

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 Bulgaria

BioPolis has been funded under FP6, Priority 5: Food Quality and Safety
Contract No. 514174

Ralf Lindner
Fraunhofer Institute for Systems and Innovation Research (Fraunhofer ISI)
Karlsruhe, Germany

March 2007

Table of contents

Summary	3
1. Introduction and background	5
1.1 General introduction	5
1.2 Characteristics of the national S&T and the innovation system	6
1.3 National support and framework conditions for biotechnology	10
1.4 Main biotechnology research actors in Bulgaria	12
2. Funding of biotechnology R&D, transfer and commercialisation	15
2.1 Introduction	15
2.2 Non-policy-directed funding of biotechnology research	16
2.3 Policy-directed funding of biotechnology research and commercialisation	17
2.3.1 National Fund for Scientific Research	17
2.3.2 National Innovation Fund	17
2.3.3 Other funding activities.....	18
2.4 Participation in Sixth Framework Programme	19
3. Performance of the national biotechnology innovation system	20
3.1 Introduction.....	20
3.2 Performance in creating a knowledge base and supporting the availability of human resources	20
3.3 Performance in knowledge transmission and application.....	23
4. Conclusions	25
4.1 Introduction.....	25
4.2 Public funding of biotechnology through policy instruments.....	25
4.3 Specific features of the instruments	26
4.4 Policy goals	27
4.5 Biotechnology research application areas.....	28
4.6 Stimulation of biotechnology activities through the instruments	29
5. Future developments	30
Annex 1 List of tables	31
Annex 2 List of figures and charts	32
Annex 3 List of contact persons	33
Annex 4 References	34
Annex 5 Performance	35
Annex 6 Abbreviations	46

Summary

Taken together, Bulgaria's economic development since the transitional recession has been quite positive. The economy is gradually moving towards the structure of an advanced industrialised economy, and between 2002 and 2005, Bulgaria enjoyed an average growth rate of 5.12%. Nevertheless, the South Eastern European country, which will become a member of the EU in 2007, merely reached 29.8% of the EU25 GDP per capita level in 2004.

Since the mid 1990s, Bulgaria's GERD as a percentage of GDP remained quite stable at an average of 0.5% – a level undercut only by few other European countries. According to National Innovation Strategy of 2004, Bulgaria aims to arrive at 1% GERD by 2010. The composition of GERD is unsatisfactory as well due to the very low share of private sector contributions to GERD (26.8% in 2003).

Compared to the end of the 1990s, the governance of the Bulgarian S&T system has clearly improved. Nevertheless, weaknesses remain concerning the coordination mechanisms, the scarce resources available for R&D and the low degree of cooperation between public and private innovation structures.

The main policy actors in the S&T field are the Ministry of Education and Science (MES) and the Ministry of Economy and Energy (MEE). The National Fund for Scientific Research (NFSR), which operates the bulk of Bulgaria's scientific funding programmes, is directly attached to the MES. Under the responsibility of the MEE, the National Innovation Fund (NIF) was established in 2005 in order to promote business-oriented applied R&D and to enhance cooperation between private and public research actors.

Bulgaria's biotechnology scene, which was supported with ample resources during the 1980s, is slowly recovering from crisis caused by the economic and political transition.

The main R&D performers are the non-university research institutes, mostly attached to one of the two large research organisations, the Bulgarian Academy of Sciences and the National Center of Agricultural Sciences. The universities are being encouraged by the government to expand their R&D activities. As Bulgaria's R&D system is overwhelmingly dominated by the public sector, the innovation structures of the biotechnology industry are underdeveloped and weak.

Traditional strongholds of Bulgaria's biotechnology research are fermentation and pharmaceutical biotechnology, enzyme technology, mineral biotechnology and genetic engineering. According to the performance data presented in this national report, Bulgaria's biotechnology research scene lags behind the EU25 levels in all categories covered. Most notably, publication activities (per capita) are among the lowest of the countries examined; the situation is even worse with regard to the citation rates. Similarly, Bulgaria shows very low performance rates in the area of knowledge transmission and application as a result of a small number of patent applications and low scientific productivity.

Public support for biotechnology is largely dominated by lump sum funds directed towards the public research institutes. One of the strategic goals within the S&T system is to reduce the share of unconditional subsidies and to significantly increase competitive mechanisms of funding procurement. For the time being, however, project funding from national sources continues to be too low.

During the period covered by BioPolis, the public funding made available for biotechnology R&D through policy-directed instruments amounted to 1.33M EUR. Despite the fact that the information about a large fraction of the non-policy-directed funding was is not available, the accessible budget data in this funding category reached 2.44M EUR – a sum nearly twice as large as the funds made available through policy-directed instruments.

1. Introduction and background

1.1 General introduction

The democratic elections of 1990 set the seal on the end of the communist era in Bulgaria. With the regime change, the Republic of Bulgaria entered the difficult phase of transition from a planned to a market economy and establishing democratic institutions and values. The South Eastern European country, which has a population of 7.7 million (2005), has been accepted to join the EU in 2007.

Taken together, Bulgaria's development since the transitional recession and the economic low point of 1997/1998 has been quite positive. Between 2002 and 2005, Bulgaria enjoyed an average GDP growth rate of 5.12%.¹ The country's GDP per capita reached 29.8% of the EU25 average in 2004, up from 26.7% in 2000. Countries with similar GDP levels currently are Romania, Turkey, Latvia or Croatia. The labour market situation also improved during the last few years as the unemployment rate decreased from 18.1% in 2002 to 10.9% in 2004.

The economy is gradually moving towards the structure of an advanced industrialised economy, as the size of the traditionally structured agrarian sector is shrinking. In 2004, the value added by the agrarian sector reached 10.1%, down from 26.2% in 1997. The industrial sector contributed 30% and services nearly 60% to GDP in 2004. Bulgaria is also increasingly integrated in European trade. Main trading partners for Bulgarian exports are Italy, Germany, Greece and Turkey, and the largest import shares are from Germany, Russia and Italy.²

Bulgaria's gross expenditure on research and development (GERD) as a percentage of GDP ranges about 1.5 points below the current EU25 level. During the period covered by BioPolis, GERD remained quite stable at an average level of 0.5% of GDP. With this intensity of R&D expenditure, the country is positioned at the lower end of the new member and accession states. Only Latvia (0.42%), Romania (0.39%), Cyprus (0.37%) and Malta (0.29%) invested less in R&D in 2004. According to the National Innovation Strategy of 2004, Bulgaria aims to arrive at 1% GERD as a percentage of GDP by 2010.

The situation with regard to the composition of R&D expenditures is unsatisfactory as well. Industry merely contributed 26.8% to GERD in 2003, slightly up from 24.8% in 2002 – a far cry from the Barcelona goal of a two-thirds share of private sector contributions. The large share of public R&D funding highlights the general dominance of the state sector in science, research and innovation.

The history of biotechnology in Bulgaria as a modern scientific endeavour actively promoted by the state reaches back until the early 1980s. As in many other Eastern Block

¹ Unless indicated otherwise, the macro-economic data are taken from Eurostat online sources, structural indicators, <http://epp.eurostat.ec.europa.eu>, accessed: 10-06-2006.

² National Statistical Institute of the Republic of Bulgaria, online source, http://www.nsi.bg/Index_e.htm, accessed: 16-01-2006.

countries, biotechnology became a scientific and economic priority in Bulgaria. After the quite successful development of biotechnology capacities, the field was neglected during the transition phase, resulting in a sharp decline of available human resources and facilities until 1997. Since then, the country's biotechnology scene has gradually been recovering (ARC Fund 2003: 9ff.)³.

The strongholds of the sector are fermentation and pharmaceutical biotechnology, enzyme technology, mineral biotechnology, and genetic engineering, with the antibiotic industry and mineral biotechnology being the most advanced. Three universities and two colleges offer biotechnology training; scientific research is mainly performed at a large number of – mostly state funded – research institutes (Ministry of Economy et al. 2001: 85)⁴.

The once large biotechnology industry collapsed after 1989 due to the loss of the markets in the former Eastern Block. Only a few of the formerly state owned biotechnology enterprises were able to recover from privatisation, downsizing and restructuring.

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

Bulgaria's S&T landscape had to cope with severe disruptions and instigate rigorous adjustments in the transition process during the post-1989 period. Financing of academic institutions was reduced and most R&D units at the state owned enterprises were closed down, highly trained personnel left the country, was jobless or not adequately employed. Moreover, many observers conclude that the Bulgarian S&T system was not only suffering under retrenchment, but many ill-founded policy decisions and the lack of political will to systematically reform the institutional landscape contributed to the slow implementation of structural changes.

