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 Portugal

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Table of contents

Summary

Portugal's economic performance has been relatively poor compared to the EU-25 average, since its annual growth rate has consistently remained below 2%. The percentage of Gross Domestic R&D Expenditure on GDP has reached a plateau since 2001, having stabilised around 0.8%. In addition to this, Portugal has suffered from a chronic weakness of business sector R&D and the majority of R&D is publicly funded and conducted at universities.

A number of policy programmes have been launched over the period 2002-05, such as the Programme for Productivity and Economic Growth (PPCE), which led to a set of initiatives to make companies more dynamic and innovative, and to strengthening the links between scientific knowledge and company innovation. Regarding innovation policy, however, Portugal continues to suffer from a lack of coordination between the agencies in charge of implementation, mainly due to a continuing separation between Portugal's science policy, under the Ministry of Science, and Portugal's technology/enterprise policy, under the Ministry of the Economy.

Biotechnology is explicitly considered as one of the priority sectors for growth and competitiveness in Portugal. However, while Portugal has a comparatively strong position in terms of scientific production in health sciences (having generated a large pool of talented researchers and scientific results of international recognition), the biotechnology sector is still weak in terms of the number of companies and investment in R&D. The lack of funding is one of the most important barriers for the development of biotechnology companies. The New Technology Based Companies (NEST) Programme, launched in late 2002, provides financial support for technology-based firms linked with Portuguese science and technology organisations, but its bureaucratic requirements have limited its achievements.

Over the period 2002-2005 Portugal allocated 95.1M EUR to biotechnology research and commercialisation, a doubling of its annual expenditure in the period 1994-98. Over 50% of biotechnology research is supported by non-policy-directed instruments: the responsive mode grants, fellowships and block grants to research laboratories of the Science and Technology Foundation (FCT), and support to the Biology Department by the National Institute for Industrial Engineering and Technology (INETI). FCT has also been the main policy agency for policy-directed instruments for biotechnology research, mainly through the support of research in Associated Laboratories established over the period 2002-05 (about 33.7M EUR). The Innovation Agency (AdI) has been the main source for policy-directed support to commercialisation activities (about 4.6M EUR). All Portugal policy-directed instruments are generic; there are no biotech-specific instruments.

Portugal's instruments to promote biotechnology research and commercialisation still address a limited range of policy goals. New policy goals addressed since 1994-98 are assuring the availability of human resources and stimulating the adoption of biotechnology for new applications.

Finally, Portugal has broadened its funding allocations across biotechnology application areas over time. While in the 1994-98 period most of the funding was directed to industrial and health biotechnology, more areas were funded in the more recent period.

However, health biotechnology still receives the largest share (about 29% of all directed funding). The only areas that seem to remain poorly funded are ethical, legal and social aspects of biotechnology and general biotechnology.

1. Introduction and background

1.1 General introduction

Portugal has a population of 10.5 million, with a GDP per capita of 13.05 EUR (current) in 2003. Employment in the service sector is relatively high, employing 57% of the labour force. The importance of the construction industry (10%) is higher than the EU average, while employment in manufacturing has declined to around 20%. The declining employment rate in textile, clothing, footwear and labour-intensive automotive components industries has not been accompanied by a significant increase of employment in high-tech manufacturing (Corado-Simoes, 2005).

Over the period 2002-2005 economic performance has been disappointing, with GDP per capita in Purchasing Power Standards (PPS) falling further behind the EU-25 average, set to equal 100. The index for Portugal's GDP per capita in PPS fell from 80.6 in 2000 to 72.2 in 2004 (Eurostat, 2005). Since 2001, Portugal's annual growth rate has consistently remained below 2%, recording negative growth in 2003 (Corado-Simoes, 2005). Portugal has shown a steady increase in its R&D activities (as measured by gross domestic R&D expenditures on GDP) from the late 1980s until 2001. However, since 2001 the percentage of gross domestic R&D expenditure on GDP has reached a plateau, having stabilised around 0.8%. This figure is well below the EU-25 average (around 1.9), and lower than the figure for some new accession countries (e.g. Czech Republic, Hungary or Slovenia).

One of the characteristics of the Portuguese innovation system is the chronic weakness of business sector R&D; the majority of R&D is publicly funded and conducted mainly at universities. This is reflected in the current composition of gross domestic R&D expenditures (GERD) by source of funding: for 2001, 61% of GERD was publicly funded while 32% was financed by industry. The figures for EU-25 were almost the reverse: 35% and 56%, respectively. Moreover, business expenditures on R&D (BERD) as a percentage of GDP, while steadily increasing over the 1990s until 2002 (from 0.13% in 1991 to 0.26% in 2002), still remains a fraction of the EU-25 average of 1.15% in 2002 (OECD, 2005).

1.2 Characteristics of national S&T and innovation system

The low gross domestic expenditure on R&D, and the low business sector R&D expenditures in particular, have been met with a range of policy initiatives to foster science and innovation. However, while there have been several programmes to foster innovation in recent years, the specific objectives of these programmes have changed frequently, creating a lack of consistency in innovation policy, together with a lack of coordination between the agencies in charge of implementing such policies (Corado-Simoes, 2005).

The most repeated criticism of innovation policy in Portugal is that it has been characterised by a divide between science policy (under the Ministry of Science) and technology/enterprise policy (under the Ministry of Economy). As Corado-Simoes (2005) notes, "Such a divide dates back from the early 1980s and was further strengthened in the late 1980s – early 1990s by the First Community Support

Framework, which witnessed the launch of two different operational programmes, one for science (CIENCIA) and another for Industry (PEDIP)".

These two national programmes were initiated, using EU structural funds, to develop the country's science and technology infrastructure. The first programme focused on developing scientific knowledge through advanced training, R&D projects and technological infrastructure. It was originally called CIENCIA, and was succeeded by Praxis XXI, which in turn was succeeded by POCTI, and more recently by POCI. The second programme aimed to foster the development of Portuguese industry. This was originally named PEDIP, and was succeeded by PEDIP II, then POE and subsequently by PRIME.

By 1999, the Third Community Support Framework (2000-2006) led to the definition of various operational programmes for innovation policy in Portugal: POE, POCTI and POSI. POE (Operational Programme for the Economy) was envisaged as the main instrument for enterprise policy, acting to improve company competitiveness factors, promoting strategic development areas and improving the business environment. POCTI (Operational Programme for Science, Technology and Innovation) was conceived as the operational programme concerned with science and training of highly-skilled human resources. This programme aimed to overcome Portugal's scientific backwardness and strengthen scientific institutions. Finally, POSI (Operational Programme for the Information Society), which focused on the information society, aimed to develop human competitiveness, by encouraging the use of computers and the internet and by modernising public administration.

With the change of Government, in 2002, a Programme for Productivity and Economic Growth (PPCE), coordinated by the Ministry of Economy, was launched. The philosophy behind PPCE led to the revision of POE and its transformation into PRIME (Programme of Incentives for Modernising the Economy). Within PRIME, a large number of initiatives were launched to make companies more dynamic and innovative, such as: IDEIA (Applied Research and Development in Companies), NEST (New Technology Based Companies), DEMTEC (Incentive System for Undertaking Pilot Projects) or NITEC (Incentive System for Creating R&D Nuclei in the Company Sector) – all launched between the end of 2002 and early 2003.

By the end of 2004, further changes were introduced: on the one hand, the operational programme on Science and Innovation (POCI 2010) replaced POCTI; and on the other hand, the operational programme on the Knowledge Society (POSC) replaced POSI. Both POCI and POSC will run until the end of 2006. Compared to POCTI, POCI is more strongly focused on strengthening the linkages between scientific knowledge and company innovation, promoting technology transfer, demonstration projects, R&D consortia and international R&D cooperative agreements.

The Ministry for Science, Technology and Higher Education (MCTES) had responsibility for implementing the operational programmes POCTI/POCI and POSI/POSC and the Ministry of Economy (ME) was responsible for the implementation of POE/PRIME. Even though these operational programmes promised an integrated innovation policy, the definition of sectoral, ministry-assigned programmes jeopardised integration, and each programme became largely self-contained (Corado-Simoes, 2005).

Regarding the innovation performance of Portugal, as shown by the European Innovation Scoreboard (EIS) 2004, Portugal is ranked 15th among the EU-25, and it is catching up in terms of the Summary Innovation Index. However, with the exception of public R&D expenditure, Portuguese scores are below two thirds of the EU-25 average for all indicators indicating performance in developing human resources or knowledge creation (i.e. working population with tertiary education or United States Patent and Trademark Office hi-tech patents). The Human resources indicator suggests that Portugal suffers from a shortage of skilled human resources and does not invest enough in high-tech activities. Regarding the level of patenting by Portuguese firms, figures remain very low, with Portugal ranking 20th or below (depending on the indicator used) among the EU-25.

