in order to sustain their operations in the UK, the pharmaceutical and related sectors will require more from the universities, including improvements in the quality and quantity of graduates and flexible provision for developing the current workforce. The concentration of biopharma companies in South East England makes the industry’s retention in this region a particular concern for the Government, the Regional Development Agency, and the universities themselves. However, the prevailing conditions in both the industry and higher education have made it difficult to achieve substantive progress towards meeting the biopharma sector’s skills needs. We believe that this Report provides the first steps towards a solution to these challenging issues.

I would like to thank our sponsors, the South East England Development Agency (SEEDA), for funding this project and to acknowledge the valuable contributions of our project partners:

The Open University
The University of Brighton
The University of Kent
The University of Southampton
The University of Surrey
fdf (Foundation Degree Forward)

I trust that you will find this Report of interest and I would be pleased to receive responses to it at the address below.

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Executive summary

The biopharma sector is a vital part of the UK economy; Government, industry and higher education (HE) are therefore keen to ensure that its skills needs are met and that the UK’s excellent track record of innovation and productivity in this field is sustained. In 2008–09, the South East Universities Biopharma Skills Consortium Project, sponsored by the South East England Development Agency (SEEDA), investigated how universities in the region could respond to the biopharma industry’s skills needs as expressed in reports on the ‘skills pipeline’. The project involved the universities of Brighton, Kent, Reading, Southampton and Surrey and the Open University. Its aims were to identify challenges and solutions to meeting skills needs and the resources required, and to explore the idea of a consortium as a means of approaching the task.

Many of the observations and recommendations in this Report reflect those found in both generic and sector-specific reports on meeting employers’ recruitment and workforce development needs, notably the Government’s framework for HE, Higher ambitions (BIS, November 2009), and the Life sciences blueprint (OLS, July 2009). However, this Report differs from and complements those reports by taking a supply-side look at the requirements of a particular sector and identifying existing barriers to serving its needs through higher education providers.

The main conclusions and recommendations from the universities’ investigation were as follows:

- Both industry and academia would benefit in multiple ways from the synergy provided by a formal HE consortium, in which the universities shared effort, resources, expertise and risk. With appropriate resourcing, such a consortium could effect greater change and offer better visibility and responsiveness to industry than institutions acting independently.

- The prevailing financial and institutional constraints in both HE and the biopharma industry have exacerbated the gap between what universities are providing and what the industry wants in its employees. Despite this, there is existing cooperation and joint activity between universities and the industry, at multiple levels.

- The biopharma industry is not a homogenous or consistent market for any type or level of HE, making it difficult for universities to plan in terms of scale, mode or type of provision.

- For long-term benefit, the industry needs to make a consistent commitment to supporting universities in developing key work-related skills in students, notably through placements. In turn, the universities should facilitate industry involvement in curriculum design and delivery and the industry could develop its own potential to deliver validated work-based learning with the support of the universities.

- The industry would benefit significantly from being clearer and more cohesive about its recruitment practices and career paths, to help the universities serve both students and employers well.
Universities need to become increasingly flexible to maximise the benefits and minimise the risks of engaging with a dynamic and changeable industry, including overcoming barriers to joint investment in programme and module design and delivery. They must offer greater and more sustainable variety in modes of study, to meet the changing demands of industry and students.

The development of masters-level, and possibly new doctorate-level, provision could serve both the universities and the industry well. By combining forces, the universities could work more economically in the provision of full masters programmes and shorter CPD packages, increasing course viability and broadening options. With industry and Research Council support, they could devise new types of postgraduate programme targeted to industry needs and conditions.

There is an unquestionable and urgent need to establish and maintain two-way academia-industry communication channels at multiple levels, to allow for well-informed dialogue on operational and strategic matters.

Without industry cooperation and significant development and operational funding from industrial and public sources, the universities are severely constrained in their ability to meet the biopharma industry’s needs.

The individual universities are alert to the needs of this and related industries and already actively address them at all levels of HE, supported by public and industrial funds as well as their own resources. It is clear, however, that more work needs to be done and that substantive progress will be difficult to achieve without further, coordinated effort between themselves, the industry and Government bodies. The universities are pursuing this collaborative investigation and engaging in focused dialogue to improve the ways they work with and for the industry, individually and collectively. Importantly, they are also exploring ways of engaging with the industry and Government bodies in a more strategic dialogue, including through the release of this Report.

This Report highlights the following key areas for development if we are to succeed in our aims:

**Developing effective and sustainable new modes of study and delivery** will require funds to buy out academic staff time and buy in technical expertise in digital development. The universities can combine their expertise in this area, but industry involvement will be necessary to ensure that both industry and academic conditions are addressed and coordinated, and to optimise the exploitation of work-based learning.

**Giving students the industrial experience that the sector seeks** in graduate recruits can only happen if the industry creates an ample and consistent pool of placements and internships, and supplements the specialist technical training that is increasingly hard to deliver in the universities.

**Devising and developing new types of masters and doctoral programmes**, which suit industry conditions and requirements, are both attractive and useful to students, and viable and sustainable within the universities, requires joint and equal effort by industry and academia, and the backing of the Research Councils. Significant developments will require funding to
buy out staff time in both industry and academia and to pump-prime new programmes.

**Identifying and anticipating industry needs** is essential if the universities are to plan and deliver appropriate and sustainable provision in the right balances and provide sound and timely information and advice to prospective and enrolled students. Creating spaces and mechanisms for sharing intelligence between academia and industry will require institutional, industrial and public investment.

It is clear, therefore, that HE cannot fully play its part in supporting the UK-based biopharma industry without the cooperation of the Government and the industry itself. This Report proposes many ways in which the universities and the industry can work collaboratively towards developing the skills base that the industry requires. However, a global industry such as pharma has no intrinsic need to invest in creating an environment conducive to its operations in the UK and it is therefore likely that the financial impetus will need to come from Government and its agencies.

Many of the initiatives showcased in recent reports on academia-industry engagement have relied initially on development funding from Government bodies to meet the needs of a given sector. *Higher ambitions* (p. 45) stresses that the Higher Education Funding Council for England (HEFCE) should devise new funding incentives for universities to develop HE programmes that deliver the skills needed for economic growth and especially those in the *New industry, new jobs* strategy, which includes biopharma. It is to be hoped that the universities’ willingness to address some of the key challenges set out in this Report will therefore be matched by appropriate practical support and collaboration from industry and financial support from Government.
1 Introduction to the project

The SE Universities Biopharma Skills Consortium Project was set up to investigate how universities in the south east could better address the skills demands of the biopharma companies operating in the region, and the desirability and feasibility of the universities working together as a consortium in this regard. The investigation was prompted by industry reports on the ‘skills pipeline’, principally those published by the Association of the British Pharmaceutical Industry (ABPI) in 2005 and 2008 and the ‘Edwards’ Report from Pfizer, Sandwich, in 2007. These successive reports indicated not a new but a greater and more urgent problem, which persisted despite much existing cooperation between universities and the biopharma sector in regional, national and European contexts. They also presented a clear call to the universities to respond to the sector’s needs.

The University of Reading led the investigative project, working with the Open University and the universities of Brighton, Kent, Southampton and Surrey. The participants’ overarching ambition was to submit a collaborative bid or bids for funds to support the universities in development and delivery in this area. The project also involved fdf (Foundation Degree Forward), whose work to support a biopharma employer consortium, primarily aimed at meeting the sector’s higher-level skills demands in workforce development, had initially brought together the views of employers and the universities, and prompted the release of funds from the South East England Development Agency (SEEDA) to support the further investigation by Reading.

1.1 Importance of the pharmaceutical and biotech sectors to the UK and the south east

The universities were keen to respond positively to support an industry of critical economic importance to the UK and the south east. The UK is a world leader in pharmaceuticals, medical biotechnology and medical technology. The pharmaceutical sector’s investment, in 2007, of £4.5bn in R&D makes it the leading UK sector on that measure and represents over a quarter of all UK business R&D. The UK medical biotechnology sectors leads Europe in the number of drugs at all stages of clinical development. The SEEDA region is home to almost 1000 health technology companies, generating revenues of £58bn annually. 14 of the world’s top 20 pharmaceutical companies (by revenue) are located in the region, with 300 pharmaceutical companies in total. The sector employs over 200,000 people, including associated services, and 30% of the UK’s life science research and development occurs in the region.

However, the industry is increasingly moving eastwards to India, China and elsewhere. It is not clear how far, if at all, these moves out of the UK relate to the reported unavailability of skilled staff here or skills deficiencies in graduates from UK universities; these are strategically important markets as well as sources of cheaper and abundant labour. Nonetheless, the Semta labour market survey reports shortage figures in this sector at levels roughly five times higher than for all UK firms, and the industry’s movement out of the UK is certainly a prompt for the Government, through its Regional Development Agencies and other bodies, to look for action among univer-
sities to provide a better match between higher education outputs and business requirements.

1.2 Project aims and methodology
In order to identify areas for action and improvement, the project sought to explore and articulate current practices and recent experiences in the universities relevant to the skills problems raised in the industry reports. Over 40 members of academic and related staff were interviewed in the six institutions. Further meetings were held with industry representatives, but the investigation’s main purpose was to capture and convey the universities’ experiences and ambitions, as a supplement to the industry reports. Some interviewees regretted that HE had not been given the chance to feed fully into, for example, the ABPI reports. The interviews were therefore intended, in part, to address frustration that the universities’ voice is not always heard, and that the conditions of HE today are therefore not duly recognised or understood, or the universities’ experience and expertise learned from.

The project therefore took a novel and holistic, provider-based, ‘supply side’ look at meeting the needs of a particular industrial sector. While the ‘demand’ side of the skills equation is usually expressed from a sector perspective, embracing all disciplines which feed into biopharma, the ‘supply’ side has generally been explored from within individual disciplines or in relation to subsections of the industry, by third parties such as the Royal Society of Chemistry or the relevant Sector Skills Councils (Semta and Cogent).

1.3 Project findings and recommendations
Based on the findings from the investigation, this Report considers the prevailing conditions in HE and the industry and identifies areas for action by both parties, mostly reported under thematic headings below. It emphasises the advantages of, and in some instances the necessity for, closer cooperation both between the universities and the industry and between the universities themselves.

In general, the response from academics to industry’s requirements was positive. There was no resistance to the principle that HE should be responsive to employers’ needs, even if the extent of that response was a matter for debate. While the purposes, aims and traditions of HE, and its value to a range of students, were to be safeguarded, there was no preciousness about education for its own sake to the exclusion of other considerations.

However, there was unanimous agreement that many of the changes that the industry wishes to see effected in HE will require it to play its part, through information and support, and not simply hand over its problems to the universities. It was also felt that, to make a noticeable difference, any adjustment in behaviour on each side would need to be on a large scale, involving broad and major changes, as well as smaller, targeted measures.

There is certainly no inertia or resistance to change at present. All institutions have strong links with industry and are already working hard to respond to its needs in both graduate recruitment and workforce development, including some very recent initiatives at all levels of higher education.
1.3.1 Responses to industry perceptions of graduate quality

Many academic staff believe that the industry expects too much of graduate recruits, as regards level of maturity and general work and life experience, as well as breadth and depth of knowledge, and particularly ‘specialist’ knowledge. They consider that employers should not expect graduate recruits to be ready for effective work from the start, but ready to be moulded into the ways of the industry, the company and the role. This perceived misalignment of expectations needs to be addressed early on to ensure that it does not become a barrier to constructive talks and measures to address real skills gaps.

Many academics believe that the best undergraduates are as good as they have ever been and that the particular strengths of today’s graduates (they are often better at presenting, at talking to people and at IT, for example) are sometimes overlooked in accounts that focus solely on ‘deficiencies’. Neither are the greater demands that the industry now makes on new recruits always acknowledged. Some staff suggest that the industry’s view of graduate quality may in any case be skewed by its lack of exposure to the most able candidates, who have a wider range of post-graduation options, including doctoral study or employment in better-paid or more attractive sectors.