Compared to the situation at the end of 1990s, the governance of Bulgaria's S&T system has definitely improved. Nevertheless, according to observers (cf. European Commission 2005a⁵; Petrov/Stefanov 2006: 28f.)⁶, the governance of the S&T system shows the following major weaknesses:

- weak coordination mechanisms between main actors,
- resources made available for R&D and innovation are far too little,
- low intensity of cooperation between public and private innovation structures,

3 ARC Fund (2003) Background Paper on Biotechnology. ForeTech – Technology and Innovation Foresight for Bulgaria and Romania, <http://foretech.online.bg/docs/background-paper-biotech-Bulgaria.pdf>, accessed: 17-05-2006

4 Ministry of Economy, German Agency for Technical Co-operation (GTZ)/Center for Economic Development (eds.) (2001) Analysis of the Bulgarian Technology Development, Working Paper, Sofia, Center for Economic Development

5 European Commission, DG Enterprise (2005a) European Trend Chart on Innovation, Annual Innovation Policy Trends and Appraisal Report Bulgaria 2004-2005, http://trendchart.cordis.lu/reports/documents/Country_Report_Bulgaria_2005.pdf, accessed: 17-05-2006

6 Petrov, M., Stefanov, R. (eds.) (2006) Innovation.bg. Measuring the Innovation Potential of the Bulgarian Economy, Sofia, Applied Research and Communications Fund

- insufficient availability of venture capital,
- and slow law making processes.

Main policy actors

The Ministry of Education and Science (MES) and the Ministry of Economy and Energy (MEE)⁷ are the main policy-making and executive bodies in the area public S&T and innovation policy. Their functions are complemented by several executive agencies and advisory bodies. Depending on the policy field, other sectoral ministries are formally responsible for research activities within their respective areas of responsibility. With regard to biotechnology-related research, the National Center of Agricultural Sciences (NCAS), one of the major research performing associations in Bulgaria, falls under the jurisdiction of the Ministry of Agriculture and Forestry.

The MES defines the national priorities in the field of education and science policy; it is responsible for the design and implementation of the policy measures in this area. Since 2003, the MES is supported by the National Council for Scientific Research (NCSR). This advisory body gives recommendations on the issues concerning Bulgaria's S&T strategy and contributes to the coordination of public activities in science and research. The Council has 19 high ranking members, including the ministers of the MES, the MEE and the Ministry of Finance, and representatives of academia. The second major institutional innovation within the realm of the MES that was introduced in 2003 was the founding of the National Fund for Scientific Research (NFSR). The Fund, which is directly attached to the scientific research department of the MES, implements the ministry's programmes promoting scientific research and supports international cooperation. The most important novelty of the NFSR was the introduction of competition in the procurement of public financing of R&D. The move away from unconditional subsidies to competitive mechanisms represents a central feature of Bulgaria's current R&D strategy (Petrov/Stefanov 2006: 26).

The MEE's responsibility within the S&T system is to develop policies to foster economic growth and competitiveness and to implement the national innovation policy concerning the business sector. On a strategic level, the economic policies of the Council of Ministers in general and the MEE in particular are strongly influenced by the Council for Economic Growth (CEG). This high level advisory body is composed of representatives of government and the business sector. The largely informal influence on the government's policy-making is based on the CEG's function as a discussion forum for economic issues; the debates provide the decision-makers with important feedback of the business community concerning proposed policy measures and the development of policy agendas.

As in the case of the MES, the MEE is also supported by an influential advisory body, the National Innovation Council (NIC). The Council is composed of eleven members and is chaired by the minister. Membership includes representatives of the MES, the Ministry of Finance, academia and the business sector. Apart from giving recommendations on the

⁷ The Ministry of Economy and the Ministry of Energy and Energy Resources were merged in August 2005.

MEE's innovation policy, the NIC also contributes to the coordination of policy measures with other ministries and agencies.

The chief instrument in Bulgaria's innovation strategy, the National Innovation Fund (NIF), started operating in March 2005. The NIF finances market-oriented applied research on a competitive basis and aims to establish links between research institutes, industry and SMEs. The fund's initial budget was only 2.5M EUR, but it is scheduled to increase to a level of 50M EUR by 2013 (European Commission 2005a: ii). Other than in the case of the NFSR which operates under the direct authority of the MES, the NIF is administered by the Bulgarian Small and Medium Sized Promotion Agency (BSMEPA).

The BSMEPA is an executive agency under the authority of the MEE; this intermediary agency is the main institution for coordinating and implementing the policies and programmes for SME promotion and development.

By and large, Bulgaria has a well developed institutional landscape incorporating all elements needed for successful governance of the S&T system. Improvements might be beneficial in the realm of the MES. An independent institution allocating funds and implementing programmes for scientific research might be able to attain a higher reputation among the recipients as an autonomous, professional and neutral promoter of scientific progress. The NFSR could represent the institutional seed of such a self-governing funding organisation.

Further improvements are also conceivable with regard to the governance processes. For instance, despite the fact that both the NIC and the NCSR include members from other actors in the S&T system, formal coordination mechanisms between the major players are not institutionalised. Probably even more expedient is a change of the culture within parts of the public administration. Observers point out that too many members of the bureaucracy continue to view private initiatives as rivals and that the understanding for the necessity to foster business activities in R&D is not yet fully internalised. This is also reflected by the general low level of cooperation and exchange between the state and the business sector, which has repeatedly been identified as the national innovation system's main weakness (Petrov/Stefanov 2006: 29).

At the level of strategic policy advice, institutional consolidation might reduce the apparent duplication and overlap of functions and improve the policy impact if the NIC and the NCSR were merged.

Key policy documents

The key policy documents in the area of science and innovation policy are the National Innovation Strategy (NIS) and the National Strategy for Science, Research and Development. Both strategy papers are principally inline with the science and innovation priorities spelled out in the National Development Plan for the years 2000-2006. For the sake of intensified integration of the policy areas covered, it has been recommended to de-

velop a single science and innovation strategy instead of two separate ones (Petrov/Stefanov 2006: 26).

The NIS, adopted in 2004, contains a mix of financial and non-financial measures. Its main reform measure was the establishment of the NIF which started operating in May 2005 (see above).

The National Strategy for Science, Research and Development was adopted by the Council of Ministers in May 2005 but has not yet been approved of by Parliament. The strategy aims to foster integration into the European Research Area and the EU Framework Programmes and seeks to strengthen the administrative capacity for designing and implementing science policy.

Main research actors

The main knowledge creating institutions in the Bulgarian innovation system are the universities and the non-university research institutes, most notably those within the Bulgarian Academy of Sciences (BAS) and the NCAS. As in most former Eastern Block countries, scientific research was mainly concentrated at the academies of science, whereas high level education was the chief domain of the universities. Since a few years, the MES is seeking to gradually overcome the legacy of functional separation by encouraging the universities to expand their research capacities. However, the limited resources have to be redistributed between a larger number of research actors.

Currently, the Bulgarian system of higher education counts 42 universities, six of which are private. According to the European Trend Chart on Innovation (European Commission 2005a: 5), the most prestigious institutions are the University 'St. Kliment Ohridski', the University of National and World Economy and the Technical University (all located in Sofia).

The BAS, which operates 51 research establishments, is an autonomous scientific organisation with an emphasis on fundamental research in a broad range of disciplines, including biology, chemistry, but also social sciences and the humanities.

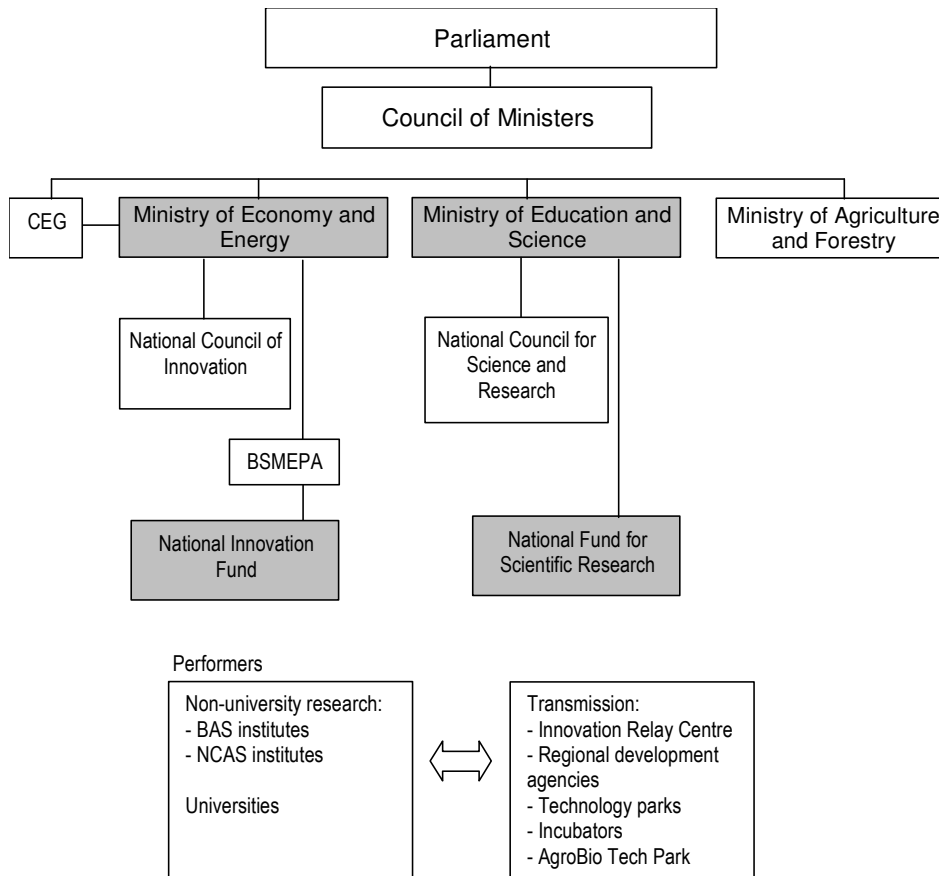
The second large research network is the NCAS, operating under the authority of the Ministry of Agriculture and Forestry. The NCAS runs 21 institutes in the area of agriculture, fishery and forestry.

