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 Finland

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Iciar Dominguez Lacasa
Fraunhofer Institute for Systems and Innovation Research (Fraunhofer ISI)
Karlsruhe, Germany

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Summary

In the reporting period (2002-2005), biotechnology was the second policy priority area in Finland after information and communication technology (ICT). However, since the mid 1990s, support for research and development (R&D) and commercialisation of biotechnology has been a key policy area in Finland. In the period 1994-1998 instruments to support biotechnology focused on the concentration of biotechnology basic research in regional (biotechnology-specific) research centres (*Biocenters*). Besides, biotechnology has been promoted through competitive funding mechanisms for university research and industrial grants and loans for the business sector. In the mid 1990s the policy system increasingly introduced top-down approaches targeting biotechnology research and development.

In the reporting period the main funding bodies of biotechnology research and commercialisation activities were the Ministry of Education, the Academy of Finland (AKA), the Finnish Funding Agency for Technology and Innovation (Tekes) and the Finnish National Fund for Research and Development. We estimate that in the period 2002-2005 biotechnology public funding in Finland amounted to 461M EUR. 75.8% of the funding was spent in research promotion while commercialisation (or industrial application) received 24% of the funding.[1] Other funding areas (such as discourse and social acceptance of biotechnology) absorbed only 0.2% of the funding.

The Finnish approach to promote biotechnology draws on the one hand on the implementation of non-policy-directed initiatives to promote research. In the period 2002-2005, 276M EUR were invested in research promotion through institutional funding for research institutes and competitive response mode mechanisms of the Academy of Finland. On the other hand, policy-directed instruments target commercialisation and to a lower extent research: 111M EUR were directed to the promotion of commercialisation or industrial application of biotechnology research results and 73.4M EUR to biotechnology research promotion. Policy-directed instruments put relatively low emphasis on certain policy goals in terms of funding. These policy goals concern biosafety, risk assessment and social acceptance of biotechnology. Even though these issues have not been neglected and promotion programmes have tackled them, these policy goals seem to have low priority in terms of funding.

The data available for policy-directed instruments indicate that basic biotechnology (with 40%) and health biotechnology (21%) are the research application areas receiving the largest share of funding. Environmental biotechnology and food biotechnology were funding gaps in the Finnish system of biotechnology promotion through policy-directed instruments in the period 2002-2005. These fields were mainly promoted through the institutional funding of research institutes (non-policy-directed instruments).

[1] The results concerning the balance between research support and commercialisation support should be interpreted with caution, since generic instruments promoting industrial development may have an impact on biotechnology. Unfortunately, the information available does not give any insights into the extent to which generic industrial policy instruments may have supported the industrial application of biotechnology.

As for public acceptance of biotechnology, according to a survey of public attitudes to new technologies the acceptance of most potential applications of biotechnology and genetic engineering in Finland more or less resembles the attitudes in the EU. In some specific cases the acceptance is below the European average.

With regard to the performance of the Finnish biotechnology innovation system, the report considers 4 areas thereof: the knowledge base, knowledge transfer and application, industrial development and market conditions.

As regards knowledge production in biotechnology, Finland shows an outstanding performance in terms of biotechnology publication counts per capita. Moreover, the Finnish performance is quite stable over the whole time frame under consideration. In terms of citations per biotechnology publications the indicator is also above the US and EU average level. However, the value of the citations indicator in the most recent period is not as satisfactory as in older periods. As in the USA and EU25, the Finnish biotechnology knowledge base concentrates on health applications. In both periods under consideration, 63% of the biotechnology publications counted relate to health biotechnology. According to OECD data, the Finnish biotechnology innovation system seems to have difficulties in training and qualifying graduates in life sciences.

With respect to the analysis for knowledge transfer and application, in terms of patents the Finnish system seems to have serious problems in translating biotechnology knowledge into industrial applications, compared to the USA and EU25. The system seems to be much more productive in producing scientific publications than industrial applications related to biotechnology. On the contrary, with regard to company creation in terms of biotechnology start-ups per capita in the period 2001-2003, Finland's performance is outstanding compared to the USA and EU25.

With regard to the assessment of the development of the biotechnology industry, in the year 2001 the Finnish biotechnology industry was quite large in terms of biotechnology companies per million capita, compared to EU25 and USA. The Finnish advantage diminishes in the year 2004, but still the industry indicators suggest a strong performance.

Finally, regarding the market for biotechnology products, Finnish innovators seem to have problems completing the development stages of biomedicines. During the time period 1995-2002, no biomedicines were reported from Finland. The venture capital invested in biotechnology was very low compared to the USA and EU15. The development of biotechnology-based agro-food products seems to be more successful: between 1996 and 2001 Finland reported a total number of 22 field trials. If we consider the per capita figures, Finland reported 4.2 field trials pMC (EU15 average 3.5).

The information available suggests that the Finnish government will continue to promote biotechnology in the future. The consolidation effort will continue to aim at closer cooperation between the various actors forged through a number of initiatives, all aiming at international competitiveness of both research and business operations. Support for commercialisation will be more strictly targeted towards feasible business strategies and international operations.

1. Introduction and background

1.1 General Introduction

According to EUROSTAT[2], with a gross domestic product (GDP) of 164 000M EUR and a population of 5.2 million inhabitants, in 2005 Finland's GDP per head was one of the largest in the EU (14% larger than the EU25 average). Even though economic growth in Finland slowed downed drastically between 2000 and 2003, reaching 1.8% growth rate of its real GDP in 2003, the economy has been recovering to reach a 2.9% growth rate in 2005. In the period 2002-2005, Finland's economy grew more rapidly than the EU25 average in terms of growth of real GDP at constant prices with an average growth rate of 2.5%.

In terms of GDP composition by sector, the service sector is the most important with 67% of GDP followed by industry (29.5%) and agriculture (2.8%). The most important industrial sectors are metals and metal products, electronics, machinery and scientific instruments, shipbuilding, pulp and paper, foodstuffs, chemicals, textiles, clothing. The country experienced a rapid expansion of the electrical and electronics goods industry in the 1990s, led by Nokia, which influenced the increasing share of Finland's manufacturing sector in its GDP. The efforts in research and development activities (R&D) have been continually growing since 1996. On average, between 2000 and 2005, Finland annually invested 3.4% of its GDP in R&D. With a GERD/GDP[3] ratio of 3.51%, in 2004 Finland was the second largest EU country (behind Sweden) in terms of R&D investment as a percentage of its GDP. [4] The private sector plays a major role in the Finnish innovation system. In 2004 industry financed 70% of the R&D activities in Finland. The largest share of industrial R&D investment concentrates on the electronic industry.

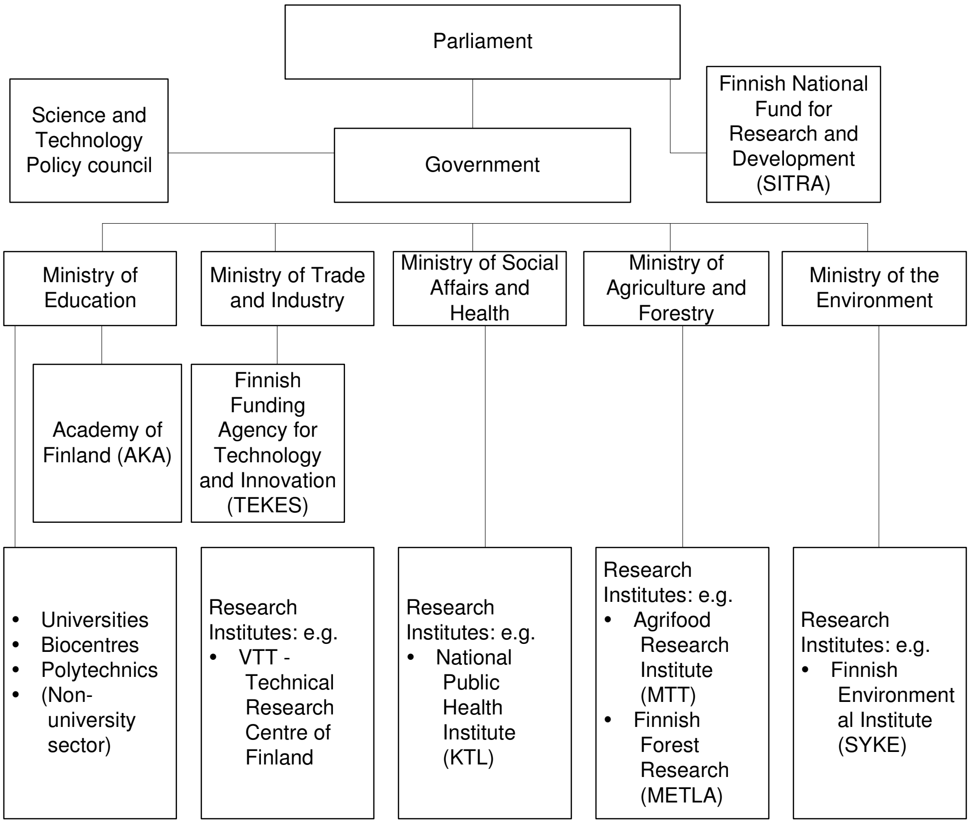
1.2. Characteristics of the national S&T and innovation system

Regarding governance and tools of innovation policy, Finland has accumulated years of experience in promoting science and technology. In the 1960s and 1970s, science policy was the main item on the policy agenda. Technology policy gained importance in the 1980s with the creation of the National Technology Agency and the implementation of technology programmes. Policy-makers have been very fast in adopting innovation policy concepts such as the national innovation system and industrial clusters. Since 1990 these concepts have been widely used for planning and implementing policy instruments. Accordingly, following a systemic approach, the government's support for innovation aims to promote a whole range of actors involved in innovation activities. Moreover, evaluation practices, benchmarking activities and other instruments for policy monitoring have significant standing in the policy-making system.

[2] This paragraph draws on data from EUROSTAT, http://www.eurostat.org (last accessed August 2006)
[3] GERD/GDP: gross expenditure on research and development expressed as a percentage of gross domestic product.
[4] Only 2004 data are available for comparisons.

Figure 1.1 depicts the governance structure of the Finnish innovation system.

Figure 1.1 Governance Structure of the Finnish Innovation Policy System



Source: European Commission (2005a)[5]

The Science and Technology Policy Council of Finland (chaired by the Prime Minister) is the highest governing body in the innovation field. It is responsible for formulating science, technology and innovation policies. The ministries are responsible for policy implementation. Science policy is the responsibility of the Ministry of Education and the Ministry of Trade and Industry implements technology policy. The other ministries contribute by implementing sector-specific science and technology strategies.

The Academy of Finland (AKA) and the Finnish Funding Agency for Technology and Innovation (Tekes) are the main support organisations funding and coordinating the initiatives and public promotion programmes related to science and technology policy. These two institutions reflect the traditional duality of science and technology policy.

