

# 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 Germany

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## Summary

In the last decade, Germany has become one of the slowest growing economies in the European Union. With an unemployment rate of 9.5% in 2005, policy activity is very much dominated by labour market and welfare system issues. However, policymakers are very engaged in promoting research and development activities. With a GERD/GDP ratio of 2.49%, in 2004 Germany was the fourth largest EU country in terms of R&D investment as a percentage of its GDP behind Sweden, Finland and Denmark. The private sector plays a major role in the German innovation system. In 2004 industry financed 67.1% of the R&D activities in Germany. This was the second largest national rate behind Finland.

The federal government and the federal states (16 *Länder*) share the responsibilities concerning the promotion of education, science, technology and innovation. Previous studies give enough empirical evidence for the commitment of the German federal government in promoting biotechnology in the last decades. In the reporting period (2002-2005) Germany continued to promote the development of the biotechnology knowledge base and its commercialisation with a broad set of policy instruments. This study estimates that 4 572.1M EUR have been allocated for these purposes in the period 2002-2005.

According to the information available, biotechnology is mainly promoted through non-policy-directed instruments. These instruments allocated 3 278M EUR, which represent 72% of the total funding in the period 2002-2005. Considering that this funding goes mainly to public research institutions, in the reporting period the largest policy effort was directed to the promotion of the knowledge base and human resources. As far as the policy-directed instruments are concerned, these allocated 1 293.7M EUR to the promotion of biotechnology. The national framework programme "Biotechnology" was the most important policy-directed instrument in terms of funding (705.5M EUR in the period 2002-2005). According to the data available, policy-directed instruments targeting commercialisation allocated 40% of the funding and 57% of the funding has been allocated to promote research. However, the interpretation of the data should be treated with caution due to data gaps concerning the extent to which generic policy-directed instruments promoting industrial research may have an impact on biotechnology R&D activities in companies. With regard to the role played by the *Länder*, policy-directed instruments here allocated 35% of the total funding in the reporting period. The federal government thus remains the main promoter of the biotechnology knowledge base and its industrial application.

The data available for the policy-directed instruments at the national level indicate that health biotechnology and industrial biotechnology were the application areas receiving the largest share of funding with this type of instrument.

According to a survey of public attitudes to new technologies in Europe, 65% of the respondents in Germany believe that developments in biotechnology and genetic engineering can positively affect our way of life over the next 20 years. This exactly matches the European average. However, German citizens quite dislike the use and development of biotechnology in terms of specific applications.

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

In terms of performance in developing the biotechnology knowledge base, in the reporting period (1994-2004) Germany outperforms the EU in terms of biotechnology publications per capita. However, the indicator giving the citation rates per biotechnology publication suggests that the quality of German biotechnology publications in terms of citations decreased between the two periods under consideration (1994/98 and 2000/04). In the most recent period the German level is below the EU level. The results are worrying. Moreover, the indicators for human capital give evidence of a critical situation as regards the availability of human resources in the life sciences.

Germany's performance in applying scientific knowledge for industrial applications is very satisfactory compared to the EU and USA in terms of patent activity. However, the results are not as favourable in terms of company creation. This weakness is clearer if we consider the indicators for industrial development and market conditions. Indicators based on the number of biotechnology companies per capita, on venture capital and on biotechnology-based products suggest that the German biotechnology system has some weaknesses in the industrial development process and in bringing biotechnology-based products to the market.

According to the information available, biotechnology will remain a focus of attention for innovation policy. In its latest strategic document, the Ministry of Education and Research has identified 4 key fields for action in the biotechnology field:

- To promote the knowledge base for product and process innovation in biotechnology. For this purpose the government sets 3 scientific fields: (i) genome research, (ii) systems biology and (iii) molecular medicine.
- To exploit the potentials of industrial biotechnology and nano-biotechnology
- To promote the valorisation of scientific results.
- To promote the dialogue between industry and society.

## **1. Introduction and background**

### **1.1 General introduction**

In 2005 Germany was the largest economy in the European Union (EU) in terms of GDP and the most populous country in the EU. According to EUROSTAT<sup>1</sup>, with a GDP of 2 244 000M EUR and a population of 82.5 million inhabitants, in 2005 Germany's GDP per head was 7% larger than the EU25 average. Between 2000 and 2003, economic growth in Germany slowed down, reaching -0.2% growth rate of its real GDP in 2003. The economy recovered slowly to reach 1.2% growth rate in 2004, but falling again in 2005 to 0.9%. With this development Germany has become one of the slowest growing economies in the European Union (EU25 average in 2005 2.3%). With an unemployment rate of 9.5% in 2005, policy activity is very much dominated by labour market and welfare system issues. Moreover, the weak economic development in eastern Germany is still a main political concern. The relatively large public deficit share as percentage of the GDP (over the 3% threshold in 2003) is an important obstacle to undertaking public investments to try to overcome the economic stagnation. The outstanding export performance is the mainstay of Germany's economic growth.

Despite the weak macroeconomic performance in the last decade and the major structural problems of the German economy, the efforts in research and development activities (R&D) grew continually between 1996 and 2003. In 2004 R&D investment declined slightly. Nonetheless, with a GERD/GDP<sup>2</sup> ratio of 2.49%, in 2004 Germany was the fourth largest EU country in terms of R&D investment as a percentage of its GDP, behind Sweden, Finland and Denmark.<sup>3</sup> The private sector plays a major role in the German innovation system. In 2004 industry financed 67.1% of the R&D activities. This was the second largest national rate behind Finland.

### **1.2 Characteristics of the national S&T and the innovation system<sup>4</sup>**

The German system has a wide range of institutions involved in designing and implementing policy instruments in science, technology and innovation policy. Chart 1.1 shows the main institutions at the federal and *Länder* levels.

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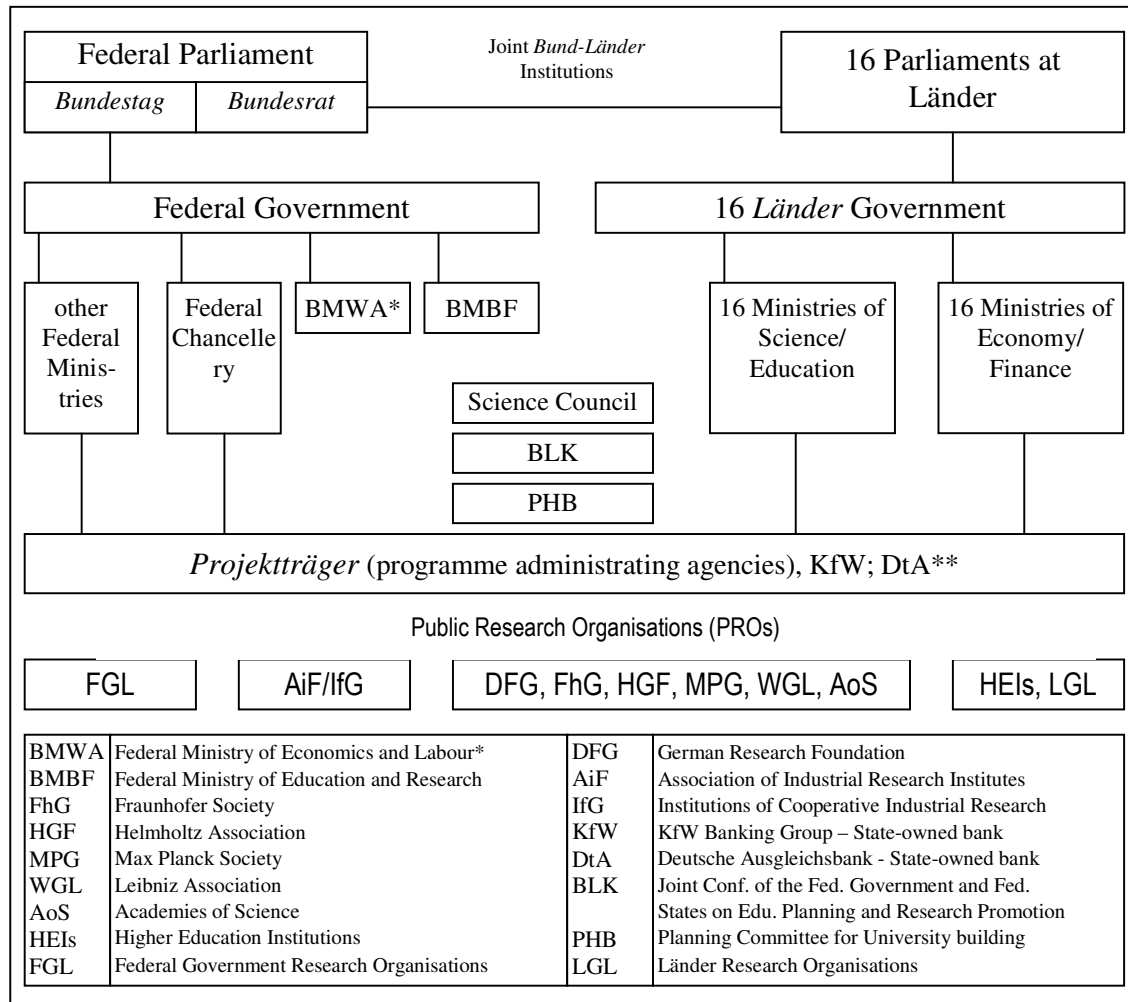
<sup>1</sup> This paragraph draws on data from EUROSTAT. <http://www.eurostat.org>

<sup>2</sup> GERD/GDP: gross expenditure on research and development expressed as a percentage of gross domestic product.

<sup>3</sup> Only data for 2004 available

<sup>4</sup> This section is largely based on European Commission (2005a) European Trend Chart on Innovation - Annual Innovation Policy Trends and Appraisal Report Germany 2004-2005. Brussels, European Commission.

Figure 1.1 Main public institutions in German Science, Research and Innovation in 2005



\*In autumn 2005 the Federal Ministry for Economic Affairs and Labour (BMW A) was divided into the Federal Ministry for Economics Affairs and Technology (BMW I) and the Federal Ministry for Labour and Social Affairs (BMAS)

\*\*In July 2003 the KfW and the DtA merged to the KfW Group

Source: European Commission(2005a)<sup>5</sup>; BioPolis Research

As shown in Figure 1.1, the federal government and the federal states share the responsibilities concerning the promotion of education, science, technology and innovation.

The federal government designs and implements a wide range of policy instruments for these purposes: (i) it promotes research and development activities in public research organisations (PROs) and in companies through project funding, (ii) it launches initiatives and designs legislation to support the industrial application of scientific results and (iii) it implements programmes to stimulate network formation, company creation and re-

<sup>5</sup> European Commission (2005): European Trend Chart on Innovation - Annual Innovation Policy Trends and Appraisal Report Germany 2004-2005.

gional development. Moreover, the federal government co-finances the German Research Foundation and the institutional funding (block grants) of the major PROs, except for the higher education institutions (HEIs) and the agencies and research organisations funded by the Länder (LGL).

As shown in Figure 1.1., in the period 2002-2005 these tasks were mainly carried out by two federal ministries: the Federal Ministry of Economics and Labour (BMWA) and the Federal Ministry of Education and Research (BMBF). In autumn 2005, the BMWA disappeared and technology policy became the remit of the Ministry for Economic Affairs and Technology (BMWV).

Table 1.1 shows the areas of promotion of the ministries in the period 2002-2005.

Table 1.1 Areas of science, technology and innovation promotion of the BMBF, BMWA, BMWV

<b>BMBF</b>	<b>BMWA / BMWV</b>
Thematic programmes (R&D project funding)	General framework conditions for innovation and entrepreneurship
Knowledge and technology transfer	Specific support for industrial innovation in SMEs and company creation
Network formation at the national and regional levels	Innovation infrastructure for the industrial sector
Tertiary education and mobility of scientists	

Source: BioPolis Research based on European Commission(2005a)

On the other side, the governments of the 16 *Länder* accomplish four main tasks: (i) to finance the education system, (ii) to promote university-related activities such as technology transfer from academia to industry, (iii) to provide (together with the federal government) institutional funding for PROs (FhG, HGF, MPG, WGL and AoS) and for the DFG and (iv) to design, implement and finance science, technology and innovation policy for the *Länder*.<sup>6</sup>

Normally, two *Länder* ministries share the responsibility of designing and implementing science, technology and innovation policy: the Ministry of Education and the Ministry of Economic Affairs.<sup>7</sup>

<sup>6</sup> The governments of the *Länder* (*Landesregierungen*) have the same legal competence to design and implement science, technology and innovation policy for the respective state as the federal government (*Bundesregierung*) does. In other words, federal policy and policy from the federal states supplement each other. The main factor limiting the legal competence of the *Länder* is the budget they can allocate for the initiatives they design.

<sup>7</sup> The official names of the ministries and the specific responsibilities in science, technology and innovation policy vary in each federal state.

Two institutions coordinate federal policy and *Länder* policy : the Joint Commission on Education Planning and Research promotion (*Bund-Länder Kommission*, BLK) and the Planning Committee for University Building (PHB). A further important institution in the governance system of science, technology and innovation policy is the Science Council (*Wissenschaftsrat*), which is the advisory board of the federal government and the states regarding science and research policy.

An important feature of the German governance system is the existence of the so-called *Projekträger*. These are project management agencies responsible for launching and managing public promotion initiatives of the federal ministries and the *Länder* ministries on a contractual basis. In other words, these agencies act as intermediary bodies between the ministries financing the initiatives and the target groups of the different programmes (consumers, PROs or companies). They are directly involved in the administration and, to a certain extent, in the conceptual design of the public promotion programmes.

State-owned banks are important institutions in the governance system as well. Between 1989 and 2003 two state-owned banks (the *Kreditanstalt fuer Wiederaufbau* KfW and the *Deutsche Ausgleichsbank* DtA) had programmes allocating funding for financing innovation in small and medium-sized enterprises (SMEs): the KfW through its innovation programme and the DtA through the innovation financing schemes of its subsidiary *Technolgiebeteiligungsgesellschaft* tbG (Society for Equity Investment).

In July 2003, the two state-owned banks KfW and DtA merged to form the KfW Bank Group. As a result, all SME-related activities received a common label and are offered by the branch 'KfWMittelstandsbank' (SME Bank). This should increase transparency and efficiency in running public programmes, and facilitate access to these programmes, including KfW's innovation programme and the venture capital programmes run by the tbG. The KfW SME Bank is hence part of the state-owned KfW Group and offers promotional loan financing of operating costs and tailor-made equity finance products to business founders, self-employed professionals and established companies.

Finally, the German Research Foundation (DFG) supports interdisciplinary research projects at universities and other public research organisations (PROs) in Germany, as well as individual scientists. In 2005 the foundation had a total budget of 1 300M EUR (58% thereof were funded by the federal government and 41.6% by the *Länder*). The main characteristics of the DFG are (i) its autonomy in regard to the funding priorities and decisions from policymakers and (ii) the allocation of its resources through competitive funding. The DFG has a wide range of instruments to promote scientific research and training. The most important are the co-ordinated programmes (which aim to encourage cooperation and interdisciplinarity and were promoted with 754.4M EUR in 2005) and the individual grants programme (which were promoted to with tune of 538.2M EUR in 2005).<sup>8</sup>

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<sup>8</sup> The data were collected from the internet site of the DFG <http://www.dfg.de> (last accessed August 2006)

### 1.3 National support and framework conditions for biotechnology

Previous studies give sufficient empirical evidence for the commitment of the federal government to promoting biotechnology in the last decades.<sup>9</sup> Already in the 1970s, the federal government showed its concern about developing the biotechnology knowledge base. Since the mid 1980s, 3 thematic programmes have been launched by the federal government targeting explicitly the development and industrial application of biotechnology in Germany:

- 1) Applied biology and biotechnology (launched in 1985)
- 2) Biotechnology 2000 (launched in 1991)<sup>10</sup>
- 3) Biotechnology Framework Programme (launched in 2000)<sup>11</sup>

Accordingly, national support for biotechnology research has been very much determined by these biotechnology-specific programmes. The last two programmes involved a wide range of instruments targeting biotechnology-related activities, such as collaborative research between industry and academia and network formation. Moreover, the initiative BioRegio, launched by the federal government in 1995 within the framework of the Biotechnology 2000 Programme, prepared the ground for the establishment of biotechnology regional clusters in Germany. This policy instrument aimed to develop the regional potentials in biotechnology, to establish biotechnology companies and networks exploiting regional knowledge and regional industrial resources. The success of the initiative raised great awareness of the potentials of biotechnology among regional policymakers. According to Giessler et al. (1999)<sup>12</sup>, besides the measures at the federal level, the regional policies designed and implemented by the 16 *Länder* in the period 1994-1998 included a number of measures promoting biotechnology. All in all, the support for biotechnology in Germany has been an important priority for policymakers in the last two decades.

According to a survey of public attitudes to new technologies in Europe (European Commission 2005b)<sup>13</sup>, in Germany 65% of the respondents believe that developments in biotechnology and genetic engineering can positively affect our way of life over the next 20

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<sup>9</sup> See for instance Giesecke, S. (2001) *Von der Forschung zum Markt - Innovationsstrategien und Forschungspolitik in der Biotechnologie*. Berlin, Freie Univ. Berlin.; Giessler, S. and T. Reiss (1999). National Report of Germany. Inventory of Public Biotechnology R&D Programmes in Europe. C. M. Enzing, J. N. Benedictus, E. Engelen-Smeets et al. Luxembourg, DG Research - European Commission., and Dominguez Lacasa, I. and T. Reiss (2004). Effectiveness of Innovation Policies: Biotechnology in Germany (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.

<sup>10</sup> See BMFT (1991) *Biotechnologie 2000: Programm der Bundesregierung*. Bonn, Federal Ministry for Research and Technology (BMFT).

<sup>11</sup> See BMBF (2001) *Rahmenprogramm Biotechnologie – Chancen nutzen und gestalten*. Bonn Berlin, Federal Ministry of Education and Research (BMBF).

<sup>12</sup> Giessler, S. and T. Reiss (1999). National Report of Germany. Inventory of Public Biotechnology R&D Programmes in Europe. C. M. Enzing, J. N. Benedictus, E. Engelen-Smeets et al. Luxembourg, DG Research - European Commission.

<sup>13</sup> 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](http://europa.eu.int/comm/public_opinion/archives/ebs/ebs_225_report_en.pdf)

years. This exactly matches the European average. However, in terms of specific applications, German citizens are quite distrustful of the use and development of biotechnology.

Germany is much stricter than the EU average in rejecting the cloning of human beings so that couples can have a baby, even when one partner has a genetic disease (73% compared to the EU average of 59%).

