BioPolis - Inventory and analysis of national public policies that stimulate research in biotechnology, its exploitation and commercialisation by industry in Europe in the period 2002–2005

National Report of United Kingdom

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Pablo D'Este, Jacqueline Senker and Janaina Costa
SPRU – Science and Technology Policy Research
Brighton, UK

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Summary

UK economic growth has been stronger than in most other industrial countries for the period 2002-2005. The GDP growth rate has been comparatively high relative to other European countries, with average growth of about 2.5% a year. In addition to this, UK has some sectors that are world leaders in innovation, such as aerospace and pharmaceuticals. However, this trend has been coupled with a long-term underinvestment in GERD as a percentage of GDP, which has placed the UK below the EU-15 average. Increasing evidence that both public and private R&D efforts have been lower than those of major industrialised countries has led to a series of policy initiatives to stimulate UK research and innovation investment.

Biotechnology is a main priority in the UK, as reflected by the favourable regulatory framework for research in biotechnology related fields, and by the establishment of institutional structures in support of research funding in this area. For instance, one of the main UK Research Councils focuses specifically on the support of biotechnology-related research (i.e. BBSRC). In addition, the UK biotechnology industry is ranked second in Europe in terms of the number of companies.

Over the period 2002-05 UK invested 1443.5M EUR in biotechnology related research. Policy-directed instruments account for 72.6% of this funding, with the majority (almost 70%) being allocated through biotech specific instruments. About 11% of policy-directed funding can be classified as supporting commercialisation activities. Non-policy-directed instruments account for 27.3% of total funding.

The most important funding agencies with policy-directed instruments for biotechnology research are BBSRC, with about 470M EUR, and the MRC, with about 198M EUR. All BBSRC's instruments are important channels of support for biotechnology research (i.e. Studentships & Fellowships, Responsive Research Grants, Special Initiatives and Sponsored-Institutes – Core Strategic Grants). Regarding the MRC, its Special Initiatives are the most important instrument for supporting biotechnology research, in terms of the amount of funding involved.

Two distinctive characteristics of the UK system are: on the one hand, the wide variety of funding sources for biomedical research, among which charities play a very important role; and on the other hand, the collaborative nature of funding, where several funding agencies cooperate in funding specific initiatives.

Regarding biotechnology application areas, health biotech received about 34% of research funding and basic biotechnology research accounted for 21%. In addition, with the exception of environmental biotechnology, all other application areas have shares below 10%.

UK policy instruments cover many activities and a wide range of policy goals to stimulate the development of a British biotech industry: they aim to create the knowledge base, stimulate knowledge transmission and application, promote industrial development and improve public acceptance of biotechnology.

The UK has a strong knowledge base, reflected in a publications output well above the EU-25 and US averages, above average citations to publications and double the European average for life science graduates. UK performance in the transmission and application of that knowledge is also above average in terms of biotech patents per million capita and in biotech start-ups, but both have slowed down over time. There has been a similar decline in the relationship of patents to publications, which is below the European average. Industrial development is also strong in terms of biotech firms, venture capital (which has shown a very sharp increase since 2001) and the number of companies launched on the Stock Exchange. Market conditions appear good in the health area, where the number of bio-medicines approved by the European Agency for the Evaluation of Medicinal Products (EMEA), that originated in UK is above the EU-25 average. However, they are weak in terms of field trials for GM crops, where the UK is well below the EU-25 average.

1. Introduction and background

1.1 General introduction

UK has a population of 59.3 million, with a GDP per capita of 26.937 (current) EUR in 2003. UK is comparatively specialised in high-tech manufacturing and medium high-tech (e.g. aircraft, office and computing equipment, pharmaceuticals) and knowledge based services (communications, finance, insurance, business services). By 2002 UK's share of exports in knowledge intensive sectors was over 20%, the highest amongst the G7 countries (see DTI, 2003), while those sectors accounted for around 45% of total value added (among the top within G7 countries).[1]

Over the past decade, UK economic growth has been steady and stronger than in most other industrial countries. For the period 2002-2005 growth rates of GDP have been comparatively high, with average growth rates at about 2.5% a year. This has led the UK to increase its GDP per capita (in PPS) relative to the EU-25 from 114 in 2001 to 120 in 2005. There is however an underlying worrying trend: while GDP per capita has been growing, productivity records, measured either by GDP per worker or per hour worked, have been poor. One of the reasons behind this performance is the comparatively high increase in the proportion of the workforce employed in the UK, which shows that the UK economy has the ability to provide job opportunities for the workforce, and a higher level of income and output for the economy as a whole (DTI, 2003a).[2]

However, there are other factors influencing the poor UK productivity record. One relates to the long-standing deficiencies in education - which lead to weak performance in the percentage of adults with adequate literacy and numeracy skills - indicating that the UK workforce has a comparatively higher share of low skilled people than other developed countries. Another problem relates to the poor public infrastructure - particularly in transport - as a consequence of a legacy of consistent under-investment over the 1980s and 1990s in a wide range of public services. A third factor, and the most crucial for the purpose of this report, relates to the UK's R&D activities (see DTI, 2002 and 2003a).

UK's gross domestic expenditure on R&D (GERD), as a percentage of GDP, has decreased steadily over the 1990s: from 2.15% in 1990 to 1.87% in 2002. This trend indicates that, by the turn of the 21st century, the overall commitment of national resources to R&D was lower than the percentage of many advanced industrialised countries (US, Japan, France and Germany, among others), and even lower than the EU-15 average. Furthermore, business expenditure on R&D (BERD) as a percentage of GDP has stabilised in recent years around 1.2%, after a period of decline in the first half of the 1990s. This figure, however, places the UK well behind its major competitors (Japan, US and Germany) and below the OECD average (DTI, 2003b). These trends in R&D point to a situation of comparative under-investment in R&D, which could not only reduce the options to develop new technologies but could also limit the

[1] According to the DTI (2003a) knowledge intensive sectors include knowledge base services, high-tech manufacturing and medium high-tech manufacturing.

[2] By 2002, UK had the third highest average employment rate (i.e. proportion of workforce that is employed), behind only Japan and the US (DTI, 2003a).

opportunities to benefit from technologies developed elsewhere. This evidence is further supported by the European Innovation Scoreboard (2004), which suggests that, while the UK innovation system is broadly performing well, there are two indicators that are in the 'falling further behind' category (i.e. below the EU-25 average and exhibiting a negative trend): business expenditures on R&D as a percentage of GDP, and the share of employment in high-tech manufacturing sectors.

Nevertheless, it is important to highlight the fact that in 2001 business expenditure on R&D was the main source of GERD, with a share of 47%, while the Government share was 29% (the figures for EU-25 were 55% and 35%, respectively). Additionally, UK has some sectors that are world leaders in innovation, such as aerospace, pharmaceuticals, biotechnology and financial services. Over the period 1991-2000, the chemicals (including pharmaceuticals), computers and office equipment and communication industries have all grown faster than the economy as a whole, and have tended to have relatively higher inputs of R&D and skilled labour forces than other industries (DTI, 2003b).

1.2 Characteristics of national S&T and innovation system

The UK Government has produced a series of innovation policy documents over the last decade that set out the main features of the country's innovation performance and the strategies that the Government will adopt. These policy initiatives have been driven by evidence showing that both public and business R&D efforts are lower than those of major industrialised economies, and by evidence indicating that a higher rate of innovation is required to reduce the productivity gap with major competitors (EIS, 2003).

The Department of Trade and Industry's (DTI) Innovation Report DTI (2003b) marked the culmination of a number of reviews into the UK innovation system. A summary of some of the main action plans proposed by the Government follows:

- Ensuring UK has the skills to support innovation

DTI and the Department for Education and Skills committed to jointly lead a skill alliance to implement the Skill Strategy, which places business needs at the centre of Government skills policy. DTI also planned to develop with Business Schools curriculum material to aid the teaching of skills for the management of high tech, fast growth businesses. These measures are addressed to remedying the UK skills gap in intermediate skills, management and leadership skills, and basic literacy, numeracy and ICT skills.

- Supporting innovation in SMEs

The Small Business Service (SBS) was set up to support innovation in SMEs through the provision of relevant advisory services, development of a flexible Leadership & Management Programme for small business leaders, strengthening links between skills and business support programmes, and working with partners to ensure local, regional and national availability of technological and design brokerage. Also, the Government planned to strengthen the Small Business Research Initiative (SBRI), a programme established by the Government in 2001 to increase the success of smaller businesses in

obtaining R&D contracts from government bodies.[3] Another measure to support innovation by SMEs was the introduction, in 2001, of a tax credit that allows companies with less than 250 employees to deduct 150 per cent of their R&D expenditure on wages and consumables from their taxable profits (HM Treasury/Inland Revenue, 2001).

- Increasing knowledge transfer from the Science, Engineering & Technology base

The Research Councils are implementing plans to increase the rate of knowledge transfer and interaction with business through activities such as collaborative research, start-up companies, and technology transfer units at universities. In addition, the DTI is developing a Technology Strategy (together with a number of stakeholders) to identify key technologies with future growth potential, and is providing funding to support collaborative research in those key technologies areas.

- Aligning national and regional innovation strategies

The DTI is working in closer partnership with Regional Development Agencies to integrate national and regional policy development and implementation planning processes. This will include setting up regional Science and Industry Councils.

Statistics showing that the UK's R&D investment have been lagging behind those of the main industrialised countries, rang many alarm bells for the British Government. The realisation that the UK must invest more strongly in its knowledge base than in the past led the Government to launch a Science & Innovation Investment Framework – 2004-2014 (HM Treasury, DTI, and Department for Education and Skills, 2004). The main target of the investment framework is to increase the level of knowledge intensity in the UK (as measured by the ratio of R&D across the economy to national gross domestic product) from its current level of 1.9% to 2.5% by 2014.

To achieve this target requires not only a substantial growth in business R&D in the UK, but also: first, a similarly significant growth in the underpinning investment in the public science base in order to supply the skills and research results to the economy, and to attract mobile business R&D investment to the UK; and second, a continued strengthening of the linkages between the public and private sector research bases.

To meet the first objective, the Government plans to make a substantial investment in the public science base, increasing funding through the DTI and the Department for Education and Skills at an average annual rate of 5.8% in real terms between 2004/05 and 2007/08. This would increase the investment in both the core funding of universities and the strategic funding for research channelled through the Research Councils.

To meet the second objective, the Government will commit additional resources through to 2007/08 to help bridge the funding gap between the commercial application of new technologies and the underpinning research. The Government proposes to launch and strengthen a set of initiatives in this direction. Among them, the Government plans to stimulate universities to increase their efforts in commercialising research,

[3] The Government Departments involved have a target of purchasing at least 2.5% of their R&D from SMEs by 2004/05 (DTI, 2003b: 90).

through increased funding for the Higher Education Innovation Fund, which will rise to £110 million a year by 2007/08.

Additionally, the Government will provide a clearer framework for setting priorities and improving the effectiveness of support for business innovation through the launch of the Technology Strategy. Within this initiative, by 2007/08 the Government will raise funding to at least £178 million for collaborative research and knowledge transfer networks, aiming at close work between DTI and business to pull through and exploit technologies from the UK and the international research base.

1.3 National support and framework conditions for biotechnology

According to the DTI (2005), by 2003 the UK biotechnology industry was ranked second in Europe in terms of the number of companies (with 455 companies), behind Germany.[4] Biotechnology companies in the area of human healthcare represent 53% of the whole UK biotech industry, while 22% of companies were classified as technology service providers, 10% as industrial and environment, 8% as service providers, and 7% as agricultural and marine biotechnology.[5]

In recent years, the sector has been facing a restructuring process caused by decline in financial support from the investment community, which has led to a decrease in the total number of employees - from 25 100 in 2001, to 22 400 in 2003, a realignment away from technology platforms and a focus on product development, and an increase in the number of companies losing their discrete identity as a consequence of being absorbed through mergers or acquisitions. However, as the DTI (2005) report concludes, the UK biotechnology industry is comparatively better positioned than the biotech industry in many European countries for two reasons: (i) a comparatively larger proportion of firms have a sustainable financial position, having either received larger volumes of equity funding or generated larger revenues; and (ii) the UK biotechnology industry is the main player, among European biotech industries, both in terms of the proportion of approved compounds in the market and the proportion of compounds awaiting approval.

Biotechnology is a main priority in UK's innovation policy. This is explicitly reflected both in terms of institutional structure and strategic initiatives. Regarding institutional structure, UK policy in support for biotechnology dates back to the early 1980s with the establishment of a Biotechnology Directorate (by the Science and Engineering Research Council) with the mission of funding postgraduates and academic research in the field of biotechnology, and with the establishment of a Biotechnology Unit within the DTI (which is the key Government actor in UK innovation policy), to raise awareness of

[4] According to DTI (2005), only companies whose primary commercial activity depends on the application of biological organisms, systems or processes, or on the provision of specialist services are included in the remit of the study. Big pharmaceutical companies and companies for whom biotechnology is an important but minor part of their business are not included as biotechnology firms.

[5] According to the DTI (2005) report, healthcare biotech includes drug delivery, drug discovery, gene therapy, and healthcare diagnostics; technology service providers include bioinformatics, functional genomics and high throughput screening; industrial and environmental includes biocleaning, bioremediation, environmental diagnostics, industrial diagnostics and water and effluent treatment; service providers include bioprocessing and contract research and manufacturing; and agricultural and marine include animal healthcare, biopesticides, crop agriculture, and food technology.

opportunities in biotechnology and to encourage industry to become more involved in biotechnology R&D (Senker et al., 2000). The high priority given to biotechnology research was further demonstrated by the 1994 restructuring of the Research Councils. The merger of the Agricultural and Food Research Council with the biotechnology and biological sciences divisions of the Science and Engineering Research Council led to the creation of a new Biotechnology and Biological Sciences Research Council, with the mission of sustaining a broad base of interdisciplinary research and training in the biological sciences (Martin, 1999).

The strong prioritisation of biotechnology in UK's policy initiatives over the 1980s and 1990s continued into the 21st century. There are two clear indications of this. On the one hand, in 2002, DTI set up seven Innovation and Growth Teams (IGTs). These are groups of business people, trade union officials, industry experts and officials from various Government departments who come together to develop a long term vision for the industry sector and to advise the Government on policies that need to be adopted by the sector to innovate and grow. The seven IGTs established cover the following sectors: automotive, environmental goods and services, aerospace, software and digital content, chemicals, bioscience, and electronics. The role of these IGTs is extremely important for the design of UK's innovation policy (DTI, 2003b).

The Bioscience Innovation and Growth Team (BIGT), launched in January 2003 with the mandate to formulate a strategic approach to the future of the UK's bioscience industry, played an important role in identifying priorities for biotechnology in a report published later that year (Bioindustry Association, DTI and Department of Health, 2003). Some of its key recommendations for the support of research in biotechnology are as follows.

- To build a strong bio-processing sub-sector within UK bioscience, BIGT proposes to build a network of four bio-processing Centres of Excellence across the UK, and to foster the development of the bio-processing community (i.e. set up an annual National Bio-processing Forum).

- To develop, attract and retain high quality scientific and managerial talent, BIGT proposes the creation of research programmes to support and extend initiatives to broaden and deepen interdisciplinary education and training.

Another key initiative in support of UK's biotechnology falls within the remit of the Technology Strategy Board (TSB). The TSB, established in October 2004, advises the DTI on business research, technology and innovation priorities for the UK, the allocation of funding across these priorities and the most appropriate ways to support them. As well as developing the Technology Strategy, the TSB oversees the Technology Programme, worth approximately £220M per year. The Technology Programme supports collaborative R&D and knowledge transfer networks. The TSB considers itself as a catalyst for increased business R&D, so as to achieve the 2014 target for business R&D to account for 1.7% of GDP.

The TSB has identified a set of seven key emerging technologies to underpin the high value-added areas of the UK economy and generate new streams of economic activity in their own right. The bioscience and healthcare technologies are one of these key emerging technologies. In this area, the TSB will seek to develop a balanced portfolio

of projects across different work-streams in biotechnology, increasing the level of UK participation in European initiatives, as well as raising the level of collaboration with other UK Government departments. The following general themes have been identified for future competitions: biomarkers; challenges in drug development; pharmacogenomics; stem cell technology; bio-processing; systems biology and bio-imaging.

A survey of attitudes to new technologies in Europe (Eurobarometer, 2005) found that the British public has the same attitude as the EU-25 average (both 65%) about the positive effect of biotechnology and genetic engineering on our way of life in the next 20 years. The British public are slightly more receptive than EU-25 average with regard to medicines and new medical technologies (97% against EU-25 94%) and to high-tech agriculture (71% compared to EU-25 average 66%). However, the UK is less receptive than the EU-25 average to the effect of nanotechnology (42% compared with an EU-25 average of 48%) and to most applications of cloning. In respect of cloning human stem cells to make cells and organs to treat people with diseases, 46% of British citizens would approve it if highly regulated and controlled (EU-25 average of 41%). With regard to the use of genetics, the British public seems to be more receptive than the EU-25 average as a whole. 35% of the UK would never approve the development of a genetic test that would prolong our expected life span by 25 years (EU-25 average 42%); 23% of British citizens disapprove the development of a genetic test that would tell us about diseases we might get (EU-25 average 34%). 13% of British citizens responded that they would never approve storing everyone's genetic data so that criminals can be caught more easily (EU-25 average 21%) and 7% were completely opposed to storing all the genetic data of our population in data banks in order to study the genetic causes of human diseases (EU-25 average 17%).

UK is among the few countries in the world that permit the use of both surplus embryos and the creation of embryos by either fertilization or by somatic cell nuclear transfer (SCNT) for human embryonic stem (HES) cell research. For this reason, the UK has become as one of the main destinations for scientists who wish to conduct HES cell research. Recent amendments to the UK's 1990 Human Fertilization and Embryology Act (HFEA) permit the use of embryos for certain purposes unrelated to reproduction. As a direct result of HES cell technology, these changes permit the use of embryos to investigate disease conditions and to develop treatments for diseases (Knowles, 2004). According to Knowles (2004), the HFEA provides the most liberal national regulatory environment for embryo research to date, permitting not only the use of surplus IVF embryos for HES cell research, but also the creation of embryos by SCNT for the purposes of HES cell research.

1.4 The main biotech policy and research actors

The main policy actors in the UK innovation system can be grouped into three categories: the Government, responsible for policy formation and funding; the actors in charge of the management of research funding; and the science base which undertakes most publicly funded R&D: this largely comprises the Higher Education system, Government laboratories and Research Council Institutes.

- Actors involved in general policy making:

The main actor regarding the governance of the UK innovation system is the Department of Trade and Industry (DTI). This Government department is tasked with the overall aim of increasing competitiveness and scientific excellence in order to generate higher levels of sustainable growth and productivity in the UK economy (Malik and Cunningham, 2005). The DTI influences UK innovation through a variety of channels. With regard to science policy, the Office of Science and Technology (OST),[6] located in the DTI, is responsible for the funding of basic research largely via the Research Councils. With regard to the exploitation of science and technology, the DTI is responsible, alone or jointly with other Ministries, for a number of initiatives (e.g. LINK Programme, Higher Education Innovation Fund), which are designed to promote the commercial exploitation of publicly funded research and stimulate collaboration between the research community and industry. The DTI also takes the lead in policies oriented to promote innovation in companies and the creation of new technology based firms, providing support for R&D and advice to companies (mainly SMEs) (Malik and Cunningham, 2005).

