CASE STUDY

High technology and economic development: the BioCity Nottingham technology incubator

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The Case Study section of the International Journal of Entrepreneurship and Innovation serves two purposes. First, the case studies presented are concerned with problematical issues that are pertinent to students of entrepreneurship. Thus they constitute appropriate teaching and learning vehicles on a variety of postgraduate and undergraduate programmes. Each case study is accompanied by a set of guidelines for the use of tutors. Second, it is envisaged that those engaged in entrepreneurial activities will find the cases both interesting and useful.

Abstract: *Since the 1990s, public policy makers and private investors have been creating bio-incubators with the aim of obtaining a foothold in what many presume is one of the hottest future industries. This case study provides an in-depth picture of the biggest UK-based bio-incubator – BioCity Nottingham. The study outlines the history and regional context of the incubator as well as its service portfolio and a profile of its supported firms. The study provides insights into the formation of biotechnology companies, the role of the regional context in shaping business models and the emergence of a science-based business network. As a major implication, Nottingham's location, remote from the epicentre of both science and venture capital in the UK, favours service-based business models. BioCity provides a fascinating opportunity to become acquainted with local conditions of business incubation.*

Keywords*: biotechnology; incubator; clusters; academic entrepreneurship; knowledge economy; technical entrepreneurship*

BioCity is a technology incubator. It aims to facilitate the setting up and growth of start-up businesses in the biotechnology sector. Launched in 2003, BioCity is a joint venture between Nottingham Trent and Nottingham Universities and the East Midlands Development Agency (EMDA). It is one of some 20 technology incubators focused on biotechnology established in the UK during the decade of the 2000s. Whereas most of these technology incubators are new purpose-built facilities housed on university campuses, BioCity is unusual in that it is located close to Nottingham's city centre in the former research laboratories of the pharmaceutical division of Boots, the UK's largest retail chemist. The incubator is currently home to some 60+ biotechnology or biotechnology-related companies with over 500 employees. More an incubator than a mere science or technology park, BioCity offers not only facilities but a range of support services designed to nurture and support embryonic start-up and spin-off businesses specializing in biotechnology.

Biotechnology in the UK

The UK is Europe's leading biotechnology economy, though it lags well behind the USA (Cooke, 2003). Significantly, the UK has been the location for many of the key research breakthroughs in bioscience (see Table 1) since the mid-twentieth century. This began with the pioneering work of Watson and Crick working at the Cavendish Laboratory in Cambridge, supported by Rosalind Franklin's X-ray diffraction results at Wilkins's laboratory at King's College in London. However, when it came to the commercialization of bioscience knowledge, it was clearly the USA that took the lead. Notable examples include the setting up of Genentech in 1976 – to synthesize human insulin using bioscience – by recombinant DNA technologist Herbert Boyer of the University of California at San Francisco and Robert Swanson of venture capitalists Kleiner Perkins (Link and Siegel, 2007), followed by Biogen in 1978 and Amgen in 1980.

During the 1990s, the commercialization climate began to shift in Europe. Significant growth took place in the UK's biotechnology sector, with the number of specialist biotechnology companies doubling to more than 250 firms employing some 12,000 staff across the country between 1994 and 1999 (DTI, 1999, p 13). Towards the end of the decade, the first technology incubators specializing in biotechnology were established in the UK.

Biotechnology incubators

The first technology incubator dedicated to biotechnology in the UK was the

Table 1. Bioscience discoveries/breakthroughs.

Date	Innovation	Scientists	Country
1953	DNA structure	Watson/Crick	UK
1974	*In vitro* recombinant DNA	Cohen/Boyer	USA
1975	Monoclonal antibodies	Milstein/Kohler	UK
1977	DNA sequencing	Sanger *et al*	UK
1978	Polymerase chain reaction	Mullis	USA
1979	p53 cancer gene	Lane	UK
1982	Cascade superfusion bioassay	Vane	UK
1985	DNA profiling	Jeffreys	UK
1988	H2 – receptor antagonist	Black	UK
1996	Transgenic sheep	Wilmut	UK
1998	Antibody protein engineering	Winter	UK
1998	Nematode worm sequencing	Sulston	UK

Source: Cooke, 2001, p 46.

Manchester Biosciences Incubator, set up in September 1999 as part of a concerted effort by Manchester to secure a bigger share of the biotechnology sector which had hitherto been concentrated in the 'golden triangle' of Cambridge–London–Oxford in the south-east of England (OECD, 1999). A feature of this incubator was its proximity to Manchester University's School of Biological Sciences, the largest biological sciences department in Europe. The incubator combines state-of-the-art laboratory facilities with a support services infrastructure.