On the other hand, academic staff generally supported the industry’s view that students often lack problem-solving experience, capacity for independent learning, and ability and/or willingness to synthesise across pockets of learning. However, there was a strong feeling that, although exacerbated by modularisation of HE courses, these problems stemmed principally from learning, teaching and examination practices in secondary education. The universities are suffering from the same problem as the industry: they are not getting what they used to get 20 years ago. It is also important to note that the UK has moved in this time from an ‘elitist’ to a ‘mass’ higher education system, which necessarily affects perceptions of student and graduate quality within the universities, the industry and beyond. Broader societal changes, not least those stimulated by new technologies, also mean that the student body today cannot easily be measured against that of the past.

1.4 Ongoing project activity

Although the SEEDA-funded project has now ended, aspects of its work are being pursued in the short term through a collaborative project by the universities of Reading and Surrey under HEFCE’s Economic Challenge Investment Fund (ECIF) scheme [see Appendix]. The ECIF bid was informed by the consortium project’s interim findings and ambitions and the HEFCE award (together with part match funding from SEEDA) will enable the group to gather intelligence about skills needs direct from the industry and, importantly and unusually, from new graduates entering the sector. It will also establish and consolidate relationships with companies operating in the region, particularly SMEs, through which further and broader engagement can be leveraged. The learning from this project will help the consortium to recognise and address barriers to cooperation between themselves and to working with industry. Publicity surrounding the award has already brought contact from other individuals and bodies looking at the biopharma skills question and some fruitful exchange of ideas and synergies.
Recent attention paid to the life sciences at the highest levels, notably the *Life sciences blueprint* published by the Office for Life Sciences in July 2009, makes this Report particularly timely. Likewise, the recommendations embodied here with regard to the biopharma industry closely match the generic recommendations expressed in the recent report from the CBI Higher Education Task Force, *Stronger together: businesses and universities in turbulent times* (September 2009). It is hoped that the SE Universities Biopharma Skills Consortium Project Report will be used to inform and add weight to the debates and action-planning currently taking place elsewhere.

2 Background conditions in HE and biopharma

The difficulties of attracting students to STEM subjects in schools, colleges and universities, and perceptions of science and science-based careers and salaries, continue to receive media attention and to cause concern at the highest Governmental levels. Despite some reports of increasing participation in sciences in secondary schools, the projections for the future of science-based industries currently remain bleak. However, it is important to recognise that the impact of Government initiatives to improve the delivery of scientific and mathematical education, for example, has yet to be felt.

Against this general background of STEM supply and demand, the investigation drew attention to some prevailing conditions in both HE and the biopharma industry which largely explain the problems experienced within and between the two, and which any solutions must therefore address. Both parties have undergone radical changes in recent years, not all self-determined.

2.1 Background conditions in HE

The broad conditions of today’s HE sector include:

2.1.1 The educational state in which students arrive from secondary education

Academic staff often find that students come to HE less equipped to learn in the ways that they would wish to teach them and the first year of an undergraduate programme can be spent getting them to the point at which they can start learning at ‘university’ level. The quality of secondary-level STEM education in particular is questioned within and beyond the universities.

2.1.2 The numbers of students arriving and the range of abilities now that HE embraces a broad rather than an elite population

The consequences of Government ambitions to increase participation in higher education are not widely acknowledged when the industry finds graduate recruits wanting. Students come to the universities in vastly greater numbers, with different expectations, and a wider ability range, affecting the range and types of learning and teaching that are possible therein.

2.1.3 The HE market and the ‘customer’ mentality of students and parents

HE has multiple ‘customers’, including the potential student (and parents), the enrolled student, the prospective employer, the Government (via HEFCE), and accrediting professional bodies. Even the needs of the first two do not

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5. For example, a recent report from the CIHE STEM Policy Group, while recognising that the 14–19 Diplomas may, in the longer term, have a positive impact on provision and uptake, noted the ongoing need to modernise school curricula. *The demand for STEM graduates and postgraduates*, CIHE, January 2009, p. 2.
necessarily overlap, as what attracts students to a course may not be what they want from it two years later (see Section 4 on placements). However, prospective and enrolled students do share more customer-like expectations, not least in relation to anticipated returns on their investment beyond graduation, including in the job market. The student voice is increasingly raised and taken note of; the wants which it articulates, and which universities must address in order to provide customer satisfaction, do not necessarily coincide with the needs of employers or other ‘customers’. Some key STEM discipline areas have declined in popularity, sometimes to the point of department closure; courses have been reworked and renamed to capture popular imagination (eg forensic science). Student choice within a modular programme can be antithetical to the industry’s preference for candidates with a solid grounding in their own discipline. On the other hand, a university may design courses which should offer employers the graduates they desire, but there is nothing to be gained by either side if the courses do not attract students, as is sometimes the case.

2.1.4 Modularisation and the compartmentalisation of learning and knowledge
Modularisation was introduced partly for flexibility of study within and between institutions, including increasing the potential for part-time study. However, the anticipated benefits of this way of structuring university study have not been realised to any great extent. Instead, customer choice and expectation of achievement has sometimes led to a mindset and framework of credit accumulation and the compartmentalisation of learning and knowledge in tertiary as in secondary education.

The quality assurance mechanisms which regulate undergraduate and increasingly postgraduate taught programmes can be counterproductive; they can restrict flexibility, innovation, spontaneity and the ability to test students across pockets of learning, making it difficult to encourage or test the type of synthesis and application of learning which the pharma industry and others seek. Even at masters level students have been known to object to being required to apply learning from one module in another in assessments, so that testing and grading take precedence over intellectual development, and a key learning opportunity can be lost in the process of accumulating credits.

While many students choose modules wisely, or have their choices restricted by professional accreditation of programmes, others seek the options which will give them ‘easy’ credits.

Some academic staff echo the industry’s complaints about the dilution of discipline content with modules outside a core degree programme (in the name of ‘student choice’), although there are many examples within the universities of successful mechanisms put in place to counteract either the trend or its consequences.

2.1.5 Decreasing emphasis on technical training and development of numeracy skills
The type of education formerly provided by the polytechnics, with all its strengths (and its ability to provide, for example, the technically proficient staff which the industry needs), has declined. It is difficult to replicate within university programmes and larger classes, as discussed further under Section 3.2.1.
Mathematical ability is widely acknowledged as a problem, inherited by the universities and difficult for them to remedy (see Section 3.2.3).

2.1.6 The insufficient and changing nature of funding for STEM courses (despite recent injections of Government funding), including the impact of adjustments to Research Council funding practices

Research Council funding for masters programmes is spread more broadly, leaving some established courses vulnerable to low student numbers. The expectation that the industry will support students on courses which are to its own benefit is not always met in practice. There is some frustration in academia with the Government’s belief that employers will pay their share of costs arising from the ‘employer engagement’ agenda just because they ‘should’. Biopharma is a global industry and has the option of looking for more conducive environments elsewhere rather than investing in the development of a UK-based workforce. There is a real danger that the skills gap will worsen as undergraduate and postgraduate students fall into the funding chasm between Government expectations and industry reality.6

2.1.7 The unreliability of development and delivery funding from Government and industrial sources

While the universities implement many changes at their own expense, it is difficult to make a step change without dedicated resource to develop and establish new courses, particularly where these have, typically at masters level, a narrower focus appropriate to developing some of the specialist skills required by industry, and therefore a more limited market. Funding from public and industrial sources is sporadic and often insufficient to effect real, sustainable change to the benefit of all parties.

Some of the universities’ problems arise from tradition rather than change: for example, they often suffer from inflexibility in modes of delivery, internal structures and processes, and sometimes mindsets, hindering innovation in ways of working with and for the industry and with each other. Nonetheless, higher education now takes place in a very different environment than most current middle and recruiting managers in the biopharma sector would themselves have experienced.

2.2 Background conditions in biopharma

Meanwhile, the industry displays some established and new characteristics, following the disaggregation and reorganisation of its structures and operations. These include:

- new sorts of work and working practices and vastly increased complexity, including extensive outsourcing within and beyond the UK
- concomitant increases in skills and knowledge demands on recruits and existing staff
- financial constraints arising from a declining drugs pipeline, patent expiries and other sector-wide factors
- quick shifts of focus and concomitant fluctuations in demand regarding numbers of graduate and postgraduate recruits and particular areas of expertise
a lack of means, and sometimes seemingly of interest, to invest in the educational development of prospective or existing staff, particularly through higher education institutions (HEIs) and a lack of sector-wide action to define and access such provision and to create the economies of scale needed by both industry and academia.

The biopharma sector’s problems are aired repeatedly not only within self-generated publications but also in reports produced or commissioned by Government and its instruments (such as Sector Skills Councils), and general industry bodies (such as the CBI). The sector’s fortunes are closely linked to generic problems with skills gaps at all levels, not just higher, and with the UK’s economic fortunes. Some reports investigating how the biopharma sector can best be supported to play its part in the latter, have highlighted how it is suffering from a number of conditions and constraints beyond its control, including reluctance of investors to invest in emerging bioscience companies (which are a vital part of any innovative supply chain), and tougher regulatory demands in the UK and EU pharmaceutical markets and therefore a general mismatch between the increasing costs of R&D and the pricing of drugs through which those costs might be recouped.8

Although the biopharma industry has some distinct characteristics, many of its skills needs (both technical and generic) are shared with recruiters of STEM graduates in other sectors. So while biopharma is the immediate concern of this Report, both the lessons learned and the Report’s recommendations are likely to be broadly applicable to many science-based industries.

2.3 Challenges for the universities in meeting the industry’s needs

Notwithstanding that upheavals in the industry may contribute to its level of engagement with recent developments in HE, its prevailing characteristics mean that the biopharma sector is not a homogenous or consistent market for the universities, making it hard for them to plan in terms of scale, timing or type of provision. The industry’s needs are not generally articulated in a way that is useful to the universities and are not easily related to what a company is prepared to support, provide or pay for at any given time. The universities have found it challenging to get the industry (including individual companies) to tell them exactly what they would like them to deliver, possibly because it is not clear to the companies themselves, so that no amount of willingness on the part of the universities can move things forward. There is a sense among academic staff that, while both parties have some distance to travel, the industry needs to move first and the universities can then follow. That said, the university sector has much to offer by way of facilitating the early steps of establishing common needs across the biopharma sector; early engagement through this part of the process would establish appropriate relationships and improved understanding.

There appears to be a low level of awareness within the industry regarding both the restrictions and the potential benefits to be found in the HE environment. Individual companies often lack awareness of the existing formal means (such as CASE studentships and Knowledge Transfer Partnerships) by which they could engage directly with universities to the benefit of all parties, including students and graduates.9 Even where they are familiar

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9. A recent report from the BBSRC Bioscience Skills and Career Strategy Panel – Strategically important and vulnerable capabilities in UK bioscience, BBSRC, October 2009 – notes that employers do not ‘demonstrate knowledge of existing mechanisms, such as CASE PhD studentships, by which they could influence the availability of opportunities for students to undertake high-level training in niche areas’ (p. 7).
with what is on offer through the universities, companies can find the related mechanisms too unwieldy.

The universities need to be sure that any significant developments they invest in are likely to have the desired impact on the industry. As noted above, there is no value in providing courses and options that meet the industry’s requirements unless students choose to take them. Many university staff tell of the difficulty of providing bespoke or even simply targeted courses in response to what the industry says it needs, when in practice the student numbers are so small. The take-up of some new programmes which have responded directly to industry needs and to some specific requests has been poor, threatening their viability. Universities will provide modules and courses, and retain staff expertise to do so, while they are financially and educationally viable, usually through sufficient student demand; this demand may or may not be generated by company sponsorship of students, or through co-funding of particular courses to lower the numbers necessary for financial viability.\textsuperscript{10} Many analyses tacitly assume a coincidence of students’ and employers’ interests, but this is not necessarily the case.

The industry’s demands for recruits with relevant industrial experience are difficult for the universities to satisfy in the absence of sufficient and suitable placements in the biopharma sector, as discussed in Section 4. Contractual arrangements can further complicate matters. Some interns placed through the Reading-Surrey Biopharma Skills ECIF project waited several weeks to begin their placements while their host companies queried contractual details. These problems (which delayed the point at which all parties could begin to benefit from the relationship and shortened its effective duration) occurred despite the absence of commercially sensitive material in any reporting requirements or any contestation of intellectual property. Subsequently, the same contractual issues complicated plans for the project’s evaluation, thereby threatening the opportunity to gain some real empirical evidence for the benefit of industry, academia and Government sponsors. However, this direct engagement between the universities and the companies has brought learning on both sides, which will inform future practice.

