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# Biotechnology in Denmark: A Preliminary Report

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The Danish Centre for Studies in Research and Research Policy

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## **Chapter 1. Introduction**

### **Main objectives**

Biotechnology has developed at a rapid pace in the last twenty years. The resulting technological advances offer a myriad of applications in a wide range of areas, the potential of which we are only beginning to see. As an industry itself, biotechnology is expected to take on increasing importance for economies in terms of job creation and productivity growth.

These developments underscore the need for a greater understanding of the development of the biotechnology industry and the use and application of biotechnology. This preliminary report examines the biotechnology sector in Denmark. The main objectives of this assessment are to:

- Examine the size of the biotech industry in Denmark, measured in terms of the number of firms and employees.
- Find the main areas of applications for Danish biotech firms.
- Examine the main geographic regions, or clusters, for biotechnology in Denmark.
- Estimate biotech R&D in Denmark and examine research and development activities for Danish biotech firms.

This report forms an initial assessment of the biotechnology sector in Denmark, based predominantly on two data sources. First, we have drawn on R&D surveys of the public and private sector undertaken by the Danish Centre for Studies in Research and Research Policy<sup>1</sup>. In both surveys, respondents are asked to estimate the percent of their total R&D expenditures that are devoted to biotechnology. We utilize this data both in estimating biotech R&D in Denmark, and in examining research activities for Danish biotechnology firms and public research institutions active within biotechnology.

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<sup>1</sup> See Danish Institute for Studies in Research and Research Policy (2003a, 2003b, 2003c). As of January 1, 2004, the institute's name has been changed to Danish Centre for Studies in Research and Research Policy.

In addition, we have made efforts to compile a comprehensive list of biotech firms in Denmark, by gathering information from a number of sources, among them: biotechnology organizations, science parks, venture capital funds, and news sources such as *Biotech Denmark* and *Ingeniøren*.

These two sources, R&D surveys and the list of Danish biotech firms, provide a great deal of information on biotechnology activities in Denmark. Though, there are a number of interesting aspects that we are unable to gain information on from these sources, and thus are outside of the scope of this current paper. Among these are: detailed information on firms' economic activities (e.g. sales, profits, exports, investments, etc.); additional information on firms' biotechnology applications and on firms that are 'users' of biotechnology; patent data; and firm level information on access to venture capital financing.

### **Classifying biotechnology firms**

Firms with biotechnology activities are classified into three groups:

#### I. Core biotechnology firms

Firms that are active in R&D in biotechnology and for which biotech constitutes the firm's central activity.

#### II. Firms active in biotechnology

Firms that have significant activities in biotechnology, but for which biotechnology may not constitute the central part of their activities.

This group includes:

- Small and medium sized firms whose main products are not biotech but rely heavily on biotechnology in research, development, and production.
- Large firms that are active in biotech R&D, but for which biotechnology does not comprise a major part of the firm's activities.
- Large pharmaceuticals firms, including those based in Denmark and other pharmaceuticals firms with active R&D in Denmark.

### III. Biotech users

Firms that are less active in biotech R&D, and are mainly involved in the use of biotechnology in the production of other products. Since Denmark has not yet conducted a biotechnology survey, our knowledge of users of biotechnology is limited. Hence, most of this report will focus on groups I and II.

Firms were identified as being biotech firms based on information from their web sites and the above-mentioned sources. This determination was made based on the OECD's definition of biotechnology as "*the application of science and technology to living organisms as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services*", and the list therein of included biotechnologies<sup>2</sup>.

#### **Organization of the report**

The remainder of this report is organized as follows. Chapter 2 provides an overview of biotechnology in Denmark in terms of the number of biotech firms and employees, and aggregate R&D expenditures in biotechnology. It also shows developments over the period, 1997 to 2003.

Chapter 3 examines biotech firms in terms of their size, location, age and areas of application. In addition, the chapter takes a brief look at the regions in which biotech firms are emerging. This includes the main region of Medicon Valley, which encompasses Copenhagen and the Skåne region of southern Sweden, and smaller regions that have developed around universities in the cities of Aarhus, Odense and Aalborg.

Chapters 4 and 5 examine private and public R&D activities in Denmark, drawing on R&D surveys in 2001 and 2002. Chapter 6 concludes.

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<sup>2</sup> See e.g. OECD (2003).

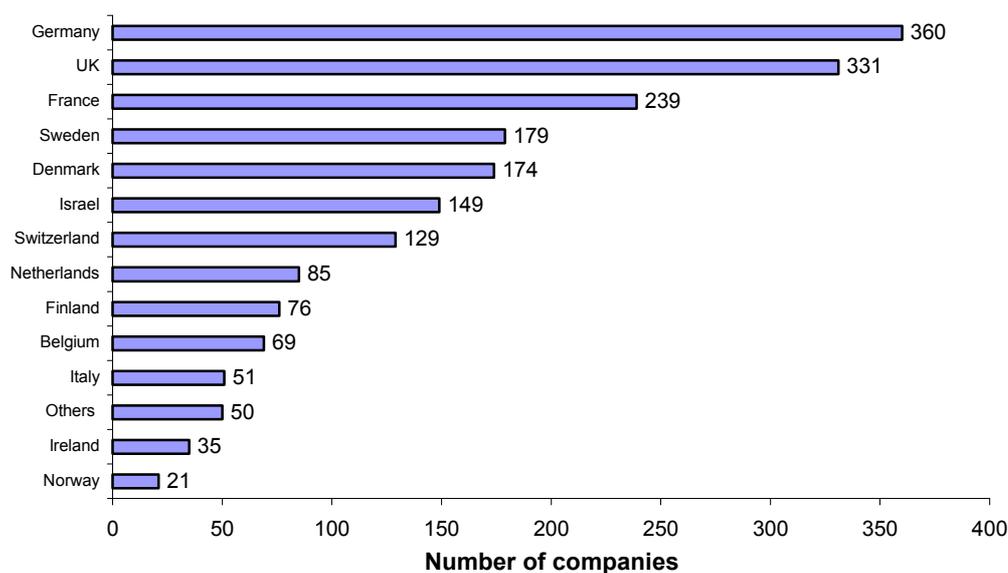
## Chapter 2. Overview

### Biotechnology firms

At the end of 2003, there were 181 core biotechnology firms (group I) in Denmark, with a total of 4766 employees<sup>3</sup>. In addition, we identified an additional 86 firms with significant activities in biotechnology (group II). This group includes large enterprises that are active within biotechnology, and pharmaceutical companies with active research in Denmark<sup>4</sup>.

Based on figures for other countries taken from Ernst & Young's European Biotechnology Report 2003<sup>5</sup>, these numbers rank Denmark fifth among European countries in terms of number of biotech companies, after Germany, the UK, France and Sweden. It should be mentioned here, though, that no minimum size criteria has been used in compiling the list of Danish biotech firms<sup>6</sup>.

**Figure 2.1 Biotech companies in Europe, 2002**



Source: Ernst & Young (2003), though figure for Denmark based on own calculations.