The attitude to the cloning of human embryo stem cells to treat people with diseases resembles the European average. 26% of citizens believe this should never occur (EU average 22%), 22% of citizens approve it only in exceptional circumstances (EU average of 20%) and 40% approve it only if it is highly regulated and controlled (EU average of 41%).

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

- 60% will never approve the use of genetic tests for children to identify talents and weaknesses (EU average 54%);
- 60% will never approve the use of genetic treatments to prolong our expected life span by 25 years (EU average 42%);
- 43% will never approve the development of genetic tests for everyone to identify diseases they might contract (EU average 34%);
- 38% will never approve genetic treatments to dispense with bad habits like smoking or alcoholism (EU average 33%);
- 45% 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%);
- 16% are totally opposed to storing everyone's genetic data so that criminals could be more easily caught (EU average 21%)
- and 31% will never approve of storing the population's genetic data to study the causes of human disease (EU average 17%).

The survey also explores public attitudes to genetic modification. Germany is also stricter than the EU average when it comes to the development of genetically modified crops to increase the variety of regionally grown food. 43% of citizens would never approve this application of biotechnology (EU average of 37%). This critical attitude is persistent in the case of environmental applications. 24% of respondents would never approve of developing genetically modified bacteria to clean up after environmental catastrophes (EU average 19%).

In general terms, the results of the survey suggest low acceptance for most potential applications of biotechnology and genetic engineering.

## 1.4 Main biotechnology research actors in Germany

Universities, non-university research organisations and industrial actors shape the German biotechnology research and development landscape.

German universities are responsible for both teaching and conducting research activities. It is difficult to determine the share of resources designated to each task. By means of the so-called "R&D coefficients", the official publications of the Ministry of Education and Research (BMBF) estimate that 9 000M EUR were invested in research activities in the year 2002 (BMBF 2004). According to this source, the budget for research at universities increased by 9.7% between 1998 and 2002. Unfortunately, there are no data available on the share of this budget directed to biotechnology research. Among the different disciplines considered in the official statistics, in 2001 natural sciences absorbed the largest volume of university research resources with 2 500M EUR (29.2% of all resources) followed by medical sciences with 2 100M EUR (25.1%). We estimate that almost all universities in Germany with medical or natural science research facilities carry out biotechnology-related research. However, to provide accurate figures goes beyond the scope of the BioPolis project.

As regards the non-university research organisations, the most important institutions are given in Table 1.2.

Table 1.2 Non-university research organisations

Institution	Annual budget*	Activities
Max Planck Society	1 380M EUR	Fundamental interdisciplinary research
Fraunhofer Society	1 250M EUR	Industry-oriented research
Helmholtz Association	2 200M EUR	Fundamental research and research services
Leibniz Association	1 100M EUR	Fundamental and industry-oriented research, research services

\*Estimation

Sources: <http://www.fraunhofer.de>, <http://www.mpg.de>, <http://www.helmholtz.de/>, <http://www.wgl.de/> (last accessed August 2006), BioPolis Research

The Max Planck Society (MPG) runs 78 institutes in Germany which are engaged in fundamental interdisciplinary research in 3 areas: biology-medicine, chemical-physics and social sciences. In 2006, the budget of the Max Planck Society amounted to 1 380M EUR; the German federal and state governments financed 82% of the Society's budget, around 13% of the budget comes from competitive funding and about 5% from donations from supporting members, evaluations, royalties, and membership.

The Fraunhofer Society coordinates 58 research institutes engaged in industry-oriented research. The Society has an annual research budget of about 1 250M EUR. The institutes have a financing scheme combining institutional grants and external (also industrial

funding): up to 30% of the budget is public institutional funding from the federal government and the *Länder*; the remainder comes from contract research. Due to the contract research activities of the institutes, the scientific and technological research focuses are mainly demand-driven. Biotechnology is hence one of the Society's many research fields.

The 15 German research centres of the Helmholtz Association carry out fundamental research in projects requiring special manpower, funding and equipment. With an annual budget of approximately 2 200M EUR, the Helmholtz Association is Germany's largest research institution. The research orientation is structured in 6 research areas, which are distributed across all 15 centres: energy, earth and environment, health (with a 346M EUR budget in 2004), key technologies (encompassing scientific computation, information technology with nanoelectronic systems, nano- and microsystems and advanced engineering materials), structure of matter, transport and space (with a 180M EUR budget in 2004).

Finally, the Leibniz Association (WGL) is the umbrella organisation of 84 institutes all over Germany with an annual budget of approx 1 100M EUR. An important characteristic of this society is the diversity of the institutes in terms of organisations and research focus. The institutes are grouped into five sections: humanities and education, economic and social sciences, life sciences, physical sciences, and environmental research. In 2005 the section "life sciences" had a total budget of 290.59M EUR, of which 74% (215.66M EUR) was institutional funding from the federal government and the *Länder*.

As for the industrial actors, there are at least 4 sources that can be used to describe industrial research and development activities in biotechnology in Germany: Ernst and Young Reports, the results of the surveys from the Federal Statistics Office (Statistisches Bundesamt 2005)<sup>14</sup>, the biotechnology company catalogue of the BIOCUM AG (Mietzsch and Kuhrt 2005)<sup>15</sup> and the figures provided by EuropaBio (EuropaBio 2005)<sup>16</sup>. These sources use different conceptual approaches to compute the number of companies carrying out biotechnology research and development activities in Germany. For this reason, the results are not comparable.

In this section we chose the results of the surveys from the Federal Statistics Office (Statistisches Bundesamt 2005) to briefly discuss biotechnology industrial research and development activities in Germany.<sup>17</sup> According to this source, in the late 1990s the biotechnology industry in Germany experienced strong growth in terms of the number of core biotechnology companies. In 2002, the biotechnology sector numbered 542 core

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<sup>14</sup> Statistisches Bundesamt (2005). Unternehmen der Biotechnologie in Deutschland - Ergebnisse der Wiederholungsbefragung 2004. Statistisches Bundesamt. Wiesbaden.

<sup>15</sup> Mietzsch, A. and M. Kuhrt (2005). BioTechnologie Das Jahr- & Adreßbuch 2005. Berlin, BIOCUM.

<sup>16</sup> EuropaBio (2005). Biotechnology in Europe: 2005 COmparative Study - Critical I Comparative Study for EuropaBio. Lyon, BioVision.

<sup>17</sup> Chapter 3 of this report discusses performance figures of the German biotechnology industry in terms of company creation. Since the analysis in chapter 3 intends to compare the German performance with EU25 and the USA, the comparability issue needs to be taken into account when choosing the source for the raw data. For this reason the sources Ernst and Young and EuropaBio have been chosen for chapter 3.

biotech companies with 13 300 employees. However, between 2002 and 2004 the sector experienced some difficulties to maintain this level of industrial activity in terms of core biotechnology companies and their employees. In 2004 the source we are considering reported 538 core biotech companies with 11 958 employees (5 438 in R&D).

With regard to the biotechnology activities in large companies, the number of employees engaged in biotechnology/life science activities grew by 15.7% from 9 499 to 10 995 employees (thereof 2 389 in biotechnology R&D).

The data suggest that in the period 2002-2004 core biotechnology companies were going through a difficult period. Industrial biotechnology activities from these companies diminish. On the other side, in terms of employees, large companies seem to be increasingly engaging in biotechnology activities.

Finally, with regard to the biotechnology R&D expenditures of industrial actors, in 2004 the expenditures reached 1 300M EUR. Core biotechnology companies and suppliers were responsible for 60% of the expenditures and large life science firms for 40%.

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

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. Data were collected through desk research (publications, documents, websites of national and regional public funding organisations and/or governmental departments), survey among representatives of funding organisations that manage the generic and biotech-specific programmes, telephone interviews with representatives of organisations that are involved in non-policy-directed and policy-directed funding. The funding organisations contacted and the contact persons who participated in the survey and/or who were interviewed can be found in Annex 3 (List of Contact Persons).

Section 2.1 introduces the definitions of the main conceptual terms. Section 2.2 presents the non-policy-directed funding and section 2.3 the policy-directed funding. Charities and foundations 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 Germany through the 6<sup>th</sup> Framework Programme.

### **2.1 Introduction**

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

Policy-directed funding includes funding which was directed by explicit policy decision-making about installing a specific instrument, such as specific R&D programmes, programmes encouraging collaboration, industrial research grants, support for centres of excellence, support for 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, only those generic instruments are included if a reference is made to (the stimulation of) biotechnology activities in the policy of the funding organisation that runs the 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 given through block grants to universities and (government) research institutes, the open-call system of research councils etc. 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 systems of research councils are included.

## 2.2 Non-policy-directed funding of biotechnology research

Table 2.1 presents the information available on the non-policy-directed funding of biotechnology research in Germany in the period 2002-2005. Considering the institutional funding for non-university research institutes and the response mode mechanisms of the German Research Foundation (DFG), 3 278M EUR were invested in promoting biotechnology research.

Table 2.1 Non-policy-directed funding of biotechnology research in M EUR

<b>Funding organisation</b>	<b>Public Research Institutions / Response Mode programmes</b>	<b>Period</b>	<b>Funds</b>
Federal government and <i>Länder</i>	Max Planck Society (MPG)	2002-2005	670
Federal government and <i>Länder</i>	Fraunhofer Society (FHG)	2002-2005	142.8*
Federal government and <i>Länder</i>	Helmholtz Association (HGF)	2002-2005	1 108*
Federal government and <i>Länder</i>	Leibniz Association (WGL)	2002-2005	517.6*
Federal government and <i>Länder</i>	German Research Foundation (DFG)	2002-2005	840*
Total*			3 278.4

\*estimation

Source: BioPolis Research

### The Max Planck Society (MPG)

According to the data provided by the MPG, the expenditures for biotechnology research in the period 2002-2005 amounted to 670M EUR, which represents 15% of the total expenditures of the society.<sup>18</sup>

### The Fraunhofer Society (FHG)

As mentioned in the previous section, biotechnology is one of many research fields of the Fraunhofer Society. The following institutes carry out biotechnology research:

- Institute for Biomedical Engineering in St. Ingbert
- Institute for Interfacial Engineering and Biotechnology in Stuttgart
- Institute for Molecular Biology and Applied Ecology in Schmallenberg-Grafschaft
- Institute for Toxicology und Experimental Medicine in Hanover
- Institute for Cell Therapy and Immunology in Leipzig
- Institute for Environmental, Safety and Energy Technology in Oberhausen
- Institute for Process Engineering and Packaging in Freising
- Institute for Systems and Innovation Research in Karlsruhe

The institutional funding of these institutes in the period 2002-2005 was 142.8M EUR.<sup>19</sup>

### The Helmholtz Association

In the Helmholtz Association there are 3 research groups specialising in biotechnology research in a narrow sense. These are part of larger research centres:

- Biotechnology Programme at Research Centre Jülich financed by the State North Rhine-Westphalia (6.5M EUR per year)
- Bioprocessing Technology Research Group at Helmholtz Centre for Infection Research (3M EUR per year)
- A GMP (Good Manufacturing Practices) Laboratory for clinical trails in the field of individual immunotherapy at the National Research Centre for Environment and Health (GSF).

However, considering the broad definition used in the BioPolis project, a large part of the activities of the health research carried out in the Helmholtz Association centres can be considered biotechnology research. Hence, we have used the figures on health research provided by the Association to estimate policy-directed biotechnology funding at the Helmholtz Association included in Table 2.1.<sup>20</sup>

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<sup>18</sup> The figures on research expenditures include institutional funding and project funding of the Society, excluding the MPI for Plasmaphysics. Project funding amounts to 0.1% of the expenditures.

<sup>19</sup> The data available refer to the total institutional funding of the institutes, which might be directed to fields other than biotechnology. This is the best estimate available.

<sup>20</sup> Health research includes (i) cancer research (37.7%), (ii) cardiovascular and metabolic disease research (9.12%), (iii) function and dysfunction of the nervous system (13.87%), (iv)infection and immunity

## Leibniz Association (WGL)

An important characteristic of the Leibniz Association (WGL) is the diversity of the institutes in terms of organisations and research focus. The institutes are grouped into five sections: humanities and education, economic and social sciences, life sciences, physical sciences, and environmental research. In 2005 the section "life sciences" had a total budget of 290.59M EUR, of which 74% (215.66M EUR) was institutional funding from the federal government and *Länder*. If we consider that 60% of the annual funding for life science might be biotechnology-related research (and that the 2005 annual funding represents the annual average funding volume in the period 2002-2005), we estimate that for the reporting period the Association invested 517.6M EUR of institutional funding in biotechnology research activities.

## German Research Foundation (DFG)

The DFG has a wide range of instruments to promote scientific research and training. As mentioned in the previous section, the main characteristics of the DFG are (i) its autonomy with regard to the funding priorities and decisions from policymakers and (ii) the allocation of its resources through competitive funding. Accordingly, the instruments used to promote training and scientific research are considered non-policy-directed instruments. Due to the interdisciplinary character of the research projects funded and the broad biotechnology definition applied in the BioPolis project, it is difficult to estimate the Foundation's share of biotechnology funding in the reporting period. We estimate that 840M EUR were directed to promote biotechnology research in the period 2002-2005. The data available represent an estimation based on (i) the funding through open calls for individual grants in the field of life sciences, (ii) the funding for priority programmes in the field of life science and finally, (iii) the funding volume for collaborative research centres in the fields of biology and medicine.<sup>21</sup>

### 2.3 Policy-directed funding of biotechnology research and commercialisation

This section presents the policy-directed instruments promoting biotechnology research and commercialisation identified in Germany for the period 2002-2005. Table 2.2 shows an overview of the instruments.

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(14.32%), (v) environmental health disorders (11.24%), (vi) comparative genomics (9.58%) and (vii) regenerative medicine (4.10%).

<sup>21</sup> The funding volume should be considered as a rough estimation of the funding of biotechnology research by the German Research Foundation.

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

Instrument	Funding Agency	Budget in M EUR	% of total
<b>National Instrument</b>			
<i>Generic</i>			
Innovation financing schemes	tbg	16	1.24%
ERP Innovation Programme	KfW SME Bank	n.a.	
ERP Startfonds	KfW SME Bank	n.a.	
National Genome Research Network	PT DLR	60	4.64%
Ethical, legal and social aspects in biomedical research (ELSA)	PT DLR	5	0.39%
Commercialisation Campaign	PT Jülich	14	1.04%
EXIST – Start-ups from Universities (including EXIST SEED)	PT Jülich	11	0.87%
Framework programme "Entrepreneurial Regions" for the new <i>Länder</i>	PT Jülich	n.a.	
InnoNet – Funding of innovative networks	VDI / VDE	n.a.	
Collective Industrial Research and Development (IGF)	AiF	19	1.44%
Innovative Competence for SMEs – PRO INNO	AiF	n.a.	
Network Management East – NEMO	AiF	n.a.	
Promotion of Research, Development and Innovation Activities in SMEs and PROs in the new <i>Länder</i> (2001-2004) and INNO-WATT (since 2004)	Euronorm	16	1.24%
<i>Biotech specific</i>			
Framework programme "Biotechnology"	PT Jülich	705.5	54.50%
<b>Total National</b>		846	65.36%

\*EU-SF: EU Structural Funds

Table 2.2 continued

<b>Instrument</b>	<b>Funding Agency</b>	<b>Budget in M</b>	<b>% of total</b>
<b>Regional</b>			
<i>Generic</i>			
L-EA Venture Fonds	L-EA	28	2.16%
Bremerhaven Economic Development Company -Innovation programme	BIS	1.4	0.11%
Bremer Innovation Agency - R&D in SMEs	BIA GmbH	1.7	0.13%
Brandenburg ILB - Promotion programme for research and development (large projects)	ILB and ZAB	n.a.	
Brandenburg ILB - Promotion programme for research and development (small projects)	LB and ZAB	n.a.	
BayTP Bavarian Technology Promotion Programme	STMWIT	4.9	0.38%
BayTOU Bavarian Programme for the establishment of technology-oriented companies	STWWIT	1.3	0.10%
BayBG - Innovation Equity Investment	BayBG	n.a.	
Bavarian High-Tech-Offensive	Bavarian State	102.8	7.94%
Berlin - Programme for promotion of research, innovations and technologies (ProFIT)	IBB	2.1	0.16%
Zukunftsfonds Berlin	TSB	4.34	0.34%
Mecklenburg-Vorpommern Regional Research Programme	PT Jülich	7.5	0.58%
Hamburg BWA Research and Development Promotion Program Directive	Innovation Foundation Hamburg	n.a.	
Hamburg Innovation Foundation R&D Program	Hamburg Innovation Foundation	n.a.	
Directive for funding activities within the Lower Saxony Innovation Promotion Program - Subsidies for R&D Projects	Lower Saxony MW	14.4	1.11%
Lower Saxony Innovative University Projects	Lower Saxony MWK	n.a.	
North Rhine-Westphalia Measure 2.1 Technology and Innovation	PT Jülich	n.a.	
North Rhine-Westphalia Technology and Innovation Program (TIP)	PT Jülich	n.a.	