There is also some concern amongst university staff that although much work could be done and to good effect, the industry (because of its short cycles and own internal changes) will always be asking for more and will never move on from viewing HE as unresponsive to its needs.

2.4 Challenges for the industry

One reason why the biopharma sector is an inconsistent and sometimes inscrutable market for the universities is that it does not work, think, train, or act as a homogeneous sector. This condition is not surprising (or peculiar to biopharma), given the need to balance collaborative working with competitive advantage, but it does lead to a lack of collective responsibility for training and competency development for the benefit of the sector, as opposed to the individual companies within it. Sector Skills Councils have noted this difficulty and are working to address it. Thus while skills statements on the sector’s behalf (such as the ABPI reports mentioned above) offer the universities a guide to ‘deficits’ within the industry as a whole, they are not an effective guide for developing and delivering solutions that

\textsuperscript{10} Strategically important and vulnerable capabilities in UK bioscience, BBSRC, October 2009, is one of few reports to make the same basic and important point (p. 7).
will be taken up at any given time by individual companies, employees or prospective employees. If the sector were to work more collaboratively not just with the universities but also within itself (as does the NHS through its Knowledge and Skills Framework\(^{11}\)), particularly in forecasting future skills requirements across its multiple components, it would provide a more stable and legible market for HE to serve.\(^{12}\) In this and other areas discussed below (such as recruitment) the industry could benefit from a collective approach to creating the pool of talent on which it can draw, within existing employees and prospective recruits.

Despite the fact that much of the SME side of the industry has grown from an academic research base, the industry is not always aware of what is or could be on offer through the universities. It can be hard for companies to negotiate varied university systems to gain this information or even to know what questions to ask, particularly if they are unused to working with HEIs. A university consortium, with a clear and single point of initial contact, should improve visibility and access to the support that the universities can provide.

2.5 New ways of working

In looking for ways forward, the universities and the industry need to work together to determine how things could be done differently under the prevailing conditions outlined above. Both parties have much to gain from an enhanced understanding achieved through dialogue and collaboration, to counter misperceptions, raise awareness and visibility of current provision and activities, and develop new models of collaborative working for mutual benefit.

For their part, the universities must create the conditions for flexibility, to maximise the benefits and minimise the risks of engaging with this dynamic, changeable industry, as with many others.

The industry should seek ways of making a consistent and meaningful commitment to working with, rather than making demands on, academia. A better assessment and articulation of not only its current but also its future skills needs would enable joint action-planning with the universities. In particular, the sector should work to supply the work experience which complements university-based education.

With improved understanding and awareness, the biopharma sector and the universities should work together to access external funds, including exploring new models of funding diverse forms of academia-industry engagement which are more cost effective for the provider and the receiver. Where change is not within their control, the two parties should combine their strengths to exert pressure on third parties.

3 Skills and knowledge development

The universities are under increasing pressure from many quarters to help students develop a broader range of skills within and beyond the curriculum, mostly in the general context of ‘graduate employability’. Within the university departments surveyed for this investigation, there was no sense of an academic environment remote or disengaged from industry. Even staff who do not research or teach in areas directly related to biopharma are

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12. The biopharma industry is, perhaps, less inclined than others to pool resources and take joint action. However, there are examples within the sector of collective (and successful) engagement with universities: the University of Dundee’s Division of Signal Transduction Therapy (DSTT) is a pre-competitive collaboration between the University, the Medical Research Council and six pharmaceutical companies. See Zella King, Division of Signal Transduction Therapy, University of Dundee: a case study, Henley Business School, University of Reading, March 2007.
broadly aware of the industry’s skills needs and fully prepared to support efforts to respond to them, particularly where they overlap with the needs of other industries and of academia itself. (While the needs of the biopharma industry were this project’s particular focus, there was strong feeling within the universities that measures to address them within curricula should, as far as possible, prepare students equally well for other career destinations.)

New ways of working in drug development have led to both new and greater skills requirements. Where, historically, graduate recruits to pharma stepped into roles in a simple hierarchical structure, which they would inhabit for some time and which would therefore involve a high degree of repetition and predictability, they now move into roles which are vastly more complex in themselves and in the networks within which they operate. Multidisciplinary teams work together to minimise attrition in the development process, increasing the likelihood of bringing a new drug to market and decreasing the time taken to do so. Graduate recruits at any level need to be secure in their subject knowledge, able to communicate it to team members from other disciplinary backgrounds, to listen, question and understand what those other team members are saying, and to make connections. They must be comfortable with ‘what if’ thinking and able to make a valuable and timely contribution to a team process where false leads and wrong turns can be vastly expensive in terms of time and money.

However, the disaggregated industry is multifaceted and a contrary view is that the industry seeks ‘super-technicians’ who can undertake a complex technique with minimum instruction and then apply it according to the instruction of their supervisor. It is undoubtedly true that both roles exist and it is important that university courses are available to prepare graduates for each of them.

It is necessary, therefore, to distinguish between changes in requirements and changes in graduate quality, or at least to recognise the relationship between the two.

Reports from the ABPI and elsewhere have given long lists of skills deficits representative of the industry, typically falling under the subheadings below in this section.13

The industry reports suggest that graduates lack:

- generic ‘employability’ skills
- technical and mathematical skills
- broad and in-depth knowledge within their own disciplines
- sufficient understanding of related disciplines
- experience in the multidisciplinarity which is at the heart of current biopharma work and widely seen as the key to new developments.

More specifically, graduates are said to lack grounding in scientific areas currently key to the industry.14 Some misalignment between the universities’ and the industry’s views of what undergraduate education should comprise is inevitable. The industry, or individual employers within it, may be looking at HE curricula in terms of graduates’ fitness for a particular role or against specific (and changing) recruitment criteria, yet universities prepare students for a number of potential roles, of which employment is one (with employment within biopharma as a subset). Direct dialogue between industry and academia, and not simply their representative bodies, would help articulate
and keep pace with ambitions and requirements on either side and consider how these might be better aligned without undue compromise. Placements, graduate internships and other existing forms of engagement and collaborative working provide a ready starting point for this dialogue.

Graduates’ perceptions and experiences of the ‘skills gap’ are also under-explored; the Reading-Surrey Biopharma Skills ECIF project is currently working to complete the picture from the side of the new recruit.

### 3.1 Generic ‘employability’ skills

The newly shaped industry has an enhanced need for strong generic ‘employability’ skills in new recruits, including communication, project management and team working. While many companies may expect, or even prefer, to complete their recruits’ specific technical training in their early months at work, in order to fit local requirements and preferences, they generally seek recruits well placed to acclimatise quickly to the work environment, learn fast and make a contribution from the start. They are looking for recruits who can deploy a range of generic skills in the application of their scientific and mathematical knowledge, including thinking across and drawing together different segments of learning, applying learning to real-life problem solving and anticipating outcomes prior to processes.

Arguably these ‘employability’ skills can only be effectively learnt in the work context and therefore not only has the decline of placements (see Section 4) lessened the scope to develop them prior to graduation but they will in any case develop naturally through employment. The universities are nonetheless working hard to develop these skills in students, by integrating team work, enquiry-based learning and problem-solving into curricula. It is important, however, that they are developed in context, with no artificial division between the skills and the application of subject knowledge, in industry or academia. The biopharma industry could therefore demonstrate its support for these attempts by providing real, current case studies which move students beyond simulations and into real-life problem solving, with all the concomitant learning.¹⁵ The industry may recognise the value of this action, but it needs an impetus and a plan to make it happen.

The inclusion of appropriate industry representatives on university programme advisory boards could be used to improve understanding in both directions and specifically to keep programme directors mindful of the generic skills that graduates need for this and other industries and the industry mindful of its role in supporting their development.

### 3.2 Technical and mathematical skills

#### 3.2.1 Lab skills

The decline in lab skills has been noted both in industry and academia. Greater student numbers and inadequate resources make it impossible to provide all undergraduates with sufficient lab training or to offer all students a ‘wet’ project in their final year. As a result, recruits may be familiar with a protocol in principle, but have not had the opportunity of experiential learning which will enable them to apply it, adapt it or create new protocols in response to changing circumstances. If they do not have access to a ‘wet’ project, students miss the opportunity to consolidate their learning and develop some of the key qualities sought by industry, not least through

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¹⁵ This is one of six key themes emerging as success factors from the employer case studies featured in *Future fit: preparing graduates for the world of work*, CBI, March 2009, p. 17.
generating results that they can call their own and expressing an opinion thereon. Practical lab experience ideally develops not only technical skills but also skills in experiment design, transferable to many contexts and valued by the industry. Lack of lab experience may make graduates less inclined to look for jobs that demand skills they do not feel secure in.16

There are two aspects to the problem: firstly, lack of basic skills and understanding of lab procedures due to insufficient exposure to lab work and especially to equipment-centred learning; secondly, lack of opportunities to develop technical expertise where a student has a particular preference or aptitude. The universities are already working to address these difficulties as far as possible within the constraints of current curricula and resources.17

The effect of these attempts to provide better lab skills training within undergraduate programmes is expected to be evident in future cohorts of graduates. Advanced optional modules within or outside curricula could provide some students with a higher level of expertise, as could vacation workshops serving students and industry employees. A coordinated, collaborative approach between the industry and the universities could support not only students but also academic and industrial staff to see the applications and potential of familiar and unfamiliar equipment in the respective contexts. Again, work is already being done to improve provision in this area.

3.2.2 In vivo skills

The universities have well-known difficulties in responding to the declared shortage in recruits with in vivo experience and skills, including direct and staff-time costs, licensing and security.18 Some universities are therefore already working with industrial partners to provide training at the partners’ premises, while others send students on courses run by, for example, the British Pharmacological Society. Lack of in vivo exposure at university does not necessarily mean that graduates will not be attracted to work in this area, but if the industry wishes recruits to have prior hands-on experience, it will need to support the universities further in delivering training.19

Again, this problem can be considered in two parts: improving awareness in those who need to understand in vivo work as part of a bigger process, and cultivating hands-on skills in those who will be practising it. Within the industry, there is also a distinction to be made between the deployment of in vivo skills and understanding in a routine context and their application in a research context; that is, between recruiting staff to undertake, or be trained in, the technical application of existing knowledge, and recruiting specialists to develop new models. In the latter case, it is the combination of in vivo skills and understanding in a routine context and their application in a research context; that is, between recruiting staff to undertake, or be trained in, the technical application of existing knowledge, and recruiting specialists to develop new models. In the latter case, it is the combination of in vivo and research skills which is particularly valuable, rather than simply technical experience and ability. Here, as elsewhere, there is a lack of clarity about the industry’s requirements, how they differ between its various parts (eg big pharma and contract research organisations), its expectations of graduate as opposed to postgraduate recruits, and likely demand for both ‘types’.20

While there is no substitute for real-life experience, it is not necessarily a requirement for those who need to understand rather than perform the process. The first part of the problem could therefore be addressed through developing interactive screen experiments (ISEs).21 These ISEs could also be used as an introductory course for those pursuing real skills development in this area, thus minimising the resources required overall. The value of such
screen experiments has been demonstrated in other areas (e.g., physics) where experimentation is demanding of resource and time. They also overcome difficulties of large class groups and offer flexible access. However, the development of suitably sophisticated resources requires dedicated staff time and therefore project funding.

Moreover, although limiting real in vivo work to smaller numbers will have some impact on costs, it does not diminish other problems, such as licensing, which cannot be overcome without action beyond the universities or industry.

3.2.3 Mathematical and statistical skills
As with lab skills, the deficiencies in maths-related skills are recognised in academia, industry and beyond. The poor mathematical skills of many science students and graduates are attributed to three main causes:

- the nature of mathematics taught at Key Stages 3 and 4, which often results in poor mathematical knowledge and competency in entrants to undergraduate science courses who do not have mathematics at AS or A2 level
- the lack of requirement for AS/A2 Mathematics for entry to most undergraduate science courses
- the nature of mathematics taught at AS/A2 levels, which means that even students arriving with those qualifications are not necessarily as well equipped, mathematically, as the universities would expect them to be.