The DTI is the key Government actor responsible for UK research and innovation policy, but a number of other Departments and Ministries are also involved in their design and finance. Of particular relevance is the Department of Education and Skills (DfES), which has responsibility for all issues relating to education in England. Its responsibilities connected with higher education are administered by the Higher Education Funding Council for England (HEFCE),[7] which allocates funds to pay for the facilities and staff to carry out undergraduate and post-graduate teaching as well as funds to provide the basic infrastructure to carry out research. Other Government Departments, such as the Department of Health and the Department for Environment, Food and Rural Affairs contribute to the design and funding of science and research policies in their respective areas of responsibility. In addition, since 1998, powers devolved to regional governments in Scotland and Wales have made them active in administering and designing technology policies for their regions. A significant characteristic of the British research system is the extent to which Government Departments and Research Councils work together in programmes of common interest, with each actor funding those parts of the programme relevant to their interests. As will be seen in Section 2 below, the LINK Programme, Knowledge Transfer Partnerships (KTP), Interdisciplinary Research Centres and the UK Stem Cell Initiative are examples of these programmes and the last of these examples also involves co-funding with charitable organisations.

- Actors in charge of the management and implementation of research and innovation activities

The main actors responsible for administering funding for research and innovation activities are the Research Councils. The budgets of the Research Councils come from the Office of Science and Technology (OST, within the DTI). Over the period 2002/03 to 2004/05, the overall budget allocated by OST to support scientific research,

[6] In April 2006, the OST was merged with the DTI's Innovation Group, for form a new Office of Science and Innovation.

[7] In Scotland these responsibilities are carried out by the Scottish Funding Council, responsible to the Scottish Executive, in Wales, by the Higher Education Funding Council for Wales, responsible to the Welsh Assembly and in Northern Ireland by the Department for Employment and Learning.

administered by the Research Councils has increased from £1.6 billion to £2.1 billion.[8] The Research Councils base their activities on a mixed approach: whilst a large proportion of funding is allocated on the basis of research proposals in response to open calls, a non-negligible part is allocated on the basis of special initiatives to support areas of priority interest for the Government, though the frequency of special calls (and volume of resources committed) vary across Research Councils. In addition, some Research Councils allocate block grants to fund their own research units or institutes. The five largest research councils, in terms of the volume of research funded (accounting for over 80% of the total science budget), are briefly described below (reporting figures for year 2004/05).

The Engineering and Physical Sciences Research Council (EPSRC), responsible for funding research in the areas of physics, chemistry, mathematics and engineering, distributes some 23% of the total science budget (about £500M a year). The Medical Research Council (MRC) is responsible for funding research in all areas of medical science, and distributes some 21% of the total science budget (around £450M a year).

The Biotechnology and Biological Sciences Research Council (BBSRC) is the UK's principal funding agency for basic and strategic biological research. BBSRC invests around £300M a year, some 14% of the total science budget. Finally, the Natural Environment Research Council (NERC) distributes about £300M a year, and the Particle Physics and Astronomy Research Council (PPARC), around £270M a year. In recent years all research councils have experienced a substantial increase in the volume of their research budgets (particularly the NERC), while the EPSRC has remained stable.

The DTI is not only responsible for funding basic research through the OST and Research Councils, but it is also the main public body supporting mission-oriented R&D. In recent years DTI has given greater priority to innovation, setting up a number of initiatives to augment the private sector's own research and development efforts. Knowledge transfer is one of the key areas to which DTI has given increasing attention, in order to increase the exploitation of the knowledge created in the UK's science base. By 2002, the DTI portfolio of programmes to encourage knowledge transfer between the science base and the industry included:

- Support for collaboration through the LINK programme and the Faraday Partnerships, which together provide £52M annually of Government support, covering a wide range of technologies from textiles to food processing, polymers, chemicals measurements and nano-composites.
- Lowering the commercial and technological risks of investment in R&D and innovation, especially for SMEs, through programmes such as SMART and the Teaching Company Scheme (now KTP). SMART provides grants for R&D in technologically innovative products, amounting to £27M in 2001/02 for 800 projects. In 2001/02 TCS provided £22M to support firms who employed graduates to work in-house on 2-year projects.
- Building universities' capacity for knowledge transfer activities through initiatives such as the Higher Education Innovation Fund (HEIF). HEIF was introduced in 2001/02 and managed by HEFCE (on behalf of OST and DfES),

[8] See figures in DTI (2002) and www.ost.gov.uk/research/funding/budget05-08/full_breakdown.pdf

with a budget of £140M over three years. It supports university activities such as the employment of specialist knowledge transfer staff, establishing business incubators, improving the intellectual property infrastructure, and providing enterprise training for staff. Two further rounds of HEIF have been implemented since the ending of the first round in 2003/04.

While the budget for DTI's overall portfolio of knowledge transfer activities was about £250M in 2002/03, the Government planned to increase that budget to £300M by 2005/06 (DTI, 2002: 67).

Finally, several Government Departments, such as the Department of Health and the Department for Environment, Food and Rural Affairs have budgetary responsibility for purchasing research to meet departmental objectives.

- Actors involved in performing R&D

The majority of publicly financed R&D is performed by universities and Research Council Institutes, which collectively form what is generally referred as the UK science base. By 2003/04 the total funds received by universities for research was £4,630M (while Research Council institutes received total funding of £856M). Of the total funding for R&D performed by universities, 71% comes from public sources, either through general funding for research infrastructure (£1 915M) or through research grants allocated on the basis of peer reviewed mechanisms, mainly via Research Councils, some £1 355M.[9]

One of the distinctive characteristics of the UK system is the wide variety of funding sources for university research, as a large proportion (about 29%) of university funds come from third parties. UK industry provided, in the year 2003/04, £247M for university research (5% of total university research funding), and overseas funding (mainly, the EU) represented 8% of the total. However, the largest third party contributors are the UK charities, with £691M (about 15% of the total). Particularly in medical research, UK charities, such as the Wellcome Trust, Cancer Research UK and the British Heart Foundation, are playing an increasingly important role as sources of funding for research (DTI, 2002). In addition, the Nuffield Council on Bio-Ethics examines ethical issues raised by new developments in biology and medicine.

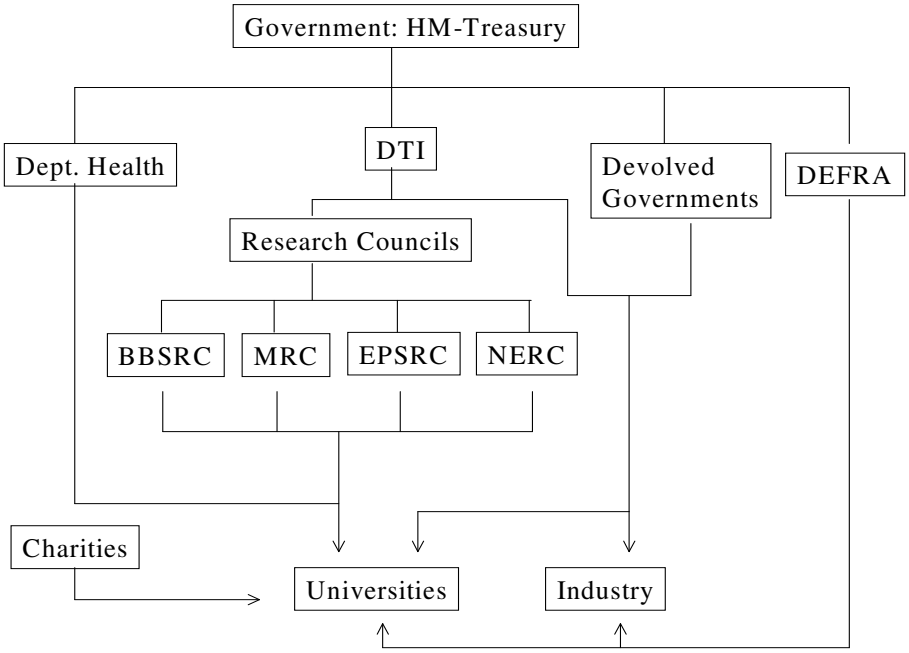
Many of the actors described above are the key players in funding UK biotechnology research and commercialisation. Figure 1 displays the main actors in regards to the UK biotechnology research system and the connections between them regarding funding flows.

- Actors with a focus on commercialisation and entrepreneurship

In addition, there are a wide range of business support organisations that operate at a number of levels throughout the system. These organisations include the Regional Development Agencies, and the Learning and Skills Council, as well as technology brokers such as the British Technology Group and contract research and development companies (Malik and Cunningham 2005).

[9] See www.ost.gov.uk/setstats/ for details on these figures.

Figure 1 The UK national system of biotechnology research funding



2. Funding of biotechnology R&D, transfer and commercialisation

2.1 Introduction

This report reviews the funding of biotechnology research and commercialisation. In the report we make a distinction between policy-directed funding and non-policy-directed funding of biotechnology.

Policy-directed funding includes funding which was directed by explicit policy decision making about installing a specific instrument, such as specific R&D programmes, programmes encouraging collaboration, industrial research grants, support for centres of excellence, support for commercialization of research, support for start-ups, programmes encouraging mobility of researchers, programmes with open calls, etc. This policy-directed funding can include biotechnology specific policy instruments and generic policy instruments. Biotechnology specific policy instruments are instruments that have been specifically set up to stimulate biotechnology. Generic policy instruments are instruments that are not dedicated to a specific technology, but which in principle stimulate all technologies, also including biotechnology. In the BioPolis project, only those generic instruments are included if a reference is made to (the stimulation of) biotechnology activities in the policy of the funding organisation that runs the program, or of the ministry/government department that funds the funding organisations or that runs the program itself.

Non-policy-directed funding of research includes funding which is part of the structural governmental support for scientific education, research and research infrastructure. This type of funding is mainly given through block grants to universities and (government) research institutes, and through the open-call system of research councils. Research councils, research institutes and government research institutes develop their own programmes through which biotechnology may be supported. In the BioPolis project only the funds for block grants to (government) research institutes and through the open-call system of research councils are included.

This chapter presents the funding of biotechnology research through policy and non-policy-directed instruments and of biotechnology commercialisation through policy-directed instruments. Data were collected through desk research (publications, documents, websites of national and regional public funding organisations and/or governmental departments), surveys completed by representatives of funding organisations that manage the generic and biotech specific programs, and interviews with representatives of organisations that are involved in non-policy-directed and policy-directed funding. The websites of the funding organisations and their programs are shown in footnotes and the names of contact persons that participated in the survey and/or who have been interviewed can be found in Annex 3 (List of Contact Persons). Section 2.2 presents the non-policy-directed funding and section 2.3 the policy-directed funding. Charities also play an important role in funding of biotechnology research in some countries; they will be addressed in section 2.4. The final section provides a short overview of the European funding of biotechnology research in the UK through the 6th Framework Program.

2.2 Non-policy-directed funding of biotechnology research

Table 2.1 summarises the organisations involved in supporting non-policy-directed funding of biotechnology research. It shows that in the period 2002-05 a total of 235.7M EUR was allocated to biotechnology research via the block grants of research institutes and the open-call mode of project funding by Research Councils.

Table 2.1 Non-policy-directed funding of biotechnology research 2002-2005 (M EUR)

Funding organisation	Public Research Institutions / Response Mode programs	Period	Funds
MRC	Research grants	2002-05	148.0
MRC	Research Institutes and units	2002-05	158.9
NERC	Research institutes and research grants	2002-05	8.4
DFID	Research department	2004-05	1.5
DARDNI	Research institute	2002-05	2.5
SEERAD	Research institutes	2002-05	68.3
Forest Research	Research laboratories	2002-05	7.0
TOTAL			394.6

Source: BioPolis Research

2.2.1 The Medical Research Council (MRC)

The Medical Research Council (MRC) is funded by the UK Government to promote research in all areas of medical and related science with the aim of improving health and the quality of life. It supports medical research by providing funding for research programmes and infrastructure, and by investing in training in universities. The annual research expenditure of the MRC is split roughly between grants to researchers in universities and medical schools, including training awards for postgraduate students and fellows and funding for the MRC's own research institutes and units. The MRC is independent in its choice of which research to support and does not generally earmark funds for particular topics. Rather, the MRC views its research as an integrated programme and research proposals in all areas compete for the available funding. However, MRC occasionally calls for research proposals in particular areas of strategic relevance. In this section we only report the non-policy-directed instruments. The MRC's policy-directed instruments are reported in Section 2.3.3.

- MRC Research Institutes and Units

In the period 2001/02 to 2004/05 the MRC allocated £882.6M (1357.8M EUR) to its research institutes and units. In the area of medical research, it is difficult to draw a clear boundary around biotechnology research. We have therefore assumed that the same proportion of the block grants was dedicated to biotechnology research in its institutes and units as that identified in the Inventory report (Enzing, 1999), namely 11.7%. On this basis we estimate that £103.7M (158.9M) was allocated to biotech research in the MRC's institutes and units in the period 2002/2005.

- Response mode research grants

The MRC Molecular and Cellular Medicine Board funds research into cancer biology, genetic mechanisms, methodology development for gene therapy, bioinformatics, biotechnology and structural studies, nanotechnology, cell biology, and developmental and stem cell biology. According to the MRC, the estimated gross spend in 2004/05 was

£180.8M (277.2M EUR). However, this estimate is based on a rather broad definition for biotechnology. Applying the criteria followed in the Inventory Report (1999), we estimate that the MRC's support to biotech research was about 13% of the MRC's gross spend in 2004/05, or £24M (37M EUR). On this basis, we estimate that £96M (148M EUR) was allocated to response mode biotechnology research grants in the period 2002-05.

MRC also supports commercialisation activities through the MRC-Technology (MRCT). MRCT undertakes commercialisation activities on behalf of the MRC, translating scientific discoveries and inventions into technologies and products with a clear healthcare benefit. It does this through the development and commercialisation of intellectual property (IP) arising from research within MRC-funded Units and Institutes. All IP which arises from employment with the MRC is owned by the MRC. In the period 2004-2005 income generated from technology exploitation came to £27.3M (42M EUR).

2.2.2 Natural Environment Research Council

The Natural Environment Research Council (NERC) is the main UK body responsible for the funding of basic, strategic and applied research in the environmental sciences. It funds four wholly owned Research Centres and one of these Research Centres conducts research in the area of biotechnology: the Centre for Ecology and Hydrology (CEH). During the period 2002-2005 CEH allocated £3.63 (5.6M EUR) of its core block grant to biotechnology research. NERC also provides grants for blue skies response mode research in universities and other approved institutions. In the period 2002-05 it allocated £1.9M (2.8M EUR) to response mode grants in the area of biotechnology, an average of 3% of its total funding for response mode research grants.

2.2.3 The Department for International Development (DFID)

The Department for International Development (DFID) is the ministry that manages Britain's aid to poor countries and works to get rid of extreme poverty. It recently established a new central research department that spent £0.5M on agricultural biotechnology research in 2004 (Agricultural and Environment Biotechnology Commission (AEBC), 2005). We estimate similar expenditure in 2005, or £1M (1.5M EUR) for 2004 and 2005.

2.2.4 Department of Agriculture and Rural Development Northern Ireland (DARDNI)

The Department of Agriculture and Rural Development Northern Ireland (DARDNI) is a regional government department that funds an Agricultural Research Institute in Northern Ireland. In 2004 it spent approx £0.4 on agricultural biotechnology research (AEBC, 2005). Similar annual expenditure over the period 2002-05, leads to a total of £1.6M (2.5 M EUR) for the entire period.

2.2.5 Scottish Executive Environment and Rural Affairs Department (SEERAD)

The Scottish Executive Environment and Rural Affairs Department (SEERAD) is a department of the Scottish Executive, the devolved regional government for Scotland.

Its Agricultural and Biological Research Group (now Science and Research Group) funds a programme of long-term, strategic agricultural, biological and related research at its six research institutes. During the period 2002-2005, SEERAD expenditure on biotechnology related research from the core grants of these institutes is estimated to be £44.4M (68.3M EUR).

2.2.6 Forest Research Agency

Forest Research, an agency of the Forestry Commission, is Britain's principal organisation for forestry and tree related research to support the forestry strategies for England, Scotland and Wales. During the period 2002-2005 it allocated approximately 7M EUR to research in the area of biotechnology.

2.3 Policy-directed funding of biotechnology research

Table 2.2 summarises the organisations involved in supporting policy-directed instruments for funding biotechnology research and commercialisation, and the funds allocated.

Table 2.2 National and regional public policy-directed biotechnology stimulating instruments during the period 2002 -2005

Instrument	Funding organisation	Budget	% of total	Use of DF/SF
National				
Generic				
Studentships/Fellowships	BBSRC	11.7	1.12	
Research grants	BBSRC	158.3	15.09	
TCS-KTP	Govt Depts/Research Councils	6.2	0.59	
Faraday Partnerships	DTI/DEFRA	7.3	0.70	
LINK	Govt. Depts/Research Councils	28.2	2.69	
Commissioned research	DEFRA	36.7	3.50	
Biotech specific				
Bio-Wise	DTI	10.8	1.03	
BEP Challenge	DTI	8.2	0.78	
MfB	DTI	0.1	0.01	
BMI	DTI	2.5	0.24	
Harnessing Genomics	DTI/DoH	53.6	5.11	
Special Initiatives	BBSRC	114.8	10.94	
Stem Cell Initiative	BBSRC/MRC	48.2	4.60	
IRCs	BBSRC/DTI/EPSRC/MoD/MRC	22.8	2.17	
Sponsored institutes: CSG	BBSRC	167.9	16.01	
Post-Genome Initiative	MRC	149.4	14.24	
Special programmes/initiatives	NERC	25.5	2.43	
Research Centres	ESRC	12.8	1.22	
Genetics for NHS	DoH	52.8	5.03	
GMO risk assessment	DEFRA	12.6	1.120	
Sub-total national		**930.4**	**88.7**	
Regional				
Generic				
Flexible Fund	SEERAD	11.8	1.12	

Instrument	Funding organisation	Budget	% of total	Use of DF/SF
SMART	ETLLD, WDA, Invest NI	6.4	0.61	
SPUR	ETLLD	1.0	0.10	
SPUR plus	ETLLD	4.9	0.47	
SCORE	ETLLD	0.1	0.01	
Proof of Concept	Scottish Enterprise/Invest NI	15.5	1.48	
Enterprise Fellowships	Scottish Enterprise	0.9	0.09	
SCIS	Scottish Enterprise	1.5	0.14	
TEP	WDA	2.1	0.20	
Technium	WDA	1.8	0.17	
CETIC	WDA	3.3	0.31	
RSA Innovation Grants	Welsh Assembly Government	0.2	0.02	
RSA grants	Welsh Assembly Government	2.1	0.20	
Knowledge Exploitation Fund	Welsh Assembly Government	1.5	0.14	√
Compete	Invest NI	1.5	0.14	
Start	Invest NI	5.7	0.54	
CoE	Invest NI	8.5	0.81	√
KTP	Invest NI	1.2	0.11	
Biotech specific				
Business Advisory Service	Scottish Enterprise	1.6	0.15	
Life Sciences ITI	Scottish Enterprise	46.0	4.39	
PREBIO	Scottish Enterprise	0.5	0.05	
Talent Scotland Life-Sci.	Scottish Enterprise	0.4	0.04	
Sub-total regional		**118.5**	**11.30**	
Total		**1048.9**	**100.00**	

Source: BioPolis Research

2.3.1 The Department of Trade and Industry (DTI)

The DTI is the ministry in charge of industrial policy in the UK. Since 1995, DTI has also been responsible for science policy and the overall funding of science and technology. At this time, the Office of Science and Technology (OST) was relocated from the Cabinet Office to the DTI in order to improve links between Government, industry and the science and engineering base. Within the DTI, the Bioscience Unit is charged with encouraging industry to enhance and increase the UK's competitiveness through the application of biotechnology. In particular, The Bioscience Unit focuses on four key areas: research and development policy, and technology transfer; the regulatory environment, with a particular emphasis on intellectual property rights; the financing and development of small firms; and the public perception of the technology.