Table 2.2 continued

<b>Instrument</b>	<b>Funding Agency</b>	<b>Budget in M</b>	<b>% of total</b>
<b>Regional Instrument</b>			
<i>Generic</i>			
Rhineland-Palatinate Research Promotion	Rhineland-Palatinate MWWFK	7.7	0.59%
Rhineland-Palatinate Foundation for Innovation - Project Funding for basic research, applied research and technology transfer	Rhineland-Palatinate Foundation for Innovation	4.3	0.33%
Initiatives of the Rhineland-Palatinate State Ministry for Economic Affairs, Transport, Agriculture and Viticulture (FiTOUR, TT Offices, etc.)	Rhineland-Palatinate MWVLW	n.a.	
Saarland Innovation Programme	Saarland MWA	n.a.	
Saxony-Anhalt Promotion Program for Industrial Research	Investment Bank Sachsen-Anhalt	11.8	0.91%
Schleswig-Holstein Directive for the Financial Support for Innovations in SMEs (BI and AI)	Economic Promotion and Technology Transfer Schleswig-Holstein GmbH	5.75	0.44%
Schleswig-Holstein Directive for the Financial Support for Research, Development and Technology Transfer (FET)	Schleswig-Holstein WWV	6.6	0.51%
Schleswig-Holstein Initiative University-Economy-Transfer	Schleswig-Holstein WWV	0.25	0.02%
Thuringia Directives for the promotion of research at Public Research Organisations (PROs)	TKM	1.41	0.11%
Thuringia promotion program for research and development in companies	TMWTA	8.9	0.69%
Thuringia Directive for the promotion of research consortia	TMWTA	4.4	0.34%
Thuringia Directive for the promotion of industrial research	TMWTA	2.5	0.19%
<i>Biotechnology Specific</i>			
Baden-Württemberg Research Programme "Transmissible Spongiforme Encephalopathies"	PT Jülich	2.31	0.18%
Verbundforschung (Consortia Research) Baden-Württemberg (scientific and industry-oriented collaborative projects), Theme 1/Biotechnology	PT Jülich	5.38	0.42%
Promotion Programme Biotechnology Baden-Württemberg, indirect-specific funding programme for biotechnology R&D in SMEs	PT Jülich	6.3	0.49%

Table 2.2 continued

Instrument	Funding Agency	Budget in M	% of total
<b>Regional Instrument</b>			
<i>Biotechnology specific</i>			
BioNord Biotechnology Centre in Bremerhaven	BIS	12.5	0.97%
Brandenburg Biotechnology Centre - Biotech Hennigsdorf	Brandenburg MW	2.5	0.19%
Hessen-Invest Start	IBH	1.75	0.14%
Hessen Biotechnology Innovation Centres in Frankfurt am Main (FIZ), Gießen (TIG) and Marburg (NTZ)	Hessen Ministry WVL	23.3	1.80%
Initiative www.Biotech-Hessen.de	HA Hessen Agentur GmbH	3	0.23%
BayBio - Promotion Programme for research and development projects in biotechnology and genetics	STWWIT	5.6	0.43%
BioTOP Berlin-Brandenburg		2.4	0.19%
Saarland - Promotion Program Life Sciences and Nanotechnology	Saarland MWA	0.46	0.04%
Saxony-Anhalt - Technology Centres		0.56	0.04%
Biosaxony – Biotechnology Offensive of the State of Saxony	Saxony State Government	160	12.36%
Hessen - ZAFES – The Centre for Drug Research, Development and Safety	State of Hessen	0.3	0.02%
LSA Life Science Agency GmbH (LSA)	The federal state of NRW	n.a.	
<b>Total Regional</b>		<b>448</b>	<b>34.64%</b>
<b>Total</b>		<b>1294</b>	<b>100%</b>

Source: BioPolis Research

According to the information available, the national initiatives amount to about 65% of the policy-directed instruments in terms of allocated budget. Among all policy-directed instruments, the National Biotechnology Framework Programme represents 54.4% of the funding. Even though the information available leaves a few gaps as far as policy-directed funding through generic instruments is concerned, we can say that the Biotechnology Framework Programme is the most important policy action in the German approach to biotechnology promotion through policy-directed instruments.

Regarding the regional policy-directed instruments, the state of Bavaria (Bayern) and Saxony (Sachsen) seem to focus largely on the promotion of biotechnology. In the case of Saxony, the public promotion was implemented through a biotechnology-specific instrument which represents 12% of the total biotechnology policy-directed funding in Germany. It is the most important initiative at the regional level.

The next sections summarise the relevant aspects of the policy-directed instruments identified.

### **2.3.1 Instruments of the KfW SME Bank (KfW Mittelstandsbank)**

Two programmes of the bank explicitly target innovation and research and development activities:

- ERP (European Recovery Programme Fund) Innovation Programme

The programme offers low-interest loans (below market rates) and equity financing for innovative enterprises. The programme covers both market-near research projects and the development of new products, processes or services and their introduction to the market. The maximum loan amount granted by KfW SME Bank for research and development projects is 5M EUR. The maximum loan amount for market introductions financed under the ERP Innovation Programme is 1M EUR for west German SMEs and 2.5M EUR for east German companies. In the period 2002-2005, the bank approved 372 applications for funding and granted 507M EUR.

In the field of biotechnology, the number of funding approvals in the period 2002-2005 was below 10. Due to the data protection law, details on the volume of loans granted to biotechnology companies are not publicly available.

Biotechnology funding volume 2002-2005: n.a.

- ERP Startfonds (since November 2004)

This programme is the follow-up initiative of the BTU 2000 Programme and provides equity for young technology-based firms. KfW SME Bank provides equity for young, innovative, technology-based firms with assistance from the German Federal Ministry for Economic Affairs and Technology (BMWi) and the ERP Start Fund. As in the BTU 2000 Programme the precondition for KfW to participate is, however, that another equity investor (lead investor) also participates with at least an equal amount. The high-tech start-ups should have less than 50 employees and sales lower than 10M EUR. The equity covers the financial needs of the research, development and marketing of innovative products, processes or services. In the period 2002-2005 the bank approved 126 applications for funding and invested 32.9M EUR.

In the field of biotechnology, the number of approved applications was below 10. Due to the data protection law, details on the volume of equity invested in biotechnology companies are not available.

Biotechnology funding volume 2002-2005: n.a.

### **2.3.2 Instruments of the Ministry for Economic Affairs and Labour (BMWA) and the Ministry of Economic Affairs and Technology (BMWI)<sup>22</sup>**

The BMWA (later the BMWI) implements policy instruments through project management organisations. The following paragraphs go into the details of the instruments classified according to the intermediary institution launching the instruments.

*tbg – Technologie-Beteiligungs-Gesellschaft mbH  
(Society for Equity Investment of the DtA)*

For the period 2002-2005 we selected 4 tbg initiatives which contributed to the industrial development of biotechnology. For our analysis in the next chapters we refer to these initiatives as "Innovation financing schemes of the tbg":

#### - BTU 2000 Programme (2000-2003)

The BTU 2000 Programme offered (i) refinancing for venture capitalists investing in small technology-based firms and (ii) equity financing for small companies for R&D and innovation activities. The funding covered research and development projects as well as the introduction to the market of innovative products, processes or services. An important condition for tbg to participate was, however, that an equity investor (lead investor) also participated with at least an equal amount. The participation covered up to 1.5M EUR for a period of 10 years.

#### - BTU Early Stage Programme

The programme provided venture capital (VC) for pre-seed and seed stages of technology-oriented start-ups. The financial resources are meant to cover the costs of developing a business plan and carrying out market research and technology development. Start-ups needed to co-operate with a mentor-investor who provided managerial support.

#### - DtA Equity Investment Programme

The programme provided equity investment (up to 5M EUR for a period of max. 3 years) in the form of a silent participation or a pure equity investment for technology companies. Precondition was a BTU participation.

#### - FUTOUR 2000 (2000-2005)

The programme FUTOUR 2000 - promotion and support of technology-oriented start-ups in the new *Länder* and Berlin (east) - of the BMWA was managed by the project management organisation VDI/VDE in collaboration with the tbg. The programme supported young entrepreneurs, providing them with (i) consulting services from the de-

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<sup>22</sup> In autumn 2005 the Federal Ministry for Economic Affairs and Labour was divided and re-arranged into the Federal Ministry for Economics Affairs and Technology and the Federal Ministry for Labour and Social Affairs

velopment of a business plan up to the marketing of the first product, (ii) grants from the BMWA and (iii) silent participations from the tbg. The promotion was specifically designed to support entrepreneurs in the establishment of high-tech companies.

These 4 initiatives were not biotechnology-specific; however they were open to biotechnology companies as long as they fulfilled the conditions for granting. In the field of biotechnology, the number of applications approved was relatively low in each initiative. Due to the data protection law, details about the volume of investment in biotechnology companies and the amount of credits and loans are not available. However, estimations are available for the whole range of tbg initiatives in the period 2002-2005.

Volume of all tbg financing schemes directed to biotechnology (2002-2005): 16M EUR.

*Project Management Organisation: VDI / VDE Innovation and Technique*

- InnoNet – Funding of innovative networks (since 1999)

The programme funds research collaborative research projects involving at least 2 research institutions and 4 SMEs. The programme aims to (i) improve co-operation between SMEs – including very small enterprises – and research institutes, (ii) improve and accelerate the implementation of R&D results into marketable products, (iii) support industrial processes and services, and (iv) stimulate research institutes to address their services to SME needs and to improve the innovation potential of SMEs.

Biotechnology funding volume 2002-2005: n.a.

*Project Management Organisation: German Federation of industrial Research Associations "Otto von Guericke" (AiF)*

- Collective industrial research and development (IGF) (since 1954)

The German AiF system of collective research is dedicated to entire industrial branches or fields of technology. Companies, mainly SMEs, in most sectors and technological fields are linked into so-called "Industrial Research Associations". These associations are members of the AiF, building a framework to carry out collective research projects. The aim of the German AiF system of collective research is to improve the technological standard and competitiveness of industrial branches or sectors by funding projects of common interest in the respective sector. In general, this kind of research is directed towards the needs of SMEs, however, large companies can participate as well.

Biotechnology funding volume 2002-2005: 18.58M EUR.

- Innovative competence for SMEs: PRO INNO (1999-2003) and PRO INNO II (July 2004-2008)

The initiatives aim to promote the innovative strength and competitiveness of SMEs, especially through the exchange of R&D employees between companies and research institutions and through collaborative R&D with other companies or with research institutions in Germany or abroad. The R&D activities can involve the development of innovative products, processes or services. The initiatives are not limited to any technological sector.

In the framework of PRO INNO (in the period 1999-2003) 6 967 grants were approved (633.16M EUR) and the biotechnology field accumulated 425 grants. Between 1.8.2004 and 31.12.2005 (in the framework of PRO INNO II), 11.4M EUR was granted to promote biotechnology-related projects.

Biotechnology funding volume 2002-2005: n.a.

- Network Management East – NEMO (since 2002)

The initiative of the Federal Ministry of Economic Affairs and Technology aims to promote the establishment of innovative networks between SMEs and research institutions, especially in the new *Länder*. The funding is directed to management tasks such as coaching and co-ordination activities and infrastructure. The funding of approved projects covers 2 phases: the phase of development of the network concept and phase of establishment of the network. The funding can cover a maximum of 0.3M EUR over 4 years.

Biotechnology funding volume 2002-2005: n.a.

#### *Project Management Organisation Euronorm GmbH*

- Promotion of Research, Development and Innovation Activities in SMEs and Public Research Organisations (PROs) in the new Länder (2001-2004) and Promotion of Research, Development and Innovation Activities in SMEs in disadvantaged regions (INNO-WATT) (2004-2008)

These initiatives provide non-repayable subsidies to the costs of highly innovative and risky projects with good marketing perspectives. The potential recipients are SMEs, start-up companies and public research organizations (PROs). The funding covers up to 70% of the total costs, depending on the project and the maximum funding volume per project is 0.375M EUR.

Biotechnology funding volume 2002-2005: 18.58M EUR.

### **2.3.3 Instruments of the Ministry for Education and Research (BMBF)**

*Project Management Organisation Health Research, German Aerospace Centre (PT DLR)*

- National Genome Research Network (since 2001)

The National Genome Research Network (NGFN) aims to bring together clinical and molecular scientists in systematic as well as in disease-oriented genome research consortia in order to foster understanding of the structure and function of the human genome and its contribution to the development of diseases of major relevance. Recipients of the funding are public research organisations and companies. The results of the NGFN should contribute to the further development of diagnostic and therapeutic approaches, especially in multi-factorial diseases.

Biotechnology funding volume 2002-2005: 60M EUR.

- Ethical, legal and social aspects in biomedical research (ELSA)(since 1997)

The initiative promotes research projects in ethical, legal and social aspects of biomedical research. The funding of research projects has to be seen as an integral part of the biomedicine programme of BMBF, concerning especially the consequences of modern molecular-based medicine for the science community and the public. The initiative is directed to public research organisations (PROs).

Biotechnology funding volume 2002-2005: 5.1M EUR.

*Project Management Organisation Jülich*

- Framework Programme "Biotechnology" (2001-2010)

The BMBF's Biotechnology Framework Programme prepares the ground for promoting research, development and innovation in biotechnology in Germany at the federal level. It takes a large number of aspects of the biotechnology innovation system into consideration. Accordingly, it involves different initiatives organised in 4 fields of action. Table 2.3 shows the key figures for the Framework Programme for the period 2001-2005.

In the period 2002-2005 the following initiatives were launched:

- Structural measures: "BioChancePlus", "BioFuture", "GoBio"
- Scientific and technological targets: "PathoGenomics ERA-NET", "Genome Analysis in the Biological System of Plants (GABI)", "FUGATO-Functional Genome Analysis in Animal Organisms"
- Research for applications: "Bionik", "Tissue Engineering", "Quantitative analysis for the description of the dynamic processes in living systems (Quant-Pro)", "Systems Biology of Microorganisms", "Functional Nutrition research"
- Preventive research: "Biological Safety Research: genetically modified plants".

Table 2.3 Biotechnology Framework Programme (Project funding in M EUR)

Fields of action	2001	2002	2003	2004	2005
Structural measures	39.5	43.0	40.0	41.0	41.0
Scientific and technological targets	83.0	95.0	95.0	98.0	77.8
Research for industrial applications	15.9	16.0	17.0	16.0	17.5
Preventive research	12.5	12.0	14.0	14.0	14.5
Total	145.7	154.0	166.0	166.0	171.0
<b>Total funding 2001-2005: 802.7M EUR</b>					

Source: BMBF (2001)

Both public research organisations and SMEs are targets of the initiatives launched within the programme.

Biotechnology funding volume 2002-2005: 705.5M EUR.

- Commercialisation Campaign (2002-2006)

With the amendment of section 42 of the Employee Inventions Act<sup>23</sup>, research institutions in Germany face the task of patenting their research results. The initiative of the Ministry for Education and Research aims to support the valorisation of research results in the form of patents. The campaign aimed to

- establish a professional patent and valorisation infrastructure in Germany;
- promote patent awareness in academia;
- train specialists in patenting issues; and
- create a network of actors involved in valorisation activities.

The Campaign covered 2 funding periods: 2002-2003 (with a budget of 27M EUR) and 2004-2006 (with a budget of ca. 27M EUR). In the second funding round, the *Länder* were very much involved in financing the campaign. The measure covered all technological sectors. Unfortunately, there are no data available for support of patenting activities in biotechnology. However, the field of life sciences received between 30 and 50% of the resources. We estimate that 30% of the total resources were invested in the biotechnology sector.

Biotechnology funding volume 2002-2005: 13.5M EUR (estimation).

<sup>23</sup> The law amending section 42 of the Employee Inventions Act ("University Teachers' Privilege") entered into force on 7 February 2002. The core of the amendment implies that like a company, the institution of higher education is entitled to make use of their employees' research results, patent them in their own name and commercialise them. A direct participation of the inventor in the commercialisation proceeds under the law (30% of the gross commercialisation proceeds) should stimulate patent awareness in the higher education sector.

- EXIST – Start-ups from Universities (including EXIST SEED) (1997-2005)

The initiative was an infrastructure measure supporting the establishment of university spin-offs and offering funding to cover the costs of developing a business plan. It aimed at promoting (i) a culture of entrepreneurship at universities, (ii) the establishment of university spin-offs and (iii) the collaboration between industry and academia. The measure covered all technological sectors and there are no data available for support in biotechnology. We estimate that 30% of the total resources were invested in the biotechnology sector.

Biotechnology funding volume 2002-2005: 11.31M EUR (estimation).

- Framework programme "Entrepreneurial Regions" for the new *Länder* (since 1999)

The BMBF innovation initiative "Entrepreneurial Regions" stands for innovation-oriented regional alliances. Within this framework the BMBF (Federal Ministry of Education and Research) has been systematically developing a series of programmes for the new *Länder* since 1999. The five programme lines are:

- InnoRegio
- Innovative Regional Growth Cores
- Centres for Innovation Competence
- Interregional Alliances for Tomorrow's Markets - Innovation Forums
- InnoProfiles.

These programmes aim to improve the conditions for innovations and set the course for the long-term success of regions ("clusters") in the new *Länder*. The measures are not technology-specific and there are no public data available on the resources invested that supported biotechnology development in regions.

Biotechnology funding volume 2002-2005: n.a.

### **2.3.4 Instruments at the sub-national level**

#### **2.3.4.1 Baden-Württemberg**

*Instruments of the L-EA Venture Capital Agency of the State Bank in Baden-Württemberg*

- L-EA Venture Fonds (2001-2011)

The L-EA Venture Fonds are a VC fund from the state bank of Baden-Württemberg for high-tech companies (mainly located in the state of Baden-Württemberg) in the fields of biotechnology and information technologies. The volume of venture capital invested per company ranges from 0.5 up to 2.5M EUR.

Biotechnology funding volume 2002-2005: 28M EUR.

*Instruments of the Baden-Württemberg State Ministry of Science, Research and Arts*

- Research Programme "Transmissible Spongiforme Encephalopathies" (since 2002)

The programme promotes basic research as well as applied approaches in the fields of agents /pathogen, transmissibility and progression. The programme targets the following key aspects: i) development of procedures for tests on living animals; ii) transmissibility of agents/pathogens and their inactivation; iii) research on animal feed /meat-and-bone-meal disposal; iv) basic research with medicinal perspectives for humans.

Biotechnology funding volume 2002-2005: 2.31M EUR.

- Research Consortia (*Verbundforschung*) Baden-Württemberg (scientific and industry-oriented collaborative projects), Theme 1/Biotechnology (2002-2005)

The so-called "*Verbundforschung*" in the state Baden-Württemberg is an initiative of two Ministries in Baden-Württemberg, the State Ministry of Science, Research and Arts and the State Ministry of Economic Affairs, to support regional R&D, co-operation between SMEs and PROs. In order to improve and accelerate technology transfer from academia to industrial application, to strengthen regional efforts in achieving sustainable development, to develop a market for research & technology, grants are given to projects with a focus on technology transfer aspects. The funding covers up to 50% of the total costs, depending on the project and the maximum funding volume per project is 1.2M EUR.

Biotechnology funding volume 2002-2005: 5.37M EUR.

- Promotion Programme Biotechnology Baden-Württemberg, indirect-specific funding programme for biotechnology R&D in SMEs (2003-2006)

The initiative was initiated by the federal state of Baden-Württemberg to support research-intensive SMEs and their strategic partnerships (R&D private, private/private and private/public co-operations) including all fields of biotechnology. Thus the goal is to foster primarily industrial and also academic biotechnology players in sharing risks, costs and skills related to innovation in order to develop more efficiently new products and technologies that could reach the market in the short/medium term. The funding covers up to 60% of the total costs, depending on the project and the maximum funding volume per project is 0.25M EUR.

Biotechnology funding volume 2002-2005: 6.3M EUR.

### 2.3.4.2 Bayern (Bavaria)

#### *Instruments of the Bavarian State*

- Bavarian High-Tech-Offensive (since 2000)

At the end of 1999 Bavaria launched the programme with 1 350M EUR in order to further develop the research infrastructure and promote research and development in the following technological fields: life sciences, information and communications technology, new materials, environmental technology and mechatronics. The initiative involves 4 pillars which cover the different public promotion projects and initiatives:

1. Establishment of world-class high-tech centres (663M EUR in the period 2000-2005)
2. Regional concepts (179M EUR in the period 2000-2005)
3. State-wide qualification, start-up and technology infrastructure programme (267.4M EUR in the period 2000-2005)
4. Internationalising the high-tech initiative (65.5M EUR in the period 2000-2005)

Pillar 1 includes most of the policy-directed instruments relevant for the purpose of Bio-Polis classified according to different technological fields. In the field of "Life Science" we have selected those biotechnology-related projects which involve (1) the establishment of research centres of excellence, (2) the establishment of incubators and/or innovation centres, (3) programmes promoting training activities, and (4) research promotion projects.