The main recent development in relation to innovation policy initiatives can be summarised under three headings. First, there has been an increase in public support for R&D activities as expressed by a significant budget increase for science and technology under the POCI_2010 operational programme. Second, three POSC initiatives, launched early in 2005, aim to strengthen technology transfer in the IT field: Centres of Excellence, Technology and Knowledge Transfer Offices (OTIC) and the NEOTEC Initiative for the provision of seed capital to support entrepreneurial projects. The third initiative was the launch of INNOV-JOVEM (in 2005) to encourage the placement of young graduates in small and medium-sized enterprises (SMEs) and to enhance SMEs' absorptive capabilities.

1.3 National support and framework conditions for biotechnology

It is important to note that the Government considers biotechnology as a strategic priority. Within PRIME, biotechnology is explicitly considered as one of the priority sectors for growth and competitiveness (PRIME, 2003). Also, in the National Innovation Plan presented by the Government in 2005, before the general election, biotechnology was considered as one of the six priority areas that should contribute to create innovation platforms (Corado-Simoes, 2005). However, while research in biotech has been supported through non-directed channels and through generic policy-directed initiatives, there has been no specific initiative to support research in biotechnology.

The biotechnology sector in Portugal is composed of 40 Portuguese biotechnology firms (most of them SMEs) with total employment of about 1,500 employees. Most of the multinational enterprises operating in Portugal in areas close to biotech do not conduct R&D activities in the country (Pissarra and Amado, 2005). The overall picture of the biotechnology system in Portugal can be characterised by the following features. Portugal has a comparatively strong position in terms of scientific production in health sciences. According to Fontes and Padua (2002) and Pissarra and Amado (2005), in recent decades Portuguese universities and public research organizations have generated a great pool of talented researchers and scientific results that are internationally recognised in the life sciences. There are two main problems with the Portuguese system of scientific knowledge production. One is connected to the extreme fragmentation of the system. There is difficulty in integrating research excellence in much too broad a range of biotechnology-related fields, making it extremely difficult to achieve the required critical mass of physical resources and personnel (Pissarra and Amado, 2005). The second problem is related to limited success in translating science into technology, particularly in biotechnology where there is a potential for wide industrial applicability of the scientific base (Fontes and Padua, 2002).

Regarding the first problem, Pissarra and Amado (2005) suggest that, in order to take full advantage of existing resources in Portugal, it would be appropriate to structure the biotechnology sector around clusters and enhance interactions between the public research sector and industry. In particular, they recommend that public funding should further support two existing biotechnology clusters. One cluster, located in Porto, is connected to biotech research in the fields of food and the environment, and has been running since 1984; the other, in the region of Oeiras, is connected to biomedical-pharmaceutical biotechnology, and has been active since 1989.

The second problem is related to a set of infrastructure barriers in three areas: (1) the lack of interface structures; (2) the absence of clear regulation for intellectual property rights (IPR); and (3) the lack of financial support for the creation of technology-based firms. Regarding the first issue, in recent years there has been an increase in technology transfer offices and Science & Technology Parks, promoted by the GAPI initiative (launched in 2001) that aimed to launch small units to provide information and develop actions to promote protection of intellectual property. However, there is still a lack of specialized lawyers in the biotechnology field who are able to provide the required support to biotech firms (Pissarra and Amado, 2005). In addition, Pissarra and Amado (2005) suggest that key initiatives encouraging university-industry collaborations, such as IDEIA and NITEC, should be further reformulated in order to be more appropriate to the requirements of biotechnology start-ups.

Regarding patenting activities, the SIUPI initiative (Intellectual Property Use Incentive System) was launched in 2000 to support the patenting expenditures incurred by companies, independent inventors and research institutions. However, academic IP is inhibited by the lack of clear regulation and a rigid institutional environment that constrains entrepreneurial activities. A new and more flexible formulation of academic career and contractual conditions that rewards success in commercialisation could overcome barriers to activities such as IP or university-industry collaborations (Fontes and Padua, 2002).

The lack of funding is one of the most important barriers for the development of biotechnology companies: since there are very few Portuguese companies with the internal resources necessary to support their research projects, venture capital acquires a very important role. However, in Portugal there is an almost total absence of funds for risk capital in biotech (Pissarra and Amado, 2005). To attenuate this problem, the Government launched the NEST (New Technology Based Companies) Programme at the end of 2002. This programme provides financial support for the creation, launch and development of technology-based firms which have a close relationship with domestic science and technology organisations and/or are expected to reach a high level of technological capability. However, the programme has only had partial success because it has imposed far too many requirements on eligible firms, raised entry barriers and excluded small entrepreneurial initiatives (Corado-Simoes, 2005).

While it is true that Portuguese industry has low absorptive capacity for scientific knowledge because of its low commitment to in-house R&D activities, it is also true that Portuguese interface structures have largely failed to raise awareness among firms about the many potential applications of biotechnology research. Indeed, as Fontes and Padua (2002) argue, one of the reasons for the relative failure of interface institutions is that technology applications in the biotechnology field remain unclear to a large proportion of potential users.

With regard to public attitudes to new technologies in Europe, a public survey Eurobarometer (2005) found that Portugal is slightly less receptive than the EU-25 average about the positive effect on our way of life in the next 20 years of biotechnology and genetic engineering, medicines and new medical technologies, or nanotechnology. However, it is slightly more receptive to high-tech agriculture than the EU-25 average. Regarding cloning animals for research into human diseases, Portugal is more receptive than the EU-25 average. It is also more receptive than the EU-25 to the cloning of human beings so that couples can have a baby when one partner has a genetic disease, with 45% of respondents disapproving (EU-25 59%).

Regarding the use of genetics, Portugal is more receptive than the EU-25 average with 36% totally opposed to developing a genetic test for children that would identify their talents and weaknesses (EU-25 average 54%), 21% totally opposed to the development of a genetic test that would prolong our expected life span by 25 years (EU-25 average 42%) and 18% totally opposed to genetic treatments to get rid of bad habits like smoking or alcoholism (EU-25 average 33%). They were closer to the EU-25 averages for other applications. The survey also examined public attitudes to genetic modification. A lower proportion of Portuguese respondents (26%) would never approve the development of genetically modified crops to increase the variety of regionally grown food (compared to the EU-25 average of 37%).

Portugal has ratified the Convention of the Council of Europe on Human Rights and Biomedicine but has no specific legislation relating embryo or HES cell Research. In accordance to having ratified the convention, embryos cannot be cloned or created by other means for HES cell research (Knowles, 2004).

1.4 The main biotech policy and research actors

The main players in the innovation field are the Ministry for Science, Technology and Higher Education (MCTES) and the Ministry for the Economy and Innovation (ME). MCTES has two advisory bodies: the Higher Council on Science, Technology and Innovation (CSCTI), which advises MCTES on policy design and implementation regarding innovation policy, and the Higher Council on Education. The main agencies under MCTES are FCT (the Science and Technology Foundation), UMIC (the Agency for Innovation and Knowledge), and AdI (the Innovation Agency). FCT mainly aims to promote and finance programmes and projects concerning scientific research carried out by universities and Associated Laboratories. UMIC mainly focuses on information society and e-Government issues. AdI is a joint venture between MCTES and ME, appointed as the managing agency of most public programmes for research, development, technology transfer and the creation of new technology based firms.

ME is responsible for enterprise policy and has several agencies linked to innovation policy, including: AdI (the Innovation Agency), INETI (The National Institute for Industrial Engineering and Technology), IAPMEI (The Institute for Supporting Small and Medium Sized Firms), the Portuguese Institute for Industrial Property and the Portuguese Institute for Quality.