Within the universities, staff find some students unable to select the appropriate mathematical tool in given circumstances, or to use it, however simple. However, there are mixed views on requiring A-level Mathematics for entry to undergraduate science courses, partly because it would deter students from applying, and partly because of a belief that students should not really require maths skills at A level. However, assumptions about both GCSE and A-level standards and content are often misplaced and the heterogeneity of A-level courses and module choice within them makes it difficult to know what a student has studied in order to achieve the qualification or to assume that all such students arrive with the same mathematical knowledge and competency.

The universities generally provide remedial courses, sometimes compulsory, but students may be disinclined to pursue subjects they chose not to follow at A level, and resentful where these are a requirement. The take-up of any optional mathematical or statistical training in the universities will, of course, depend on the students’ perception of its necessity and their ambitions or otherwise to enter an industry which requires this proficiency. As in other areas, the more common ground that can be found between provision for this and other industries, the better. Improved information and advice at secondary level would help clarify that a student will require good mathematical skills to progress in a scientific career and that those skills will also enable them to get the most out of their undergraduate science programme.

The mathematical ability of students arriving at the universities may improve in due course through Government initiatives throughout schools, from the ‘numeracy hour’ onwards, but it is too soon for their impact to be evident or accurately forecast. In the meantime, the industry is already working to
provide a better understanding and articulation of what it requires in this regard in graduate entrants from science courses, at which point the universities will be better placed to consider how to help it meet its needs.

The deficits in mathematical and statistical skills articulated by the industry cover not only a general poor standard of mathematical competency among graduate recruits, but more specific deficiencies in areas pertinent to the contemporary drug development process, such as statistical and quantitative analytical techniques. Again, the industry’s requirements have been amplified by new ways of working. The importance of improving mathematical and computational skills in industry staff and new recruits, and the need to ‘convert’ mathematicians and statisticians to biopharma, arise also from the desire to pursue an integrative and systems biology approach to biopharma research.

Despite the general agreement across academia and industry that mathematical ability is a problem, the ‘gap’ varies according to discipline (it is reputedly less evident in chemistry graduates than those from biosciences) and recruitment context. Requirements will vary between companies and departments and mathematical ability will be prioritised accordingly in recruitment selection criteria. Increasing emphasis on ‘soft’ skills in graduate recruitment may mean that unrealistic or untested assumptions are made about other key skills.

### 3.3 Subject knowledge and curriculum expectations

The industry’s observations that new recruits have insufficient knowledge within their own discipline are likely to arise more from a mismatch of expectations about what should be taught in undergraduate programmes than an inherent deficiency in those curricula. There is also no evident agreement on this matter across the biopharma sector. Better dialogue between the industry and the universities and within the industry itself could lead to agreement about some key components of curricula suited to this and other industries, as well as to academia’s own needs. Accreditation of degree programmes by professional bodies has helped firm up some existing curricula and these bodies may be a route for the industry to voice its needs.23 However, alongside calls for thorough coverage of individual disciplines in undergraduate curricula and criticisms of the dilution of those curricula with non-scientific material outside the purely scientific, come calls within and around the industry for more interdisciplinarity, as the key to innovation in the sector. Like other aspects of specialisation, many within and beyond the academic community consider that interdisciplinarity in individuals is best developed at masters level.24

In other fields, industrial partners have designed modules for inclusion as final-year options, with the intention of priming students for an industry they have expressed an interest in joining.25 Similarly, some university courses have a common core in the initial years followed by a final-year specialism linked to a distinct career route or industry application. This approach minimises ‘interference’ with the main body of the programme and also brings the advantages of direct industry engagement for participating students, as well as the dialogue between academia and industry over learning and teaching issues which would be welcome in the area of

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23. One of seven key actions in the recent Life sciences blueprint relates to the accreditation of undergraduate bioscience degrees by the Society of Biology. However, the BBSRC’s Bioscience Skills and Careers (BSC) panel has questioned whether the current funding model gives the universities sufficient capacity to run courses to meet accredited standards. See Strategically important and vulnerable capabilities in UK bioscience, BBSRC, October 2009, p. 5.

24. See, for example, The review and refresh of Bioscience 2015, BERR, January 2009, p. 57.

25. See, for example, interview with Mike Pilbeam, VP, Cisco Systems at http://www.engsc.ac.uk/engage/industryacademia.asp, in which he explains how some universities have integrated Cisco-accredited training programmes into their undergraduate curricula. Examples include the BEng and BSc programmes in Network Computing at Staffordshire University and the BSc Networking and Systems Support at Glasgow Caledonian University.
biopharma. The opportunity to specialise in the final stages of a degree, rather than from the start, should also ensure that this route enhances rather than limits a student’s job opportunities.

An alternative to industry-specific ‘interventions’ in the university curriculum is to build on the graduate internship model currently being explored through the Reading-Surrey Biopharma Skills ECIF project [see Appendix], with universities supporting industry in the ‘conversion’ of new recruits to the biopharma industry. In this model, the new recruit pursues training on the job and through an industry-defined university short course(s). If the industry were to agree on a common core of material for the universities to deliver, then not only could critical mass be achieved to allow the providers to sustain the programme, but the interns themselves could transfer the benefits of their training to other employers in the sector, if necessary or desired.

3.4 Knowledge deficits in specialist areas

The last aspect of the ‘skills gap’ arises from requirements, sometimes temporary, for expertise in specialist areas. When a requirement cannot be met, there is a skills shortage and consequent demands for improved supply, mostly through masters-level programmes. However, these requirements, and therefore the shortages, change regularly in response to factors other than the supply of qualified graduates or postgraduates. Not only is it difficult for universities to respond quickly to sudden demands, but they should also be wary of over-catering for what may be a short-lived or intermittent shortage. Some ways of managing the risk in catering for an uncertain market are discussed in Section 6 on masters programmes and Continuing Professional Development (CPD).

4 Placements

The value of industrial placements (to individuals, institutions and industry) is universally recognised, as are the difficulties with comparability and consistency of provision (regarding both quantity and quality). Whilst not always willing or able to provide placements, companies in the biopharma sector look for relevant work experience in their graduate and postgraduate recruits.

Many recent generic ‘skills’ reports exhort employers to provide short and one-year placements, for the benefit of students and ultimately industry. However, the recent recession and related factors, including the restructuring of the industry, have exacerbated the problem of supplying placements in this sector and intensified the need to develop ways of tapping into the SME ‘market’ to help meet demand.

Placements have been a longstanding if by no means a universal feature of undergraduate chemistry courses. However, whether for reasons of supply or demand, relatively few students currently have a placement year as part of their BSc or MChem course (15% and 35% respectively). There is less tradition of placements in biological sciences programmes, but these are increasing, at least within some of the universities involved in this study. The placement year has itself moved, in many cases, from the more-or-less freestanding ‘sandwich’ year (which took place within but did not necessarily form an assessed part of a degree) to a programme of work-based learning, often complemented by
ongoing remote study through the university, attracting credits and contrib-
uting to a student’s overall degree classification. This shift has made not only
the supply but also the quality and comparability of placements a concern for
universities, students and accrediting professional bodies.

4.1 Challenges in placement provision
The universities can experience difficulties not only in guaranteeing the
availability of placements and in setting them up, but also in managing and
assessing them where they form a fully accredited part of a degree. Where
a placement is a significant assessed element of a degree programme, it is
particularly important to ensure that all students have comparable scope to
learn and to perform; they are effectively customers in this regard. Where
a course is accredited by a professional body, the latter may be cautious in
accepting work-based learning where a placement is undertaken in lieu of
university-based modules or otherwise forms an integral, assessed part of a
degree programme.

There are sometimes issues of confidentiality, where students report on
projects which include commercially sensitive material. These difficulties can
be overcome, but the process is not simple and may need renegotiating with
every new contract. As noted above, contractual concerns can be a barrier to
engagement even where confidentiality is not under threat.

With more institutions and programmes pursuing placements within
biopharma, competition has increased for universities and students. For the
latter, the shortage of placements has meant that the application process has
become almost as rigorous as that for recruitment to a permanent post, and
potentially off-putting.

Placements are often seen and used successfully as a means of attracting
students to a university course, but students are sometimes later disinclined
to pursue them. Finance and time may be factors, but some students also
do not like to be split from their cohort two or more years into their degree
programme. The problem will be exacerbated if students become more
inclined to compress rather than expand the duration of their study in the
face of rising fee levels.

The universities’ experience, generally, is that businesses in the biopharma
sector do not want to host placements of less than a year, and certainly
look for a minimum of six months, to justify the investment in training the
placement student in this complex and high-risk environment. However,
some companies do offer much shorter familiarisation placements. For
example, GlaxoSmithKline (GSK) runs a fully funded week-long summer
placement scheme for chemistry undergraduates thinking of working in
the pharma industry. Such schemes provide a dedicated but limited space
for some technical and generic skills development rather than the broader
benefits of extended work experience.

The universities recognise that companies, too, can find placements a
challenge. Those newly involved in providing placements (typically but not
exclusively SMEs) may struggle initially with the responsibility to devise and
deliver a programme of learning, particularly where this forms an assessed
part of a university programme. The host cannot always fully exploit
placement students because they lack the necessary education, maturity,
experience, clearance, professional accreditation, and so on.
A better understanding of the value of hosting placements would be welcome and it is hoped that the Reading-Surrey Biopharma Skills ECIF project will provide insights into the views of big pharma and SMEs, and that these can be articulated to the sector to encourage broader participation. However, it is unlikely that sufficient provision of placements will be achieved without financial backing from public sources.

4.2 Action by the industry

A properly managed, consistent, quality-controlled placement scheme for the sector could provide a focus for employer input into degree programmes and give the industry the chance to address directly many of the skills deficits it itemises, with support from the universities. As a first step, the industry would be responsible for assessing the quality of a placement opportunity and defining entry and exit states. There is already action on this front, looking particularly at how the involvement of SMEs can be facilitated and the quality of placements regulated.

A natural next step would be for the industry, as a body, to assess and accredit students’ learning and performance on these placement years, not necessarily as part of a degree programme but in their own right. Among other things, this would relieve the current difficulty the universities have in embracing assessed placements within their quality assurance frameworks and strike a balance between the full integration of an assessed placement into university programmes and the traditional sandwich year’s comparative detachment from structured learning.

A placement which is truly useful to all parties can be hard to develop, particularly if it lasts less than a year. However, company-sponsored undergraduate studentships – traditional in some other industries – would extend the relationship over three or four years, bringing return on investment and potentially assisting graduate recruitment.

4.3 Action by the universities

Some universities are more experienced and adept at facilitating placements than others, but companies sometimes have difficulty finding the right point of contact within a university, particularly if they are not habitual placement providers. These university contacts may be based in academic departments or in careers services; particularly in the latter, the contact may change regularly (as may the industry contact) making it difficult to build an effective and consistent relationship. The universities need to be alert to, and address, these potential barriers to industry involvement, particularly with the need and desire to embrace SMEs in this activity.

The universities also need to look at alternatives for students who do not want, cannot get, or are unsuited to industry placements. These might include:

- Summer vacation research-based opportunities in the universities, providing a different type of real work experience and skills development. Such schemes already exist, generically, but rely on uncertain funding and on the active involvement and altruism of academic staff, who may gain less than they invest.
- Schemes for summer placements within universities’ own laboratories. Some institutions already provide these schemes on a selective basis, sup-

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29. The AGR briefing on work experience offers a useful summary of generic direct and indirect benefits that employers may gain from hosting work placements and providing other types of work-related support for students. See Work experience – an employers guide, Association of Graduate Recruiters, 2008, pp. 5–7.

30. Placements can also be a potentially important component of a research degree programme and some of the Research Councils have been considering ways of supporting doctoral students to gain broader experience outside their area of research.

31. For example, through a group involving Cogent and invited industry partners.

ported by, for example, Wellcome and Nuffield. As noted above, GSK offers week-long summer placements which offer undergraduates an insight into the role of the graduate chemist in the pharmaceutical industry and a limited amount of skills training and development.