In the period 2002-2005 the DTI has taken a number of initiatives to support the development of biotechnology in general, as well as funding R&D and technology transfer through a variety of generic policy instruments (such as LINK, SMART and TCS-KTP). The policy initiatives undertaken by the DTI are described below, and the budgetary information for the period 2002-05 is shown in Table 2.3.1.

a) Bio-Wise

Bio-Wise was a specific instrument to promote biotechnology, launched by the DTI in 1999 and discontinued in 2005. It aimed to: (1) improve the competitiveness of UK industry through the use of biotechnology and (2) support the development of the UK

biotechnology supplier industry. The aim of the Bio-Wise programme was to promote awareness and adoption of industrial biotechnology, and provide advice for users and suppliers of industrial biotechnology through the organisation of workshops and seminars, and the provision of an advice help-line. The programme also funded Demonstrator Projects oriented to encourage the commercial application of novel biotechnology solutions. Since its start, the programme has involved a public investment of £14.4M (22.2M EUR), including £3.1M for demonstrator projects.

Over the period 2002-2005, Bio-Wise committed a total amount of £7M (10.8M EUR). The main policy goal pursued by the programme was the adoption of biotechnology for new industrial applications and, to a lesser extent, to boost business investment in R&D (about £0.3M, 0.5M EUR)). Regarding the application areas of biotechnology covered, almost all the funding supported environmental biotech.

b) Biotechnology Exploitation Platform (BEP) Challenge

The BEP Challenge (now discontinued) was a biotech-specific instrument that helped groups of universities and other publicly funded research institutions to obtain specialist advice about, and develop expertise in, all aspects of intellectual property management and exploitation. Grants of up to £250 000 (0.385M EUR) (later increased to £400 000 (0.616M EUR) helped public sector research organisations to secure the necessary skills to audit and manage their intellectual property portfolios and match them with potential industrial markets. Grants covered up to 50% of the eligible costs. Following a successful pilot phase the full BEP programme was launched in August 1999. Total DTI support to this programme has been about £8.8M (13.6M EUR) (including the pilot). This initiative aimed to stimulate more effective exploitation of publicly funded bioscience research by encouraging syndicates with complementary research in biotechnology to work together and build portfolios of intellectual property rights.

Over the period 2002-2005, the DTI committed about £5.3M (8.2M EUR) to this biotech specific initiative. The main policy goal of this programme has been the transmission of knowledge from academia to industry, and the main application area covered is related to capacity building and support for patenting.

c) The Manufacturing for Biotechnology Initiative (MfB)

The MfB initiative, a biotech-specific instrument, was launched in June 1998. Under this initiative a series of workshops and seminars have been held to promote discussion and help companies with their manufacturing decisions. MfB also provides training grants of up to 75% of costs to enable small companies to send employees on Masters level course modules in bio-processing at five registered centres of excellence across the country. In August 1999, it also launched a further scheme for small and medium-sized biotechnology enterprises, aimed at helping them to conduct feasibility studies to better assess manufacturing options. The scheme provides 50% of eligible costs up to a maximum of £5K (0.008M EUR).

Over the period 2002-2005, the DTI committed about £0.09M (0.14M EUR) to this initiative. The main policy goals of this programme have been to increase the availability of human resources and to favour the adoption of biotechnology for new

industrial applications. The most important application area covered by this programme is health biotechnology.

d) The Biotechnology Mentoring and Incubator (BMI) Challenge

The BMI Challenge, a biotech-specific instrument, was launched in July 1996 with DTI funds of up to £5M (7.7M EUR) to be made available over three years. The programme offers awards of up to £500 000 (0.77M EUR) towards a maximum of 50% project costs over three years. The aim of this programme is to stimulate the creation and growth of quality biotechnology companies in the UK. The programme encourages intermediaries to provide mentoring services (provision of business services such as commercial appraisal of technology, financial advice and support) and incubator infrastructure that provides a nurturing hot-house environment to accommodate a number of start-up companies in their very early stages. Over the period 2002-2005, £1.64M (2.52M EUR) was allocated to this programme.

The main policy goal of this initiative is to stimulate firm creation, the main application area covered has been health biotech, and the main activities supported have been financial support for start-ups and creation of incubators.

e) Small Firms Merit Award for Science and Technology (SMART)

SMART is a generic programme that makes awards on the basis of an annual competition open to individuals or businesses in the UK with up to 50 employees and an annual turnover up to £4.3M (6.6M EUR). On offer are grants of 75% of project costs, up to a maximum grant of £45K (0.07M EUR), to help carry out technical/commercial feasibility studies (lasting 6 to 18 months) into innovative projects. SMART winners who complete their projects successfully may apply for further funding of 50% of project costs under SPUR to develop a prototype. The maximum grant any one beneficiary can receive for a combination of SMART and SPUR is £170 000 (0.26M EUR). No information is available on the funding allocated by SMART to biotechnology-related projects.

f) Support for Products Under Research (SPUR)

SPUR is a generic programme that gives awards to support the development of new products and processes which involve significant technological advance. It is open to established business in the UK with up to 250 employees and an annual turnover not exceeding £17M (26.2M EUR). Projects must cost at least £50 000 (0.08M EUR) and be of 6 to 36 months duration. The grant is normally 30% of project costs up to a maximum grant of £170 000 (0.26M EUR). No information is available on the funding allocated by SPUR to biotechnology-related projects.

g) Teaching Company Scheme (TCS) - Knowledge Transfer Partnerships (KTP)

The Teaching Company Scheme is a generic programme that funds projects which allow one or more graduates to be placed in a company for 1 to 3 years to work on a specific technology transfer project. Both an academic and an industrial supervisor guide the student. Since (2003) this scheme has been superseded by the Knowledge Transfer Partnership (KTP) programme. For their first Partnership, firms with less than 250 employees can expect to contribute one third of project costs; firms with over 250

employees contribute 50%. A number of TCS (KTP) programmes have focused on biotechnology projects. KTP is funded by a variety of public sector sponsors, including the Research Councils, Government Departments and regional governments which fund projects that fall within their overall remit. Based on the allocation of funds to current projects in 2005, we have estimated that funds committed by KTP to supporting biotechnology over the period 2002-2005 amount to about £4M (6.2M EUR).[10]

h) Faraday Partnerships

Faraday Partnerships are a generic programme that foster alliances of organisations and institutions, which can include research and technology organisations, universities, professional institutes, trade associations and firms, dedicated to the improvement of the competitiveness of UK industry through the research, development, transfer and exploitation of new and improved science and technology. Faraday Partnerships are dedicated to improving the competitiveness of UK industry through more effective interaction between the science and technology base and industry. Effective interaction requires the identification of industry needs and the subsequent synthesis of the knowledge and experience of those who can satisfy these needs. Crucially, each Faraday Partnership employs a number of technology translators – people with broad experience of knowledge transfer – who can facilitate projects between Partnership members.

This programme has been running since 2002. The main policy goals pursued by this programme are the support of both a high level of biotechnology research and industry-oriented research, collaboration among scientific disciplines, transmission of knowledge from academia to the industry and its application for industrial resources, the adoption of biotechnology for new industrial applications, and the encouragement of business investment in R&D. The application areas that have been covered by this programme are environmental biotechnology, food biotechnology and industrial biotechnology.

The DTI has committed a total budget of £40M (61.6M EUR) to this programme over the period 2002-05**,** of which £4.3M (6.6M EUR) was related to biotechnology projects Of this budget, about £1.7M (2.6M EUR) was allocated to projects involving environmental biotech, £1.2M (1.8M EUR) to food biotech, and £1.4M (2.2M EUR) to industrial biotechnology.

i) Knowledge Transfer Networks (KTN)

In 2005 Knowledge Transfer Networks (KTN), a generic programme, was initiated by the DTI. A Knowledge Transfer Network is a single Network in a specific field of technology that brings together businesses, universities, research and technology organisations, the finance community and other intermediaries who will provide a range of activities and initiatives to enable the exchange of knowledge and stimulation of innovation amongst this community. So far KTN has not committed a significant amount of funding, but there are plans to prioritise bioprocessing, industrial biotechnology and food processing.

[10] This estimate is based on information about current KTP projects available at the KTP website, accessed 5 June, 2006 at: www.ktponline.org.uk

j) The LINK Programme

The LINK programme, a generic programme, is the Government's principal mechanism for promoting collaborative, pre-competitive partnerships research between industry and the research base. It aims to accelerate the transfer and exploitation of technology, and to bridge the gap between science and the marketplace. Government Departments and Research Councils provide up to 50% of the eligible costs of a project with the balance coming from industry. The LINK Programme covers a wide range of technology and product areas from food and bio-sciences, through engineering to electronics and communications. Within LINK the current biotech-related programmes supported by the DTI are Bioremediation and Applied Genomics (see sections 2.3.4 and 2.3.8 for other LINK programmes with a biotechnology component).

The main goal of the Bioremediation programme is to enable the commercial application of bioscience for the clean up of contaminated land, air and water. The programme is jointly funded by the DTI, BBSRC, EPSRC, NERC, SEERAD (Scottish Executive Environment and Rural Affairs Department) and the Environmental Agency. The overall public funding for this programme has been £5.7M (8.8M EUR), with £3.74M (5.8M EUR) allocated over the period 2002-05. DTI's contribution amounted to £0.98M (1.5M EUR) over the period 2002-05. The main policy goals covered by this programme have been the support of high-level industry-oriented research, the transmission of knowledge from academia to industry and the adoption of biotechnology for new industrial applications. Regarding the application areas covered, the most important is environmental biotech, and to a much lesser extent industrial biotechnology.

The LINK Programme in Applied Genomics for healthcare applications was launched in July 2000. DTI and its co-sponsors, BBSRC and MRC have funded 21 projects, at a total value of £28M (43.1M EUR). Government funding over the life of the programme has been £16.5M (25.4M EUR), while the public funding for the period 2002-05 amounts to £13.2M (20.3M EUR). DTI's contribution amounted to £5.5M (8.5M EUR) over the period 2002-05. The main policy goals covered by this programme have been the support of high level industry-oriented research, the transmission of knowledge from academia to industry, the adoption of biotechnology for new industrial applications and business investment in R&D. Regarding the application areas covered, half of the budget has been allocated to projects related to health biotechnology, while almost a quarter of the budget has supported research projects in the areas of industrial and basic biotech, with a marginal fraction for animal biotechnology.

k) Harnessing Genomics Programme:

The Harnessing Genomics Programme was announced in February 2001. This major biotechnology specific programme was designed to help industry to take up the rapidly developing opportunities provided by genomics. The Harnessing Genomics Programme comprised three main elements: (i) stimulation of industrially-relevant R&D and enabling technologies (together with the associated training); (ii) development of a successful UK bio-manufacturing capability; and (iii) mentoring and incubation support to new companies.

The projects supported within this programme include:

- Bioscience Beacon Projects were launched in 2002 and funded 6 scientific projects collectively worth £8.9M (13.7M EUR), covering a diverse mix of highly innovative areas. All of these projects are related to either bio-informatics or gene function analysis.
- Genetics Knowledge Parks (GKPs) were launched in 2002 by the DTI and the Department of Health. DTI's contribution to this programme is £4.5M (6.9M EUR), while the Department of Health is responsible for an investment of £10M (15.4M EUR). This £14.5M million (22.3M EUR) investment over five years is aimed at supporting the development of Genetics Knowledge Parks in Newcastle, Manchester, Oxford, Cambridge, London and Cardiff. All are linked to multi-disciplinary centres of excellence and offer access to internationally recognised academic research and clinical expertise in genetics in relation to healthcare. These Parks aim to build the knowledge base in all aspects of human genetics, ensuring that the National Health Service (NHS) is better placed to exploit the findings of genetics research and to benefit UK industrial competitive advantage. These Parks are also developing programmes to promote better engagement of the general public in a range of ethical, legal, and social issues associated with developments in human genetics.
- Other projects include: support for regional initiatives in bioscience; support towards the National Bio-manufacturing Centre (Speke); support for bio-informatic courses, etc. Over the period 2002-05, DTI's investments in these projects have amounted to £11.4 millions (17.6M EUR).

The Harnessing Genomics Programme covers a wide range of policy goals: high level of biotechnology research; high level of industry-oriented research; knowledge flow and collaboration among scientific disciplines (in particular, Beacon projects); the transmission of knowledge from academia to industry; the adoption of biotechnology for new industrial applications; firm creation; social acceptance of biotechnology (only applicable in the case of GKPs); and business investments in R&D. Regarding the biotechnology application areas, the Programme mainly covers health biotech (90% of the budget), while industrial biotech and ELSA account for the remaining 10%.

Table 2.3.1 Total budget committed by DTI to policy-directed biotechnology stimulating instruments during the period 2002-2005 (£M)

	2002	2003	2004	2005	Total	Type of programme
Bio-Wise	1.3	0.9	2.5	2.3	7.0	Specific
BEP Challenge	1.4	1.0	1.4	1.5	5.3	Specific
MfB Initiatives	0.04	0.05	---	---	0.09	Specific
BMI Challenge	0.7	0.5	0.4	0.04	1.64	Specific
Faraday Partnerships	0.4	1.2	1.5	1.2	4.3	Generic
Harnessing Gen - Beacons	4.0	4.7	0.1	0.1	8.9	Specific
Harnessing Gen – GKPs	0.7	1.2	1.4	1.2	4.5	Specific
Harnessing Gen – Others	1.1	7.4	2.6	0.3	11.4	Specific
LINK - Bioremediation	0.08	0.1	0.3	0.5	0.98	Generic*
LINK - Applied Genomics	1.1	0.7	2.5	1.2	5.5	Generic
TCS – KTP					4.0	Generic
Total	10.82	17.75	12.7	8.34	53.61	

*LINK is a generic programme, with bio-specific modules.
Source: BioPolis Research

2.3.2 The Biotechnology and Biological Sciences Research Council (BBSRC)

BBSRC is the UK's principal funder of basic and strategic research in biotechnology and the biological sciences. To deliver its mission, BBSRC supports research and training in universities and research centres, including BBSRC-sponsored institutes, and promotes knowledge transfer from research to application in industry. BBSRC's science programmes are administered by seven committees, each dealing with a major area of the Council's scientific remit: agri-food; animal sciences; biochemistry and cell biology; bio-molecular sciences; engineering and biological systems; genes and developmental biology; and plant and microbial sciences. The committees operate two mechanisms for funding research grants: through responsive mode, where researchers can apply at any time for funding for research (and which represents the bulk of the funding); and through special initiatives – when BBSRC allocates a certain amount of funding to specific areas of research. Below we indicate the overall amount of funding distributed by BBSRC through: fellowships and studentships; responsive research grants; special initiative grants; and core strategic grants to BBSRC sponsored-institutes involved in biotechnology.

BBSRC's Strategic Plan describes the Council's objectives for 2003-2008 (BBSRC, 2003). The scientific priorities described in this document focus on four areas: Sustainable Agriculture; the Healthy Organism; Bioscience for Industry; all of which are underpinned by the central priority of Integrative (and Systems) Biology. The focus of the Bioscience for Industry priority area is on meeting the research needs of industry and includes such areas as bio-processing, bioremediation, and exploiting systems biology. Given the interdependent nature of these research areas, the Bioscience for Industry priorities draw upon and complement every other scientific priority area. This makes it clear that biotechnology is at the centre of BBSRC's research mission. In fact, about 30% of BBSRC's total research budget goes to biotechnology. For this reason, we consider training awards and responsive grants in biotechnology as directed policy.[11]

a) Studentships and Fellowships

Maintaining and developing an expert community of bioscience researchers is a key element of BBSRC's mission. To meet this the Council gives a great priority to ensure that BBSRC's support at the postgraduate and postdoctoral level will provide suitable skilled manpower (BBSRC, 2003). BBSRC distributed around £2.1M (3.2M EUR) in 2003/04, and £1.7M (2.6M EUR), in 2004/05, to studentships and fellowships in the area of biotechnology. This data, suggests that approximately £1.9M (2.9M EUR) per annum has been allocated by BBSRC to studentships and fellowships in biotech-related areas of research. On this basis we estimate that £7.6M (11.7M EUR) was allocated to studentships and fellowships in the period 2002-2005.

[11] It is important to note, though, that this criteria differs with the one used in the Inventory Report (Enzing et al, 1999), where BBSRC funding through studentships, fellowships and responsive grants was classified as non-directed policy.

b) Responsive mode research grants

All research Committees within BBSRC fund research that can be classified as biotechnology-related research. However, the main funders of this type of research are the Agri-Food, Engineering & Biological Systems, Genes and Developmental Biology, and Plant & Microbial Sciences Committees. For instance, the Genes and Developmental Biology Committee has a broad scientific remit to support research which includes: genetics of developmental processes, stem cell biology, genetics of aging, sequence analysis and genome organisation, evolutionary genetics, gene therapy, etc. According to the information provided by BBSRC, BBSRC allocated £24.8M (38.2M EUR) in 2003/04 and £26.6M (41M EUR) in 2004/05 to responsive research grants in the area of biotechnology. This leads to an estimate that about £25.7M (39.6M EUR) is allocated annually by BBSRC to response mode research grants in the area of biotechnology with a total estimate for the period 2002-2005 of £102.8M (158.3M EUR).

c) Special Initiatives

BBSRC supports a number of funding schemes outside the normal response mode mechanism for research grants, where it calls for research proposals on selected topics. From data provided by BBSRC, the Council allocated a total of £42.8M (65.9M EUR) in the years 2003/04 and 2004/05. On the basis of this information, we estimate that over the period 2002-2005 about £74.6M (114.8M EUR) was allocated by BBSRC for special initiatives.

In addition, there are three initiatives where BBSRC collaborates with other funding bodies: the MRC for the Stem Cell Initiative,[12] the EPSRC for an interdisciplinary research collaboration (IRC) in proteomic technologies,[13] and the DTI for some LINK programmes.[14] BBSRC allocated £10M (15.4M EUR) to research grants in the Stem Cell Initiative over the period 2003-2008. On this basis, we estimate that approximately 50% (8.2M EUR) for the period 2002-2005. The IRC in proteomics commenced in Spring 2005, with funding of £11M (16.9M EUR), shared equally between the EPSRC and BBSRC. The IRC is funded for 5 years; we therefore estimate that BBSRC allocated £0.75M (1.1M EUR) to the IRC during the period 2002-05. BBSRC contribution to LINK programmes over the period 2002-05 amounted to 0.4M EUR to Bioremediation and 6.1M EUR to Applied Proteomics.

d) BBSRC Institutes – core strategic grants (CSG)

BBSRC funds several of its own Institutes to undertake research in a wide range of areas, from animal health to crop science. All these institutes undertake research in the area of biotechnology, even though biotechnology may not be their principal research objective. From data provide by BBSRC, the Council allocated a total of £54.5M (83.9M EUR) in the years 2003/04 and 2004/05 to core strategic grants in the area of biotechnology research. On the basis of this information, we estimate that over the period 2002-2005 about £109M (167.9M EUR) was allocated by BBSRC for projects in biotech within BBSRC-sponsored institutes.

[12] See section 2.3.3 below
[13] See section section 2.3.5 below
[14] See section 2.3.1 above

The distribution between application areas of all BBSRC's funds for biotechnology research in the period 2002-2005 are as follows: 24% to basic biotech ('non-oriented research'); 23% to health biotech; 10% to industrial biotech; 1.5% to environmental biotechnology and the other 41.5% covers the broad area of agricultural production and technology.

Table 2.3.2 estimates the overall contribution of BBSRC to support biotechnology related research through policy-directed instruments in the period 2002-05.

Table 2.3.2 Summary for BBSRC support of biotechnology research (£M)

	2003-04	**2004-05**	**Estimate for the period 2002-05**
Studentships & Fellowships	2.1	1.7	7.6
Responsive research grants	24.8	26.6	102.8
Initiatives inc. joint initiatives with other RCs and Govt. Depts.	23.7	19.8	87.1
Sponsored Institutes – CSGs	24.7	29.8	109.0
Total	*75.3*	*77.2*	*306.5*

Source: BioPolis Research (The breakdown for the years 2003-04 and 2004-05 was provided by BBSRC. An estimate for the period 2002-05 has been estimated on the basis of this information.)

