



Biotechnology Clusters

BIOTECHNOLOGY CLUSTERS

Report of a team led by
Lord Sainsbury, Minister for Science

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Preface

Taking as our starting point the Government's Competitiveness White Paper "Our Competitive Future: Building the Knowledge Driven Economy"

I was delighted to lead a team on a fact-finding mission looking at biotechnology clusters.

The growth of biotechnology clusters is an exciting development, but this is the first time that an attempt has been made to undertake a more systematic analysis of what contributes to success in this sector, and what the barriers might be to further development.

Government must do all it can to support the success story of the UK biotechnology industry and ensure that we maintain our lead in Europe. We have succeeded in creating many small biotechnology companies. The challenge now is to see them grow into established businesses. Building successful clusters requires concerted action across a range of policy areas from supporting the science base to encouraging the flow of venture capital into companies and having urban planning policies that allow clusters to grow.

I believe this has been a timely examination and I hope that it will be helpful to Government and others in determining and implementing future policy in this area. Whilst this report concentrates on biotechnology clusters, many of the ideas we suggest for supporting cluster development could apply equally to clusters in other industrial sectors. We have therefore recommended that further work is undertaken to better understand the importance of clusters throughout the economy.

I should like to thank the team of experts who assisted me in the visit programme and in producing this report. On behalf of the team, I would like to record our gratitude to all those who contributed to our visits in the UK and the US, and would like in particular to say how much we appreciated the assistance provided to us by our consulates in Boston and Seattle.

Lord Sainsbury of Turville, Minister for Science

Executive Summary and Recommendations

This report draws on a fact-finding mission to examine biotechnology clusters in the UK.¹ The UK leads Europe in biotechnology, although it is still some way behind the US.² The report builds on the work of Michael Porter and others³ which show benefits to start ups and SMEs from being located in a cluster. The UK has achieved much in building biotechnology clusters in some areas and creating a supportive environment for biotechnology start ups, and we aim to capture and spread best practice about cluster development. The report also aims to better understand how Government and others may further support cluster development to enable UK biotechnology companies to meet new challenges. The next few years will be critical ones which will determine how many start-ups grow into significant and globally competitive businesses.

Clusters can be defined as geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated institutions. Successful clusters have a range of different factors in place, and the ten factors we view as critical are shown below. These factors exist to varying degrees in the areas we visited in the UK. We do not believe, however, that there is any single formula or sequence for building successful clusters, and we do not think it is realistic for every region in the UK to develop a biotechnology cluster. Rather we see a cluster approach as building on strengths and removing barriers to development. To get the factors right for cluster development requires actions and co-ordination between government departments, devolved administrations, regional economic development agencies, universities, companies and others. We offer a number of specific recommendations and issues for further consideration aimed at removing barriers to cluster development. Although these arise from our work on biotechnology clusters we think that many of the same issues arise in other sectors in the knowledge driven economy, and the recommendations would therefore apply equally there.

¹ See Appendix 1 for Terms of Reference

² A comprehensive analysis of what needs to be done to ensure the UK maintains its European lead in biotechnology is provided in the forthcoming *Genome Valley* report

³ Described in Chapter 2

Critical factors for cluster development

- i) Strong science base**
- ii) Entrepreneurial culture**
- iii) Growing company base**
- iv) Ability to attract key staff**
- v) Availability of finance**
- vi) Premises and infrastructure**
- vii) Business support services and large companies in related industries**
- viii) Skilled workforce**
- ix) Effective networks**
- x) Supportive policy environment**

i Strong Science base

Leading edge science (including basic, applied and clinical research), academic entrepreneurs and a critical mass of research activity provides the lifeblood of biotechnology clusters. The UK has a world class research base and is particularly strong in many areas of bioscience. In our view, however, a number of barriers and disincentives remain to the effective exploitation of the UK science base. One such barrier can be determining ownership of intellectual property (IP) from research funded by bodies with differing IP policies.

We recommend that Research Councils, Medical Charities and others work with the Office of Science and Technology to review their respective policies on Intellectual Property (IP) ownership to ensure clarity and avoid conflicting claims, for example by ensuring that IP ownership is vested in the organisation generating the IP (paragraphs 5.2 to 5.5).

ii Entrepreneurial culture

We applaud the improvements made by universities and research institutes in recent years to improve commercial awareness and entrepreneurship among researchers. We found, however, that young researchers often lack opportunities to build the skills needed for commercialising research. We also see a role for further business competitions to foster entrepreneurship amongst young researchers,⁴ and commend the \$50k scheme run by MIT (see Chapter 5) as a model.

⁴ In addition, or as an extension to, the Young Entrepreneurs Scheme and Bioscience Business Plan run by the BBSRC

We recommend that universities seek, in collaboration with the new Science Enterprise Centres, to make more knowledge about management and entrepreneurship available to their science undergraduates and graduates (paragraphs 5.7).

We recommend that universities, in conjunction with venture capitalists and other sponsors, introduce student business competitions similar to the MIT \$50k prize to stimulate entrepreneurship and the number and quality of university start-ups (paragraphs 4.10 and 5.7).

iii Growing company base

Clusters need thriving start ups as well as more mature companies that can act as role models. A key challenge is how to capitalise on the UK's European lead in biotechnology start ups and support these companies as they develop. A crucial issue for companies in biotechnology and other research driven sectors is how to sustain their R&D activities over the relatively long periods before products reach market. We consider that existing mechanisms do not adequately meet needs and were greatly impressed during our visits to the US by the role played by the Small Business Innovation Research (SBIR) programme in supporting the early development of research driven companies.

The DTI will consider, in consultation with other Government Departments and devolved administrations, the lessons which can be learnt from the US about ways to stimulate R&D in SMEs (paragraphs 5.8 and 5.9).

iv Ability to attract key staff

Biotechnology companies must be able to attract the best management and scientific staff from overseas and larger companies. Clusters can help attract staff by providing an intellectual and business 'buzz' and offering a range of employment opportunities for partners and career development. The quality of life, areas of natural beauty and vibrant international cities also play a role in individual decisions about where to locate. Share options are also important for attracting the best staff, and we found that UK biotechnology companies wanting to attract UK managers, who had gone to the US, back to the UK were not able to match the share options the managers were getting there.

We welcome the decision by the Chancellor to provide incentives to enable companies to attract and retain the best staff, and from next year small, growing companies will be able to offer key staff tax-advantaged options over shares up to £100,000. (paragraphs 5.10 and 5.11).

v Availability of finance

Biotechnology companies are often dependent on the financial community to support them for long periods of time. Companies and investors value being located close to each other in clusters. A problem at the national level is a growing shortfall in the amount of equity finance available for biotechnology companies. We are impressed by the increase in equity finance that has been achieved in Germany through enhanced incentives. Substantial amounts of equity finance will need to flow into biotechnology companies in the UK over the next decade if we are to maintain our lead in Europe and we believe that improving incentives for private investment is the most effective way to increase equity finance in the UK for high technology companies.

We welcome the recent changes to Capital Gains Tax to provide taper relief which introduces lower effective rates⁵ which we believe will help to increase equity finance in the UK (paragraph 5.12).

vi Premises and infrastructure

Biotechnology companies require specialist premises with leasing arrangements which are flexible enough to meet their changing needs. We found that laboratory space is often not available in locations where they are needed, or do not provide the terms and conditions which adequately meet company needs. We encourage the private sector, university landlords and others to consider ways to provide short term leasing arrangements for biotechnology companies, and for biotechnology companies to communicate better their current and future accommodation needs. We also consider government can play an important role through the planning system.

We recommend that the Regional Development Agencies give consideration to the need to promote ‘Urban Networks for Innovative Cluster Areas’ (UNICAs) in their regional strategies, and that the DETR issue guidance to Regional Planning Bodies and local authorities on how to take account of this concept through the planning system (paragraphs 5.13 to 5.18).

⁵ 10% for longterm holdings of shares qualifying as business assets.

vii Business support services and large companies

Proximity to specialist business services, such as patent agents, lawyers, recruitment and property advisors form an important benefit for companies in clusters. Proximity to large companies in industries relating to biotechnology (e.g. pharmaceutical, agrifood and chemical) is an important driver to cluster development in a number of ways, such as providing management expertise, partnering opportunities and customers to biotechnology companies.

viii Skilled workforce

In most areas we found that biotechnology companies were generally able to recruit scientists and technicians to meet their needs. We were also impressed by a number of innovative training programmes designed to meet specific needs of local biotechnology companies that have been set up in some parts of the country (paragraph 3.31)

ix Effective networks

We found a number of regional biotechnology associations that provided opportunities for companies, researchers, and others to meet and exchange views and information, as well as undertaking a range of activities to promote biotechnology in the area. Whilst these biotechnology associations in the UK are in their infancy, we found much to commend in the support they provided to companies and in the growth of clusters. We consider that the limited amount of public money that has been secured for the associations has been successfully used and, at least for the short term, we support the case for continuing support.

We recommend that the DTI and the RDAs find ways to provide continuing financial support for the regional biotechnology associations linking together biotechnology clusters, and to establish new ones in areas with emerging clusters (paragraphs 5.19 and 5.20).

x Supportive policy environment

Public policy cannot create clusters, they must be business driven. Central, regional and local government do, however, create the conditions which encourage their formation and growth. Central Government is responsible for setting the macro-economic conditions which support innovation and in ensuring that regulations are necessary and proportionate. In Scotland, Wales, and Northern Ireland some of these functions are devolved to the new administrations. We believe that Government can play a new role in collecting

and analysing comparative data in order to map clusters across sectors in the UK. This would provide a tool for government to understand better the dynamics of cluster development.

To better understand the dynamics of clusters, the DTI will consider developing the UK Competitiveness Index to stimulate data capture for individual clusters and conduct a mapping exercise of cluster activity across sectors in the UK (paragraph 5.21).

We found that regional economic development agencies can play a leading role in catalysing partnerships to support cluster development and improving the environment for cluster growth. The English Regional Development Agencies create a new opportunity for clusters to be supported at a regional level and for DTI policies to be implemented in a way which 'goes with the grain' of cluster development. The economic development agencies of the devolved administrations can play a similar role to animate cluster development at the regional level. We commend in particular the innovative approach that Scottish Enterprise has taken in developing a clusters approach.

We invite Regional Development Agencies, and the equivalent agencies of the devolved administrations, in those areas with existing or strong potential for biotechnology clusters, to look at improving the environment for cluster growth, for example by addressing skills, planning, supply chain and inward investment issues (paragraph 5.22).

Chapter 1

The Importance of Clusters

- 1.1 There is a significant body of evidence and economic analysis which demonstrates the importance of clusters to economic growth,⁶ which we summarise in this chapter. The aim of this report is to build on these studies in order to gain a better understanding of the working and dynamics of biotechnology clusters and to identify any barriers to their continued development in the UK. In order to achieve these objectives, we undertook a series of fact finding visits in the UK and US which are described in Chapters 3 and 4 respectively. Chapter 2 provides an overview of the UK biotechnology sector drawing on a more comprehensive analysis in the forthcoming “Genome Valley” report.⁷
- 1.2 We define clusters here as “geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated institutions (for example, universities, standards agencies, and trade associations) in particular fields that compete but also co-operate.”⁸ Silicon Valley in the United States is perhaps the best known example of a cluster, but there are many other examples in different regions and sectors.⁹
- 1.3 During our fact finding visits we did not attempt to define strictly the geographical size of clusters. This depends in part on perceptions of proximity. In the US we found clusters tend to be thought of as locations that can be visited within a single business day, and from this perspective the UK might be viewed as a single cluster. In contrast, in the UK the prevailing view is a much shorter journey (around one hour). The size of a cluster is also determined by labour market mobility, i.e. how far staff are prepared to move their place of work without moving house.