This was followed by a boom in biotechnology incubators during the 2000s, reminiscent of the science park boom of the 1980s (Oakey, 2012), though this time without quite the same level of public attention. Table 2 shows that by 2010, some 20 biotechnology incubators had been set up in the UK during the course of the decade of the 2000s. These biotechnology incubators are of three main types (Crocker, 2010). First, there are those operated by university teams as an integral part of the university, such as the Sheffield Bioincubator. Second, there are those, like Manchester, Imperial, London and Queen Mary, operated by independent university or research centre subsidiaries. This group includes several such as Roslin, Colworth, Diagnox and Tetricus, linked not to a university but to a major research centre. Finally, there is a third group which operate entirely as independent entities, but in which one or more universities has a stake (Crocker, 2010). Examples of such biotechnology incubators include BioCity Nottingham and BioPark Herts. The active involvement of universities in all three types of incubator is a reflection of efforts by the UK government to promote academic entrepreneurship, especially the commercialization of research undertaken by academic staff in universities through university spin-off companies.

In almost all cases there has been some form of public sector contribution to the building and fitting-out costs of these incubators, though many have subsequently gone on to become self-financing and independent of ongoing state support. Public funding has come from a number of sources, but particularly important has been the role of the regional development agencies (RDAs), which were able to tap into a number of central government initiatives including a £75 million 'Incubator Fund' made available through the Small Business Service and a £50 million 'Regional Innovation Fund' (Wynarczyk and Raine, 2005, p 208). The fact that most of the RDAs prioritized biotechnology and health sciences as a growth sector helps to account for both the number and distribution of biotechnology incubators established during the 2000s. Another important source of public funding was the European Union in the form of the European Regional Development Fund

Table 2. Biotechnology incubators in the UK.

	Incubator	Location	Region	Number of firms	Start date	Size, m^2
1	Babraham	Cambridge	East	31	1998	7,000
2	BioCity Nottingham	Nottingham	East Midlands	67	2003	12,000
3	BioPark Herts	Welwyn	East	25	2006	4,750
4	Bradford Bioincubator	Bradford	Yorks & Humberside	10	n/a	–
5	Cardiff Medicentre	Cardiff	Wales	16	n/a	1,770
6	CELS Bioincubator	Newcastle	North-east	5	n/a	372
7	Colworth Science Park	Bedford	East	16	2004	1,909
8	Diagnox	Oxford	South-east	12	2000	300
9	Imperial Incubator	London	London	21	2006	2,230
10	Leeds Bioincubator	Leeds	Yorks & Humberside	10	2007	2,044
11	London BioScience IC	London	London	29	2001	1,800
12	Manchester (UMIC)	Manchester	North-west	23	1999	9,320
13	MerseyBio	Liverpool	North-west	13	2004	1,718
14	Norwich Bioincubator	Norwich	East	19	2002	1,860
15	Papworth Cardiothoracic Inc	Cambridge	East	4	2006	1,300
16	Queen Mary BioEnterprises IC	London	London	n/a	2008	3,623
17	Roslin	Edinburgh	Scotland	18	1999	2,000
18	Sheffield Bioincubator	Sheffield	Yorks & Humberside	4	2005	2,700
19	Tetricus Bioscience	Wiltshire	South-west	6	2002	2,090
20	York Biocentre	York	Yorks & Humberside	13	2003	3,000

Source: Incubator websites.

(ERDF) and the European Structural Fund (ESF) (Wynarczyk and Raine, 2005, p 208).

If public funding represents a supply factor driving the move to establish biotechnology incubators in the 2000s, a demand factor has been the restructuring of the pharmaceutical industry that has been taking place during the course of the decade. Described as a 'seismic shift' (Crocker, 2010, p 6), the restructuring has seen large pharmaceutical companies move to abandon the vertically integrated model of new drug development built up in the final decades of the twentieth century (Corley, 2002), close research laboratories and shed thousands of research jobs, as they cut back on in-house research and development (R&D) and exit research in certain fields. AstraZeneca, GlaxoSmithKline, Pfizer and Merck all announced closures of major R&D facilities in the UK in the latter part of the 2000s (McCoy, 2010). Instead, pharmaceutical companies increasingly looked to open innovation models (Chesbrough, 2006) as a source of new drugs, in which smaller companies with lower costs, smaller teams, more efficient working practices, higher scientific expertise and the ability to recognize new molecular entities (Hipwell, 2010) became a source of tomorrow's breakthrough drugs, leaving pharmaceutical companies to handle the later stages of the development process, along with marketing and distribution.

These two factors working together help to explain the rapid growth in the number of biotechnology incubators that has taken place in the UK, not just within the golden triangle of Cambridge–London–Oxford, but across the country in the last 10 years. A recent study (Crocker, 2010) indicates that the growth in the number of biotechnology incubators is reflected in the proportion of new start-up life sciences companies located within such incubators. The study identified a total of 315 new life sciences start-ups formed within the UK in the five years 2005–09 (Crocker, 2010), just under half (44%) of which were located within a biotechnology incubator.