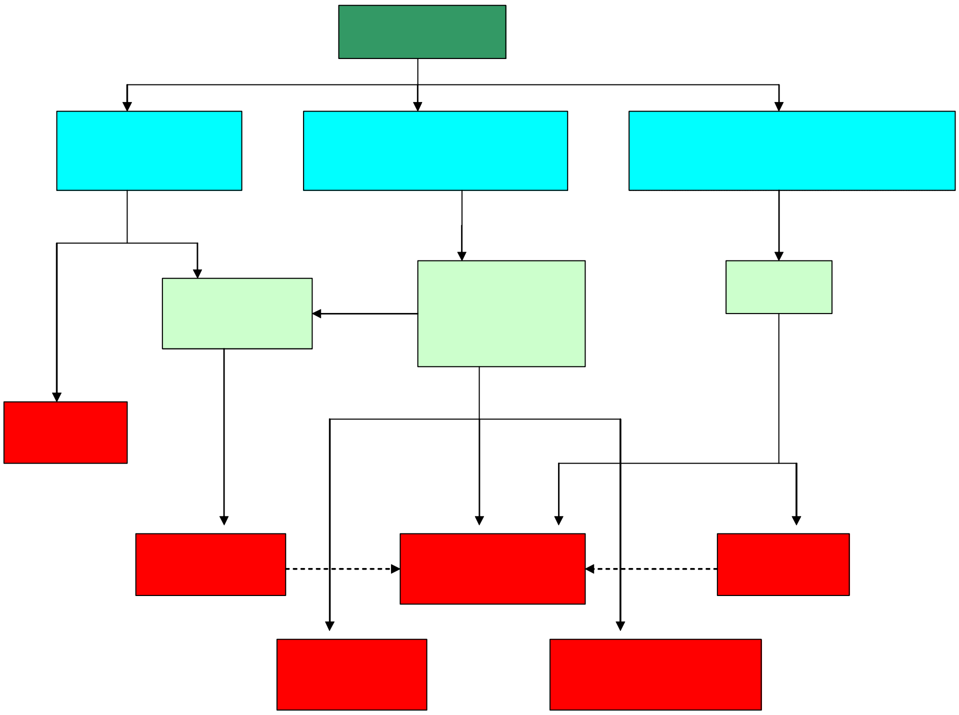
Other Ministries involved in innovation policy include the Ministry of Education, responsible for primary and secondary education; the Ministry for Public Works, responsible for the design and launch of basic infrastructure projects; the Ministry for Labour and Social Security, responsible for policies oriented to facilitate the access of enterprises to skilled personnel; and the Ministry for Agriculture, Rural Development and Fisheries that sponsors R&D activities in agriculture and fisheries, managed by INIAP (the National Institute for Research on Agriculture and Fisheries).

While coordination of innovation policy has been generally weak, there have been recent attempts to improve coordination between MCTES and ME, such as the joint design of a new programme for R&D consortia (i.e. IDEIA) and the joint venture AdI as the main agency responsible for managing R&D and innovation-focused measures. Moreover, the Government that took office in 2005 launched a ‘Technological Plan’, under the responsibility of the ME, and the Technological Plan Coordination Unit was created for the implementation and coordination of the Technological Plan.

The main actors involved in research activities in Portugal are summarised in Figure 1. The organisations in green are the main bodies responsible for the management of research funding, while the organisations in red are responsible for carrying out research. INIAP is a special case since it is both responsible for managing research funding and carrying out research. The two most important national sources in terms of biotechnology funding are the Science and Technology Foundation (FCT) and the Innovation Agency (AdI). FCT allocates funding through response mode project grants, through the support of university based research centres, and through the award of fellowships and training grants. AdI funds applied and industrially-oriented research, including research consortia between public sector research organisations and industry, and was developed to link science and technology policy.

The National Laboratories are publicly funded organisations financed directly by the various government departments. They establish their own priorities in consultation with the responsible Ministry. Besides scientific research, the National Laboratories are also responsible for the provision of advice to Government on the definition of scientific programmes and on the appropriate instruments for science and technology policies. It is important to note that there is no formal policy regarding the support of biotechnology research by the National Laboratories. However, there are two laboratories that conduct research on biotech: INETI and INIAP. In Section 2 we provide a detailed description of these organisations in terms of their support to biotechnology research.

Figure 1. Main actors of the biotechnology research & innovation system in Portugal



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

2.1 Introduction

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

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

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

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

2.2 Non-policy-directed funding of biotechnology research

Table 2.1 summarises the funding organisations responsible for non-policy-directed funding for biotechnology research. In the period 2002-2005 they allocated 28.3M EUR to this research. The biotech research activities of each of the organisations concerned are discussed in more detail below.

Table 2.1 Non-policy-directed funding of biotechnology research

Funding organisation	Public Research Institutions and Response Mode programs	Funding 2002-05 (M EUR)
FCT	Research Projects	13.1
FCT	Fellowships	12.8
INETI	Dept. of Biotechnology	2.4
Laboratórios Associados	Structural Funding	26.2
TOTAL		54.5

Source: BioPolis Research

2.2.1 The Science and Technology Foundation (FCT)

The FCT supports non-policy-directed funding of scientific research through open calls for research projects and fellowships, described below.

a) Research projects

Researchers at any Portuguese university, National Laboratory, Associated Laboratory or private non-profit organisations (e.g. Gulbenkian Foundation) can apply for these grants which are funded from both national and EU structural funds (through the POCTI/POCI and POSI/POSC programmes). Research proposals are peer reviewed by panels of national and international scientists. There were two calls in the period 2002-2005 (in 2002 and 2004).

In order to identify the budget assigned to biotech research projects and the proportion relative to the overall budget, we examined the titles and key words of approved projects from the 2002 and 2004 calls across a set of scientific areas.[1] The FCT classification of scientific areas only includes one area containing the word Biotechnology - Biochemical Engineering and Biotechnology - and many projects are in other scientific areas (particularly in Health Sciences and Natural Sciences), as shown in Table 2.2 below.

Table 2.2 provides a list of the scientific fields (and their sub-disciplines) within which we have identified approved projects in biotechnology from the 2002 call. As Table 2.2 shows, the biotech-related projects cover a wide variety of scientific sub-disciplines. A substantial underestimate of the magnitude of support for biotechnology research would arise from considering only the Biochemistry & Biotechnology sub-discipline.

[1] The data for approved projects in the 2002 call is available on-line: www.fct.mces.pt; data for approved projects in the 2004 call was provided by FCT.

Table 2.2 List of scientific sub-fields and number of biotech projects for the 2002 open call

Scientific field	Scientific sub-fields	Nº of projects	Nº of projects in Biotech
Natural Sciences	Molecular & Structural Biology	14	7
Natural Sciences	Cell Biology	19	6
Natural Sciences	Biology of Systems and Ecology	27	6
Natural Sciences	Sciences of Earth, Sea and Atmosphere	40	5
Natural Sciences	Animal and Veterinary Sciences	14	2
Health Sciences	Molecular and Genetic Medicine	16	10
Health Sciences	Neurosciences	9	2
Health Sciences	Microbiology and epidemiology and public health	22	5
Health Sciences	Organs, systems and Oncology	20	5
Health Sciences	Pharmacology and Pharmaceutical Sciences	13	1
Exact Sciences	Chemistry	41	0
Engineering and Technology	Agricultural and Forest Sciences	44	6
Engineering and Technology	Biochemistry & Biotechnology	8	8
Engineering and Technology	Chemical Engineering	33	1

Note: All the figures correspond to the 2002 open call. In the 2004 call some of the sub-fields changed slightly relative to 2002, but the main scientific areas are the same.
Source: BioPolis Research based on data available at www.fct.mctes.pt/projectos/pub/2002/.

Table 2.3 provides information about the overall budgets assigned to approved projects by FCT in the last four open calls. Some of these calls cover two calendar years, since, because of administrative problems, there were no calls in 2000 and 2003.

Table 2.3 Proportion of Biotech budget relative to overall projects funded (M EUR)

	Total Budget (i)	Sub-fields Budget (ii)	Biotech budget (iii)	(iii) / (i) (%)	(iii) / (ii) (%)
Open Call 1999/2000	58.7	33.3	7.4	12.6 %	22.2%
Open Call 2001	49.8	30.4	4.9	9.8 %	16.1%
Open Call 2002	40.7	21.9	4.3	10.7 %	19.8 %
Open Call 2003/2004	77.9	40.6	8.7	11.2	21.4 %

Source: BioPolis Research based on data available at www.fct.mces.pt/pt/apoios/projectos/bd/.

b) Fellowships

FCT provides funding for MSc, PhD and postdoctoral fellowships. FCT provided data on the overall amount of resources committed to fellowships in the areas of Biology, Health and Biotechnology for the period 2000-2004. While the amount of resources committed to biotech-related fellowships has been growing in absolute terms, they have remained fairly stable as a proportion of total fellowships over the period 2000-2004. Over the period 2002-2005, we estimate that there was a total investment of about 12.8M EUR in postgraduate fellowships.

2.2.2 The National Institute for Industrial Engineering and Technology (INETI)

The National Institute for Industrial Engineering and Technology (INETI) carries out high-level fundamental and applied research, and is committed to facilitating the adoption of biotechnology for new industrial applications. Its Department of Biotechnology carries out biotech-related research. The annual average budget of this department for the period 1999-2004 was 0.6M EUR which suggests an estimate for the period 2002-2005 of 2.4M EUR.

2.2.3 Associated Laboratories

Regarding the Associated Laboratories, the funding allocated for biotechnology related research over the period 2002-05 for CNC, IBMC, ITQP, is considered as non-policy-directed because these institutions were established as Associated Laboratory before 2002. The amount of structural funding these laboratories were granted within the period 2002-05 was 26.2M EUR (this information is shown with more detail in table 2.5 below).

2.3 Policy-directed funding of biotechnology research and commercialisation

Policy-directed funding of biotechnology research is carried out at the national level by the generic instruments of three organisations: The Science and Technology Foundation (FCT), The Innovation Agency (AdI) and The National Institute of Research in Agriculture and Fisheries (INIAP). Table 2.4 summarises the instruments used and the budgets allocated by each of these instruments. There is no regional funding of biotechnology research.