2.3.3 The Medical Research Council (MRC)

The MRC is involved in several policy-directed biotechnology research instruments, discussed below.

a) Special Initiatives

In the period 2002-2005 MRC has taken forward two strategic initiatives via allocations made by the UK Government through its Spending Reviews: the Post-Genome Research Initiative and the Stem Cell Research Initiative. The Post-Genome Research Initiative was set up over the years 2001/02. Over the period 2002-2005 this initiative was allocated a total budget of £97M (149.4M EUR).

The MRC worked with other agencies and medical charities to develop the UK Stem Cell Initiative (UKSCI) which is also supported by the Department of Health[15] and the DTI. UKSCI had an overall budget of £40M (61.6M EUR), £26M (40M EUR) of which was awarded to MRC.[16] The MRC's Stem Cell Initiative was launched in 2003, with a total expected duration of 3 years. It is a multi-disciplinary programme to encourage basic research aimed at generating new insights into fundamental stem cell biology and developmental processes, and to foster more applied research leading to the development of human therapies for major diseases and disabilities. One of the activities supported by the initiative is the establishment of the UK Stem Cell Bank at the National Institute for Biological Standards and Control (NIBSC)[17] to characterise

[15] www.dh.gov.uk/Home/fs/en

[16] In addition to funding for UKSCI, an estimate for UK public investment in stem cell research (response mode grants by government departments, research councils and regional government and expenditure by medical charities) at £22 million in 2003/04 and £31 million in 2004/05 (UKSCI, 2005).

[17] www.nibsc.ac.uk/

and store ethically sourced, quality controlled adult, foetal and embryonic stem cell lines, and to make them available for medical research and clinical applications. The UK Stem Cell Bank[18] is funded by the MRC (75%) and BBSRC (25%).

The main policy goals covered by these two special initiatives are to encourage a high level of biotechnology research and knowledge flow through collaboration among scientific disciplines, and to strengthen the availability of human resources. Finally, in terms of the biotechnology application areas covered by the initiatives, health and basic biotechnology are the most important ones. Table 2.3.3 summarises the information on funding through the special initiatives.

Table 2.3.3 MRC special initiatives: overall funding (£M)

Special Initiatives	2002	2003	2004	2005	Total
Post-Genome Research	20	24	25	28	97
Stem Cell Research	---	---	6	20	26
Total	20	24	31	48	123

Source: information provided by MRC

b) Interdisciplinary Research Collaborations (IRCs)

Nanotechnology is a multidisciplinary field with a high potential impact on many aspects of medicine and health care, including areas as diverse as biosensors, drug discovery and delivery, and regenerative implants. The MRC, together with the EPSRC, BBSRC, Ministry of Defence and DTI, established two Interdisciplinary Research Collaborations (IRCs) in the field of nanotechnology. One IRC is in Cambridge (with the Universities of Bristol and UCL) and another one in Oxford (with the Universities of Glasgow and York and the National Institute for Medical Research). The Oxford IRC has a clear remit to focus on bio-nanotechnology, and particularly on molecular motors, functional proteins and DNA devices, but biotechnology has a less prominent role in the Cambridge IRC. A total of £20M (30.8M EUR) was shared by the IRCs over 6 years (from 2002-2007). We estimate that the allocation to IRCs for the period 2002-05 at 20.5M EUR MRC's contribution amounts to £3M (4.6M EUR) over 6 years and the allocation for the period 2002-2005 amounted to about £2M (3M EUR). The main policy goals pursued by this initiative are to encourage a high level of biotechnology research, collaboration among scientific disciplines and availability of human resources, and its main application area is in health biotechnology.

c) LINK Programme Applied Genomics

As mentioned in Section 2.3.1, the LINK programme in Applied Genomics has been sponsored by a number of funding agencies, including the MRC. MRC's contribution to amounted to £3.7M (5.7M EUR) for the period 2002-05.

2.3.4 Natural Environment Research Council (NERC)

NERC allocates a substantial part of its budget to thematic funding. Thematic funding programmes are policy-directed and aim to develop research in key priority areas. .

[18] www.ukstemcellbank.co.uk/

Biotechnology-related research occurs mainly within the Environmental Genomics and Post Genomics and Proteomics Programmes. Environmental Genomics ran from 2000-2006 and was allocated £14.4M (22.2M EUR) during the period 2002-05. The Environmental Genomics thematic programme aims to facilitate the exploitation and, where appropriate, acquisition of whole or partial genome sequence data in environmental biology. The main policy goal covered by Environmental Genomics is to support a high level of biotechnology research, and to a lesser extent to support knowledge flow and collaboration among scientific disciplines, and the availability of human resources. The main biotechnology application area covered is environmental biotechnology (almost 70% of the budget), and capacity building accounts for the remainder.

The Post Genomics and Proteomics Programme builds on but is separate from the Environmental Genomics Programme. It commenced in 2004 and will run for about 5 years, with an budget of £11.4M (17.5M EUR). £1.2M (1.8M EUR) was allocated to projects in the period 2004-05. It aims to focus on the application of integrated genomic and/or proteomic approaches to answering environmental questions.

The NERC also contributed £1.5M (2.3M EUR) to one of the Special Initiatives administered by BBSRC, known as GeneFlow in Plants and Micro-organisms. This initiative aims to provide a greater understanding of the biological events that control and influence the insertion of new genetic material into the genomes of plants and microorganisms and of the consequences of gene flow. The GeneFlow programme ran from late 2000 to 2006. We estimate that the amount allocated to GeneFlow by NERC during the period 2002-2005 was 1.5M EUR.

NERC also contributed to the Bioremediation and Aquaculture LINK programmes; its support to the Bioremediation programme over the period 2002-05 amounted to £0.42M (0.65M EUR). The Aquaculture LINK Programme ran from 1997-2003. NERC was the main sponsor, but DEFRA also supported some projects. In the period 2002-2005, two projects relating to biotechnology in the Aquaculture LINK programme were allocated 0.1M EUR by NERC.[19]

2.3.5 Engineering and Physical Sciences Research Council (EPSRC)

The EPSRC has contributed to the establishment of two Interdisciplinary Research Collaboration Centres (IRCs) in nanotechnology (as mentioned in Section 2.3.3). Over the period 2002-05, EPSRC's contribution to these IRCs has amounted to £9.7 million (14.9M EUR). It also contributed to a new IRC in proteomics, launched in mid 2005 and jointly funded with BBSRC (see also section 2.3.2 above). It received a budget of £11M (16.9M EUR) for 5 years (2005-2010), with the funding divided equally between the EPSRC and BBSRC. We estimate that the EPSRC's allocation to the IRC in proteomics for 2005 was £0.75M (1.2M EUR). Also, EPSRC has contributed to the Bioremediation LINK Programme, with a total budget over the period 2002-05 of £0.52M (0.8M EUR).

[19] Information extracted from Aquaculture database compiled by FRM Ltd. and sponsored by DEFRA

2.3.6 Economic and Social Research Council (ESRC)

The ESRC budget (about £80M per year/123.2M EUR) is spent in four main ways: through research centres, research programmes, research grants and research resources (ESRC, 2005). The most distinctive mechanism by which the ESRC has supported biotech-related research is through the establishment of research centres. Selected through competition, centres are funded for an initial period of ten years, subject to a satisfactory mid-term review. The main focus of their research is ethical, legal and social aspects of biotechnology (ELSA), but the centres also aim to promote knowledge flow and collaboration between social scientists and scientists and to improve the availability of human resources in the area. Since 2002, the ESRC has funded four research centres to undertake social science research on the impact of genomics. The research is coordinated by a Genomics Policy and Research Forum and complemented by a Genomics Survey to provide basic understanding of public attitudes to human, animal, plant and environmental genomics and how these attitudes are changed and formed over time. For the period 2002-2005 the budget allocated to the research centres is estimated to be £8.3M (12.8M EUR) out of the total of £11.8M (18.2M EUR) shown in Table 2.3.4.

Table 2.3.4 Research Centres funded by the ESRC in Biotech related research (£M)

Research Centres	**Period of funding**	**Total Budget allocated (£M)**
Centre for Economic Aspects of Genomics (CESAGEN)	2002-2007	4.3
Centre for Genomics in Society (EGENIS)	2002-2007	2.5
Centre for Social and Economic Research on Innovation in Genomics (INNOGEN)	2002-2007	2.1
Genomics Policy and Research Forum	2004-2009	2.9
Total		*11.8*

Source: BioPolis Research

2.3.7 Department of Health (DoH)

In June 2003 a White Paper was launched to set out a vision of how patients could benefit in future from advances in genetics, raise awareness of the potential of genetics in healthcare and to set out a comprehensive plan for preparing the NHS to help realise the benefits of genetics in healthcare (Department of Health, 2003). In addition to the £11M (16.9M EUR) committed since 2002 to specialised genetic services, the 2002 plan included an investment of over £50M (77M EUR) during the period 2004-2006 for two new Genetics Reference Laboratories in Manchester and Salisbury and the formation of a UK Genetic Testing Network.

The Government has an ambitious vision for harnessing the potential benefits for patients that emerge from advances in new genetics knowledge and technology: more personalised prediction of risk, more accurate diagnosis, safer use of medicines and new treatment options. Among many proposals, the White Paper recommends: (i) modernising genetic laboratories; (ii) generating new knowledge and applications through investment in genetic research and development; and (iii) increasing the public understanding of genetics and ensuring public confidence through a robust and proportionate system of regulation.

Some of the initiatives within the White Paper include:

1. To develop existing centres of expertise and deal with inadequate staff numbers and infrastructure. This involves a strategic programme to boost the workforce in genetics laboratories during the period 2003-06, to invest on upgrading the NHS and genetics laboratory facilities, and to invest in IT for genetics laboratories in the Genetic Testing Network.

2. To maintain and strengthen UK's role in generating new genetic knowledge and applying it to healthcare by supporting the development of genetics knowledge parks (see further details on this programme in Section 2.3.1k above).

3. Since the Government realises that developments in genetics present ethical challenges and require public acceptance and confidence, the Government will support a programme of events and initiatives to increase people's awareness and understanding of genetics.

Some of the White Paper funding commitments expand beyond our period of interest. Therefore, we estimate that for the period 2002-05 the contribution to policy-directed funding by the Department of Health for biotechnology application in the NHS is about £44.3M (68.2M EUR).

2.3.8 Department of Environment, Food and Rural Affairs (DEFRA)

DEFRA commissions research in support of policy-making and to help plan for the future. Its annual expenditure on science is £155M (238.5M EUR). Some projects are carried out by DEFRA's science Agencies (Veterinary Laboratories Agency, Centre for the Environment, Fisheries and Aquaculture Science and the Central Science Laboratory) and other major contractors where DEFRA needs to maintain expertise and facilities. DEFRA also commissions research carried out by other PROs through competitions advertised on its website, as well as supporting research jointly funded with others: mainly LINK Programmes.

The biotechnology projects commissioned are part of generic programmes to support policy (e.g. Sustainable Farming and Food Science). In the period 2002-2005, all projects related to biotechnology in these generic programmes amounted to £23.9M (36.7M EUR).[20] DEFRA also supported four generic LINK Programmes that include biotechnology projects: Sustainable Arable LINK, Horticulture LINK, Sustainable Livestock Production LINK and Aquaculture LINK. In the period 2002-2005 expenditure on projects related to biotechnology in these LINK Programmes totalled £1.3M (2M EUR). In addition it contributed £0.45M (0.7M EUR) to a Faraday Partnership concerning biotechnology.[21]

In terms of biotech-specific support, DEFRA has a GMO research programme designed to underpin the risk assessment of GMOs and their use in the UK. According to the

[20] See DEFRA website of research projects accessed 3 July 2006 at:
http://www2.defra.gov.uk/research/project_data/Default.asp
[21] Information from DEFRA database of research projects accessed 3 July 2006 at:
http://www2.defra.gov.uk/research/project_data/Default.asp

information provided by DEFRA, the expenditure on biotech related research for the period 2002-2005 was about £8.2M (12.6M EUR). This programme does not support biotechnology directly, but it ensures that the results of biotechnology research are properly monitored for any risks to the environment or human health.

2.3.9 Devolved Government

The UK Parliament devolved certain powers to Scottish Parliament (under the Scotland Act 1998) and to Welsh Assembly (under the Government Wales Act 1998). This section describes the initiatives undertaken by these two regional governments in relation to biotechnology research. In addition, it presents information about initiatives to support biotechnology in Northern Ireland. Total expenditure on policy-directed instruments by regional government is shown in Table 2.3.5.

Table 2.3.5 Expenditure by UK regional administrations on policy-directed biotechnology research (M EUR)

Region	Generic	Biotech-specific	Total
Northern Ireland	19.7	-	19.7
Scotland	37.1	48.5	85.6
Wales	13.2	-	13.2
Total regional support	63.3	48.5	118.5

Source: BioPolis Research

Scotland

The Scottish Parliament is able to pass laws on a range of issues including Education, Health, Agriculture and Justice. The Scottish Executive is the devolved government of Scotland, accountable to the Scottish Parliament. The Scottish Executive Environment and Rural Affairs Department (SEERAD) funds policy-directed biotechnology research. The Scottish Executive Enterprise, Transport and Lifelong Learning Department (ETLLD) has responsibility for policies connected to economic growth, industrial development, further and higher education, skills and lifelong learning. Scottish Enterprise is Scotland's main economic development agency, funded by the Scottish Executive. In November 1999 Scottish Enterprise launched a 4-year, £40M (61.6M EUR) Framework for Action strategy to grow a biotechnology cluster in Scotland. The strategy was renewed in 2003.

SEERAD has a Flexible Fund of £6.5M (10M EUR) per annum which is used to commission specific research to meet Departmental policy or strategic needs from its sponsored Institutes, universities and Research Council Institutes. In the period 2002-05 approximately £7.7M (11.8M EUR) was allocated to biotechnology projects.

Scottish Enterprise provides access to a wide range of generic instruments to promote the commercialisation of science and technology. The following instruments are provided directly by the ETLLD:[22]

[22]Information about these policies available on the Scottish Enterprise website accessed at http://www.scottish-enterprise.com/sedotcom_home/sig/life-sciences.htm 18 October 2005

- SMART - SCOTLAND is a competition for SMEs with less than 50 employees or individuals planning to start a new business. Winners receive funding for 75% of the cost of carrying out a technical and commercial feasibility study lasting between 6 and 18 months, with a maximum grant of £50 000 (0.08M EUR). The total budget for the period 2002-05 was 10.6M EUR and 3.2M EUR was allocated to biotech projects.
- SPUR provides further assistance to SMART winners who complete their projects to develop a pre-production prototype. This programme also supports SMEs with up to 250 employees to undertake highly innovative research and technical development. It provides grants to cover 35% of eligible costs, up to a maximum grant of £0.15M (0.23M EUR) for projects of between 6 months and 3 years in duration, which involve eligible projects costs of at least £75K (0.11M EUR). 1M EUR was allocated to biotech projects in the period 2002-2005.
- SPUR Plus provides grant support for SMEs with up to 250 employees to undertake expensive leading edge technology development in areas such as biotechnology. To be eligible for support projects must normally involve eligible project costs of at least £1M (1.54M EUR). Assistance of up to £500 000 (0.77M EUR) at 35% of eligible costs is available to support development up to pre-production prototype stage. From a total budget of 16.5M EUR, 4.9M EUR was allocated to biotech projects in the period 2002-2005.
- SEEKIT (established in 2005) promotes co-operation in R&D and knowledge transfer between small to medium sized enterprises (SMEs) and the Scottish public sector science base. No funding has yet been allocated to biotech.
- SCORE support joint R&D projects between public sector research organisations and Scottish SMEs. Under this scheme, an SME or group of SMEs with a specific technical problem or need can assign a significant part of the research to a public sector research body. From a total budget of 1.2M EUR in the period 2002-20050, 0.05M EUR was allocated to biotech projects.

Scottish Enterprise provides the following generic instruments to support the commercialisation of science and technology:

- Proof of Concept Programme (established in 1999) awards grants to assist the pre-commercialisation of cutting-edge technologies emerging from Scotland's universities, research institutes and National Health Service boards. From a total budget of 32.3M EUR in the period 2002-2005, 13.7 M EUR was allocated to biotech projects.
- Enterprise Fellowships (established in 1997) are for post-graduate students or researchers at a Scottish University or Research Institute interested in developing a spin-out company based around their ideas. The Fellowships provide a year's salary to develop the idea, business training and access to mentors. From a total budget of 3.5M EUR for the period 2002-2005, 0.9M EUR was allocated to biotech projects.
- Small Company Innovation Support (SCIS) provides financial support to SMEs for projects that lead to the development and introduction of new products and processes. The total budget for the period 2002-2005 was 12.3M EUR. There are records for expenditure on biotech projects only for 2005, when they amounted to 0.5M EUR. On this basis we estimate that 1.5M EUR was allocated to biotech projects in the whole period.

Scottish Enterprise also has three life-science specific instruments:

- The Life Sciences Business Advisory Service provides support to companies for commercialisation, raising finance, marketing, product development and business planning. It is successor to the Biotech Business Advisory Service which has been running for the past 5 years, but is broader, covering all life sciences. 1.6M EUR was allocated to biotech projects in the period 2002-2005.
- A Life Sciences Intermediate Technology Institute (ITI Life Sciences) was launched in 2003. ITI Life Science aims to leverage Scotland's research excellence by developing new technologies that target future market needs. The strategy is to create and fund R&D programmes based on a detailed assessment of future market needs by experienced analysts. ITI Life Sciences has an annual budget of £15M (23.2M EUR) to commission pre-competitive market-driven research programmes that will stimulate entrepreneurial activity in Scotland. Ideas, initiatives and proposals for assessment come from the research and business organisations that are members of the ITI, with no geographical restrictions for applicants or their programme collaborators. Over the period 2002-2005 we estimate that £30M (46M EUR) was allocated by this programme to biotech projects.
- PREBIO is an annual intensive 8-week technical and people and business skills course for new Life Sciences graduates. In 2001 it was piloted in the East of Scotland with 90% of graduates completing the course being recruited to the biotechnology sector. In 2002 it ran across Scotland with over 60 graduates and a success rate of over 88% in employment within 3 months of the completion of the course. 0.5M EUR was allocated to biotech projects in the period 2002-2005.
- Talent Scotland Life Sciences offers the latest news and information from the Life Sciences communities in Scotland in order to encourage highly skilled managers, engineers, scientists and academics to view Scotland as their career destination of choice. 0.4M EUR was allocated to biotech projects in the period 2002-2005.

Overall, SEERAD, ETLLD and Scottish Enterprise provided about £55.6M (85.6M EUR) to support biotechnology during the period 2002-2005. Apart from SEERAD's Flexible Fund which supports research in PROs, most of the other instruments are related to the policy goals of supporting firm creation and stimulating business investment in R&D, though a few of them are mainly focused on securing the availability of human resources (i.e. Talent-Scotland and PREBIO) or on a high level of industry-oriented research (i.e. Proof of Concept Programme). While the information provided was generally poor regarding the biotechnology application areas covered by the initiatives, it is important to note that almost all funding channeled through the ITI programme involved technologies connected to health biotech.

Finally, two measures to help SMEs gain access to early stage investment funding were introduced by the Scottish Executive: the Scottish Co-Investment Fund, which provides equity investment (from £10 000 to £500 000 – 0.015M EUR to 0.8M EUR) in partnership with private sector investors; and the Business Growth Fund, which provides small loans and equity investments (between £20 000 and £100 000 – 0.03M EUR and 0.15M EUR) to firms satisfying specific criteria.