- Short work-shadowing opportunities to raise awareness of and interaction with the industry in a low-cost, low-risk, low-intervention way.
- Promotion of paid or unpaid, non-assessed, short-term projects responding to specific company needs. Some universities already facilitate such schemes in multiple sectors in summer vacations, giving extensive pre- and in-placement support to participating students (with associated costs) and exercising quality control of placement and student. There is potential, however, for the rising number of independent agencies to do the brokering directly between students and employers with no cost or responsibility to the universities.

4.4 Action by Government
The placements question is unlikely to be resolved without both funding and pressure from Government bodies to ensure quantity and quality. A shift in Government pressure from the universities to the industry might be appropriate in this instance. In Germany, for example, an industrial sector is made responsible for the provision of placements, with tax levies for under-supply. However, a ‘carrot’ rather than ‘stick’ mechanism might be more effective. If companies were rewarded or compensated for hosting placements by, for example, R&D tax credits or other incentives in areas of strategic and commercial value to themselves, the benefits to the biopharma sector could be twofold: a graduate body with work experience plus enhancement of UK-based biopharma activity.

5 Modes of study and delivery
There is clear potential for developing new ways of delivering undergraduate and taught postgraduate courses, including more part-time and distance-learning provision, which should address many of the problems experienced by the industry and the universities.

Significant movement on this front requires:
- willingness to question the necessity of current ways of delivering and the settings in which learning and teaching can take place
- further collaboration with industry – much is already happening, yet the skills problem persists
- collaboration between the universities, pooling teaching and curricula
- creating a credit framework which will accommodate both different patterns of study and the movement of students between universities
- a substantial increase in online materials
- exploration of the potential of work-based learning within traditional and new degree formats
- funding to allow the development of new ways of doing and new resources
- funding for part-time students from public or industrial sources

Part-time and distance-learning provision can broaden access to higher education in two ways: it allows students to study alongside other commitments
and in some instances it is open to entrants without traditional qualifications.\textsuperscript{32} New 2+2 courses offered by the Open University in collaboration with other universities are a major step in this direction, although the success of the model when students revert to traditional modes of study and delivery in their second two years remains to be seen. It should be remembered, though, that part-time students are sometimes disadvantaged under current funding structures (often needing to pay their fees upfront), so that expanding provision in the universities is not the complete answer to the problem of access.\textsuperscript{33}

Work-based learning (WBL) is also an important means of access to biopharma-relevant training, notably but not exclusively through foundation degrees (FDs). It is also, of course, at the heart of in-course placements. WBL could be more broadly exploited in the context of undergraduate and masters programmes, notwithstanding the challenges of defining, assessing and managing the quality of this type of ‘provision’. The universities could usefully share experience and expertise in this regard. For example, the Open University offers wholly distance-learning FDs in Analytical Sciences and Health Sciences, aimed at up-skilling existing employees, and featuring new work-based learning modules, while the University of Kent is leading in the area of Bioscience and Pharmaceuticals as part of the Working Higher consortium led by the University of Hull.\textsuperscript{34}

Part-time options on full-time programmes tend to be hampered by the structure and timetable of the latter (including the requirement for physical presence at a university on an irregular pattern). There are examples within the universities of part-time options which have had few or no registrations, although it is unclear whether this is due to problems with attendance patterns or other factors. Wholly part-time courses are dependent on healthy student numbers to remain viable, but these numbers are hard to maintain while the bulk of delivery is through attendance at a university. The Open University’s FD in Analytical Sciences, on the other hand, seeks to recruit students on a national scale, enabling a larger pool to be targeted and leading to viable cohort numbers.

The universities need to be certain of the market for such provision before finding means of serving it. Does the current poor uptake demonstrate lack of real demand? Or do prospective students and/or their employers find the obstacles presented by current course structures insurmountable? In any case, non-traditional provision works best when, as in the Open University, it is not simply an adjustment of traditional provision and it is accessible remotely. That said, distance-learning delivery does not obviate the need to achieve high student numbers for viability.

If the challenges of attendance patterns can be overcome, with part-time options considered from the start, it makes sense to create as much overlap as possible between full-time and part-time provision, both to minimise work and so that part-time courses do not need to be self-sufficient and reliant on a minimum number of registrants. It would also facilitate movement between part-time and full-time study.\textsuperscript{35} As noted above, modularisation of undergraduate and taught postgraduate programmes was in part intended to facilitate this type of flexibility, as well as transfers between institutions, but it has yet to be capitalised on, especially at undergraduate level.

Similarly, development of online and distance-learning materials, for undergraduate and taught postgraduate programmes, would benefit all student

\begin{footnotesize}
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\item\textsuperscript{32} For these and other reasons it is a prominent feature in the Government’s recent HE framework document, \textit{Higher ambitions}, BIS, November 2009.
\item\textsuperscript{33} In this as in other respects, the Open University’s non-traditional approach to enrolment and delivery of courses means that the challenges for the part-time student are met head on: for example, the OU offers financial assistance to those with annual earnings below £25,000 and provides courses for free to students earning less than £16,000 per annum, with the assessment based on student rather than parental income.
\item\textsuperscript{34} Examples from beyond this group of universities include the foundation degrees in Biomedical Sciences and Medical Sciences offered by the University of Greenwich.
\item\textsuperscript{35} \textit{Higher ambitions}, BIS, November 2009, predicts that the distinctions between part-time and full-time labels should become increasingly irrelevant (p. 38).
\end{itemize}
\end{footnotesize}
types and greatly increase accessibility. It would also provide the potential to exploit much wider geographical markets, including beyond the UK. Some universities are already developing online materials for use by their own students within regular university-based programmes and the Open University is investing in global online delivery of a masters programme in medicinal chemistry. The Open University experience shows that online learning can take place effectively with remote tutor support and minimal face-to-face interaction compared with traditional university-based programmes. Online forums at a group or national level are also popular and effective in supporting learning.

However, the full potential of new technologies has yet to be exploited and cross-institutional development might focus particularly on resources covering material common to, for example, all BSc Chemistry programmes, so that staff time and other resources were then focused on those elements of programmes which can only be delivered ‘live’. These ‘live’ elements could potentially be delivered within the industry. Industrial partners could also contribute to the development of online modules, including work-related problem-solving scenarios, and provide opportunities for work-based learning supported by online and other distance-learning materials. In addition to considerable staff time and other resources, these types of development require thinking outside the normal full-time, on-site, academic programme ‘box’.

6 Masters programmes and CPD

Masters-level courses serve both to up-skill and to re-skill, whether prior to joining the industry or as in-post CPD, and are therefore a critical area for development in the universities. Access to the biopharma industry without postgraduate qualifications can be difficult (see Section 8, below) and while first-degree graduates are suitable for some roles, they may lack the depth of education and training necessary for specialist areas. The masters qualification therefore has an existing function in developing both scientific knowledge and research skills beyond undergraduate level.

In recent years, the traditional one-year, full-time masters programme (sometimes with a two-year, part-time option) has been joined by part-time modular programmes (such as the Applied Toxicology programme at the University of Surrey) designed specifically for participants in employment. Students on the latter programmes can study individual modules as certified CPD units and, if desired, accumulate credits towards a postgraduate certificate, diploma or masters qualification.

There is scope for further development of the modular masters/CPD programmes in this field, particularly through collaboration between the universities. There is also scope to work with the industry to strengthen industry-relevant components in new and existing courses, and to explore the potential for the masters course to deliver some of the benefits of PhD study, particularly with regard to capacity for independent research.

However, while the masters market offers them many opportunities, which they might exploit better in collaboration, it also presents the universities with a number of challenges – such as fluctuating demand and intermittent funding – not all of which are wholly within their control. The sub-sections
below outline some of these challenges and offer suggestions for developing masters-level provision to meet them.

6.1 The challenges of the masters market

As with other courses, masters programmes can only survive if sufficient students enrol on them, and this in turn relies on the accessibility and appeal of the courses, career opportunities for those graduating from them, and the availability of student funding.

Broadly speaking, funding for registration on full-time masters courses comes either through the UK Research Councils, sponsorship from major pharmaceutical companies, or students’ personal financial means. Funding from Research Councils is being spread across a wider range of courses, leaving some programmes which previously attracted studentships with reduced or no student support from this source. Some university staff perceive an expectation on the part of the Councils that the industry should subsidise masters provision aimed at its own needs, but, as noted above, this expectation is not always met. For a number of reasons, some of which are discussed below, and despite its ongoing investment in many programmes, industry is not a reliable source of funding for masters programmes within the universities. It remains to be seen whether undergraduate fees will affect the market for full-time masters courses, but, in the absence of sufficient funding, there is a risk that graduates will be more inclined to go into careers which they can enter without postgraduate training, rather than compounding their debts with further study.

Modular training programmes do not attract Research Council funding in the same way as traditional masters courses, although some have been developed with the support of, for example, the BBSRC. The focus of such programmes is on CPD units rather than a masters qualification, and most students are sponsored by their employers to attend individual or multiple modules rather than to attain a full masters degree by this means, as many already have an equivalent or higher qualification. The programmes are therefore self-funding and rely on steady custom from the industry.

The existing and potential overlap between masters programmes and CPD for in-post scientists is an important part of the skills-development picture, as discussed further below. However, in moving towards a masters-level market more focused on CPD, the universities will need to consider the costing and viability implications if participants opt to take CPD modules instead of full MSc courses.

Both traditional and modular postgraduate courses are vulnerable to the unpredictable rise and fall of industry’s demands for different specialisms. The universities have a difficult balance to achieve between under- and oversupply of specialist postgraduates and particularly in retaining latent academic expertise for training future cohorts while there is no current demand from employers. Some ‘niche’ areas require such low numbers that it is not surprising if postgraduates (particularly self-funders) opt to specialise in areas where there is more likelihood of subsequent related employment. A skills shortage may therefore be a consequence of lack of sufficient demand, which then leads to a lack of supply. As noted above, the universities need to devise ways of engaging with the industry on action and succession planning, so that appropriate cycles of specialist provision can be planned and managed.
Most important for any effective development in this area will be an improved understanding of the industry’s and individuals’ requirements from masters-level provision. For example, are employers and/or employees more interested in the completion of individual relevant modules than in the achievement of a masters qualification? What are the preferred modes of attendance, for course members and for their employers? What are the real barriers to engagement with this form of CPD?

6.2 Developing the masters and related CPD markets

Because the industry’s requirements change so often and so quickly, and its capacity to support staff development fluctuates in response to organisational and economic factors, the universities should concentrate on building the capacity for flexibility, in delivery and content. This capacity could be developed within but especially between the universities. Collaboration might include sharing masters modules across the institutions and development of joint programmes between them. Even more so than in undergraduate programmes, flexibility and innovation is the key to viability and managing risk and there is scope for broadening the range of courses available for studying on a part-time, incremental basis and the means by which they can be accessed.

6.2.1 Study and delivery modes

Appropriate patterns of attendance and remote access to learning materials are essential to ensuring the viability of masters-level courses. The cost of having an employee out of the office and potentially supporting their university attendance in a distant location, as much as the fee cost of the education itself, often accounts for some companies’ reluctance to sponsor employees on complete masters programmes or individual CPD modules within the universities. Regular short absences can also be disruptive to learners and their colleagues. For the universities’ part, day-release attendance severely limits a course’s geographical reach. Where attendance is necessary, fewer, longer blocks are often preferable to day release and, as noted above, some universities have successfully developed delivery on this basis, for complete masters courses or individual CPD modules. There is scope to expand this model within and across the universities, learning from their collective experience of serving this and other industrial fields.

Remote delivery of masters-level modules is under-explored in the universities (and probably the industry), with the exception of the Open University. Online delivery is particularly underdeveloped, not least because of the resources required to rethink and develop provision in this way. The expertise and experience within the universities could be exploited to good effect, particularly where courses might combine distance-learning elements with occasional but more limited university attendance. (While sponsors may prefer a wholly distance-learning course, many participants enjoy and benefit from the face-to-face interaction with their tutors and fellow course members.)