In addition, a number of state institutes are linked to different executive agencies and/or ministries in order to provide specific scientific services.

The Bulgarian R&D system is overwhelmingly dominated by the public sector. Only about a quarter of all organisations performing R&D are located in the business sector. The innovation infrastructure run by the private sector remains to be undeveloped. The most prominent private initiatives are either privatised parts of former state infrastructures or the result of successful EU projects (Petrov/Stefanov 2006: 28).

Figure 1.1 gives an overview over Bulgaria's public funding regime in the area of S&T and the main biotechnology research performers.

Figure 1.1 Biotechnology promotion in Bulgaria – institutional landscape



Source: BioPolis Research

1.3 National support and framework conditions for biotechnology

Public promotion of biotechnology

Bulgaria has long established traditions in conventional fermentation technologies used in the making of wine, beer and dairy products. In the 1950s, a number of specialised research institutes were founded in order to support the Bulgarian fermentation industries with new technologies and human resources. In the health area, the first industrial production plant for antibiotics was built in 1952, followed by a second one in 1959 (Ministry of Economy et al. 2001: 86).

As biotechnology became an economic and scientific priority in 1983, the Programme for Development of Biotechnology in Bulgaria was launched. Through this large-scale programme an impressive number of new institutes, laboratories and biotechnology centres

were founded throughout the country. The following areas of biotechnology were supported with large sums (ARC Fund 2003: 9f.):

- fermentation technology,
- pharmaceutical biotechnology,
- plant biotechnology, particularly genetics and cell engineering,
- environmental biotechnology,
- R&D infrastructures and human resources.

As a consequence of the transition period after 1989, biotechnology-related capacities, infrastructures and resources were drastically cut down or degenerated. One of the main problems for the biotechnology scene was that biotechnology products were mainly designed for domestic use and for exports to the former Eastern Block countries. Bulgaria was not able to compensate the collapse of demand through new markets in the West because Bulgarian products mostly did not meet the existing GMO requirements (Ministry of Economy et al. 2001: 88f.).

Since the end of the 1990s, the situation for Bulgaria's biotechnology scene has gradually improved. Even so, funding for the public institutes - particularly those within the NCAS - remains at a low level. The limited resources are mainly used to pay for salaries and the maintenance of the infrastructures, leaving insufficient operational budgets to actually finance research activities. As a consequence, the dual processes of further privatisation and contraction of the public research landscape have been characteristic for the past few years.

Public acceptance

Public acceptance of life sciences and biotechnology in Bulgaria contrasts the broad patterns of the European public. Generally, the Bulgarian population holds fairly positive views on science and technology. According to a recent Eurobarometer (European Commission 2005b: 73-97)⁸ survey, Bulgarians are receptive to the advances of scientific progress. However, the responses to a number of technology fields deviate from the EU25 averages. For instance, 70% of the respondents believe nuclear energy has positive effects, whereas in the EU25 only 52% support this opinion. Biotechnology and genetic engineering, on the other hand, are understood to have positive effects by 65% of the EU25 respondents, but only 59% of the Bulgarians hold the same view. At the same time, Bulgarians are considerably less sceptic concerning the development of genetically modified crops than the EU25 average: only 14% of the Bulgarian respondents said that they would never approve of developing GMOs to increase the variety of regionally grown food, whereas 37% of the EU25 respondents demonstrated explicit rejection (ibid: 93).

⁸ European Commission (2005b) Social Values, Science and Technology (Special Eurobarometer 225/Wave 63.1 – TNS Opinion & Social, Brussels: Directorate General Press and Communication.

Regulatory framework

In 1993, Bulgaria introduced a new intellectual property law and a new patent system which is by and large in line with the European patent system. In 2002, Bulgaria acceded to the European Patent Convention.

The first regulation related to biotechnology was issued in 1996 by the Ministry of Agriculture. The law was largely based on the EU Directive 90/220/EEC and covered the release of GMOs into the environment.⁹ Licenses for environmental releases of genetically modified plants were to be issued by a special Council for Safe Use of GMOs under the Ministry of Agriculture and Forestry. In 2000, Bulgaria took the next step in biosafety regulation by ratifying the Cartagena Protocol. As part of the EU harmonisation process, Bulgaria adopted a regulation on the requirements for labelling foods containing GMOs one year later. As in most European countries, the threshold for labelling is a one percent GMO share.

In June 2005, the GMO Act entered force specifically regulating the application of biotechnology. To date, it is the most comprehensive Bulgarian law dealing with all aspects of genetic engineering; the GMO Act is largely in compliance with the EU Directives 2001/18 EC and 98/81 EC.

1.4 Main biotechnology research actors in Bulgaria

Biotechnology-related scientific research and development is mainly the domain of the public research institutes within the frameworks of the BAS and the NCAS. Thematic strongholds are agricultural, plant and food biotechnology. Health-related research is mainly performed by the BAS institutes of Molecular Biology and Experimental Morphology and Anthropology.

The AgroBio Institute (ABI), formed in 2000 as a result of the reorganisation of the Institute of Genetic Engineering, is widely acknowledged to be an example for "good practice" among the non-university biotechnology research institutes. Other than most Bulgarian institutes, the ABI is financed mainly by its participation in national and international competitions. Furthermore, patent ownership and entrepreneurial activities generate additional resources. Only a smaller share of the budget is retrieved from lump sums allocated by the Ministry of Agriculture. The main research areas of ABI include molecular genetics (structure and regulation of gene expression, genome polymorphism), cellular genetics (plant transformation and regeneration, haploids and dihaploids, cell selection, pest resistance, cytogenetics clonal propagation), biochemistry (proteins and isoenzymes, phytohormones), and phytopathology (biotic stress, diagnostics of pathogens).

⁹ The following is largely based on information provided by the InvestBulgaria Agency, see <http://www.investbg.government.bg>, accessed: 22-02-2006.

A noteworthy initiative of the ABI was realised in 2003 with the establishment of the AgroBio Tech Park in Sofia. The joint venture of the ABI, the NCAS, the Ministry of Agriculture and Forestry and the Sofia University 'St. Kliment Ohridski' established a market-oriented scientific manufacturing enterprise. Table 1.1 lists the non-university research institutes conducting biotechnology research.

Table 1.1 Biotechnology-related research at non-university institutes

Bulgarian Academy of Sciences (BAS)
'Doncho Kostoff' Institute of Genetics, Sofia
Institute of Botany, Sofia
Institute of Experimental Morphology and Anthropology, Sofia
Institute of Molecular Biology, Sofia
'Metody Popoff' Institute of Plant Physiology, Sofia
'Stefan Angeloff' Institute of Microbiology, Sofia
National Centre of Agricultural Sciences (NCAS)
AgroBio Institute (ABI), Sofia
Cotton and Durum Wheat Research Institute, Chirpan
Dobrudja Agricultural Institute
Fruit Growing Institute, Plovdiv
Institute of Agriculture and Seed Science 'Obraztsov Chiflik', Rousse
Institute of Agriculture, Karnobat
Institute of Agriculture, Kyustendil
Institute of Cryobiology and Food Technologies, Sofia
Institute of Forage Crops, Pleven
Institute of Maize, Kneja
Institute of Plant Genetic Resources, Sadovo
Institute of Viticulture and Enology, Pleven
Research Institute, Troyan
Vegetable Crops Research Institute 'Maritsa', Plovdiv
Other
National Center of Infectious and Parasitic Diseases, Sofia
Research Institute for Wine Industry, Sofia

Source: Bulgarian Biotechnology Information Center (<http://www.bgbic.abi.bg>); BAS online sources (<http://cl.bas.bg/about-bas/directory-of-bas/biological-sciences>) and BioPolis Research.

Of the more than 40 Bulgarian universities, only five are active in the area of biotechnology research. Despite the efforts to establish capacities at the universities, scientific research is still in its infancy at most universities. Table 1.2 lists the universities with the largest biotechnology research capacities.

Up-to-date information about the Bulgarian commercial biotechnology industry is not readily available. The bulk of industrial biotechnology enterprises are former state owned companies. Their activities are concentrated in the area of pharmaceuticals and fermentation, and food biotechnology (Table 1.3).