<sup>3</sup> Employee data stems from the NewBiz Business Information Source database. Note that these are preliminary estimates. For some firms, we were unable to determine whether the number of employees includes employees outside Denmark. For firms where no employee data was available (which was only the case for some smaller firms), the number of employees was estimated based on total assets. Employment was estimated for 36 firms, amounting to 1.2 % of total employees in core biotech firms.

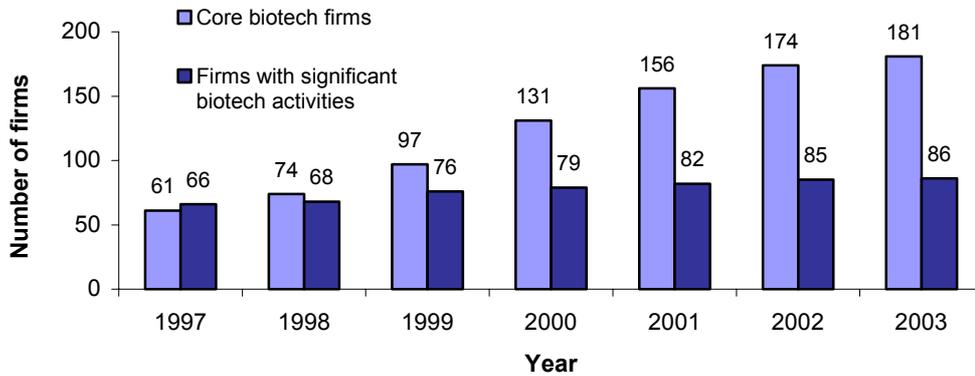
<sup>4</sup> Pharmaceutical companies with only sales and distribution in Denmark were not included.

<sup>5</sup> See Ernst & Young (2003).

<sup>6</sup> We have not yet confirmed if any size criteria is used for Ernst & Young's figures. See Chapter 3 for more details on the size distribution of Danish biotech firms.

Figures 2.2 and 2.3 show the number of biotech firms in Denmark and the number of biotech firm startups for 1997-2003. They indicate the rapid growth in the

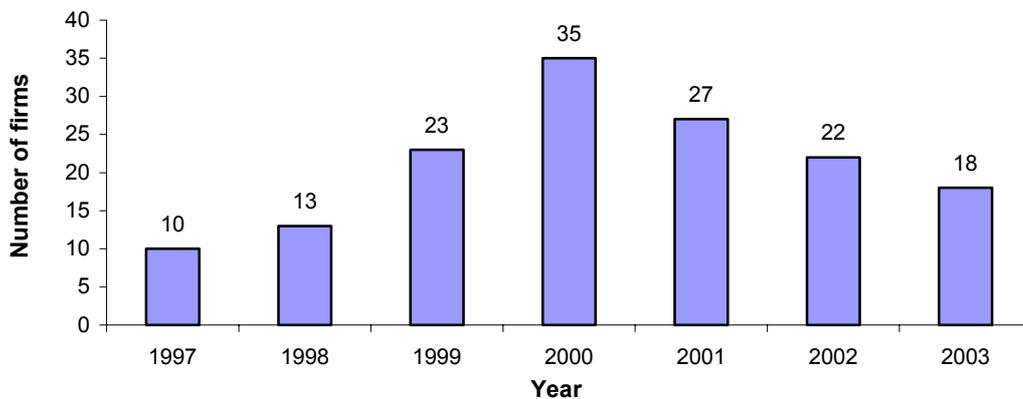
**Figure 2.2 Number of biotech companies in Denmark**



Source: Own calculations, based on information from several sources. Firms' start and end dates from NewBiz Business Information System.

number of firms in the last few years, with a large number of biotech start ups, particularly in 2000 and 2001. The number of core biotech firms has increased from 61 in 1997 to 181 in 2003. The number of firms with significant biotech activities has been more stable, which is perhaps to be expected since a large part of these are large, well established firms.

**Figure 2.3 Core biotech firms by year of foundation, 1997-2003**



Source: Own calculations, based on information from several sources. Firms' start and end dates from NewBiz Business Information System.

## Research and development in biotechnology

Biotechnology research in Denmark spans core biotech firms, universities and hospitals, and a number of large enterprises active in biotechnology. Most notable for the latter group are pharmaceutical companies with research bases in Denmark.

We estimate that private sector R&D in biotechnology amounted to DKK 4.8 billion (€ 649 million) in 2001<sup>7</sup>. This comprises 22 percent of total private sector R&D in Denmark in 2001<sup>8</sup>. For this same year (2001), we estimate biotech R&D in the public sector to be DKK 1.05 billion (€ 142 million), and DKK 1.06 billion in 2002, which amounted to 10 percent of total public sector R&D in Denmark in 2002.

Table 2.1 shows the developments in private and public sector R&D over the period 1997-2001<sup>9</sup>. These biotech R&D estimates are based primarily on responses of firms and public research institutions, in which they have given the percentage of their total R&D that is within biotechnology. In addition, for firms in the R&D database that did not answer this ‘focus area’ question though were identified as core biotech firms (group I), we estimated that all of their R&D was within biotechnology. Detailed information on the approximation methods used is included in the Annex.

**Table 2.1 Total biotechnology R&D, 1997-2001, DKK millions**

Sector	1997	1998	1999	2000	2001
Private	3,078	4,034	3,938	4,371	4,805
Public	752	808	865	1,054	1,054
Total	3,830	4,843	4,803	5,426	5,859

Source: Own calculations based on Danish Centre for Studies in Research and Research Policy's R&D database, firm annual reports. 1€ = 7.4 DKK.

For private sector, year 2000 estimated based on average of 1999 and 2001. For public sector, 1998 estimated, based on averages of 1997 and 1999.

To avoid double counting and exclude R&D conducted outside Denmark, extramural R&D are not included in estimates of aggregate levels of biotech R&D given in Table 2.1.

<sup>7</sup> This figure is based on data for biotech firms for which we have or were able to obtain R&D figures. Total R&D figures are unweighted. More details can be found in Chapter 4 and in the Annex.

<sup>8</sup> Total private sector R&D in Denmark was 21.9 billion DKK for 2001. See Danish Institute for Studies in Research and Research Policy (2003a).

<sup>9</sup> Private sector R&D data for 2002 is expected to be available in May 2004.

There has been fairly steady growth in private sector R&D within biotechnology, with average annual growth rates of 12.4 percent over 1997-2001. This is much in line with growth rates of total private sector R&D in Denmark<sup>10</sup>. Average annual growth rates for public sector R&D within biotechnology were 9.1 percent for 1997-2001, though public sector biotech R&D was more or less constant from 2000 to 2001. This slowdown in the growth of public biotech R&D continued into 2002, with an increase of less than one percent in expenditures.

Table 2.2 shows developments in the number of full time employee equivalents (FTE) engaged in biotech R&D in Denmark. In 2001, an estimated 5,546 FTE's were utilized in biotech R&D. This amounts to around 14 percent of aggregate totals for Denmark in 2001.