These projects are:

- BioMed Innovation and Start-up Centre (13.3M EUR in the period 2000-2005)
- Centre for Experimental Molecular Medicine at the University of Würzburg (ZEMM) (30.3M EUR in the period 2000-2005)
- Biotechnological development laboratory with animal unit. Department of Genetics, University of Erlangen-Nürnberg (16.30M EUR in the period 2000-2005)
- Competence Centre for New Materials at the University of Bayreuth (5.1M EUR in the period 2000-2005)
- Medical Applications of Biotechnology (6.5M EUR in the period 2000-2005)
- Biotechnology Research and Development Centre at the University of Regensburg (4.4 M EUR in the period 2000-2005)
- BioPark Regensburg (21M EUR in the period 2000-2005)
- Accompanying research and monitoring of publicly released genetically modified organisms (2.3M EUR in the period 2000-2005)
- Establishment of a course in biotechnology at Munich Technical University (2.6M EUR in the period 2000-2005)
- Establishment of an innovation and start-up centre for green biotechnology (11.8M EUR in the period 2000-2005)

- Research project Biofunctionality of Food Ingredients (4.6M EUR in the period 2000-2005)
- Competence Centre for Sustainable Raw Materials in Straubing (36M EUR in the period 2000-2005)

Biotechnology funding volume (2002-2005): 154.2M EUR<sup>24</sup>.

*Instruments of the Bavarian State Ministry of Economic Affairs, Infrastructure, Transport and Technology*

- BayTP Bavarian Technology Promotion Programme

The initiative aims to support companies (especially SMEs) in improving or developing new products, processes or in the application of new technologies in all sectors (except for software development).

Biotechnology funding volume 2002-2005: 4.9M EUR.

- BayBIO (1999-2007)

The initiative aims to support companies (especially SMEs) and public research institutions in Bayern (Bavaria) in carrying out risky and innovative research projects in the fields of biotechnology and genetic engineering, and in using the research results to develop new products, processes, technologies and services in these fields. Both collaborative and individual projects can be promoted.

Biotechnology funding volume 2002-2005: 5.6M EUR.

- BayTOU Bavarian Programme for the establishment of technology-oriented companies

The programme aims to promote technology-oriented start-up companies in their establishment phase by sponsoring the company owners in the early phase of defining the business model or by funding key research and development projects for the establishment of the company.

Biotechnology funding volume 2002-2005: 1.3M EUR.

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<sup>24</sup> The programmes considered include investments in the construction of research centres and incubators. These are considered to be policy-directed since they are part of the umbrella programme "High-Tech-Offensive". The Initiative has been running since the end of 1999. Data available cover the period 2000-2005 (6 years). To calculate the investments for the period 2002-2005 (4 years) the budgets have been estimated by calculating annual budgets and considering the budget for 4 years.

### *Instruments of the BayBG Bavarian Equity Investment GmbH*

#### - BayBG Equity investments

The innovation business field of the BayBG offers equity investment targeting the financing needs of companies in projects involving new products, new production processes, new services and new innovation-driven company formation. The BayBG participates in medium-sized companies through various funds: as silent partners or through the temporary acquisition of limited liability capital, but always as minority shareholders.

Biotechnology funding volume 2002-2005: n.a.

### **2.3.4.3 Berlin**

#### *Instruments of the Investment Bank Berlin*

#### - Programme for promotion of research, innovations and technologies (ProFIT) (since 2004)

The programme provides subsidies, loans and refundable financial participation on the costs of research, development and marketing activities concerning new technologies and/or products in all fields. The focus is laid on small and medium sized enterprises. The regular volume for every applicant amounts up to 0.4M EUR for subsidies and 0.5M EUR for refundable financial aid. The rate of contribution of applicant depends on the project and varies between 0% and 75%. The form of promotion depends on the character of the project. The funding covers up to 75% of the total costs, depending on the project and the maximum funding volume per project is 0.4M EUR.

Biotechnology funding volume (2002-2005): 2.1M EUR (co-financed with EU structural funds)

#### *Instruments of the TSB Technology Foundation Innovation Centre Berlin*

#### - Zukunftsfonds Berlin (since 2001)

*Zukunftsfonds Berlin* supports innovative projects expected to have a strategic impact on Berlin's regional development. *Zukunftsfonds* provides funding for innovative R&D projects in biotechnology, information technology, medical technology, traffic systems technology and optical technology. Projects eligible for funding have to be internationally competitive in terms of both their applied research and product development components. They should introduce new products, processes or services to the marketplace. Applicants should be part of a science and industry network located in Berlin. Partners from other regions are welcome to participate, but any R&D work funded by *Zukunftsfond* has to be carried out in Berlin. Applicants should be able to conclusively demonstrate their ability to generate revenue in Berlin at the end of the funding period, either by commercialising applications developed during the project or by acquiring additional grants from other

funding sources. The funding covers up to 50% of the total costs, depending on the project and the maximum funding volume per biotechnology project is 2.03M EUR.

Biotechnology funding volume (2002-2005): 4.3M EUR (co-financed with EU structural funds)

*Instruments of the Berlin State Ministry of Economic Affairs*

- BioTOP Berlin-Brandenburg (since 1998)

The initiative is an information platform for biotechnology actors in Berlin-Brandenburg <http://www.biotop.de/>. The goal of the initiative is to inform biotechnology companies in the states Berlin-Brandenburg about promotion programmes, potential business and research partners, relevant events, etc.

Biotechnology funding volume (2002-2005): 2.4M EUR (co-financed with EU structural funds)

#### **2.3.4.4 Brandenburg**

*Instruments of the Brandenburg State Ministry for Economic Affairs*

- Promotion programme for research and development (large projects) (2004-2006)

The programme is coordinated and managed by the Investment Bank of the state of Brandenburg (ILB) and the Brandenburg Economic Development Board (ZAB). It allocates funding for innovative large R&D projects to be accomplished in the state of Brandenburg for the development of new products, new processes or new technologies. The funding covers up to 60% of the total costs, depending on the project and the maximum funding volume per biotechnology project is 2.5M EUR.

Biotechnology funding volume 2001-2005: not available (co-financed with EU structural funds).

- Promotion programme for research and development (small projects) (2004-2006)

The programme allocates funding for innovative R&D projects to be accomplished in the state of Brandenburg for the development of new products, new processes or new technologies. The funding covers up to 50% of the total costs, depending on the project and the maximum funding volume per biotechnology project is 0.2M EUR.

Biotechnology funding volume 2001-2005: not available (co-financed with EU structural funds)

- Brandenburg Biotechnologiezentrum - Biotech Hennigsdorf (2002)

The centre serves as an incubator and network platform for companies in the biotechnology field. It aims to offer the companies independence in terms of infrastructure without requiring great investments. In 2002 the Brandenburg state allocated funding to improve the infrastructure.

Biotechnology funding volume (2002-2005): 2.5M EUR (co-financed with EU structural funds).

#### **2.3.4.5 Bremen**

*Instruments of the Senator for Economic Affairs and Ports*

*Instruments coordinated by the BIS - Bremerhaven Economic Development Company*

- BioNord Biotechnology Centre in Bremerhaven (2003)

The centre serves as an incubator and network platform for companies in the food technology and biotechnology sector. It aims to offer the companies independence in terms of infrastructure without requiring great investments. The centre was opened in 2003.

Biotechnology funding volume (2002-2005): 12.5M EUR (co-financed with EU structural funds).

- Research and Development Innovation Programme (since 2003)

Promotion programme for collaborative research between public research organisations and SMEs. The funding covers up to 70% of the total costs, depending on the project and the maximum funding volume per project is 0.2M EUR.

Biotechnology funding volume (2002-2005): 1.4M EUR (co-financed with EU structural funds).

*Instruments coordinated by the BIA - Bremer Innovation Agency GmbH*

- Research and Development in SMEs (since 2004)

The programme supports SMEs in the development of innovative products, processes or services. The subsidies cover up to 65% of the total costs, depending on the project and the maximum funding volume per project is 0.1M EUR.

Biotechnology funding volume (2002-2005): 1.7M EUR (co-financed with EU structural funds)

#### **2.3.4.6 Hamburg**

##### *Instruments of the Hamburg Board for Economics and Labour (BWA)*

- Hamburg BWA Research and Development Promotion Programme Directive (since 1977)

The directive sets the framework for financial support for projects involving the development of new or substantially improved products, procedures and services. The directive differentiates between projects involving basic research for potential industrial applications and projects involving applied research and development activities. The target groups are SMEs, which may conduct research individually or in collaboration with other companies or with public research organisations PROs. The funding covers between 35 and 50% of the total costs and the maximum funding volume per project is 0.125M EUR.

Biotechnology funding volume (2002-2005): n.a.

##### *Instruments of the Hamburg Innovation Foundation*

- Hamburg Innovation Foundation R&D Programme (since 1998)

The programme promotes industrial research. The target groups are SMEs which may conduct research individually or in collaboration with other companies or with public research organisations PROs. The programme differentiates between projects involving basic research for potential industrial applications and projects involving applied research and development activities. The funding covers between 25 and 50% of the total costs, depending on the type of project and the maximum funding volume per project is 0.1M EUR.

Biotechnology funding volume (2002-2005): n.a.

#### **2.3.4.7 Hessen**

##### *Instruments of the Hessen Ministry for Economic Affairs, Transport and Regional Development*

- Hessen-Invest Start (2002-2005)

Promotion programme of the Hessen State Investment Bank – IBH - for financing technological companies in their early phase, in particular in the fields of biotechnology and new media. Target groups are graduates, research groups and engineers from existing companies. Set-up activities, start-up costs, product development, research and development are all eligible for promotion. Product ideas should be developed up to the point where they are ready for marketing. The funding does not cover the total costs of the actions and the maximum funding volume per project is 0.2M EUR.

Biotechnology funding volume (2002-2005): 1.75M EUR.

- Biotechnology Innovation Centres in Frankfurt am Main (FIZ), Gießen (TIG) and Marburg (NTZ)

The biotechnology innovation centres have been established as incubators to provide university spin-offs and joint ventures, with regional and international collaborators, the possibility to establish a company in close proximity to the university. The centres aim to act as incubators and network platforms for biotechnology start-ups.

Biotechnology funding volume (2000-2003): 35M EUR.

- Initiative Hessen-Biotech (since 1999)

The information platform for biotechnology actors in Hessen "[www.biotech-hessen.de](http://www.biotech-hessen.de)". The goal of the initiative is to inform biotechnology companies in the state of Hessen about promotion programmes, potential business and research partners, relevant events, etc.

Biotechnology funding volume (2002-2005): 3M EUR.

- ZAFES – The Center for Drug Research, Development and Safety (2002)

The centre was founded at the Johann Wolfgang Goethe University in Frankfurt in 2002 as a centre of excellence to promote collaborative research between university and industry.

Biotechnology funding volume (2002-2005): 0.3M EUR.

#### **2.3.4.8 Niedersachsen (Lower Saxony)**

*Instruments of the Lower Saxony State Ministry of Economic Affairs, Labour and Transport*

- Directive for funding activities within the Lower Saxony Innovation Promotion Programme - Subsidies for R&D Projects (since 2001)

The funding is allocated by the Investment and Promotion Bank Lower Saxony and coordinated by the BioRegion GmbH. The initiative aims to support companies in research and development activities. These activities should target the production of new products, processes or services across all sectors. The initiative favours especially those projects which involve collaboration with research institutions. The funding covers on average 40% of the total costs, depending on the type of project.

Biotechnology Funding Volume (2002-2005): 14.4M EUR (co-financed with EU structural funds)

*Instruments of the Lower Saxony State Ministry of Science and Culture*

- Innovative University Projects

The programme supports interdisciplinary research projects at universities and public research organisations.

Biotechnology funding volume (2002-2005): n.a.

**2.3.4.9 Mecklenburg-Vorpommern (Mecklenburg-Western Pomerania)**

*Instruments of the Mecklenburg-Western Pomerania State Ministry for Education, Science and Culture*

- Regional Research Programme (since 2001)

Within the programme, research activities at public research organisations in co-operation with industry are funded. Calls are published and the proposals are evaluated by an external jury, who gives advice on possible funding activities. The projects are funded for two to three years. Prolongation up to five years is possible after positive mid-term evaluation.

Biotechnology funding volume (2002-2005): 7.5M EUR (co-financed with EU structural funds).

**2.3.4.10 Nordrhein-Westfalen (North Rhine-Westphalia)**

*Instruments of the North Rhine-Westphalia State Ministry of Innovation, Science, Research and Technology*

- North Rhine-Westphalia Measure 2.1 Technology and Innovation (2001-2005)

The measure is part of the structural fund programme (EFRE-Fund, Objective 2), which aims to overcome the structural weaknesses in the Ruhr district and other structurally weak regions of North Rhine-Westphalia by mobilising regional strengths. An important initiative within the measure is the "Competition Future Ruhr district". With a budget of 102M EUR, this promotion programme was directed to technology-oriented research and development projects involving collaboration between companies and academia. The funding covers between 25 and 50% of the total costs of the action, depending on the type of project.

Biotechnology funding volume (2002-2005): n.a.

- Technology and Innovation Programme (TIP) (since 2001)

The programme aims to strengthen SMEs in fast growing technological sectors. The programme funds:

- research and development projects (carried out individually or in collaboration) of high technological and economic risk,
- feasibility studies,
- equipment investments for technology-oriented start-ups and for the introduction of new products or processes,
- complementary services for the development and industrial application of innovations,
- consulting services and training activities for SMEs,
- establishment and development of technological infrastructure

The funding covers on average 30% of the total costs, depending on the type of project.

Biotechnology funding volume (2002-2005): n.a.

#### **2.3.4.11 Rheinland-Pfalz (Rhineland-Palatinate)**

*Instruments of the Rhineland-Palatinate State Ministry of Science, Training, Research and Culture*

- Rhineland-Palatinate Research Promotion (since 1995)

Under the umbrella term "Research Promotion", the Ministry has different instruments targeting research and development in different scientific fields and technologies. The instruments include:

- subsidies for research projects
- subsidies for research projects in selected fields of focus
- subsidies for research centres
- subsidies for competence centres

The universities in Rheinland-Pfalz (Rhineland-Palatinate) are the main recipients of these instruments. These are mainly bottom-up approaches in the sense that the universities can present their research proposals to the ministry at any point in time (there are no concrete calls to apply for the funding). The funding covers on average 100% of the total costs, depending on the type of project.

Biotechnology funding volume (2002-2005): 7.7M EUR.

*Instruments of the Rhineland-Palatinate State Ministry for Economic Affairs, Transport, Agriculture and Viticulture*

In the period 2002-2005, the state Ministry implemented a number of programmes to promote research and development and innovation in companies, company creation and knowledge and technology transfer from academia to industry. These programmes are:

- FiTOUR: promotion of innovative technology-oriented start-ups from universities, research institutions and companies
- Output-oriented Innovation Promotion
- Promotion of Technology Transfer (3 initiatives)
  - o Funding for the procedures of patent applications
  - o BITT – Consulting
  - o Innovation Assistants

These programmes do not focus on any sector or technology. Companies from all sectors and technologies may apply for funding and consulting support. Budget data are not available.

Biotechnology funding volume (2002-2005): n.a.

*Instruments of the Foundation Rhineland-Palatinate for Innovation*

- Project funding for basic research, applied research and technology transfer (since 1991)

The Foundation promotes the scientific and technological development in Rheinland-Pfalz (Rhineland-Palatinate). The promotion activities concentrate on natural sciences and technique fields. Recipients of this action are mainly PROs. The funding covers on average 100% of the total costs, depending on the type of project.

Biotechnology funding volume (2002-2005): 4.3M EUR.

#### **2.3.4.12 Saarland**

*Instruments of the Saarland State Ministry for Economic Affairs and Labour*

- Saarland - Promotion of Life Sciences and Nanotechnology (since 2000)

The programme offers subsidies for small and medium-sized enterprises (SMEs). The goal is to create incentives for investing in R&D in the fields of nanotechnology and biotechnology. The programme funds three types of activities: (i) pilot projects (ii) research projects to develop skills needed to acquire competitive funding for running research projects (iii) subsidies for the employment of research staff. The funding covers up to 50% of the total costs of the action, depending on the type of project.

Biotechnology funding volume (2002-2005): 0.46M EUR.

- Saarland Innovation Programme (since 2001)

The initiative aims to support companies in research and development activities which target the production of new products, processes or services across all sectors. The initiative favours especially those projects which involve collaboration with research institutions. The funding covers between 40 and 65% of the total costs of the action, depending on the type of project.

Biotechnology funding volume (2002-2005): n.a.

- Saarland Offensive for Entrepreneurship

The initiative is a network platform for start-ups and entrepreneurs which offers information on all issues related with the establishment of a company.

Biotechnology funding volume (2002-2005): n.a.

#### **2.3.4.13 Sachsen (Saxony)**

*Instruments of the Saxony State Government (Ministry for Economic Affairs and Labour, Ministry for Science and Arts, Ministry for Environment and Agriculture)*

- Biosaxony – Biotechnology Offensive of the State of Saxony (since 2000)

The biotech offensive of Sachsen (Saxony) has been running since July 2000. Since then more than 200M EUR have been invested to advance biotechnology in Sachsen (Saxony):

- 100M EUR have been allocated to the construction of two biotechnology incubators,
- 40M EUR have been allocated to set up 12 biotech-chairs in Leipzig and Dresden,
- 60M EUR are available for research projects.
- The founding and location of companies is especially supported – as in the Bio City Leipzig and in the BioInnovationCenter Dresden.
- Information, consulting and contacts to funds and financing sources can be obtained at [www.biosaxony.de](http://www.biosaxony.de) – the one-stop shop for biotechnology in Saxony. Biosaxony also mediates to generate additional funds from the German federal government and the European Union.

Biotechnology funding volume (2002-2005): 160M EUR (co-financed with EU structural funds).<sup>25</sup>

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<sup>25</sup> The funding includes investments in the construction of research centres and incubators. These are considered policy-directed, since they are part of the umbrella programme "Biosaxony". The Initiative has been running since July 2000. Data available cover the period 2000-2005 (5 years). To calculate the investments for the period 2002-2005 (4 years), the budgets have been calculated by estimating annual budgets and considering the budget for 4 years.