The Academy of Finland (AKA) reports to the Ministry of Education. It concentrates on science policy, providing funding for high-quality scientific research and training on a

[5] European Commission (2005). European Trend Chart on Innovation - Annual Innovation Policy Trends and Appraisal Report Finland 2004-2005.

competitive basis. The annual budget amounts to around 200M EUR. This funding is allocated primarily among university institutes and research centres. [6]

The Finnish Funding Agency for Technology and Innovation (Tekes) funds industrial projects as well as projects in research organisations. In 2005, 429M EUR (which come from the state budget via the Ministry of Trade and Industry) were invested in R&D projects in companies, universities and research institutes. In 2005 Tekes was the largest financer of public R&D in Finland. The agency provides funding for companies, universities and research centres for long-term R&D projects[7].

Finally, the Finnish National Fund for Research and Development (SITRA) is an independent public foundation under the supervision of the Finnish parliament. Its duty is the stimulation of company creation and business development through financial support. It provides venture capital for high-tech business.[8]

1.3. National support and framework conditions for biotechnology

According to the Academy of Finland (2002)[9], biotechnology is the second priority area in Finland after information and communication technology (ICT). Since the mid 1990s support for R&D and commercialisation of biotechnology has been a key policy area in Finland. In the period 1994-1998 instruments to support biotechnology focused on the concentration of biotechnology basic research in regional (biotechnology-specific) research centres (*Biocenters*). Besides, biotechnology has been promoted through competitive funding mechanisms for university research and industrial grants and loans for the business sector. In the mid 1990s, the policy system increasingly introduced top-down approaches targeting biotechnology research and development. The Ministry of Education has played a major role in the implementation of biotechnology promotion programmes (Academy of Finland 2002) The strategy of the Ministry has been structured along the following evaluation exercises and national programmes:

- First MoE Working Group 1987
- Funding programmes 1988-1997 (1st Phase)
- EMBO Evaluation 1996
- MoE Follow-up Group 1997
- Funding programme 1998-2000 (2nd Phase)
- MoE "Biotechnology 2000" Working Group 2000
- Funding programme 2001-2003 (extension of the 2nd phase)

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[6] Academy of Finland, http://www.aka.fi (last accessed September 2006)

[7] The funding is awarded through grants and loans. The conditions depend on the type of loan or grant and the institution receiving it (university, research unit or company). For small and medium-sized companies (SMEs), grants and loans have more attractive conditions. Universities can get funding up to 100% of the costs. http://www.tekes.fi/eng/information/funding.html (last accessed September 2006).

[8] Finnish National Fund for Research and Development (SITRA), http://www.sitra.fi (last accessed September 2006).

[9] Academy of Finland (2002). Biotechnology in Finland - Impact of public research funding and strategies for the future evaluation report, Academy of Finland.

- Biotech 2002 Evaluation

Further, the government has emphasised supporting the availability of financial capital for the creation of technology-based companies through SITRA (Dominguez Lacasa and Reiss 2004).[10]

All in all, in the last two decades the government has been very much concerned about supporting the development of biotechnology and its industrial application.

According to a survey of public attitudes to new technologies in Europe (European Commission 2005b)[11], 64% of the respondents in Finland believe that developments in biotechnology and genetic engineering can positively affect our way of life over the next 20 years. This result is more or less the same as the European average (65%).

As regards human cloning 66% of the respondents reject the cloning of human beings so that couples can have a baby, even if one partner has a genetic disease (EU average 59%). Regarding the attitude to the cloning of human embryo stem cells to treat people with diseases, 27% of Finnish citizens believe this should never occur (EU average 22%), 32% approve it only in exceptional circumstances (EU average 20%), while 35% of citizens approve it only if is highly regulated and controlled (EU average 41%). Only 5% would approve it in all circumstances (EU average 11%). This is the lowest share in the EU.

The survey explores public attitudes to several applications of genetics. Interestingly, in most cases the percentage of Finnish citizens who would never approve these applications is higher than the EU average:

- 49% will never approve the use of genetic tests for children to identify talents and weaknesses (EU average 54%);
- 48% will never approve the use of genetic treatments to prolong our expected life span by 25 years (EU average 42%);
- 41% will never approve of developing genetic tests for everyone to identify diseases they might get (EU average 34%);
- 36% will never approve genetic treatments to get rid of bad habits like smoking or alcoholism (EU average 33%);
- 30% are totally opposed to using genetic testing to produce a child that could be a bone-marrow donor for a sibling with a life-threatening disease (EU average 31%);
- 27% are totally opposed to storing everyone's genetic data so that criminals could be more easily caught (EU average 21%);
- and 22% will never approve storing the population's genetic data to study the causes of human disease (EU average 17%).

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[10] Dominguez Lacasa, I. and T. Reiss (2004) Effectiveness of Innovation Policies: Biotechnology in Finland (1994-2001). Efficiency of innovation policies in high technology sectors in Europe (EPOHITE). T. Reiss, J. Calvert, I. Dominguez Lacasa et al. Luxembourg, Office for Official Publications of the European Communities.

[11] European Commission. (2005) "Special Eurobarometer 225- Social Values, Science and Technology." Retrieved 01.08.2006, from http://europa.eu.int/comm/public_opinion/archives/ebs/ebs_225_report_en.pdf

The survey also explores public attitudes to genetic modification. In this application field, the attitudes in Finland more or less resemble the attitudes in the EU on average. When it comes to the development of genetically modified crops to increase the variety of regionally grown food, 34% of the Finnish citizens would never approve this application of biotechnology (EU average 37%). In the case of environmental applications, 21% of the respondents would never approve developing genetically modified bacteria to clean up after environmental catastrophes (EU average 19%).

In general terms, the results of the survey suggest that the acceptance of most potential applications of biotechnology and genetic engineering more or less resembles the attitudes in the EU on average. In some specific cases the acceptance is below the European average.

1.4. The main biotechnology actors

A network of 20 public universities, 29 polytechnics and 19 public research institutes carry out research and development activities in Finland. Most of their resources come from the state budget. Besides this network of public institutions, the private sector plays a major role in the Finnish innovation system.

According to the latest OECD biotechnology statistics(OECD 2006)[12], in 2003 total R&D expenditure on biotechnology by both the public and the business sector was PPP$ 192.9 million (3.7% of all R&D expenditures in Finland). The actors involved in biotechnology research and development are university institutes, state-owned research centres and private companies.

Among the universities, the following institutions have been included in the last biotechnology evaluation activities of the Ministry of Education[13]:

- University of Helsinki
- University of Kuopio
- University of Oulu
- University of Tampere
- University of Turku
- Abo Akademi University
- Helsinki University of Technology
- Tampere Univeristy of Technology
- University of Joensuu
- University of Jyvaeskyla

The evaluation document estimates that the biotechnology research funded from the university budget (institutional funding) can be approximately 28.2M EUR per year.

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[12] OECD (2006) Biotechnology Statistics, OECD.

[13] Academy of Finland (2002) Biotechnology in Finland - Impact of public research funding and strategies for the future evaluation report, Academy of Finland.

The research centres involved in biotechnological research are VTT Biotechnology, the National Public Health Institute (KTL), Agrifood Research Finland (MTT), the Finnish Forest Research Institute (METLA) and the Finnish Environment Institute (SYKE).

With regard to the private sector, there are two sources that can be used to describe the biotechnology industry in Finland: the 2003 survey of Statistics Finland and the surveys of the Research Institute of the Finnish Economy (METLA) (OECD 2006)[14]. Statistics Finland reported 102 firms engaging in biotechnology in 2003, which employed 2 394 employees. METLA reported 120 biotechnology companies at the end of 2003 (112 were SMEs). In that year the diagnostics and devices sector had the largest number of companies (43 SMEs), followed by the drug discovery and development sector (with 34 SMEs).

Finally, as regards regional clusters, in all 5 major Finnish cities there are local environments with a concentration of actors conducting R&D biotechnology activities: Helsinki region, Kuopio region, Oulu region, Tampere region and Turku region.

[14] OECD (2006) Biotechnology Statistics, OECD.

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 implementing a specific instrument, such as specific R&D programmes, programmes encouraging collaboration, industrial research grants, support for centres of excellence, support for the commercialisation 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, these generic instruments are included only if a reference is made to (the stimulation of) biotechnology activities in the policy of the funding organisation that runs the programme, or of the ministry / government department that funds the funding organisations or that runs the programme 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 awarded through block grants to universities and (government) research institutes, the open-call system of research councils *et cetera*. 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.

In this chapter the funding of biotechnology research through policy and non-policy-directed instruments and of biotechnology commercialisation through policy-directed instruments is presented. 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 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 Finland through the 6th Framework Programme.

2.2. Non-policy-directed funding of biotechnology research

Table 2.1 shows the non-policy-directed policy instruments identified for the period 2002-2005. According to the information available, public funding through non-policy-directed instruments amounted to 276.3M EUR.

Table 2.1 Non-policy-directed funding of biotechnology research

Responsible Ministry	Public Research Institutions / Response Mode programmes	Period	Funds M EUR
Ministry of Education	Biocentres	2002-05	66.4
Ministry of Education	Special Projects	2002-05	7.01
Ministry of Education	Academy of Finland – Centres of Excellence in Research	2002-05	13.8
Ministry of Education	Academy of Finland – Other Response Mode Programmes[1]	2002-05	150.9
Ministry of Trade and Industry	VTT Biotechnology[4]	2002-05	14.8
Ministry of Social Affairs and Health	National Public Health Institute (KTL)	2002-05 [2]	14.9
Ministry of Agriculture and Forestry	Finnish Forest Research Institute (METLA)	2002-05 [2,3]	3.1
Ministry of Agriculture and Forestry	MTT Agrifood Finland	2002-05 [2]	17.4
Ministry of the Environment	Finnish Environmental Institute (SYKE)	2002-05 [2]	2.7
	Total	2002-05	276.3

Source: BioPolis Research

[1] Includes all instruments of the Academy of Finland except for the programmes described in section 2.3 and the initiative "Centres of Excellence in Research". The figures are based on the OECD's biotechnology definition that was used in the Biotechnology Evaluation Report 2002 (Academy of Finland 2002)
[2] Data for 2005 were not available. The data of 2004 were used for 2005.
[3] Institutional funding may be overestimated, proportion allocated to biotechnology difficult to assess in multidisciplinary projects.
[4] No up-to-date data available. The figures are based on the funding for the year 2001.

The next sections elaborate the information gathered for each instrument.

2.2.1 The Ministry of Education

The Biotechnology Development Programme of the Ministry of Education involves two types of university finding: first, an earmarked part, which according to an agreement between the university (six universities) and the Ministry is allocated to biotechnology research. Next, it allocates earmarked funding for special projects (five universities as recipients). The annual amounts, in M EUR, were:

Table 2.2 Non-policy-directed funding of the Ministry of Education (without the Academy of Finland). Funding in M EUR

Year	Biocentres	Special Projects
2002	16.6	
2003	16.6	3.45
2004	16.6	2.3
2005	16.6	1.26

2.2.2 The Academy of Finland[15]

The Academy of Finland provides funding for high-level scientific research. Academy support for research at Finnish universities and research institutes amounts to over 200M EUR. The Academy has four research councils that decide on the allocation of funding within their respective fields. These councils use both response mode mechanisms and programmes for specific scientific fields.