**Table 2.2 Total FTE's in biotech R&D, 1997-2001**

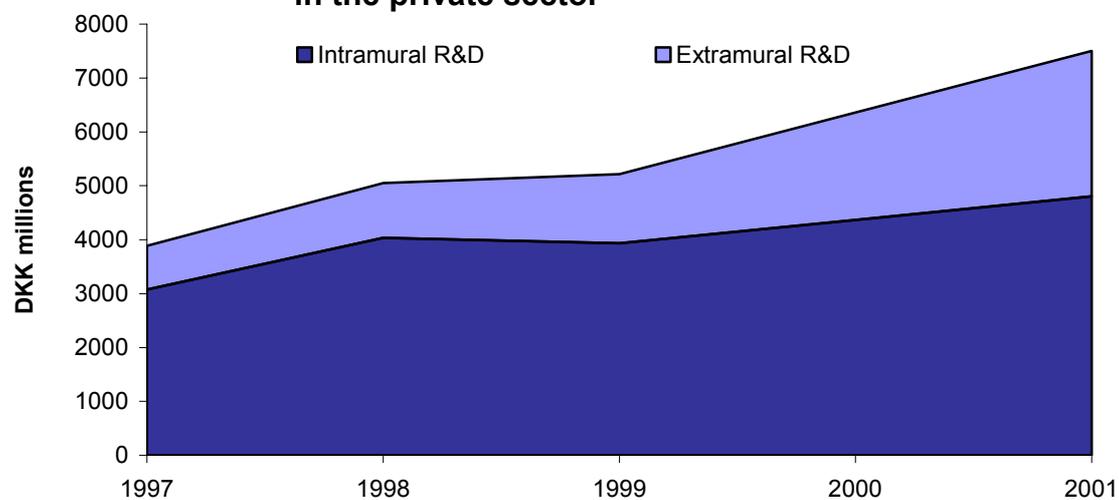
Sector	1997	1998	1999	2000	2001
Private	3,528	3,648	3,742	3,885	4,028
Public	1,373	1,551	1,729	1,464	1,518
Total	4,902	5,199	5,471	5,349	5,546

Source: Own calculations based on Danish Centre for Studies in Research and Research Policy's R&D database, firm annual reports. An FTE, or full time equivalent, is equal to a year of total working time for one employee. For the private sector, the year 2000 was estimated based on average of 1999 and 2001. For the public sector, 1998 was estimated, based on averages of 1997 and 1999.

Figure 2.4 shows the developments in firms' intramural and extramural biotech R&D. While growth in firms' intramural R&D in biotechnology has been fairly steady in recent years, increases in firms' purchases of biotech R&D have been more dramatic, as figure 2.4 illustrates.

<sup>10</sup> Average growth rates for total private sector R&D were 11.3 percent for 1997-2001. See Danish Institute for Studies in Research and Research Policy (2003a).

**Figure 2.4 Intramural and extramural biotechnology R&D in the private sector**



Extramural R&D in biotechnology has increased from DKK 812 million (€ 110 million) in 1997 to DKK 2.7 billion (€ 365 million) in 2001, with extramural R&D comprising 36 percent of firms' total biotech R&D expenditures in 2001<sup>11</sup>. This reflects strong growth in overall biotech research activity in recent years, and also suggests that trade in biotechnology research and development has become more prevalent.

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<sup>11</sup> Note: extramural R&D includes intramural R&D that is conducted outside Denmark. To avoid double counting and exclude R&D conducted outside Denmark, extramural R&D are not included in estimates of aggregate levels of biotech R&D given in table 2.1.

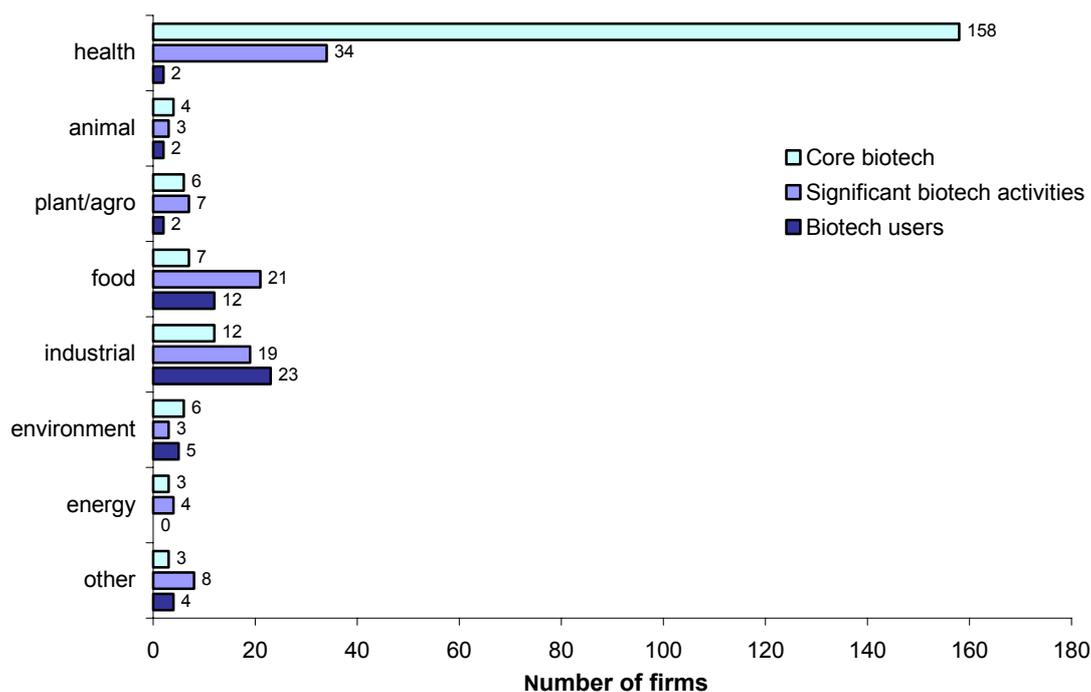
## Chapter 3. Biotech firms by application and region

### Biotechnology applications

In identifying biotech firms, each firm was classified according to their main areas of biotechnology applications. If a firm's biotech activities were related to more than one area of application, then the firm was included in each area.

Over 87 percent of core biotech firms in 2003 have activities within the area of human health, which is by far the greatest concentration of firms. Figure 3.1 shows areas of application for core biotech firms (group I), firms with significant biotech activities (group II), and biotech users (group III).

**Figure 3.1 Biotech firms by area of application, 2003**



Source: Own calculations based on information from several sources on firms' biotechnology activities.

After human health, the next largest group (among core biotech firms) is in biotech products for industrial applications, with smaller numbers of firms having applications within agriculture, food processing, and the environment.

When considering larger firms that are also active in biotechnology (i.e. group II), it can be seen that there are a larger number developing biotechnology products for application in industry and food processing.

### Industry classification

Firms involved in biotechnology are classified in a wide variety of industries. This reflects the fact that, given that much development in biotechnology is relatively recent, there is no industry classification for biotechnology, and also that biotechnology is used in a broad range of applications. Table 3.1 lists the main industry classifications for biotechnology firms in 2003, both for core biotech firms and for all firms identified as being involved in biotechnology (i.e. groups I, II, and III).