⁶ Key texts include: Porter, M (1990) *The Competitive Advantage of Nations*; Cooke, P and Morgan, K K. (1998) *The Associational Economy: Firms, Regions, and Innovation*. Oxford University Press; Swann, P et. al. (1998) *the Industrial Dynamics of Industrial Clustering*

⁷ DTI (forthcoming): *Genome Valley*.

⁸ Porter (1990) *The Competitive Advantage of Nations*.

⁹ Cooke P. and Morgan K. (1998) *The Associational Economy: Firms, Regions, and Innovation*. Oxford University Press

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- 1.4 Clusters are particularly important in knowledge based sectors,¹⁰ despite the trend towards globalisation arising from rapid advances in transport and communication and accessible global markets. This is because the type of knowledge that creates competitive advantage often requires proximity or regular face-to-face interactions and trust in order to be effectively communicated.
- 1.5 Previous studies and economic analysis demonstrate that clusters can raise innovation and productivity in a number of ways. Companies benefit from sharing knowledge about best practice and reduce costs by jointly sourcing services and suppliers. Frequent interactions facilitate formal and informal knowledge transfer and encourage the formation and efficiency of collaboration between institutions with complementary assets and skills. There is also the “general importance of being in the midst of the buzz”.¹¹ The critical mass effect attracts further companies, investors, services, and suppliers into the cluster, as well as creating a pool of skilled labour.
- 1.6 Local training institutions and infrastructure can provide further benefits for companies. Rivalry between firms can stimulate competitiveness and encourage constant upgrading. Many of these benefits are likely to be more important for SMEs than for larger companies which are more able to capture them internally.
- 1.7 We do not see it as the Government’s role to create clusters. Clusters must be business driven and they form due to a variety of reasons, e.g. specialised demand, prior existence of related industries or institutions, or historical accident. Quality of life and other non economic factors can be equally important in determining growth. Clusters arise from making the most of synergies across and between companies and academic and research based institutions.
- 1.8 Governments, however, can create the conditions which encourage the formation and growth of clusters. This can mean, for example, ensuring both national and regional policies do not inadvertently place barriers to cluster development, catalysing the formation of social interactions and collaborations within a cluster, and ensuring research and innovation support programmes build on existing strengths so as to work with the grain of cluster

¹⁰ Audretsch D. (1989), “Agglomeration and the Location of Innovative Activity” *Oxford Review of Economic Policy*, Vol. 14, No. 2; and for case of biotechnology Prevezer (1997) “The Dynamics of Industrial Clustering in Biotechnology.” *Small Business Economics*, No. 9

¹¹ Krugman P. (1998) “What’s New about the New Economic Geography?” *Oxford Review of Economic Policy*, Vol 14, No 2

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development.¹² The Government has already done much to support the development of biotechnology and associated cluster development.¹³ Our approach in this study is to look at what needs to be done to build on existing activities and to ensure clusters continue to flourish.

- 1.9 We take the view that Government support for clusters cannot constitute a complete industrial policy. Cluster policy should be part of a wider set of policies that include national and non-sectoral policies and programmes that support and enhance innovation and competitiveness. An agenda for addressing the broad set of national issues that are required to ensure the UK remains a leader in biotechnology is to be set out in the DTI's forthcoming 'Genome Valley' report.¹⁴

¹² Porter (1998) *On Competition*, Harvard Business Review Book

¹³ We report on existing government initiatives in Chapter 3

¹⁴ DTI (forthcoming): *Genome Valley*.

Chapter 2

An Overview of the UK Biotechnology Sector

- 2.1 Biotechnology offers enormous opportunities for improving the quality of life and being a major creator of wealth and high quality jobs for the UK. The world market for biotechnology products is forecast to reach £70 billion by the year 2000,¹⁵ and biotechnology-dependent sales by UK industry to reach £9 billion. The sectors for which biotechnology holds most promise account for almost a quarter of all UK's industrial output, employment and export earnings – including pharmaceuticals, agriculture and food.
- 2.2 In this report we employ a broad definition of biotechnology as an enabling technology, and not an industrial sector.¹⁶ Biotechnology companies are those whose primary business focus is the commercialisation of these new technologies.
- 2.3 The UK leads Europe in biotechnology, although it is still some way behind the US. The UK sector has grown rapidly to more than 270 biotechnology SMEs (table 1), accounting for around a quarter of all European biotechnology SMEs¹⁷ and three quarters of those which are publicly listed in Europe. If a wider definition is used (i.e. including consultancy and services), there are some 460 bioscience companies employing 40,000 people.¹⁸ The UK also boasts a relatively well developed venture capital industry which has invested some £344 million in biotechnology over the last 10 years.¹⁹

¹⁵ EuropaBio: *Benchmarking the Competitiveness of Biotechnology in Europe*. An independent report for EuropaBio by Business Decisions Limited and the Science Policy Research Unit, June 1997

¹⁶ Biotechnology is the application of knowledge about living organisms, and their components, to industrial products and processes

¹⁷ Ernst & Young (1999)

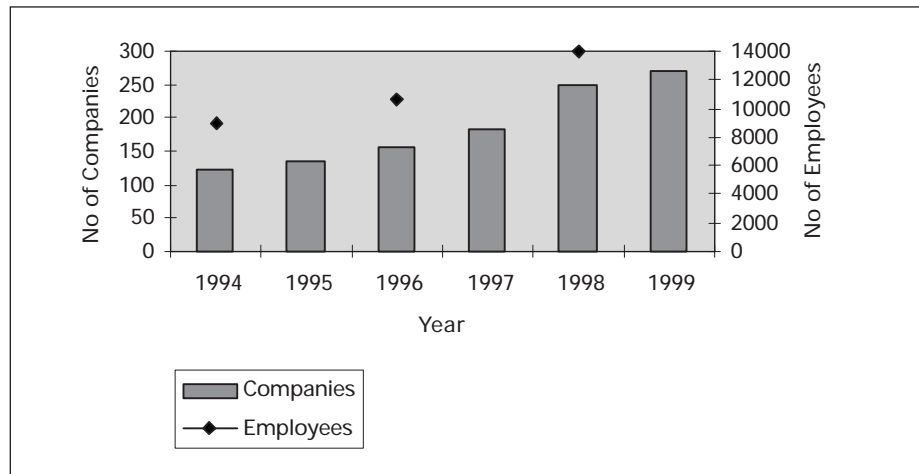
¹⁸ BioIndustry Association (1999) *Industrial Markets for UK Biotechnology*

¹⁹ European Venture Capital Association

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Table 1: Growth in UK Specialist Biotechnology Companies



Source: Ernst & Young

2.4 The UK is strong in all elements of the supply chain for biotechnology, from the crucial scientific research base (in universities and public research institutes as well as in large and small companies) through to the presence of major multinational companies which can pull through products into world markets. Government annual expenditure on bioscience research is some £650 million. Charities such as the Wellcome Trust, Cancer Research Campaign and the Imperial Cancer Research Fund also provide significant funding. The research strengths (excluding the private sector) of the UK in biotechnology are spread across a number of regions in the UK (Map 1), with leading bioscience research Universities located across England, Scotland and Wales (table 2). The UK hosts a number of world leading research institutes, such as the Sanger Centre and Roslin Institute; international research establishments, such as the European Bioinformatics Institute; and regulatory bodies, such as the Medicines Control Agency and the European Agency for the Evaluation of Medicinal Products in London.

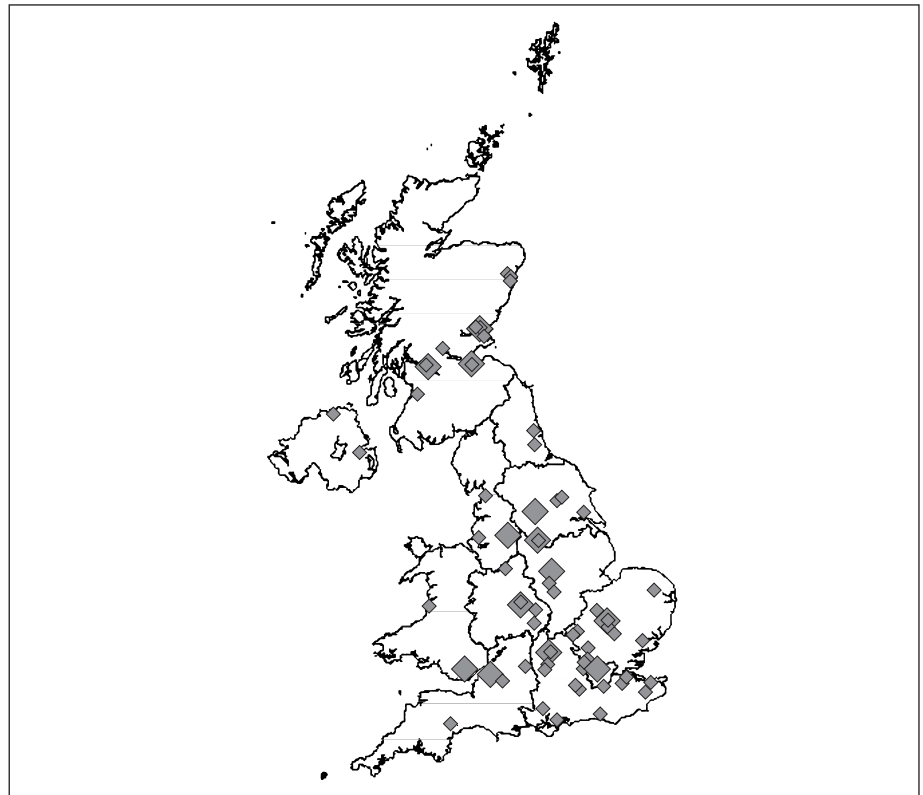
2.5 The distribution of specialist biotechnology companies in the UK is concentrated in East Anglia (Cambridge), South East England (Oxfordshire and Surrey) and Central Scotland (see Map 2). The estimates provided to us during our study²⁰ (table 2) indicate that Oxford, Cambridge, and Central Scotland each have 50 or more specialist biotechnology companies while other regions typically have far less. More mature companies which are publicly listed are mainly located in Cambridge, Oxford, London and the South East, with some also located in Central Scotland and Wales.

²⁰ Consistent annual information on numbers, size, and location of biotechnology companies is not available.