The regional context

Nottingham (population: 285,000) is the largest of the three cities in the East Midlands region of the UK. The East Midlands is the fourth largest of the nine English regions by land area and, as its name implies, is centrally located within the UK. Average earnings are slightly below the national average, at £17,713 (EMDA, 2006), as is gross value added per head (91.5 compared with 100 for the UK as a whole), but unemployment is lower, at 7.2%, compared with 7.8% for the UK as a whole (ONS, 2009). The region also has the highest proportion of its workforce engaged in manufacturing, at 12.6% in 2010 (8.2% for the whole of the UK).

At one time, Nottingham's industrial base, like much of the East Midlands, was primarily centred on textiles, particularly hosiery and knitwear, but the sector is now of only minor importance, and today the city is home to a diverse range of industries including financial services, healthcare, tobacco and light engineering. Although the region was not one of the 10 locations identified as the site of an established cluster by Lord Sainsbury's team in its survey of biotechnology clusters in the UK in 1999 (DTI, 1999) and is not one of the better known centres of the pharmaceutical industry, like Hertfordshire, Surrey or Cheshire (Shohet, 1998), the city does have a strong science base, and was one of six cities in the UK designated a 'Science City' in 2005, in recognition of its scientific assets and the importance of science and technology in helping to drive the local economy. These assets are reflected in the fact that one in five of all jobs in Greater Nottingham is in a science-related sector. Similarly, the East Midlands region has two research-intensive universities at Nottingham and Leicester. The former was where Magnetic Resonance Imaging (MRI) was developed by Sir Peter Mansfield, for which he received the Nobel prize for Medicine in 2003, while the latter is home to the UK's only 5-star genetics department (Asthana *et al*, 2009) and the source of an important biotechnology breakthrough in the form of DNA profiling (Cooke, 2003). Also, the region has for a long time had a significant presence in pharmaceutical manufacturing. It is home to three pharmaceutical companies, Boots, AstraZeneca and Reckitt Benckiser, which have (or until recently had) major facilities in or near Nottingham.

Development of the incubator

With financial support from EMDA and Nottingham Trent and Nottingham Universities, BioCity has been able to build on the local economy's strength in pharmaceutical manufacturing and its science base. The first phase of the BioCity development opened in 2003 in a refurbished five-storey block, formerly home to the research laboratories of the pharmacy chain Boots. These laboratories were donated to Nottingham Trent University in 2002 by the German chemical firm BASF which acquired the Boots Pharmaceutical division in 1996. This facility provides generic laboratory space for small biotechnology start-ups, together with an administrative hub comprising office space, meeting rooms, café and a conference room.

Phase two of the incubator was launched in July 2006 with the opening of the adjacent Stewart Adams building, named after the Boots scientist who led the team that discovered the painkiller Ibuprofen on the site. The development was part funded by EMDA and the Greater Nottingham Partnership. This additional facility provided a particular focus on medicinal chemistry and pharmaceutical applications, with larger laboratories. The third phase saw the opening of the adjacent Laurus Building. This provided an additional 48,000 square feet of space, bringing the total size of the incubator to some 129,000 square feet. This part of the incubator provides grow-on laboratory facilities.

BioCity: facilities and business support services

As a technology incubator, BioCity caters specifically for new start-up companies specializing in a range of bioscience applications, although particularly those in the therapeutic and diagnostic healthcare fields. Its offering for prospective tenants extends well beyond facilities in the form of laboratories and office space, to include a range of support services. The facilities themselves include four different types of accommodation:

- virtual tenancies – providing access to facilities without actually occupying physical space;
- early-stage start-ups – accommodation in the Innovation Centre comprising: laboratories and offices (150–2,000 sq ft); cold rooms; central laboratory facilities (including autoclave, glass wash and washing machine); and technician-serviced nuclear magnetic resonance (NMR) facility;
- larger businesses specializing in chemistry – similar laboratory facilities (circa 2,000 sq ft) in the Stewart Adams building; and
- grow-on facilities – 7,000–10,000 sq ft in the Laurus building.

It is the second of these two facilities that forms the incubator proper. It offers laboratory facilities, down to as little as 150 square feet, for nascent biotechnology companies. They are made available on flexible tenancy agreements at three months' notice, allowing start-up companies the flexibility to increase or decrease the space occupied as circumstances require. The main entry requirement for the Innovation Centre is that tenants have to operate in the bioscience, pharmaceutical, medical technology or healthcare sectors. Of the other facilities which are relatively new additions, the Stewart Adams Building is for larger businesses specializing in chemistry, while the Laurus building provides 'grow-on' facilities. Both of the latter facilities are more akin to the facilities available in conventional science/technology parks. In all cases the facilities available are tailored to the particular needs of the biotechnology sector and comprise laboratory and office accommodation.