#### **2.3.4.14 Sachsen-Anhalt (Saxony-Anhalt)**

*Instruments of the Saxony-Anhalt State Ministry for Economic Affairs and Labour - Investment Bank Sachsen-Anhalt*

- Saxony-Anhalt Promotion Programme for Industrial Research

The initiative aims to support companies in research and development activities which target the production of new products, processes or services. The initiative favours especially those projects which involve collaboration with research institutions.

Biotechnology funding volume (2002-2005): 11.8M EUR<sup>26</sup>.

- Saxony-Anhalt Technology Centres

The biotechnology centres have been established as incubators to provide biotechnology start-ups with infrastructure in close proximity to universities and research centres. The technology centres aim to be incubators and network platforms for biotechnology companies.

- BioCenter Halle

Biotechnology funding volume (2002-2005): 360M EUR.

- Biotech Start-Up Center Gartesleben (Food and Plant Biotechnology)

Biotechnology funding volume (2002-2005): 203M EUR

#### **2.3.4.15 Schleswig-Holstein**

*Instruments of the Schleswig-Holstein State Ministry for Science, Economic Affairs and Transport*

- Schleswig-Holstein Directive for the Financial Support for Innovations in SMEs (BI and AI) (since 1999)

The directive sets the framework for the promotion of innovation in SMEs. The funding is allocated by the Agency for Economic Promotion and Technology Transfer Schleswig-Holstein (WTSH). The main purpose is to create employment in innovative branches and to strengthen the innovative competence and the competitiveness of SMEs.

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<sup>26</sup> The funding volume is a rough estimation. Data available covers the sectors chemicals, pharmaceuticals and biotechnology for the period 2002-2005. To estimate the funding directed to biotechnology, 1/3 of the budget was taken.

Biotechnology funding volume (2002-2005): 5.7M EUR (co-financed with EU structural funds)

- Schleswig-Holstein Directive for the Financial Support for Research, Development and Technology Transfer (FET) (2001-2006)

FET is the main instrument of the Ministry of Science, Economic Affairs and Transport in support of R&D in different technological fields of technology (e.g. biotechnology).

The main purpose of the programme is

- to reinforce the transfer of R&D results to marketable products,
- to strengthen the innovative competence and the competitiveness of SME,
- to give incentives to research institutions in order to make them adjust their research activities to the needs of SMEs

The Ministry gives grants to public research institutions and SMEs which collaborate with these institutions in R&D projects. The funding covers up to 50% of the total costs, depending on the project and the maximum funding volume per project is 2.7M EUR.

Biotechnology funding volume (2002-2005): 6.6M EUR (co-financed with EU structural funds).

- Schleswig-Holstein Initiative University-Economy-Transfer (HWT) (since 2004)

HWT supports small collaborative projects between universities and enterprises in Schleswig-Holstein. The companies have to provide at least 20% of the project costs. After receiving a positive vote by a jury of experts, projects can be funded with up to 0.1M EUR. Focus is applied research.

Biotechnology funding volume (2002-2005): 0.25M EUR.

#### **2.3.4.16 Thüringen (Thuringia)**

##### *Instruments of the Thuringia State Ministry of Culture*

- Thuringia Directives for the promotion of research at public research organisations (PROs) (since 1995)
  - Thuringia Directive for the promotion of regional research focus in the framework of research consortia, research priorities and the establishment of research institutes.
  - Thuringia Directive for the promotion of initiatives to establish research infrastructure.

Both directives set the framework for promoting scientific research and development at PROs.

Biotechnology funding volume (2002-2005): 1.41M EUR.

*Instruments of the Thuringia State Ministry for Economic Affairs, Technology and Labour*

- Thuringia promotion programme for research and development in companies (since 2000)

The programme funds research projects carried out by SMEs and in some cases by large companies. The research projects may be carried out individually or in collaboration with other companies or PROs. The funding covers 40% of the total costs and the maximum funding volume per project is 2M EUR.

Biotechnology funding volume (2002-2005): 8.9M EUR (co-financed with EU structural funds).

- Thuringia Directive for the promotion of research consortia (*Verbundprojekte*) (since 1997)

The directive sets the framework for funding collaborative research between companies and public research organisations (PROs) involving technology-oriented and innovative research projects. The directive differentiates between projects involving basic research for potential industrial applications and projects involving applied research and development activities. The funding covers between 25 and 50% of the total costs and the maximum funding volume per project is 0.205M EUR.

Biotechnology funding volume (2002-2005): 4.4M EUR.

- Thuringia Directive for the promotion of industrial research (since 2001)

The directive sets the framework for industrial grants for SMEs. The grants are allocated by the Thuringia Construction Bank. The funding aims to promote applied research. The funding covers between 30% of the total costs and the maximum funding volume per project is 0.400M EUR.

Biotechnology funding volume (2002-2005): 2.5M EUR (co-financed with EU structural funds).

## 2.4 Foundations

Table 2.4 shows the main biotechnology-relevant activities identified for the purpose of the project carried out by foundations at national level in the period 2002-2005. These are the Foundation for German Science and the German Federal Foundation for the Environment.<sup>27</sup>

### 2.4.1 Instruments of the Foundation for German Science

- Donation Professorships and Lectureships

The Foundation for German Science co-finances the establishment of professorships and lectureship positions at public universities. In doing so, the foundation contributes to both training and research at German universities. The instrument is not limited to any scientific discipline or technology.

Biotechnology funding volume (2002-2005): 3M EUR.

### 2.4.2 Instruments of the Deutsche Bundesstiftung Umwelt- DBU (German Federal Foundation for the Environment)

- Project funding in the field of bio-process engineering<sup>28</sup>

The *Deutsche Bundesstiftung Umwelt* (DBU) focuses on supporting projects for environmental protection and environmental education programmes aimed at changing patterns of behaviour. The subsidies are concentrated on small and medium-sized enterprises. The DBU particularly encourages co-operation projects between small and medium-sized enterprises and research institutions. The foundation has established focus fields in the promotion of applied environmental research. To estimate biotechnology funding for our purposes, the funding volume of the field "bio-process engineering" was considered.

Biotechnology funding volume (2002-2004): 7.9M EUR.

Table 2.4 Overview of biotechnology stimulating instruments by foundations

Instrument	Foundation	Budget in M EUR
Donation Professorships and Lectureships	Foundation for German Science	3
Project Funding (bio-process engineering)	DBU	7.09

Source: BioPolis Research

<sup>27</sup> The "Volkswagen Stiftung" was also included in the survey. According to the information provided, in the reporting period there were no activities relevant for biotechnology research.

<sup>28</sup> The information has been collected from the Annual Reports of the Foundation and the internet database on project funding at <http://www.dbu.de>

## 2.5 Participation in 6th Framework Programme

Table 2.5 shows the participation of German research groups in the 6<sup>th</sup> Framework Programme in the thematic priorities relevant for biotechnology. The information shows the number of groups involved as co-ordinators and as participants in the projects.

Table 2.5 Involvement of Germany in biotechnology/life sciences programmes of the 6<sup>th</sup> Framework Programme

<b>Sixth Framework Programme<sup>1</sup></b>	<b>Participation as project manager in # of projects (% of total)</b>	<b>Participation as member of the project team in # of projects (% of total)</b>
Thematic priority		
1. Life sciences, genomics and biotechnology for health	130 (17%)	1507 (18%)
2. Nanotechnologies, section bio-nanotechnology	3 (25%)	26 (25%)
5. Food quality and safety	5 (6%)	159 (10%)

<sup>1</sup> First and second call, all types of projects

<sup>2</sup> Persons/groups can participate in more projects, resulting in more participations

Source: BioPolis Research

In the thematic priority nanotechnologies, section "Bio-nanotechnology", 25% of the projects had a German co-ordinator. In the case of life sciences, 17% of the projects were co-ordinated by a German team. In terms of participation, as a member team the importance of the German participation in each thematic priority is similar to the participation as co-ordinators. In the thematic priorities "Bio-nanotechnology" and "Life Sciences" Germany has the largest participation quotas of all participating countries.

### **3. Performance of the national biotechnology innovation system**

#### **3.1 Introduction**

This chapter analyses the performance of the German 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 the performance is structured along 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 Germany, the USA and EU25 will be shown. To establish a comparison, the values reach by EU25 have been chosen as reference in each indicator. The absolute figures are presented in Annex 5. For each indicator, data are presented for three periods. Depending on the data availability, the periods chosen can vary considerably between the indicators; Table A.5.1. in Annex 5 presents the specific years for each period for each indicator.

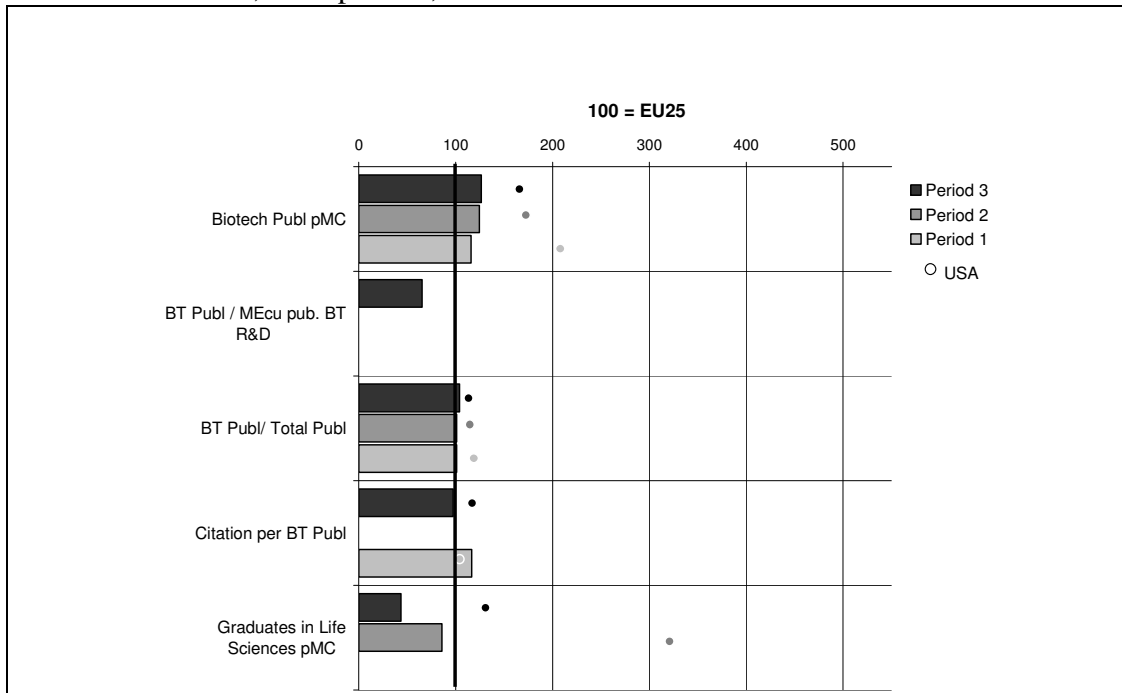
#### **3.2 Performance in creating a knowledge base and supporting the availability of human resources**

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.

With regard to the production of biotechnology knowledge in terms of biotechnology publications per million capita (pMC), the German performance reveals values clearly above those of EU25, however below the US level. Moreover, over the three time periods considered, we can observe a continuous increase in the number of biotechnology publications pMC. However, these gains are not above the overall increase in scientific knowledge (cf. total publications). In other words, the rate of knowledge production in biotechnology seems to follow the overall trend across all fields. The share of biotechnology publications within all publications remains quite stable (11% in 1994-98 and 14% in 2002-04). EU25 reaches 11% in the period 1994-98 and 13% in the period 2002-04. According to the most recent data available, Germany's share of biotechnology publications over all publications ranges above the EU25 share. Highest European shares are achieved by Sweden (16% in 2002-04) and Finland (16% in 2002-2004).

As regards the productivity of the knowledge production process (in terms of biotechnology publications per public biotechnology R&D expenditures), Germany's performance is well below that of EU15. Data are not available for the USA.

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



Source: BioPolis Research

Data: Science Citation Index, OECD Education Database, European Commission 1999

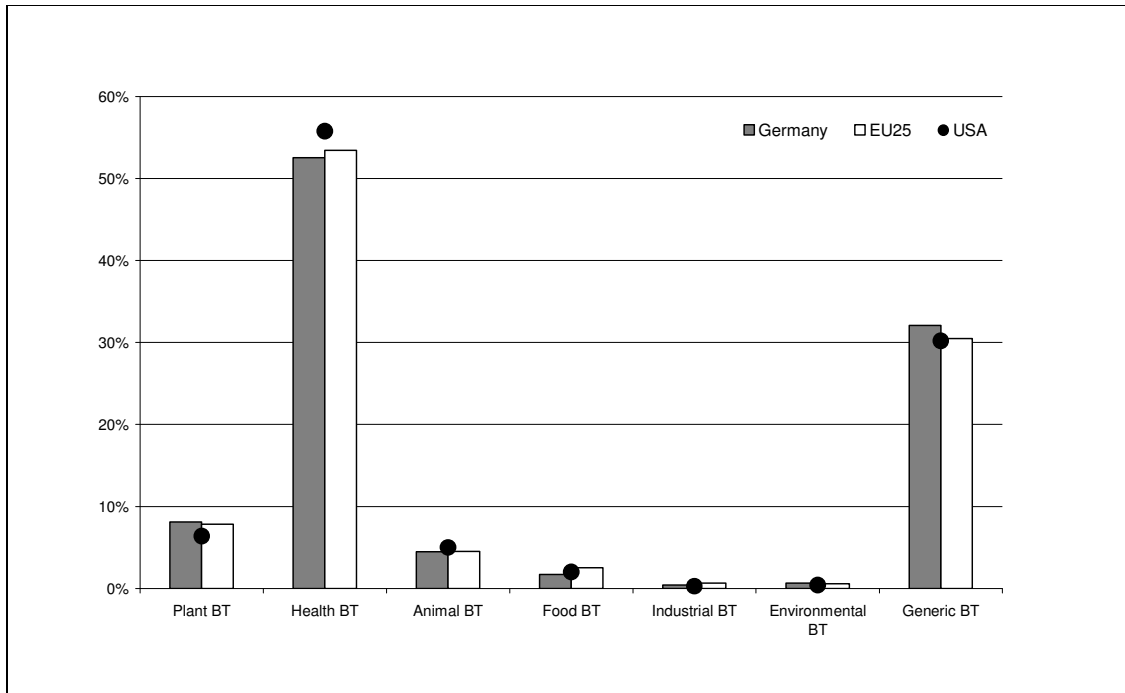
Note: the European reference region for indicator 2 (BT Publ./MEcu pub. BT R&D) is EU15.

The indicator giving the citation rates per biotechnology publication suggests that the quality of German biotechnology publications in terms of citations decreased between the two periods under consideration, 1994/98 and 2000/04. In the most recent period the level is below the EU level. The results are worrying.

With regard to the number of graduates in life sciences, the indicator graduates in life science pMC compared to EU25 and the US is disappointing. The number of graduates in life sciences pMC in Germany increased from 73 to 82. However, EU25 and US show a considerably better indicator performance for both periods (91 and 189 in the case of EU25 and 273 and 246 in the case of the US in each period). Over the two periods covered (1998 and 2002), Germany is behind both regions and the gap with EU25 increased significantly. The empirical evidence suggests a critical situation concerning the availability of skilled human resources in Germany in the field of life sciences.

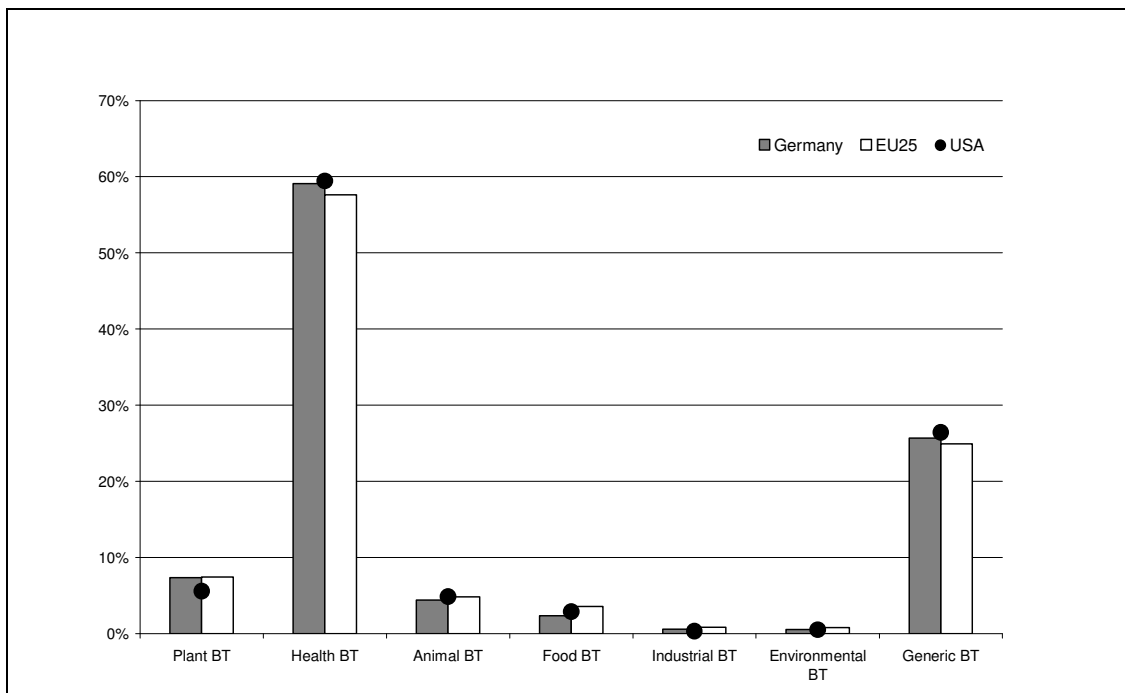
Chart 3.2.1 shows a set of bibliometric indicators for the period 1994-1996 which aims at presenting the profile of the biotechnology scientific output in Germany. For 7 research biotechnology fields, the chart gives the share of publications within the total biotechnology output. The set of indicators gives a simple specialisation profile. Chart 3.2.2 shows the same set for the period 2002-2004 and Chart 3.4 the growth rates between the two periods.