- Response mode mechanisms of the Academy of Finland

Regarding the response mode mechanisms, the Academy of Finland has a range of different instruments for different purposes. On the one hand, it provides funding for research projects, researcher training, and international cooperation, as well as research posts for academy professors and academy research fellows. We estimate that in the period 2002-2005, the Academy invested 150.9M EUR in biotechnology funding via response mode mechanisms. Moreover, the academy runs the programme "Centres of Excellence in Research".

[15] As the Academy's research field classification does not include a separate sub-field for biotechnology,, data provided by the Academy for BioPolis are based on the same operationalisation of the OECD's biotechnology definition as used in the Biotechnology evaluation report in 2002. Estimates of the biotechnology funding cover the following fields of the research classification used by the Academy of Finland:
- 5400 (biochemistry, molecular biology, microbiology, genetics and biotechnology)
- 5410 (cell and developmental biology, physiology and ecophysiology)
- 5380 (agriculture and food sciences)
- 5460 (pharmacy).

All the projects which fall under the four sub-fields are not biotechnology projects, but on the other hand, some of the biotechnology projects funded by the Academy have been classified into other sub-fields. The volume of funding to 5380 and 5460 is a small fraction compared to classes 5400 and 5410.

- Finnish Centres of Excellence in Research (2000 - 2005 and 2002 - 2007)[16]

The national centre of excellence policy is aimed at raising the goals and quality standards of Finnish research. Centre of excellence programmes are open to all disciplines. One of the key objectives is to promote interdisciplinary research.

Units appointed to the programme are research and researcher training units that consist of one or more high-profile research groups that are either at or very close to the international cutting edge in their own field of expertise. A centre of excellence may operate within a university and/or research institute.

Funding for centres of excellence in research comes not only from the Academy, but also from the host organisations of the units concerned, the National Technology Agency Tekes and various foundations. In addition to this regular contractual funding, most units have other sources of national and international funding.

Centre of excellence programmes are administered and coordinated by the Academy of Finland in close collaboration with the National Technology Agency. The Academy monitors the work and operation of centres of excellence in research, drawing upon experiences gained and upon recent international trends in further developing its international centre of excellence policy.

2.2.3 Public Research Institutes

The biotechnology activities of the main Finnish research institutes have been considered in the framework of BioPolis. These are:

- VTT Biotechnology
- National Public Health Institute (KTL)
- MTT Agrifood Research Finland
- Finnish Forest Research Institute (METLA)
- Finnish Environment Institute (SYKE)

- VTT Biotechnology

VTT Technical Research Centre of Finland is the largest research organisation in Finland, with annual institutional funding of 78M EUR. The organisation covers a wide range of research areas. In biotechnology the focus lies on enzyme technology and its applications. Moreover, biotechnology applications for the effective use of renewable natural resources and for the production of industrial chemicals and materials are becoming an important

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[16] According to the website of the Academy of Finland, the Finnish centres of excellence strategy defines a centre of excellence "as a research or researcher training unit that consists of one or more high-level research teams". It shall have a clear set of common research objectives and work under the same management. A centre of excellence may be a unit operating within a university or research institute, or an assembly of units or research teams and researchers working in several different organisations. It may also be operating in collaboration with a university or research institute in the private sector.

research focus. Public funding for the promotion of industrial and energy applications of biotechnology has been channelled through the non-policy-directed funding for this institute. According to the information available (Academy of Finland 2002), in 2001 VTT received 3.7M EUR in institutional funding from the Ministry of Trade and Industry.[17]

- National Public Health Institute (KTL)

The institute is funded by the Ministry of Social Affairs and Health. The average annual budget for biotechnology research at the National Public Health Institute (2002-2004) was 6M EUR (institutional funding 70%, external funding 30%). Total number of person-years in biotechnology research in the research institute was 75.5M in 2004.

According to Eskola (2005)[18], the primary strengths of the institute in health biotechnology research are the researchers' genetic, microbiological and epidemiological expertise, the infectious diseases monitoring system, as well as assay collections and biobanks collected by the institute over many decades.

According to Eskola (2005), in 2004 the Ministry of Social Affairs and Health and the National Public Health Institute agreed to prepare a biotechnology strategy for the institute. It was proposed that biotechnological research at the institute be directed to the following fields:

1. genetic background of common diseases
2. microbes and people (microbes as causes of infectious diseases, microbes behind chronic diseases, and normal flora and health), and third,
3. the use of molecular biology and genetic data for the monitoring and control of public health (monitoring of communicable diseases, environmental health control and analysis of unexpected health problems).

- MTT Agrifood Research Finland

MTT Agrifood Research Finland is a research body of the Ministry of Agriculture and Forestry. With 14 different locations across Finland, MTT carries out agricultural and food research. The institute is structured in 4 research areas:

- biotechnology and food
- animal production
- plants
- economics and
- the technology programme. ??? 5 areas???

[17] There are no up-to-date data for this institute.

[18] Eskola, J. (2005) "Molekyylibiologiasta ja geenianalyyseistä terveyttä väestölle" Publications of the National Public Health Institute B5/2005 retrieved August 2006, from http://www.ktl.fi/portal/suomi/julkaisut/julkaisusarjat/kansanterveyslaitoksen_julkaisuja_b/.

The average annual budget of the institute in the period 2002-2005 was 40M EUR. Biotechnology research focuses on genomics research, which charts the traits of plants, animals and microbes. The average annual budget for biotechnology research at the Finnish Environment Institute (2002-2004) was 6M EUR (institutional funding 70%, external funding 30%). Total number of person-years in biotechnology research in the Research Institute in 2004 was 75.5.

- Finnish Forest Research Institute (METLA)

Also the responsibility of the Ministry of Agriculture and Forestry, METLA conducts research and generates research information about the forest, nature and environment, the different uses of forests, and about forestry and the forest cluster.

The overall budget of the Finnish Forest Research Institute has been about 40M EUR of which about 70% has been direct government funding from the Ministry of Agriculture and Forestry. The average annual budget for biotechnology research in the period (2002-2004) was 1M EUR (institutional funding 70%, external funding 30%). Total number of person-years in biotechnology research in the Research Institute in 2004 was 40.5.

- Finnish Environment Institute (SYKE)

The Finnish Environment Institute (SYKE) is a research institution for which the Ministry of the Environment is responsibile. The average annual budget of the Finnish Environment Institute (2002-2005) was 40M EUR; thereof 60% institutional funding and 40% external funding. SYKE conducts biotechnology research in 3 areas:

1. Applied biotechnology for environmental protection
2. Molecular microbiology in environmental "diagnostics"
3. Impacts of genetically modified organisms (GMOs) on the environment and society.

The average annual budget for biotechnology research at the Finnish Environment Institute (2002-2004) was 1M EUR (institutional funding 70%, external funding 30%). In 2004 the institute had 9 scientists and 4 technicians involved in biotechnology.

2.3. Policy-directed funding of biotechnology research and commercialisation

This section presents the policy-directed funding instruments in the period 2002-2005.[19] The instruments are mainly research and technology programmes promoting project funding. The information is structured according to the funding organisation implementing the programmes: the Academy of Finland and Tekes. At the end of the section we briefly discuss the activities of SITRA. Table 2.3 gives an overview of the relevant programmes identified for the period 2002-2005. No relevant promotion programmes were identified at the regional level.

Table 2.3 National and regional public policy-directed biotechnology stimulating instruments during the period 2002-2005

Instrument	Funding Agency	Budget in M EUR	% of total	Use of EU SF*
National Instruments				
Generic				
Drug 2000 Technology Programme	Tekes (65%) AKA (35%)	n.a.	n.a.	No
Biotech-specific				
COMBIO - Commercialisation of Biomaterials	Tekes	26	14%	No
NeoBio - Novel Biotechnology	Tekes	75	40%	No
Diagnostics 2000	Tekes	10.5	6%	no
Research Programme on Structural Biology (RAKBIO 2000-2002)	AKA (70%) Tekes(30%)	1.6	1%	no
Research Programme on Systems Biology and Bioinformatics (SYSBIO)	AKA (84%) Tekes(16%)	5.4	3%	no
Environmental, Societal and Health Effects of Genetically Modified Organisms (ESGEMO)	AKA	1.8	1%	no
Biological Functions - Life 2000 (2000-2003)	AKA (97%), Tekes (3%)	10	5%	no
Sitra Life Sciences corporate finance	Sitra	55	30%	no
Regional Instruments				
Not considered				
Total		185.3	100	

*EU SF: EU Structural Funds
Source: BioPolis Research

[19] Data have been gathered by using secondary literature, by conducting short telephone interviews with policy-makers and by circulating a standardised questionnaire among the responsible policy-makers.

2.3.1 The Finnish Funding Agency for Technology and Innovation (Tekes)

Tekes uses technology programmes to allocate its funding. These programmes focus on selected sector or technological fields and run for several years using, in most cases, competitive annual calls to identify the promising research projects.

- NeoBio – Novel Biotechnology 2001-2005

The NeoBio Programme was launched in October 2001 for a period of 4 years and 3 months. The goal of NeoBio - Novel Biotechnology programme was to advance the development and application of modern biotechnological methods in product R&D across industry sectors, as well as the emergence of new, internationally competitive businesses. With a total budget of 75M EUR, NeoBio funded universities' and research centres' applied research projects and companies' R&D projects.

Biotechnology funding volume 2002-2005: 75M EUR.

- COMBIO - Commercialisation of Biomaterials 2003-2007

The goal of the COMBIO programme is to further develop the strong Finnish biomaterial technology base in health care and to use business technologies to support the commercialisation of research results.

Biotechnology funding volume 2002-2005: 26M EUR.

- Diagnostics 2000 – 2000-2003

Tekes initiated the Diagnostics 2000 technology programme in 2000. The programme had a budget of 34M EUR during the years 2000-2003, focusing on clinical diagnostics. One of the most important goals of the programme was to achieve a functional network for cooperation among companies producing diagnostic devices and the universities and research institutes developing new methods. A total of 62 projects were funded. 47 companies and 27 research institutes participated in the programme. The budget for public research projects amounted to 11.3M EUR, of which Tekes provided 10.3M EUR. The budget for industrial R&D projects totalled 21.4M EUR of which Tekes provided 10.2M EUR.

The research projects were divided into four theme groups:
- Infectious diseases
- Degenerative diseases
- Method development
- DNA diagnostics

Biotechnology funding volume 2002-2005: 10.5M EUR.