Table 2.4 National public policy-directed biotechnology stimulating instruments during the period 2002 – 2005

Instrument	Funding organisation	Budget (M EUR)	% of total	Use of DF/SF
Generic				
Associated Labs.	FCT	33.7	83.0	√
IDEIA	AdI	4.6	11.3	√
Agro Programme	INIAP	2.3	5.7	√
Total		**40.6**	**100**	

Source: BioPolis Research

2.3.1 Science and Technology Foundation (FCT)

The mission of FCT is to promote the advancement of scientific and technological knowledge in Portugal. FCT is the main body responsible for the administration of the generic POCTI/POCI programme (‘Programa Operacional Ciencia, Tecnologia e Inovação: 2000-2010’). The main mechanism through which it supports policy-directed funding of biotechnology research is through funding for Associated Laboratories (Laboratórios Associados).

These laboratories are either private non-profit or public research organisations that have been awarded special status by the MCTES because of their high scientific merit. This status of Associated Laboratory is linked to the commitment to pursue a set of research objectives in accordance with national science and technology policy, and it is granted for a maximum period of 10 years. Since 2000, 9 Associated Laboratories have been established that conduct research in biotechnology among their primary lines of research activities These 9 Labs are listed in Table 2.5, together with their size, overall budget and main areas of research in the field of biotechnology.[2]

Table 2.5 List of Associated Laboratories and overall research budgets for the period 2002-05 (M EUR)

Associated Laboratories	Establishment Date	N° staff researchers	Overall budget 2002-2005 (est.)	Main Biotech-related research area
CEBIP	Nov. 2001	---	6.8	Health Biotech (genomics / proteomics)
CBQF	Dec. 2004	61	0.4	Food & Environmental Biotech
CEAR	Dec. 2004	42	0.7	Environmental / Marine Biotech
CIMAR	Mch. 2002	105	6.9	Environmental / Marine Biotech
CNC	Nov. 2000	---	2.8	Health Biotech (drug delivery methods)
CQFB	Nov. 2001	160	16.6	Industrial & Process Biotech.
IBMC	Nov. 2000	202	7.3	Health Biotech (genetic diseases)
ITQB	Nov. 2000	81	16.1	Health & Biochemistry
LPSR	Dec. 2004	17	2.3	Industrial & Process Biotech.
Total budget			59.9	

Note: The full names of the Associated Laboratories are provided in Annex 6
Source: BioPolis Research based on information available at www.fct.mces.pt/pt/apoios/laboratoriosassociados/bd/.

For the purpose of this report, we consider funding for labs established from November 2001 as policy-directed funding. They received an investment of 33.7M EUR over the period 2002-2005.

For the Associated Laboratories committed to biotech research that were established before 2002, we have considered their funding as non-directed policy (see the figures for this non-directed policy in Section 2.2.3).

Not all institutions are fully committed to biotechnology related research, since they have a broader research portfolio in which biotech is only one of the research areas covered (as is the case for CEBIP, CIMAR, CNC, and IBMC). Therefore, only the budgets related to biotech areas were considered to estimate the expenditure in biotech related research. These estimates are shown in Table 2.2.

[2] The annual budget of these recently established Associated Laboratories has been calculated on the basis of the structural funding that these labs received from FCT for the period 2002-2005. The other main source of funding comes from project grants; this funding is discussed above in Section 2.2 non-policy-directed funding of biotechnology research.

2.3.2 Innovation Agency (AdI)

The Innovation Agency (Agência de Inovação: AdI) is the main body in charge of managing the support programs dealing with innovation. Responsibility for AdI is shared between the FCT and two agencies of the Ministry of Economy (IAPMEI and PME). AdI seeks to facilitate the commercialisation of basic research, support innovation, stimulate public-private partnerships, and promote technology transfer. The three main programmes funded by AdI to support innovation are: IDEIA, DEMTEC and NITEC. They are all generic programmes.

a) IDEIA

The program Applied Research and Development in Companies (IDEIA) was set up in 2003, as a continuation of a pre-existing programme (R&D in Consortium, initiated in 2001). The main objective of IDEIA is to stimulate cooperation between firms and the national scientific and technological system, in order to: (i) facilitate the transfer of technology from public research organisations to industry; (ii) provide support to in-house innovative activities at companies, and (iii) support Portuguese consortia in international research and technology projects. The programme will accept proposals from public research organisations, SMEs and large companies until the end of 2006 and will provide support for carrying out projects until the end of 2008.

The main policy goals of the IDEIA program are to support: a high level of industry-oriented (and applied) research, the availability of human resources, and the transmission of knowledge from academia to industry. It is worth noting that although IDEIA supports the adoption of biotechnology for new industrial applications, it is a generic policy instrument, open to companies from all sectors of economic activity. Consistent with these policy goals, IDEIA supports activities such as: applied research, research networks, mobility of researchers between academia and industry, collaborative research between industry and public research organisations, grants for industrial research, and protection of IPR at public research organisations.

IDEIA is intended to support projects involving companies and S&T organisations. Projects should have a maximum duration of three years and may include two types of actions: industrial research focused on the development of new technologies and the mastering of new competencies; and pre-competitive research for the development of prototypes and pilot projects with a view to the economic valorisation of research results. Incentives consist of a non-reimbursable grant, when support is below 0.1M EUR, and a combination of a non-reimbursable grant and a zero-interest loan, when support is higher. Applicants must contribute a minimum of 25% of the cost, and the maximum amount of funding per project is 1.1M EUR.

IDEIA and its predecessor, R&D in Consortium, managed an overall budget of 56M EUR from 2001 until 2005. Ten percent of that budget was assigned to biotech related projects (5.6M EUR), of which 2.2M EUR was allocated by the IDEIA programme in the period 2003-2005. We estimate that the budget for biotech-related projects for the period 2002-2005 amounts to 4.6M EUR. As Table 2.6 shows, while a broad range of application areas have been covered in this programme (the exceptions being basic biotechnology and non-technical areas of biotechnology), health and plant biotech represent the two most important application areas, accounting for almost 70% of the total budget.

Table 2.6 IDEIA support of innovation in biotech (M EUR)

Application areas	Budget 2002-2005	Share (%)
Plant Biotech	1.4	30.3
Animal Biotech	0.08	1.8
Environment Biotech	0.08	1.8
Health Biotech	1.75	37.5
Food Biotech	0.75	16.1
Industrial Biotech	0.58	12.5
Total	4.6	100

Source: BioPolis Research based on data provided by AdI.

b) Incentive System for Pilot Projects of Technologically Innovative Products and Processes (DEMTEC)

The initiative DEMTEC was launched in 2003 and had a duration of 4 years. This initiative supports demonstration or pilot projects that aim for the industrial validation of new technologies and the adoption of technologies for new industrial applications. The total budget for this initiative is 16M EUR, with maximum funding per project of 1.25M EUR with applicants required to contribute 50% of the cost. However, in the years in which this initiative has been running, no funded projects have yet related to biotech.

2.3.3 The National Institute of Research in Agriculture and Fisheries (INIAP)

Within the III Support Framework for 2000-2006, the European Council approved the Operational Program for Agriculture and Rural Development (AGRO Program). The AGRO Program includes Measure 8 "Technological Development and Experimentation" and Action 8.1 "Experimental Development and Demonstration" which has the main purpose of financing experimental development and demonstration projects, carried out in institutional partnerships, and contributing to update the agro-rural sector through the introduction of new technologies. All the AGRO - Action 8.1 projects are funded with 75% of the budget coming from EU structural funds (i.e. FEOGA) and with 25% of the budget coming from the Portuguese government budget.

The AGRO Manager has given INIAP a contract to manage the technical, administrative and financial aspects of the Action. INIAP has a double role: through its Agro Technical Support structure it supervises the call for proposals, ex-ante evaluations, budgets and monitoring of on-going projects; and through its operational units, INIAP also applies for grants and conducts research.

The beneficiaries of the AGRO program are entities within the scope of the agro-rural area, which have accumulated expertise in working in the area of technological development and demonstration (this includes: research and technological development centres; farmers and forestry associations; owners of agricultural, forestry and agro-industrial enterprises; public companies that work in the field of experimentation and agricultural demonstration; other companies or private entrepreneurs that have as their main purpose both research and technological development). The participating entities have the duty of promoting the diffusion of the project and its results.