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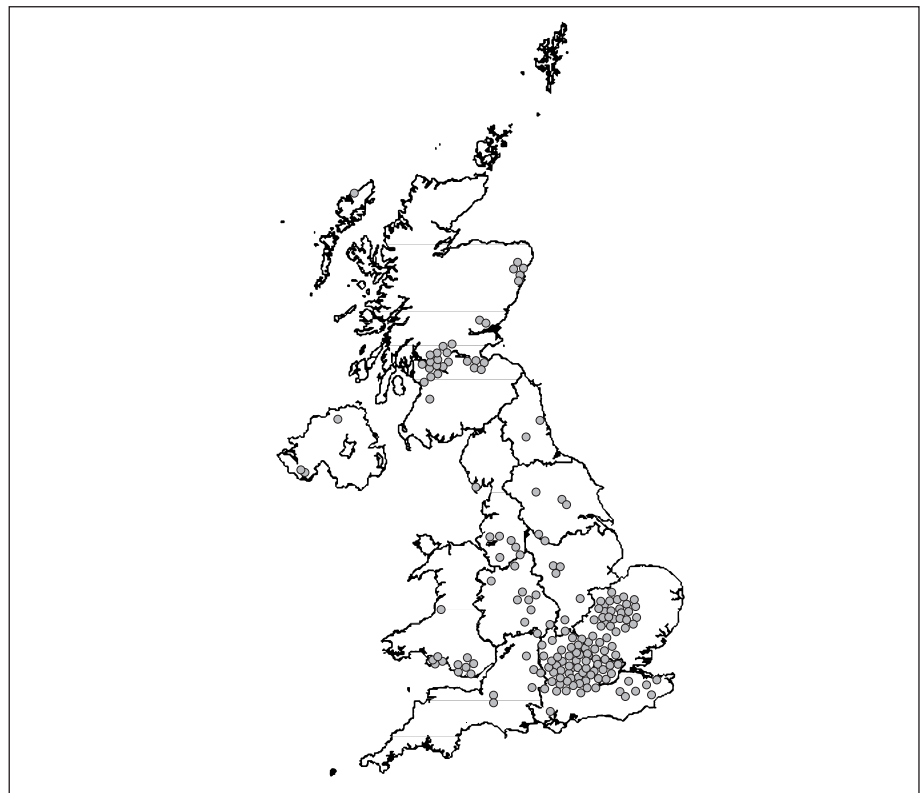
Map 1: Location of research centres of excellence relating to biotechnology



◆ = All centres

◆ = Leading biotechnology research Universities (top 15 funded universities by BBSRC, MRC, or Wellcome Trust)

Map 2: Location of UK specialist biotechnology companies



Source: Based on Ernst & Young 1999

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2.6 The areas we covered in our visits correspond in most cases to the boundaries of the new Regional Development Agencies in England, although the precise locations of the visits reflect the concentration of biotechnology activities within the areas. Oxford, Cambridge, and Norwich were treated separately because they seemed to us to have particular concentrations of biotechnology activities. In Scotland we focused on the concentration of biotechnology related activities in the triangle of Edinburgh, Glasgow and Dundee. For Wales, our focus was on South Wales, though it included representatives from West Wales.

Table 2: Biotechnology company and research strengths in areas visited

<i>Area</i>	<i>Cluster location</i>	<i>No. companies⁽¹⁾</i>	<i>No. of public companies</i>	<i>Premier research and regulatory institutes</i>	<i>Top funded Universities bioscience⁽²⁾</i>
Cambridge	30 mile radius of Cambridge	approx. 150	5-10	LMB, Sanger, Babraham, EBI	Cambridge
Oxfordshire	A34 corridor Oxford to Didcot	approx. 50	5-10	IMM, Human Genetics Centre	Oxford
London	No particular centre	approx. 50	5-10	MCA, EMEA	UCL, Imperial College, UMDS, School of Tropical Hygiene
South East (Surrey, Sussex, Kent)	No particular centre	50-100	5-10		Sussex
Central Scotland	Edinburgh, Glasgow, Dundee	approx. 50	<5	Roslin Institute	Edinburgh, Glasgow, Dundee
North West (Manchester)	M62 Manchester to Liverpool	25-30	<5	Paterson Institute	Manchester, Liverpool
Yorkshire & Humber	York, Sheffield, Leeds	20-40	<5	Central Science Laboratory	Sheffield, Leeds, York
North East – (Newcastle)	Newcastle, Sunderland, Durham	10-20	<5		Newcastle
Wales	Cardiff	10-20	<5	UWCM	Cardiff
Norwich	Norwich Research Park	0	0	John Innes Centre, Institute of Food Safety	East Anglia

⁽¹⁾ Information provided by regional organisations

⁽²⁾ Includes top 15 funded Universities by either BBSRC, MRC, or Wellcome Trust

2.7 A number of European countries – particularly Germany, France and the Netherlands – are making concerted efforts to reduce the UK's lead in biotechnology, and according to some indicators are being successful.²¹ Germany has the second largest biotechnology sector in Europe and has

²¹ Ernst & Young (1999) *European Life Sciences 99 Sixth Annual Report: Communicating Value*

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experienced a rapid increase in the number of biotechnology companies in recent years (from 173 in 1998 to 220 in 1999).²² In doing so Germany has succeeded in narrowing slightly the UK's lead in purely numerical terms from some 70 companies in 1998 to 50 in 1999.

- 2.8 Germany has generously funded its biotechnology sector through the Biotechnology 2000 Programme (including the Bio Regio contest) with an annual budget of £124.5 million.²³ The Bio Regio is particularly interesting in the context of this report because it seeks explicitly to support cluster growth, for example by providing seed capital to start ups in selected regions. The selected regions (Munich, Rhine/Neckar and Rhineland) have developed a variety of programmes and strategies to support biotechnology clusters, while other regions have been stimulated to create initiatives of their own.
- 2.9 The availability of government financing for biotechnology start ups has led to a rapid increase in the number of biotechnology companies in Germany. It has also catalysed an expansion of venture capital funds. The pace of development has been such that there are understandable concerns about the long term viability of these companies, a large number of whom will require funding in an increasingly competitive market.

²² Ernst & Young (1998, 1999)

²³ The development of the biotechnology sector in Germany and the support mechanisms in place are covered in: DTI/FCO (1998) *Biotechnology in Germany: Report of an ITS Expert Mission*.

Chapter 3

UK clusters

- 3.1 We undertook visits to nine areas in the UK and two in the US during our fact-finding mission. The findings of the UK visits are discussed in this chapter and the US visits in the following chapter. In each area we visited several organisations reflecting the area's strengths, including biotechnology start ups, university departments, research institutes and large companies using biotechnology. We also held an interactive discussion during each visit with opinion formers from across the area, including business leaders, researchers, technology transfer managers, venture capitalists, specialist patent and legal services, property developers, science park and incubator managers, and local and regional government. (Appendix 3 lists each visit and Appendix 4 contains a short description of each).
- 3.2 In Chapter 1 we stressed that clusters require a range of factors to be operative. Table 3 lists the factors that we view as critical for cluster development. In the first part of this chapter we describe the extent to which these factors have developed in the areas visited. It seems to us that two areas - Oxford and Cambridge - have enough of the critical factors to be considered fully functioning clusters, although they also have many of the problems associated with success. All of the other areas visited are at earlier stages of cluster development with Central Scotland and the South East counties of Surrey, Sussex, and Kent having the greatest number and maturity of companies. We consider London as a unique case due to its enormous potential to generate biotechnology start ups. The second part of the chapter then examines barriers to cluster development highlighting examples of good practice and particular issues which we return to in the recommendations in Chapter 5.

Table 3: Factors that encourage cluster development

Strong science base	Leading research organisations: University departments, hospitals/medical schools and charities Critical mass of researchers, World leading scientist(s)
Entrepreneurial culture	Commercial awareness and entrepreneurship in Universities and research institutes, Role models and recognition of entrepreneurs Second generation entrepreneurs
Growing company base	Thriving spin-out and start up companies More mature 'role model' companies
Ability to attract key staff	Critical mass of employment opportunities Image/Reputation as biotechnology cluster Attractive place to live
Premises and infrastructure	Incubators available close to research organisations Premises with wet labs and flexible leasing arrangements Space to expand, Good transport links: Motorways, Rail, International airport
Availability of finance	Venture capitalists, Business angels
Business support services and large companies	Specialist business, legal, patent, recruitment, property advisors, Large companies in related sectors (healthcare, chemical, agrifood)
Skilled workforce	Skilled workforce, Training courses at all levels
Effective networking	Shared aspiration to be a cluster. Regional trade associations. Shared equipment and infrastructure Frequent collaborations
Supportive policy environment	National and sectoral innovation support policies Proportionate fiscal and regulatory framework Support from RDAs and other economic development agencies, Sympathetic planning authorities

Oxford and Cambridge

- 3.3 Both Oxford and Cambridge have world renowned research universities; leading research hospitals (The John Radcliffe and Addenbrookes); and a number of important research institutes, such as the Institute for Molecular Medicine and the Wellcome Trust Human Genetics Centre at Oxford, and the Laboratory of Molecular Biology, Sanger Centre, the Babraham Institute and European Bioinformatics Institute at Cambridge.
- 3.4 Both areas have well established entrepreneurial cultures with university spin outs dating from the 1980s. Academic spin outs are a particularly important source of new companies in the biotechnology sector. We found this activity can also be an important benefit to the University. For example, Oxford Asymmetry – a spin out from the University – invests significant amounts to support research in its parent department.
- 3.5 Oxford and Cambridge have geographical concentrations of companies, including both start ups and more mature companies, and the information available suggests that they have experienced rapid growth in the number of

companies. For example, a recent survey suggests that over 60 percent of the biotechnology organisations around Cambridge have been established since 1985.²⁴

- 3.6 A major factor in the success of a cluster is whether or not leading researchers and managers are attracted to live in the area. We found that the 'intellectual buzz' of the research environment, proximity to London, rural setting, and access to international airports were all important factors. High house prices on the other hand are a negative factor. The critical mass of biotechnology companies is a further attraction of Oxford and Cambridge as it provides relative employment security, opportunities to move from one company to another and opportunities for partners to find employment in the area.
- 3.7 There are a number of incubators and Science Parks that cater for biotechnology companies in both Oxford and Cambridge. The DTI Biotechnology Mentoring and Incubator Challenge has supported the Oxfordshire BiotechNet and Babraham Bioincubator near Cambridge and, in addition, a new Bioscience Centre at St John's Innovation Park in Cambridge is due to be completed later in 1999. Companies in these areas, however, still encounter problems in securing premises and are not always able to negotiate suitably flexible leasing arrangements. The application of planning controls may also be having an effect and transport infrastructure may need to be updated.
- 3.8 In addition to strong research and company bases, Oxford and Cambridge both have a pool of skilled staff, local venture capitalists and business angel networks, a range of supporting services with legal, patent, recruitment, and property advisers, incubators, science parks, regional biotechnology associations (see paragraphs 3.39) and a strong image and awareness of being a cluster. Despite the relatively high property values, investors are keen for biotechnology companies to locate in either area, in order for the companies to benefit from these factors, and also to associate the company with the image of Oxford and Cambridge as leading scientific centres.
- 3.9 Established biotechnology companies and large companies in biotechnology related sectors play an important role in cluster development. We found in Oxford and Cambridge that established biotechnology companies and 'serial entrepreneurs', provide management expertise and informal mentoring for start ups. The proximity to large pharmaceutical companies provides partnering opportunities for product development, manufacture, and marketing

²⁴ Eastern Region Biotechnology Initiative (1999) *Biobusiness Trends '99*

and a source of management expertise for biotechnology companies. Managers and research staff from large pharmaceutical companies may join local companies or even start up their own. The consolidation of the pharmaceutical industry is likely to contribute to this process.

- 3.10 We believe it is important to build on the strengths of Oxford and Cambridge and further develop their potential to be world leading biotechnology clusters. There are, however, challenges to further development, that we consider in Chapter 5.