- Drug 2000 - biomedicine, drug development and pharmaceutical technology (2001-2006)

Drug 2000 is a technology programme focused on biomedicine, drug development and pharmaceutical technology. The programme was launched by Tekes together with the Academy of Finland at the beginning of 2001 and has been implemented in two periods of three years each. The annual budget of the programme is approximately 20M EUR, of which Tekes finances 12-13M EUR. The programme covers the entire drug development process, from the identification and validation of new drug effects to the creation of new medical preparations and the development of new means of administering doses.

Biotechnology funding volume 2002-2005: n.a.

2.3.2. The Academy of Finland (AKA) - Research Programmes

- Biological Functions - Life 2000 (2000-2003)

The research programme on Biological Functions, Life 2000, was the largest research programme ever launched in Finland for purposes of funding both basic and applied research in the bio sector. Running for three years from 2000 to 2003, it had a budget of 14M EUR and involved 89 research groups from 18 universities and research institutes and one company. Funding came from the Academy of Finland and the National Technology Agency Tekes. The programme areas covered neuroscience, developmental biology, functional genomics, biophysics, and bioinformatics as well as ethical, legal and socio-cultural issues related to bio research.

Projects in the field of developmental biology explore the mechanisms through which genes and gene defects regulate development; locate the expression patterns of specific genes and gene products at cellular level during development; and research reproduction biology and stem cells. Studies in neuroscience are aimed to improve the practical applicability of research results in the diagnosis, prevention and treatment of nervous diseases and in the development of artificial intelligence and information technology. Several projects in the programme are concerned with developing and utilising methods of genetic engineering and the technology of genome-wide methods, as well as methods of biophysics and bioinformatics. Various EC conventions, recommendations and decisions have created a framework for research in the life sciences and for the application of the results thereof. Against this background, the projects studied the ethical, legal and socio-cultural dimensions related to the methods, results and applications of bioscience research.

Biotechnology funding volume 2002-2005: 10M EUR.

- Structural Biology – RAKBIO (2000-2002)

The objective of the research programme was to increase our understanding of how the molecular structures of biological systems are associated with their function. This goal was pursued by stepping up the research effort in structural biology and bioinformatics: the purpose is to set up interactive research teams and networks representing several different disciplines and to strengthen their know-how and methodological expertise.

The programme's budget was 4.9M EUR, with the Academy of Finland accounting for 3.4M EUR and the National Technology Agency for 1.5M EUR of the funding.

Biotechnology funding volume 2002-2005: 1.6M EUR.

- Systems Biology and Bioinformatics (SYSBIO) 2004-2008

The main objective of the SYSBIO Research Programme is to promote an integrative and holistic approach in research into complex biological processes at the systems level. Multi-disciplinarity, inter-disciplinarity and trans-disciplinarity are essential characteristics of the programme, with bioinformatics envisioned to play a central integrating role in the projects. The programme aims to create new knowledge through high-quality, multidisciplinary and collaborative research, to promote efficient and synergistic use of existing resources and infrastructures, to develop research environments, methodologies and co-operation of researchers, to promote research training and mobility and national and international networking. Attention is also paid to applications, IPR issues and commercialisation of research results as well as ethical and social aspects.

Biotechnology funding volume 2002-2005: 5.4M EUR.

- Environmental, Societal and Health Effects of Genetically Modified Organisms (ESGEMO) (2004-2008)

The objectives of the programme are:

- to create new knowledge about environmental and health effects and potential risks of genetically modified organisms (GMOs); basic knowledge on related ecology and population genetics is emphasised
- to develop novel tools for research and assessment of the potential impacts of GMOs on nature and its complex processes
- to evaluate the socio-economic and technological impacts of the use of GMOs, including ethical considerations and public acceptance of novel biotechnology

The programme thus aims to strengthen the knowledge base for risk assessment and risk management of GMOs. The results should have potentially wide social and economical implications, and be of interest to several stakeholders. Furthermore, the programme fosters national and international research collaboration and supports the training of researchers and experts.

Biotechnology funding volume 2002-2005: 1.8M EUR.

2.3.3. SITRA

SITRA is the major source of seed investment for start-up companies in Finland. In the period 2002-2005, it invested venture capital mainly in Finnish start-ups in the medical and technology sectors. With the SITRA Life Sciences, corporate finance venture capital investments were directed to early stage companies in the life sciences sector. The portfolio of biotechnology companies was in the range of 55M EUR.

Biotechnology funding volume 2002-2005: 55M EUR.

2.4. Participation in 6th Framework Programme

Table 2.4 shows the participation of Finnish research groups in the 6th Framework Programme in thematic priorities relevant for biotechnology. The information shows the number of groups involved as coordinators and as participants in the projects.

Compared to other countries, the participation of Finnish research groups in the 6th Framework Programme is quite low. In the case of life sciences, 2% of the projects were coordinated by a Finnish team. In the thematic priority nanotechnologies, section "bionanotechnology", none of the projects had a Finnish coordinator. In the case of food quality and safety, only 4% of the projects had Finnish coordinators. In terms of participation as a team member, Finnish participation in each thematic priority is similar to the participation as coordinators. Finland had no participants in the thematic priorities "Bionanotechnology".

Table 2.4 Involvement of Finland in biotechnology/life sciences programmes of the 6th Framework Programme

Sixth Framework Programme[1] Thematic priority	**Participation as project manager in # of projects (% of total)**	**Participation as member of the project team in # of projects**[2] **(% of total)**
1. Life sciences, genomics and biotechnology for health	18 (2%)	171 (2%)
2. Nanotechnologies, section bionanotechnology	0	0
5. Food quality and safety	4 (4%)	30 (2%)

Source: BioPolis Research

[1] First and second call, all types of projects

[2] Persons/groups can participate in more projects, resulting in more participations

3. Performance of the national biotechnology innovation system

3.1. Introduction

This chapter analyses the performance of the Finnish 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, in order to avoid capturing erratic trends. National trends are benchmarked against the performance of the EU25 Member States and the USA.

The presentation of performance is structured along the four main areas of the innovation system: the knowledge base, processes of knowledge transfer and application, industrial development and markets for biotechnology-based products. For each area, the different indicators for Finland, the USA and EU25 will be shown. To establish a comparison, the values reach by the EU25 have been chosen as reference in each indicator. The absolute figures are presented in Annex 5.

3.2. Performance in creating a knowledge base and supporting the availability of human resources

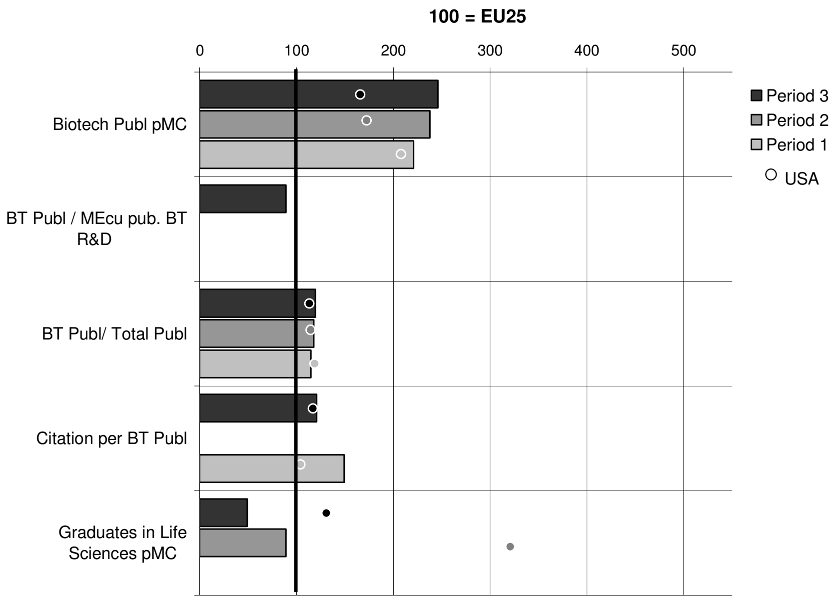
The indicators chosen for the assessment of the overall performance in creating a knowledge base and supporting the availability of human resources are given in Chart 3.1.

As given in Chart 3.1, the Finnish innovation system does not differ much from the USA or EU25 in terms of the share of biotechnology publications over the total publication output. However, compared with the USA and EU25, the overall performance of the Finnish biotechnology innovation system in strengthening the knowledge base is very good. As far as knowledge production in biotechnology is concerned, Finland shows an outstanding performance in terms of biotechnology publication counts per capita. Moreover, the Finnish performance in this indicator is quite stable over the whole time frame under consideration. In terms of citations per biotechnology publications, as given in Chart 3.1, the level is also above the USA and EU average level. However, the performance of this indicator in the most recent period is not as satisfactory.

With regard to the ratio of biotechnology publications in 2000-20002 per million ECU invested by the state in biotechnology research and development in the period 1995-1998, the performance is surprising. Compared to EU15, the Finnish system of knowledge production seems to be using a relatively large volume of public resources.

According to the data available from the OECD to assess the availability of human capital, the Finnish biotechnology innovation system seems to have difficulties in training and qualifying graduates in life sciences. The number of graduates per capita is far below the USA and EU25 levels.

Chart 3.1 The biotechnology knowledge base indicators, comparison with EU25 and USA, three periods, index values[20]



Source: BioPolis Research
Data: Science Citation Index, OECD Education Database, European Commission 1999
Note: the European reference region for indicator 2 (BT Publ./MEcu pub. BT R&D) is EU15.

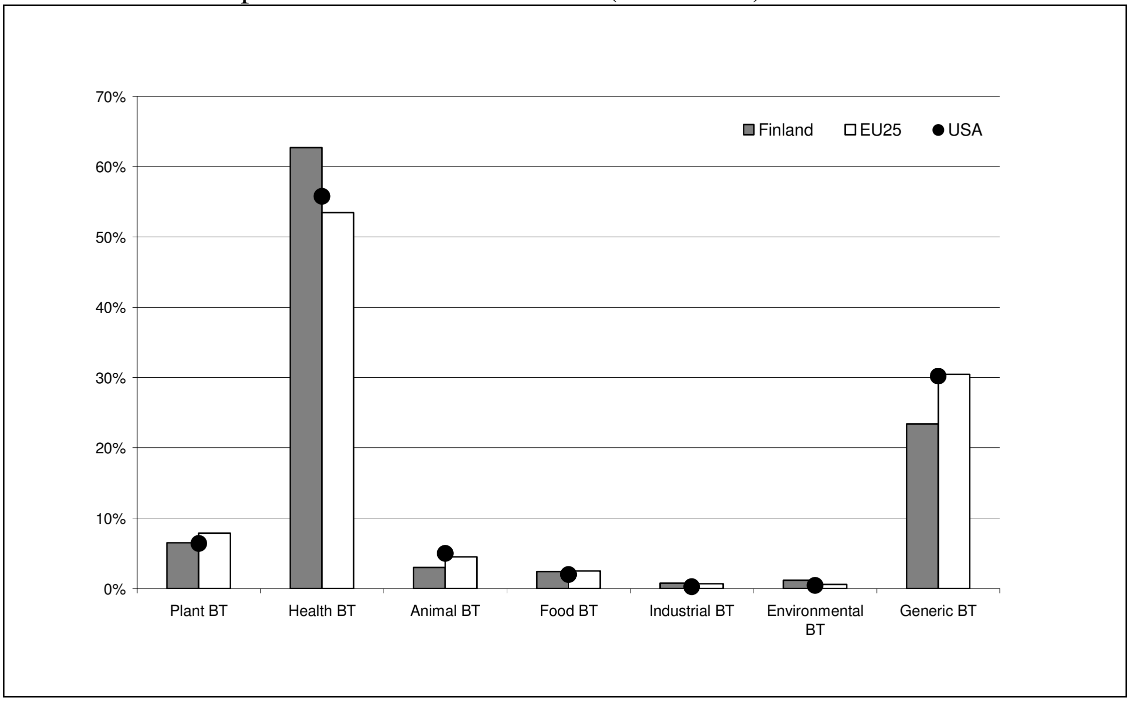
When considering the share of publications in different sub-fields of biotechnology within the total biotechnology publication output in two different time periods, charts 3.2.1, 3.2.2 and 3.3 provide insights into the content of the Finnish biotechnology knowledge base and its dynamics.