Table 1.2 Biotechnology research at Bulgarian universities

Agricultural University, Plovdiv
Technical University Sofia, Department of Biotechniques
University 'Paisii Hilendarski', Plovdiv
University 'St. Kliment Ohridski', Biological Faculty, Sofia
University of Chemical Technology and Metallurgy, Department of Biotechnology, Sofia

Source: Bulgarian Biotechnology Information Center (<http://www.bgbic.abi.bg>) and BioPolis Research.

Table 1.3 Bulgarian enterprises active in biotechnology, including R&D

AgroBioTech Park, Sofia
Balkanpharma Razgrad – Research Institute for Antibiotics
Biovet, Peshtera
DeoDan, Sofia
ELBY, Sofia
Pharmagen, Sofia
Plastchim, Botevgrad

Source: ARC Fund (2003), BioPolis Research.

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

2.1 Introduction

This report reviews the funding of biotechnology research and commercialisation. A distinction is made between policy-directed funding and non-policy-directed funding of biotechnology.

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

In this chapter the funding of biotechnology research through policy and non-policy-directed instruments and of biotechnology commercialisation through policy-directed activities are presented. The data were collected through desk research (publications, documents, websites of national and regional public funding organisations and/or governmental departments), surveys of representatives of funding organisations that manage the generic and biotech-specific programs and interviews with representatives of organisations that are involved in non-policy-directed and policy-directed funding. The funding organisations' website addresses and the names of contact persons that have kindly participated in the survey and/or have been interviewed can be found in Annex 3 (List of Contact Persons) and Annex 4 (References). Section 2.2 describes the non-policy-directed funding and section 2.3 the policy-directed funding. Charities do not play a role in the funding of biotechnology research in Bulgaria. The final section 2.4 provides a short overview over Bulgaria's participation in the Sixth European Framework Programme.

2.2 Non-policy-directed funding of biotechnology research

As has been pointed out in chapter 1, a competitive system of research financing based on open calls and project funding is in the midst of being established. Accordingly, the largest share of public expenditures promoting biotechnology R&D is currently spent through non-policy-directed avenues, the most important being the lump sums directed towards the large number of public research institutes within the BAS and NCAS.

The BAS provided budget data for six of its institutes carrying out biotechnology research. Between 2002 and 2005, the biotechnology-related activities of the institutes were supported with a total sum of 2.4M EUR. The most important areas of research in terms of funding were health and plant biotechnology. In addition to these lump sums, the BAS institutes also acquired project funding from the NFSR and the EU.

The institutes within the NCAS framework are mainly financed through the Ministry of Agriculture and Forestry. Unfortunately, the representatives of the NCAS did not provide any budget data.

Under the authority of the Ministry of Education and Science, the NFSR makes available funding on the basis of an open call system. The instrument Regular Annual Competition promoted scientific research was endowed with a total sum of 76 700 EUR in 2005. During the period under review, biotechnology-related projects were supported with a total sum of approximately 20 000 EUR or between five and ten percent of the programme budget.

With its programme Promotion of Scientific Research in Higher Education the NFSR intends to stimulate university research. Since 2004, funding is made available for researchers at universities based on an open competition. Between 2004 and 2005, biotechnology-related projects were supported with approximately 20 000 EUR or 25% of the total programme budget.

Table 2.1 Non-policy-directed funding of biotechnology research

Funding organisation	Public Research Institutions / Response Mode programs	Period	Funds in M EUR
BAS	Institutional funding	2002-2005	2.4
NCAS	Institutional funding	2002-2005	n.a.
NFSR	Regular Annual Competition	2002-2005	0.02
NFSR	Promotion of Scientific Research in Higher Education	2004-2005	0.02
Total			2.44

Source: BioPolis Research

2.3 Policy-directed funding of biotechnology research and commercialisation

2.3.1 National Fund for Scientific Research

Policy-directed funding for R&D is mainly the domain of the NFSR. Of the seven instruments currently being offered by the Fund, two are relevant for biotechnology in the category policy-directed funding.

The National Scientific Programmes, which were introduced in 2003, aim to increase the competitiveness of the Bulgarian national research scene. Funding is focused on selected scientific fields that are thematically in line with the priorities set up in the National Development Plan. The topics are approved of by the Council of Ministers. The funding priority "Genomics", one of the eight priorities selected within the National Scientific Programme (Bulgarian Ministry of Education and Science 2005: 9)¹⁰, was supported with 0.19M EUR between 2003 and 2005.

The Programme for Upgrading Research Capacity, introduced in 2005, intends to improve and renovate the existing research base in scientific institutes and universities. Research entities performing biotechnology were supported with a total sum of 0.7 EUR or 23% of the total programme budget in 2005.

2.3.2 National Innovation Fund

The main objective of the NIF, founded in 2005, is to increase the competitiveness of the Bulgarian economy by stimulating R&D in innovative market-oriented products. The R&D investments of the private sector are stimulated by subsidizing a certain share of the R&D investments of a company.

The Innovation Fund subsidises technological cooperation aimed at the development of innovative and sustainable products, processes or services. The BSMEPA has been commissioned by the MEE to implement the measure. The subsidy is for two types of projects: Firstly, R&D projects focused on the technological development of new products, processes or services or on a substantial improvement of existing products, processes or services. Secondly, feasibility studies for investigation of the achievability of an R&D project. All legal entities, registered under the Bulgarian Commercial Law, may apply for a subsidy of a project to be implemented by them alone or in partnership with universities. Up to 50% of industrial research projects may be subsidised, pre-competitive development activities are supported with up to 25%. Participating SMEs receive an additional 10% subsidy for their share of the project on top of the normally applicable subsidy percentage. The entire project is eligible for an extra 10% subsidy if the company implements a project in cooperation with scientific organizations.

¹⁰ Bulgarian Ministry of Education and Science (2005) National Science Fund. Annual Report 2004, Sofia, National Science Fund.

During the first year of its existence, the NIF made available 2.56M EUR for R&D in the business sector, 0.45M EUR of the budget were made available for biotechnology-related projects.

2.3.3 Other funding activities

Within Civil Society Development Programme 2002, a project under the title Empowering Bulgarian Civil Society on GMOs and Consumer Protection was implemented in 2004/2005. The activities of this initiative were part of the Innovation Relay Center framework which is coordinated by the Bulgarian Applied Research and Communication Fund (ARC Fund). The project objective was to raise public awareness on the issues of GMOs and novel foods; the main deliverable of the project was the development of a brochure with policy recommendations for raising consumer awareness.

The underlying rationale of the project was based on the observation that the wider public is fairly unfamiliar with biotechnology applications in agriculture and food production. There is a significant information gap between the professionals (scientists, legislators and state authorities) and the large consumer community that hinders active participation of consumers in decision-making processes as well as the exercise of their rights of making informed choices concerning safe food products. Unbiased information is very much required for the so called "novel foods" – genetically modified and organic foods that are perceived to have multidimensional impact on environment, human health, industry, culture, society and ethics.

The project which targeted the issues of ELSA had to total budget of 60 000 EUR for a running time of one year. As funding was provided by the EU PHARE programme and the Austrian Science and Research Liaison Office in Bulgaria, the budget is not included in the ensuing tables.

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

Instrument	Funding organisation	Budget in M EUR	% of total	Use of DF/SF
National				
<i>Generic</i>				
Programme for Upgrading Research Capacity	NFSR	0.7	52.2	
NIF	NIF	0.45	33.6	
<i>Biotech specific</i>				
National Scientific Programme "Genomics"	NFSR	0.19	14.2	
Total		1.34	100	

Source: BioPolis Research

2.4 Participation in Sixth Framework Programme

Judging from the absolute number of participations, Bulgarian researchers have not been very visible in FP6 programmes. The participation of Bulgarian researchers in the position of project coordinators has not been reported. Involvement as regular members of project teams occurred six times in the area of life sciences, genomics and biotechnology for health and twelve times in the area of food quality and safety.

Table 2.4 Bulgarian involvement in biotechnology/life sciences programmes of the Sixth Framework Programme

Sixth Framework Programme¹	Participations as coordinator	Participations as member of the project team²
Thematic priority		
1. Life sciences, genomics and biotechnology for health	0	6 (0.1%)
2. Nanotechnologies, section bionanotechnology	0	0
5. Food quality and safety	0	12 (0.7%)

¹ First and second call, all types of projects.

² Persons/groups can participate in more projects, resulting in more participation.

Source: BioPolis Research

3. Performance of the national biotechnology innovation system

3.1 Introduction

This chapter analyses the performance of the Bulgarian 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 EU Member States and the US.

The presentation of the performance is structured along two main areas of the innovation system: the knowledge base and processes of knowledge transmission and application. Unfortunately, performance data for industrial development and market conditions were not obtainable for Bulgaria. For the two available areas, data are shown for a number of different indicators for Bulgaria, the USA and EU25 (or EU15). The EU-values have been chosen as reference in each indicator. The absolute figures that are used to calculate the values for the indicators presented and the sources for the data can be found in Annex 5. In principle, for each indicator data are given for three periods. The periods chosen can vary considerably between the indicators; Table A.5.1. presents for each indicator the specific years for each period and provides additional background information.