Unlike science parks, incubators provide more than premises, and BioCity is no exception in this. Alongside premises, BioCity tenants also have access to an extensive range of support services. These include an on-site café with Internet access, a staffed reception area, parking, meeting rooms, informal areas for networking and a conference room. As an additional service, BioCity rents out large specialist items of laboratory equipment to tenants, particularly small early-stage enterprises. Tenants can rent an NMR facility on a 'pay-as-you-go' or 'pay monthly' basis. Similarly, there is a metalloprotein and mass spectroscopy facility that can be rented by the half-day or full day. Providing tenants, especially smaller ones, with access to these sorts of facilities, which would be too costly for them to purchase outright and which they could not justify in terms of usage, forms an important part of the support services provided by BioCity.

The support services extend to the provision of training courses for start-up businesses. These include an intensive three-day training programme, the BioCity Boot Camp, for bio-entrepreneurs keen on setting up bioscience businesses. Aimed at recent bioscience graduates, postdoctoral and academic researchers, as well as those already working in industry but who are keen to go it alone and set up their own business, the programme aims to develop a range of business skills in those who have traditionally been more at home in a scientific environment. One feature of the training is that it is provided by seasoned bio-entrepreneurs and industry professionals and covers all aspects of running a small business. Because it is delivered by individuals working in the biotechnology sector, the programme not only develops business skills, but it also provides an opportunity for accumulating valuable social capital through networking, or as one recent attendee put it, 'the programme is very useful for widening your network of support' (BioCity, 2011).

Networking is also facilitated through Medilink East Midlands. Based at BioCity, Medilink is the life sciences industry association for the East Midlands region. It organizes a regular programme of events at BioCity. These events are specifically designed to bring together a variety of actors involved in biotechnology, including businesses, clinicians and academics, in order to facilitate networking. The events include breakfast briefings, seminars, lectures and training events covering a variety of aspects of biotechnology and bio-entrepreneurship. In 2012, the topics covered by such events included: confidentiality agreements; laboratory techniques; medical device regulations; Alzheimers research; grant funding: why? what? how? and medical imaging. Medilink also organizes a number of special interests groups (SIGs) that meet regularly covering fields relevant to biotechnology, such as regenerative medicine, biomaterials and infectious diseases – all designed to bring together individuals working in these fields in a variety of capacities.

One of the aspects of networking that BioCity tries to promote through both its training activities and other events is access to funding opportunities. However, given the limited nature of the capital market for early-stage investment in the East Midlands region, the scope for this is limited, and BioCity has established its own venture capital fund, the Mobius Life Sciences Fund. This Midlands-based investment fund is dedicated to the life sciences sector and receives investment funds direct from BioCity. It provides seed investment to very early-stage companies operating in the healthcare and life sciences sector. Focusing on incubator tenant companies, it seeks to invest in companies with new technologies that have market potential. It normally invests through taking an equity stake, and as well as contributing capital, it provides advice and guidance covering aspects such as market potential and regulatory requirements. Among its portfolio of BioCity tenants are CellAura Technologies Ltd, XenoGesis Ltd and Haemostatix Ltd. The Mobius Life Sciences fund aims eventually to recoup its investment through capital gains when investee companies are subsequently sold or floated. An example of this process is provided by former BioCity tenant R5 Pharmaceuticals, which was established in 2006, grew rapidly and was then sold to Aesica Pharmaeuticals in 2010.

Tenant companies

What sorts of biotechnology companies are located within the incubator? A survey of the biotechnology companies at BioCity in 2009 (Smith and Ehret, 2010) found that 15 out of 39 companies surveyed, comprising just over one-third (38.5%) of them, could be classified as classic drug discovery or 'product' biotechnology companies, using what Pisano (2006) terms a 'monetization of intellectual property (IP)' business model. With this business model, the company aims to capitalize on a scientific breakthrough by patenting it and

Table 3. University spin-off companies at BioCity.

	Company	Description	Start	Parent university	Business model
1	*CellAura Technologies Ltd*	Produces fluorescent agonists and antagonists for use in molecular pharmacology and imaging at the single cell level	2003	Nottingham	Service
2	*CompanDX Ltd*	Utilizes a range of proteomic genomic bioinformatics technologies to enable the discovery of novel biomarkers	2008	Nottingham Trent	Service
3	*Critical Pharmaceuticals Ltd*	Developing proprietary drug delivery technologies for injectable sustained-release drugs	2004	Nottingham	Product
4	*CrossGen Ltd*	Developing microarrays using genome hybridization technology for species without sequenced genomes	2005	Nottingham	Service
5	*Eminate Ltd*	Designs commercial applications of micro- and nanoparticles, coatings and powders	2006	Nottingham	Product
6	*Haemostatix Ltd*	Developing protein-based products to prevent or control different forms of bleeding	2003	Leicester	Product
7	*Monica Healthcare Ltd*	Developing wearable devices utilizing wireless technologies for use in obstetric applications	2005	Nottingham	Product
8	*Oxtox Ltd*	Developing a drug sensor that uses a novel technology to detect whether a person is under the influence of drugs	2006	Nottingham	Product
9	*Pharminox Ltd*	Developing novel small molecule drugs for use in the treatment of cancer	2002	Oxford	Product
10	*Promethean Particles Ltd*	Develops and manufactures bespoke nanoparticles for use in a range of industries	2008	Oxford	Service
11	*Q-Flo Ltd*	Commercializing a continuous process to manufacture yarns from carbon nanotubes	2004	Cambridge	Product
12	*RegenTec Ltd*	Produces injectable scaffolds for use in regenerative medicine	2001	Nottingham	Product
13	*X-Link Ltd*	Developing applications of the transglutaminase family of enzymes for wound healing and scar management	2000	Nottingham Trent	Product