Chart 3.2.1 Share of subfields (in %) of total biotechnology publication for Germany 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 Germany in comparison with EU25 and USA (2002-2004)



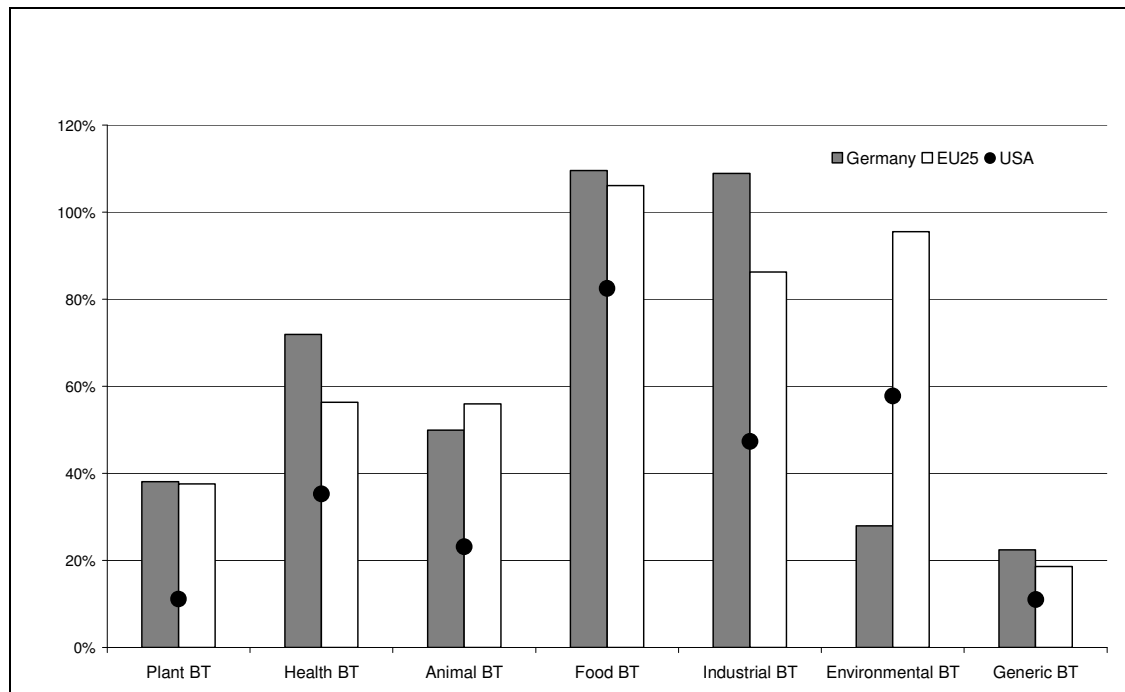
Source: BioPolis Research  
 Data: Science Citation Index

The bibliometric analysis reveals two main focuses of the German biotechnology scientific output: health and generic biotechnology. In both time periods these biotechnology areas seem to produce the largest volume of biotechnology publications. This profile is in line with those of the EU25 and the USA. However, in the time period 1994-1996, the USA seems to have a slightly stronger focus than Germany and the EU25 on the area of health biotechnology. In the second time period shown in Chart 3.2.2, the focus on health biotechnology increases for the 3 regions. In the time period 2002-2004 the profile for the three regions is almost the same.

With regard to the comparison between 1994/96 and 2002/04 shown in Chart 3.3, Germany experienced the most pronounced increases of publication activities in the subfields of food (+110%) and industrial biotechnology (+109%). Health biotechnology reaches the third largest growth rate (+72%). In comparison with EU25, Germany deviated most from the European patterns in the environmental biotechnology area. Germany reaches the lowest rate of knowledge production across Europe in this subfield.

On the other hand, in health biotechnology and industrial biotechnology the German growth rates are considerably larger than the growth rates of EU25 and USA.

Chart 3.3 Biotechnology subfields growth rates for Germany in comparison with EU25 and USA (1994-1996 and 2002-2004)



Source: BioPolis Research  
 Data: Science Citation Index

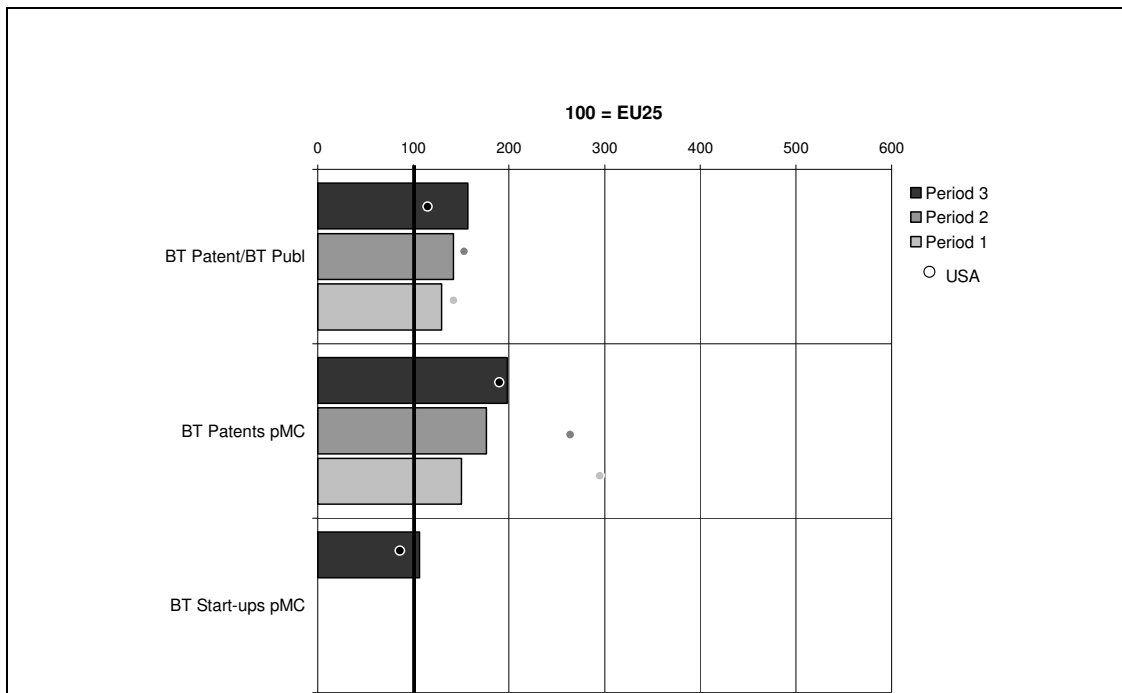
### 3.3 Performance in knowledge transfer and application

The indicators chosen for the assessment of the overall performance in knowledge transfer and application are given in Chart 3.4.

As regards the first of the three indicators – biotechnology patents per biotechnology publication – Germany outperforms the EU25. Moreover, the performance has improved over time. In period 3, Germany attains the largest share of biotechnology patents per publication among the three regions included in the chart. If we consider all the countries in the BioPolis project, with 0.11 biotechnology patents per biotechnology publication in the period 2001-2003, Germany ranks third behind Iceland and Denmark. In terms of this indicator, the data suggest an outstanding ability in knowledge transfer on the part of Germany.

Regarding the second indicator (biotechnology patents pMC), the results support the good German performance. In all three periods Germany outperforms the EU25. In the most recent period (2001-2003), Germany ranks better than the USA which show a decreasing trend in terms of biotechnology patents pMC.

Chart 3.4 Performance indicators for biotechnology knowledge transfer and applications, three periods, Germany 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.

Finally, in terms of company creation, with 125 biotechnology start-ups (1.5 pMC) in the time period 2001-2003, Germany performed at the level of EU25 and slightly better than

the USA in terms of biotechnology start-ups pMC. Top performer Denmark reached 8.4, and the second best performer Switzerland reported four start-ups pMC.

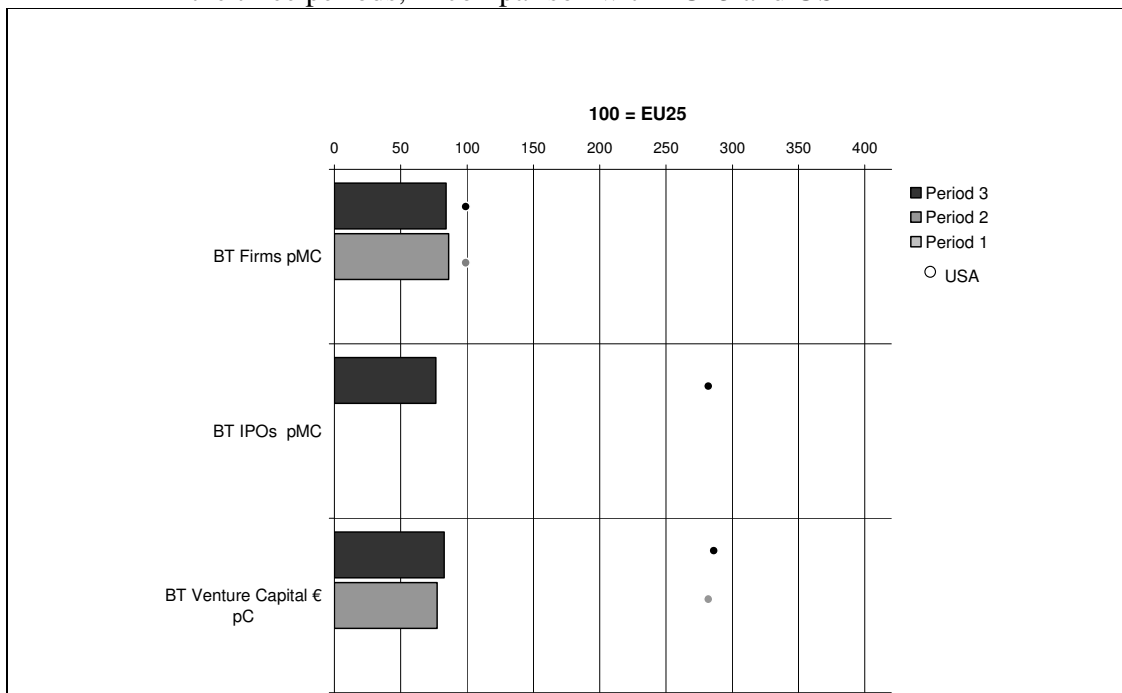
All in all, German performance in knowledge transfer and application is very satisfactory compared to EU25 and the USA. Germany seems to be very successful in developing industrial applications for biotechnology research results. Only in terms of company creation is the performance average.

### 3.4 Industrial development

The indicators chosen for the assessment of the overall performance in biotechnology industrial development are given in Chart 3.5.

German performance in this area is quite disappointing. The first indicator (biotechnology companies pMC) suggests that, in per capita terms, Germany has a small biotechnology industry compared to EU25 and the USA. Moreover, if we consider the absolute figures, the number of biotechnology companies in Germany is decreasing in the two selected years (360 biotechnology companies in 2001 and 346 in 2004).

Chart 3.5 Performance indicators for Germany'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

With regard to the second indicator (IPOs pMC), in the period 2002-2005 Germany was clearly behind the EU25. In absolute terms, 4 initial public offerings were accomplished by German biotechnology companies. In the same period, the UK and USA accounted for 15 and 52 IPOs respectively.

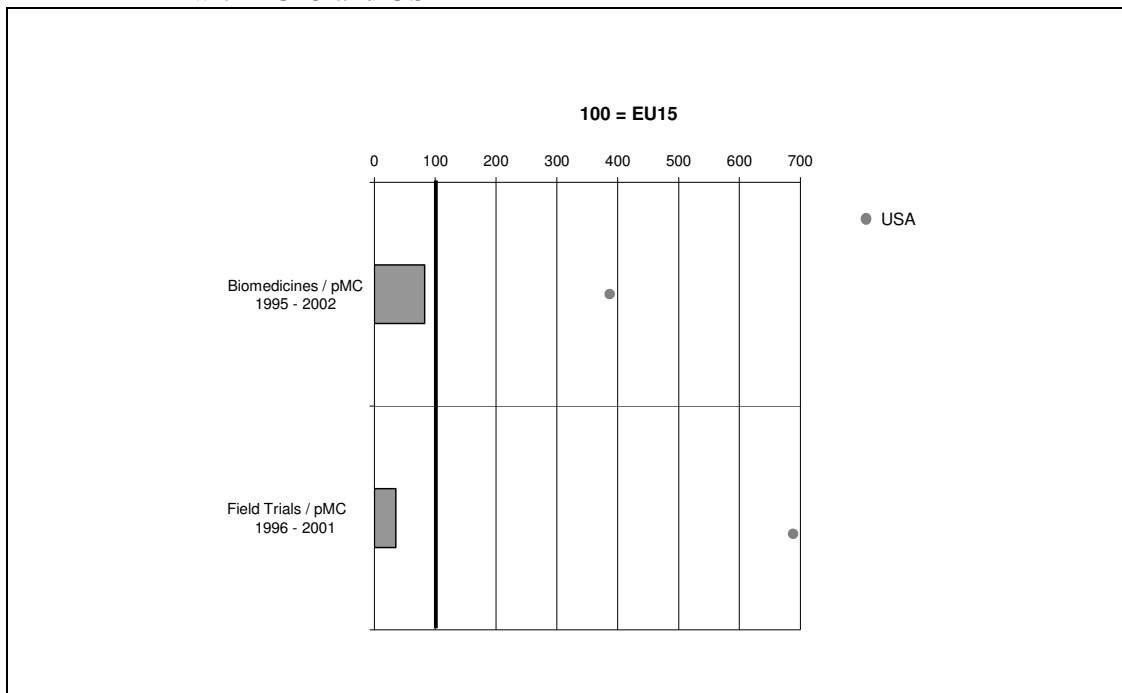
Finally, as regards the amount of venture capital invested in biotechnology companies, Germany remains below the EU25 level in both time periods. Even though the trend points out a positive development vis-à-vis EU25, the performance remains disappointing. With 233M EUR venture capital in 2004, Germany does not attain the EU25 level of investment in per capita terms.

All in all, German performance in biotechnology industrial development (in terms of number of biotechnology companies, venture capital invested and IPOs) reveals important weaknesses in the industrial capacity of the biotechnology innovation system.

### 3.5 Market conditions

The indicators chosen for the assessment of the overall performance in biotechnology industrial development are given in Chart 3.6.

Chart 3.6 Performance indicators for Germany’s market conditions, in comparison with EU25 and USA



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

For the time period 1995 – 2002, 7 biomedicines were reported from Germany. As given in Chart 3.6, the performance is below the EU15 average in per capita terms. The same

results hold for the field trials. Between 1996 and 2001, Germany reported a total number of 102 field trials. In absolute terms, Germany ranks second behind the USA (which held 278 field trials in the same period). However, if we consider the per capita figures, Germany shows 1.2 field trials pMC which brings the country into a quite weak position compared to the USA and EU15.

As in the area of industrial development, the overall performance in the market for biotechnology products is weak. The German biotechnology innovation system seems to have serious problems in developing biotechnology products to bring into the market.

## 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 Germany at the national and regional levels in the period 2002-2005. The key aspects of the German biotechnology policy approach considered in the analysis are:

- Funding volume per type of policy instrument
- Target groups of the policy instruments and co-financing conditions
- 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 through non-directed, generic and specific instruments for the period 2002-2005.<sup>29</sup>

Moreover, the funding information available has been classified according to the policy goals of the instruments implemented to allocate the funding. The table thus gives funding information on "research"<sup>30</sup>, "commercialisation"<sup>31</sup> promotion and "other"<sup>32</sup> policy goals.

According to the information available, biotechnology is mainly promoted through non-policy-directed funding (72% of the total funding in the period 2002-2005). Considering that this funding goes mainly to public research institutions, in the reporting period the

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<sup>29</sup> The data included in the table correspond with the information presented in chapter 2. Data have been gathered by using secondary literature, conducting short telephone interviews with policymakers and circulating a standardised questionnaire among the responsible policymakers.

<sup>30</sup> Refers to funding targeting the following policy goals: (i) to stimulate high level of biotechnology research, (ii) to stimulate high level of industry-oriented (and applied) research, (iii) to stimulate knowledge flow and collaboration among scientific disciplines, (iv) to guarantee the availability of human resources.

<sup>31</sup> Refers to funding targeting the following policy goals: (i) to stimulate the transfer of knowledge from academia to industry and its application to industrial resources (ii) to promote the adoption of biotechnology for new industrial applications, (iii) to stimulate company creation, (iv) to promote business investment in R&D.

<sup>32</sup> Refers to funding targeting the following policy goals: (i) to stimulate social acceptance of biotechnology and (ii) to promote bio-safety research and risk assessment.

largest policy effort in terms of funding invested was engaged in the promotion of the knowledge base and human resources.

As regards the policy-directed instruments, at a first glance it seems that research promotion remained the main policy focus. According to the data available, policy instruments targeting commercialisation allocated 40% while 57% of the funding was dedicated to research-related policy goals. However, the interpretation of the data should be treated with caution since data from generic instruments promoting industrial investment in R&D at the national level are not available.

With regard to the proportion of regional funding, regional policy instruments received 35% of the total funding allocated through policy-directed instruments. The federal government thus remained the main promoter of the biotechnology knowledge base and its industrial application.

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

	<b>Total in M</b>
<b>RESEARCH</b>	<b>2002-2005</b>
<b>1. Non-policy-directed</b>	
Public research institutions <sup>1)</sup>	2 438.4
Response mode <sup>1)</sup>	840
<b>Total Non-policy-directed</b>	<b>3 278.4</b>
<b>2a. Policy-directed generic</b>	
National	61.8
Regional	97.9
<b>Total 2a.</b>	<b>159.7</b>
<b>2b. Policy-directed biotech-specific</b>	
National	488.2
Regional	84.1
<b>Total 2b.</b>	<b>572.3</b>
<b>COMMERCIALISATION</b>	
<b>3a. Policy-directed generic</b>	
National <sup>2)</sup>	122.2
Regional	199.4
<b>Total 3a.</b>	<b>77.2</b>
<b>3b. Policy-directed biotech-specific</b>	
National	176.4
Regional	140.4
<b>Total 3b</b>	<b>316.8</b>
<b>4. OTHER</b>	
National	42.4
Regional	3.1
<b>Total other</b>	<b>45.5</b>
<b>TOTAL Policy-directed (2+3+4)</b>	<b>1 294</b>
<b>Grand Total (1+2+3+4)</b>	<b>4 572</b>

Source: BioPolis Research

<sup>1)</sup> The figures present a rough estimation of the funding for biotechnology research.

<sup>2)</sup> Data missing

### 4.3 Specific features of the instruments

Table 4.2 includes the policy-directed instruments. The table shows the target groups of each instrument and whether the subsidies or grants are based on the co-financing principle (the subsidy does not finance the entire costs of the actions promoted).