Wales

The Welsh Assembly is able to pass laws in a range of areas including agriculture, economic development, education and training and the environment. In 2002, the Welsh Assembly identified the bioscience industry as a key growth sector for the Welsh economy (Welsh Assembly Government, 2002). Its policy is mainly implemented by the Welsh Development Agency (WDA), the economic development agency for Wales. The WDA has several generic instruments to achieve this aim (WDA website), as follows:

- SMART Cymru is a research and development (R&D) scheme to assist new product and process development in new start-up or existing SMEs. It has various phases including grants for technical feasibility, industrial research or pre-competitive development as well as exploitation grants for those who have undertaken a previous phase of the programme. Technical feasibility pays 75% of eligible costs, maximum grant of £15 000 (0.02M EUR); industrial research pays 60% of eligible costs, maximum grant of £60 000 (0.09M EUR); pre-competitive development pays 35% of eligible costs, with a maximum grant of £200 000 (0.3M EUR); and exploitation pays 50% of eligible costs, with a maximum grant of £20 000 (0.03M EUR). Biotech projects were allocated £1.4M (2.2M EUR) in the period 2002-05 from a total budget of £245 000 (376.9M EUR).
- The Technology Exploitation Programme (TEP) helps eligible SMEs to take advantage of technology to improve their businesses. It consists of two main elements: (1) financial assistance for investment in new technologies, products and services. Grants cover 50% of the investment with a maximum of £7 000 (0.011M EUR); (2) identification of suitable providers of technology services and expertise to meet an SME's needs and introduction to the company. If a technology service provider or expert requires payment, then financial support may be available at 50% of the costs to a maximum of £7 000 (0.011M EUR). From a total budget of £14M (21.5M EUR) for the period 2002-2005, 2.1M EUR was allocated to biotech projects.
- Technium is a network of business incubation facilities across Wales for knowledge-based start-up and spin-out companies. Technium facilities provide business and technical support, access to specialist laboratory facilities and specialist academic support for R&D projects from local Centres of Research Excellence. Technium Aberystywyth and Technium Optic are particularly relevant to young bioscience businesses. 1.8M EUR was allocated to these facilities in the period 2002-2005.
- The Centres of Excellence for Technology and Industrial Collaboration (CETIC) Programme was introduced in 2001. The Centres of Excellence are based in higher education institutes and are recognised for their excellence in research. Businesses can take advantage of the extensive industry relevant academic expertise, know-how and specialised facilities that are available in the 18 Centres of Excellence. The Aber BioCentre specialises in the life sciences. Accreditation from the WDA to be a Centre of Excellence and a Commercial Manager provide support for the Aber BioCentre to find commercialisation and technology development opportunities from across the Centre. From a total budget of £8.8M (13.5M EUR) for Centres of Excellence during the period 2002-2005, 3.3M EUR was allocated to the Aber BioCentre.

The Welsh Development Agency also administers two generic programmes that provide financial support to SMEs. The Wales Spinout Programme gives people the opportunity to start a business in Wales in conjunction with a Higher Education Institution (HEI) by providing help in the form of premises, loans, and technical and business expertise. Finance Wales aims to encourage innovation and entrepreneurship by offering financial solutions on a commercial basis, which are designed to complement existing sources of finance. Its funds derive from the public and private sectors, as well as from the EC. Support includes loans for capital investment. Equity investment for the medium to long-term is provided in return for a stake in a potential high growth business. Mezzanine is a form of risk capital used where the provision of traditional bank finance is considered too risky by a lender. All Mezzanine deals involve a mixture of debt and equity.

In addition to WDA instruments, the Welsh Assembly Economic Development & Transport Department (EDT) has two generic Regional Selective Assistance grants, fully funded by the Welsh Government, that provide financial support to companies in Assisted Areas of Wales. These are:

- Regional Selective Assistance (RSA) is a discretionary grant scheme available to businesses seeking assistance of more than £50 000 (0.077M EUR) towards investment projects (i.e. buildings, equipment and intellectual property) that will create or safeguard jobs in the Assisted Areas of Wales. 2.1M EUR was allocated to biotech projects in the period 2002-2005.
- Regional Selective Assembly Innovation Grants are a funding of last resort scheme for small and medium sized businesses needing financial assistance of between £5 000 (0.0077 EUR) and £50 000 (0.08 EUR) towards an investment project anywhere in Wales. 0.2M EUR was allocated to biotech projects in the period 2002-2005.

The Welsh Assembly Government also has an instrument, the Knowledge Exploitation Fund (KEF), that provides financial assistance to enable Higher and Further Education Institutions in Wales to create a culture of entrepreneurship and innovation, develop the skills of staff and students within their institutions, and facilitate the transfer of knowledge to industry. This instrument is supported by EU Structural Funds. KEF has a number of sub-programmes including Collaborative Industrial Research Projects, a Patent and Proof of Concept Fund, Technology Transfer Centres and Technology Transfer Networks. The maximum grant available varies between programmes.From a total budget of 19.8M EUR in the period 2002-2005, 1.5M EUR was allocated to biotech projects.

The total funds allocated to biotechnology projects through the generic programmes of the Welsh Development Agency, the Welsh Assembly EDT and the Welsh Assembly Government amount to 13.2M EUR.

Northern Ireland

The devolved government and executive of Northern Ireland was suspended in October 2002 The Secretary of State for Northern Ireland has assumed responsibility for the direction and control of Northern Irish Departments. Programmes to support

biotechnology are administered by Invest Northern Ireland, the main economic development agency, responsible to the Ministry for Enterprise, Trade and Investment.[23] The following generic programmes provided support amounting to £12.9M (19.7M EUR) to support biotechnology research and commercialisation during the period 2002-2005:

- SMART NI provides three types of assistance to small firms. Smart Micro offers grants up to £10,000 for firms with up to 10 employees and covers 50% of eligible project costs. This can be used to fund the development of low-cost prototypes of an innovative product or process. SMART Stage 1 supports individuals and small firms to carry out technical and commercial feasibility studies. It provides grants of up to £45 000 for firms with up to 50 employees, covering a maximum of 75% of project costs. SMART Stage 2 is for SMEs that have successfully completed SMART Stage 1, and wish to develop a pre-production prototype. Grants of up to £150 000 covering 40% of eligible project costs are available to SMEs for developing new products or processes that involve significant technical advance. SMART NI allocated £2.5M (3.8M EUR) in the period 2002-05 and £0.62M (1M EUR) was allocated to biotechnology projects.
- Compete provides support for companies to develop innovative products and manufacturing processes. Phase 1 of Compete provides 50% of the costs of preparing a project definition plan, with a maximum of £15 000. Phase 2, project development work, provides up to 40% of eligible costs, up to a maximum of £250 000. In the period 2002-05 Compete allocated £18M (27.7M EUR), with biotechnology projects receiving £0.95M (1.5M EUR).
- The Start programme aims to increase the amount of industrial research undertaken by Northern Ireland based companies either on their own or in partnership with Northern Ireland universities. Grants cover 50 per cent of eligible project costs and there is no maximum project size. A typical Start project will run for three years, but can be longer or shorter if required. Projects are usually either 'company only' projects or partnership projects, involving a company and a local university (or universities) and/or another company. In the period 2002-2005, grants for biotechnology projects amounted to £3.7M (5.7M EUR).
- The RTD Centres of Excellence (CoE) programme supports the establishment of R&D Centres to stimulate leading edge, industrially exploitable and commercially focused research. It was launched in October 1994, and has resulted in the establishment of 18 centres of excellence with investments totalling £34 million (52.3 M EUR) of which 60% has been contributed through the European Regional Development Fund. In the period 2002-05 £5.55M (8.5M EUR) was allocated to CoEs in biotechnology.
- The Proof of Concept programme supports the pre-commercialisation of leading-edge technologies emerging from Northern Ireland's universities. It ran from 2003 with a budget of £5M (7.7M EUR) and the programmes is currently being reviewed. During the period 2002-2005 £1.18M (1.8M EUR) was allocated to biotechnology projects.

[23] Information about programmes on Invest NI website accessed 11 July 2006 at: http://www.investni.com/index/develop/research_and_development-3.htm

- A Knowledge Transfer Partnership brings together businesses, research bodies and recent graduates to work on mutually beneficial company-based projects that last for 1-3 years. (See section 2.3.1g above for further information). It awarded £4.3M (6.6M EUR) in the period 2002-2005, of which £0.8M (1.2M EUR) was allocated to biotechnology projects.

2.4 Charities

This section describes the main UK charities that support biotechnology research.

The Wellcome Trust's mission is to foster and promote research with the aim of improving human and animal health. The research supported by the Wellcome Trust embraces several areas of biotechnology research, such as gene therapy, stem cell research, bioethics and tissue engineering (Wellcome Trust, 2005). The Wellcome Trust uses a range of mechanisms to support this research, from research grants, including researchers at universities, to supporting specific institutes, such as the Wellcome Trust Genome Campus and Sanger Institute. In the year 2005 the Wellcome Trust's total charitable expenditure was £483M (744M EUR). Following the criteria set by the Inventory Report we estimate that the expenditure in biotechnology related research is about 20% of its total budget, meaning that for the period 2002-05, the charity spent 595M EUR.

In 2002, the Imperial Cancer Research Fund (ICRF) and the Cancer Research Campaign (CRC) which both supported biotechnology related research in the health area, merged to become Cancer Research UK. The Cancer Research UK portfolio covers the following areas of research: biology, causes and prevention of cancer, advanced diagnostic and prognostic techniques, clinical studies of new therapies and trials of new anti-cancer drugs, covering a broad spectrum of cancer types. Following the same criteria set by the Inventory Report we estimate that for the period 2002-2005 Cancer Research UK has allocated about 10% of its total budget (i.e. £216M for 2005) to biotechnology related research, which amounts to 133M EUR for the whole period.

The British Heart Foundation supports research into the causes, prevention, diagnosis and treatment of diseases of the heart and circulation through basic science lectureships, fellowships, programme grants, special projects and project grants. Again, following the same criteria set by the Inventory Report we estimate that the British Heart Foundation allocates 10% of its budget (£50M for the year 2005) to biotechnology related research, which amounts to 30M EUR for the period 2002-05.

2.5 Participation in 6th FP and use of development funds

Table 2.4 Involvement of UK in biotechnology/life sciences programmes of the 6th Framework Program

Sixth Framework Programme	Participation as project manager in # of projects (% of total)	Participation as member of the project team (% of total)
Nanobio	1 (8.3)	9 (8.5)
Life Sciences for Health	109 (14.4)	1274 (14.9)

Food Quality and Safety	18 (2.0)	292 (18.3)

Source: BioPolis Research

UK acted as the coordinator of 128 European Commission 6th Framework Programme projects: it was coordinator of 109 projects in the Life Sciences for Health thematic priority, 1 project in Nanobio and 18 projects in the Food Quality and Safety. It provided nine partners to projects under the Nanobio thematic priority, 1274 partners to Life Sciences for Health, and 292 partners to Food Quality and Safety. UK participation is just above its demographic weight compared to EU total population in the Life Sciences for Health programme and for the number of partners in the Food Quality and Safety programme. Representation is below average in the Nanobio programme and in managing Food Quality and Safety projects.

3. Performance Indicators

3.1 Introduction

This chapter analyses the performance of the UK biotechnology innovation system for two or three time periods (depending on data availability) as shown by a range of indicators for scientific and commercialisation performance. Each time period includes several years, to avoid capturing erratic trends. National trends are benchmarked against the performance of the EU25 Member States and the US.[24]

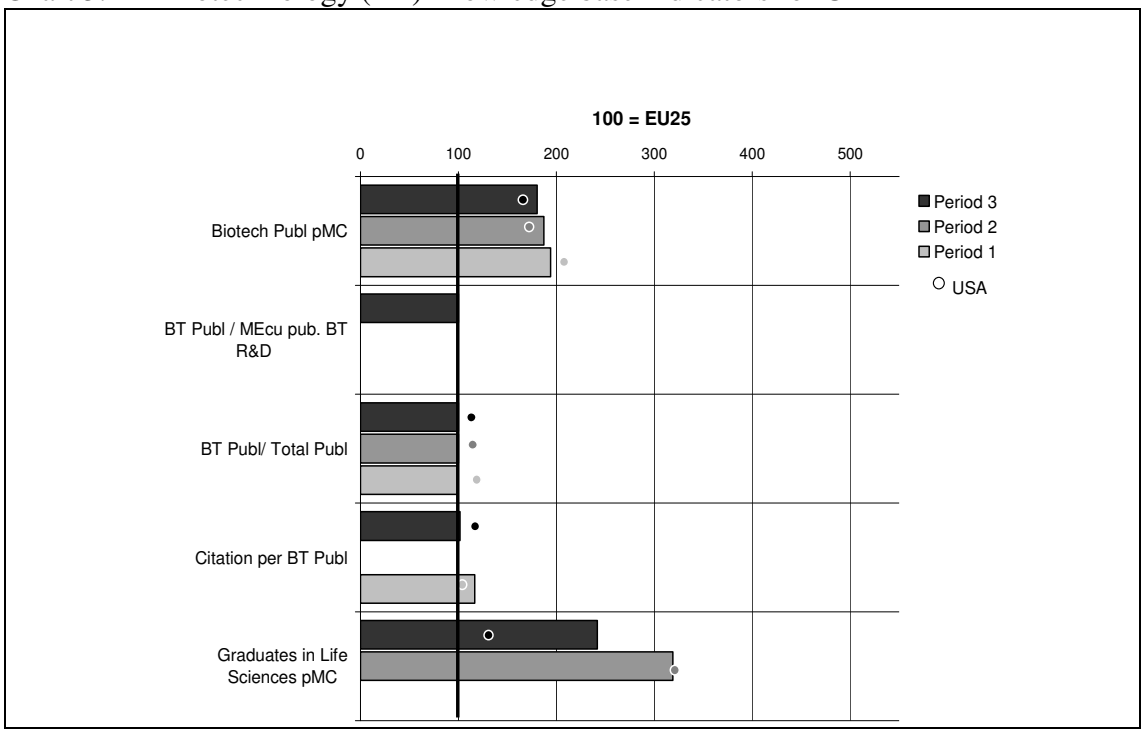
The presentation of performance is structured along the four main areas of the Innovation System: the knowledge base, processes of knowledge transmission and application, industrial development and markets for biotechnology based products. For each area a comparison of a number of different indicators for UK, the USA and EU25 is shown. To establish a comparison, the values of EU25 have been chosen as a reference for each indicator. The absolute figures that are used to calculate the values for the indicators presented in this chapter and the sources for the data can be found in Annex 5. The periods chosen can vary considerably between the indicators; table A.5.1 presents the specific years of each period for each indicator.

3.2 Creating a knowledge base and supporting the availability of human resources

As Chart 3.1 shows, UK is well above the EU-25 average for most of the biotechnology knowledge base indicators, with the exception of the ratio of biotechnology publications to total publications and the quality of its publications (as measured by citations to biotech publications) for which UK is close to the average. UK remains very well positioned regarding its performance in the generation of biotechnology publications, and performs particularly well in relation to the availability of graduates in life sciences per million capita, being more than double that of the European average and almost double the US figure.

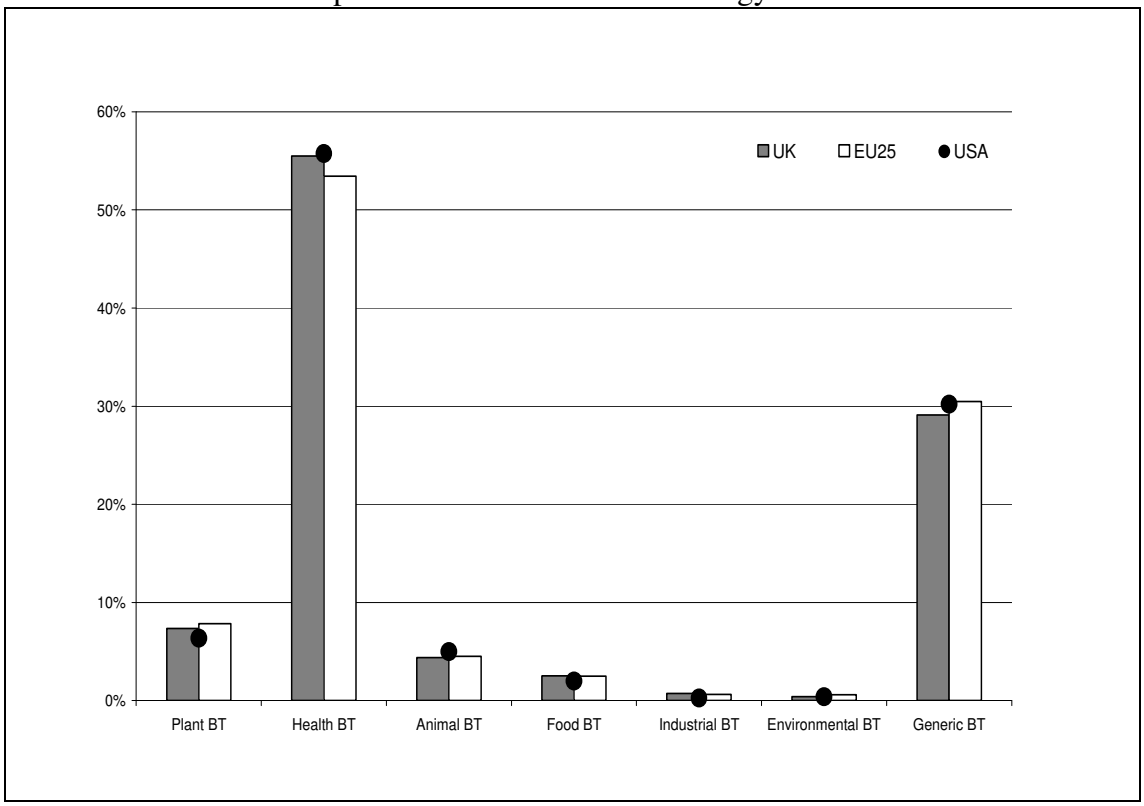
[24] For a detail discussion on the strengths and limitations of science and technology indicators see Moed et al (2004).