then either licensing it or selling it to a third party with the resources to commercialize it. In contrast, 24 companies making up nearly two-thirds (61.5%) of those surveyed were utilizing an alternative 'service' business model. With this business model, companies are not seeking to commercialize IP, but instead focus on the provision of a narrow range of specialized services that typically facilitate the new product development process of third parties (Kasabov and Delbridge, 2008). These research services, often based on the possession of specialized tacit knowledge or cumulative experience and expertise, include: outsourced R&D services, quality management and testing, and data handling and storage.

The presence of a significant proportion of biotechnology firms within the incubator who are using a service business model is not entirely surprising. A recent report on the biotechnology sector, the Life Sciences Start-up Report (Crocker, 2010), which surveyed 315 biotechnology start-up companies in the UK established between 2005 and 2009, found that for the UK overall, 44% could be classified as 'service-oriented' – that is, providing research services to other firms. But there were significant regional variations. In London, the product model was dominant, with three-quarters (76%) of biotechnology start-ups operating a product business model and only 24% utilizing a service business model. However, in other regions of the UK, such as Yorkshire, the north-east and Wales, located away from the 'golden triangle' of Cambridge–London–Oxford (Lawton Smith *et al*, 2008), the picture was quite different. Here, 60% of the biotechnology firms were found to be utilizing a service business model. Thus BioCity's profile with service-oriented biotechnology firms dominant is in line with what one might expect, given its location in the East Midlands, a peripheral region as far as the main biotechnology clusters in the UK are concerned.

Spin-off companies

Given that technology incubators are typically established in order to facilitate what many refer to as 'academic entrepreneurship' – in particular the commercialization of knowledge derived from scientific research in universities, through the medium of university spin-off companies – one would expect some of these companies to be present among the incubator's tenants. Table 3 shows that this is indeed the case. There are currently 13 university spin-off companies among BioCity's tenants. Not surprisingly, the majority are spin-offs from the two local universities that established the incubator in the first place, with seven from Nottingham University and two from Nottingham Trent. Nearby Leicester University is home to a spin-off too. Interestingly, BioCity has also succeeded in attracting spin-offs from further afield, including three from universities in the so-called 'golden triangle' of Cambridge–London–

Oxford. Two are Oxford University spin-offs and one is a Cambridge University spin-off.

RegenTec Ltd

Typical of the university spin-off companies at BioCity is RegenTec Ltd. Based at BioCity since 2003, RegenTec Ltd is a spin-off company from the School of Pharmacy at the University of Nottingham that employs a product business model. Working in the field of regenerative medicine, it has developed intellectual property and expertise in tissue regeneration technologies, specifically injectable 'scaffolds' that solidify within the body and are used to support tissue growth. They are widely used in orthopaedic applications. They enable tissue regeneration to occur in clinical situations in which the body's natural repair processes have failed. RegenTec Ltd has grown steadily to the point where it now has 15 employees and to date the company has filed four patents.

XenoGesis Ltd

If RegenTec Ltd provides an example of a BioCity start-up that is using a product business model, then XenoGesis Ltd is an example of one using the alternative service business model. However, unlike RegenTec Ltd, XenoGesis Ltd is not a university spin-off company. The company's origins lie not in the university sector, but in the pharmaceutical industry. XenoGesis Ltd was founded in 2011 by Dr Richard Weaver, former Associate Principal Scientist at AstraZeneca, along with two former colleagues, following the pharmaceutical giant's decision to close its research facility at Loughborough in 2010. XenoGesis Ltd is a contract research organization that specializes in providing laboratory-based drug analysis services to global pharmaceutical companies working in the drug discovery field. Its particular specialist expertise is in pre-clinical drug metabolism and pharmacokinetics (DPMK), quantitative bio-analysis and expert interpretation. Hence one of the features of BioCity has been its ability to attract not only university spin-offs but also start-up companies established by individuals with a pharmaceutical industry background.