As in the USA and EU25, the Finnish biotechnology knowledge base concentrates on health applications. In both periods under consideration 63% of the biotechnology publications counted relate to health biotechnology. On the other hand, industrial and environmental biotechnology each accounts for 1% of the biotechnology publications.

Despite the low level in terms of publications reached by these fields, the growth rates are the lowest among the 7 sub-fields considered. On the other hand, publication counts in food and animal biotechnology show the largest growth rates between the two periods.

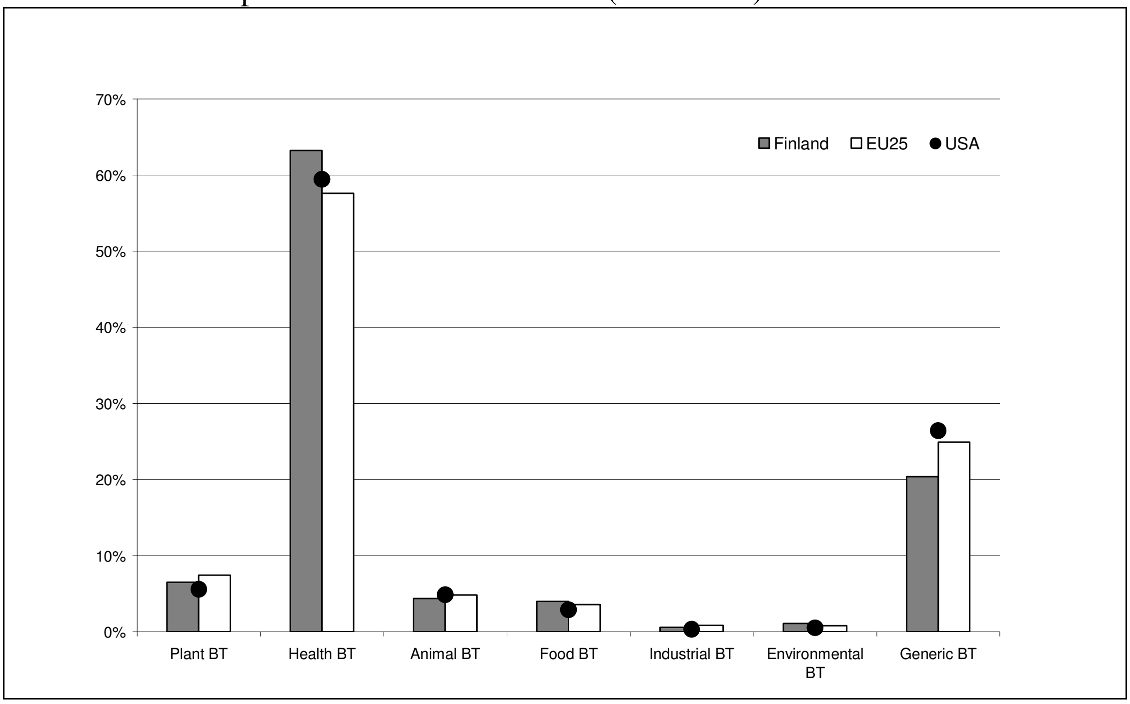
[20] For a detailed discussion of the strengths and limitations of science and technology indicators, see Moed, H.F.; Glänzel, W.; Schmoch, U. (eds.) (2004) Handbook of Quantitative Science and Technology Research. The Use of Publication and Patent Statistics in Studies of S&T Systems., Dordrecht: Kluwer Academic Publishers.

Chart 3.2.1 Share of subfields (in%) of total biotechnology publication for Finland in comparison with EU25 and USA (1994-1996)



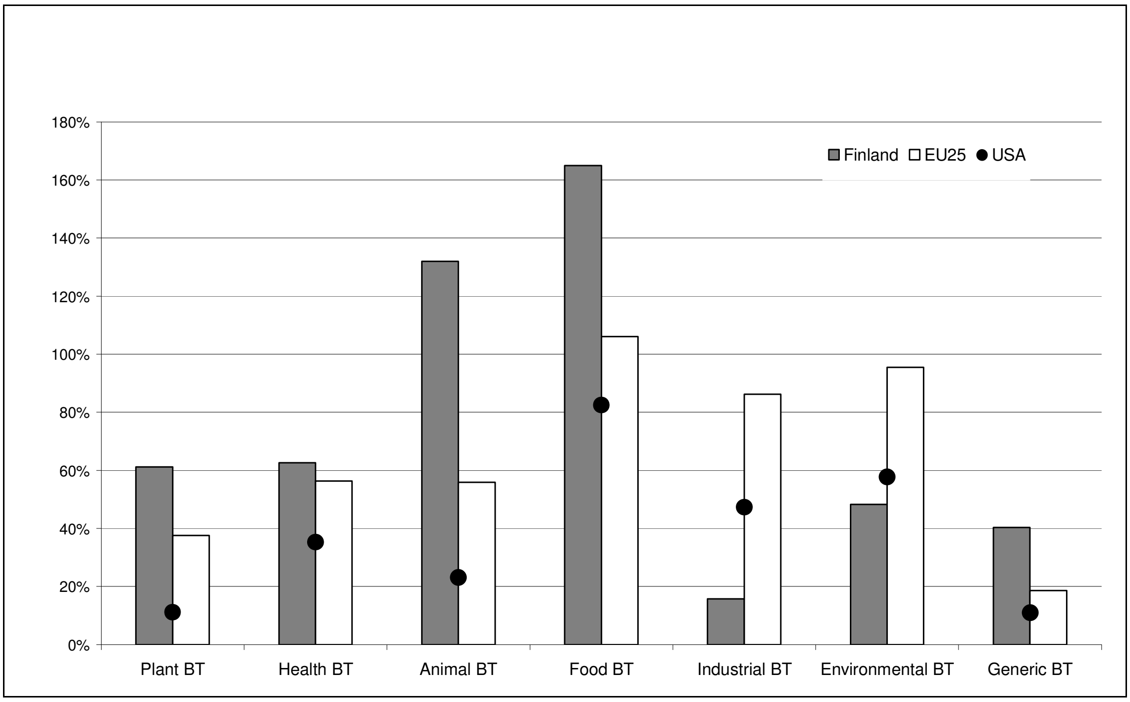
Source: BioPolis Research
Data: Science Citation Index

Chart 3.2.2 Share of subfields (in%) of total biotechnology publication for Finland in comparison with EU25 and USA (2002-2004)



Source: BioPolis Research
Data: Science Citation Index

Chart 3.3 Biotechnology sub-fields growth rates for Finland in comparison with EU25 and USA (1994-1996 and 2002-2004

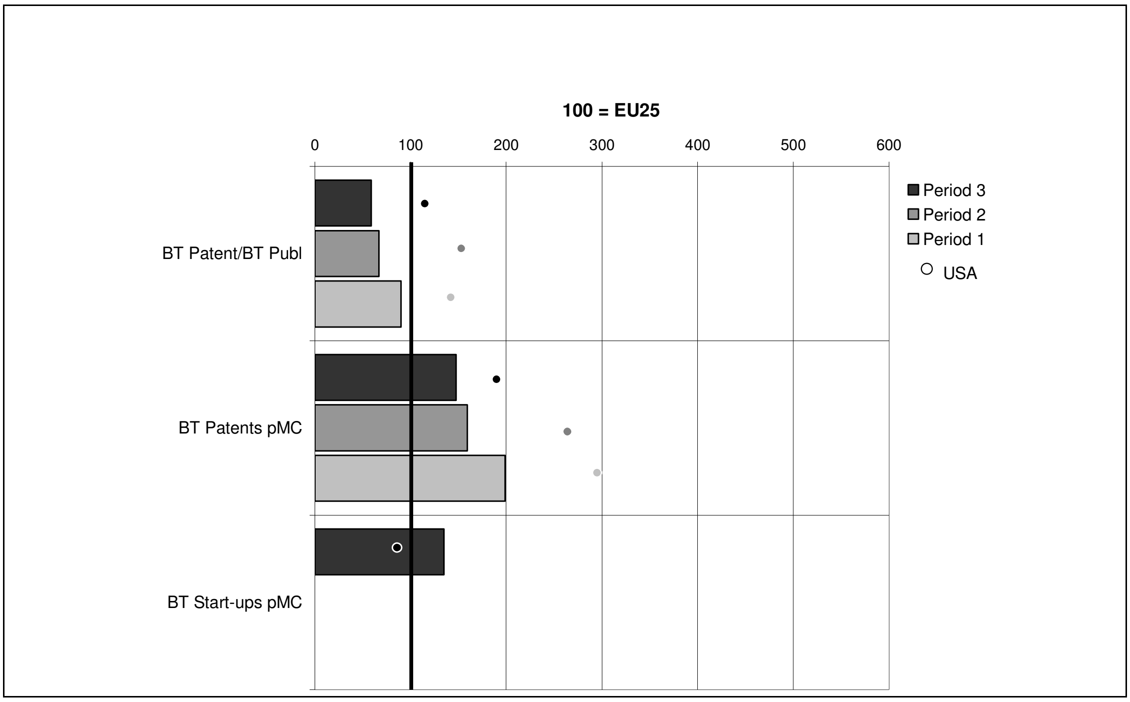


Source: BioPolis Research
Data: Science Citation Index

3.3 Performance in knowledge transfer and application

Chart 3.4 gives 3 indicators assessing the performance of the Finnish biotechnology innovation system in knowledge transfer and application. According to the data available, in terms of patents the Finnish system seems to have serious problems in translating biotechnology knowledge into industrial applications. The system seems to be much more productive in producing scientific publications than industrial applications related to biotechnology. The ratio BT patent per BT publication is far below the EU25 level. Additionally, even though the number of patents per million capita in Finland is above the EU25 level, Finnish performance is weakening. On the contrary, with regard to company creation in terms of biotechnology start-ups in the period 2001-2003, Finland outperforms both the EU25 and the USA.