Central Scotland, North West, North East, Norwich, South East (Surrey, Sussex, Kent), Wales, Yorkshire

- 3.11 We felt that the other areas visited are at earlier stages of cluster development. Central Scotland has a number of centres of research excellence, such the Roslin Institute and the Wellcome Trust building at Dundee University, as well as a large and growing number of biotechnology companies (the number has increased from 9 in 1985 to 50 in 1999).²⁵ Scottish Enterprise has played an important role in supporting the development of a strong biotechnology sector in Scotland and is leading efforts to create a Scottish biotechnology cluster. We found that many companies greatly valued the support they received through Scottish Enterprise. In our view, however, in Scotland there is not yet a sufficient range of investors and supporting services and networking between companies and researchers for it to be considered as a fully functioning cluster.
- 3.12 The South East counties of Surrey, Sussex and Kent have over 50 biotechnology companies. This area also has many service providers, a number of large pharmaceutical companies and close proximity to the London based investors and research organisations. The Southern BioScience initiative has done much to foster networking and support the development of biotechnology across this region, but it is only in the early stages of becoming a cluster. We found that companies feel too geographically apart from one another to perceive themselves as a cluster.
- 3.13 The other areas visited (the North East, North West, Norwich, Yorkshire, Wales), all have significant research strengths (see descriptions in Appendix 4). For example, the North West is strong in clinical based research with leading research hospitals (Christie Hospital and Paterson Institute) and a new Wellcome Trust Clinical Research Facility. Norwich and Yorkshire have

²⁵ Figures provided by Scottish Enterprise

strengths in plant and food biotechnology, based on strong academic and interdisciplinary departments and also local concentrations of companies in the food and agrochemical sectors. The North East has research strengths spread across the universities in this region, including a leading Department of Genetics at Newcastle University. In Wales, the University of Wales College of Medicine is an important focus for biotechnology research and a new School of Biosciences has been established at Cardiff University. Improved understanding and communication of the differential research strengths in these areas would, we believe, help signpost potential investors and research partners to the best locations. An important step in this direction is the way in which universities in many of these areas are increasing collaboration and coordination of research, with a good example being the White Rose partnership between the Universities of York, Sheffield, and Leeds.²⁶ These areas do not yet have the company base (both start ups and more mature biotechnology companies) which characterise clusters. Although good data on the number of specialist biotechnology companies does not exist, the information provided to us suggests all of these areas have 30 companies or less, and a limited number of University spin out companies. Nevertheless, these areas have some important advantages over the more established clusters in Oxford and Cambridge, such as lower property values and in some cases access to European structural funds and Regional Selective Assistance.

- 3.14 These areas sometimes have greater difficulty attracting key researchers and management in comparison to the more established clusters, as they have yet to establish an image as biotechnology centres. We believe, though, that major investments, such as the John Innes Centre in Norwich and the International Centre for Life in Newcastle, can be promoted to help create positive images. Research stars and important new research centres can also transform the image of an area. We found, for example, that Professor David Lane at Dundee University, as a leading researcher in cancer genetics, and the new Wellcome Trust building at Dundee, helped to attract researchers and staff to the area.
- 3.15 Some of these areas have recently established specialist incubator facilities that may significantly increase the number of start ups. The most impressive example is the Manchester Biotech Incubator building, a £15 million investment dedicated to fostering biotechnology start ups. Another example of good practice is the Medicentre located at University of Wales College of Medicine in Cardiff, which provides a variety of accommodation units for

²⁶ The White Rose partnership includes a number of initiatives between the universities to increase critical mass in bioscience

start ups in the healthcare sector. In other areas we found that the lack of incubator facilities is a major obstacle to start ups. Typically these areas did not have Science Parks with the same level of experience in accommodating biotechnology companies as we found in Oxford and Cambridge.

- 3.16 We found that these areas do not have a critical mass of investors and supporting services which have experience in meeting the needs of biotechnology companies. Some of these areas have centres for finance and business services, such as Manchester, which may become more adept at financing and servicing the biotechnology sector as it develops locally. Companies are able to access specialist services and the investment community in other regions (particularly London), but at greater inconvenience than is the case in Oxford, Cambridge, and London where these are available locally.
- 3.17 Large companies can play an important role in cluster development, and this is apparent in the South East area (Surrey, Sussex, and Kent). Scotland and Wales, have few such companies which may constitute a greater challenge in accessing the expertise these companies hold. In the North East and North West there are large pharmaceutical and chemical manufacturing sites which contribute to the development of biotechnology in the region and we would encourage them to continue and increase their support and involvement. The North West and North East have strong track records of pharmaceutical production which may provide a base for capability in biotechnology manufacturing, and we understand that each of these areas is examining ways to take this forward.

London

- 3.18 London seems to us to be a unique case. It has a number of leading Universities and research hospitals and accounts for over one third of the publicly funded research in Britain and trains over one quarter of the country's graduates.²⁷ There are more venture capitalists and specialist services than elsewhere in the UK, and London is home to the UK and EU medicines regulatory agencies (Medicines Control Agency, Medical Devices Agency and European Medicines Evaluation Agency). We therefore believe that London has a huge potential for biotechnology start ups that can benefit from its unique strengths.

²⁷ London Development Partnership (1999) *London: The Knowledge Capital*

- 3.19 We do not think, however, that London is yet realising its full potential, and we found that securing suitable incubation facilities in the right locations in London is problematic for start ups. There is a danger that this can prevent company formation or cause significant delays while ad-hoc arrangements for premises are put in place. Given London's potential for biotechnology start ups, we consider the improved provision of incubator facilities to be a priority action. We would like to see the DTI working together with London First, the London Development Partnership, universities in London and property developers to address this issue, so that developments are initiated which the Greater London Authority can support when it has been set up.
- 3.20 High property values and space constraints in London are greater than elsewhere in the UK. We therefore believe that biotechnology companies will naturally locate the later stages of development and manufacturing activities outside London. Depending on their business needs they may choose to relocate to existing clusters at Oxford and Cambridge or areas of the UK where property values are lower and there is more space available to expand. It is important though that London has the facilities to support the early stages of biotechnology companies. In our view this process could be facilitated through improving biotechnology networks between London and other areas.
- 3.21 Although London and other areas of the UK have significant potential in biotechnology, we do not believe it is realistic for every region to develop a biotechnology cluster. Successful biotechnology companies do develop outside clusters, especially where local links to the food industry and environmental industries are important. Companies throughout the UK can realise some of the benefits of clusters due to the relatively small size of the UK and through establishing virtual networks with related companies and research.
- 3.22 We also recognise that for successful industrial application, biotechnology cannot be seen in isolation from other technologies. In particular the convergence of technologies, for example between biotechnology and information technologies in bioinformatics, create opportunities for new clusters. Whilst we have restricted our study to biotechnology, we suggest that an understanding of clusters across technologies is an important area for further government action.

Barriers to cluster development

3.23 Cluster formation is influenced by historical antecedents and the process of building on existing strengths. As we found when we visited Seattle and Boston in the US, it takes many years for factors such as successful companies and reputations to develop and we do not believe there is any single recipe for cluster development. In the following sections we examine barriers relating to the development of the ten critical factors identified in paragraph 3.2, grouped into three sets of issues: exploitation of the research base (covering a strong science base and entrepreneurial culture), company development (covering the ability to attract key staff, supportive physical and transport infrastructure, availability of finance, business support services and large companies, and a skilled workforce), and government support for cluster development (effective networks, and government support at regional and national level).

Exploitation of the research base

3.24 We were struck by the way that research organisations (including university departments, research institutes funded by government or charities, medical schools and research hospitals) are major drivers of cluster development, through research collaborations, providing services and facilities, helping to create an intellectual 'buzz' and as a source of start up companies.

3.25 The contribution of research organisations to cluster development is dependent on positive attitudes towards commercially relevant activities within the organisations. We were impressed at the extent to which cultures and attitudes across universities and research institutes are changing in this respect. We also encountered a frank recognition of the need to develop further and a willingness to do so.

3.26 The Research Assessment Exercise (RAE) seems to us to be a significant difficulty for those wishing to undertake commercially relevant research. The previous RAE did not explicitly recognise commercially valuable work and the pressure to publish, inherent in the RAE, often goes counter to commercial needs to maintain for a certain length of time a level of confidentiality about research work. Although there are schemes to give incentives for commercial work, the rewards are lower than for RAE, and other returns from commercial research, such as royalties, licensing and spin outs take many years to be realised. We welcome the new advice for Panel Chairs for the next RAE which broadens the definition of research output to include patents and commercially confidential work. We have also asked DTI officials to raise these issues for the Fundamental Review of the RAE being undertaken by HEFCE.

- 3.27 Technology transfer and industrial liaison offices can provide vital support to the exploitation of research. We found the support provided by some universities was good but performance was far from uniform. We believe that further consideration needs to be given to resourcing these offices and providing a framework that encourages entrepreneurship and co-ordination across regions, so that they can realise the true commercial potential of their intellectual property (IP). We encourage the OST and universities to address these issues as a priority. We comment on the need for clarity of ownership of IP in Chapter 5 which we consider needs urgent action.
- 3.28 Spin outs from research organisations are important vehicles for exploiting biotechnology research. These spin outs require incubators with wet laboratory space located very close to research organisations, such that scientists can continue academic work and access easily the facilities of the host organisation. In a number of the clusters we visited the problem is being alleviated through the creation of specialist incubation facilities. Support provided under the DTI's Biotechnology Mentoring and Incubator Challenge²⁸ was considered to be helpful in increasing the number and, particularly the quality of academic spin-outs.
- 3.29 Many of those we met, especially in the more established clusters, considered the financing of academic start ups to have become easier in recent years through the development of seedcorn funds by some universities, research councils and others, and Business Angel networks. We believe that University Challenge will make further improvements in this area.

Company development

- 3.30 A successful cluster requires more than start up companies. It must provide an environment in which existing companies mature and develop. One of the most important factors influencing company development is whether they can attract the right management team and staff. Leading biotechnology researchers and managers are internationally mobile, and, in order to meet the large demand for experienced managers in the biotechnology industry, we ought to be attracting back some of the many managers and researchers who have gone to the US because of the opportunities there. Many of those we met thought that exciting science, and quality of life were important factors in which the UK was able to compete. We are, however, concerned that

²⁸ Further comment on the BMIC scheme is provided later in paragraph 3.37

biotechnology companies in the UK are not able to offer competitive benefit packages to attract leading people. In this area we can learn much from the US. Chapter 5 sets out measures which are proposed in the UK.