Chart 3.1 Biotechnology (BT) knowledge base indicators for UK



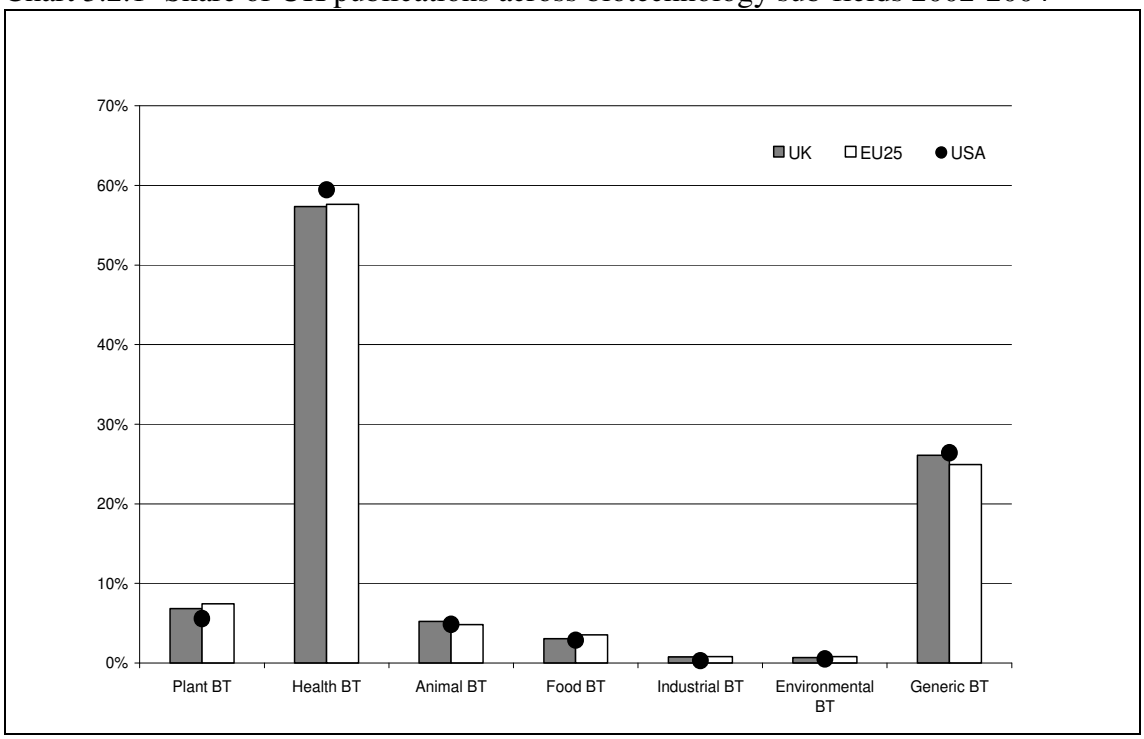
Source: BioPolis Research

Chart 3.2.1 Share of UK publications across biotechnology sub-fields 1994-1996



Source: BioPolis Research

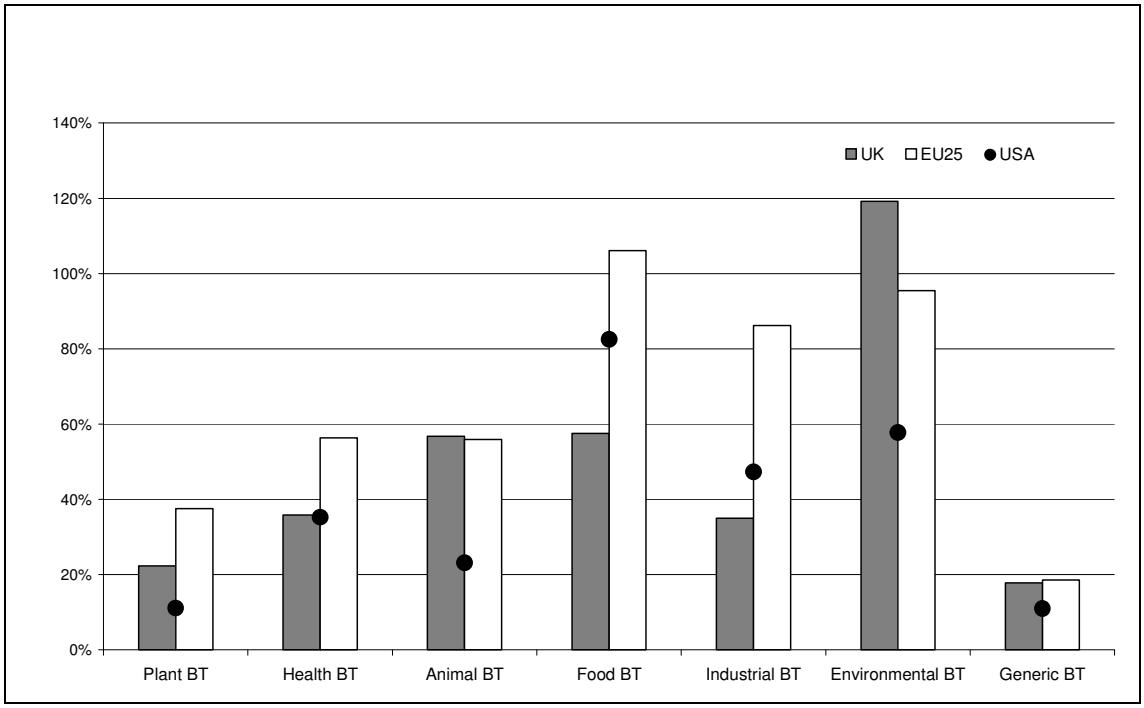
Chart 3.2.1 Share of UK publications across biotechnology sub-fields 2002-2004



Source: BioPolis Research

Charts 3.2.1 and 3.2.2 show UK performance by sub-field in two different periods, 1994-1996 and 2002-2004 with health and generic biotechnology accounting for the largest shares in both periods. As shown in Chart 3.4, there has been an increase in UK biotech publications in each sub-field, with the most dramatic rise in environmental biotechnology (119%). With the exception of animal, environmental and generic biotech, UK has a lower growth rate than the EU-25 average in most other fields.

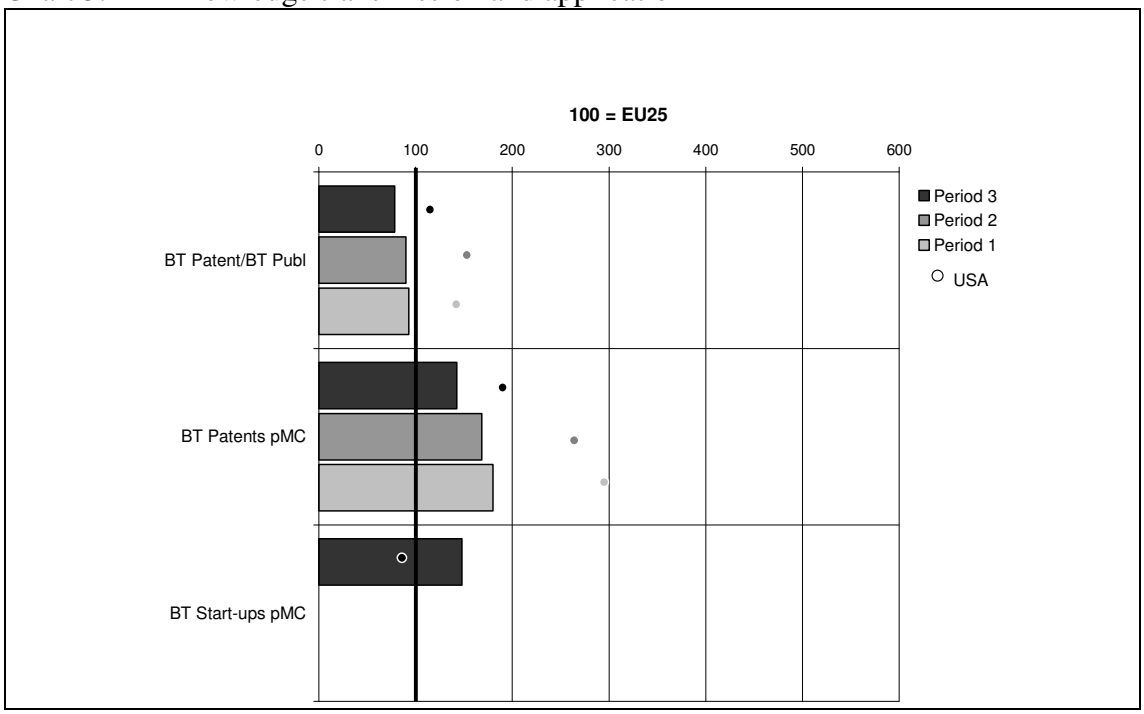
Chart 3.3 Biotechnology subfields: growth rates of UK publications between 1994/96 and 2002/04



Source: BioPolis Research

3.3 Performance in knowledge transmission and application

Chart 3.4 Knowledge transmission and application



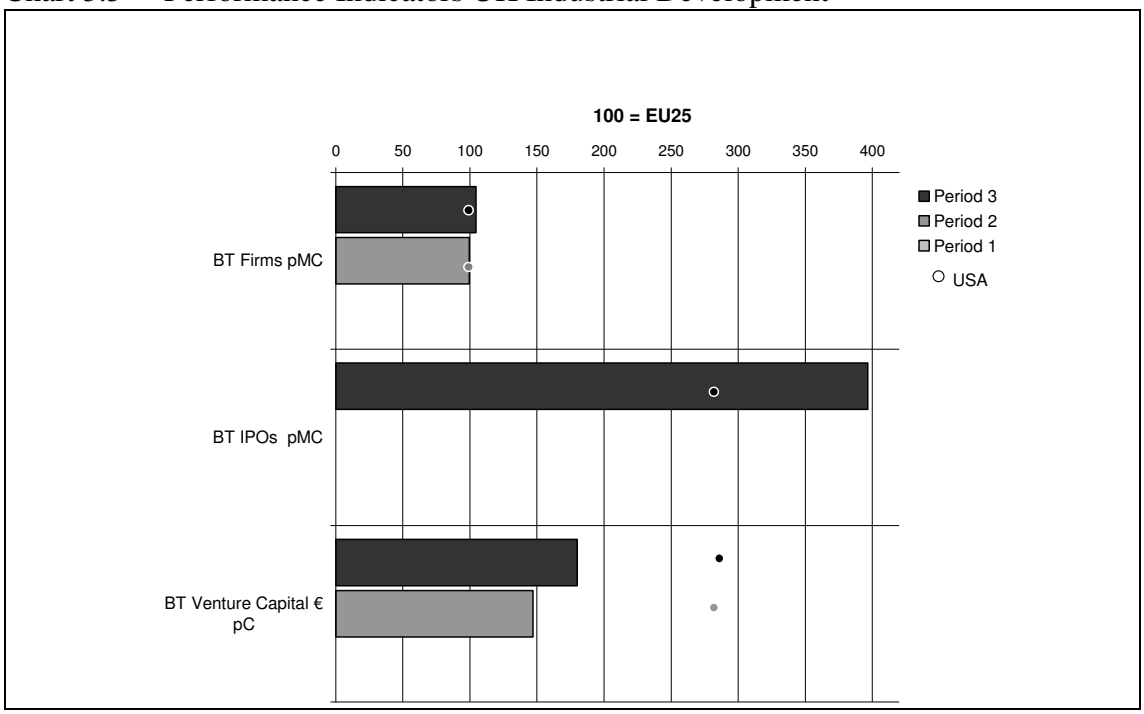
Source: BioPolis Research

Chart 3.5 shows that UK is above average in biotech patents per million capita and in biotech start-ups. However, both biotech patents per publication and per million capita display a decreasing trend over time.

3.4 Industrial development

Chart 3.6 shows that UK industrial development indicators are above the EU-25 average, with the exception of biotech firms per million capita (where UK is at the average). Venture capital per million capita has shown a very sharp increase in trend since 2001 but is still below US performance.However, the index for the number of biotech companies launched on the Stock Exchange (IPOs) is very high, and well above the US.

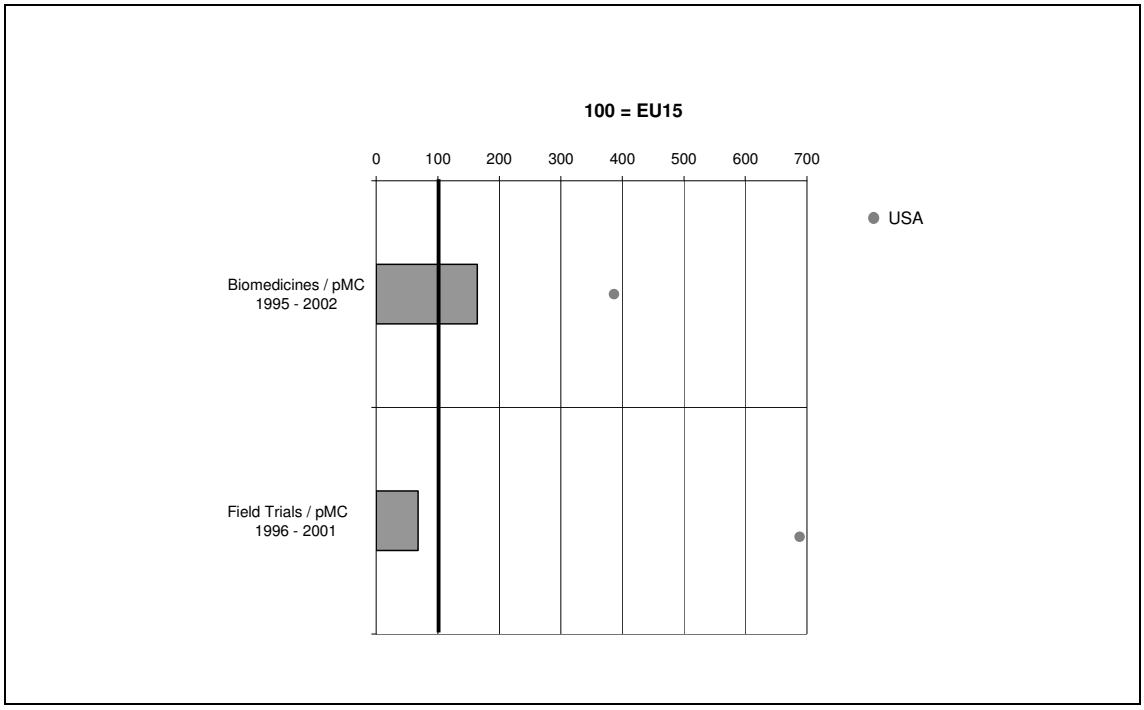
Chart 3.5 Performance Indicators UK Industrial Development



Source: BioPolis Research

3.5 Market conditions

Chart 3.6 Performance Indicators UK Market Conditions



Source: BioPolis Research

Regarding market condition indicators, the number of bio-medicines approved by the European Agency for the Evaluation of Medicinal Products (EMEA), that originated in UK per million capita is above the EU-25 average - for which the index has been set at 100. However, with an index of 68 for field trials of GM crops, the UK is well below the EU-25 average.

4. Conclusions

4.1 Introduction

The chapter contains tables that summarise information about UK's funding of biotechnology, in terms of the types of policy instruments used, the policy goals addressed, the research applications areas funded and the activities that are stimulated.

4.2 Public funding of biotechnology through policy instruments

Table 4.1 shows that public funding of biotechnology research and commercialisation through non-directed and directed policy instruments in the period 2002-05 amounted to 1443.5M EUR. It is possible only to present the total public funds this period, as information on the breakdown by year was not available. Policy-directed instruments account for more than 80% of this funding, with the majority (almost 70%) being allocated through biotech specific instruments. About 11% of policy-directed funding can be classified as supporting commercialisation activities. In this table, "Other" refers to funding for research to improve the social acceptance of biotechnology or connected to bio-safety or risk assessment. This research was allocated 2.4% of total funding for biotechnology research. Non-policy-directed instruments account for less than one fifth of total funding.

Table 4.1 Public funding of biotechnology through non-policy-directed and policy-directed instruments in the period 2002-2005 (in M EUR)

	2002	2003	2004	2005	Total
RESEARCH					
1. *Non-policy-directed*					
Public Research Institutions	**---**	**---**	**---**	**---**	244.8*
Response Mode	**---**	**---**	**---**	**---**	149.8
Total					**394.6**
2a. *Policy-directed Generic*					
National	---	---	---	---	227.5
Regional	---	---	---	---	39.1
Total					**266.6**
2b. *Policy-directed Biotech-specific*					
National	---	---	---	---	539.4
Regional	---	---	---	---	45.9
Total	---	---	---	---	**585.3**
COMMERCIALISATION					
1a. *Policy-directed Generic*					
National	---	---	---	---	20.9
Regional	---	---	---	---	30.9
Total					**51.8**
1b. *Policy-directed Biotech-specific*					
National	---	---	---	---	108.1
Regional	---	---	---	---	2.6
Total	---	---	---	---	**110.7**
OTHER					
1a. *Policy-directed Generic*					
National	-	-	-	-	-
Regional	-	-	-	-	-

	2002	2003	2004	2005	Total
Total	-	-	-	-	-
1b. *Policy-directed Biotech-specific*					
National	-	-	-	-	34.5
Regional	-	-	-	-	-
Total					**34.5**
GRAND TOTALS	---	---	---	---	**1443.5**

*including 77.8M EUR for regionally funded institutes
Source: BioPolis Research

4.3 Specific features of the instruments

Table 4.2 provides further information about the organisations responsible for specific instruments, the recipients of grants, and the proportion of the grants provided by public authorities.

Table 4.2 Participants/recipients and co-financing requirements of policy-directed programs that fund biotech activities in the period 2002-2005

Instrument	Funding agency	Participants/ Recipients			Financial contribution required (%)	
		PROs	SMEs	LFs	Recipients	Other public authorities
National						
Generic						
Studentships & Fellowships	BBSRC	√				
Response Research Grants	BBSRC	√				
Commissioned Research	DEFRA	√				
Faraday Partnerships	DTI	√	√	√		
LINK	DTI/BBSRC/NERC/EPSRC/MRC/ DeFRA	√	√	√	√	
TCS-KTP	DTI	√	√	√	√	
Biotech specific						
Special Initiatives	BBSRC/MRC/ NERC	√				
Sponsored-Institutes - CSG	BBSRC	√				
GMO Programme	DEFRA	√				
Genetics for NHS	DoH	√				
Bio-Wise	DTI	√	√	√		
BEP Challenge	DTI	√			√	
MfBI	DTI	√	√		√	
Harnessing Gen-Beacons	DTI		√	√		
Harnessing Gen-Others	DTI		√	√		
Harnessing Gen-GKPs	DTI/DoH	√				
BMI Challenge	DTI		√	√	√	
IRCs	MRC/	√				

Instrument	Funding agency	Participants/ Recipients			Financial contribution required (%)	
		PROs	SMEs	LFs	Recipients	Other public authorities
	EPSRC/BBSRC					
Research Centres	ESRC	√				
Regional						
Generic						
Flexible Fund	SEERAD	√				
SMART Scotland	ETLLD		√		√	
SPUR	ETLLD		√		√	
SPUR Plus	ETLLD		√		√	
SCORE	ETLLD	√	√		√	
Proof of Concept	Scottish Enterprise	√				
Enterprise Fellowships	Scottish Enterprise	√				
SCIS	Scottish Enterprise		√		√	
SMART - Cymru	WDA		√		√	
TEP	WDA		√		√	
Technium	WDA		√			
CETIC	WDA	√				
RSA Assembly Innovation Grants	Welsh Assembly		√			
RSA Cymru Wales	Welsh Assembly		√	√		
KEF	Welsh Assembly	√				
Smart NI	Invest NI		√		√	
Compete	Invest NI		√		√	
START	Invest NI	√	√	√	√	
Proof of Concept	Invest NI	√				
Centres of Excellence	Invest NI	√	√	√		
KTP	Invest NI	√	√	√	√	
Biotech specific						
Life Sci. Advisory Serv.	Scottish Enterprise		√	√		
ITI Life Sciences	Scottish Enterprise	√	√	√		
PREBIO	Scottish Enterprise	√				
Talent Scotland Life Sciences	Scottish Enterprise	√	√	√		

Source: BioPolis Research

4.4 Policy goals

Table 4.3 shows the policy goals that are covered by directed instruments and funding by policy goal for the period 2002-2005. The majority of funding is allocated to achieving a high level of biotechnology research. Regional players are responsible for the majority of funding of commercialisation instruments, especially firm creation and industrial investment in research. National instruments focus on the adoption of biotechnology for new industrial applications, an area neglected by the regions.