**Table 3.1 NACE codes of biotechnology firms, 2003**

Industry	NACE code	Number core biotech firms	Total number biotech firms	Percent of total biotech firms
Plant and animal breeding	1.1 – 1.2	1	5	1.6
Food products and beverages	15	2	26	8.4
Chemicals & Chemical Products (less Pharmaceuticals)	24 (not 24.4)	12	17	5.5
Pharmaceuticals	24.4	13	28	9.0
Paper, Rubber & Plastics, Non-Metallic Mineral Products	21, 25, 26	1	7	2.3
Machinery	29	0	14	4.5
Electrical Machinery	31	3	6	1.9
Medical Instruments, Other instruments	33	4	9	2.9
Wholesale trade	51	8	19	6.1
Computer & Related Activities	72	4	5	1.6
Research & Development	73	100	118	37.9
Other Business Activities	74	16	32	10.3
Health Services	85	9	9	2.9
Other		2	6	1.9
Unknown		6	10	3.2
<b>TOTAL</b>		<b>181</b>	<b>311</b>	<b>100.0</b>

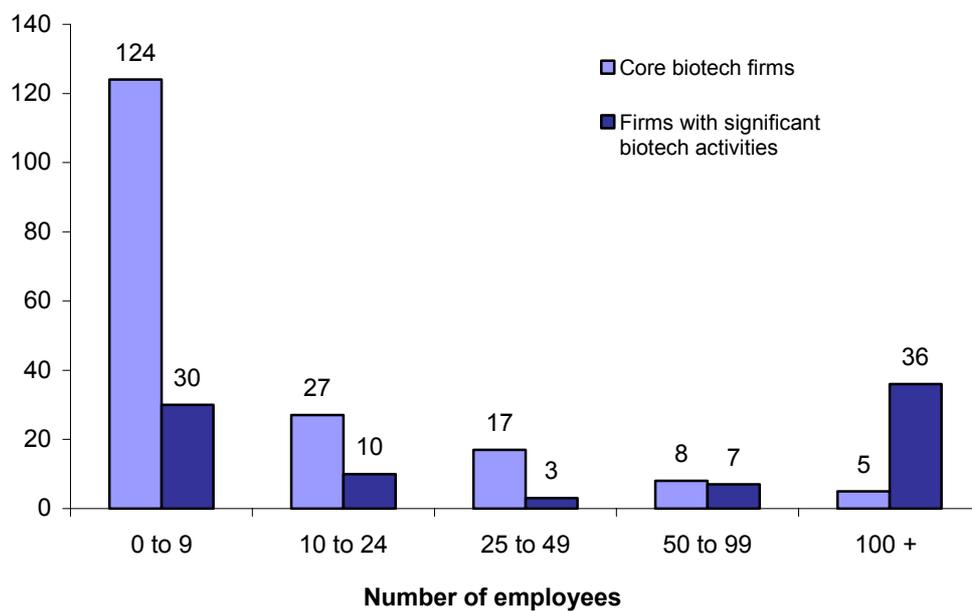
Source: Information on firms' NACE codes from NewBiz Business Information Source.

By far the most common industrial classification for core biotech firms is Research and Development. Though, it can also be seen that there are a number of other common classifications, in particular, Chemicals, Pharmaceuticals, and, perhaps less expected, Wholesale Trade, and Other Business Activities. NACE codes for other biotech firms (groups II, III) are even more varied, reflecting the wide variety of firms that are involved in biotechnology.

**Firm size**

A significant number of core biotech firms are small firms that have been established in the last few years, reflecting both the growth in new biotech firms and the relatively young age of the industry as a whole. Figures 3.2 and 3.3 show the distribution of firms by number of employees and the number of start-ups in recent years.

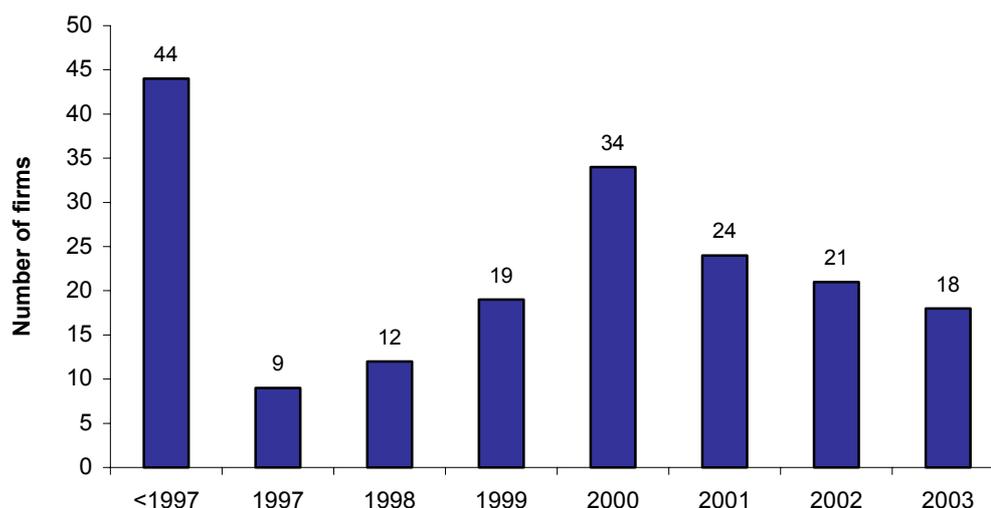
**Figure 3.2 Biotech firms by size, 2003**



Source: Own calculations based on employee data from NewBiz Business Information Source

It can be seen that 124 out of 181 core biotech firms in 2003 had less than 10 employees, and only 13 had 50 or more employees. Furthermore, 54 percent of core biotech firms have been established in 2000 or later.

**Figure 3.3 Core biotech firms in 2003 by year of foundation**



The large number of startups in recent years reflects the strength of biotech research in Denmark, with basic research generating a number of new firms. However, it also indicates both the very young age of a large part of the biotech industry in Denmark, and the small average size of Danish biotech firms. It is likely that the Danish economy has not yet felt the impact of the large increases in the number of core biotech firms. Ahead of many of these small biotech firms lie the challenges of securing financing for their continued work, and of turning promising basic research results into successful products.

Of the 181 core biotech firms in 2003, 6 firms are publicly traded on the Copenhagen Stock Exchange<sup>12</sup>. This number may increase in the near future, as initial public offerings have been under discussion for a number of other firms<sup>13</sup>.

<sup>12</sup> Bavarian Nordic, Bioscan, Genmab, Neurosearch, Novozymes and Pharmexa.

<sup>13</sup> Among the firms named in connection with potential IPO's in the near future are Acadia Pharmaceuticals, Dakocytomation, Gastrotech, Life Cycle Pharma, Nordic Bone, TopoTarget, and Zealand Pharma. See various issues of *Biotech Denmark*.