- 3.31 In some areas, local training institutions have, in partnership with industry and others, created courses to fill skills gaps. The Oxford Brookes University has set up a biotechnology degree course, with input from local industry and support from the local TEC, Oxfordshire BioLink and the Oxford Trust. In Cambridge the Babraham Institute has established a biotechnology training and skills centre. Southern Bioscience is taking a range of actions to stimulate further education colleges in the region, such as the North East Surrey College at Epsom, to undertake more technician level training and fill identified skills gaps. The University of Manchester and the Defence Evaluation and Research Agency have created a centre for teaching integrative research in biology supported by the pharmaceutical industry, research councils and charities. Another example, outside the areas we visited, comes from the University of Ulster which has established two new undergraduate courses on biotechnology. We commend these examples of imaginative initiatives to address local training needs and would encourage others to follow.
- 3.32 Biotechnology companies typically need to secure finance from the investment community over a relatively long period of time before their products reach market. Seedcorn funding is becoming more available (see paragraph 5.8). We found, however, that companies are experiencing difficulties securing funding for continued growth. Without corrective action we believe this gap will become more serious with the growing numbers of biotechnology companies.
- 3.33 Biotechnology companies in the UK are facing challenges in finding premises in suitable locations as they develop. A variety of premises are required to meet the needs of companies as they expand and flexibility is needed if companies suffer setbacks. The success in supporting and incubating start up companies is likely to amplify this shortfall. Post incubation, biotechnology companies are typically more self sufficient and do not need to be located in the immediate vicinity of research organisations. They do, however, want to locate within the same area so that staff do not need to relocate and the company maintains good access to research organisations and networks.

- 3.34 Science Parks, where available, are sometimes able to provide suitable premises but often after a wait of several months, potentially slowing company growth and creating problems for young companies with limited and uncertain finances. The effect of clusters is to concentrate the growth of companies in particular areas which are usually attractive places to live. The consequence is that there is a tension between the need to provide for growth (not only of the companies themselves but of associated housing and transport development) and the need to protect the environment. This has to be resolved through the planning system. We believe that the correct response is to plan proactively for growth in areas where companies want to locate and expand, so that clusters can grow without adversely affecting the environment. This is particularly important because managers and researchers in biotechnology companies are mobile and could well go to other countries, and because a certain amount of local growth will also inevitably take place which might lead to traffic congestion and overcrowding which degrades the environment.
- 3.35 We were encouraged to discover that a small number of property developers were becoming more ready to talk to biotechnology companies about their needs and to accept more flexible leases.²⁹ The creation of a critical mass of client companies in a cluster to support speculative building is an important feature, and there is a role here for the new and existing Regional Development Agencies (RDAs) and the regional biotechnology associations to champion this cause with property developers. We would like to see this approach to meeting accommodation needs extended and recommend actions in Chapter 5.
- 3.36 Training and skills are not considered a major problem in general but with important exceptions, particularly in Good Laboratory Practice and Good Manufacturing Practice. A greater skills shortage for small companies was high calibre management. The Science Enterprise initiative was welcomed as providing scientists with training in business skills. Business schools have a role to play by providing training in entrepreneurship for managers of the future and providing management and business development training for companies.

Government support for clusters

- 3.37 Governments can support and facilitate cluster development in a variety of ways. The regulatory and fiscal framework provides incentives that influence company formation and growth within clusters. Innovation and technology transfer support schemes can help build on strengths. DTI programmes in

²⁹ A good example is Milton Park, Abingdon

these areas were generally thought helpful in developing biotechnology in the areas we visited. The Biotechnology Mentoring and Incubator Challenge has supported the provision of incubator facilities and mentoring services for start ups in a number of areas, and Biotechnology Exploitation Platforms have supported exploitation of Intellectual Property within research organisations (table 5)

Table 5: BMI and BEP awards granted in areas visited

<i>Area</i>	<i>BMI Awards</i>	<i>BEP Awards</i>
Cambridge	Babraham BioIncubator and Mentoring Service	Bioscience Partnership
Oxfordshire	Oxfordshire BiotechNet	
London	Merlin Ventures*, Imperial College Company Maker The Wheb Partnership	Envision Cancer Research Ventures
South East (Surrey, Sussex, Kent, excluding Oxfordshire)	Progeny*	
Central Scotland		
North West (Manchester)		MANIP
Yorkshire – (Leeds, Sheffield , York)	BioIncubator York	White Rose
North East – (Newcastle)		
Wales		Western Arc
Norwich		The UK Plant Science Platform
South West	Swibtech Western	Biotech

*coverage not limited to region

- 3.38 Government can also play a role in catalysing the development of networking activities and regional biotechnology organisations. A fully functioning cluster requires the existence of effective networks which allow a rapid flow of information and are able to engage the participation of all those with a stake in biotechnology. We found that the sense and benefits of being in a cluster depended on the extent and depth of interactions between constituent members.
- 3.39 The regional biotechnology associations supported by the DTI and others (see table 6) have been influential in fostering networking and engendering a co-operative environment. We found on some visits that key individuals or ‘cluster champions’ had been vital in forming networks and engaging the key

local players. Conversely, in the absence of such a network the level of interaction was sometimes relatively modest. This was particularly the case in London and Wales with the consequence that the local biotechnology communities are often not aware of local opportunities for premises, skills, and complementary expertise.

Table 6: Regional biotechnology associations

Cambridge	Eastern Region Biotechnology Initiative (ERBI)
Surrey	Southern BioScience
Oxford	Oxfordshire BioLink
Manchester	NW Biotech initiative*
York	BioScience York
Newcastle	NE Biotech Initiative*
Scotland	Scottish Enterprise activities

* Not formally launched

3.40 Regional biotechnology associations play a wider role than solely promoting networking. They are also providing information about the cluster, lobbying, facilitating collaborative agreements, addressing education and training needs, and promoting the cluster nationally and internationally (table 7). We were pleased to note that since our visit to Cambridge, the Eastern Region Biotechnology Initiative has held a conference to profile the region and conducted a comprehensive survey of the cluster and its needs.³⁰ We comment further on biotechnology networks in Chapter 5, as we consider these networks to be an important way that Government can facilitate cluster development at a local level.

Table 7: Examples of Activities of Regional Biotechnology Associations

Networking	Seminars, workshops, conferences on scientific and business issues, Social events, Newsletters
Providing information/ Signposting	Websites, Company directories Port of call for inward investors, Company visits Disseminate DTI schemes
Articulating needs/ Lobbying	Interaction with local government Interaction with national government
Collaboration/ joint action	Purchasing consortia (e.g. laboratory materials) Equipment sharing schemes, Mutual access to libraries Access to legal expertise/ documentation
Education/Training	Seminars/workshops on specific topics, e.g. regulatory issues, marketing, business development Encourage training institutions to put on courses
Promotion	Attending trade fairs/conferences, Organising conferences Partnering events with overseas companies Presentations for local companies

³⁰ Eastern Region Biotechnology Initiative: *Biobusiness Trends '99*.

Chapter 4

Biotechnology in the US

- 4.1 The US is the world leader in biotechnology. In 1998, there were 1,283 biotechnology companies in the US, employing 153,000 people, with many more in the support and supply chain. Sales of biotechnology products last year reached over \$13 billion. This contrasts with about 1,200 companies and 46,000 employees in the whole of the European industry.
- 4.2 There are more than 65 biotechnology drug products and vaccines approved by the US Food and Drug Administration, with more than 295 biotechnology drug products and vaccines currently in clinical trials, and hundreds more in early development in the US. There has also been a significant increase in the number of agricultural products available in the US, as genetic modification is used to replace traditional breeding techniques.
- 4.3 The US industry can trace its roots to the late 1970s and early 1980s and has created a number of successful so-called “lighthouse” companies such as Amgen, Genentech and Genzyme, which have had a major influence on the industry. This comparative longevity compared to the UK and the rest of the European biotechnology industry is a significant factor in the growth of clusters where success can take 15 or more years to achieve; most companies in the UK have been established for less than 10 years. A summary of the performance of the US biotechnology industry over the last two years is shown in the table below:

	<i>No of companies</i>	<i>No of employees</i>	<i>R&D expenses</i>	<i>Product sales</i>	<i>Market Capitalisation</i>
1998	1,283	153,000	\$9.9 bn	\$13.4 bn	\$97 bn
1997	1,274	140,000	\$8.5 bn	\$11.5	\$93 bn
% growth	1%	9%	16%	17%	4%
(Ernst & Young: Bridging the Gap 1999)					

US clusters

- 4.4 The main biotechnology clusters in the US are San Francisco, Maryland, San Diego, Boston, Seattle and North Carolina. We included two US clusters, Boston and Seattle, in our fact-finding visits. We also gathered information on other US clusters (Appendix 3 lists each visit and Appendix 4 contains short

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Biotechnology in the US

descriptions) and in Seattle we met some of the architects of the clusters in Maryland, San Diego, North Carolina and Silicon Valley. Seattle was of particular interest to us as an emerging cluster. Since 1990 it has experienced a rapid rate of company formation to consistently rank in the top five US biotechnology centres in terms of number of companies. In contrast, Boston, Massachusetts is one of the leading and most established clusters in the US, second only to the San Francisco Bay Area, which has all the key elements of a mature, successful, cluster.

- 4.5 In both cases, biotechnology clusters have formed around centres of research excellence: the University of Washington, Washington State University and the Fred Hutchinson Cancer Research Center in Seattle, and the Massachusetts Institute of Technology (MIT), the Whitehead Institute for Biomedical Research, and Harvard and Boston universities, in Boston. World class researchers have acted as a role model for other scientists and related entrepreneurial activity. A good example is Leroy Hood, who was attracted back to Seattle by the opportunity to set up a new, purpose built, research centre for bioinformatics and genomics. At MIT, the role of Professor Robert Langer in creating a succession of successful biotechnology start-ups has had a hugely positive effect on the already strong entrepreneurial climate in Boston and has bolstered MIT's formidable reputation.
- 4.6 We were particularly interested to learn about the so-called "can-do" mentality which has contributed so much to the US economic success. We found plenty of evidence that this was a key to many of the achievements in clusters such as Boston and San Diego. The comments made to us by British biotechnology entrepreneurs working in the US were particularly telling, since they put this factor as high as any other in the decision to make their careers in the US. We also encountered a refreshingly positive attitude to failure and without doubt the fear of failure is lower in the US, where entrepreneurs typically use failure as a means of learning from their mistakes. As the Government said in its White Paper, changing attitudes in the UK will take time and we are pleased that measures are being reviewed to ensure that the law does not contribute to the stigma of failure.

Exploitation of the science base

- 4.7 Last year, the National Institutes of Health achieved the largest budget increase in its history. The NIH budget for 1999 totals \$15.6 billion, which represents a \$2 billion or 14.4% increase over 1998. Basic research in the biological sciences is also supported through the National Science Foundation, with a

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budget for 1999 of \$391 million. Other federal agencies, which have major research programmes which impact on biotechnology include:³¹

- the US Department of Agriculture (\$1.660 billion)
- NASA – the Office of Life and Microgravity Sciences (\$264 million)
- the US Department of Energy – the office of Biological & Environmental Research, which supports the human genome mapping project (\$433 million)

4.8 The scale of available resources is impressive. US universities, and other publicly funded research bodies have a strong record of exploiting the science base, and we saw plenty of compelling evidence in Seattle and Boston of technology transfer operations working effectively and enjoying real success. Of particular interest were the arrangements whereby researchers are allowed a significant number of days a year for consultancy and commercial activities which provides positive encouragement to keep in touch with the outside world.³²

4.9 Laws in the US governing the ownership of intellectual property (IP) were clarified in the innovative Bayh-Dole University and Small Business Patent Act (1980). The principle aim of the Act is to promote commercialisation from federally supported research and to allow universities to own patents arising from it. The degree of clarity which this measure has brought to IP ownership, income and equity among staff, department, technology transfer office and the university is commendable³³ and prompted us to consider what comparable improvements could be made in the UK (see Chapter 5).