As Bulgaria is one of the EU accession countries, the performance data presented in this report should be treated with additional caution. An important indicator for scientific performance is the publications data in the Science Citation Index (SCI). However, the SCI's bias towards English-language journals could distort country comparisons if, for instance, Bulgarian scientists have a tendency to publish in journals in languages that are not covered by the SCI. Moreover, lack of patent data may reflect failure by the national patent system or in its implementation to meet international standards.

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

The performance indicator biotechnology publications pMC illustrates that Bulgarian biotechnology publication activities merely reach 20% of the EU25 publication level. Across all time periods covered, the low performance remained stable, as publications pMC increase from 43 in 1994-1996 to 61 in 2002-2004. Among the countries with similar performance levels are Malta, Lithuania or Romania.

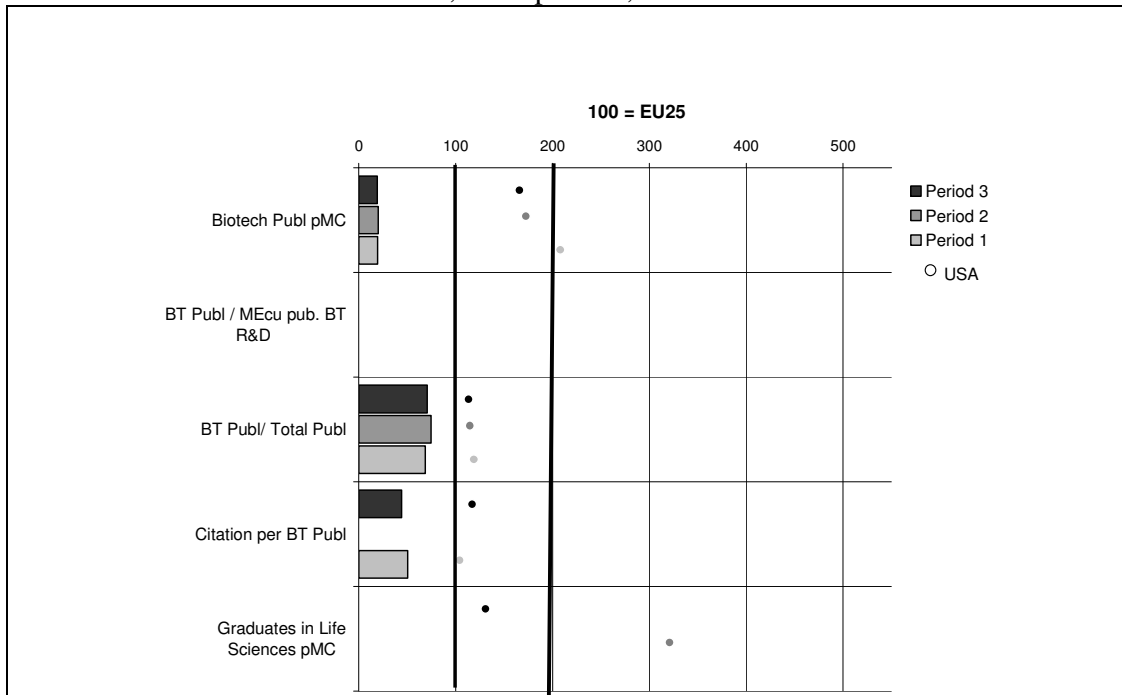
The situation with regard to the second indicator, biotechnology publications as a share of total publications, is a bit better. Between 8 and 9% of all Bulgarian scientific publications are-related to biotechnology; the EU25 share ranges between 11 and 13%.

Judging from the citation rates, the quality of Bulgarian biotechnology publications ranges clearly below the EU25 level. The rates during both time periods were the lowest

of all countries covered. Apparently, the crisis of the Bulgarian research landscape during the 1990s is reflected by these figures.

Taken together, Bulgaria needs to step up its efforts in the area of knowledge creation considerably if the EU25 average is to be reached.

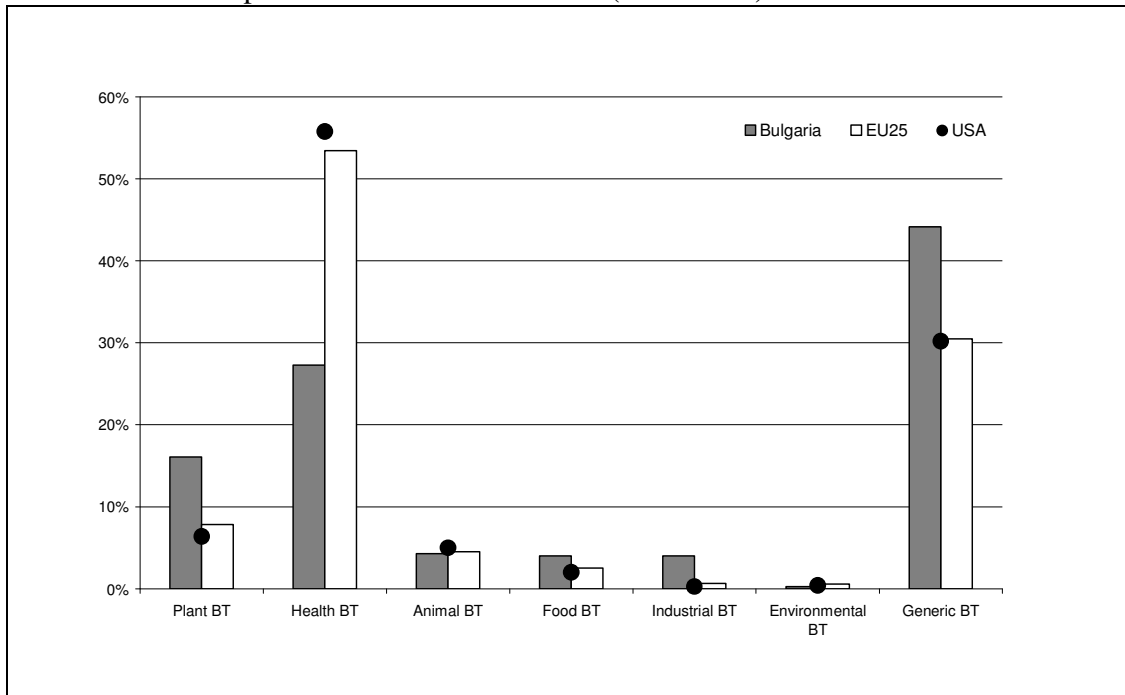
Chart 3.1 The biotechnology knowledge base indicators of Bulgaria, comparison with EU25 and USA, three periods, index values



Source: BioPolis Research

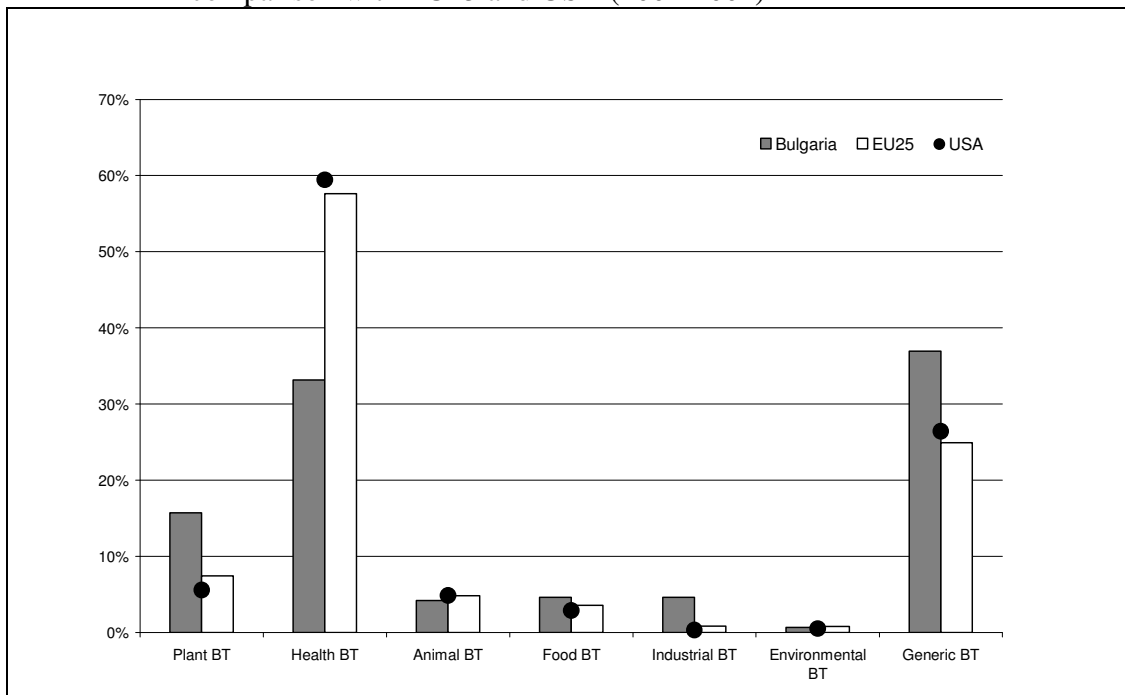
The analysis of Bulgarian publication activities shows that generic, health and plant biotechnology are the by far most important areas of activity in the research scene. Between the two time periods covered (1994-1996 and 2002-2004), the share of generic biotechnology slightly decreased from 44% to 37%, whereas plant biotechnology remained quite stable at a 16% share. Health biotechnology increased slightly from 27% to 33%. The relative strength of the small subfields remained largely unchanged over the two time periods. Compared to the reference regions, Bulgarian publication activities deviated from the EU and the US patterns. For instance, the share of health-related publications in Bulgaria is about 30 percentage points lower than in the EU25; in turn, Bulgaria's share of generic biotechnology publications is about twelve points higher than in the reference regions.