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	Co-financing	Participants/Recipients		
			LF	PRO	SME
<b>National Policy Instruments</b>					
<i>Generic (non biotechnology specific)</i>					
Innovation financing schemes	tbg	✓			✓
ERP Innovation Programme	KfW SME Bank				✓
ERP Startfonds	KfW SME Bank				✓
National Genome Research Network	PT DLR	✓	✓	✓	✓
Ethical, legal and social aspects in biomedical research (ELSA)	PT DLR			✓	
Commercialisation Campaign	PT Jülich			✓	
EXIST – Start-ups from Universities (including EXIST SEED)	PT Jülich			✓	
Framework programme "Entrepreneurial Regions" for the new <i>Länder</i>	PT Jülich	✓		✓	✓
InnoNet – Funding of innovative networks	VDI / VDE	✓		✓	✓
Collective Industrial Research and Development (IGF)	AiF	✓		✓	✓
Innovative Competence for SMEs - PRO INNO	AiF	✓		✓	✓
Network Management East – NEMO	AiF	✓		✓	✓
Promotion of Research, Development and Innovation Activities in SMEs and Public Research Organizations (PROs) in the new <i>Länder</i> (2001-2004) and INNO-WATT (since 2004)	Euronorm			✓	✓
<i>Biotechnology-specific</i>					
Framework programme "Biotechnology"	PT Jülich	✓		✓	✓

Table 4.2 continued

Regional Instruments	Funding Agency	Co-financing	Participants/Recipients		
			LF	PRO	SME
<i>Generic (non biotechnology specific)</i>					
L-EA Venture Fonds	L-EA		✓	✓	✓
Bremerhaven Economic Development Company Innovation programme	BIS	✓			✓
Bremer Innovation Agency - R&D in SMEs	BIA	✓	✓		✓
Brandenburg ILB - Promotion programme for research and development (large projects)	ILB ZAB	✓			✓
Brandenburg ILB - Promotion programme for research and development (small projects)	ILB ZAB	✓			✓
BayTP Bavarian Technology Promotion Programme	STMWIT	✓			✓
BayTOU Bavarian Programme for the establishment of technology-oriented companies	STWWIT	✓			✓
BayBG - Innovation Equity Investment	BayBG			✓	✓
Bavarian High-Tech Offensive	Bavarian State	✓	✓	✓	✓
Berlin - Programme for promotion of research, innovations and technologies (ProFIT)	IBB	✓	✓	✓	✓
Zukunftsfonds Berlin	TSB	✓		✓	✓
Mecklenburg-Vorpommern Regional Research Programme	PT Jülich				✓
Research and Development Promotion Programme Directive	Hamburg BWA	✓		✓	✓
Hamburg Innovation Foundation R&D Programme	Innovation Foundation Hamburg	✓	✓	✓	✓
Directive for funding activities within the Lower Saxony Innovation Promotion Programme - Subsidies for R&D Projects	Lower Saxony MW	✓	✓	✓	✓
Lower Saxony Innovative University Projects	Lower Saxony MWK			✓	
North Rhine-Westphalia Measure 2.1 Technology and Innovation	PT Jülich	✓		✓	✓
North Rhine-Westphalia Technology and Innovation Programme (TIP)	PT Jülich	✓			✓
Rhineland-Palatinate Research Promotion	Rhineland-Palatinate MWWFK	✓		✓	
Rhineland-Palatinate Foundation for Innovation - Project Funding for basic research, applied research and technology transfer	Rhineland-Palatinate Foundation for Innovation	✓		✓	
Initiatives of the Rhineland-Palatinate State Ministry for Economic Affairs, Transport, Agriculture and Viticulture (FITOUR, TT offices, etc.)	Rhineland-Palatinate MWVLW	✓			✓
Saarland Innovation Programme	Saarland MWA	✓			✓
Saxony-Anhalt Promotion Programme for Industrial Research	Investment Bank Sachsen-Anhalt	✓		✓	✓
Schleswig-Holstein Directive for the Financial Support for Innovations in SMEs (BI and AI)	Economic Promotion and Technology Transfer Schleswig-Holstein GmbH	✓			✓

Table 4.2 continued

Regional Instruments	Funding Agency	Co-financing	Participants/Recipients		
			LF	PRO	SME
<i>Generic (non-biotechnology-specific)</i>					
Schleswig-Holstein Directive for the Financial Support for Research, Development and Technology Transfer (FET)	Schleswig-Holstein WWV	✓		✓	✓
Schleswig-Holstein Initiative University-Economy Transfer	Schleswig-Holstein WWV	✓	✓	✓	✓
Thuringia Directives for the promotion of research at Public Research Organisations (PROs)	TKM			✓	
Thuringia promotion programme for research and development in companies	TMWTA	✓	✓	✓	✓
Thuringia Directive for the promotion of research consortia	TMWTA	✓	✓	✓	✓
Thuringia Directive for the promotion of industrial research	TMWTA	✓			✓
<i>Biotech-specific</i>					
Baden-Württemberg Research Programme "Transmissible Spongiforme Encephalopathies"	PT Jülich			✓	
<i>Verbundforschung</i> (Consortia Research) Baden-Württemberg (scientific and industry-oriented collaborative projects), Theme 1/Biotechnology	PT Jülich	✓	✓	✓	✓
Promotion Programme Biotechnology Baden-Württemberg, indirect-specific funding programme for biotechnology R&D in SMEs	PT Jülich	✓			✓
BioNord Biotechnology centre in Bremerhaven	BIS		✓	✓	✓
Brandenburg Biotechnology Centre - Biotech Hennigsdorf	Brandenburg MW		✓		✓
Hessen-Invest Start	IBH	✓			✓
Hessen Biotechnology Innovation Centres in Frankfurt am Main (FIZ), Gießen (TIG) and Marburg (NTZ)	Hessen Ministry WVL		✓		✓
Initiative <a href="http://www.Biotech-Hessen.de">www.Biotech-Hessen.de</a>	HA				✓
BayBio - Promotion Programme for research and development projects in biotechnology and genetics	STWWIT	✓		✓	✓
BioTOP Berlin-Brandenburg			✓	✓	✓
Saarland - Promotion Programme Life Sciences and Nanotechnology	Saarland MWA	✓			✓
Saxony-Anhalt - Technology Centres				✓	
Biosaxony – Biotechnology Offensive of the State of Saxony	Saxony State Government	✓	✓	✓	✓
Hessen - ZAFES – The Centre for Drug Research, Development and Safety	State of Hessen		✓		
LSA Life Science Agency GmbH (LSA)	The federal state of NRW				✓

Source: BioPolis Research

#### 4.4. Policy goals

Table 4.3 presents the policy-directed instruments. 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 company 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 granted grants, subsidies and/or credits.

The data available suggest that policy-directed instruments were mainly directed to promote a high level of biotechnology research (policy goals 1 and 2 with 359M EUR and 287M EUR respectively in the reporting period). Next, the transfer of knowledge from academia to industry and its application to industrial resources (policy goal 5) was an important policy goal in terms of funding (with 218M EUR). The most disregarded policy goal in terms of funding was the promotion of social acceptance of biotechnology. The interpretation of the data should be treated with caution, since data from generic instruments promoting industrial investment in R&D are not available.

Considering the policy instruments at the regional level, the information available reveals an interesting picture. In terms of allocated funding, regional policy instruments concentrate largely on promoting industry-oriented research (policy goal 2 with 130M EUR) and on company creation (policy goal 7 with 170M EUR).

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
<b>National</b>										
<i>Generic</i>										
Innovation financing schemes of the tbg							✓			
ERP Innovation Programme <sup>1)</sup>										
ERP Startfonds <sup>1)</sup>										
✓National Genome Research Network	✓		✓							
Ethical, legal and social aspects in biomedical research (ELSA)			✓					✓		
Commercialisation Campaign					✓					
EXIST – Start-ups from Universities (including EXIST SEED)					✓		✓			
Framework programme "Entrepreneurial Regions" <sup>1)</sup>										
InnoNet – Funding of innovative networks <sup>1)</sup>										
Collective Industrial Research and Development (IGF)		✓								
Innovative Competence for SMEs - PRO INNO <sup>1)</sup>										
Network Management East – NEMO <sup>1)</sup>										
Promotion of Research, Development and Innovation Activities in SMEs and Public Research Organizations (PROs) in the new Länder (2001-2004) and INNO-WATT (since 2004)		✓				✓				
<b>Total National Generic Instruments M EUR <sup>2)</sup></b>	<b>30</b>	<b>28.2</b>	<b>33.6</b>	<b>0</b>	<b>19.15</b>	<b>6.4</b>	<b>21.68</b>	<b>1.5</b>	<b>0</b>	<b>0</b>
<i>Biotech-specific</i>										
Framework Programme "Biotechnology"	✓	✓	✓		✓					✓
<b>Total National Biotechnology Specific Instruments in M EUR <sup>2)</sup></b>	<b>317.48</b>	<b>128.4</b>	<b>42.33</b>	<b>-</b>	<b>176.38</b>	<b>-</b>	<b>-</b>	<b>-</b>		<b>40.92</b>
<b>Total National Policy-directed Instruments in M EUR <sup>2)</sup></b>	<b>347.48</b>	<b>156.6</b>	<b>75.93</b>	<b>0</b>	<b>195.53</b>	<b>6.4</b>	<b>21.68</b>	<b>1.5</b>	<b>0</b>	<b>40.92</b>

Table 4.3 continued

	1*	2	3	4	5	6	7	8	9	10
<b>Regional</b>										
<i>Generic</i>										
L-EA Venture Fonds							✓		✓	
Bremerhaven Economic Development Company - Innovation programme	✓	✓	✓		✓	✓				
Bremer Innovation Agency - R&D in SMEs									✓	
Brandenburg ILB - Promotion programme for research and development (large projects) <sup>1)</sup>										
Brandenburg ILB - Promotion programme for research and development (small projects) <sup>1)</sup>										
BayTP Bavarian Technology Promotion Programme									✓	
BayTOU Bavarian Programme for the establishment of technology-oriented companies							✓			
BayBG - Innovation Equity Investment										
Bavarian High-Tech Offensive		✓		✓			✓			
Berlin - Programme for promotion of research, innovations and technologies (ProFIT)	✓	✓	✓			✓				
✓Zukunftsfonds Berlin		✓			✓	✓				
Mecklenburg-Vorpommern Regional Research Programme	✓									
Hamburg BWA Research and Development Promotion Programme Directive <sup>1)</sup>										
Hamburg Innovation Foundation R&D Programme <sup>1)</sup>										
Directive for funding activities within the Lower Saxony Innovation Promotion Programme - Subsidies for R&D Projects						✓			✓	
Lower Saxony Innovative University Projects <sup>1)</sup>										
North Rhine-Westphalia Measure 2.1 Technology and Innovation <sup>1)</sup>										
North Rhine-Westphalia Technology and Innovation Programme (TIP) <sup>1)</sup>										
Rhineland-Palatinate Research Promotion	✓	✓	✓	✓	✓	✓	✓	✓		✓
Initiatives of the Rhineland-Palatinate State Ministry for Economic Affairs, Transport, Agriculture and Viticulture (FiTOUR, TT offices, etc.)										
Rhineland-Palatinate Foundation for Innovation - Project Funding for basic research, applied research and technology transfer	✓	✓	✓	✓	✓	✓	✓	✓		

Table 4.3 continued

	1*	2	3	4	5	6	7	8	9	10
<b>Regional</b>										
<i>Generic</i>										
Saarland Innovation Programme <sup>1)</sup>										
Saxony-Anhalt Promotion Programme for Industrial Research									✓	
Schleswig-Holstein Directive for the Financial Support for Innovations in SMEs (BI and AI)					✓		✓		✓	
Schleswig-Holstein Directive for the Financial Support for Research, Development and Technology Transfer (FET)		✓			✓					
Schleswig-Holstein Initiative University-Economy Transfer		✓			✓					
Thuringia Directives for the promotion of research at Public Research Organisations (PROs)	✓		✓							
✓✓✓Thuringia promotion programme for research and development in companies		✓	✓		✓	✓	✓		✓	
Thuringia Directive for the promotion of research consortia					✓					
Thuringia Directive for the promotion of industrial research		✓							✓	
<b>Total Regional Generic Instruments</b>	11.91	78.78	5.04	2.15	16.36	12.1	49.84	0.45	43.9	0.77
<i>Biotech-specific</i>										
Baden-Württemberg Research Programme "Transmissible Spongiforme Encephalopathies"					✓					✓
<i>Verbundforschung</i> (Consortia Research) Baden-Württemberg (scientific and industry-oriented collaborative projects), Theme 1/Biotechnology					✓					
Promotion Programme Biotechnology Baden-Württemberg, indirect-specific funding programme for biotechnology R&D in SMEs		✓				✓				
BioNord Biotechnology Centre in Bremerhaven							✓			
Brandenburg Biotechnology Centre - Biotech Hennigsdorf							✓			
Hessen-Invest Start							✓			

Table 4.3 continued

	1*	2	3	4	5	6	7	8	9	10
<b>Regional</b>										
<i>Biotech-specific</i>										
Hessen Biotechnology Innovation Centres in Frankfurt am Main (FIZ), Gießen (TIG) and Marburg (NTZ)							✓			
✓✓ Initiative www.Biotech-Hessen.de						✓			✓	
✓ BayBio - Promotion Programme for research and development projects in biotechnology and genetics									✓	
BioTOP Berlin-Brandenburg						✓			✓	
Saarland - Promotion Programme Life Sciences and Nanotechnology									✓	
✓✓✓ Saxony-Anhalt – Technology Centres							✓			
Biosaxony – Biotechnology Offensive of the State of Saxony		✓		✓			✓			
Hessen - ZAFES – The Centre for Drug Research, Development and Safety					✓					
LSA Life Science Agency GmbH (LSA) <sup>1)</sup>										
<b>Total Regional Biotech-specific Instruments M EUR<sup>2)</sup></b>	0	52.09	0	32	6.14	4.9	120.6	0	8.76	1.85
<b>Total Regional instruments M EUR<sup>2)</sup></b>	11.9	130.9	5.0	34.2	22.5	17.0	170.5	0.5	52.7	2.6
<b>Grand Total in M EUR<sup>2)</sup></b>	359	287	81	34	218	23	192	2	53	44

Source: BioPolis Research

1) No information / estimations available on the budget invested per policy goal

2) The figures include only those national instruments for which comprehensive data per policy goal are 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 Company 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 allocated to each research area in the period 2002-2005. The application 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 at the national level indicate that health biotechnology and industrial biotechnology are the application areas receiving the largest share of funding. The framework programme "Biotechnology" has a strong influence in the funding profile per biotechnology application areas.

Table 4.4 Coverage of biotech application areas and funding through national 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
<b>National Instruments</b>									
<b>Generic</b>									
ELSA								✓	
INNO-WATT									✓
EXIST									✓
Valorisation Campaign									✓
tbg Innovation financing <sup>1)</sup>									✓
IGF <sup>1)</sup>									
NGFN				✓					
ERP Innovation programme <sup>1)</sup>									
ERP Startfonds <sup>1)</sup>									
InnoNet									✓
Pro-Inno									✓
ZUTECH <sup>1)</sup>									
NEMO <sup>1)</sup>									
Entrepreneurial Regions <sup>1)</sup>									
Total				60.0				5.1	56.8
<b>Biotech-specific</b>									
Framework programme Biotechnology	✓	✓		✓	✓	✓		✓	
Total	77	6.3		370.4	16.9	213.1		21.9	
<b>Grand Total National Instruments<sup>2)</sup></b>	<b>77</b>	<b>6</b>	<b>0</b>	<b>430.4</b>	<b>17</b>	<b>213</b>	<b>0</b>	<b>27</b>	<b>57</b>

Source: BioPolis Research

1) No information / estimations available on the budget invested per biotechnology field

2) The figures include only those national instruments for which comprehensive data per research area are 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 capabilities, infrastructure; not area specific

#### 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) Set 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 research networks (with 247M EUR), and collaborative research between industry and academia (with 246M EUR). Next, applied research (with 217M EUR) received much attention from public policy. The creation of incubators (147M EUR) and grants for industrial research (155M EUR) were also strongly promoted. All in all, the results suggest that network biotechnology activities were the main focus of attention of biotechnology policy in Germany in the period 2002-2005. If we consider the policy instruments at the national and regional level, the results are quite similar, except for the establishment of incubators and technology centres. According to the information available, both *Länder* and the federal government designed policy-directed instruments to promote applied research and industrial exploitation of research results. However, the regional governments engaged in the promotion of incubators and technology centres, while the central government invested more than 50% of the policy-directed biotechnology funding for the promotion of network formation and collaborative research between industry and academia.