4.10 We were impressed by the work of the MIT Entrepreneurship Center and the role it plays in teaching entrepreneurship to MIT engineers (with courses covering the nuts and bolts of business plans, starting and building a high-tech company and new product and venture development). We believe that British universities can learn from such courses, and hope that the Science Enterprise Centres will take a lead in doing so. We were also interested to learn about the impetus business competitions can provide to both technology transfer and the development of a culture of entrepreneurship within clusters. The \$50k

³¹ Figures from AAAS report XXIV *Research and Development FY2000*

³² Further details can be found in CVCP (1999) *Technology Transfer: the US Experience*

³³ See also CVCP (1999) *Technology Transfer: the US Experience*

Entrepreneurship Competition run by MIT particularly caught our attention and we were impressed by its achievements since its inception in 1990. Unlike many other business competitions,³⁴ the “MIT \$50k” provides support to student entrepreneurs who submit business plans for real, rather than imaginary, new ventures showing significant business potential. Since its inception the competition has supported the creation of over 35 companies with an aggregate value of over \$500 million.³⁵ We noted the unquestioning focus on enterprise and the excitement generated within the Institute and amongst local sponsors. We believe there is a compelling case for universities and the venture capital community to create similar business competitions in the UK (see Chapter 5).

Company development

4.11 Federal support for the biotechnology industry is typically focused on funding basic research and on maintaining the provision of a suitably trained workforce. The provision of start-up finance is seen as a matter for the private sector. The only – but nevertheless significant – federal programme which supports start-ups is the Small Business Innovation Research Programme (SBIR).³⁶ Under this scheme 2.5% of the external research budget of 11 US Federal agencies is set aside for funding R&D in small firms and the programme is regarded as effective in encouraging university faculty to set up small companies. The National Academy of Science is undertaking a comprehensive review of the schemes and early indications are that its report will be favourable. The scheme is not, however, uniformly popular with all government agencies because it takes funding away from specific research areas and because it is felt that the quality of research proposals from industry tend not to be as good as those from universities. Another concern we heard was that some companies spend most of their time chasing SBIR money, so much so that their survival can become dependent on SBIR grants. Nevertheless, our overall impression was that the programme had played a very significant role in the formation of biotechnology companies, and had been successful.

³⁴ In the UK, the Young Entrepreneurs Scheme (YES) is similar but for imaginary business plans submitted by students, while the Bioscience Business Plan competition is for real business plans but for academic staff.

³⁵ The MIT \$50k competition provides \$30k to the winner and \$10k each to two runners up.

³⁶ The SBIR programme provides more than \$1 billion a year to innovative small firms in the US.

- 4.12 The SBIR scheme provides higher levels of grant than the UK SMART scheme – up to \$100,000 for feasibility studies and \$750,000 for development studies. SBIR is also considered more user friendly than SMART for those with scientific training, by having greater similarity to research grant applications and for relying on peer review. Although elements of the SBIR programme (such as the required implementation of labour laws and training programmes) can be burdensome for small start-ups we were impressed overall by the positive impact and achievements attributed to the programme, particularly by those we met in Boston. We believe there is a case for the UK to consider the lessons that can be learnt from the US about ways to boost the level of support available to innovative small businesses (see Chapter 5).
- 4.13 The US venture capital industry is the most mature in the world and it has been a major contributor to the success of the US biotechnology industry. In the first six months of 1998 the amount of venture capital financing for biotechnology companies was \$615 million with 50% of this going on later stage investments, a pattern which is similar to the UK. A shortage of seed finance has led to the growth in state-initiated venture capital funds in California, Massachusetts, Maryland, North Carolina and Seattle. In the absence of an established venture capital industry, a valued source of finance in Seattle is that of business angels. This development has in turn given rise to a “choir” of angels and “cherubims” operating a level below Seattle’s most famous investor, Bill Gates.

State grants and initiatives

- 4.14 States have their own economic development initiatives to support the growth and development of the biotechnology industry. These include tax incentives, as well as specific programmes and initiatives which impact on cluster development. For example, California has introduced a number of tax incentives which include exempting biotechnology companies from the 6% state sales tax, North Carolina provides exemption for manufacturing equipment purchases and in Washington State high tech firms receive a credit against their business and occupancy taxes for R&D expenditures. Massachusetts offers a number of tax incentives, including a 10-15% tax credit on research with a 15 year carry forward, and a 3% investment tax credit on fixed assets with a three year carry forward.³⁷

³⁷ Unlike the UK’s proposed R&D tax credit the measure in Massachusetts does not benefit loss-making tax exhausted companies.

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Biotechnology in the US

- 4.15 In Boston we heard a telling example of how a state's attitude to the industry can crucially affect the investment climate. Genzyme told us that when they were looking where to build their new manufacturing facility one option would have been to move to the biotechnology manufacturing cluster in North Carolina. Their choice ultimately was influenced by a strong political will to anchor the investment in Boston.
- 4.16 Biotechnology trade associations operating at a state level are also an important part of the cluster landscape. The Washington Biotechnology and Biomedical Association (WBBA) has been important during the early phases of the Seattle cluster, pressing for tax changes and other infrastructure elements. In Massachusetts, the Massachusetts Biotechnology Council (MBC) has been running for 15 years as a non-taxable lobbying organisation. Its achievements include managing to persuade the US Food and Drug Administration to open an office in Boston, the introduction of tax credits, organisation of common purchasing and the development of an extensive education and training programme in biotechnology.
- 4.17 As we indicated in Chapter 3, comparable cluster networks in the UK are still in their infancy but they can and should learn from the experience of American clusters. The link being established between the Massachusetts Biotechnology Council and the Eastern Region Biotechnology Initiative is a positive step in this direction.

Chapter 5

Encouraging the development of clusters in the UK

- 5.1 The previous two chapters have described our understanding of clusters in the UK and US in terms of the factors we see as critical, identifying examples of best practice and barriers to further development. In the following paragraphs, we make recommendations and raise issues for further consideration in order to address the barriers to the development of clusters in the UK, drawing from our findings in the US.

Science base

- 5.2 Universities, other public research institutes and teaching hospitals, are important components of clusters as sources of company formation, skilled personnel, and collaborative partners with industry. However, as we have noted earlier, some are more active than others in contributing to the growth of clusters.
- 5.3 We were impressed during our visits by the extent to which the culture within universities towards commercialising their IP is improving. We also encountered a growing recognition of the need to improve further, and to secure the resources to do this professionally and to consider possible synergies with IP held by other HEIs. The support provided by some universities through their technology transfer offices is good but performance is far from uniform. We therefore suggest that greater priority should be given by universities to improving the way their technology transfer operations are resourced so that they can realise the true commercial potential of their intellectual property. We encourage the OST and universities to address these issues as a priority.
- 5.4 We also came across another significant obstacle to technology transfer. Deciding on the ownership structure of IP was identified by a number of those we met as a major impediment to commercialising research findings. Problems were particularly acute for multi-funded research where too often the disparate IP policies of the funding bodies (including BBSRC, MRC, Wellcome and other charities) produced conflicting claims on ownership which can take lengthy negotiations to resolve and deter potential investors.

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- 5.5 In contrast, as we comment in Chapter 4, the system of IP ownership in the US has the virtue that there are clear procedures for the vesting of IP with the research institute or university, and that there are formulas for allocating royalty and licensing revenues.

We recommend that Research Councils, Medical Charities and others work with the Office of Science and Technology to review their respective policies on Intellectual Property (IP) ownership to ensure clarity and avoid conflicting claims, for example by ensuring that IP ownership is vested in the organisation generating the IP.

- 5.6 Biotechnology start ups also need to have a sufficiently broad technology base to enable them to grow. We are encouraged by what has been achieved to date by the DTI's Biotechnology Exploitation Platforms Challenge (see Chapter 3) in helping to bring together complementary IP across research institutions. We are pleased to learn that there are plans for an extension of £6.4 million to the Challenge for the next 4 to 5 years.

Entrepreneurial culture

- 5.7 The teaching of entrepreneurship and management to engineers and others is valuable and we believe that universities in this country can learn from the approach and courses run by the MIT Entrepreneurship Centre. As we note in Chapter 4, business competitions can be a valuable way to boost commercialisation and engender a real sense of adventure and entrepreneurship among university students. We believe, that there is a need for universities and the venture capital community to create business competitions in the UK which are based on real rather than imaginary ideas and that they are properly resourced and bidders are supported so that they have access to advice on IP protection, business planning and raising finance. It would be possible for such competitions to operate at the regional level, and take advantage of the Reach Out fund and the new micro-project element of the SMART scheme.

We recommend that universities seek, in collaboration with the new Science Enterprise Centres, to make more knowledge about management and entrepreneurship available to their science undergraduates and graduates.

We recommend that universities, in conjunction with venture capitalists and other sponsors, introduce student business competitions similar to the MIT \$50k prize to stimulate entrepreneurship and the number and quality of university start-ups.

Growing company base

- 5.8 Equity finance is typically the main way biotechnology SMEs finance their research and development activities, but Government also has an important supporting role to play. In the UK there have been a number of welcome improvements in support for early stage R&D based companies, such as University Challenge, Venture Capital Trusts, and various sectoral programmes,³⁸ as well as planned improvements such as the Enterprise Fund and the proposed R&D tax credit.
- 5.9 The SMART scheme has been very successful in providing vital finance and endorsement at the early stage of development and has recently benefited from additional support from the DTI. But like those that we consulted we suggest that there should be further support mechanisms for early-stage start-ups to increase their financing options. We believe there is an important opportunity for Government to stimulate R&D particularly in areas which may otherwise be neglected because they are seen to be too far ahead of viable markets or in a niche market. We were impressed by the R&D support available for SMEs in biotechnology and other sectors provided by the Small Business Innovation and Research (SBIR) programme in the US, and believe the benefits it provides should be subject to further analysis.

The DTI will consider, in consultation with other Government Departments and devolved administrations, the lessons which can be learnt from the US about ways to stimulate R&D in SMEs.

³⁸The Biotechnology Mentoring and Incubator Challenge and the UK Biotechnology Finance Advisory Service

Ability to attract key staff

- 5.10 Biotechnology companies, although often small, compete and operate globally. To succeed they must be able to attract high calibre management. In the UK, in order to meet the growing demand for experienced managers, we need to attract back some of the managers who went in the early years of the biotechnology industry to the US. Equity-based remuneration is an important way that a cash-poor company can remunerate and provide incentives to its staff. When in the US, we heard that companies in biotechnology and other high technology sectors were offering share options schemes in the region of £500,000. The current tax advantaged Company Share Option Scheme in the UK gives incentives to hold up to £30,000 in shares under option at any one time. This limit may be too low to apply to key management joining high risk companies, although such companies may choose to offer higher levels of options without the tax advantages of approved schemes.
- 5.11 The Government has recognised there is a need to consider whether tax incentives might be required to encourage high calibre managers to join and stay with smaller companies. US experience tends to suggest that share options can be a very effective way of encouraging the entrepreneurial spirit needed to make businesses grow rapidly, and we saw plenty of evidence to support this view during our two US visits. The number of British entrepreneurs who have been attracted to work in the US biotechnology industry (often occupying senior positions) is a trend we must reverse and ways must therefore be found to improve the attractiveness of share options. We note that a series of recent reports³⁹ have all promoted the case for targeted tax-advantaged share incentive schemes.