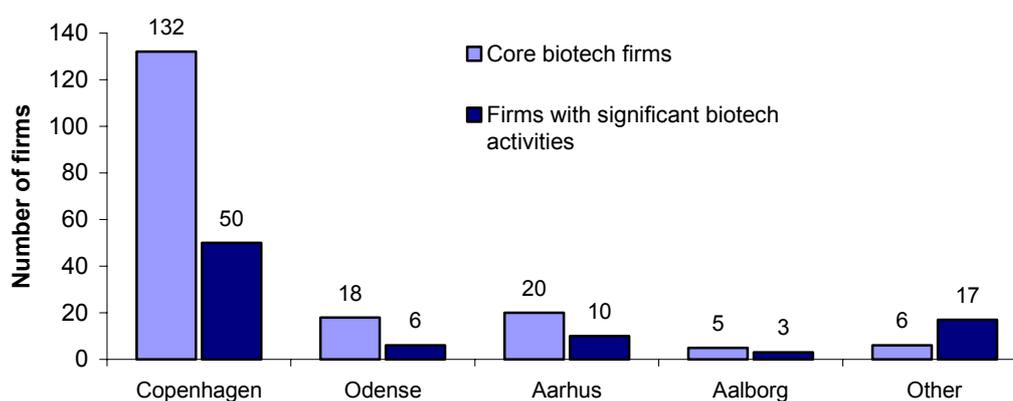
## Biotech regions

The large majority of biotech firms in Denmark are located in Greater Copenhagen, which along with the Skåne region in southern Sweden forms the Medicon Valley region. Medicon Valley is among the largest biotech clusters in Europe<sup>14</sup>. There are several public research institutions conducting biotech research in Copenhagen, among them the University of Copenhagen and the Technical University of Denmark. In addition, Medicon Valley is also home to a number of pharmaceutical companies, Novo Nordisk, H. Lundbeck, Leo Pharma, and Astra Zeneca<sup>15</sup>.

The presence of these pharmaceutical companies has influenced biotech research in the area, with emphasis on research in neuroscience, cancer, diabetes and inflammatory diseases<sup>16</sup>.

Figure 3.4 shows the distribution of biotech firms by region in Denmark. 132 core biotech firms, or 73 percent, are located in the Greater Copenhagen area. It can be seen that, in addition to Medicon Valley, biotech clusters have also begun to emerge around the other main universities and hospitals in Denmark, in the cities of Aarhus, Odense, and recently, in Aalborg.

**Figure 3.4 Biotech firms by region, 2003**



Each region contains city and surrounding region (or county); 'Other' includes all other regions in Denmark (Bornholm, West Zealand, all counties in Jutland except Aarhus and North Jutland)

<sup>14</sup> See Boston Consulting Group (2002).

<sup>15</sup> Note that Astra Zeneca is predominantly located in the 'Swedish' part of Medicon Valley.

<sup>16</sup> See Boston Consulting Group (2002).

The emergence of a biotech cluster in Aarhus has its base in the University of Aarhus with 30,000 students (over 7,000 in life sciences), venture capital firms located in the area, and structural initiatives such as science parks. Growth in biotechnology in Odense has been driven primarily by research in the area of proteomics, which has resulted in the establishment of a number of biotech firms.

### **Venture capital**

An important factor for the start-up and growth of biotech firms is access to venture capital financing. We do not have firm level data on venture capital and other sources of financing for biotech firms in Denmark. However, we can draw on some information on venture capital investment in Denmark from the Danish Growth Fund (Vaekstfonden)<sup>17</sup>.

In 2002, DKK 2.1 billion (€ 284 million) in venture capital were raised by Danish firms, down from DKK 3.4 billion (€ 459 million) in 2001. The percentage of total venture capital investments in biotech firms was 14 percent in 2002, up from 7 percent in 2001. Hence, biotech firms in Denmark raised DKK 294 million (€ 40 million) in 2002, and DKK 238 million (€ 32 million) in 2001, with the number of new investments in biotech firms amounting to 10 in 2002 and 17 in 2001<sup>18</sup>. In addition, Vaekstfonden and the Danish Venture Capital Association (DVCA) find<sup>19</sup> that there is increasing interest in biotechnology for future venture capital investments. This gives some indication that Danish biotechnology may gain greater access to venture capital funding in the coming years.

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<sup>17</sup> See Vaekstfonden (2003).

<sup>18</sup> See Vaekstfonden (2003).

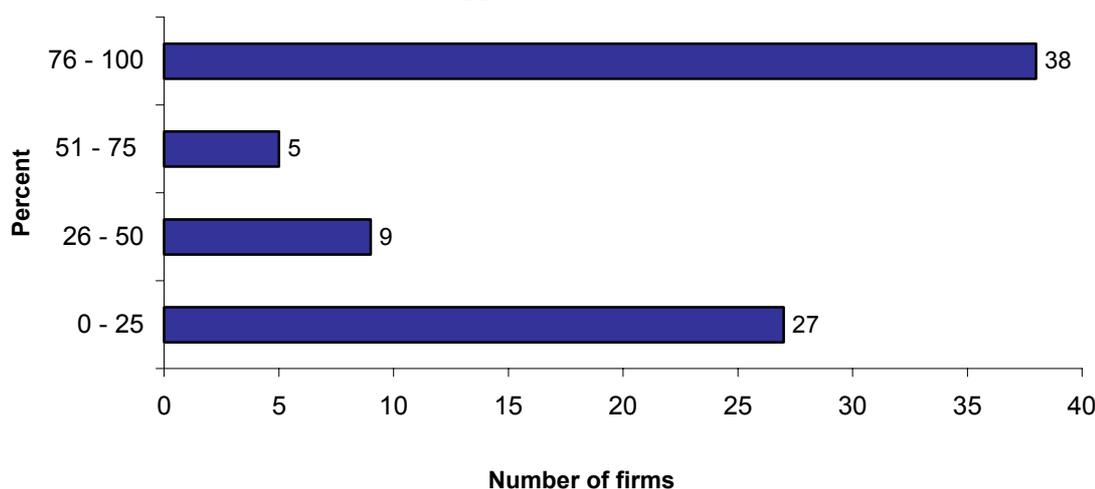
<sup>19</sup> See DVCA and Vaekstfonden (2004).

## Chapter 4. Private sector biotechnology R&D

This chapter examines the R&D activities of biotech firms. It is based on data from the Danish R&D Survey 2001<sup>20</sup>, for the private sector. In the survey, 597 out of 2465 firms responded that they had R&D activities in 2001. We identify 80 firms in the sample that had R&D within biotechnology<sup>21</sup>. Of these 80 firms, 28 are core biotechnology firms (group I), 38 had significant activities in biotechnology (group II), and 14 were identified as users of biotechnology (group III).

Figure 4.1 shows the distribution of these firms according to the percentage of their total R&D that was within biotechnology.

**Figure 4.1 Firms by percent of total R&D expenditures within biotechnology, 2001**



In order to gain as comprehensive a sample on biotech R&D as possible, annual reports were examined for all core biotech firms with ten employees or greater that were not in the R&D sample. Eighteen of these firms reported R&D expenditures

<sup>20</sup> See Danish Institute for Studies in Research and Research Policy (2003a).

<sup>21</sup> These estimates are based primarily on responses of firms and public research institutions on the percent of their total R&D that is devoted to biotechnology. In addition, for firms in the R&D database that did not answer this 'focus area' question though were identified as core biotech firms, we estimated that all of their R&D was within biotechnology. Detailed information on the methods used is included in the annex.