Discussion and implications

The case provides crucial insights into the incubation process of biotechnology in the UK. In Nottingham, three significant forces drove the emergence of the bio-incubator: (1) the need for a regional transformation from a manufacturing to a knowledge-based economy, (2) the aim of university-based researchers to commercialize scientific findings by means of spin-off companies, and (3) the pharmaceutical industry's retreat from vertically integrated R&D and the subsequent opening-up of business models.

BioCity is in many respects an exceptional example of a bio-incubator, due to its size, its organizational structure and its service portfolio. By hosting 60+ companies in more than 100,000 sq ft, it is the biggest bio-incubator in the UK, if not in Europe. While some incubators provide little more than office and laboratory space, BioCity offers its tenant companies one of the broadest service portfolios available in the sector. On top of flexible offerings of facilities for biotechnology start-ups, the incubator offers customized services such as the use of specialized equipment and laboratories, support services and consulting on crucial aspects of business affairs, such as finance, accounting or IP commercialization, as well as support for forming networks and building up social capital. As a bio-incubator, BioCity offers a quite unique service through its own venture capital fund.

The case of BioCity elucidates crucial conditions for those who engage in the creation of regional clusters of science-based businesses. As a region, the East Midlands shows crucial differences from typical high-tech clusters such as Silicon Valley, Route 128 or the UK's golden triangle. Most notably, the region lacks viable access to venture capital and the scale of research-focused universities. Nevertheless, the region has a solid basis of universities and research-driven businesses to nurture science-based businesses. The lack of access to venture capital shows its footprint in the business models of its tenant companies: a comparatively large share of BioCity companies strive to earn cash through offering research services, driven in part at least by the lack of funding opportunities. Another factor in the role of services is the dissolution of major R&D divisions of pharmaceutical companies that unlocks talent and resources for the offering of outsourced services.

As a major implication, innovation managers and regional policy makers should focus their attention on local conditions of the emergence of high-tech clusters. While clusters such as Silicon Valley provide great inspiration, regional incubators are likely to face a set of specific challenges. BioCity provides a fascinating opportunity to become acquainted with local conditions of business incubation.

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References

Asthana, P., Miles, N., and Bragg, S. (2009), *Life Sciences and Medical Technologies*, GHK, London.

BioCity (2011), 'Budding bio-entrepreneurs sought for BioCity Boot Camp', BioCity press release, 21 February, BioCity, Nottingham.

Chesbrough, H. (2006), *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Harvard Business School Press, Boston, MA.

Cooke, P. (2001), 'Biotechnology clusters in the UK: lessons from localisation in the commercialisation of science', *Small Business Economics*, Vol 17, No 1, pp 43–59.

Cooke, P. (2003), 'Geographical clustering in the UK biotechnology sector', in Fuchs, G., ed, *Biotechnology in Comparative Perspective*, Routledge, London.

Corley, T.A.B. (2002), 'The British pharmaceutical industry since 1861', in Richmond, L., Stevenson, J., and Turton, A., eds, *The Pharmaceutical Industry: A Guide to Historical Records*, Ashgate, Aldershot.

Crocker, G. (2010), *Opportunity: UK Life Science Start-up Report 2010*, Mobius Life Sciences Fund, Nottingham.

DTI (1999), *Biotechnology Clusters:*

Report of a Team led by Lord Sainsbury, Minister of Science, Department of Trade & Industry, London.
EMDA (2006), 'A flourishing region: regional economic strategy for the East Midlands 2006–2020', East Midlands Development Agency, Nottingham.
Hipwell, D. (2010), 'Big Pharma kisses the blockbuster years good-bye', *The Independent on Sunday*, 29 August.
Kasabov, E., and Delbridge, R. (2008), 'Innovation, embeddedness and policy: evidence from three UK regions', *Technology Analysis and Strategic Management*, Vol 20, No 2, pp 185–200.
Lawton Smith, H., Romeo, S., and Bagchi-Sen, S. (2008), 'Oxfordshire biomedical university spin-offs: an evolving system', *Cambridge Journal of Regions, Economy and Society*, Vol 1, No 2, pp 303–319.
Link, A.N., and Siegel, D.S. (2007), *Innovation, Entrepreneurship and Technological Change*, Oxford University Press, Oxford.
McCoy, M. (2010), 'Where chemists go after Big Pharma', *Chemical and Engineering News*, Vol 88, No 43, 25 October, pp 34–36.
Oakey, R. (2012), *High-Technology Entrepreneurship*, Routledge, London.
OECD (1999), *Business Incubation: International Case Studies*, Organisation for Economic Cooperation and Development, Paris.
ONS (2009), *Regional Trends 2009–10*, Office for National Statistics, London.
Pisano, G. (2006), *Science Business: The Promise, the Reality and the Future of Biotech*, Harvard Business School Press, Boston, MA.
Shohet, S. (1998), 'Clustering and UK biotechnology', in Swann, G.M.P., Prevezer, M., and Stout, D., eds, *The Dynamics of Industrial Clustering: International Comparisons in Computing and Biotechnology*, Oxford University Press, Oxford, pp 194–224.
Smith, D.J., and Ehret, M. (2010), 'Business models in the biotech sector: evidence from UK biotech incubators', *21st ISPIM Conference, 6–10 June, Bilbao*.
Wynarczyk, P., and Raine, A. (2005), 'The performance of business incubators and their potential development in the North East of England', *Local Economy*, Vol 20, No 2, pp 205–220.