There is also potential for companies (or the industry collectively) to remove the necessity for off-site attendance by working with the universities to develop in-house masters programmes, incorporating work-based learning and supported by extensive online resources. Such programmes could usefully combine respective areas of expertise and resource in ways that
might inform other, ‘open’ programmes at undergraduate and postgraduate levels. In this as in other areas, the bigger pharma companies might act as CPD hubs for their supply-chain SMEs.

Providing what companies want and in the form that they can most easily access would benefit both sides. However, a radical rethink of provision would require not only close cooperation between the universities and the industry but also significant development funding.

**6.2.2 Exploiting and sharing modular masters programmes**

Exploring new modes of study and delivery in modular masters programmes would also facilitate collaborative development and delivery of masters programmes across institutions, expanding choice for students and employers, exploiting common ground and complementary specialisms, and reducing and sharing risk within the universities.

One means of broadening choice for students and their sponsors is pooling existing module options and facilitating the transfer of credits between institutions, allowing students to build up a programme from units across a number of partner universities. However, the universities could gain still more by identifying or creating common, core elements in their masters programmes, which could be combined with specialist modules within the partner universities, playing to respective institutional strengths. Common elements delivered through online or other distance learning methods will be best placed to cope with larger student numbers. Other options might include modules developed and delivered by industrial partners or from programmes outside the life and physical sciences, such as management. This type of flexible programme might also address the need to attract and ‘convert’ non-life sciences graduates, such as mathematicians, bringing different skills sets to the industry.

By taking a modular approach to a range of courses, rather than only to individual programmes, new courses could be developed from the basis of existing modules, making it quicker, easier and less risky for the universities to respond to changes in industry demand. This approach would require universities to achieve critical mass on individual modules rather than on whole programmes, thereby minimising the vulnerability of new and existing courses to lack of student numbers as well as increasing the universities’ flexibility to respond promptly to industry flux. Individual universities would not need to develop and sustain new courses single-handedly.

A major step change in this respect would require universities to:

- review existing course content
- identify, develop and potentially share core components and specialist modules
- explore and exploit the potential for distance-learning, online delivery and industry-developed modules
- create structures for the joint operation and ongoing review of masters-level programmes, including credit transfer and franchised delivery.

The potential overlap between masters modules and CPD, as demonstrated in modular programmes, should also be fully exploited, not only to help maintain numbers on any one component, but also to enrich the mix of experience and expertise in any student group. Quality assurance processes...
for off-the-peg CPD would also be subsumed within assessment and accreditation of standard programmes. However, the universities would need to take steps to counteract the tendency for modularisation to exacerbate the compartmentalisation of learning and knowledge, particularly at the level at which a masters qualification (as opposed to a certificate or diploma) is awarded.

6.3 New types of masters programme

In addition to reconfiguring existing types of postgraduate programme, there is scope for the universities to work with industry to develop new types of masters-level study and qualification, suited to industry’s broader requirements and interests and appealing to students. Investment and development in this area requires clarification of the industry’s needs and a joint exploration of how postgraduate study and support within the universities could be used to serve them. However, some proposals from within the universities include:

6.3.1 Industrial masters

Two-year full-time (or part-time equivalent) masters courses combining technical and research skills development and a specialist research area focused on industrial interests and requirements would serve the industry and students well, offering something of the benefits of PhD study yet in a shorter time and at lower cost. Such a scheme would also sit well with European structures, particularly where the research project had the capacity to lead into a subsequent shortened PhD registration. However, similar ideas have been tried before, with limited uptake, and their future success will depend on endorsement and support by Research Councils. The industry would also need to be actively involved in the design and delivery of such courses and particularly in facilitating industrial research projects.

6.3.2 Practice-based masters

In addition to facilitating the involvement of industry employees in modular masters programmes, as discussed above, there is also scope for developing qualifications based principally on work-based learning supplemented by a university-based training and development programme. The types of framework envisaged for undergraduate placements could usefully be employed in this context, defining and assessing what should be achieved rather than defining the means of achieving it. A one-year registration could lead to a diploma, with the option to gain a masters qualification through an independent research project.

6.3.3 Graduate internships

An alternative model for new starters in the industry would be graduate internships run from the universities in partnership with industry hosts, along the lines of the Reading-Surrey Biopharma Skills ECIF internships. In these, the universities manage and support graduates’ transition to and initial development within the industry, where they spend most of their time. However, the supply of internships, and their attractiveness to graduates and hosts, relies entirely on external funding, at least within the current financial climate. The graduate intern format may suit companies and their general operations because it adds to their capacity but not their headcount, makes fewer demands than an undergraduate placement, and assumes
that industry-relevant skills development will happen through the intern addressing the companies' present needs.

In each case a fully developed model would require the universities to work closely with industry to develop a new framework for such programmes, and endorsement and development funding from industrial or public sources. However, potential advantages include:

- broader SME involvement
- postgraduate opportunities for graduates with a more hands-on, work-related orientation
- a cost-effective way of delivering and accessing postgraduate education, with in-built work experience
- in the case of internships in particular, the potential for longer-lasting relationships, to the benefit of intern, hosts and university.

6.4 Other forms of CPD

Not all CPD or workforce-development provision is or can be delivered within the degree programme framework. Individuals and particularly companies do not always want courses of the size and shape of modules in masters programmes and the formal mechanisms for accessing training in that way may be off-putting to those with a specific and immediate training need.

It is also important to keep in mind that up-skilling and re-skilling within the industry will not always be at postgraduate level. Staff development spans the full range of HE taught provision. However, as discussed above, it is hard to implement CPD crossover with current forms of undergraduate programme and some attempts to do so have been unsuccessful. Advances in remote delivery, as discussed elsewhere in this Report, should help make undergraduate-level CPD provision feasible, as long as there is a market for it. The Open University already offers some of its undergraduate modules as CPD and not solely as part of full degree programmes.

Foundation degrees are an established mechanism for the development of higher education and skills among work-based learners. There are already a number of relevant courses for this sector; the Working Higher consortium has been set up to strengthen provision at this level. The universities have direct experience of FD programmes; however, these have not always attracted sufficient sponsored students to remain viable, despite being developed with and set up to deliver skilled staff to employers. The universities will need a better understanding of the industry’s requirements and demand for training at this level before considering how they might best combine forces with each other and industry to deliver it.

The universities already support industry’s workforce development through standalone provision at the universities and in individual companies. This interaction varies from academic staff giving talks and running workshops in companies to ‘open’ and ‘closed’ short courses provided for industry in the universities. Some of these have been initially developed with Research Council funding and then ‘adopted’ by the industry, to become self-sustaining occasional courses, responsive to industry conditions and kept under continuous review with direct industry involvement and support. Such programmes are positive examples of effective and sustained collaboration between HE and industry and provide models for further cooperation.
However, the market for these types of CPD, as for other aspects of provision for the biopharma sector, can be difficult for the universities to forecast accurately. Semta’s labour market survey found the principal stated barriers to training to be loss of staff time (48% of respondents) and the high cost of training locally (33%). As for suggested solutions, the lead one at 21% was availability of more money for training, while 18% of respondents specifically looked to an increase in Government funding for workforce development. Much further down the list are choices in timing of courses (4%), more local provision (4%), skill sharing between companies (2%), more online training (1%) and more short courses (1%). It is not easy, therefore, to see how the universities might address the sector’s workforce development needs where there is little correspondence between stated barriers and proposed solutions: if staff time is the main barrier, then one would expect flexibility in delivery modes rather than financial subsidy to be the main solution.

The quick changes of focus characteristic of the industry should bring ongoing demand for re-skilling and up-skilling, through ‘open’ and ‘closed’ courses, if the universities can sell their services more effectively and be more responsive in design and delivery. However, the universities face some challenges:

• broadly speaking, employers are more used to thinking about universities in the context of educating entrants to their organisations rather than existing staff, for which purpose they look to in-house or private training providers
• some companies view universities as expensive, outmoded and inflexible providers of CPD
• the universities require consistent custom to make CPD viable, yet the market is not reliable
• keeping up with the industry’s requirements is resource intensive and courses of all types need to be kept under constant review.

On the positive side, there is already considerable expertise in the universities in designing and delivering CPD, and several institutions already have units which oversee CPD business, acting as intermediaries between academic staff and industrial clients, and these could be further exploited to expand provision for the biopharma sector.

The universities must achieve a workable balance between predetermining CPD provision (based on understanding of likely and common demand and institutional expertise) and responding to the current requirements of individual companies. It is not often practicable or financially desirable to respond to a one-off request, unless it can be met largely from existing material. A global view of resources within and across the universities and flexibility in modes of delivery, including collaborative responses, will help. Working with industry to share knowledge and resources for education and training in respective contexts, and to improve understanding about needs, could usefully underpin plans for CPD development.

The challenges that the universities face in making their CPD capacity visible and appealing to the industry are likely to become more acute. A recent CBI paper anticipates that companies will want an increased return on training investment and a lower cost, looking more to on-line, virtual learning environment (VLE) and in-house delivery and less to face-to-face provision outside

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39. The CIHE makes the same observation, generically, in conclusions as to actions that will enable HEIs to increase their income from work-based learning. Being part of the networks SMEs use may help to achieve this end (Workforce development: what works and why, CIHE, June 2007, p. 6).
40. The shape of business, the next 10 years, CBI, November 2009, p. 21.
of the workplace. In other fields, CPD provision for a given sector, whether by one or more universities, has been separately branded. There are also examples of universities and colleges working collaboratively to address the express workforce-development needs of other industrial sectors.

6.4.1 Accreditation of CPD

Emphasis on assessment and accreditation of CPD may be mismatched with employers’ expectations and need not be an obstacle to getting courses developed and operating. However, individual participants may be keener to receive some evidence of participation and achievement. The value of accreditation is hard to establish and varies according to context: some companies have little interest in whether external courses attract credits, yet look for HE validation of their own in-house courses. While some aspects of accreditation may mean a lack of responsiveness and flexibility on a university’s part, another view is that the rigour of university provision could be better marketed as a ‘badge of quality’. In this and other respects, the HE sector needs to be better at articulating its distinctiveness as a CPD provider.

6.5 How the industry can help

If the industry could be more unified in its approach to staff development, it would provide a more substantial and predictable market for the universities. In other fields, sector-related qualifications have been developed through consultation with industry; in cases where demonstrating specific competences is a prerequisite (or at least a preference) for practice there has been a guaranteed market for this provision. A stable market will, in turn, generate the capacity for ongoing development.

A more-unified approach may not be feasible, but if representative groups from industry were able to clarify some generic needs for CPD, in terms of ambitions, content and modes of access, the universities would be better placed to develop, between them, a more strategic and flexible means of satisfying those requirements.

7 Doctoral research

While a doctorate is not universally essential to career progress within the biopharma industry, it seems to be so in some companies (see Section 8 below). Various reasons, not mutually exclusive, are given for this preference for PhDs, including specialist knowledge; higher technical and research skills levels; greater intellectual maturity; the ability to work independently and to see major projects through to completion; and a demonstrable commitment to one’s science. It is not clear whether the benefits of doctoral research, to researcher and to industry (or academia), lie chiefly in the development of skills or the expansion of the body of knowledge. Without better understanding of the reasons for recruiting PhDs, it is difficult to judge whether the same objectives could be achieved by other (possibly cheaper and quicker) means, such as the industrial masters discussed above.

Nonetheless, PhD graduates are a key group for recruitment to biopharma, other employees who enter without a doctorate later seek to attain one, and research undertaken at doctoral level is intrinsically valuable to the industry.
The universities face continual challenges in finding ways to fund doctoral (and other) research and in forging the links between this research and the industry, which both parties would consider strongly desirable. CASE studentships provide a clear industry focus through the input of an industrial supervisor and in-course placements. However, universities can only apply for CASE funding with the support of industrial partners and these have sometimes been hard to come by. This may be due partly to lack of awareness among industry staff, but also to their doubts about the value of the CASE model: the placement length is short and the work is not always easily integrated into the student’s doctoral research. Some university staff report that the industry does not realise that it can take the lead and be the principal investigator. Whatever the reasons for lack of involvement in existing schemes, if the industry wishes to ensure a healthy pool of doctoral graduates, it needs to work with the universities to devise the best means of doing so.