Grants to public research organisations are given as a non-refundable 100% incentive, while if the partnerships involve only private entities then grants cover 75% of eligible costs.[3] The Minister of Agriculture Rural Development and Fisheries has responsibility for decisions on applications over 0.25M EUR, and has delegated this responsibility to the Secretary of State for Rural Development whilst the AGRO Program Manager has responsibility for decisions on applications up to 0.25M EUR. The first call for project proposals, in 2001, had a total of 197 approved projects with a total funding of 26.3M EUR, and all projects started by December 2001 and for this reason we included this call's whole budget. Around 6% (1.55M EUR) of the overall budget assigned by INIAP was devoted to projects in the biotech field (in terms of the number of projects, 10 out of the 197 approved projects corresponded to biotechnology). The second call, in 2003, had 89 projects approved (with a total budget of 15.5M EUR) and 6 projects in the area of biotechnology (accounting for 1.14M EUR). As Table 2.7 shows, most of the biotech-related research corresponds to either plant, animal or food biotech. For the purpose of this study that concentrates on period of 2002-2005 we consider only two-thirds of budget for the second call as most of the projects started in 2004 but ended in 2006. Therefore the total amount for the AGRO Programme is 2.3M EUR.

Table 2.7 Agro-Programme: support for innovation in biotech (M EUR)

Application areas	Call 2001	Share (%)	N° Projects	Call 2003	Share (%)	N° Projects
Plant Biotech	1.11	71.6	6	0.39	34.2	2
Animal Biotech	0.17	11.0	2	0.50	43.8	3
Environment Biotech	0.00	0.00	0	0.00	0.00	0
Food Biotech	0.27	17.4	2	0.25	21.9	1
Total	1.55	100	10	1.14	100	6

Source: BioPolis Research based on data on projects granted provided by AGRO Technical Support Structure for the Action 8.1

2.4 Charities

Calouste Gulbenkian Foundation

The Calouste Gulbenkian Foundation supports The Instituto Gulbenkian de Ciência (IGC) to carry out biomedical research and education by means of research groups or individual scientists, in particular young post-doctoral fellows. The total budget allocated by the Foundation to the Institute amounts to 5M EUR per annum, amounting to 20M EUR for the period 2002-05.

The Institute's scientific interests are focused on the genetic basis of development and evolution of complex systems, privileging organism-centred approaches in experimental models that include plants, yeast, flies and mice, and on the genetics of complex human diseases. The IGC campus includes basic and applied research institutions in biology, biotechnology and chemistry with complementary interests and competences: protein structure and design, synthesis and theory of chemicals with biological interest,

[3] As long as there is one public entity in the partnership, then grants cover 100% of all costs, both of the private and public partners.

molecular microbiology, plant biotechnology, fermentation, downstream processing, etc).

2.5 Participation in 6th FP and use of development funds

Table 2.8 Involvement of Portugal in biotechnology/life sciences programmes of the 6th Framework Program

Sixth Framework Programme	Participation as project manager in # of projects (% of total)	Participation as member of the project team (% of total)
Nanobio	0 (0)	4 (3.8)
Life Sciences for Health	4 (0.5)	60 (0.7)
Food Quality and Safety	1 (1.1)	21 (1.3)

Portugal acted as the coordinator of 5 European Commission 6th Framework Programme projects: it was coordinator of 4 projects in the Life Sciences for Health thematic priority and 1 project in the Food Quality and Safety thematic priority. It provided four partners to projects under the Nanobio thematic priority, 60 partners to Life Sciences for Health, and 21 partners to Food Quality and Safety. Apart from the Nanobio programmes, participation in these programmes is lower than Portugal's demographic weight.

3. Performance of the national biotechnology innovation system

3.1 Introduction

This chapter analyses the performance of the Portugal biotechnology innovation system for two or three time periods (depending on data availability) as shown by a range of indicators for scientific and commercialisation performance. Each time period includes several years, to avoid capturing erratic trends. National trends are benchmarked against the performance of the EU25 Member States and the US.[4]

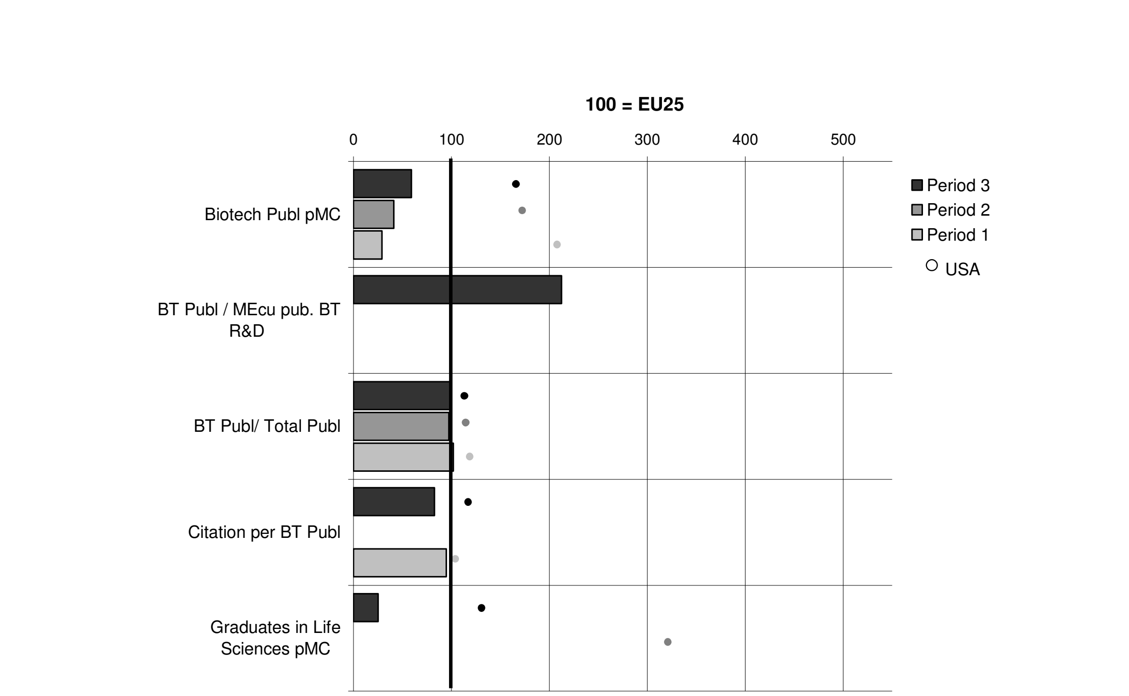
The presentation of performance is structured along two main areas of the Innovation System: the knowledge base and processes of knowledge transmission and application. Lack of data availability prevents the analysis of processes of biotechnology commercialisation or markets for biotechnology based products.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

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

As Chart 3.1 shows, while Portugal is well-below the EU-25 average in biotech publications and in Graduates in Life Sciences per million capita, the ratio of biotechnology publications per million capita have been continuously increasing over time.

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

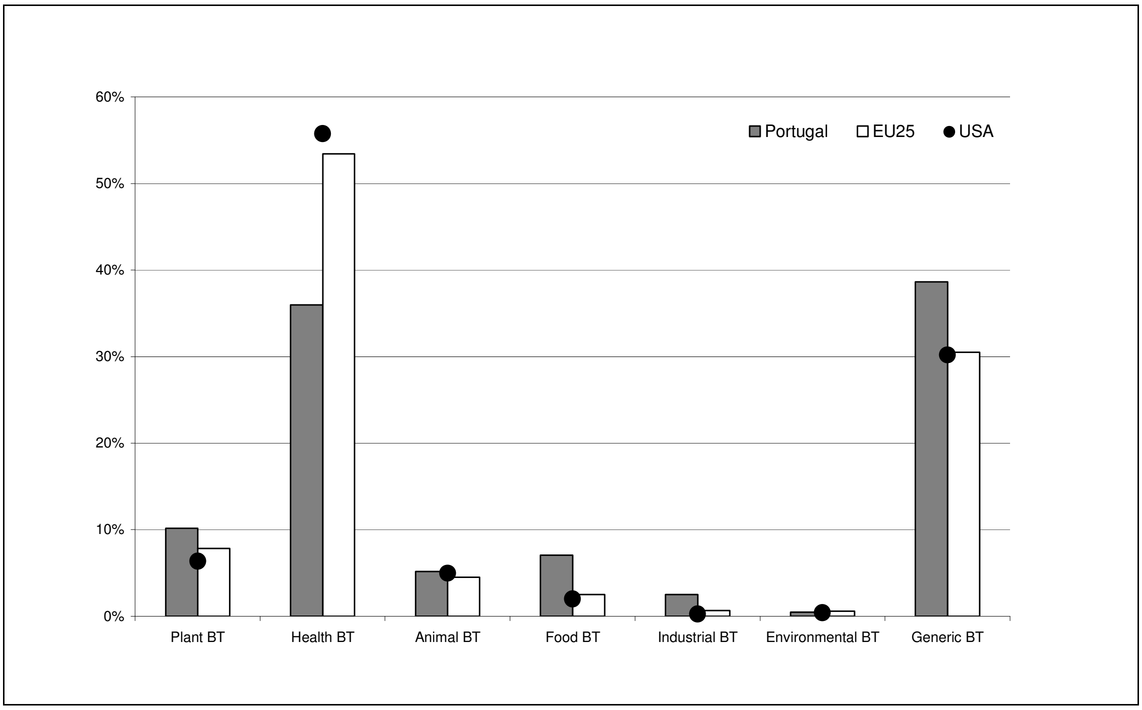
Chart 3.1 Biotechnology (BT) knowledge base indicators for Portugal