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
<b>National Policy Instruments</b>																			
<i>Generic</i>																			
Innovation financing schemes tbg													✓						
ERP Innovation Programme <sup>1)</sup>																			
ERP Startfonds <sup>1)</sup>																			
National Genome Research Network		✓		✓				✓											
ELSA	✓	✓			✓														
Commercialisation Campaign												✓							
EXIST (including EXIST SEED)														✓					
Entrepreneurial Regions <sup>1)</sup>																			
InnoNet <sup>1)</sup>																			
IGF		✓						✓										✓	
PRO INNO <sup>1)</sup>																			
NEMO <sup>1)</sup>																			
Promotion of Research Collaboration in the new <i>Länder</i> (2001-2004) and INNO-WATT (since 2004)		✓																✓	
<i>Biotech-specific</i>																			
Framework Programme "Biotechnology"		✓	✓	✓				✓										✓	✓
Total National Funding <sup>2)</sup>	1	158	49	245	3	0	0	224	0	0	0	14	16	11	0	0	115	0	16

Table 4.5 continued

	1*	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
<b>Regional Policy Instruments</b>																			
<i>Generic</i>																			
L-EA Venture Fonds													✓						
Bremerhaven Economic Development Company Innovation programme	✓	✓						✓									✓		
Bremer Innovation Agency - R&D in SMEs																	✓		
Brandenburg ILB - Promotion programme for research and development (large projects) <sup>1)</sup>																			
Brandenburg ILB - Promotion programme for research and development (small projects) <sup>1)</sup>																			
BayTP Bavarian Technology Promotion Programme																	✓		
BayTOU Bavarian Programme for the establishment of technology-oriented companies																	✓		
BayBG - Innovation Equity Investment <sup>1)</sup>																			
Bavarian High-Tech Offensive		✓				✓			✓						✓				
Berlin - Programme for promotion of research, innovations and technologies (ProFIT)	✓	✓		✓															
Zukunftsfonds Berlin								✓									✓		
Mecklenburg-Vorpommern Regional Research Programme		✓						✓											
Hamburg BWA Research and Development Promotion Programme Directive <sup>1)</sup>																			
Hamburg Innovation Foundation R&D Programme <sup>1)</sup>																			
Directive for funding activities within the Lower Saxony Innovation Promotion Programme - Subsidies for R&D Projects		✓						✓									✓		
Lower Saxony Innovative University Projects <sup>1)</sup>																			

Table 4.5 continued

	1*	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
<b>Regional Policy Instruments</b>																			
<i>Generic</i>																			
North Rhine-Westphalia Measure 2.1 Technology and Innovation <sup>1)</sup>																			
North Rhine-Westphalia Technology and Innovation Programme (TIP) <sup>1)</sup>																			
Rhineland-Palatinate Research Promotion	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓							
Rhineland-Palatinate Foundation for Innovation - Project Funding for basic research, applied research and technology transfer	✓	✓		✓	✓		✓												
Initiatives of the Rhineland-Palatinate State Ministry for Economic Affairs, Transport, Agriculture and Viticulture (FiTOUR, TT offices, etc.) <sup>1)</sup>																			
Saarland Innovation Programme <sup>1)</sup>																			
Saxony-Anhalt Promotion Programme for Industrial Research																		✓	
Schleswig-Holstein Directive for the Financial Support for Innovations in SMEs (BI and AI)													✓					✓	
Schleswig-Holstein Directive for the Financial Support for Research, Development and Technology Transfer (FET)		✓						✓											
Schleswig-Holstein Initiative University-Economy Transfer																			
Thuringia Directives for the promotion of research at PROs	✓	✓																	
Thuringia promotion programme for research and development in companies <sup>1)</sup>																			
Thuringia Directive for the promotion of research consortia		✓						✓											
Thuringia Directive for the promotion of industrial research																		✓	

Table 4.5 continued

	1*	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
<b>Regional Policy Instruments</b>																				
<i>Biotech-specific</i>																				
Baden-Württemberg Research Programme "Transmissible Spongiforme Encephalopathies"	✓	✓																		
<i>Verbundforschung</i> (Consortia Research) Baden-Württemberg (scientific and industry-oriented collaborative projects), Theme 1/Biotechnology								✓												
Promotion Programme Biotechnology Baden-Württemberg, indirect-specific funding programme for biotechnology R&D in SMEs																	✓			
BioNord Biotechnology Centre in Bremerhaven															✓					
Brandenburg Biotechnology Centre - Biotech Hennigsdorf											✓									
Hessen-Invest Start													✓							
Hessen Biotechnology Innovation Centres in Frankfurt am Main (FIZ), Gießen (TIG) and Marburg (NTZ)															✓					
Initiative <a href="http://www.Biotech-Hessen.de">www.Biotech-Hessen.de</a>																✓				✓
BayBio - Promotion programme for research and development projects in biotechnology and genetics								✓										✓		
BioTOP Berlin-Brandenburg																✓				✓
Saarland - Promotion Programme Life Sciences and Nanotechnology																	✓			
Saxony-Anhalt - Technology Centres															✓					
Biosaxony – Biotechnology Offensive of the State of Saxony	✓	✓				✓									✓					
Hessen - ZAFES – The Centre for Drug Research, Development and Safety			✓																	
LSA Life Science Agency GmbH (LSA) <sup>1)</sup>																				
Total Regional Funding <sup>2)</sup>	30.1	59.5	1.5	1.5	1.9	33.7	0.3	21.6	61.6	0.0	2.7	0.2	32.6	0.0	147.1	2.7	39.6	0.0	2.7	

Table 4.5 continued

<b>Biotechnology Activity</b>	<b>1*</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>13</b>	<b>14</b>	<b>15</b>	<b>16</b>	<b>17</b>	<b>18</b>	<b>19</b>
Total Funding <sup>2)</sup>	31	217	50	247	5	34	0	246	62	0	3	14	49	11	147	3	155	0	18

Source: BioPolis Research

<sup>1)</sup> **No information / estimations available on the budget invested per activity**

<sup>2)</sup> **The figures include only those instruments for which comprehensive data per activity are available.**

\* Many different types of activities are supported by the policy instruments:

1 Basic research	6 Biotechnology training	11 Science and technology park	16 Awareness of biotech by companies not yet actively engaged in it
2 Applied research	7 Mobility of researchers between academia and industry	12 Protection of IPR in public research organisations	17 Grants for industrial research
3 Centres of excellence	8 Collaborative research between industry	13 Financial support for start-ups	18 Other incentives for business investment and public research organisations
4 Research network	9 Set up research institute/centre of industrial interest	14 Non-financial support for start-ups	19 Support for public discourse activities
5 Mobility of researchers among disciplines	10 Technology transfer office	15 Creation of incubators	

#### 4.7 Dynamics: Comparison with period 1994-1998<sup>33</sup>

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	635.4	957.1
Regional	n.a.	45.5
Total	635.4	1 002.6

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 a tremendous 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
<b>1. Creation of knowledge base and human resources</b>	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		√	√	√
<b>2. Knowledge transfer and application</b>	5. To facilitate transfer of knowledge from academia to the industry and its application for industrial purposes	√	√	√	√
	6. To stimulate the adoption of biotechnology for new industrial applications		√	√	√
	7. To assist company creation	√	√	√	√
<b>3. Market</b>	8. To monitor and improve the social acceptance of biotechnology		√		√
<b>4. Industrial development</b>	9. To encourage business investment in R&D	n.a.	√	√	√

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

<sup>33</sup> Information for the period 1994-1998 is drawn from Giessler, S. and T. Reiss (1999). National Report of Germany. Inventory of Public Biotechnology R&D Programmes in Europe. C. M. Enzing, J. N. Benedictus, E. Engelen-Smeets et al. Luxembourg, DG Research - European Commission.

Table 4.7 compares the periods 1994-1998 and 2002-2005 in terms of instruments targeting selected policy goals. According to the information available, in both periods the profile of policy instruments implemented is quite similar. In the period 2002-2005 there are specific policy instruments targeting the promotion of knowledge flow and collaboration among scientific disciplines. This was not the case in the period 1994-1995.

As regards the funding of biotechnology application areas, as in the period 1994-1998 the funding profile of policy-directed instruments at the national level concentrates on health and on industrial biotechnology.

## 5. Future developments

In its latest published strategic document (BMBF 2006)<sup>34</sup>, the Federal Ministry of Education and Research, announces that 15 000M EUR will be invested until 2009 to promote research and development. The goal of the federal government is to reach the 3% investment share of GDP for research and development by 2010 (Lisbon target).

Biotechnology remains a focus of attention for innovation policy. In the biotechnology field the document identifies 4 key fields for action:

- To promote the knowledge base for product and process innovation in biotechnology. For this purpose the government sets 3 scientific fields: (i) genome research, (ii) systems biology and (iii) molecular medicine.
- To exploit the potentials of industrial biotechnology and nano-biotechnology
- To promote the valorisation of scientific results.
- To promote the dialogue between industry and society.

Moreover, the strategic document presents specific initiatives to be launched in the short term:

- The promotion programme "BioIndutrie 2021", to be launched by the BMBF in 2006 targeting the application of biotechnology for the development of industrial processes;
- The promotion programme "Nanobiotechnology", to be launched by the BMBF in 2006;
- The extension of the initiative "BioChance Plus" (launched by the BMBF within the Biotechnology framework programme) after 2007
- The extension of the start-up initiatives High-tech Gründerfonds (BMWi) and Go-Bio (BMWF) to promote the valorisation of research results.
- To review the Gene Act in 2006.

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<sup>34</sup> BMBF (2006). Die Hightech-Strategie für Deutschland. Bonn, Berlin, Bundesministerium für Bildung und Forschung.

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| <a href="http://www.bmwi.de">http://www.bmwi.de</a>                                       | Federal Ministry of Economics and Technology |
| <a href="http://www.biotechnologie.de">http://www.biotechnologie.de</a>                   | Federal Portal for Biotechnology             |
| <a href="http://www.fz-juelich.de/ptj/englisch">http://www.fz-juelich.de/ptj/englisch</a> | Projektmanagement Organisation Jülich        |

<http://www.fhg.de>

Fraunhofer Society

<http://www.mpg.de>

Max Planck Society

<http://www.wgl.de>

Leibniz Association

<http://www.helmholtz.de/>

Helmholtz Association

<http://www.dfg.de>

German Research Foundation

<http://www.dbu.de/>

Deutsche Bundesstiftung Umwelt

## 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

	<b>Indicator</b>	<b>Chart</b>	<b>Comments</b>	<b>Time periods</b>
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

	<b>Indicator</b>	<b>Chart</b>	<b>Comments</b>	<b>Time periods</b>
Ind. 6	Graduates in life sciences pMC	3.1	Index: Reference Region EU17 =100 and US data for comparison	- (2) 1998 (3) 2002
Ind. 7	BT publications in subfields, as % of total BT publications	3.2.1	Data in % EU25 and US data for comparison	1994-1996
		3.2.2		2002-2004
Ind. 8	Growth rate of BT publications in subfields	3.3	EU25 and US data for comparison Small field effect	Growth rate between 1994-96 (period 1) and 2002-04 (period 3)
Ind. 9	Biotech patent applications pMC	3.4	EU25 and US data for comparison	(1) 1994-1996 (2) 1998-2000 (3) 2001-2003
Ind. 10	Number of biotechnology companies pMC	3.5	European (data available) and US data for comparison	(2) 2001 (3) 2004
Ind. 11	Number of biotech start-ups pMC	3.4	European (data available) and US data for comparison	(3) 2001-2003 (only one period)
Ind. 12	Number of biotech IPOs pMC	3.5	European (data available) and US data for comparison	(3) 2002-2005
Ind. 13	Venture capital in € pC	3.5	European (data available) and US data for comparison	(2) 2002 (3) 2004
Ind. 14	BT acceptance index	No Chart - Discussed in text of chapter 3	Source: BT Policy Benchmarking 2005. The biotechnology acceptance index is a composite index and draws on questions Q.12, Q.13.1 and Q14.01 and Q14.09 of the Eurobarometer 58.0	2002
Ind. 15	Eurobarometer 225	No Chart - discussed in text of chapter 3	See section 3.3 and sections 3.4.1, 3.4.2, and 3.4.3 of the Special Eurobarometer 225 <sup>35</sup>	2005
Ind. 16	Biomedicines	3.6	Source: BT Policy Benchmarking 2005 Index: Reference Region EU15 =100 US data for	1995-2002

35 [http://europa.eu.int/comm/public\\_opinion/archives/ebs/ebs\\_225\\_report\\_en.pdf](http://europa.eu.int/comm/public_opinion/archives/ebs/ebs_225_report_en.pdf)

	Indicator	Chart	Comments	Time periods
			comparison	
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 (M EUR )		
	94-96	98-00	02-04	1996	2000	2004
EU25	97521	128716	145646	447	451	457
Germany	20688	29174	33276	82	82	83
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
Germany	253	355	403	116	124	126
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 publications	Non-policy-directed funding	Policy-directed funding		Total public spending on BT (M Ecu)	BT publications/ 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.		
Germany	33276	1616	1385	176	3177	10	65
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. Share of BT publications of total publications: absolute and indexed

	BT publications			Total publications		
	94-96	98-00	02-04	94-96	98-00	02-04
EU25	97521	128716	145646	860652	1024327	1117392
Germany	20688	29174	33276	180785	229776	245252
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
Germany	11%	13%	14%	101	101	104
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
Germany	7.17	7.10	117	97
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 (M EUR )	
	1998 / 1999	2002	1998 / 1999	2002
EU17	46.859**	81316	552**	431
Germany	5977	6740	82	82
USA	75253*	70950	276*	288
	Graduates pMC		Index EU17=100	
	1998 / 1999	2002	1998 / 1999	2002
EU17	91**	189	100	100
Germany	73	82	86	43
USA	273*	246	299	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	Industrial	Environmental	Generic
EU25	100%	8%	53%	5%	3%	1%	1%	30%
Germany	100%	8%	53%	4%	2%	0%	1%	32%
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	Industrial	Environmental	Generic
EU25	100%	7%	58%	5%	4%	1%	1%	25%
Germany	100%	7%	59%	4%	2%	1%	1%	26%
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 3.2.1. BT publications in subfields for the period 1994-1996

	1994-1996							
	Total	Plant	Health	Animal	Food	Industrial	Environmental	Generic
EU25	97217	7629	51944	4375	2434	624	576	29635
Germany	20837	1691	10945	934	356	90	136	6685
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 3.2.2 BT publications in subfields for the period 2002-2004

	2002-2004							
	Total	Plant	Health	Animal	Food	Industrial	Environmental	Generic
EU25	140984	10494	81220	6821	5017	1162	1126	35144
Germany	31847	2335	18820	1400	746	188	174	8184

USA	141680	7910	84234	6872	4070	436	724	37434
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Source: BioPolis Research

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

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

	1994-1996/2002-2004						
	Plant	Health	Animal	Food	Industrial	Environmental	Generic
EU25	38%	56%	56%	106%	86%	95%	19%
Germany	38%	72%	50%	110%	109%	28%	22%
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 (M EUR)		
	94-96	98-00	01-03	1996	2000	2003
EU25	4924	8921	10119	447	451	455
Germany	1355	2870	3643	82	82	83
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
Germany	17	35	44	150	177	198
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
Germany	1355	2870	3643	20688	29174	32149
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
Germany	0.07	0.10	0.11	130	142	157
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
Germany	364	360	350	346	82260	82440	82537	82532
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
Germany	4.427	4.367	4.24	4.19	86	85	97	84
USA	5.11045	5.1121	5.065	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	
Germany	125	31	82537	
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
Germany	0.38	104	1.5	106
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 Available	29	452927	454869	457154	461593	456636
Germany	0	82440	82537	82532	82501	82502
USA	52	287941	290789	291685		290138
	IPO /pMC	Index				
	2002-2005	2002-2005				
EU Available	0.00	100				
Germany	0.00	76				
USA	0.00	282				

Note: EU Available is the result of the sum of available EU Member States

IPO data: Ernst and Young 2002-2006, London Stock Exchange, Frankfurt Stock Exchange, Euronext, Nasdaq, Burril & Company

Source: BioPolis Research

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

	Venture capital in biotechnology companies M EUR			Population in T		
	2002	2002	2002	2002	2003	2004
Europe	1100	920	2800			
EU Available	890	883	1111	315584	319663	325131
Germany	180	222	233	82440	82537	82532
USA	2288	2498	2855	287941	290789	291685
	Venture capital in /pC			Index		
	2002	2003	2004	2002	2003	2004
Europe						
EU Available	2.8	2.8	3.4	100	100	100
Germany	2	3	3	77	97	83
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 (M EUR)	Biomedicines / pMC	Index
	1995-2002	2002		1995-2002
EU15	39	378	0.10	100
Germany	7	82	0.08	82
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

	<b>Field trials</b>	<b>Population in M</b>	<b>Field trials pMC</b>	<b>Index</b>
	<b>1996-2001</b>	<b>2001</b>	<b>1996-2001</b>	<b>1996-2001</b>
EU15	1334	379	4	100
Germany	102	82	1	35
USA	6745	278	24	688

Note: EU15 is the result of the sum of the 15 old EU Member States

Source: BioPolis Research

Field trails: Biotechnology Innovation Scoreboard 2002

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

<b>BT acceptance index 2002</b>		
	<b>Index average</b>	<b>N (sample size)</b>
EU15*	100.29	16828
Germany	101,70	1024

\*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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### Websites:

London Stock Exchange <http://www.londonstockexchange.com/>

Frankfurt Stock Exchange <http://deutsche-boerse.com/>

Euronext <http://www.euronext.com/>

Nasdaq	<a href="http://www.nasdaq.com/">http://www.nasdaq.com/</a>
Burril & Company	<a href="http://www.burrillandco.com/">http://www.burrillandco.com/</a>
EuropaBio	<a href="http://www.europabio.org/">http://www.europabio.org/</a>
EUROSTAT	<a href="http://epp.eurostat.cec.eu.int/">http://epp.eurostat.cec.eu.int/</a>
OECD Education Database	<a href="http://www.oecd.org/">http://www.oecd.org/</a>
OECD Statistics	<a href="http://www.oecd.org/">http://www.oecd.org/</a>
STN International	<a href="http://www.stn-international.de/">http://www.stn-international.de/</a>
Questel Orbit	<a href="http://www.questel.orbit.com/index.htm">http://www.questel.orbit.com/index.htm</a>

## **Annex 6    Abbreviations**

AiF	German Federation of industrial Research Associations "Otto von Guericke"
AoS	Academies of Science
BayBG	BayBG Bavarian Equity Investment GmbH
BIA	Bremer Innovation Agency GmbH
BIS	Bremerhaven Economic Development Company
BMBF	Federal Ministry of Education and Research
BMWA	Federal Ministry of Economics and Labour
BMWi	Federal Ministry of Economics and Technology
BMAS	Federal Ministry for Labour and Social Affairs
Brandenburg MW	Brandenburg State Ministry for Economic Affairs
BT	Biotechnology
DFG	German Research Foundation
DBU	Deutsche Bundesstiftung Umwelt
DtA	Deutsche Ausgleichsbank - State-owned bank
Euronorm	Project Management Organisation Euronorm GmbH
FHG	Fraunhofer Society
HA	Hessen Agentur GmbH
Hamburg BWA	Hamburg Board for Economics and Labour
HEI	Higher Education Institutions
HGF	Helmholtz Society
Hessen MWVL	Hessen Ministry for Economic Affairs, Transport and Regional Development
FGL	Federal Government Research Organisations
IBB	Investitionsbank Berlin
IBH	Hessen State Investment Bank
IfG	Institutions of Cooperative Industrial Research
ILB	Investment Bank of the State of Brandenburg
IPO	Initial Public Offering
KfW	KfW Banking Group – State-owned bank

KfW SME Bank	KfW Mittelstandsbank
L-EA	L-EA Venture Capital Agency of the State Bank in Baden-Württemberg
LF	Large Firm
Lower Saxony MW	Lower Saxony State Ministry of Economic Affairs, Labour and Transport
Lower Saxony MWK	Lower Saxony State Ministry of Science and Culture
M	Million
MPG	Max Plank Society
pMC	Per Million Capita
PRO	Public Research Organisation
PT DLR	Project Management Organisation Health research, German Aerospace Center
PT Jülich	Project Management Organisation Jülich
Rhineland-Palatinate MWVLW	Rhineland-Palatinate State Ministry for Economic Affairs, Transport, Agriculture and Viticulture
Rhineland-Palatinate MWVFK	Rhineland-Palatinate State Ministry of Science, Training, Research and Culture
Saarland MWA	Saarland State Ministry for Economic Affairs and Labour
Saxony State Government	Saxony State Government
Schleswig-Holstein WWV	Schleswig-Holstein State Ministry for Science, Economic Affairs and Transport
SME	Small and Medium Enterprise
STMWIT	Bavarian State Ministry of Economic Affairs, Infrastructure, Transport and Technology
tbg	Technologie-Beteiligungs-Gesellschaft mbH
TKM	Thuringia State Ministry of Culture
TMWTA	Thuringia State Ministry for Economic Affairs, Technology and Labour
TSB	TSB Technologiestiftung Innovationszentrum Berlin
VDI / VDE	VDI / VDE Innovation and Technique
WGL	Leibniz Gemeinschaft
ZAB	Brandenburg Economic Development Board

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