Students pursuing a doctorate with a more defined company focus (including as employees, on a part-time basis) have sometimes fallen victim to the industry’s sudden changes of direction, which may mean that a project to which the PhD research is related is sidelined. Although understandable, this type of disruption is antithetical to the nature of doctoral study as traditionally conceived. There can also be problems in not being able to publish the results of their project, which again deviates fundamentally from the usual practices and outcomes of PhD research and currently needs to be overcome on a case-by-case basis. (This can also happen at BSc and MSc level, but far less critically.)

There is some debate, therefore, as to whether the industry focus should be avoided, as too risky, or embraced as an essential part of a different type of doctorate. Leaving aside the question of the comparability of doctorates achieved through traditional and new routes, the development of Professional Doctorates (such as those which have been developed in the engineering field and supported by the EPSRC) could be beneficial in this field. Effort should be expended not only on securing Research Council funding for target scientific areas, but also on exploring how the educational, developmental and scientific benefits of the doctorate can best be achieved in the context of the biopharma sector.

8 Recruitment to the biopharma industry

While the universities can strive to produce graduates more attractive to the biopharma industry, the industry needs to make itself attractive to those graduates. The deficits the industry observes may indicate not (or not only) that graduates are insufficient in quantity and quality, but rather that the industry is unable to attract sufficient graduates of a suitable standard. Among the explanations for problems in attracting graduates or postgraduates into biopharma are negative perceptions of the industry, its activities and its ethics; lack of awareness of the range of roles and organisational types within it; salary levels relative to other sectors; and assumptions about limited career progression (for example, that taking a lab-based role
commits a recruit to lab work for life). These facets of the industry’s difficulties in recruitment come on top of the broader difficulties in recruiting both to STEM study and to scientific careers and the predicted shortages across all industries – science-based and other – which look to recruit STEM graduates.47 The important role of employers and business organisations in marketing STEM careers is increasingly acknowledged in papers and reports around the STEM recruitment question.

If the industry does not convert the best undergraduates into employees, and offer either an attractive alternative to studying for a higher degree, or an alternative route to gaining one, then those candidates are particularly well placed to enter other fields where no postgraduate degree is required, or to pursue a research degree. The challenge is to identify the factors that will draw today’s graduates to the industry; these might include the ends to which biosciences can be put, particularly where they coincide with the altruism and idealism thought characteristic of the younger graduate body, set alongside good and clear employment and salary prospects and potential mobility within a global market.48 Although there is some data-based contestation of the widely held belief that the City saps the human capital that would otherwise head for pharma,49 the Government’s recent Higher ambitions and other documents challenge those sectors (such as biopharma) that require high-level scientific skills to have a more realistic approach to graduate recruitment, student sponsorship, and so on, in order to nurture and secure the quantity and quality of candidates they need.50 The shortage of good STEM graduates available to the biopharma sector may indicate a lack of availability at the salary level that the industry is prepared to pay, rather than a scarcity of skilled personnel per se.

In any case, the data on the difficulties of attracting good staff is inconsistent and inconclusive: a report on the chemical skills pipeline finds on the one hand that ‘employers felt that a range of chemical science skills were in short supply, including physical organic chemistry and analytical science’ but on the other that ‘the majority of chemical science employers stated that they had no problems in filling vacancies and were satisfied with the number of applications they received’.51

In this as in other sectors, it can be hard for the universities to get companies to deviate from historical recruitment habits, such as targeting particular universities or programmes. While the universities must intelligently and effectively promote their programmes and graduates, the industry needs to be alert to changing university and course profiles in order to find what it is looking for, particularly if it wishes the full range of the HE sector to be responsive to its needs. The universities can help by presenting clear and consistent information about course structures and content.

8.1 Preferred type and level of degree qualification on entry

The universities have found the industry unclear and inconsistent in the relative values it places on the various types of programme available to undergraduates. It is therefore hard for them to provide guidance to prospective students or to review their own course portfolios in the light of employer needs.

Findings from a recent Royal Society of Chemistry report suggest that employers recruiting to scientific roles (especially research related) favour
The report also found that graduates with an MChem were twice as likely as those with a BSc to undertake further study and more likely to go into roles in science (p. 6). However, it is not clear whether the pattern is determined by graduate or employer preferences. Semta’s Bioscience Sector Skills Agreement. Stage 2: assessment of current provision, July 2008, found that ‘some employers are sceptical about the Integrated Masters First Degrees [eg MChem] introduced in the 1990s. On the one hand they help address some of the limitations of school leavers reported by university staff, and in principle deliver a graduate with understanding at Masters level, while on the other some employers think that the four years involved could perhaps have been better spent in other ways’ (p. viii).

52. The chemical skills pipeline, RSC, 2009, p. 8. The report also found that graduates with an MChem were twice as likely as those with a BSc to undertake further study and more likely to go into roles in science (p. 6). However, it is not clear whether the pattern is determined by graduate or employer preferences. Semta’s Bioscience Sector Skills Agreement. Stage 2: assessment of current provision, July 2008, found that ‘some employers are sceptical about the Integrated Masters First Degrees [eg MChem] introduced in the 1990s. On the one hand they help address some of the limitations of school leavers reported by university staff, and in principle deliver a graduate with understanding at Masters level, while on the other some employers think that the four years involved could perhaps have been better spent in other ways’ (p. viii).

The focus on recruitment of graduates (and ‘graduate quality’) may in any case be something of a red herring, as much recruitment to the biopharma industry is at postgraduate level – both MSc and particularly PhD. Moreover, some companies only recruit experienced candidates and do very little either graduate or postgraduate recruitment, a practice enabled by the sector’s recent downsizing, which has created a market of experienced personnel. Such recruitment practices as stipulating a minimum period of experience for entry-level posts are likely to put off the brighter graduate with more options. A short-term outlook (such as focusing on the level of initial support required by a BSc recruit compared with a recruit with more work or research experience) deters some recruiting managers from looking at graduate candidates and therefore at opportunities to recruit from a bigger pool or to encourage graduates to look to a career in the sector.

Although some companies are more transparent than others in the relationship between qualifications and role, the reasons for recruiting PhDs are often unclear, as discussed above. There is a general perception in the universities that it is necessary to have a PhD in order to progress to senior roles in the industry, even if companies sometimes suggest otherwise. There is a related perception that some companies like to have a visibly high proportion of staff qualified to PhD level, in the belief that this will give them a competitive edge. These practices may also, of course, reflect a common tendency to recruit in one’s own image. Where companies are more open about needing a PhD to progress, they exclude or deter graduate entrants and may end up with an imbalance between ‘senior’ and ‘junior’ staff.

The predominance of PhDs at the top of some companies may also be explained by the coincidence between the qualities required for successful completion of a doctorate and those which are likely to make someone successful in the workplace. This predominance encourages, in turn, a perception that a PhD is necessary to access the higher ranks, even if that is not formally the case.

It may also be that the expansion of HE has devalued the undergraduate degree, leaving the PhD as a clear and simple means of identifying the bright student dedicated to their science. As a result, students leaving undergraduate programmes can find themselves in competition with PhD graduates for jobs, especially within big pharma where work retained in-house is more likely to have a research focus.

It may be that some companies recruit into specialist areas at PhD level because the BSc entrant has an insufficient depth of knowledge and there
are too few masters-level graduates available. However, there is also some evidence of masters programmes set up to address particular stated industry needs (eg the *in vivo* skills gap), but which companies do not recruit from because they want candidates with PhDs. That said, the relative benefits of employing bachelors, masters and doctoral graduates are not always clear to the industry; the universities should work to make these distinctions more apparent and in terms that the industry can understand.

8.2 Clarity of entry routes and career paths

From the universities’ viewpoint, neither entry mechanisms nor career paths in the industry are well marked. Unlike some competitor sectors (such as Professional and Financial Services), graduate schemes are not common in the biopharma sector.\(^{53}\) For the universities and other parties to assist not only in preparing students for the industry but also in attracting them to it, a clearer picture must be gained of the sector’s recruitment practices, the reasoning behind them, the career paths open to recruits and their merits relative to careers in other industries. If practices and pathways turn out to be greatly divergent between companies, it is difficult for the universities to provide students with useful information, advice and guidance. In that case, individual relationships with larger companies will continue to dominate and the recruitment and skills needs of SMEs will not be well understood or easily addressed. The universities have a responsibility to provide transparent and sound information about entry routes and career prospects for graduates of their programmes, but the industry needs to support them in this task.\(^{54}\)

With no clear career path in view and/or low or fluctuating demand for graduates in specialist areas, students at all levels are likely to be disinclined to pursue specialist subjects, thereby exacerbating shortages.\(^{55}\)

8.3 Promoting the industry in the universities

Regardless of the level at which it recruits, the industry needs to raise awareness of what it can offer graduates. It can do this through, for example, in-course placements, vacation and graduate internships, shadowing opportunities, supplying real-life problem-solving exercises, and even simply awarding student prizes. Ongoing involvement in departments and curricula, particularly by SMEs, would improve students’ awareness of the breadth of the industry as well as potentially enriching their academic experience. Academic presentations by industrial speakers can, for example, present an integrated focus to a scientific problem, softening the academia vs industry interface and allowing students to consider where and how they would prefer to apply and develop their scientific knowledge.

The universities need to make it easy for SMEs to get involved in these activities, beyond existing one-to-one relationships; this would require considerable effort initially but should get easier thereafter.

One simple measure which could address many of the industry’s concerns regarding graduate recruitment and quality is offering company-sponsored studentships at undergraduate level. In exchange for a bursary and providing vacation work placements, the company shapes a long-term relationship with a student, maximising the return on its investment, even if there is no post-graduation obligation on either side. As discussed above, the biopharma industry could focus on developing a pool of talent for the benefit of the sector, rather

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53. Semta’s *Labour market survey of the pharmaceutical and bioscience sectors*, 2006, found (p. 15) that of the 178 sites surveyed, only 15% had a formal graduate trainee scheme. Of those, only 23% of the 100 sites recruiting BSc graduates had such a scheme, 41% of the 55 sites recruiting MSc/MSci/MChem graduates, and 23% of the 84 sites recruiting PhD graduates. (This survey covered all aspects of recruitment, not just scientific roles.)

54. The ABPI has recently produced a leaflet – ‘Life enhancing careers’ – outlining careers for scientists in the pharmaceutical industry and directing students to the ABPI’s own online careers resources and those of the Royal Society for Chemistry and the Society of Biology.

55. Again, the BBSRC report on *Strategically important and vulnerable capabilities in UK bioscience*, October 2009, makes this point (p 6).
than for individual companies. The sponsored student gains all the benefits of extensive work experience and mentoring, as well as financial support. Such schemes are also very useful promotional vehicles for companies and the industry, initially through advertising the opportunities but also through the ambassadorial role of the sponsored students themselves.

8.4 Recruiting beyond the life and physical sciences
In addition to general difficulties in recruiting graduates from programmes in the life and physical sciences, the industry has specific problems in recruiting from other disciplines, such as mathematics and engineering, which it needs to attract in smaller but critical numbers. However, limited resources mean that awareness-raising activities, such as sponsored placements and careers talks, generally exclude these non-core disciplines. Similarly, pharmacy graduates are well placed all round to meet the industry’s skills requirements, yet there is no transparent point of entry, career path or enticement for them, particularly compared with the prospects and rewards in pharmacy practice itself. The industry might therefore consider ways of alerting and enticing graduates from a wider range of disciplines to meet its current and future skills needs.

8.5 How the universities can help
Recruitment to A-level and undergraduate programmes in STEM subjects remains a widely recognised problem, despite notable progress in recent years. The universities are addressing their own problems in recruiting to the life and physical sciences. Some universities already offer entrance and performance scholarships in these fields to boost interest and access, but more external funding is needed to make a significant impact. Coordinated work between the universities and the industry could help establish further targeted scholarships. Courses which feed into biopharma are in competition with medical programmes for the top entrants and also with pharmacy, although capping of numbers and market saturation may help deflect students in other directions.