Note: Periods 1, 2 and 3 refer to 1994-1996, 1998-2000 and 2002-2004 respectively.
Data: Science Citation Index
Source: BioPolis Research

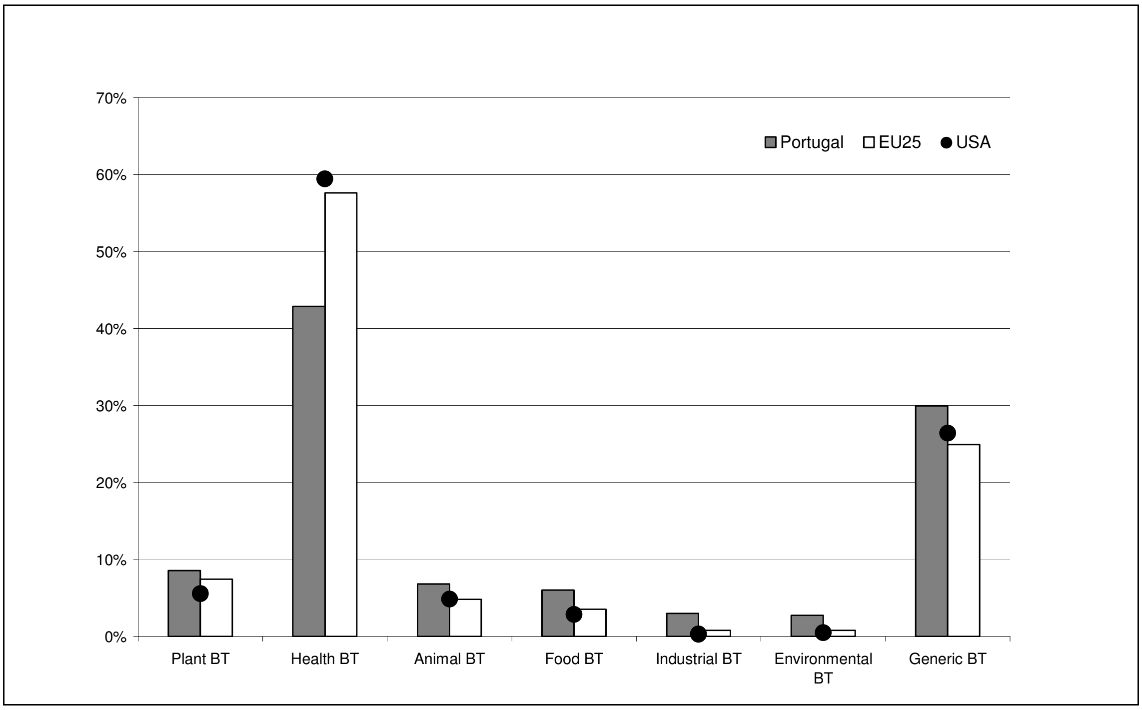
Charts 3.2.1 and 3.2.2 show that health biotech and generic biotech account for the largest share of publications in both periods.

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



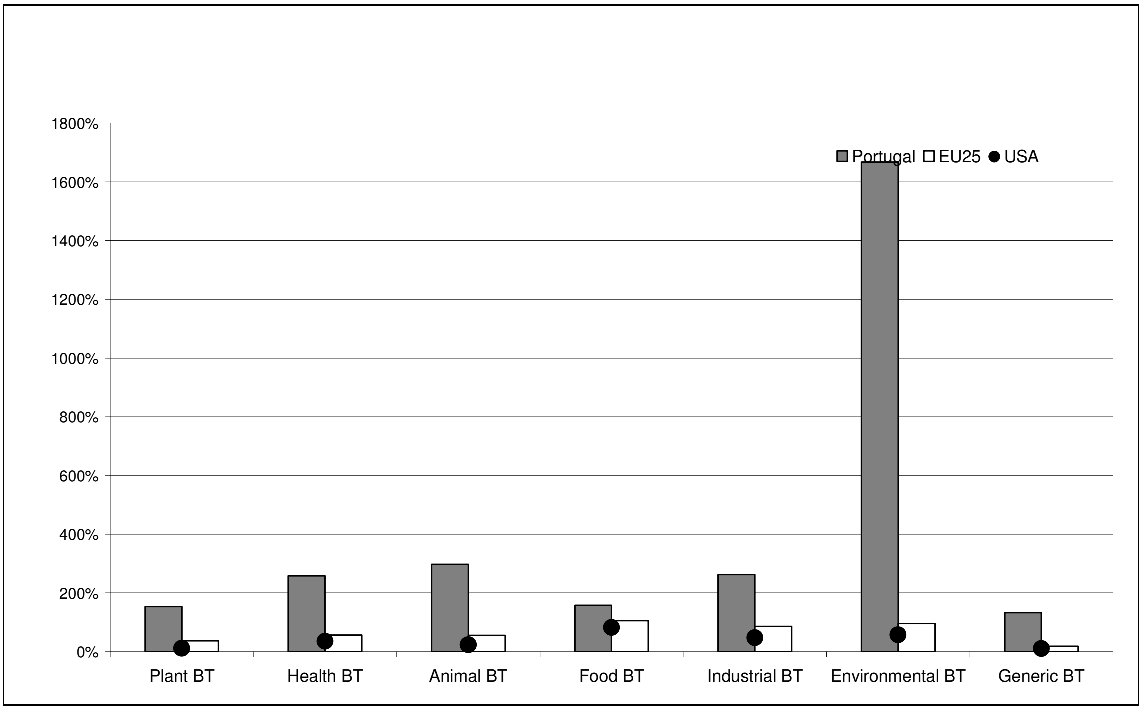
Data: Science Citation Index
Source: BioPolis Research

Chart 3.2.2 Share of Portuguese publications across biotechnology sub-fields 2002-2004



Data: Science Citation Index
Source: BioPolis Research

Chart 3.3 Growth rates of Portuguese publications across biotechnology sub-fields between 1994/96 and 2002/06



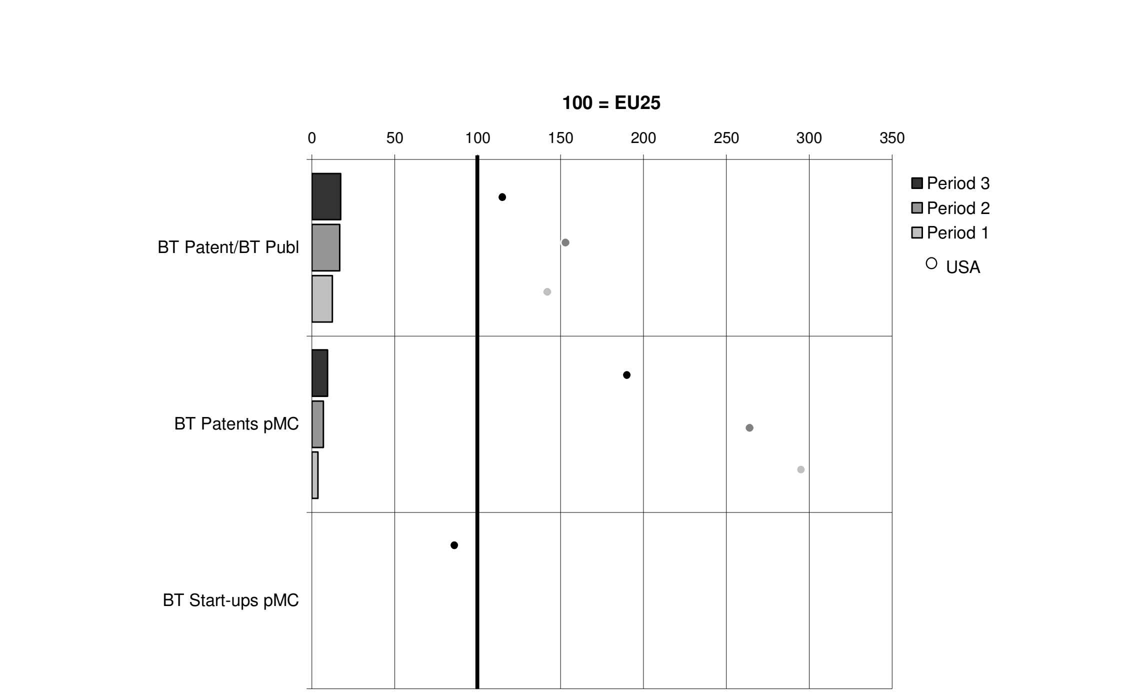
Data: Science Citation Index
.Source: BIOPOLIS Research

Chart 3.3 shows that biotechnology publications in the field of environment have experienced an outstanding increase, although it is relevant to point out that the initial number of publications in this field was very low (3 in the first period and 53 in the second period). In general, publication growth rates in Portugal are larger than those of EU-25 and US in all biotechnology fields.