Useful websites

BioCity Nottingham: http://www.Biocity.co.uk.
Mobius Life Sciences Investment Fund: http://www.mobiuslifesciences.com/.
Office of Life Sciences: http://www.bis.gov.uk/ols.
UK Bioincubator forum: http://www.ukbioincubation.com.
UK Life Sciences Report 2011: http://www.biocity.co.uk/assetlibrary/documents/mobius/UK%20Life%20Science%20Start-Up%20Report%20-%20Transition.pdf.

See overleaf for 'Teaching note'

TEACHING NOTE

1. Case summary

Knowledge-based industries figure prominently in notions of economic development in the twenty-first century. While the nature of the knowledge varies considerably, scientific knowledge is prominent, and one field in which there have been great strides in the last 30 years is the life sciences. This has led to the development of biotechnology, which seeks to exploit the rapidly expanding body of knowledge associated with advances in cellular and molecular biology to provide a range of novel products that take the form of new diagnostic and therapeutic applications in healthcare and also agriculture, food, energy and the environment.

While many industries involve links with science, and indeed are based on advances in science, the biotechnology sector is unusual in that, to use Pisano's (2006, p 1) words, it involves 'the fusion of science and business'. Indeed, science and business are more tightly interwoven than in any other industry. With such an intimate relationship with scientific knowledge, universities play a prominent part in the biotechnology sector, leading to close links between private enterprise and universities. This has in turn led governments around the world to become involved in seeking to promote the growth of the biotechnology sector through stimulating the formation of small biotechnology firms, and one of the principal vehicles for doing this has been the technology incubator specializing in biotechnology. In many respects, the biotechnology incubator formed one of the principal instruments of economic development policy in the first decade of the twenty-first century, much as science and technology parks did in the 1980s.

This case study provides an insight into these developments through focusing on a single technology incubator specializing in biotechnology. It is based in the UK, one of the countries where local and national government has been most active in promoting the development of the biotechnology sector in order to make up for perceived market failure in commercializing advances in the life sciences. Furthermore, the incubator is outside the UK's life sciences 'golden triangle' of Cambridge–London–Oxford, being located in one of the peripheral regions where many of the biotechnology incubators established in the 2000s are to be found.

The case study not only outlines the formation and development of the incubator, details the services it offers and provides mini-cases that highlight the nature and characteristics of the biotechnology start-up firms located within it, but it also provides an overview of the development of biotechnology in the UK and includes a substantial amount of contextual material that provides a picture of the local economy in which the incubator is located.

2. Case study themes and issues

The case study covers a variety of different themes and, as such, can be used to explore a variety of issues and themes with students, including the following:

- understanding the nature of science-based businesses;
- analysing the role of technology incubators in facilitating the development of science-based businesses;
- exploring the relationship between science-based businesses and the local economy;
- providing insights into high-tech entrepreneurship, including academic entrepreneurship;
- differentiating incubators from science/technology parks; and
- analysing the importance of business models in determining the nature of science-based businesses.

3. Discussion questions

The case study can be used to address a variety of issues. Potential discussion questions might include:

(i) How would you classify the range of support that BioCity provides for start-up biotechnology firms?
(ii) What is a service business model and why are there more companies using this business model at BioCity?
(iii) What is the Mobius Life Sciences Investment Fund and why was it set up?
(iv) How have advances in bioscience and the growth of biotechnology led to an increase in academic entrepreneurship?
(v) What is social capital? Why do bio-entrepreneurs need it? How does BioCity help them accumulate it?
(vi) What is open innovation? How does it provide potential opportunities for small biotechnology companies?

4. Suggested teaching approach and strategy

This case study is appropriate for students studying various aspects of high-tech entrepreneurship. It is probably best tackled as a group exercise in the following stages:

- Begin with a short presentation outlining key features of the biopharma-sector.
- In groups of 4–5 participants, carefully read and analyse the case study. Each group is instructed to prepare answers to the questions. Additional background and contextual information can be obtained by visiting the incubator's website at: http://www.biocity.co.uk/. The focus of the analysis should be the questions outlined above.
- Presentation of answers by each group. Other participants should be encouraged to question and discuss the points raised by each group.
- Concluding discussion should be designed to consolidate the points raised and draw out key issues.

5. Model answers

(i) How would you classify the range of support that BioCity provides for start-up biotechnology firms?