We welcome the decision by the Chancellor to provide incentives to enable companies to attract and retain the best staff and from next year small, growing companies will be able to offer key staff tax-advantaged options over shares up to £100,000.

³⁹The report on the financing of high technology businesses by a group headed by Sir Peter Williams; the Smaller Quoted Companies group; and the report of the DTI Competitiveness Working Party on Investment.

Chapter 5

Encouraging the
development of
clusters in the UK

Availability of finance

5.12 An impressive amount of venture capital has been invested in the UK biotechnology industry over the last ten years (see Chapter 2). As the industry grows, however, there is a very real risk that the current levels of venture capital will not keep pace with demand and fresh impetus will be required to unlock additional funds. It is inevitable that the growth of the industry in Europe will give rise to fresh investment opportunities which will further dilute the availability of venture capital in the UK. The US experience suggests that changes in Capital Gains Tax (CGT) may influence investment. We are pleased that the Government has recognised the need to provide incentives in this key area.

We welcome the recent changes to Capital Gains Tax to provide taper relief which introduces lower effective rates⁴⁰ which we believe will help to increase equity finance in the UK.

Premises and infrastructure

5.13 Concerns were expressed on all our visits in the UK about the shortages of specialist premises and the length and inflexibility of leases. Unlike many other high technology sectors, biotechnology companies need specialist premises (with wet labs) which are flexible enough to meet their needs as they develop.

5.14 We learnt that often companies were obliged to take on leases of 15-20 years which is far too long for a young start up which is struggling to look beyond its first year and faces almost daily uncertainties about its future. Long lease times also create problems for companies wishing to expand quickly or conversely who encounter problems and need to contract. To find a way round this companies were forced to occupy two or more separate sites, hampering their efficiency and internal communication. As we noted in paragraph 3.35, there are some property developers who are becoming more ready to talk to biotechnology companies about their needs and to accept more flexible leases.⁴¹ We encourage the private sector, University landlords and others to consider ways to provide short term leasing arrangements for biotechnology companies, and for biotechnology companies to communicate better their current and future accommodation needs.

⁴⁰ 10% for longterm holdings of shares qualifying as business assets.

⁴¹ We also note the Business Property Federation initiative on simplified business leases, which we hope may facilitate the provision of short term and flexible leasing arrangements.

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- 5.15 A related difficulty is planning restrictions which can be a significant barrier to cluster growth. At present this is a particular problem in Cambridge, Oxford and London, but we think that it is problem that other areas may encounter as clusters develop. In the knowledge driven economy, university towns will become more dynamic generators of the sources of economic growth, particularly for small, research-intensive businesses. The conflict between environmentally sensitive areas and growth must be resolved in innovative ways. There is an assumption that when biotechnology companies reach the large-scale production stage much of that work will be contracted to third parties. But as we found time and again proximity is much more important in the early stages and therefore research and incubation will need to remain close to leading knowledge centres.
- 5.16 We are encouraged by the emphasis on economic development as part of DETR's work to modernise planning, and the review of planning and clusters announced in the Competitiveness White Paper. An innovative planning solution, consistent with the development of clusters is to manage high technology growth by fashioning 'Urban Networks', and to designate zones where innovative clusters may develop. These 'Urban Networks for Innovative Cluster Areas' (UNICAs) consist of a research and incubator-intensive 'mother city', well-linked by digital and land-transport communications to modest and easily accessible growth points for specialised production, analysis, testing and services. Existing axes such as the M11 in Cambridgeshire, M40 and A34 in Oxfordshire, could form the spinal links to local growth points nearby. Technology park development in growth points could be stimulated by private finance initiative (PFI) and partnership investments involving the property, investment, and even 'big pharma' industries. This issue needs to be taken into account in the economic strategies of RDAs.
- 5.17 The objective must be to plan for growth which meets the needs of clusters while avoiding unacceptable impacts on sensitive environments. We suggest that the preparation of UNICA zones could be progressed by DETR in association with RDAs and local government in England and, as appropriate, by the devolved authorities elsewhere in the UK. In England we think the most appropriate and timely way to progress the concept of UNICA zones would be for DETR to incorporate guidance in a Planning Policy Guidance note. The Regional Planning bodies, taking account of the RDA's strategy, could then incorporate the designation of UNICA zones in Regional Planning Guidance which could then be implemented as appropriate by the

Chapter 5

Encouraging the development of clusters in the UK

relevant local authorities. We also suggest that government should consider how resources could be directed to these growth points to help support the required infrastructure.

We recommend that the Regional Development Agencies give consideration to the need to promote ‘Urban Networks for Innovative Cluster Areas’ (UNICAs) in their regional strategies and that the DETR issue guidance to Regional Planning Bodies and local authorities on how to take account of this concept through the planning system.

- 5.18 We are pleased that DETR is considering these issues in the review they are leading with the DTI on how the planning system can best help promote the needs of clusters.

Effective networks

- 5.19 We heard a lot of positive things about the role of regional biotechnology associations and were impressed by what has been achieved so far. It was apparent the associations, typically industry led, were highly valued by member companies and had helped to create a sense of identity and a collaborative environment. Services to members, equipment sharing and lobbying were other benefits which these initiatives offer.
- 5.20 All of the initiatives had been established recently with public pump-priming funding from the DTI and others. It is our view that it would be premature for them to become fully self funding in the short term and that future public support is therefore justified.

We recommend that the DTI and the RDAs find ways to provide continuing financial support for the regional biotechnology associations linking together biotechnology clusters, and to establish new ones in areas with emerging clusters.

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Supportive policy environment

5.21 It appears to us that a starting point in the process of mapping progress in clusters is the development of reliable, quantifiable data on the level of innovation, and the growth of the number of companies and other bodies. Comparative data of this kind has been part of the cluster landscape in the US for a number of years and has proved to be a powerful tool to improve competitiveness and healthy rivalry between individual states. We therefore support plans for the development of innovation indices in the UK.

To better understand the dynamics of clusters, the DTI will consider developing the UK Competitiveness Index to stimulate data capture for individual clusters and conduct a mapping exercise of all cluster activity across sectors in the UK

5.22 As we have commented earlier, it is important to distinguish between the separate, but complementary roles of the DTI and the RDAs in helping clusters to flourish. The role of the former should be to develop national programmes and policies. The focus of the RDAs should be on the tailoring of national programmes and policies to regional circumstances and helping with their implementation at a local level. We believe that it is essential that the DTI and RDAs work closely together in this area and we hope that this report will encourage them to do so.

We invite Regional Development Agencies, and the equivalent agencies of the devolved administrations, in those areas with existing or strong potential for biotechnology clusters, to look at improving the environment for cluster growth, for example by addressing skills, planning, supply chain and inward investment issues.

Appendix 1

Terms of Reference

- to identify biotechnology clusters which exist in the UK and to look at how well they are working and to identify the critical success factors
- to consider whether there are issues preventing any of the clusters from flourishing in the UK and to propose actions (perhaps led by DTI, perhaps by Regional Development Agencies or others)
- to select a UK cluster and analyse in detail its dynamics, networks, barriers and problems and to use it as a demonstrator to pilot support mechanisms which might subsequently be made available to other clusters.
- report of findings and recommendations to be finalised by 30 June

Appendix 2

Members of Cluster Team supporting Lord Sainsbury

Professor Philip Cooke

Professor of Regional Development and Director of the Centre for Advanced Studies in the Social Sciences, Cardiff University

Dr Chris Evans OBE

Chairman, Merlin Ventures Limited

Professor Mark Ferguson CBE

Professor, School of Biological Sciences, University of Manchester

Professor Sir Gareth Roberts

Vice Chancellor, University of Sheffield

Professor Alan Wilson

Vice Chancellor, University of Leeds

Appendix 3

Programme of visits and meetings

Each of the visits comprised:

- site visits and meetings at biotechnology companies
- site visits and meetings at research institutions
- brainstorming meetings which involved representatives of biotechnology companies, universities, research institutions, university industrial liaison and technology transfer offices, venture capitalists, specialist IP and legal services, property developers, science park and incubator managers, local government, Government Offices, Regional Development Agencies, etc.

The visits in chronological order were:

CAMBRIDGE

The Institute of Biotechnology (University of Cambridge)

The MRC Laboratory of Molecular Biology

Peptide Therapeutics

The Babraham BioIncubator

Axis Genetics

Eastern Regional Biotechnology Initiative

Brainstorming meeting held at Peptide Therapeutics

SURREY

Biocompatibles Plc at Farnham

Microgen Bioproducts Ltd at Camberley

Vanguard Medical based Surrey Research Park

BIBRA – British Industrial Biological Research Association at Carshalton

Brainstorming meeting held at University of Surrey

Appendix 3

Programme of visits
and meetings

OXFORD

Oxagen at Milton Park, Abingdon
Prolifix at Milton Park, Abingdon
Oxford GlycoScience, Abingdon Science Park
Powderject Pharmaceuticals, Oxford Science Park
Institute of Molecular Medicine
Brainstorming meeting held at Oxford Science Park

MANCHESTER

North West Biotechnology Initiative
Manchester Biotech Incubator Building
Eli Lilly & Company, Crewe
AstraZeneca R&D site, Alderly Park, Macclesfield
Brainstorming meeting hosted by North West Regional Development Agency

YORK

Plant Science Laboratory, University of York
Smith & Nephew Group Research Centre, University of York Campus
Biocode Ltd, University of York Campus
MAFF Central Science Laboratory
CBAMS Ltd, Central Science Laboratory
Brainstorming meeting held at Central Science Laboratory

LONDON

Brainstorming meeting held at the DTI

NEWCASTLE

Helena BioSciences, Sunderland
Novocastra Laboratories, Newcastle
International Centre for Life, Newcastle
University of Newcastle
Brainstorming meeting held at International Centre for Life

Appendix 3

Programme of visits
and meetings

SEATTLE, US

Chiroscience R&D

Fred Hutchinson Cancer Research Center

Immunex Corporation

University of Washington

Attendance at BIO'99 Trade Conference

Meeting with architects of biotechnology cluster in Seattle and other areas of US

SCOTLAND

Brainstorming meeting hosted by Scottish Enterprise

Dundee University

Cyclacel, Dundee

Quantase, Perth

WALES

Biocatalyst, Cardiff

Brainstorming meeting held at University of Wales, Cardiff

Nycomed Amersham, Cardiff

NORWICH

University of East Anglia (including brainstorming meeting)

Institute of Food Research

John Innes Centre

BOSTON, US

Massachusetts Office of Economic Development

Massachusetts Institute of Technology

Whitehead Institute for Biomedical Research

Boston University

Genzyme Corporation

Professor Michael Porter, Harvard Business School

Palmer & Dodge

Massachusetts Biotechnology Council

Appendix 4

Areas visited in UK and US

UK AREAS VISITED

CAMBRIDGE

Science base: A centre of scientific excellence represented by the University, and institutes such as: Laboratory of Molecular Biology, Babraham Institute, Sanger Centre, and the European Bioinformatics Institute.

Company base: Cambridge is the leading biotechnology centre in the UK with some 150 specialist biotechnology companies mostly located within 30 miles of the town centre.

Finance, business services and large companies: There are many investors and specialist service providers (some 200 firms) including patent agents, accountants, lawyers, venture capitalists. Major pharmaceutical research sites are located close by (e.g. Glaxo Wellcome at Stevenage and Smithkline Beecham at Harlow).