3.3 Performance in knowledge transmission and application

Chart 3.4 shows that Portugal is performing well below EU-25 average in terms of the indicators for knowledge transmission and application. However, Portugal has displayed slight growth over time in both biotech patents to publications and biotech patents per million capita.

Chart 3.4 Knowledge transmission and application



Note: Periods 1, 2 and 3 refer to 1994-1996, 1998-2000 and 2001-2003 respectively.
Data: Database of European Patents (Host Questel Orbit , EPPATENT), Database of International Patent Applications (WOPATENT), EuropaBio
Source: BioPolis Research

3.4 Industrial development and market conditions

To date, indicators for industrial development suffer from lack of data about biotech companies in Portugal, caused by absence of comparable official biotechnology statistics, based on a common definition, for European countries. The only comparative data on biotech firms in Europe is provided by Ernst & Young reports which do not record any Portuguese companies. However, Pissarro and Amado (2005) have identified 40 Portuguese biotechnology firms (most of them SMEs), although they do not provide the definition used to cover such firms.

Regarding indicators for market conditions, none of the bio-medicines approved by the European Agency for the Evaluation of Medicinal Products (EMEA) originate from Portugal. Moreover, Portugal, with an index of 25 for field trials of GM crops is well below the EU-15 for which the index has been set at 100.

4. Conclusions

4.1 Introduction

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

4.2 Public funding of biotechnology through policy instruments

Table 4.1 summarises information about the non-policy-directed and policy-directed instruments by which Portugal funds biotechnology research and commercialisation. It is only possible to provide budgets for the whole period 2002-2005; data on individual years is not available. A significant proportion of the budget for research is provided by non-policy-directed instruments (57.3%), indicating that efforts to implement biotech research as a priority are weak. There are no biotech-specific instruments and the proportion of funds allocated to commercialisation is less than 5% of total expenditure.

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

	2002	2003	2004	2005	Total
RESEARCH					
1. *Non-policy-directed*					
Response Mode	---	---	---	---	25.9
Public Research Institutions					28.6
Total	---	---	---	---	**54.5**
2a. *Policy-directed Generic*					
National					36.0
Total	---	---	---	---	**36.0**
COMMERCIALISATION					
1a. *Policy-directed Generic*					
National	---	---	---	---	4.6
Total	---	---	---	---	**4.6**
GRAND TOTALS	---	---	---	---	**95.1**

Source: BioPolis Research

4.3 Specific features of the instruments

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

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

Instrument	Funding agency	Participants/Recipients			Financial contribution required (%)	
		PROs	SMEs	LFs	Recipients	Other Public authorities
National						
Generic						
Associated Labs.	FCT	√				
IDEIA	AdI		√		√	
Agro-Programme	INIAP	√	√		√	

Source: BioPolis Research

4.4 Policy goals

Table 4.3 shows the policy goals that are covered by directed instruments and funding by policy goal for the period 2002-2005. The majority of funding is allocated to achieving a high level of biotechnology research.

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 (in M EUR)*						
	1	2	3	4	5	6	9
National							
Generic							
Associated Labs. – Core funding	√	√		√	√		
IDEIA (& R&D in Consortium)		√		√	√		√
Agro-programme						√	
Total	8.4	10.0	0.0	9.2	10.0	2.3	0.8
% of Grant Total	20.7	24.5	0.0	22.6	24.6	5.7	1.9

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

Source: BioPolis Research

4.5 Biotech research application areas

Table 4.4 shows the application areas of biotechnology funded by each policy instrument as far as this information was provided. Seven application areas are funded and basic biotechnology and health biotechnology research receive higher proportions of this funding than either plant or animal biotechnology.

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)

	Funding of biotechnology application areas (in M EUR)*						
	1	2	3	4	5	6	7
National							
Generic							
Associated Labs. – Core funding	√	√	√	√		√	√
IDEIA (& R&D in Consortium)	√	√	√	√	√	√	
Agro-programme	√	√			√		
Total	5.54	4.45	3.45	11.9	1.24	7.31	6.74

Source: BioPolis Research
*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 (capacity building, support for patenting etc)

4.6 Stimulation of biotech activities through the instruments

Table 4.5 shows the type of activities that were stimulated for the period 2002-2005 through the various policy-directed instruments. There are many activities that can be stimulated by policy instruments, mentioned below the table. Table 4.5 shows only the activities that were stimulated by Portuguese policy instruments in the period. It indicates that these instruments addressed only a very limited range of activities to promote either biotechnology research or commercialisation.

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

Funding instruments	1	2	6	7	8	9	16	18
National								
Generic								
Associated Labs.–Core funding	√	√	√			√		
IDEIA (& R&D in Consortium)		√		√	√			√
Agro-programme							√	

Source: BioPolis Research
*
1 Basic research

2 Applied research
3 Centres of excellence
4 Research networks
5 Mobility of researchers among disciplines
6 Biotechnology training
7 Mobility of researchers between academia
and industry
8 Collaborative research between industry and public research organisations
9 Establishment of 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 active
17 Grants for industrial research
18 Other incentives for business investment
19 Support for public discourse activities

Source: BioPolis Research

4.7 Dynamics: comparison with 1994-1998

Table 4.6 shows that compared to 1994-98, there has been a significant increase in the average annual amount allocated by Government to biotech research (including both policy-directed and non-directed instruments).

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
Total	11.6M ECU	23.8M EUR

Source: BioPolis Research

Since the 1994-98 period, Portugal has slightly increased the range of policy goals covered by its instruments, though all belong to the category of generic instruments. Additional policy goals addressed are to assure the availability of human resources and to stimulate the adoption of biotechnology for new biotechnology applications.

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

Presence of instruments					
Policy areas	**Policy goals**	**1994-1998**		**2002-2005**	
		G*	**S****	**G**	**S**
1. Creation of knowledge base and human resources	1. To promote high level of biotechnology basic research	√		√	
	2. To promote high level of industry-oriented (and applied) research	√		√	
	3. To support knowledge flow and collaboration among scientific disciplines				
	4. To assure availability of human resources			√	

Presence of instruments						
Policy areas	**Policy goals**	**1994-1998**		**2002-2005**	
		G*	**S****	**G**	**S**
2. Knowledge transmission and application	5. To facilitate transmission of knowledge from academia to the industry and its application for industrial purposes	√		√	
	6. To stimulate the adoption of biotechnology for new industrial applications			√	
	7. To assist firm creation				
3. Market	8. To monitor and improve the social acceptance of biotechnology				
4. Industrial development	9. To encourage business investment in R&D	√		√	

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

Portugal has broadened its funding allocations across biotech application areas. While in the 1994-98 period most of the funding was directed to industrial and health biotech, more areas were funded in the more recent period. However, health biotech still receives the largest share (about 29% of all directed funding). The only areas that seem to remain largely unfunded are ethical, legal and social aspects of biotech and general biotech.

5. Future developments

The new Portuguese Government that came to power in 2005 launched a Technological Plan, but it is not yet known whether new instruments will be developed to implement this Plan, or if the Innovation Plan announced in 2005 by the previous government, which identified biotechnology as a priority, will be maintained. Analysts of biotechnology have identified two main problems with the Portuguese biotechnology research system which present policy instruments do not address sufficiently: the coverage of much too broad a range of biotechnology-related fields (Pissarra and Amado, 2005), and poor translation of science into technology in biotechnology (Fontes and Padua, 2002). The first problem could be addressed by redirecting funds away from the non-policy-directed response mode towards a biotechnology-specific instrument that focused on fewer application areas, and the second by developing a broader range of policy instruments to support knowledge transfer and the adoption of biotechnology by existing firms.