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



Source: BioPolis Research

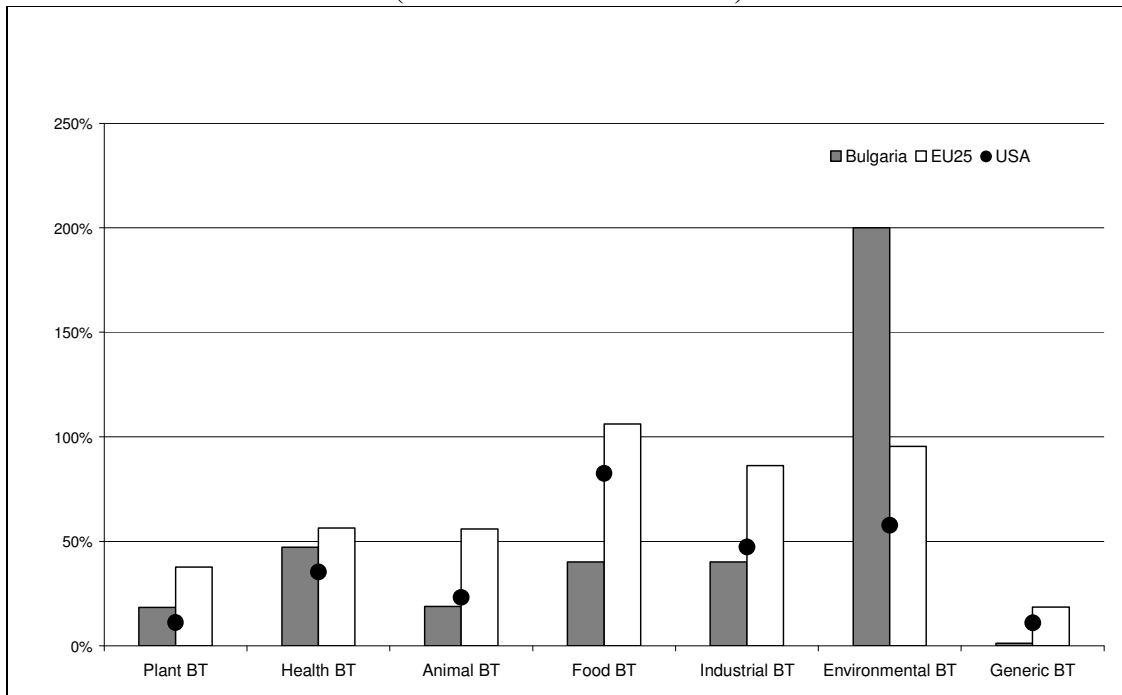
Chart 3.2.2 Share of subfields (in %) of total biotechnology publication for Bulgaria in comparison with EU25 and USA (2002-2004)



Source: BioPolis Research

Between 1994-1996 and 2002-2004, Bulgaria showed rather disappointing growth rates in nearly all biotechnology subfields. The only subfield indicating a higher growth rate than in the reference regions was registered in environmental biotechnology, increasing by 200% (EU25: + 95%).

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

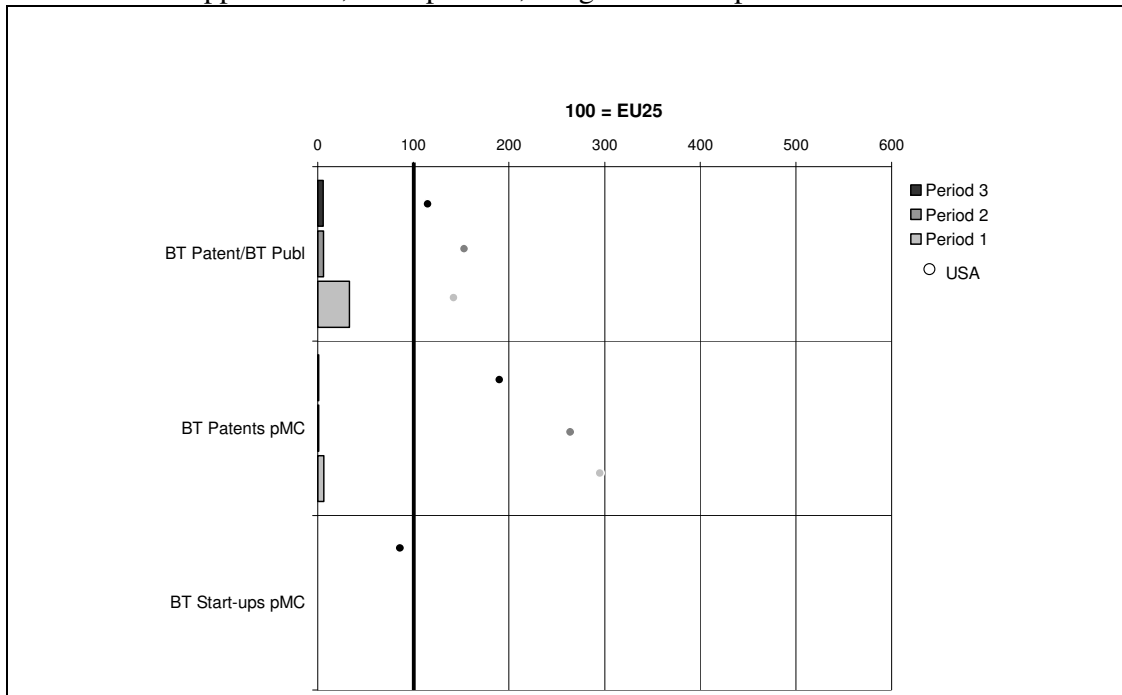


Source: BioPolis Research

3.3 Performance in knowledge transmission and application

Both indicators in the category knowledge transmission and application prompt the conclusion that this side of the innovation system is largely neglected. The main reason for the under average performance are the very low numbers of patents. During the period 1994-1996, Bulgarian scientists applied for six patents, in both of the two ensuing periods only two applications were issued. Of course, the activities of the newly established NIF could not yet be reflected by the performance data. Countries with similar biotechnology patenting levels are Cyprus and Romania.

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



Source: BioPolis Research

4. Conclusions

4.1 Introduction

This concluding chapter provides an overview over the main characteristics of the policy-directed instruments that have been used by the Bulgarian government in the period 2002-2005 to stimulate biotechnology R&D, technology transfer and commercialisation, including research on social, ethical and legal aspects of biotechnology. The overview summarises the funding of biotechnology in terms of the types of policy instruments used, the policy goals addressed, the research application areas funded and the activities that are stimulated.

Table 4.1 summarises the public expenditure totals for the period 2002-2005 by two main categories (research and commercialisation). In addition, totals for sub-categories such as generic and specific funding schemes are listed. The ensuing Table 4.2 gives information about the main recipients of the promotion activities. Tables 4.3 through 4.5 provide overviews over the policy goals, the biotechnology application areas and the activities covered by each of the policy instruments that have been relevant for biotechnology promotion activities between 2002 and 2005. While the shown funding patterns for the policy goals, application areas and activities deliver useful indications of priorities, promotional styles and perhaps certain lacunae, the aggregated budgets for each of the categories should be interpreted with due caution. In most instances, the reported budget shares had to be based on informed approximations of the programme officers of the funding agencies and ministries because the BioPolis classifications are not in accordance with the internal accounting and budgeting systems of the institutions providing the funding data. Furthermore, particularly with regard to Table 4.5 (coverage of biotechnology activities), the reported funding totals tend to be sketchy because making coherent assignments of specified budgets for individual activities was not always feasible.

4.2 Public funding of biotechnology through policy instruments

During the period 2002-2005, public institutions promoted biotechnology-related activities in Bulgaria with a total sum of 3.77M EUR. The largest share – 64.7% – of the funds was spent through non-policy-directed schemes. This high percentage confirms the general observation that non-university research institutes funded with unconditional lump sums remain to be a central characteristic of Bulgaria's research landscape. Policy-directed research funding represents the second largest share, accounting for 21.5% of the total public expenditures. The amount spent for commercialisation activities reaches a share of 12.5%.