Placement years remain an initial attraction to many students, even if they are sometimes less inclined to take the opportunity when it comes. However, as discussed above, universities are only able to offer placements if these are available in sufficient quantity and quality. The universities need to be mindful of students’ own preferences and ambitions, and educate the industry in this regard, particularly when considering investing in the development of tailored programmes. Although the needs of students and industry should not be conflated, students’ choice of courses and modules should be supported with sufficient information about employers’ requirements in this and other industries to enable them to make informed, strategic decisions.

8.5.1 University-based careers information, advice and guidance
Not all careers or academic staff are well placed to provide sufficient and up-to-date information to students. Careers staff based centrally rather than in academic departments may be less attuned to the industry’s changing needs or visible to students as repositories of useful information. In some universities, these problems are exacerbated by regular changes in case load, breaking continuity between the advisors and the students, academic staff and industry contacts. Universities need to be alert to the difficulties...
arising from discontinuity and find means of addressing them, particularly with regard to external relationships. Some universities have already given their careers service a more employer- rather than student-focused direction; however, many careers advisors are also keen to safeguard their professional impartiality and are uncomfortable with promoting particular industries, or even groups of industries, rather than supporting students in a personal and free choice. These practical and philosophical questions stretch well beyond the problems of a specific sector and are currently being considered in the universities.

There is, of course, scope for subjective careers information, not least in the form of industrial involvement in universities in many of the ways considered above. Such input is welcomed by students, who prefer to hear ‘from the horse’s mouth’ what the industry does, how their skills might be deployed there, and what an employer might be looking for in potential recruits. Companies should be mindful of the image they present of themselves and the industry in their choice of speaker; they should also make a clear distinction between an educational lecture within the curriculum and a careers presentation outside it, even if the two things serve, for them, the same end.

The universities are building up considerable expertise in the application of new technologies to graduate careers information and are well placed to assist the industry in the development of online resources to support students’ choices prior to and during their degrees, in relation to employment in the biopharma sector. Financial support would also enable the two parties to coordinate work on outreach in the primary and secondary sectors, to begin to address the related problems of recruitment to STEM courses and to biopharma.

There remains the challenge of getting students at any level to access and learn from the careers provision available to them. The universities are well aware of this problem and are looking for ways to address it, but the students’ role, active or otherwise, is often underplayed in industry and Government commentaries on graduate recruitment and employment.

9 Academia-industry engagement

Within the universities, there is no shortage of ideas, big or small, about how industry and academia could be mutually supportive, tempered only by estimations of the industry’s capacity for involvement, financial or otherwise. The universities (and the Government) need to encourage and facilitate further ‘HE engagement’ on the part of the industry and not just ‘industry engagement’ on the part of the universities.57 There is already considerable engagement in both directions at a number of levels, through individual and institutional relationships, yet the ‘skills’ problem persists. Some of its aspects, such as lab skills development within undergraduate programmes, arise largely from conditions in HE; others, such as the inconsistent provision of undergraduate placements, from those in the industry. It can be a big and sometimes risky step from analyses by industry or Government bodies, such as the ABPI or the Sector Skills Councils, to what individual companies, with their own circumstances and agendas, need and are prepared to pay for at any given point.
There is some scepticism in the universities about the roles and value of such intermediary bodies as Sector Skills Councils in brokering relationships between industry and HE.

See, for example, Workforce development: what works and why, CIHE, June 2007, p. 5.

Direct and ongoing dialogue, which takes into account the ambitions and constraints of both parties, is essential if feasible, timely and sustainable solutions are to be developed. Discussions at practitioner level should feed into more strategic, higher-level discussions. The universities need to look at new spaces and new ways of engaging with all parts of the industry for the explicit purpose of understanding better the issues that it has raised in its reports, through varied forms of interaction, including some of those described above. The particular challenges of working with SMEs are widely acknowledged and engagement can be disproportionately time-consuming for both sides. Approaches through effective employer networks may therefore be more economical and effective, where such networks exist or can be formed to support the universities in this endeavour.

It is a commonplace of anecdotal and formal reports that industry and academia have marked cultural differences, not least the languages through which they express their conditions and needs. The direct exchange of knowledge, skills, resources and information between the biopharma industry and academia through a shared vocabulary is therefore essential to any progress in meeting the industry's stated needs. The contractual issues discussed earlier with regard to placements are a prime example of barriers that could be removed, or reduced, through improved understanding and determination to facilitate interaction for mutual benefit. The universities need to address the industry on its own terms and help the biopharma sector and individual companies to see that there is a genuine business case to engage with and particularly to invest in HE at various levels.

The universities must also acknowledge – particularly when asking for more funds – the industry's current investment and be sure that the return on these funds is appropriately captured and demonstrated. It is tempting to paint a picture of a funding desert, whereas there has been continued (if in some areas declining) investment on the part of both the industry and the Government. However, some of the problems itemised here persist despite this funding, while others, such as the fluctuating demand for certain specialist skills and knowledge, cannot be resolved by money alone. There is therefore a real necessity for the universities to be tapped into the industry's patterns of behaviour and expenditure and for the industry to assist the universities in forecasting demand and planning supply. If the universities wish to generate further industry engagement and business, they must cultivate a 'capacity to cope', from which base they can negotiate the funds strictly necessary to do so.

The secondment of staff from the universities to industry and vice versa could serve the professional development of the individuals and the broader interests of their organisations, notwithstanding the difficulties that such absences can create. Industry Fellowships already enable academics to spend time within the industry, including learning about its training and skills needs. The Reading-Surrey Biopharma Skills ECIF project is enabling four former industry employees to view the skills-development picture from the perspective of higher education and to work towards forming a bridge of understanding and means of cooperation between the two sides. This type of venture relies on funding but it also requires a formal mechanism for capturing and exploiting the benefits of learning from these and other types of engagement.
With the proper agents in place, the universities and the industry could improve mutual understanding and development of education and training in academic and industrial contexts. Dedicated resource in the universities could both highlight their interest in working with the industry and improve the biopharma sector’s understanding of what HE can do with and for them.

10 Next steps

The investigation into how the universities could work with the industry to meet the latter’s needs is continuing through the Reading-Surrey Biopharma Skills ECIF project [see Appendix]. The Industry Liaison and Internship Fellows appointed to help implement the project have an explicit remit to further the work undertaken within the SE universities group to date. The findings will be formally circulated after September 2010, when the funded activities cease.

10.1 Formalising the consortium

In the meantime, the universities are exploring the idea of a formalised regional consortium as a way of addressing some of the issues faced by themselves and the biopharma industry, as highlighted in this Report. Such a consortium will constitute a purposeful, coordinated, visible, practitioner-based response from the HE sector to the biopharma industry and Government, demonstrating the universities’ ongoing interest in developing interaction and provision in this area. To the benefit of all parties, it will develop and exploit new types of interaction and activity, including:

10.1.1 Improving dialogue

An HE consortium will facilitate direct, open and focused dialogue between the universities and between the universities and the regional industry. Improved dialogue will promote and sustain mutual understanding of individual strengths, capacities and ambitions and make the universities better placed to understand and meet the industry’s recruitment and ongoing workforce-development needs. With the consortium in place, the industry will have a single, clear point of contact with a broad range of HE providers, for discussions about education, training and knowledge exchange, while the consortium will provide the universities with a focus for reviewing and updating practices and provision across the region.

10.1.2 Maximising resources and effort

The universities’ combined forces will enhance their capacity to effect change within their own practices and their flexibility to respond to the biopharma industry’s requirements by pooling resources and expertise in ways that better serve the industry at minimal risk to themselves. Collaborative and complementary ways of working will bring economies of scale for the universities and for the industry. Certainly a collective response to the industry’s needs should help the universities to cope with the ebb and flow of demand for specialist training and skills.

An HE consortium will also allow for more effective collaboration with individual companies and consortia within the biopharma sector. With the appropriate structure and resources, the combined forces of HE and industry consortia will act as a hub for the development and dissemination of new
In particular, the universities are exploring ways of cooperating in order to enhance skills and knowledge relevant to the biopharma sector through:

• collaborative design, development and delivery of programmes and modules, and new modes of access and delivery
• sharing information and resources between institutions
• collaboration and interaction with industry, including reciprocal input into programme design in the universities and in industry
• collective action to inform and influence external parties, including Government and industrial bodies.

10.1.3 Informing and influencing

Importantly, a consortium will offer the opportunity for a broader HE voice to feed into future biopharma sector reports, whether generated by industry or Government bodies, and to provide the industry with a view from the outside. In turn, the combined voice of the consortium and the regional industry should have weight in policy and funding discussions with the Government and its agencies.

In the first instance, it is particularly important that this project’s findings are fed forward into higher-level debates about skills development in the life and physical sciences. In this dissemination, it will be necessary to distinguish between those areas in which the universities believe they can implement change and enhancement more-or-less independently or in partnership with the industry, and those in which they and/or the industry cannot effect improvement without (a) action and change elsewhere (eg in secondary education) and/or (b) external funding.

10.2 Requirements for substantive change

Some of the consortium’s ambitions can be achieved through simple communication networks, but substantive change to the ways that the universities operate in this area and engage with industry will require:

• significant and redefined ‘HE engagement’ on the part of the biopharma industry
• major reconsiderations of how courses are designed, structured and delivered and new ways of exploiting complementary resources across the full range of HE activity relevant to biopharma
• finance to support the exceptional and complex challenge that the universities are taking on in their ambition to work collectively to serve the needs of a multifaceted industrial sector across the full spectrum of higher education.

Without both industry cooperation and significant development and operational funding, the universities are severely limited in their capacity to effect change on the scale required. The consortium will therefore seek appropriate sources of funding to pursue selected objectives, including some of the proposals above. The universities will look for their ambitions and effort to support this key industry, and the requirements to do so, to be recognised with appropriate levels of financial investment from industrial and particularly Government sources.

60. In keeping with the Government’s desire for joint centres of excellence between universities and businesses – see Higher Ambitions, BIS, November 2009, p. 46.
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Appendix – Reading–Surrey Biopharma Skills ECIF project

The University of Reading is leading a collaborative project with the University of Surrey to address the immediate and long-term skills and knowledge needs of the biopharma industry in the South East, supported by funds from HEFCE’s Economic Challenge Investment Fund (ECIF) and the Regional Development Agency (SEEDA). The ECIF was set up to help universities respond rapidly to meet the immediate needs of individuals and businesses during the recession. The project began in April 2009 and runs until September 2010.

The Reading-Surrey ECIF project is supporting the development of targeted opportunities for companies, employees and graduates facing a depleted job market, particularly in areas which the biopharma industry has identified as high priority. The ECIF funds are being used to help overcome some of the financial and practical barriers that have prevented companies from taking on recent graduates and from accessing the universities’ expertise in other ways, particularly in the current financial climate. They are also facilitating the direct dialogue with biopharma companies that is essential to making progress in meeting the sector’s skills needs.

The project funds over 30 graduate internships, lasting 5 or 11 months, which combine industrial placements with higher-level education and skills development in the universities. The internships are developing interns’ expertise in areas of key interest to the industry, and contributing to the business of host companies. The interns are recent graduates or postgraduates recruited on a competitive basis according to aptitude for and interest in careers in biopharma, particularly in areas of skills shortage.

The 19 host companies were also recruited on a competitive basis and represent the full spectrum of the regional biopharma industry, from multinationals to the smallest SMEs.

Interns and hosts are supported by four Industry Liaison and Internship Fellows with strong industry backgrounds. The Fellows develop relationships between businesses and the universities; identify specific and urgent training needs in the interns and more generally; develop and facilitate the development and delivery of specialist education and training in HEIs and industrial bases; mentor interns; and work with university careers advisers to develop specialist knowledge to support STEM undergraduates.

Academic mentors work with industry supervisors to enhance the interns’ academic and intellectual development, and to construct informal interest groups in the areas in which the interns are operating.

The project is also supporting the development and delivery of CPD courses to existing industry staff, in response to needs identified by the Fellows in discussion with industry contacts forged through the scheme.

Thus the project addresses current conditions in the industry and in graduate employment, fosters dialogue between academia and the biopharma sector and enhances, in this and other ways, the universities’ understanding of the sectors’ skills needs and how these might be met. The project’s findings will feed into the ongoing work of the SE Universities Biopharma Skills Consortium.