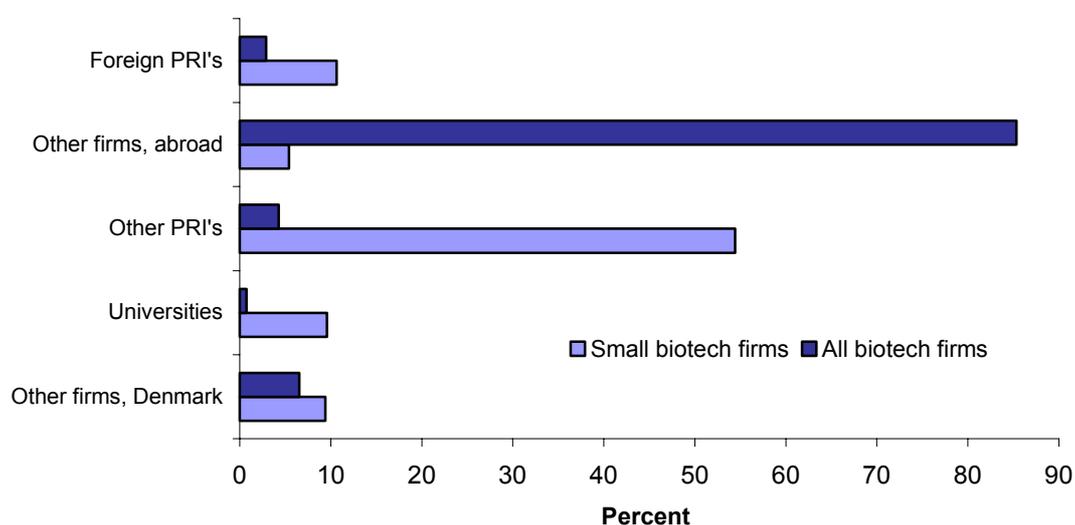
in their annual reports<sup>22</sup>. This then gives a total 98, comprising 77 percent of core biotech firms in Denmark with at least 25 employees<sup>23</sup>.

### Intra- and extramural biotech R&D

Based on this group of firms, we estimate that a total of DKK 4.8 billion (€ 649 million) was spent on biotechnology R&D in Denmark in 2001. Almost three quarters of aggregate biotech R&D in 2001 was conducted by firms with significant biotech activities (group II), and around one quarter was undertaken by core biotech firms (group I). This extensive biotech research by pharmaceuticals and other large companies then provides a strong base for the development of smaller core biotech firms.

In addition, these firms purchased an additional DKK 2.7 billion (€ 356 million) in biotech R&D. Figure 4.2 shows the distribution of purchased R&D according to sources. For comparison, figures are shown for all firms with biotech R&D<sup>24</sup> and for small biotech firms (under 50 employees).

**Figure 4.2 Extramural R&D by source, 2001**



<sup>22</sup> We then estimated the shares of their reported R&D that comprised intra- and extramural R&D based on core biotech firms of a similar size in the R&D sample.

<sup>23</sup> And 65 percent of all core biotech firms with 10 or more employees.

<sup>24</sup> Figures are for total extramural R&D for each firm. In order to focus on biotechnology R&D, only firms with at least 20 % of their R&D focused on biotechnology are included here.

For all biotech firms in the R&D sample, 85 percent of extramural R&D was purchased from other firms outside Denmark, with a small reliance on R&D from universities and other public research institutions (PRI). The picture is very different for smaller biotech firms, with 75 percent of extramural R&D stemming from universities and other PRI's (both Denmark and abroad). While numbers for large biotech firms are qualitatively similar to aggregate averages, those for small biotech firms are substantially different, and indicate a much greater degree of contact with public research institutions.

### **Employment**

An estimated 4,409 employees were involved in biotech research in 2001, amounting to 4,028 full time equivalent employees (FTEs)<sup>25</sup>. For biotech firms with less than 50 employees, 65 percent of the staff (in terms of FTEs) was involved in R&D, with the average being 20 percent for firms with more than 50 employees. These shares of total employees involved in research and development indicates the high research intensity of firms, in particular smaller biotech companies.

Wages and salaries amounted to about 46 percent of total R&D expenses for biotech firms, which is similar to aggregate averages<sup>26</sup>. Total R&D expenditures per FTE for these firms amounted to about DKK 916,000 (€ 124,000).

### **External financing**

On average, biotech firms in this sample relied on external financing for 22 percent of their R&D expenditures. Use of external financing is somewhat higher for smaller firms, at an average of 33 percent of R&D expenditures for firms with 50 employees or less. Figure 4.3 below shows the distribution of external financing by source, for all biotech firms and small biotech firms.

Considering first all biotech firms in the R&D sample, the largest source of external funding is foreign enterprises, which account for over 30 percent of external funds to R&D activities, followed by public investment funding via the Danish Growth Fund (Vaekstfonden), and the National Agency for Enterprise and Housing (Erhvervsfremme Styrelsen). It can also be seen that small biotech firms rely more

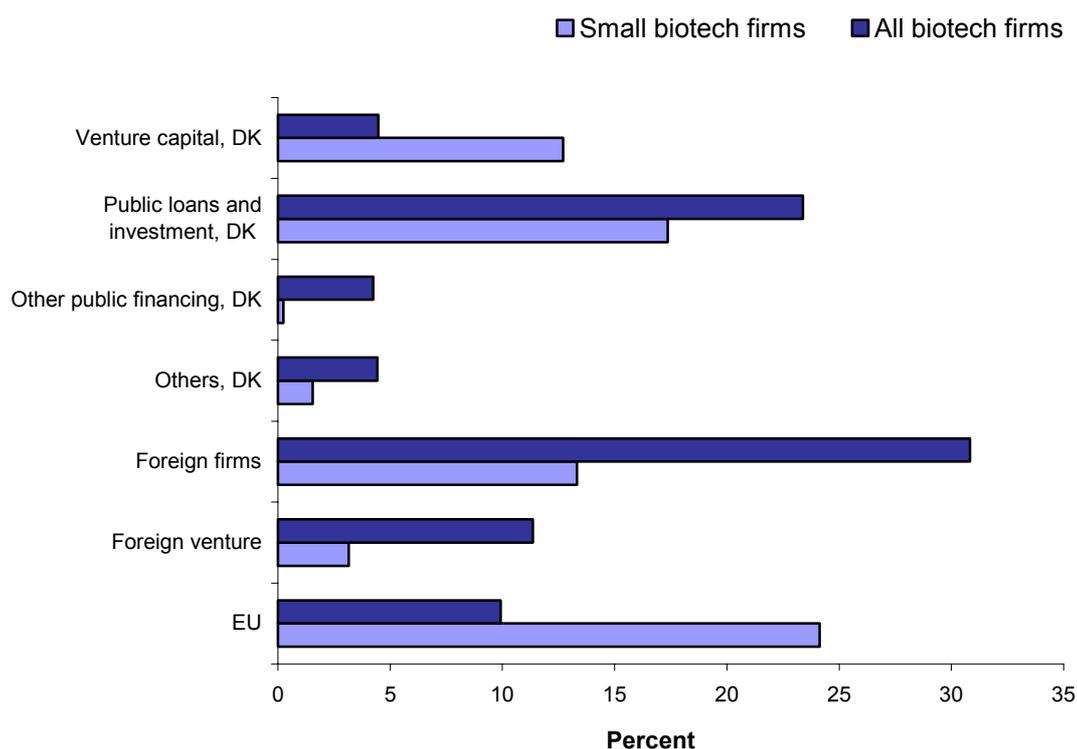
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<sup>25</sup> Note: this estimate is based on firms in the R&D sample only.