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

	Total
RESEARCH	
1. Non-policy-directed	
Public Research Institutions	2.4
Response Mode	0.04
Total	2.44
2a. Policy-directed Generic	
National	0.67
Total	0.67
2b. Policy-directed Biotech-specific	
National	0.14
Total	0.14
COMMERCIALISATION	
1a. Policy-directed Generic	
National	0.47
Total	0.47
1b. Policy-directed Biotech-specific	
National	0.05
Total	0.05
GRAND TOTALS	3.77

Source: BioPolis Research

4.3 Specific features of the instruments

Table 4.2 indicates that the three Bulgarian policy-directed instruments promoting biotechnology provide support for public research organisations as well as for the business sector. Based on the information presented in Table 4.2, funding gaps or excessive duplication with regard to funding opportunities for the different types of applicants cannot be identified.

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

Instrument	Funding agency	Participants/Recipients			Financial contribution required (%)	
		PROs	SMEs	LFs	Recipients	Other public authorities
National						
<i>Generic</i>						
Programme for Upgrading Research Capacity	NFSR	√	√			
National Innovation Fund (NIF)	BSMEPA		√	√		

Instrument	Funding agency	Participants/Recipients			Financial contribution required (%)	
		PROs	SMEs	LFs	Recipients	Other public authorities
<i>Biotech specific</i>						
National Scientific Programme	NFSR	√				

Source: BioPolis Research

4.4 Policy goals

According to Table 4.3, Bulgarian policy-directed instruments promoting biotechnology cover six of the ten policy goals. Judging from the funding amounts distributed across these six policy goals, the transmission of knowledge from academia to industry (policy goal 5) seems to be the most important funding priority in the national biotechnology promotion strategy. Nearly 30% of the total expenditures are allocated in favour of this policy goal. The policy goals high level of biotechnology research (1), knowledge flow and collaboration among scientific disciplines (3) and availability of human resources (4) are each supported with 16.5% of the total funds. Not covered by the three instruments are the policy goals adoption of biotechnology for new industrial applications (6), firm creation (7), social acceptance (8) and biosafety (10).

If the individual expenditures for policy goals are grouped into the five policy areas defined by BioPolis¹¹, policy areas 1 and 2 are supported unevenly. About 60% of the expenditures are directed towards the creation of a knowledge base, whereas policy area 2 (knowledge transfer and application) receives roughly 28% of the funds. However, against the background to Bulgaria's below average output performance in knowledge creation, the emphasis on policy area 1 seems justified.

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

	Policy goals									
	1*	2	3	4	5	6	7	8	9	10
National										
<i>Generic</i>										
Programme for Upgrading Research Capacity	√		√	√	√					
National Innovation Fund (NIF)		√			√				√	
Total	0.17	0.15	0.17	0.17	0.32	–	–	–	0.15	–
<i>Biotech specific</i>										

¹¹ The policy area 1 "creation of knowledge base and human resources" is composed of policy goals 1 to 4, policy area 2 "knowledge transfer and application" includes policy goals 5 to 7 and 9. The remaining policy goals 8 and 10 constitute policy areas of their own.

	Policy goals									
	1*	2	3	4	5	6	7	8	9	10
National Scientific Programme	√		√	√	√					
Total	0.05	–	0.05	0.05	0.05	–	–	–	–	–
Grand Total	0.22	0.15	0.22	0.22	0.37	–	–	–	0.15	–
% of GrandTotal	16.5	11.3	16.5	16.5	27.8	–	–	–	11.3	–

* Legend:

1 = High level of biotechnology research

2 = High level of industry-oriented (and applied) research

3 = Knowledge flow and collaboration among scientific disciplines

4 = Availability of human resources

5 = Transmission of knowledge from academia to industry and its application to industrial resources

6 = The adoption of biotechnology for new industrial applications

7 = Firm creation

8 = Social acceptance of biotechnology

9 = Business investment in R&D

10 = Bio-safety, Risk assessment

Note: The figures in this table should be read as merely indicative of the relative expenditure allocated to the various policy goals. Since many goals overlap in one instrument, the split of expenditure between goals is only a rough estimate and/or informed guess. On the other, it is important to bear in mind that instruments of some goals (e.g., social acceptance programmes) may require less expenditure than others even if they are set as a policy priority.

Source: BioPolis Research

4.5 Biotechnology research application areas

Unfortunately, budget information about the distribution of the expenditures across the eight biotechnology application areas is only available for one of the three policy-directed instruments. Hence, a meaningful discussion of the data presented in Table 4.4 is not possible.

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

	Biotechnology application areas							
	1*	2	3	4	5	6	7	8
National								
<i>Generic</i>								
Programme for Upgrading Research Capacity								
National Innovation Fund (NIF)								
Total								
<i>Biotech specific</i>								
National Scientific Programme							√	√
Total							0.1	0.03
Grand Total							0.1	0.03

* Legend:

1 = Plant biotechnology

2 = Animal biotechnology

4 = Health biotechnology

5 = Food biotechnology

7 = Basic biotechnology

8 = Ethical, legal, social aspects of biotechnology

3 = Environmental biotechnology 6 = Industrial biotechnology

Note: Figures in the table should be understood as rough estimates of expenditure in a given application area.

Source: BioPolis Research

4.6 Stimulation of biotechnology activities through the instruments

As in the case of the information about the coverage of biotechnology application areas by the funding instruments, the data on the coverage of activities promoting biotechnology are incomplete as well. However, for each of the three instruments it is known which of the areas are covered. The distribution of funds across the activities is only available for the Programme for Upgrading Research Capacity.

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	17
National									
<i>Generic</i>									
Programme for Upgrading Research Capacity	√		√		√	√	√		
National Innovation Fund (NIF)		√						√	√
Total	n.a.	0.15	n.a.	–	n.a.	n.a.	n.a.	0.15	0.15
<i>Biotech specific</i>									
National Scientific Programme	√			√	√		√	√	
Total	n.a.	–	–	n.a.	n.a.	–	n.a.	n.a.	–
Grand Total	n.a.	0.15	n.a.	n.a.	n.a.	n.a.	n.a.	0.15	0.15

* Legend:

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

Note: Figures in the table should be understood as rough estimates of expenditure for a given activity.

Source: BioPolis Research

5. Future developments

Major changes in the Bulgarian biotechnology landscape are not to be expected in the next few years. At least in the short- and medium-term, R&D will have to cope with the insufficient funding. Significant improvements will also depend on the success of the continued efforts to consolidate the large – but under financed – institutional research landscape by consequently setting thematic priorities.

On the side of the scientific community coordinated efforts are underway intended to make political leaders more responsive to the needs of science. It remains to be seen if these activities will increase the political will of decision-makers to support R&D in general and biotechnology in particular.

Annex 1 List of tables

Table 1.1	Biotechnology-related research at non-university institutes	13
Table 1.2	Biotechnology research at Bulgarian universities	14
Table 1.3	Bulgarian enterprises active in biotechnology, including R&D	14
Table 2.1	Non-policy-directed funding of biotechnology research.....	16
Table 2.2	National public policy-directed biotechnology stimulating instruments during the period 2002-2005	18
Table 2.4	Bulgarian involvement in biotechnology/life sciences programmes of the Sixth Framework Programme	19
Table 4.1	Public funding of biotechnology through non-policy-directed and policy-directed instruments in the period 2002-2005 (in M EUR)	26
Table 4.2	Participants/recipients and co-financing requirements of policy-directed programs that fund biotech activities in the period 2002-2005	26
Table 4.3	Coverage of policy goals and funding by goal by policy-directed instruments in the period 2002-2005 (in M EUR)	27
Table 4.4	Coverage of biotech application areas and funding through policy-directed instruments by biotech application area in the period 2002-2005 (in M EUR).....	28
Table 4.5	Coverage and funding of biotech activities in the period 2002-2005 through policy-directed instruments (in M EUR)	29

Annex 2 List of figures and charts

Figure 1.1	Biotechnology promotion in Bulgaria – institutional landscape	10
Chart 3.1	The biotechnology knowledge base indicators of Bulgaria, comparison with EU25 and USA, three periods, index values	21
Chart 3.2.1	Share of subfields (in %) of total biotechnology publication for Bulgaria in comparison with EU25 and USA (1994-1996)	22
Chart 3.2.2	Share of subfields (in %) of total biotechnology publication for Bulgaria in comparison with EU25 and USA (2002-2004)	22
Chart 3.3	Biotechnology subfields growth rates for Bulgaria in comparison with EU25 and USA (1994-1996 and 2002-2004).....	23
Chart 3.4	Performance indicators for biotechnology knowledge transmission and applications, three periods, Bulgaria in comparison with EU25 and USA	24

Annex 3 List of contact persons

Name, first name	Institution	Contact date
Angelieva, Karina	National Fund for Scientific Research	21-12-2005
Atanassov, Atanas	ABI	27-04-2006
Chipev, Nesho	BAS	19-06-2006
Denchev, Boiko	BSMEPA; National Innovation Fund	22-02-2006
Doynova, Galina	BSMEPA; National Innovation Fund	13-03-2006
Georgieva, Kristina	ABI	06-03-2006
Kireva, Ginka	NCAS	29-03-2006
Marinova, Denitsa	ARC Fund	01-03-2006
Marinova, Elena	ABI	16-01-2006
Pavlova, Lora	National Fund for Scientific Research	16-01-2006
Vutsova, Albena	National Fund for Scientific Research	10-01-2006
Yakimoff, Naum	BAS	09-05-2006

Annex 4 References

ARC Fund (2003) Background Paper on Biotechnology. ForeTech – Technology and Innovation Foresight for Bulgaria and Romania, <http://foretech.online.bg/docs/background-paper-biotech-Bulgaria.pdf>, accessed: 17-05-2006.