Chart 3.4 Performance indicators for biotechnology knowledge transfer and applications, three periods, Finland in comparison with EU25 and USA



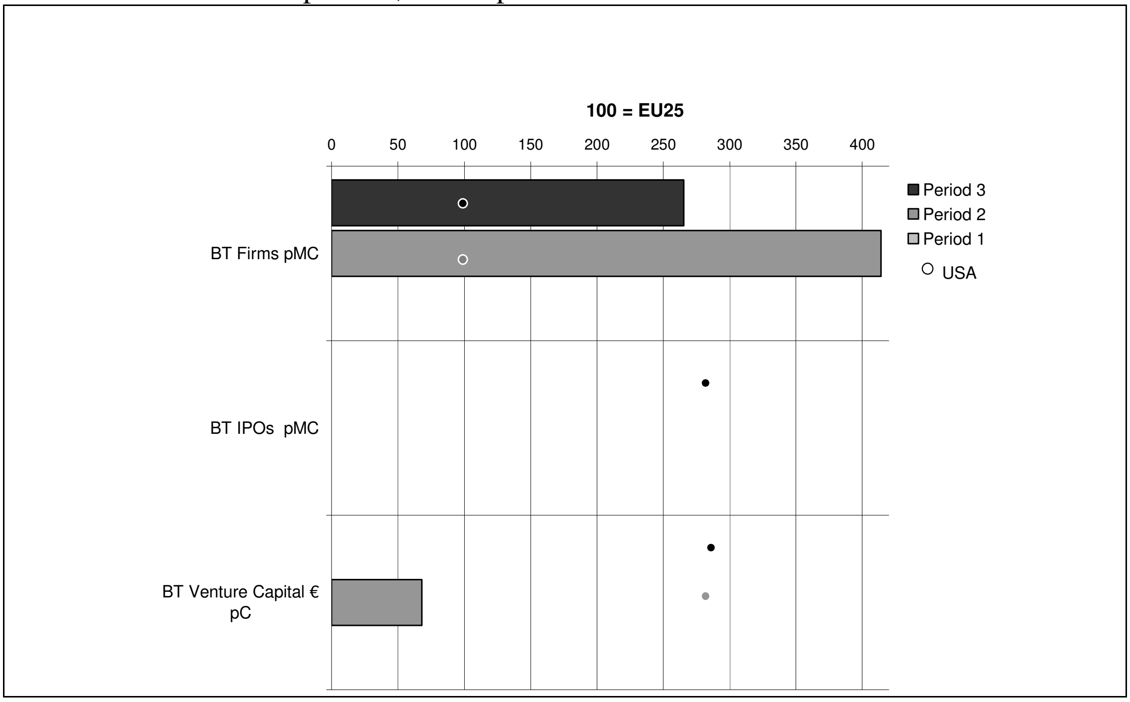
Source: BioPolis Research
Data: Database of European Patents (Host Questel Orbit , EPPATENT), Database of International Patent Applications (WOPATENT), EuropaBio
Note: the European reference region for indicator 11 (number of biotech start-ups pMC) is EU15.

3.4 Industrial Development

The indicators chosen to assess the overall performance in biotechnology industrial development are given in Chart 3.5.

With regard to the assessment of the development of the biotechnology industry, in the year 2001 (period 2), the Finnish biotechnology industry was quite large in terms of biotechnology companies per million capita, compared with the EU25 and USA. The Finnish advantage diminishes in the year 2004 (period 1) but still the industry indicators suggest a strong performance. According to the sources considered, between 2001 and 2005 no IPOs (initial public offerings) took place. As given in the chart, in 2002 (period 2) the volume of venture capital per capita was very low compared with the situation in the EU25 and in the USA. In this respect, the conditions for industrial development in 2002 seemed to be quite unattractive.

Chart 3.5 Performance indicators for Finland's Industrial developments for the three periods, in comparison with EU25 and USA



Source: BioPolis Research
Data: Ernst &Young Beyond Borders (report 2002, 2003, 2004, 2005), Websites of the London Stock Exchange, the Frankfurt Stock Exchange, Euronext, Nasdaq, Burril & Company

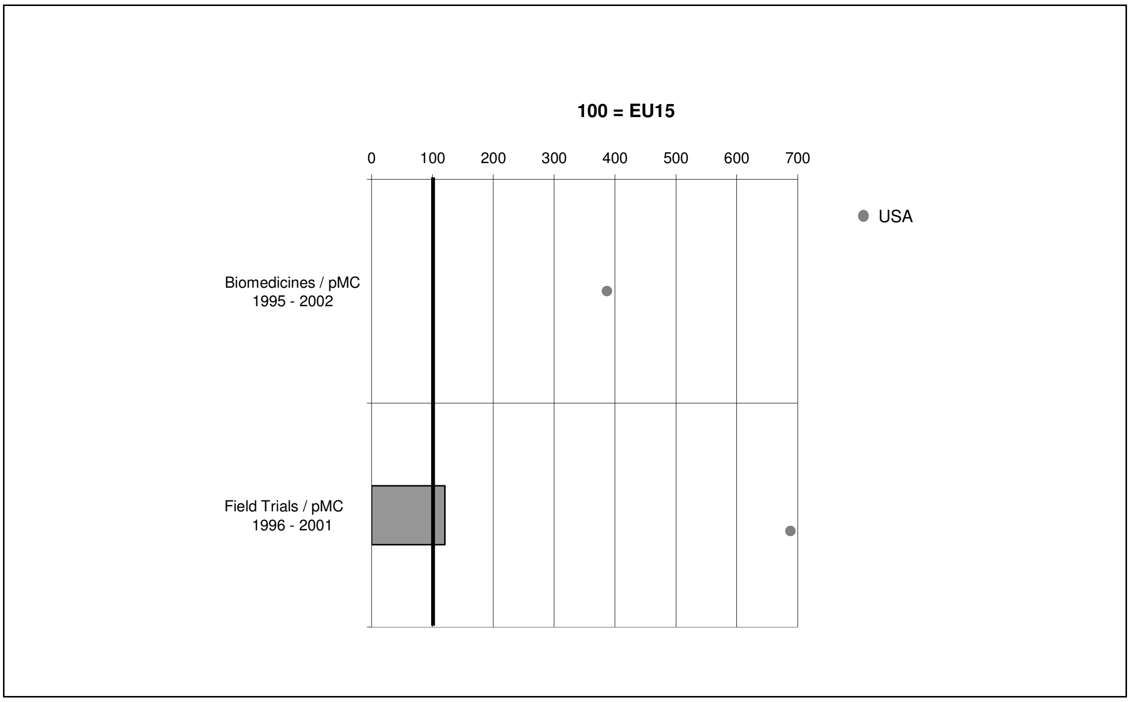
3.5 Market conditions

The indicators chosen to assess the overall performance in biotechnology industrial development are given in Chart 3.6.

During the time period 1995-2002, no biomedicines were reported from Finland.

Between 1996 and 2001, Finland reported a total number of 22 field trials. In absolute terms, Finland holds a weak position compared to the USA (with 6 745) and the best European performer France (397). However, if we consider the per capita figures, Finland reported 4.2 field trials pMC which brings the country slightly above the EU15 average (3.5).

Chart 3.6 Performance indicators for the Finland's Market Conditions, in comparison with EU25 and USA



Source: Benchmarking of public biotechnology policy 2005, Biotechnology Innovation Scoreboard 2002

4. Conclusions

4.1. Introduction

This chapter aims to give an analytical overview of the information described in the previous chapters. The information is presented in tables giving selected aspects of the policy instruments implemented in Finland at the national level in the period 2002-2005. The key aspects of the Finnish biotechnology policy approach considered in the analysis are:

- Funding volume per type of policy instrument
- Target groups of the policy instruments
- Policy goals addressed by the policy instruments in terms of funding
- Biotechnology research fields covered by the policy instruments
- Biotechnology activities stimulated through the policy instruments
- Trends in the types of policy instruments implemented (comparison with the period 1994-1998)

The next sections comment on these issues.

4.2. Public funding of biotechnology through policy instruments

Table 4.1 provides information on public funding of biotechnology per funding area (research or commercialisation) and per type of policy instrument (non-policy-directed, generic and specific policy-directed instruments) for the period 2002-2005.[21]

According to the information available, in the period 2002-2005 biotechnology public funding amounted to 461M EUR. Considering all types of instruments, 75.8% of the funding was spent on research promotion while commercialisation (or industrial application) received 24% of the funding.[22] Research is mainly funded through non-policy-directed instruments (institutional funding for research institutes and competitive response mode mechanisms of the Academy of Finland). Other funding areas (such as discourse and social acceptance of biotechnology) absorbed 0.2% of the funding.

As for policy-directed instruments, 111M EUR were invested in the promotion of commercialisation (or industrial application) of research results and 73.4M EUR were invested in research promotion. With regard to the implementation of generic and biotechnology-specific instruments, the information available suggests that in the period 2002-2005 generic policy-directed instruments played a minor role in the promotion of biotechnology.

[21] The data included in the table correspond with the information presented in chapter 2.

[22] The results concerning the balance between research support and commercialisation support should be interpreted with caution, since generic instruments promoting industrial development may have an impact on biotechnology. The information available does not give any insights into generic industrial policy instruments.

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

	Total in M EUR
RESEARCH	
1. *Non-policy-directed*	
Public Research Institutions [1)]	119.3
Response Mode[2)]	171.7
Total 1	**276.3**
2a. *Policy-directed Generic*[3)]	
National	n.a.
Regional	
Total 2a	**n.a.**
2b. *Policy-directed Biotech-specific*	
National	73.4
Regional	
Total 2b	**73.4**
COMMERCIALISATION	
3a. *Policy-directed Generic*[3)]	n.a.
National	
Regional	
Total 3a	**n.a.**
3b. *Policy-directed Biotech-specific*	
National	110.95
Regional	n.a.
Total 3b	**110.95**
4. OTHER	
National	0.9
Regional	n.a.
Total other	**0.9**
TOTAL (1+2+3+4)	**461.5**

Source: BioPolis Research

[1)] Data include the institutional funding of the research institutes KTL, METLA, MTT, SYKE, VTT and the Biocentres

[2)] Data include the funding of research of the Academy of Finland directed to biotechnology research through response mode instruments, except for the research programmes included under 2b and the budget for special projects at universities of the Ministry of Education

[3)] We have identified the technology programme Drug 2000 as a national policy-directed instrument, however, data on biotechnology funding are not available. Information on policy instruments for industrial development is not available.