Table 4.3 Coverage of policy goals and funding by goal by policy-directed instruments in the period 2002-2005 (in M EUR)

	1*	2	3	4	5	6	7	8	9	10
National										
Generic										
Studentships & Fellowships	√			√						
Responsive Research Grants	√		√	√						
Commissioned research	√	√								
Faraday Partnerships	√	√	√		√	√			√	
LINK		√			√					
TCS-KTP		√		√	√				√	
Total	104.4	35.2	40.8	47.1	16.9	1.2	0.0	0.0	2.8	0.0
Biotech specific										
Special Initiatives BBSRC	√	√	√	√	√					
Sponsored-Institutes - CSG	√	√								
GMO Programme										√
Genetics for NHS (except Harnessing Gen)		√		√	√	√		√		√
Bio-Wise						√			√	
BEP Challenge					√					
MfBI				√		√				
Harnessing Gen	√	√	√		√	√		√	√	
BMI Challenge							√			
IRCs	√		√	√						
Research Centres			√	√				√		√
Special Initiatives MRC	√		√	√						
Stem Cell Initiative	√		√		√					
Special Initiatives NERC	√									
Total	212.8	129.8	110.1	86.8	72.3	26.9	2.5	14.0	6.4	20.5
Regional										
Generic										
Flexible Fund	√	√								
SMART Scotland							√		√	
SPUR									√	
SPUR Plus		√							√	
SCORE					√				√	
Proof of Concept Programme		√			√		√			

	1*	2	3	4	5	6	7	8	9	10
Enterprise Fellowships							√			
SCIS									√	
SMART–Cymru							√		√	
TEP					√		√		√	
Technium							√			
CETIC					√					
RSA Assembly Innovation Grants							√		√	
RSA Cymru Wales							√		√	
Knowledge Exploitation Fund					√					
Smart NI							√		√	
Compete							√		√	
START					√				√	
Proof of Concept					√		√			
Centres of Excellence		√								
KTP-NI				√	√					
Total	4.9	32.6	0.0	0.6	9.0	0.0	8.5	0.0	13.4	0.0
Biotech specific										
Life Sciences Advisory Service					√		√			
ITI Life Sciences		√								
PREBIO				√						
Talent Scotland Life Sciences				√						
Total	0.0	46.0	0.0	0.9	1.6	0.0	0.5	0.0	0.5	0.0
Grand Total	322.1	243.6	150.9	135.4	99.8	28.1	11.5	14.0	23.1	20.5
% of Grand Total	30.7	23.2	14.4	12.9	9.5	2.7	1.1	1.3	2.2	1.9

* 1 = High level of biotechnology research
2 = High level of industry-oriented (and applied) research
3 = Knowledge flow and collaboration among scientific disciplines
4 = Availability of human resources
5 = Transmission of knowledge from academia to industry and its application to industrial resources
6 = The adoption of biotechnology for new industrial applications
7 = Firm creation
8 = Social acceptance of biotechnology
9 = Business investment in R&D
10= Bio-safety, Risk assessment

Source: BioPolis Research

4.5 Biotech research application areas

Table 4.4 shows the application areas of biotechnology funded by each policy instrument as far as this information was provided. Health biotechnology and basic biotechnology research receive the majority of this funding; They are followed by environmental, animal and plant biotechnology which, however, lag far behind.

Table 4.4 Coverage of biotech application areas and funding through policy-directed instruments by biotech application research area in the period 2002-2005 (in M EUR)

	Biotech application areas								
	1*	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
National									
Generic									
Studentships & Fellowships	√	√	√	√	√	√	√		
Responsive Mode Grants	√	√	√	√	√	√	√		
Commissioned Research	√	√				√		√	
Faraday Partnerships	√		√		√	√			
LINK	√	√	√	√					
TCS-KTP		√	√	√	√	√	√		
Total	39	56.2	19.6	44.3	35.8	19.9	33.5	0.1	0.0
Biotech specific									
Special Initiatives - BBSRC	√		√				√		
Sponsored-Institutes - CSG	√	√	√	√			√		
GMO Programme			√						
Genetics for NHS				√				√	√
Bio-Wise			√						
BEP Challenge									√
MfBI				√					
Harnessing Gen				√		√		√	
BMI Challenge				√					
IRCs				√					
ESRC Research Centres								√	
Special Initiatives - MRC				√			√		
Special Initiatives - NERC	√		√						√
Total	44.4	33.6	76.4	231.0	0.0	1.8	235.7	31	28.1
Regional									
Generic									
Flexible Fund	√	√	√						
Proof of Concept Programme	√	√	√	√	√	√	√		
Enterprise Fellowships		√	√	√					
Proof of Concept				√					
Centres of Excellence				√					
Total	4.5	4.3	4.8	19.7	0.6	4.1	0.5	0.0	0.0
Biotech specific									
Life Sciences Advisory Service									√
ITI Life Sciences				√					
PREBIO									√
Talent Scotland Life Sciences									√
Total	0.0	0.0	0.0	46.0	0.0	0.0	0.0	0.0	2.5
Grand Total	87.9	94.1	100.8	341.0	36.4	25.8	269.7	31.1	30.6

Note: The total budget for application areas differs from the Policy Goals budget because information was not available for the distribution of the budget across application areas for the following regional instruments: SCIS, SMART–Cymru, SMART NI, SMART Scotland, SPUR, SPUR Plus, Score, RSA Assembly Innovation Grants RSA Cymru Wales Grants, TEP, Technium, CETIC, Compete, START and KTP-NI

*1 = Plant biotechnology 6 = Industrial biotechnology

2 = Animal biotechnology
3 = Environmental biotechnology
4 = Health biotechnology
5 = Food biotechnology
7 = Basic biotechnology
8 = Ethical, legal, social aspects of biotechnology
9 = General (research relevant to several areas)

Source: BioPolis Research

4.6 Stimulation of biotech activities through the instruments

Table 4.5 shows the type of activities that were stimulated for the period 2002-2005 through the various policy-directed instruments. There are many activities that can be stimulated by policy instruments, mentioned below the table. Table 4.5 shows only the activities that were stimulated by British policy instruments in the period.

Table 4.5 Coverage and funding of biotech activities in the period 2002-2005 through policy-directed instruments (in M EUR)

	Biotechnology Activities																		
	1*	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
National																			
Generic																			
Studentships & Fellowships	√	√																	
Responsive Research Grants	√	√																	
Commissioned Research	√	√																	
Faraday Partnerships					√			√											
LINK Programme	√	√						√									√		
TCS-KTP							√	√											
Biotech specific																			
Special Initiatives – BBSRC	√	√		√	√														
Sponsored-Institutes - CSG	√	√	√																
GMO Programme	√	√																	
Genetics for NHS			√	√		√													
Bio-Wise		√								√						√			√
BEP Challenge										√		√					√		
MfBI						√													
Harnessing Gen-Beacons	√	√																	
Harnessing Gen-Others						√													
Harnessing Gen-GKPs											√								
BMI Challenge													√		√				
IRCs		√		√	√														
Research Centres			√																√
Special Initiatives – MRC	√	√		√	√														
Special Initiatives - NERC	√	√																	
Regional																			

	Biotechnology Activities																		
	1*	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Generic																			
Flexible Fund	√	√																	
SMART Scotland													√				√		
SPUR																	√		
SPUR Plus																	√		
SCORE								√											
Proof of Concept Programme		√																	
Enterprise Fellowships													√	√					
SCIS																	√		
SMART – Cymru																	√		
TEP													√					√	
Technium														√	√				
CETIC			√																
RSA Ass. Innovation Grants													√					√	
RSA Cymru Wales													√					√	
Knowledge Exploitation Fund							√	√		√		√							
Smart NI																			
Compete																			
START																			
Proof of Concept																			
Centres of Excellence																			
KTP																			
Biotech specific																√			
Life Sciences Advisory Service														√					
ITI Life Sciences		√															√		
PREBIO						√													
Talent Scotland Life Sciences						√													

*Many different types of activities are supported by biotech instruments:

1 Basic research
2 Applied research
11 Science and technology park
12 Protection of IPR in public research organisations

3 Centres of excellence
4 Research network
5 Mobility of researchers among disciplines
6 Biotechnology training
7 Mobility of researchers between academia and industry
8 Collaborative research between industry and public research organisations
9 Set up research institute/centre of industrial interest
10 Technology transfer office

Source: BioPolis Research

13 Financial support for start-ups
14 Non-financial support for start-ups
15 Creation of incubators
16 Awareness of biotech by companies not yet active in it.
17 Grants for industrial research
18 Other incentives for business investment
19 Support for public discourse activities

4.7 Dynamics: comparison with 1994-1998

Table 4.6 compares research funding in the period 2002-2005 (for non-policy-directed and policy-directed instruments, but excluding expenditure on instruments to support commercialisation) with data gathered for the Inventory report (Enzing et al, 1999). It indicates lower annual funding for biotechnology research in UK during the recent period than during 1994-98. However, comparison between the two periods must be treated with great caution because there were major differences in the criteria for data gathering in the two periods. In the former period, the major funder of biotechnology research in the UK, BBSRC, was treated as if its total research funding fell in the field of biotechnology (See Enzing et al, 1999, Vol. 3, p. UK-21). During the recent period, the contact in BBSRC provided data only for research that focuses exclusively on biotechnology and this amount represented approximately 33% of the funds that BBSRC allocated to research grants, core strategic grants, special initiatives, studentships and fellowships in the period. On the assumption that BBSRC actually allocated a similar proportion of its total budget to biotechnology research in the period 1994-1998,[25] average total national funding per annum in the period 1994-98 would amount to 228.6M ecus which, together with regional funding, would suggest that total annual funding for the earlier period was 249.1M ecus, and not the 428.2M ecus shown in Table 4.6. The revised figure for the earlier period suggests that annual funding of 360.9M EUR for research in the period 2002-2005 indicates growth of annual expenditure on biotechnology research over time, with the increase accounted for both by inflation and by the growth in Research Council budgets over the period (see section 1.4 above).

In both periods (i.e. 1994-1998 and 2002-2005) health biotech was the most important area of biotechnology research (accounting for 33% in the second period), followed by basic biotechnology research (which in the second period represents about 20% of research funding). In the period 1994/98 health biotechnology also accounted for the largest share while all other application areas had a relatively even distribution of funding.

Table 4.6 Comparison of biotechnology research funding through non-policy-directed funding and policy-directed instruments in the periods 1994-1998 and 2002-2005

Funding	Average total funding per annum for biotechnology research in 1994-1998	Average total funding per annum for biotechnology research in 2002-2005
National	406.8M ECU	311.8M EUR
Regional	21.4M ECU	49.1M EUR
Total	428.2M ECU*	360.9M EUR

*Using the same criteria for BBSRC's biotech funding in 1994-98 as in 2002-2005 reduces total annual funding from 428.2M ECU to 249.1M ECU
Source: BioPolis Research

[25] The Inventory Report gives an estimate of BBSRC's total funding for the period 1994-98 as 1330M ECU, or an average of 266M ECU per annum. Adding 33% of this amount (87.8M ECU) to other public sources of national and regional funding for biotechnology research results in a revised average figure of 249.1M ECU per annum, rather than the 482.2M ECU shown.

Table 4.7 compares the coverage of policy goals by policy-directed instruments in 1994-98 and 2002-2005. It shows a wide coverage of policy goals by both generic and specific instruments in both periods, and no change in coverage over time.

Table 4.7 Coverage of policy goals by policy-directed instruments in the periods 1994-1998 and 2002-2005

Presence of instruments					
Policy areas	**Policy goals**	**1994-1998**		**2002-2005**	
		G*	**S****	**G**	**S**
1. Creation of knowledge base and human resources	1. To promote high level of biotechnology basic research	√	√	√	√
	2. To promote high level of industry-oriented (and applied) research	√	√	√	√
	3. To support knowledge flow and collaboration among scientific disciplines	√	√	√	√
	4. To assure availability of human resources	√		√	√
2. Knowledge transmission and application	5. To facilitate transmission of knowledge from academia to the industry and its application for industrial purposes	√	√	√	√
	6. To stimulate the adoption of biotechnology for new industrial applications	√	√	√	√
	7. To assist firm creation	√	√	√	√
3. Market	8. To monitor and improve the social acceptance of biotechnology		√		√
4. Industrial development	9. To encourage business investment in R&D	√	√	√	√

* G = generic instruments; ** S= Biotechnology specific instruments
Source: BioPolis Research

5. Future Developments

In April 2006, the DTI created a new Office of Science and Innovation (OSI), formed by merging DTI's Innovation Group (IG) into the Office of Science and Technology (OST). The Office of Science and Innovation aims to develop further the excellence of the UK's research base, and to promote innovation by more effective co-ordination between these areas (DTI, 2006).

The Bioscience Innovation and Growth Team (BIGT) was launched in January 2003 with the mandate to formulate a strategic approach to the future of the UK's bioscience industry. It is aimed to play an important role in identifying priorities in biotechnology, and to make recommendations to the DTI on policy design. Some recommendations made so far by the BIGT are: the creation of a National Clinical Trials Agency that makes participation in NHS-based trials more effective for all constituents; to build a strong bio-processing sub-sector within UK bioscience, through a network of four bio-processing Centres of Excellence across the UK, and to foster the development of the bio-processing community (i.e. set up an annual National Bio-processing Forum); and the creation of a Bioscience Leadership Council, to take responsibility for delivering the BIGT's recommendations.

Within the Technology Programme "Succeeding Through Innovation", the DTI has allocated an amount of £10 million (15.4M EUR) to a competition for funding in the area of 'Regenerative Medicine Technologies'. This competition, which commenced in November 2005, invites proposals in a number of areas including innovative developments in bioactive materials intended for medical devices, cell-based therapies and underpinning technologies which can increase the function and efficacy of devices and therapies for regenerative medicine. The projects should be business led and science collaborator may include research institutes, universities, clinical institutions and NHS Trust. Finally, BBSRC, EPSRC and MRC have indicated that they are interested in co-funding projects where there is a significant high quality academic component (www.dti.gov.uk/technologyprogramme).

At the regional level, the Scottish Executive launched a strategy in early 2005 that was designed to help Scotland to achieve critical mass in the life sciences sector by 2020 (Scottish Executive, 2005). The strategy focuses on four main factors:

- to develop, attract and retain high quality human resources;
- to strengthen public and private funding of the sector;
- to focus on areas of competitive promise; and
- to continue to promote collaboration between the public and private sectors.

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Annex 3 List of contact people

Jim Aland, Natural Environment Research Council (NERC)

Matthew Bell, Department of Environment, Food and Rural Affairs (DEFRA)

Janet Brown, Scottish Enterprise

Douglas Brown, Scottish Executive Environment and Rural Affairs Department (SEERAD)

Anthony Cornwell, Forest Research Agency

Jo Dekkers, The Medical Research Council (MRC)

Stephen Elsby, Engineering and Physical Sciences Research Council (EPSRC)

Tim Evans, Trade & Invest in Wales, Economic Development & Transport Department of the Welsh Assembly Government.

Roisin Goodwin, Invest Northern Ireland

William Leitch, The Department of Trade and Industry (DTI)

Teresa Martin, Scottish Executive

Alex Reid, Scottish Executive

David Sherlock, Department of Environment, Food and Rural Affairs (DEFRA)

Jane Stratford, Department of Environment, Food and Rural Affairs (DEFRA)

Beverley Thomas, Biotechnology and Biological Sciences Research Council (BBSRC)

William Thomas, Natural Environment Research Council (NERC)

Paul Tomsen, Engineering and Physical Sciences Research Council (EPSRC)

Sarah Lea Turner, NERC Centre for Ecology and Hydrology

Bob Wallis, Welsh Development Agency

Annex 4 References

Agriculture and Environment Biotechnology Commission (AEBC) (2005). What shapes the research agenda in agricultural biotechnology? Information and analysis paper. London: AEBC. Accessed 7 June 2006 at: http://www.aebc.gov.uk/aebc/subgroups/ra_info_analysis_paper.pdf

BBSRC (2003). Strategic Plan 2003-2008. Updated version accessed 5 June 2006 at: http://www.bbsrc.ac.uk/about/pub/policy/bbsrc_stratplan.pdf

Bioindustry Association, DTI and Department of Health (2003). Bioscience 2015: improving national health. increasing national wealth. A report to the Government by the Bioscience Innovation and Growth Team, London, DTI accessed 15 June 2006 at: http://www.bioindustry.org/bigtreport/index2.html

Department of Health (2003). Our inheritance, our future: realising the potential of genetics in the NHS. London, Stationery Office.

DTI (2002). Investing in Innovation. A Strategy for science, engineering and technology. London, DTI, HM Treasury and Department for Education and Skills.

DTI (2003a). UK productivity and competitiveness indicators, London, DTI.

DTI (2003b). Innovation Report Competing in the Global Economy: the Innovation Challenge. London, DTI.

DTI (2004). Department of Trade and Industry – Five year programme. Creating wealth from knowledge. London, DTI.

DTI (2005). Comparative statistics for the UK, European and US Biotechnology Sectors. Analysis year 2003. Report prepared by Critical I Limited for the DTI, February 2005.

DTI (2006). Office of Science and Technology website, accessed 5 June 2006 at: http://www.ost.gov.uk/sitemap.htm

ESRC (2005). Annual Report and Accounts 2005-05. London, The Stationery Office.

EIS (2004) European Innovation Scoreboard 2004 accessed 10 May 2006 at: http://trendchart.cordis.lu/scoreboards/scoreboard2004/pdf/eis_2004.pdf

Enzing, C. et al (1999). Inventory of public biotechnology R&D programmes in Europe, 3 volumes, Luxembourg: Office for Official Publications of the European Communities.

Eurobarometer, (2005). Social values, Science and Technology, Special Edition No. 225/Wave 63.1, European Commission accessed 29 March 2006 at: http://europa.eu.int/comm/public_opinion/archives/ebs/ebs_225_report_en.pdf

HM Treasury, DTI, and Department for Education and Skills (2004). Science & Innovation Investment Framework: 2004-2014, London, July.

HM Treasury and Inland Revenue (2001). Increasing Innovation. A Consultation Paper. Budget 2001, London accessed 9 June 2006 at: http://www.hm-treasury.gov.uk./media/08D/1C/438.pdf

Knowles, L.P. (2004): "A regulatory patchwork human ES cell research oversight", Nature Biotechnology 22(2): 157-163.

Malik, K. and Cunningham, P. (2005). Annual Innovation Policy Trends and Appraisal Report United Kingdom 2004-2005. European Trend Chart on Innovation, Brussels, European Commission.

Martin, P. (1999). National Report of the United Kingdom. Inventory of public biotechnology R&D programmes in Europe. Volume 3. Luxembourg, Office for Official Publication of the European Communities.

Moed, H.F.; Glänzel, W.; Schmoch, U. (eds.) (2004): Handbook of Quantitative Science and Technology Research. The Use of Publication and Patent Statistics in Studies of S&T Systems., Dordrecht: Kluwer Academic Publishers.

Scottish Executive (2005), Scottish Life Sciences Strategy. Achieving Critical Mass, accessed 14 November 2005 at: http://www.scotland.gov.uk/library5/enterprise/slss.pdf

Senker *et al.* (2000) European Biotechnology Innovation System. UK Report. Brighton, SPRU, University of Sussex, September 2000.

Wellcome Trust (2005) Annual Report, London.

Welsh Development Agency website accessed 4 January 2006 at: http://www.wda.co.uk/index.cfm//technology_and_innovation/technology___innovation/support/developing_key_sectors/en10206

Welsh Assembly Government (2002), A Winning Wales. The National Economic Development Strategy of the Welsh Assembly Government, Economic Policy Division, National Assembly for Wales, Cardiff accessed 4 January 2006 at: http://www.wales.gov.uk/themesbudgetandstrategic/content/neds/awinningwales-0302-e.pdf

Annex 5 Performance

Introduction

This Annex includes the data that was used to develop the indicators discussed in Chapter 3. Chapter 3 describes four sets of indicators used to measure the performance of the national biotechnology system of innovation, in terms of:

1. Creating a knowledge base and supporting the availability of human resources: Charts 3.1, 3.2.1, 3.2.2 and 3.3
2. Knowledge transmission and application: Chart 3.4
3. Industrial development: Chart 3.5
4. Market conditions: Chart 3.6

The indicators aim to capture trends in performance and compare the national situation with that of a reference region. To present trends in performance, most indicators are provided for three or two different time periods, depending on data availability. To avoid capturing erratic trends, each time period includes several years, again depending on data availability. Information on which years have been captured for each period and comments concerning the index used can be found in the last two columns of Table A5.1.