<sup>26</sup> In 2001, 51 percent of total private sector R&D was spent on wages and salaries. See Danish Institute for Studies in Research and Research Policy (2003a).

heavily on Danish venture capital funding for external financing, and also on funding from the EU. The smaller share of external financing from foreign private sources suggests that smaller biotech firms may have difficulties in attracting funds from international investors.

**Figure 4.3 External financing of R&D by source, 2001**

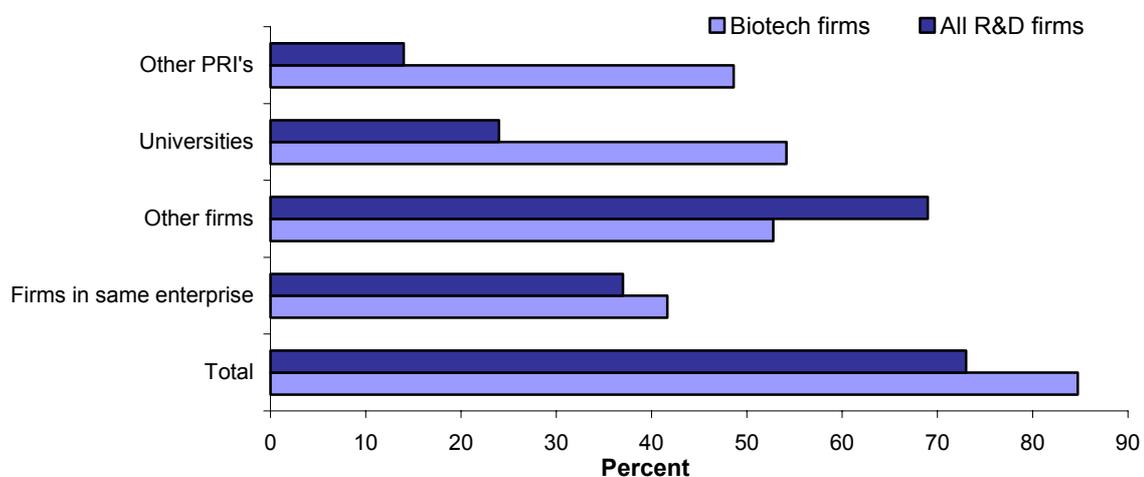


### Cooperation

In the 2001 R&D survey, firms were asked about their cooperation with partners in Denmark, the EU and outside the EU. Of the 80 biotech firms in the R&D sample, 72 answered the question on cooperation<sup>27</sup>. About 85 percent of these firms answered that they were actively involved in some form of cooperation with another firm or organization. Figure 4.4 shows the percentage of firms (among those that answered the cooperation question) that had cooperation by type of partner, both for cooperation within Denmark and internationally.

<sup>27</sup> We have not attempted to make estimates for firms that did not respond to the question on cooperation. It may be considered probable, though, that they had less cooperation than the firms that answered, which would imply that the percentages may be slightly lower for all 80 firms.

**Figure 4.4 Cooperation by type of partner**



Source: Danish Institute for Studies in Research and Research Policy (2003a) and own calculations.

For comparison, aggregate averages for the R&D survey are also included<sup>28</sup>. While a large percentage of biotech firms also collaborate with other enterprises, most notable from Figure 4.4 is the high degree of cooperation among biotech firms with universities and other public research institutions.

<sup>28</sup> To the extent that biotech firms that did not answer the question on cooperation were less likely to have cooperation, percentages for biotech firms may be slightly overstated in relation to aggregate values. Though, this does not affect the qualitative results on cooperation discussed above.

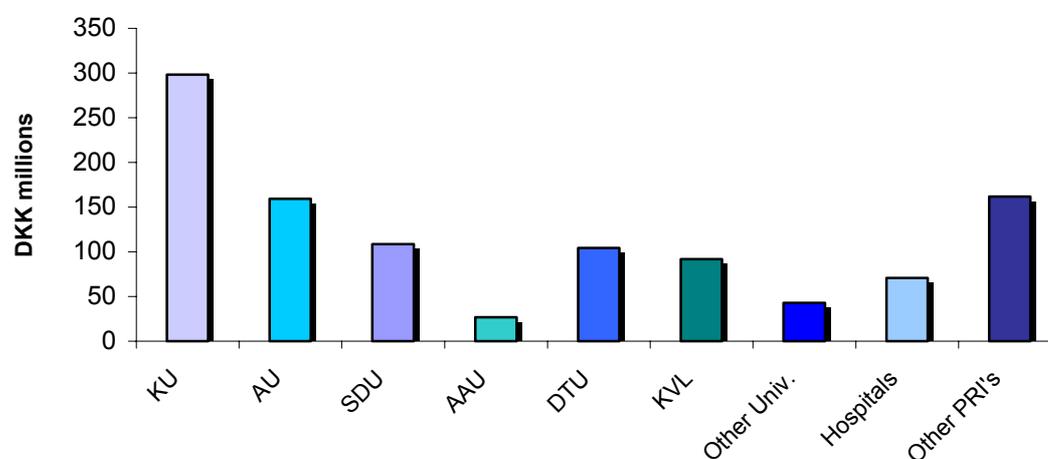
## Chapter 5. Public sector biotech R&D

In 2002, biotech R&D in the public sector amounted to DKK 1.06 billion (€ 143 million). In all 122 units<sup>29</sup>, covering a broad range of areas, reported R&D in biotechnology<sup>30</sup>. About 66 percent of this research is conducted in the Greater Copenhagen area, with the remaining 34 percent concentrated in universities and hospitals in Aarhus, Odense and Aalborg.

### Institutions

Figure 5.1 shows the distribution of public sector biotech R&D among universities, hospitals and other research institutions. The majority of public biotech R&D is conducted at six universities, three of which<sup>31</sup> are located in Greater Copenhagen.

**Figure 5.1 Public biotech R&D expenditures by sector and university, 2002**



KU = University of Copenhagen; AU = University of Aarhus; SDU = University of Southern Denmark; AAU = Aalborg University; DTU = Technical University of Denmark; KVL = Royal Veterinary and Agricultural University. Note: 1€ = 7.4 DKK.

<sup>29</sup> Units are the smallest administrative units in public research institutions, for example a department or center at a university or hospital. See Danish Institute for Studies in Research and Research Policy (2003c).

<sup>30</sup> In addition to those that reported biotechnology research, 9 of the 122 units were estimated to conduct R&D in biotechnology based on responses in earlier years. See the Annex for more details.