4.3. Specific features of the instruments

Table 4.2 includes the policy-directed instruments per type according to the categories national/ regional and generic/biotechnology-specific. Additionally, the table shows the target groups of each instrument.

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

Instrument	Funding agency	Participants/Recipients*			Co-financing
		LFs	PROs	SMEs	
National					
Generic					
Drug 2000	Tekes (65%) AKA (35%)	✓	✓	✓	✓
Biotech-specific					
COMBIO	Tekes	✓	✓	✓	✓
NeoBio	Tekes	✓	✓	✓	✓
Sitra Life Sciences corporate finance	SITRA			✓	
RAKBIO 2000-2002	AKA (70%) Tekes (30%)		✓		
SYSBIO	AKA (84%) Tekes (16%)		✓		
ESGEMO	AKA		✓		
Life 2000	AKA (97%) Tekes (3%)		✓	✓	✓
Diagnostics 2000	Tekes	✓	✓	✓	✓
Regional					
Generic	n.a.				
Biotech-specific	n.a.				

Source: BioPolis Research

*LFs: large firms, PROs: public research organisations, SMEs: small and medium-sized enterprises

In the overview given in Table 4.2, it is clear that in the period 2002-2005 policy-directed biotechnology funding was mainly implemented through biotechnology-specific instruments. SITRA concentrated on providing financial resources to companies. All other policy-directed instruments target the activities of public sector research organisations. In the Tekes technology programmes, all actors considered (SMEs, LFs and PROs) are eligible for funding. Interestingly, Tekes, an institution focusing mainly on applied research and technology development, is involved in almost all policy-directed initiatives.

4.4. Policy goals

Table 4.3 presents the policy-directed instruments per type according to the categories national/ regional and generic/biotechnology-specific). Additionally, the table shows the policy goals explicitly addressed by each instrument. The policy goals considered are:

1. To stimulate a high level of biotechnology research
2. To stimulate a high level of industry-oriented (and applied) research
3. To stimulate knowledge flow and collaboration among scientific disciplines
4. To guarantee the availability of human resources
5. To stimulate the transfer of knowledge from academia to industry and its application to industrial resources
6. To promote the adoption of biotechnology for new industrial applications
7. To stimulate firm creation
8. To stimulate social acceptance of biotechnology
9. To promote business investment in R&D
10. To promote bio-safety research and risk assessment

Finally, for each type of policy instrument the table gives an estimation of the funding allocated for each policy goal.

In terms of funding, the stimulation of industry-oriented research and the promotion of business investment in R&D were the most important policy goals of policy-directed instruments. More than 65% of policy-directed funding was engaged in reaching these policy goals. This empirical evidence suggests that policy-directed funding in Finland has been very much engaged in promoting the industrial application of biotechnology.

If we consider the data presented in Table 4.1., it seems that the Finnish approach to biotechnology promotion drew on the one hand on the implementation of non-policy-directed funding to promote research and, on the other hand, on policy-directed instruments to promote the industrial application of research results.

According to the data available, policy-directed instruments have put relatively low emphasis on certain policy goals in terms of funding. These policy goals concern bio-safety, risk assessment and social acceptance of biotechnology. Even though these issues have not been neglected and promotional programmes have tackled them, these policy goals seem to have had low priority in the period 2002-2005 in terms of funding.

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										
Drug 2000[1)]										
Total										
Biotech-specific										
COMBIO		✓								
NeoBio		✓							✓	
Sitra Life Sciences corporate finance						✓	✓		✓	
RAKBIO 2000-2002	✓		✓		✓					
SYSBIO	✓		✓	✓						
ESGEMO	✓		✓		✓			✓		✓
Life 2000	✓									
Diagnostics 2000		✓			✓					
Total	12.85	56	2.75	1.8	5.95	18.33	18.33	0.45	68.33	0.45
Regional										
Generic										
Total										
Biotech-specific										
Total										
Grand Total	12.85	56	2.75	1.8	5.95	18.33	18.33	0.45	68.33	0.45
% of Grand Total	7%	30%	1%	1%	3%	9.9%	9.9%	0%	36.9%	0%

Source: BioPolis Research

1) Data on biotechnology funding are not available.

*

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 Transfer 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

4.5. Biotechnology research application areas

Table 4.4 presents the biotechnology research application areas stimulated by the national policy-directed instruments and the funding dedicated to each research area in the period 2002-2005. The applications areas considered are:

1) Plant biotechnology
2) Animal biotechnology
3) Environmental biotechnology
4) Health biotechnology
5) Food biotechnology
6) Industrial biotechnology
7) Basic biotechnology
8) Ethical, legal, social aspects of biotechnology
9) General (applies to programmes addressing capability building, patenting activities, networking, etc. and a research field which cannot be specified)

For each type of policy instrument, the table gives an estimation of the funding allocated for each research area.

The data available for the policy-directed instruments indicate that basic biotechnology (40%) and health biotechnology (21%) have been the research application areas receiving the largest share of funding. The general area (involving framework conditions where a research area cannot be specified) absorbed 30% of the funding.

Environmental biotechnology and food biotechnology have been funding gaps in the Finnish system of biotechnology promotion through policy-directed instruments in the period 2002-2005. These fields were promoted through the funding of research institutes (see section 2.2.3).

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

	Biotech application areas								
	1*	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
National									
Generic									
Drug 2000 [1)]				✓					
Total				n.a.					
Biotech-specific									
COMBIO				✓					
NeoBio	✓			✓		✓	✓		
RAKBIO							✓		
SYSBIO	✓	✓		✓			✓	✓	
ESGEMO	✓							✓	
Life 2000							✓		
Diagnostics 2000				✓					
Sitra Life Sciences corpo-rate finance									✓
Total	4.89	0.3		39.4		10	75.43	0.28	55
Charities									
Total									
Grand Total National	**4.89**	**0.3**		**39.4**		**10**	**75.43**	**0.28**	**55**
% of Grand Total National	**2.6**	**0.2**	**0.0**	**21.3**	**0.0**	**5.4**	**40.7**	**0.2**	**29.7**

Source: BioPolis Research

1) No data available

*

1 = Plant biotechnology
2 = Animal biotechnology
3 = Environmental biotechnology
4 = Health biotechnology
5 = Food biotechnology
6 = Industrial biotechnology
7 = Basic biotechnology
8 = Ethical, legal, social aspects of biotechnology
9= General biotechnology

4.6. Stimulation of biotechnology activities through the instruments

Table 4.5 presents the biotechnology activities stimulated by the national policy-directed instruments. The biotechnology activities considered are:

1) Basic research
2) Applied research
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
9) Setting up research institute/centre of industrial interest
10) Technology transfer office
11) Science and technology park
12) Protection of IPR in public research organisations
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 actively engaged in it
17) Grants for industrial research
18) Other incentives for business investment and public research organisations
19) Support for public discourse activities

The data available suggest that policy-directed instruments stimulated mostly financial support for start-ups (30% of the biotechnology funding) and industrial research (27% of the biotechnology funding). Next, basic research (with 23% of the biotechnology funding) received large attention from public policy. Applied research (9%) and mobility of researchers (7%) have also been strongly promoted. All in all, the results suggest that industrial aspects have been the main focus of attention of policy-directed instruments in Finland in the period 2002-2005.

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 Policy Instruments																			
Generic																			
Drug 2000 [1)]	✓	✓																	
Biotech-specific																			
COMBIO		✓			✓														
NeoBio		✓															✓		
Sitra Life Sciences corporate finance													✓						
RAKBIO 2000-2002	✓																		
SYSBIO	✓																		
ESGEMO	✓																		
Life 2000	✓	✓																	
Diagnostics 2000		✓		✓				✓											
Total National Funding	**43**	**16.8**		**3**	**13**			**4.5**					**55**				**50**		
% of Total National Funding	**23%**	**9%**		**2%**	**7%**			**2%**					**30%**				**27%**		

Source: BioPolis Research

[1)] no funding data available

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

1 Basic research
2 Applied research
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
9 Setting up research institute/centre of industrial interest
10 Technology transfer office
11 Science and technology park
12 Protection of IPR in public research organisations
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 actively engaged in it
17 Grants for industrial research
18 Other incentives for business investment and public research organisations
19 Support for public discourse activities

4.7. Dynamics: comparison with period 1994-1998[23]

Table 4.6 Comparison of biotechnology research funding through non-policy-directed 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	57.2	87.4
Regional	n.a.	n.a.
Total	**57.2**	**87.4**

Source: BioPolis Research

Table 4.6 gives a comparison of the annual average biotechnology research funding in the periods 1994-1998 and 2002-2005 through non-policy-directed funding and policy-directed instruments. The data suggest that the promotion of biotechnology has experienced considerable growth in these two periods.

Table 4.7 Coverage of policy goals by the 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 a high level of biotechnology basic research	✓	✓	✓	✓
	2. To promote a 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 transfer and application	5. To facilitate transfer of knowledge from academia to industry and its application for industrial purposes		✓		✓
	6. To stimulate the adoption of biotechnology for new industrial applications	n.a.	n.a.		✓
	7. To assist firm creation	n.a	n.a		✓
3. Market	8. To monitor and improve the social acceptance of biotechnology		✓		✓
4. Industrial development	9. To encourage business investment in R&D	n.a.	n.a.		✓

Source: BioPolis Research

G = generic instruments; ** S= Biotechnology-specific instruments

[23] Data and information for the period 1994-1998 draw on Benedictus, J. N. (1999). National Report of Finland. In: Inventory of public biotechnology R&D programmes in Europe. C. M. Enzing, J. N. Benedictus, E. Engelen-Smeetset al. Luxembourg, DG Research - European Commission.

Table 4.7 compares the periods 1994-1998 and 2002-2005 in terms of the existence of policy-directed instruments targeting selected policy goals. According to the information available, in both periods the profile of policy instruments implemented is quite similar. Policy-directed instruments are mainly biotechnology-specific. Generic instruments have been launched in both periods to promote basic and applied research. In the period 2002-2005, there are specific policy instruments targeting policy goals in the areas of knowledge transfer and application, market and industrial development. A comparison with the previous period concerning these policy areas is not possible since information for the period 1994-1998 is not available.

Regarding the promotion of biotechnology application areas, in the period 1994-1998 health biotechnology was the area receiving the highest priority. About 50% of the funding granted by Tekes and AKA was allocated to research in relation to health. In the period 2002-2005, basic biotechnology receives the highest priority in terms of funding. General initiatives promoting the development of research and commercialisation capacity (such as networking, patent activities, etc.) are the second main funding area. Health biotechnology reached third position in terms of funding. It seems that the funding profile in Finland has moved towards the promotion of basic generic developments of biotechnology, where the application area is not clearly defined.

5. Future developments

The information available suggests that the Finnish government will continue to promote biotechnology in the future. The consolidation effort will continue, aiming at closer co-operation between the various actors forged through a number of initiatives, all aiming at international competitiveness of both research and business operations. Support for commercialisation will be more strictly targeted towards feasible business strategies and international operations.