Bulgarian Ministry of Education and Science (2005) National Science Fund. Annual Report 2004, Sofia, National Science Fund.

European Commission, DG Enterprise (2005a) European Trend Chart on Innovation, Annual Innovation Policy Trends and Appraisal Report Bulgaria 2004-2005, http://trendchart.cordis.lu/reports/documents/Country_Report_Bulgaria_2005.pdf, accessed: 17-05-2006.

European Commission (2005b) Social Values, Science and Technology (Special Eurobarometer 225/Wave 63.1 – TNS Opinion & Social, Brussels: Directorate General Press and Communication.

Ministry of Economy, German Agency for Technical Co-operation (GTZ)/Center for Economic Development (eds.) (2001) Analysis of the Bulgarian Technology Development, Working Paper, Sofia, Center for Economic Development.

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

Petrov, M., Stefanov, R. (eds.) (2006) Innovation.bg. Measuring the Innovation Potential of the Bulgarian Economy, Sofia, Applied Research and Communications Fund.

Zvetkov, Z. (2004) Budeshteto na zemedelskata nauka v Republika Bulgaria (The Future of Agricultural Research in Bulgaria), Chirpan: Nacionalen Zentur za Agrarni Nauki (National Center for Agricultural Science).

Websites:

Bulgarian Biotechnology Information Center	http://www.bgbic.abi.bg
InvestBulgaria Agency	http://www.investbg.government.bg
National Statistical Institute of Bulgaria	http://www.nsi.bg

Annex 5 Performance

Introduction

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

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

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

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

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

	Indicator	Chart	Comments	Time periods
	sciences pMC		Region EU17 =100 and US data for comparison	(3) 2002
Ind. 7	BT publications in subfields, as % of total BT publications	3.2.1	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 ¹²	2005
Ind. 16	Biomedicines	3.6	Source: BT Policy Benchmarking 2005 Index: Reference Region EU15 =100 US data for comparison	1995-2002

¹² http://europa.eu.int/comm/public_opinion/archives/ebs/ebs_225_report_en.pdf

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

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

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

- To benchmark each country we chose EU25 (or EU15 if data was not fully available) as the reference region. In those cases where data for EU25 or EU15 were not available, the reference corresponds to the sum of national data available. Moreover, to ease the presentation of indicators with different scales in a given chart, an index value was used.

Raw data for the Charts in chapter 3

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

	BT publications			Population (million)		
	94-96	98-00	02-04	1996	2000	2004
EU25	97521	128716	145646	447	451	457
Bulgaria	358	470	474	8	8	8
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
Bulgaria	43	57	61	20	20	19
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.		
Bulgaria	474				n.a.		n.a.
USA	154402				n.a.		n.a.

Source: BioPolis Research

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

BT public expenditures in research: Inventory Project, Table 3.4 Executive Summary

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

	BT publications			Total publications		
	94-96	98-00	02-04	94-96	98-00	02-04
EU25	97521	128716	145646	860652	1024327	1117392
Bulgaria	358	470	474	4597	5026	5159
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
Bulgaria	8%	9%	9%	69	74	70
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
Bulgaria	3.10	3.21	50	44
USA	6.39	8.54	104	117

Source: BioPolis Research

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

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

	Graduates in Life Sciences		Population (million)	
	1998 / 1999	2002	1998 / 1999	2002
EU17	46859**	81316	552**	431
Bulgaria	n.a.	n.a.	8	8
USA	75253*	70950	276*	288
	Graduates pMC		Index EU17=100	
	1998 / 1999	2002	1998 / 1999	2002
EU17	85**	189	100	100
Bulgaria	n.a.	n.a.	n.a.	n.a.
USA	273*	246	321	131

Index EU17=100 for 1998 is EU-16, because for Portugal no data available

* data for 1998; ** data for 1999

Source: BioPolis Research

Graduates data OECD Education Database
Population source for US is the OECD

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

	1994-1996							
	Total	Plant	Health	Animal	Food	Industrial	Environmental	Generic
EU25	100%	8%	53%	5%	3%	1%	1%	30%
Bulgaria	100%	16%	27%	4%	4%	4%	0%	44%
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%
Bulgaria	100%	16%	33%	4%	5%	5%	1%	37%
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
Bulgaria	374	60	102	16	15	15	1	165
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
Bulgaria	452	71	150	19	21	21	3	167

USA	141680	7910	84234	6872	4070	436	724	37434
-----	--------	------	-------	------	------	-----	-----	-------

Source: BioPolis Research

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

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

	1994-1996/2002-2004						
	Plant	Health	Animal	Food	Industrial	Environmental	Generic
EU25	38%	56%	56%	106%	86%	95%	19%
Bulgaria	18%	47%	19%	40%	40%	200%	1%
USA	11%	35%	23%	83%	47%	58%	11%

Source: BioPolis Research

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

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

	BT patents			Population (million)		
	94-96	98-00	01-03	1996	2000	2003
EU25	4924	8921	10119	447	451	455
Bulgaria	6	2	2	8	8	8
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
Bulgaria	1	0	0	7	1	1
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
Bulgaria	6	2	2	358	470	497
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
Bulgaria	0.02	0.00	0.00	33	6	6
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
Bulgaria	n.a.	n.a.	n.a.	n.a.				
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
Bulgaria	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
USA	5,11045	5,112158	5,06553	4,95054	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	
Bulgaria	n.a.	n.a.		
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
Bulgaria	n.a.	n.a.	n.a.	n.a.
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
Bulgaria	0	7892	7846	7801	7761	7825
USA	52	287941	290789	291685		290138
	IPO /pMC	Index				
	2002-2005	2002-2005				
EU Available	0.00	100				
Bulgaria	0.00	0				
USA	0.00	282				

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

Source: BioPolis Research

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

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
Bulgaria	n.a.	n.a.	n.a.			
USA	2288	2498	2855	287941	290789	291685
	Venture capital in EUR/pC			Index		
	2002	2003	2004	2002	2003	2004
Europe						
EU Available	2.8	2.8	3.4	100	100	100
Bulgaria	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
USA	8	9	10	282	311	286

Source: BioPolis Research

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

Raw data for Chart 3.6. Number of Biomedicines pMC

	Biomedicines	Population (Million)	Biomedicines / pMC	Index
	1995-2002	2002		1995-2002
EU15	39	378	0.10	100
Bulgaria	n.a	n.a	n.a	n.a
USA	115	289	0.40	387

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

Source: BioPolis Research

Number of medicines: Benchmarking of public biotechnology policy 2005

Raw data for Chart 3.6. Number of field trials pMC

	Field trials	Population in M	Field trials pMC	Index
	1996-2001	2001	1996-2001	1996-2001
EU15	1334	379	4	100
Bulgaria	n.a.	n.a.	n.a.	n.a.
USA	6745	278	24	688

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

Source: BioPolis Research

Field trials: Biotechnology Innovation Scoreboard 2002

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

BT acceptance index 2002		
	Index average	N (sample size)
EU15*	100,29	16828
Bulgaria		

*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

References:

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

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

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

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

Websites:

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

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

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

Annex 6 Abbreviations

ABI	AgroBio Institute
BAS	Bulgarian Academy of Sciences
BGN	Bulgarian Leva
BSMEPA	Bulgarian Small and Medium Enterprises Promotion Agency
CEG	Council for Economic Growth
EC	European Commission
ELSA	Ethical, legal, social aspects (of biotechnology)
EU	European Union
FP	Framework Programme
GMO	genetically modified organism
MEE	Ministry of Economy and Energy
MES	Ministry of Education and Science
NCAS	National Center of Agricultural Sciences
NCSR	National Council for Scientific Research
NFSR	National Fund for Scientific Research
NIC	National Innovation Council
NIS	National Innovation Strategy
pMC	per million capita
R&D	research and development
PRO	public research organisation
S&T	science and technology

All rights reserved.

No part of this publication may be reproduced and/or published by print, photoprint, microfilm or any other means without the previous written consent of TNO, Fraunhofer and SPRU.

In case this report was drafted on instructions, the rights and obligations of contracting parties are subject to either the Standard Conditions for Research Instructions given to TNO, Fraunhofer and SPRU or the relevant agreement concluded between the contracting parties. Submitting the report for inspection to parties who have a direct interest is permitted.

© 2007 TNO (NL) - Fraunhofer (DE) – SPRU (UK)