Premises and infrastructure: A number of Science Parks (e.g. Cambridge Science Park, and Granta Park) and incubator facilities (e.g. Babraham Bioincubator, St Johns Innovation Centre) available. Problems reported with restrictions on planning permission and transport infrastructure.

Networks and Regional Biotechnology Associations: The Eastern Region Biotechnology Initiative (ERBI) was set up in 1997 with matching funding from the DTI Local Challenge Fund to enhance the development of biotechnology in the east of England through networking and other activities.

Source: Visit and Eastern Region Biotechnology Initiative

Appendix 4

Biotechnology
clustering in UK
and US areas

SOUTH EAST (SURREY, SUSSEX, KENT)

Science base: Ten universities across the region of which Sussex is a leading bioscience research university.⁴³ Research institutes include BIBRA international which provides contract research and other services.

Company base: Estimated to be some 150 biotechnology related companies spread through out the region (including service providers). Leading companies include Vanguard Medica and Biocompatibles.

Finance, business services and large companies: Many of biotechnology related companies in area are service providers. Proximity to finance, and services communities in London. Many pharmaceutical industry companies represented in the area.

Premises and infrastructure: Specialist incubator space is available at the Sittingbourne incubator, Kent, and there are other incubators and Science Parks (e.g. at University of Surrey, Reading, and University of Southampton)

Networks and Regional Biotechnology Associations: Southern Bioscience was launched in 1998 and has increased networking opportunities as well as undertaking a range of other activities including overseas partnering and trade missions.

Source: Visit and Southern Bioscience

OXFORD

Science base: Oxford University is leading bioscience research university. Also other biotechnology research organisations, including: John Radcliffe Hospital, AEA Technology, MRC Radiobiology Institute, Wellcome Trust Human Genetics Centre.

Company base: More than 50 biotechnology companies based in Oxfordshire, many of whom are spin outs from Oxford University, e.g. Oxford Glycoscience, Oxford Molecular and Oxford Asymmetry.

Finance, business services and large companies: Well developed business angel network around Oxford and specialist service providers.

⁴³ Leading bioscience research university defined as among the top 10 universities funded by either BBSRC, MRC or Wellcome Trust (see Table 3 in main text)

Appendix 4

Biotechnology
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Premises and infrastructure: The DTI supported BiotechNet is providing mentoring and incubator facilities. Oxford is well connected to London, Heathrow airport, and a number of major pharmaceutical companies in South East England.

Networks and Regional Biotechnology Associations: The Oxfordshire Biolink initiative, launched in April 1999, aims to enhance networking and promote biotechnology in the region.

Source: Visit and Oxfordshire Biolink

NORTH WEST

Science base: The Universities of Manchester and Liverpool represent a large number of bioscience researchers and seven RAE 5* or 5 rated bioscience departments. The North West is well placed for clinical research with leading institutes (Paterson and Christie), the Wellcome Trust Clinical Research Facility.

Company base: Up to 30 biotechnology companies estimated to be located in the North West around Manchester, including number of public companies (ML Laboratories, Tepnel Life Sciences, Proteus).

Finance, business services and large companies: Manchester has a large investment community and a strong presence of some technology investors, such as 3i. Limited number of investors who specialise in biotechnology. Strong track record in pharmaceutical and fine chemical manufacturing, and also some pharmaceutical industry research sites, (e.g. Astra-Zeneca at Alderley).

Premises and infrastructure: The newly constructed Manchester Biotech Incubator Building is a major £15 million investment providing specialist incubator space and support for biotechnology start ups. A further incubator facility is planned in Liverpool (MerseyBio). Manchester airport provides good international links. There are also some Science Parks, such as Westlakes, but not yet with a specialist focus on biotechnology.

Networks and Regional Biotechnology Associations: A North West biotechnology Initiative is in the process of being established with the aim of promoting the North West as a centre of excellence for biotechnology and providing networking opportunities

Source: Visit and North West Biotechnology Initiative

Appendix 4

Biotechnology
clustering in UK
and US areas

YORKSHIRE & HUMBER

Science base: York University has a number of bioscience research strengths, including plant science research in which close links are being established with the MAFF Central Science Laboratory. The White Rose partnership aims to promote collaboration in the biosciences between Leeds, Sheffield and York Universities.

Company base: Around 40 companies undertaking biotechnology activities, including some specialist biotechnology companies and University spin outs.

Finance, business services and large companies: Non specialist legal and financial support services in Leeds, Sheffield and York. Bioincubator York provides mentoring services for biotechnology start ups.

Premises and infrastructure: A number of science parks and incubators in the area (e.g. York Innovation Centre), although none of them yet have their own laboratory incubator space.

Networks and Regional Biotechnology Associations: BioScience York, supported by York City Council and the University of York, has been a major promoter of biotechnology in the region and helped engender collaborative patterns of working between companies and research institutes.

Source: Visit and York City Council

LONDON

Science base: Strong science base, accounting for over one third of public funded research in the UK. Leading bioscience research universities include: University College London and Imperial College. There are also a number of leading research hospitals including United Medical and Dental School, Guy's and St Thomas' Hospital.

Company base: Around 50 biotechnology companies in London some of which are company headquarters, including start ups and inward investors.

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Biotechnology
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Finance, business services and large companies: home to many of the UK's biotechnology finance community and specialist service providers. Over 10 % of pharmaceutical employment is in London, including headquarters, R&D, and manufacturing sites.

Premises and infrastructure: Perceived shortage of incubators with laboratory space for start ups located close to the major research centres. Good transport links to other parts of the country and international

Networks and Regional Biotechnology Associations: No dedicated biotechnology network, though a relevant network is London Medicine.

Source: Visit and London First

NORTH EAST

Science base: Five universities (Durham, Newcastle, Northumberland, Sunderland and Teeside) with bioscience research. A major new investment, the International Centre for Life, will house the RAE 5* rated University of Newcastle Department of Genetics.

Company base: An estimated 18 biotechnology companies, including some start ups.

Finance, business services and large companies: Limited number of biotechnology investors (an exception is 3i), and business service providers. Several major pharmaceutical companies have manufacturing sites in the North East (e.g. Glaxo, MSD, Zeneca Life Science Molecules)

Premises and infrastructure: The International Centre for Life is to provide specialist incubator facilities for biotech SMEs, and other incubation units are available at the Business Innovation Centre, Sunderland.

Networks and Regional Biotechnology Associations: Plans to establish a North East Biotechnology Initiative to promote biotechnology in the area and improve networking and support for the sector.

Source: Visit and Government Office North East

Appendix 4

Biotechnology
clustering in UK
and US areas

CENTRAL SCOTLAND

Science base: Edinburgh, Dundee and Glasgow have leading research Universities and are world leaders in some areas of research such as Oncology at Dundee University and Neuroscience at Glasgow University. Other important research organisations include the Roslin Institute (nuclear transfer technology) and the Moredun Institute (veterinary biotechnology), as well as research hospitals such as Ninewells Hospital in Dundee.

Company base: 50 biotechnology companies in Scotland, mainly based in the triangle of Edinburgh, Glasgow and Dundee.

Finance, business services and large companies: Some leading CROs based in Scotland. e.g. Quintiles, and Inveresk. Small number of local specialist investors, service providers, and large companies in related sectors.

Premises and infrastructure: Number of relevant incubators and science parks, such as Edinburgh Bioparks and BioAdventures near Glasgow.

Networks and Regional Biotechnology Associations: Scottish Enterprise have supported networking activities, such as BioDundee.

Scottish Enterprise has also supported the development of the sector through assisting with grants and loans, and providing equity investments. Scottish Enterprise is developing a cluster strategy for the Scottish biotechnology sector.

Source: Visit and Scottish Enterprise

WALES

Science base: Bioscience research is undertaken in Universities throughout Wales. Cardiff is home to a leading bioscience research university and medical school.

Company base: Figures from Ernst & Young (1998) register 10 specialist biotechnology companies in Wales, and there are around 50 companies relating to biotechnology.

Finance, business services and large companies: Limited number of specialist finance providers and business services and few large companies relating to biotechnology. An exception is the research site of Nycomed Amersham located outside Cardiff.

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Biotechnology
clustering in UK
and US areas

Premises and infrastructure: Medicentre at University of Wales College of Medicine provides 32 accommodation units for new and growing healthcare companies. Some science parks located in South Wales.

Networks and Regional Biotechnology Associations: The Welsh Development Agency supports a number of initiatives which help networking, such as the Wales Medical Technology Forum, though not a dedicated biotechnology network. The Agency also produces a biotechnology directory and has a Centres of Expertise programme to promote HEI departments with strong industrial links.

Source: Visit and Welsh Office

NORWICH

Science base: Norwich has a strong bioscience research community of some 3000 scientists at the University of East Anglia, John Innes Centre and Institute for Food Research.

Company base: Few, if any, biotechnology companies located in Norwich
Finance, business services and large companies: Specialist investment community and service providers nearby in Cambridge.

Premises and infrastructure: No specialist premises or incubator facilities available yet for biotechnology companies

Networks and Regional Biotechnology Associations: Norwich is included in the area covered by the Eastern Region Biotechnology Initiative. There are good informal networks between the University and research institutes.

Source: Visit and Norwich Research Park

AREAS OF UK NOT VISITED

Midlands: leading bioscience universities include Birmingham, Leicester, and Nottingham.

South West: The University of Bristol is a leading bioscience university. The Defence Evaluation and Research Agency provides contract research and other services for biotechnology companies.

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Biotechnology
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and US areas

Northern Ireland: The University of Ulster was 5* rated for Biomedical Sciences in the 1996 RAE. It has introduced a new BSc course in biotechnology. There are around 40 healthcare companies located in Northern Ireland.

US AREAS VISITED

BOSTON

Boston is one of the leading centres for biotechnology in the US, second only to California.

Science base: Major research organisations include the Massachusetts Institute of Technology (MIT), Whitehead Institute for Biomedical Research, and Harvard and Boston universities.

Company base: There are some 245 biotechnology companies in Massachusetts employing around 17,000 people, with leading companies including Biogen and Genzyme. It is one of the most mature of the US clusters with 79 companies founded in the 1980s, though it is still growing rapidly with 112 new companies since 1996.

Finance, business services and large companies: There is a large venture capital community (over 150 firms) in Massachusetts and further funding is available through the Massachusetts Technology Development Corporation and several other financing agencies.

Networks and Regional Biotechnology Associations: The Massachusetts Biomedical Research Institute, set up in 1984, aims to promote the sector by providing access to state and federal grants and loans and assisting technology transfer.

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Biotechnology
clustering in UK
and US areas

SEATTLE

In the context of the US biotechnology scene, Seattle is an “emerging” biotechnology cluster and now ranks among the top five biotech centres in the US by number of firms.

Science base: Major research centres are the University of Washington and the Fred Hutchinson Cancer Research Center, which are an important source of start ups and collaborations.

Company base: There are 115 companies in the Seattle biotechnology and medical technology cluster employing 12,400 people, with nearly one-third of the companies (36) formed in the last five years.

Finance, business services and large companies: The cluster lacks venture capitalists, though has a well established business angel community and specialist patent agents.

Networks and Regional Biotechnology Associations: The Washington Biotechnology and Biomedical Association has acted as a lobbying and networking organisation for the cluster and the State government have taken measures, such as tax reforms, to encourage the sector.



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