In December 2005, the Ministry of Education published the results of the work carried out by a "biotechnology committee" regarding the development needs in the field of biotechnology in Finland (Jäppinen 2005)[24]. The committee had been appointed to look into the actors in biotechnology, especially molecular medicine, genetics and epidemiology, the financing resources, and the development needs in these research fields. In order to make the funding activities more systematic, to support increasing cooperation among research groups and to prevent reduplication in the establishment of facilities and infrastructure, the committee proposed the formulation of a national biotechnology strategy, which should be drafted by a future biotechnology council. The aim of coordinating the research activities goes further, with the suggestion of merging/ uniting ??? all the five Finnish Biocentres, the sectoral research centres focusing on biotechnology and biotechnology institutes attached to universities in a Biocenter Finland. Moreover, an International Centre of Molecular Medicine, Genetics and Epidemiology should be established, with strong networking activities with EMBL and research institutes in other Nordic countries.

Concerning the activities to promote training of human resources, the resources of molecular medicine, genetics and epidemiology graduate schools should be increased and cooperation in post-graduate education between sectoral research institutes, universities and graduate schools should be strengthened. The need to develop the pool of human resources will be additionally tackled by initiating biotechnology degree programmes enhancing disciplinary cooperation between chemistry, physics, information technology and medicine. In addition, cross-disciplinary education should be established combining science studies with law, marketing and management. Moreover, the extent of IPR and business knowledge should be increased in the graduate schools.

Following the suggestions of the "biotechnology committee", in 2006 several consolidation efforts were carried out in the biotechnology research and development field and new structures were created. The main biotechnology development regions and their development institutions created HealthBIO as a new competence cluster for health-related biotechnology. By coordinated cooperation and networking of both regional and other national activities, and with a multi-disciplinary approach to top-level expertise and competencies, the cluster aims to build on the international competitiveness of the Finnish biotechnology by:

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[24] Jäppinen, A. (2005) Biotechnology 2005. Reports of the Ministry of Education, Finland Helsinky, Ministry of Education

- making new and existing know-how more efficiently available for business processes
- identifying and fostering new business ideas and opportunities
- developing enabling tools and procedures to support the funding, growth and internationalisation especially of SMEs
- international networking of the entire innovation process
- enhancing the differentiation and profiling of the participating regions.

That same year the Molecular Medicine Research Centre was established at the University of Helsinki. The centre is a joint undertaking of Finnish biocentres and an important part of the development of the entire biocentre network. It will develop into an international research institute and start networking with the European Molecular Biology Laboratory.

In 2006 the government was in the process of selecting 5-6 Strategic Centres for Science, Technology and Innovation. Various biotechnology applications should be strongly represented amongst them and the pre-selected list identified health, bio-refineries in the context of the forest industry, and energy and environment applications as strategic areas where biotechnology will play an important role.

As for the technology programmes of Tekes after 2005, it seems that research funding strategy is a broader integration of the technology. One example is the programme SYMBIO launched in June 2006 covering a wide range of technology-based industries, from the chemical industry and biotechnology, through to environmental technology, and, indirectly, to production technology. Moreover, the instrument aims to promote knowledge flow between academic disciplines. The main goal is to upgrade industrial processes through biotechnology applications. Cross-cutting instruments of this type will receive more weight in the future.

The Ministry of Social Affairs and Health has set up a working group to promote the use of collections of samples of human origin for medical purposes ("biobanks"). The task of the working group is to put forward a proposal for the necessary law amendments, with a view to securing the use of both the existing and new sample collections in future research and product development. The Ministry has assessed that unique collections and experience in using them, combined with up-to-date scientific know-how, provides Finnish biotechnology with an excellent background for both scientific advances and health development opportunities. The working group also aims to actively promote the public discussion of the various biobank-related questions.

Regarding the promotion of biotechnology applications in the food, agriculture and energy sectors, the government is interested in promoting further development of biotechnology applications in these areas. Energy and industrial applications of biotech, e.g. biorefineries, will play a greatly enhanced role.

Annex 1 List of tables

Annex 2 List of charts

Annex 3 List of contact persons

Ministry of Education
Sakari Karjalainen

Ministry of Trade and Industry
Pekka Lindroos

Academy of Finland
Riitta Mustonen

Tekes
Maritta Perälä-Heape
Mika Sievi-Korte
Merja Hiltunen

SITRA
Pasi Lehtinen

National Public Health Institute - KTL
Jari Kirsilä

Finnish Forest Research Institute - Metla
Katri Karkkainen

Agrifood Research Finland - MTT
Eeva-Liisa Ryhänen

Finnish Environment Institute - SYKE
Kirsten S. Jørgensen

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European Commission	http://europa.eu.int/comm/public_opinion/
Eurostat	http://www.eurostat.org

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	3.1	Index: Reference	(2) 1998

	Indicator	Chart	Comments	Time periods
	sciences pMC		Region EU17 =100 and US data for comparison	(3) 2002
Ind. 7	BT publications in subfields, as % of total BT publications	3.2.1 3.2.2	Data in % EU25 and US data for comparison	1994-1996 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[25]	2005
Ind. 16	Biomedicines	3.6	Source: BT Policy Benchmarking 2005 Index: Reference Region EU15 =100 US data for comparison	1995-2002

25 http://europa.eu.int/comm/public_opinion/archives/ebs/ebs_225_report_en.pdf

	Indicator	Chart	Comments	Time periods
Ind. 17	Field trials	3.6	Source: Biotechnology Innovation Scoreboard 2002 Index: Reference Region EU15 =100 US data for comparison	1996-2001

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
Finland	2464	3512	4094	5	5	5
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
Finland	482	679	784	221	238	246
USA	454	492	529	208	172	166

Source: BioPolis Research
Publication data: Science Citation Index (through online database vendor STN International)
Population data: 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 spend-ing on BT (M Ecu)**	**BT publica-tions/ M Ecu 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.		
Finland	4094	210	72,5	3,9	286	14	89
USA	154402				n.a.		n.a.

Source: BioPolis Research
Publication data: Science Citation Index (through online database vendor STN International)
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
Finland	2464	3512	4094	18928	23708	26287
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
Finland	13%	15%	16%	115	118	119
USA	13%	14%	15%	119	115	113

Source: BioPolis Research
Publication data: Science Citation Index (through online database vendor STN International)

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
Finland	9.16	8.80	149	121
USA	6.39	8.54	104	117

Source: BioPolis Research
Citations data: Science Citation Index (through online database vendor STN International)

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	46859**	81316	552**	431
Finland	389	483	5	5
USA	75253*	70950	276*	288
	Graduates pMC		Index EU17=100	
	1998 / 1999	2002	1998 / 1999	2002
EU17	91**	189	100	100
Finland	76	93	89	49
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
Graduates data OECD Education Database
Population source for US is the 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%
Finland	100%	7%	63%	3%	2%	1%	1%	23%
USA	100%	6%	56%	5%	2%	0%	0%	30%

Source: BioPolis Research
Publication data: Science Citation Index (through online database vendor STN International)

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%
Finland	100%	7%	63%	4%	4%	1%	1%	20%
USA	100%	6%	59%	5%	3%	0%	1%	26%

Source: BioPolis Research
Publication data: Science Citation Index (through online database vendor STN International)

Raw data for Chart 3.3. 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
Finland	2486	162	1559	75	60	19	29	582
USA	111686	7118	62274	5580	2230	296	459	33729

Source: BioPolis Research
Publication data: Science Citation Index (through online database vendor STN International)

Raw data for Chart 3.2.1 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
Finland	4012	261	2536	174	159	22	43	817
USA	141680	7910	84234	6872	4070	436	724	37434

Source: BioPolis Research
Publication data: Science Citation Index (through online database vendor STN International)

Raw data for Chart 3.2.2 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%
Finland	61%	63%	132%	165%	16%	48%	40%
USA	11%	35%	23%	83%	47%	58%	11%

Source: BioPolis Research
Publication data: Science Citation Index (through online database vendor STN International)

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
Finland	112	163	171	5	5	5
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
Finland	22	32	33	199	159	148
USA	33	52	42	295	264	190

Source: BioPolis Research
Publication data: Science Citation Index (through online database vendor STN International)
Patent data: `EPPATENT, WOPATENT` (online database vendor 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
Finland	112	163	171	2464	3512	4020
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
Finland	0.05	0.05	0.04	90	67	59
USA	0.07	0.11	0.08	142	153	115

Source: BioPolis Research

Publication data: Science Citation Index (through online database vendor STN International)
Patent data: `EPPATENT, WOPATENT` (online database vendor 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
Finland	110	76	72	69	21.3	14.63	13.83	13.22
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
Finland	21.3	14.63	13.8	13.2	5181	5195	5206	5220
USA	5.11	5.11	5.06	4.95	99	99	116	99

Note: EU Available is the result of the sum of available EU Member States
Source: BioPolis Research
Biotech companies data: Ernst and Young 2002-2005, 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 (EU15 - Cyprus - Greece + Norway + Switzerland)	523	132	367051	
Finland	10	0	5206	
USA	355	83	290789	
	Biotech start-up/pMC	**Index**	**Biotech start-up/pMC**	**Index**
	2001-2003	**2001-2003**	**2003**	**2003**
Europe (EU15 - Cyprus - Greece + Norway + Switzerland)	1.4	100	0.36	100
Finland	0.00	0	1.9	135
USA	1.2	86	0.29	79

Source: BioPolis Research
Start-ups data: 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 Availiable	29	452927	454869	457154	461593	456636
Finland	0	5195	5206	5220	5237	5214
USA	52	287941	290789	291685		290138

	IPO /pMC	Index
	2002-2005	2002-2005
EU Availiable	0.00	100
Finland	0.00	0.00
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: BioPolisResearch

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
Finland	10			5195		
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
Finland	2			68		
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
Finland	0	5	0.00	0
USA	115	289	0.40	387

Note: EU15 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 Trials pMC	Index
	1996-2001	2001	1996-2001	1996-2001
EU15	1334	379	4	100
Finland	22	5	4	120
USA	6745	278	24	688

Note: EU15 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)
EU15*	100.29	16828
Finland	100.18	986

*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
Source: BioPolis Research
BT acceptance index: Benchmarking of public biotechnology policy 2005

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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

AKA	The Academy of Finland
BT	Biotechnology
EU	European Union
GDP	Gross Domestic Product
GMOs	Genetically Modified Organisms
ICT	Information and Communication Technology
KTL	National Public Health Institute
LFs	Large Firms
M EUR	Million Euro
METLA	Finnish Forest Research Institute
MoE	Ministry of Education
MTT	Agrifood Research Finland
pMC	Per million capita
PROs	Public Research Organisations
Publ.	Publications
R&D	Research and Development
SITRA	Finnish National Fund for Research and Development
SMEs	Small and Medium Enterprises
SYKE	Finnish Environment Institute
Tekes	Finnish Funding Agency for Technology and Innovation