Annex 1 List of tables

No. *Title* *Page*

Annex 2 List of figures and charts

No. *Title* *Page*

Annex 3 List of contact people

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Annex 5 Performance

Introduction

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

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

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

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

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

	Indicator	Chart	Comments	Time periods
			comparison	
Ind. 7	BT publications in subfields, as % of total BT publications	3.2.1 3.2.2	Data in % EU25 and US data for comparison	1994-1996 2002-2004
Ind. 8	Growth rate of BT publications in subfields	3.3	EU25 and US data for comparison Small field effect	Growth rate between 1994-96 (period 1) and 2002-04 (period 3)
Ind. 9	Biotech patent applications pMC	3.4	EU25 and US data for comparison	(1) 1994-1996 (2) 1998-2000 (3) 2001-2003
Ind. 10	Number of biotechnology companies pMC	3.5	European (data available) and US data for comparison	(2) 2001 (3) 2004
Ind. 11	Number of biotech start-ups pMC	3.4	European (data available) and US data for comparison	(3) 2001-2003 (only one period)
Ind. 12	Number of biotech IPOs pMC	3.5	European (data available) and US data for comparison	(3) 2002-2005
Ind. 13	Venture capital in € pC	3.5	European (data available) and US data for comparison	(2) 2002 (3) 2004
Ind. 14	BT acceptance index	No Chart - Discussed in text of chapter 3	Source: BT Policy Benchmarking 2005. The biotechnology acceptance index is a composite index and draws on questions Q.12, Q.13.1 and Q14.01 and Q14.09 of the Eurobarometer 58.0	2002
Ind. 15	Eurobarometer 225	No Chart - discussed in text of chapter 3	See section 3.3 and sections 3.4.1, 3.4.2, and 3.4.3 of the Special Eurobarometer 225[5]	2005
Ind. 16	Biomedicines	3.6	Source: BT Policy Benchmarking 2005 Index: Reference Region EU15 =100 US data for comparison	1995-2002
Ind. 17	Field trials	3.6	Source: Biotechnology Innovation Scoreboard 2002 Index: Reference Region EU15 =100 US data for	1996-2001

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

	Indicator	Chart	Comments	Time periods
			comparison	

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

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

Raw data for the Charts in chapter 3

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

	BT publications			Population (million)		
	94-96	98-00	02-04	1996	2000	2004
EU25	97521	128716	145646	447	451	457
Portugal	635	1202	1983	10	10	10
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
Portugal	63	118	189	29	41	59
USA	454	492	529	208	172	166

Source: BioPolis Research
Publications: SCI
Population: EUROSTAT and OECD

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

	BT Publications	Non-policy-pirected funding	Policy-directed funding		Total public spending on BT (Mecu)	BT Publications/ Mecu BT public expenditure	Index
			Biotech specific	Generic			
	2002-2004	1994-1998	1994-1998	1994-1998	1994-1998	2002-2004/ 1994-1998	
EU25	145646				n.a.		
Portugal	1983	23.3	0	34.8	58.1	34	213
USA	154402				n.a.		n.a.

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

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

	BT publications			Total publications		
	94-96	98-00	02-04	94-96	98-00	02-04
EU25	97521	128716	145646	860652	1024327	1117392
Portugal	635	1202	1983	5497	9829	15391
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
Portugal	12%	12%	13%	102	97	99

USA	13%	14%	15%	119	115	113

Source: BioPolis Research
Publications: SCI

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

	Citations to BT publications		**Index EU25=100**	
	94-98	**00-04**	**94-98**	**00-04**
EU25	6.14	7.28	100	100
Portugal	5.82	6.02	95	83
USA	6.39	8.54	104	117

Source: BioPolis Research
Citations: SCI

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

	Graduates in Life Sciences		**Population (million)**	
	1998 / 1999	**2002**	**1998 / 1999**	**2002**
EU17	46859**	81316	552**	431
Portugal	n.a.	492	n.a.	10
USA	75253*	70950	276*	288
	Graduates pMC		**Index EU17=100**	
	1998 / 1999	**2002**	**1998 / 1999**	**2002**
EU17	91**	189	100	100
Portugal	n.a.	48	n.a.	25
USA	273*	246	321	131

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

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

	1994-1996							
	Total	**Plant**	**Health**	**Animal**	**Food**	**Indus-trial**	**Environ-mental**	**Generic**
EU25	100%	8%	53%	5%	3%	1%	1%	30%
Portugal	100%	10%	36%	5%	7%	3%	0%	39%
USA	100%	6%	56%	5%	2%	0%	0%	30%

Source:BioPolis Research
Publications: SCI

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

	2002-2004							
	Total	Plant	Health	Animal	Food	Indus-trial	Environ-mental	Generic
EU25	100%	7%	58%	5%	4%	1%	1%	25%
Portugal	100%	9%	43%	7%	6%	3%	3%	30%
USA	100%	6%	59%	5%	3%	0%	1%	26%

Source: BioPolis Research
Publications: SCI

Raw data for Chart 3.3. BT publications in subfields for the period 1994-1996

	1994-1996							
	Total	Plant	Health	Animal	Food	Indus-trial	Environ-mental	Generic
EU25	97217	7629	51944	4375	2434	624	576	29635
Portugal	639	65	230	33	45	16	3	247
USA	111686	7118	62274	5580	2230	296	459	33729

Source: BioPolis Research
Publications: SCI

Raw data for Chart 3.3. BT publications in subfields for the period 2002-2004

	2002-2004							
	Total	Plant	Health	Animal	Food	Indus-trial	Environ-mental	Generic
EU25	140984	10494	81220	6821	5017	1162	1126	35144
Portugal	1923	165	824	131	116	58	53	576
USA	141680	7910	84234	6872	4070	436	724	37434

Source: BioPolis Research
Publications: SCI

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

	1994-1996/2002-2004						
	Plant	Health	Animal	Food	Industrial	Environ-mental	Generic
EU25	38%	56%	56%	106%	86%	95%	19%
Portugal	154%	258%	297%	158%	263%	1667%	133%
USA	11%	35%	23%	83%	47%	58%	11%

Source: BioPolis Research
Publications: SCI

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

	BT patents			Population (million)		
	94-96	98-00	01-03	1996	2000	2003
EU25	4924	8921	10119	447	451	455
Portugal	4	14	22	10	10	10
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
Portugal	0	1	2	4	7	9
USA	33	52	42	295	264	190

Source: BioPolis Research
Publications: SCI
Patents: Questel Orbit

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

	BT patents			BT publications		
	94-96	98-00	01-03	94-96	98-00	01-03
EU25	4924	8921	10119	97521	128716	140219
Portugal	4	14	22	635	1202	1756
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
Portugal	0,01	0,01	0,01	12	17	17
USA	0,07	0,11	0,08	142	153	115

Source: BioPolis Research
Publications SCI
Patents Questel Orbit

Raw data: Number of field trials pMC, discussed in Chapter 3

	Field Trials	Population in M	Field Trials pMC	Index
	1996-2001	2001	1996-2001	1996-2001
EU15	1334	379	4	100
Portugal	9	10	1	25
USA	6745	278	24	688

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

Raw data for biotechnology acceptance, discussed in Chapter 3.

BT Acceptance Index 2002		
	Index Average	**N (sample size)**
EU - 15*	100,29	16828
Portugal	99,35	954

*Weighted Average according to the weight "W13" of the Eurobarometer 58.2, which considers population differences among countries and corrects for inconsistencies in the national samples
Source: BioPolis Research
BT acceptance index: Benchmarking of public biotechnology policy 2005

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EUROSTAT http://epp.eurostat.cec.eu.int/

OECD Education Database http://www.oecd.org/

OECD Statistics http://www.oecd.org/

STN International http://www.stn-international.de/

Questel Orbit http://www.questel.orbit.com/index.htm

Annex 6 Abbreviations

AdI	Agência de Inovação (The Innovation Agency)
CBQF	Centro de Biotecnologia e Quimica Fina (Centre for Biotechnology and Fine Chemistry)
CEAR	Centro de Estudios do Ambiente e do Mar (Centre for Studies of the Environment and the Sea)
CEBIP	Centro de Biologia e Patologia Molecular (Centre for Molecular Biology and Pathology)
CIMAR	Centro de Investigacao Marinha e Ambiental (Centre of Marine and Environmental Research)
CNC	Centro de Neurociencias de Coimbra (Centre for Neurosciences of Coimbra)
CSCTI	Conselho Superior de Ciência, Tecnologia e Inovação (Higher Council on Science, Technology and Innovation)
FCT	Fundação para a Ciência e a Tecnologia (Science and Technology Foundation)
IAPMEI	Instituto de Apoio às Pequenas e Médias Empresas e ao Investimento (The Institute for Supporting Small and Medium Sized Firms)
IBMC	Instituto de Biologia Molecular e Celular (Institute of Molecular and Cell Biology)
IGC	Instituto Gulbenkian de Ciência (Gulbenkian Institute of Science)
INETI	Instituto Nacional de Engenharia e Tecnologia Industrial (The National Institute for Industrial Engineering and Technology)
INIAP	Instituto Nacional de Investigação Agrária e das Pescas (The National Institute of Research in Agriculture and Fisheries)
ITQB	Instituto de Tecnologia Quimica e Biologica (Institute of Chemical and Biological Technology)
LPSR	Laboratorio de Processos de Separacao e Reaccao (Laboratory of Processesof Separation and Reaction)
MCTES	Ministério da Ciência, Tecnologia e Ensino Superior (Ministry for Science, Technology and Higher Education)
ME	Ministério da Economia e da Inovação (Ministry of the Economy and Innovation)
SME	Small and medium-sized enterprises
UMIC	Unidade de Missão Inovação e Conhecimento (Agency for Innovation and Knowledge)