Table A5.1. Performance indicators, charts, comments and time periods

	Indicator	Chart	Comments	Time periods
Ind. 1	Biotech publications per million capita (pMC)	3.1	Index: Reference Region EU25 =100 and US data for comparison	(1) 1994-1996, (2) 1998-2000, (3) 2002-2004
Ind. 2	Biotech publications per BT public R&D expenditure	3.1	Only for those countries included in the inventory Index: Reference Region EU25 =100	BT Pub. 2002-2004 / Total Pub. Expenditure 1994-1998 M Ecu
Ind. 3	BT patents / BT publications	3.4	Index: Reference Region EU25 =100 and US data for comparison	(1) 1994-1996 (2) 1998-2000 (3) 2001-2003
Ind. 4	BT publications / Total pub.	3.1	Index: Reference Region EU25 =100 and US data for comparison	(1) 1994-1996 (2) 1998-2000 (3) 2002-2004
Ind. 5	Citations to BT publications	3.1	Index: Reference Region EU25 =100 and US data for comparison Small country effect	(1) 1994-1998 (3) 2000-2004
Ind. 6	Graduates in life sciences pMC	3.1	Index: Reference Region EU17 =100 and US data for	(2) 1998 (3) 2002

	Indicator	Chart	Comments	Time periods
			comparison	
Ind. 7	BT publications in subfields, as % of total BT publications	3.2.1	Data in % EU25 and US data for comparison	1994-1996
		3.2.2		2002-2004
Ind. 8	Growth rate of BT publications in subfields	3.3	EU25 and US data for comparison Small field effect	Growth rate between 1994-96 (period 1) and 2002-04 (period 3)
Ind. 9	Biotech patent applications pMC	3.4	EU25 and US data for comparison	(1) 1994-1996 (2) 1998-2000 (3) 2001-2003
Ind. 10	Number of biotechnology companies pMC	3.5	European (data available) and US data for comparison	(2) 2001 (3) 2004
Ind. 11	Number of biotech start-ups pMC	3.4	European (data available) and US data for comparison	(3) 2001-2003 (only one period)
Ind. 12	Number of biotech IPOs pMC	3.5	European (data available) and US data for comparison	(3) 2002-2005
Ind. 13	Venture capital in € pC	3.5	European (data available) and US data for comparison	(2) 2002 (3) 2004
Ind. 14	BT acceptance index	No Chart - Discussed in text of chapter 3	Source: BT Policy Benchmarking 2005. The biotechnology acceptance index is a composite index and draws on questions Q.12, Q.13.1 and Q14.01 and Q14.09 of the Eurobarometer 58.0	2002
Ind. 15	Eurobarometer 225	No Chart - discussed in text of chapter 3	See section 3.3 and sections 3.4.1, 3.4.2, and 3.4.3 of the Special Eurobarometer 225[26]	2005
Ind. 16	Biomedicines	3.6	Source: BT Policy Benchmarking 2005 Index: Reference Region EU15 =100 US data for comparison	1995-2002
Ind. 17	Field trials	3.6	Source: Biotechnology Innovation Scoreboard 2002 Index: Reference Region EU15 =100 US data for	1996-2001

[26] http://europa.eu.int/comm/public_opinion/archives/ebs/ebs_225_report_en.pdf

	Indicator	Chart	Comments	Time periods
			comparison	

The following methodological issues are related to some of the indicators:

- Indicator 3 (Patent BT / Publications BT) replaces the indicator *BT publications basic research/ BT publications applied research*. Results of the EPOHITE project have shown that the original indicator does not differ significantly in the case of old EU member states. This might be the result of methodological problems associated with the indicator, since the definition of basic and applied research is based on a journal classification made by SCI. The explanatory power of this indicator is therefore questionable.
- To calculate the citation rate first the publications for the period 1994-1996 (set 1) were searched and all the publications in 1994-1998 that cited any publications in set 1 (set 2). Citation rate has been calculated by (number of publications in set 2) / (number of publications in set 1). However, many of the articles in set 2 cited not only one article in set 1 and these duplicated citations are not taken into account in our calculation. For example, if there are 2 articles in set 1 and they each has one citation but cited by the same article, there is only 1 article in set 2. The citation rate for the 2 articles in set 1 is 0.5 instead of 1. This depreciation is more obvious in countries with more publications such as USA and EU25 since the possibility to cite multiple articles in set 1 is large. Accordingly the citation rates of USA and EU25 are a bit underestimated.
- The indicator 'Citations to BT publications' seems to have a 'small country effect' bias. Small countries show a relatively large citation rate. A possible explanation might be that, as far as number of publications is concerned, larger countries usually have a larger 'middle quality' share of research results (in terms of impact) while smaller countries usually have a 'low in number but good in quality' publications impact. This can be explained by the concentration of resources allocated to selected research groups in small countries. Small countries may concentrate resources in outstanding research units. Accordingly, fewer publications may have greater impact.
- The EU25=100 index is applicable in the indicator 'Graduates in life sciences pMC' since data was only available for 17 member states.
- For those countries starting from zero in period 1 (1994/1996), the growth rate of BT publications in subfields was set to 100% if the number of publications in period 3 (2002-2004) was larger than zero. On the other hand, if the country reduced the number of publications to zero in the period 2002-2004, the growth rate was -100%.Given that a relative growth rate was used, small fields tended to have relatively larger growth rates.
- To benchmark each country we chose EU25 (or EU15 if data was not fully available) as the reference region. In those cases where data for EU25 or EU15 were not available, the reference corresponds to the sum of national data available. Moreover, to ease the presentation of indicators with different scales in a given chart, an index value was used.

Raw data for the Charts in chapter 3

Raw data for Chart 3.1. BT publications per million capita (pMC): absolute and indexed values

	BT publications			Population (million)		
	94-96	**98-00**	**02-04**	**1996**	**2000**	**2004**
EU25	97521	128716	145646	447	451	457
UK	24836	31849	34297	59	60	60
USA	119802	135508	154402	264	276	292
	BT publications/pMC			**Index EU25=100**		
	94-96	**98-00**	**02-04**	**94-96**	**98-00**	**02-04**
EU25	218	285	319	100	100	100
UK	423	534	575	194	187	180
USA	454	492	529	208	172	166

Source: BIOPOLIS research
Publications: Science Citation Index (SCI) (through online database vendor STN International)
Population: EUROSTAT and OECD

Raw data for Chart 3.1. BT publications per BT public R&D expenditure

	BT Publi-cations	**Non-policy-directed funding**	**Policy-directed funding**		**Total Public Spending on BT (Mecu)**	**BT Publications / Mecu BT public expenditure**	**Index**
			Biotech specific	**Generic**			
	2002-2004	**1994-1998**	**1994-1998**	**1994-1998**	**1994-1998**	**2002-2004/ 1994-1998**	
EU25	145646				n.a.		
UK	34297	1036	687.8	413.2	2137	16	100
USA	154402				n.a.		n.a.

Source: BIOPOLIS research
Publications: SCI
BT public expenditures in research: Inventory Project, Table 3.4 Executive Summary

Raw data for Chart 3.1. BT publications, as share of total publications: absolute and indexed values

	BT publications			Total publications		
	94-96	**98-00**	**02-04**	**94-96**	**98-00**	**02-04**
EU25	97521	128716	145646	860652	1024327	1117392
UK	24836	31849	34297	221618	253499	263131
USA	119802	135508	154402	889506	941191	1045894
	Share of BT publication			**Index EU25=100**		
	94-96	**98-00**	**02-04**	**94-96**	**98-00**	**02-04**
EU25	11%	13%	13%	100	100	100
UK	11%	13%	13%	99	100	100

USA	13%	14%	15%	119	115	113

Source: BIOPOLIS research
Publications: SCI

Raw data for Chart 3.1. Citations to BT publications: absolute and indexed values

	Citations to BT publications		Index EU25=100	
	94-98	00-04	94-98	00-04
EU25	6.14	7.28	100	100
UK	7.17	7.40	117	102
USA	6.39	8.54	104	117

Source: BIOPOLIS research
Citations: SCI

Raw data for Chart 3.1. Graduates in life sciences pMC: absolute and indexed values

	Graduates in Life Sciences		Population (million)	
	1998 / 1999	2002	1998 / 1999	2002
EU17	46,859**	81,316	552**	431
UK	16015*	26991	59*	59
USA	75,253*	70,950	276*	288
	Graduates pMC		Index EU17=100	
	1998 / 1999	2002	1998 / 1999	2002
EU17	85**	189	100	100
UK	271*	456	319	242
USA	273*	246	321	131

Index EU17=100 for 1998 is EU-16, because for Portugal no data available
* data for 1998; ** data for 1999
Source: BioPolis Research
OECD Education Database
Population source for US OECD

Raw data for Chart 3.2.1. BT publications in subfields, as share of total number of BT publications for the period 1994-1996

	1994-1996							
	Total	Plant	Health	Animal	Food	Indus-trial	Environ-mental	Generic
EU25	100%	8%	53%	5%	3%	1%	1%	30%
UK	100%	7%	55%	4%	3%	1%	0%	29%
USA	100%	6%	56%	5%	2%	0%	0%	30%

Source: BioPolis Research
Publications: SCI

Raw data for Chart 3.2.2. BT publications in subfields, as share of total number of BT publications for the period 2002-2004

	2002-2004							
	Total	**Plant**	**Health**	**Animal**	**Food**	**Indus-trial**	**Environ-mental**	**Generic**
EU25	100%	7%	58%	5%	4%	1%	1%	25%
UK	100%	7%	57%	5%	3%	1%	1%	26%
USA	100%	6%	59%	5%	3%	0%	1%	26%

Source: BioPolis Research
Publications: SCI

Raw data for Chart 3.2.1. BT publications in subfields for the period 1994-1996

	1994-1996							
	Total	**Plant**	**Health**	**Animal**	**Food**	**Indus-trial**	**Environ-mental**	**Generic**
EU25	97217	7629	51944	4375	2434	624	576	29635
UK	24822	1826	13770	1088	629	180	104	7225
USA	111686	7118	62274	5580	2230	296	459	33729

Source: BioPolis Research
Publications: SCI

Raw data for Chart 3.2.2. BT publications in subfields for the period 2002-2004

	2002-2004							
	Total	**Plant**	**Health**	**Animal**	**Food**	**Indus-trial**	**Environ-mental**	**Generic**
EU25	140984	10494	81220	6821	5017	1162	1126	35144
UK	32617	2233	18702	1706	991	243	228	8514
USA	141680	7910	84234	6872	4070	436	724	37434

Source: BioPolis Research
Publications: SCI

Raw data for Chart 3.3. Growth rate of BT publications in subfields between 1994-96 and 2002-04

	1994-1996/2002-2004						
	Plant	**Health**	**Animal**	**Food**	**Industrial**	**Environ-mental**	**Generic**
EU25	38%	56%	56%	106%	86%	95%	19%
UK	22%	36%	57%	58%	35%	119%	18%
USA	11%	35%	23%	83%	47%	58%	11%

Source: BioPolis Research
Publications: SCI

Raw data for Chart 3.4. BT Patents pMC: absolute and indexed values

	BT patents			Population (million)		
	94-96	**98-00**	**01-03**	**1996**	**2000**	**2003**
EU25	4924	8921	10119	447	451	455
UK	1164	1986	1883	59	60	59
USA	8590	14396	12348	264	276	292*
	BT patents/pMC			**Index**		
	94-96	**98-00**	**01-03**	**94-96**	**98-00**	**01-03**
EU25	11	20	22	100	100	100
UK	20	33	32	180	168	143
USA	33	52	42	295	264	190

Source: BioPolis Research
Publications: SCI
Patents: Questel Orbit

Raw data for Chart 3.4. BT Patents per BT publications: absolute and indexed values

	BT patents			BT publications		
	94-96	**98-00**	**01-03**	**94-96**	**98-00**	**01-03**
EU25	4924	8921	10119	97521	128716	140219
UK	1164	1986	1883	24836	31849	33306
USA	8590	14396	12348	119802	135508	148853
	BT patents/ BT publications			**Index EU25=100**		
	94-96	**98-00**	**01-03**	**94-96**	**98-00**	**01-03**
EU25	0,05	0,07	0,07	100	100	100
UK	0,05	0,06	0,06	93	90	78
USA	0,07	0,11	0,08	142	153	115

Source: BioPolis Research
Publications SCI
Patents Questel Orbit

Raw data for Chart 3.5. Number of BT companies pMC for the period 2001-2004: absolute and indexed values

	BT companies				Population in T			
	2001	**2002**	**2003**	**2004**	**2001**	**2002**	**2003**	**2004**
Europe	1879	1878	1861	1815	452016	452641	454580	456863
EU Available	1643	1650	1782	1605	319337	319484	408602	322210
UK	306	331	334	311	59863	59140	59329	59673
USA	1457	1472	1473	1444	285102	287941	290789	291685
	BT companies pMC				**Index**			
	2001	**2002**	**2003**	**2004**	**2001**	**2002**	**2003**	**2004**
Europe								
EU Available	5	5	4	5	100	100	100	100
UK	5.115	5.597	5,63	5,212	99	108	129	105
USA	5.11045	5.1122	5.0655	4.9505	99	99	116	99

Note: EU Available is the result of the sum of available EU member states
Source: BioPolis Research

Biotech companies: E&Y Beyond Border 2002, 2003, 2004, 2005; EuropaBio

Raw data for Chart 3.5. BT start-ups pMC for the period 2001-2003 and year 2003: absolute and indexed values

	BT start-ups		Population in T	
	2001-2003	2003	2003	
Europe (EU 15 - Cyprus - Greece + Norway + Switzerland)	523	132	367051	
UK	125	36	59329	
USA	355	83	290789	
	Biotech start-up/pMC	Index	Biotech start-up/pMC	Index
	2001-2003	2001-2003	2003	2003
Europe (EU 15 - Cyprus - Greece + Norway + Switzerland)	1,4	100	0,36	100
UK	2,1	148	0,61	169
USA	1,2	86	0,29	79

Source: BioPolis Research
Start-ups: EuropaBio

Raw data for Chart 3.5. Number of BT IPO's pMC: absolute and indexed values

	BT IPO	Population T				
	2002-2005	2002	2003	2004	2005	2002-2005
EU Available	29	452927	454869	457154	461593	456636
UK	15	59140	59329	59673	60035	59544
USA	52	287941	290789	291685		290138

	IPO /pMC	Index
	2002-2005	2002-2005
EU Available	0.00	100
UK	0.00	397
USA	0.00	282

Note: EU Available is the result of the sum of available EU member states
IPO data: Ernst and Young 2002-2006, London Stock Exchange, Frankfurt Stock Exchange, Euronext, Nasdaq, Burril & Company
Source: BIOPOLIS Research

Raw data for Chart 3.5. Venture capital pC: absolute and indexed values

	Venture capital in biotechnology companies M EUR			Population in T		
	2002	2002	2002	2002	2003	2004
Europe	1100	920	2800			
EU Available	890	883	1111	315584	319663	325131
UK	245	263	367	59140	59329	59673

USA	2288	2498	2855	287941	290789	291685
	Venture capital in EUR/pC			**Index**		
	2002	**2003**	**2004**	**2002**	**2003**	**2004**
Europe						
EU Available	2,8	2,8	3,4	100	100	100
UK	4	4	6	147	160	180
USA	8	9	10	282	311	286

Source: BioPolis Research
VC data: E&Y Beyond Borders 2002, 2003, 2004, 2005

Raw data for Chart 3.6. Number of Biomedicines pMC

	Biomedicines	**Population (Million)**	**Biomedicines / pMC**	**Index**
	1995-2002	**2002**		**1995-2002**
EU15	39	378	0,10	100
UK	10	59	0.17	164
USA	115	289	0,40	387

Note: EU 15 is the result of the sum of the 15 old EU member states
Source: BioPolis Research
Number of medicines: Benchmarking of public biotechnology policy 2005

Raw data for Chart 3.6. Number of field trials pMC

	Field trials	**Population in M**	**Field Ttials pMC**	**Index**
	1996-2001	**2001**	**1996-2001**	**1996-2001**
EU15	1334	379	4	100
UK	144	60	2	68
USA	6745	278	24	688

Note: EU 15 is the result of the sum of the 15 old EU member states
Source: BioPolis Research
Field trials: Biotechnology Innovation Scoreboard 2002

Raw data for biotechnology acceptance. Data are mentioned in the text of Chapter 3.

BT acceptance index 2002		
	Index average	**N (sample size)**
EU - 15*	100,29	16828
UK**	98.11	1001

*Weighted Average according to the weight "W13" of the Eurobarometer 58.2, which considers population differences among countries and corrects for inconsistencies in the national samples
** Without North Ireland
Source: BioPolis Research
BT acceptance index: Benchmarking of public biotechnology policy 2005

References:

Biotechnology Innovation Scoreboard 2002 (2002), European Commission Enterprise DG. http://194.78.229.48/extranettrend/reports/documents/report7.pdf, accessed 1/6/2005.

Enzing, C.M. et al. (1999): Inventory of Public Biotechnology R&D Programmes in Europe, Luxembourg: Office for Official Publications of the European Communities.

Ernst & Young (2002, 2003, 2004) Beyond Borders - The Global Biotechnology Report, Cambridge, Ernst & Young Global Health Sciences.

Reiss, T. et al. (2005) Benchmarking of public biotechnology policy 2005, European Commission Enterprise DG. http://europa.eu.int/comm/enterprise/phabiocom/comp_biotech_comp.htm, accessed 1/6/2005

Websites:

London Stock Exchange	http://www.londonstockexchange.com/
Frankfurt Stock Exchange	http://deutsche-boerse.com/
Euronext	http://www.euronext.com/
Nasdaq	http://www.nasdaq.com/
Burrill & Company	http://www.burrillandco.com/
EuropaBio	http://www.europabio.org/
EUROSTAT	http://epp.eurostat.cec.eu.int/
OECD Education Database	http://www.oecd.org/
OECD Statistics	http://www.oecd.org/
STN International	http://www.stn-international.de/
Questel Orbit	http://www.questel.orbit.com/index.htm

Annex 6 Abbreviations

BBSRC	Biotechnology and Biological Sciences Research Council
BEP	Biotechnology Exploitation Platform
BIGT	Innovation and Growth Team
BMI	Biotechnology Mentoring and Incubator
CEH	Centre for Ecology and Hydrology
CETIC	Centres of Excellence for Technology and Industrial Collaboration
CSG	Core Strategic Grants
DARDNI	Department of Agriculture and Rural Development Northern Ireland
DEFRA	Department of Environment, Food and Rural Affairs
DfES	Department of Education and Skills
DFID	Department for International Development
DoH	Department of Health
DTI	Department of Trade and Industry
EPSRC	Engineering and Physical Sciences Research Council
ETLLD	Executive Enterprise, Transport and Lifelong Learning Department
GKPs	Genetics Knowledge Parks
HEFCE	Higher Education Funding Council for England
HEI	Higher Education Institution
HEIF	Education Innovation Fund
HFEA	Human Fertilization and Embryology Act
ICRF	Imperial Cancer Research Fund
IGTs	Innovation and Growth Teams
IP	Intellectual property
IRCs	Interdisciplinary Research Collaborations
ITI	Intermediate Technology Institute
KEF	Knowledge Exploitation Fund
KTN	Knowledge Transfer Networks
KTP	Knowledge Transfer Partnerships
MfB	Manufacturing for Biotechnology Initiative
MoD	Ministry of Defence
MRC	Medical Research Council
MRCT	MRC-Technology
n.a.	Not available
NERC	Natural Environment Research Council
NHS	National Health Service
NIBSC	National Institute for Biological Standards and Control
OST	Office of Science and Technology
PPARC	Particle Physics and Astronomy Research Council
SBRI	Small Business Research Initiative
SBS	Small Business Service
SCIS	Small Company Innovation Support
SEERAD	Scottish Executive Environment and Rural Affairs Department
SMART	Small Firms Merit Award for Science and Technology
SPUR	Support for Products Under Research
TCS	Teaching Company Scheme
TEP	Technology Exploitation Programme
TSB	Technology Strategy Board
UKSCI	UK Stem Cell Initiative

WDA	Welsh Development Agency