A key feature of the support that BioCity provides for biotechnology start-up companies is that it is differentiated in terms of what is provided and why. Essentially, BioCity provides three different forms of support. The first category comprises the provision of facilities suitable for biotechnology applications. These are principally laboratory facilities. They are made available on a very flexible basis in terms of both size and lease. These facilities

comprise the incubator itself, complemented by additional 'grow-on' facilities.

The second category of support comprises services offered to tenants. These include shared services such as reception, parking, conferencing, cafeteria, equipment hire and training. The availability of such services means that biotechnology start-ups are not distracted from the task of company growth and survival by trying to provide these services themselves.

The third category comprises networking facilities/opportunities. These include networking events designed to bring new bio-entrepreneurs into contact with people and organizations that may be able to help facilitate firm growth. At BioCity there is a wide range of networking events, many of which are provided through the regional life sciences industry association Medilink. Networks represent an opportunity for accessing a range of resources, both tangible and intangible. The latter are likely to be particularly important and to include finance, knowledge and expertise and human resources.

(ii) What is a service business model and why are there more companies using this business model at BioCity?

As its name implies, the service business model involves the provision of services, typically research services for third parties. This is in sharp contrast to the conventional 'product' business model associated with biotechnology. The product business model involves the commercialization of intellectual property (IP). It is the classic 'drug discovery' model.

The service business model, in contrast, relies more on expertise, often in the form of tacit knowledge rather than IP. Essentially, biotechnology start-up companies provide services for other companies, often large pharmaceutical companies. These services may include testing, analysis, information provision, etc. The popularity of the service business model at BioCity is largely a function of the regional context. The East Midlands region has a biotechnology knowledge base (that is, universities and research institutes involved in life sciences research), but it is not as developed or sophisticated as that found in the 'golden triangle' of Cambridge–London–Oxford. Significantly, the East Midlands region does not have the scale and scope of venture capital that can be found in and around London. As a result, in the East Midlands there is less life sciences research to capitalize on and less venture capital to develop it. The East Midlands does, however, have a comparatively strong pharmaceutical industry base.

(iii) What is the Mobius Life Sciences Investment Fund and why was it set up?

The Mobius Life Sciences Investment Fund is BioCity's own biotechnology-focused venture capital fund. As such, it represents a potential source of investment funding for biotechnology start-up companies within the incubator. Based in Nottingham and focused on the life sciences, it aims to invest in small biotechnology companies that possess IP which can be developed and commercialized. Like any venture capital fund, the Mobius fund invests in small companies with a view to capital gains, typically when the company is sold or floated through an initial public offering (IPO). The intention behind Mobius is to compensate for the lack of conventional private sector venture capital in the region. The Mobius Fund has made a number of investments to date, including one in R5 Pharmaceuticals Ltd, which was subsequently realized as a capital gain when the firm was sold to the pharmaceutical company, Aesica.

(iv) How have advances in bioscience and the growth of biotechnology led to an increase in academic entrepreneurship?

Biotechnology is science-based, and consequently advances in science form the main source of the IP that biotechnology companies aim to commercialize as new drugs. Universities represent one of the main sources of scientific knowledge. Hence many of the advances and breakthroughs in scientific knowledge occur in universities. Academic entrepreneurship is the term given to the commercialization of scientific knowledge that takes place through spin-off companies. Bioscience is a relatively new discipline that has developed immensely in the last 30 years, and it has been a driver behind the growth of academic entrepreneurship.

Academic entrepreneurship does have its critics. There are those who argue that (a) the returns are often low, and (b) entrepreneurship is a distraction for academics who should focus on advancing knowledge.

(v) What is social capital? Why do bio-entrepreneurs need it? How does BioCity help them accumulate it?

Social capital is an individual's stock of personal contacts. These contacts can provide bio-entrepreneurs with access to key resources, including not only knowledge, expertise and know-how, but also physical resources such as equipment, premises and money. Social capital often operates on an informal level through social activities, personal friendships, informal meetings, etc. BioCity aims to offer new bio-entrepreneurs the opportunity to develop their social capital by arranging events that bring them into contact with people who have connections to biotechnology and may possess potentially useful resources (for example, knowledge, expertise and experience). This is important since, in the early stages of new venture creation, entrepreneurs often have to beg and borrow resources rather than purchasing them directly.

(vi) What is open innovation? How does it provide potential opportunities for small biotechnology companies?

Open innovation refers to the use of external inputs in the innovation process. The term is associated with the work of Chesbrough (2006). The link to biotechnology is due to the fact that big pharmaceutical companies have increasingly reduced the scale and scope of their own in-house R&D, preferring to rely on open innovation and external sources for new technologies. This has created opportunities for small biotechnology companies that can act as sources of (a) new intellectual property (IP) which can then be developed and commercialized, and (b) contract research services, performing routine research tasks that pharmaceutical companies would previously have carried out in-house.