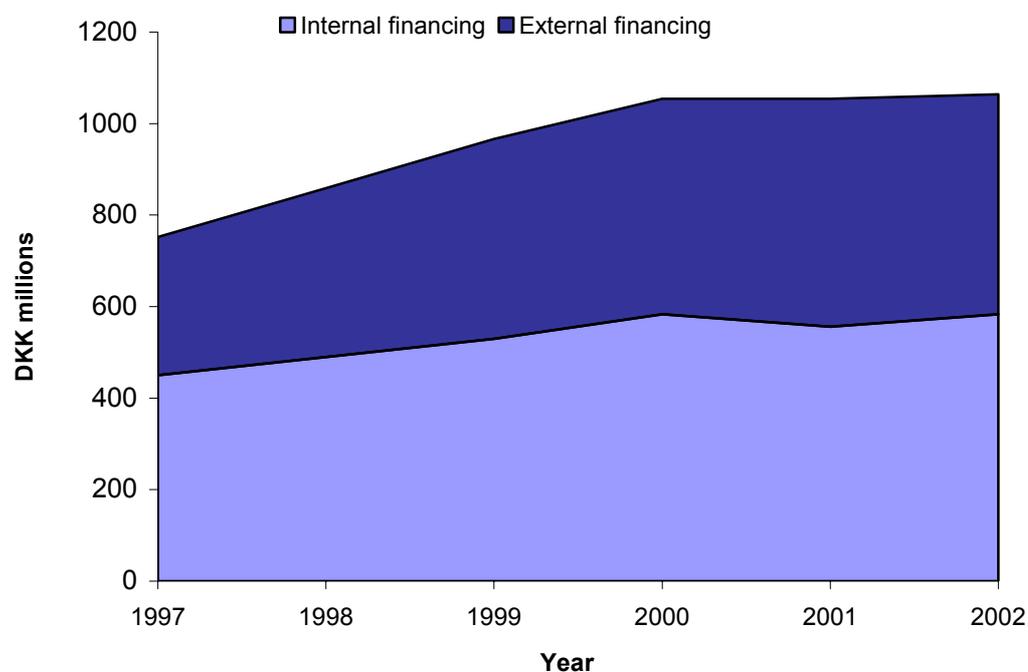
<sup>31</sup> University of Copenhagen, Technical University of Denmark, Royal Veterinary and Agricultural University.

Among public institutions, the largest share of biotech R&D is conducted at the University of Copenhagen, followed by the University of Aarhus and the University of Southern Denmark. In all, over 78 percent of biotech R&D in the public sector was conducted at universities, 7 percent in hospitals, and the remaining 15 percent in other research institutions and non-profit organizations.

### Sources of finance for biotech R&D in the public sector

Figure 5.2 shows the development over time of the financing of public biotech R&D. It indicates that public research institutions have increasingly sought external funds, i.e. financing not part of the institution's regular budget, to finance their research in biotechnology. This trend is also present for public sector research and development as a whole<sup>32</sup>. The share of biotech R&D financed outside of regular budgets has increased from 40 percent in 1997 to 45 percent in 2002. Though, both the amount of external funding and total biotech R&D in the public sector have remained more or less constant for 2000-2002.

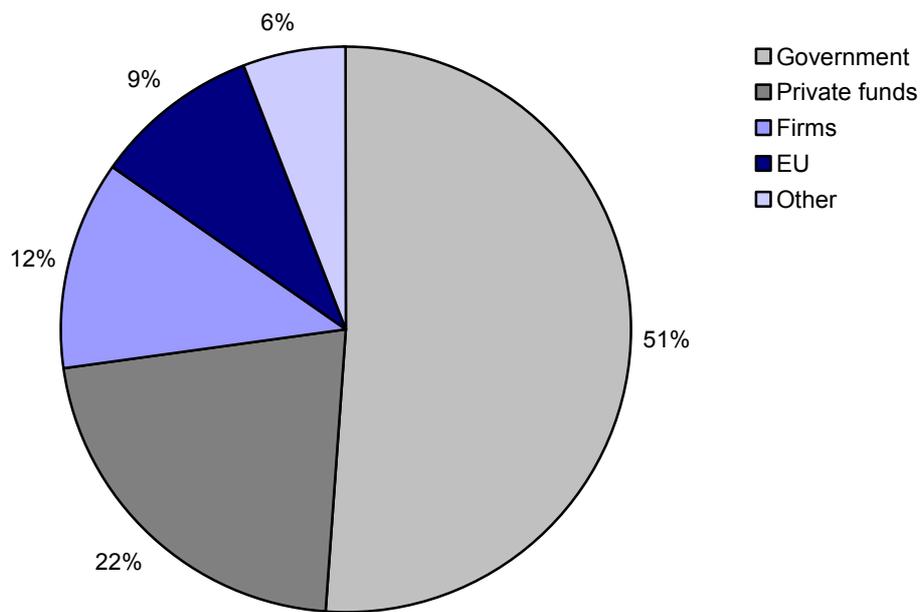
**Figure 5.2 Internal and external financing of public biotech R&D**



<sup>32</sup> See Danish Institute for Studies in Research and Research Policy (2003c).

Figure 5.3 shows the distribution of the external financing of public biotech R&D by source. The majority of external funding (51 percent) comes from the government, 22 percent stems from funds and organizations in Denmark, and 9 percent from the EU.

**Figure 5.3 Sources of external financing:  
public biotech R&D, 2002**



## **Chapter 6. Concluding remarks**

This report has made a preliminary examination of the biotechnology sector in Denmark, based on data from Danish R&D surveys and a compiled list of biotech firms in Denmark. Here we can summarize some of the main findings.

Denmark has experienced strong growth in the number of biotech firms in recent years, with total core biotechnology firms numbering 181 in 2003. The large majority of these firms are small in size, with 124 having less than ten employees.

A major part of biotech activity in Denmark is conducted in larger firms that also have activities outside of biotechnology. This group includes pharmaceutical companies located in Denmark, along with a number of other large firms. While we do not have detailed information on sales and income for these firms, it seems likely that a major share of the contribution of biotechnology to economic activity in Denmark comes from these firms. In addition, biotechnology research conducted by these firms and in universities provides a strong base for the development of smaller biotech firms.

The center of biotech activity in Denmark is in Greater Copenhagen, which forms part of the Medicon Valley region. In addition, smaller biotech clusters have emerged around universities in the cities of Aarhus and Odense, and to a smaller extent, in Aalborg.

Intramural biotech R&D in Denmark has increased at an average annual rate of 12.4 percent over 1997 – 2001, which is much in line with growth rates for total R&D. Increases in extramural biotech R&D have been much more dramatic, indicating increased activity in trade and contracting of biotech R&D.

Data on the R&D activities of biotechnology firms indicates, among other things, substantial involvement of small and medium sized biotech firms (less than 50 employees) with public research institutions (PRI). Both compared to larger firms involved in biotechnology and to aggregate averages, these firms obtain a large share of their extramural R&D from universities and other public research institutions and have a higher degree of involvement in collaborative projects with PRI's.

## **Annex. Calculating biotech R&D for firms and public research institutions**

In Danish R&D surveys, firms are asked to estimate what percentage of R&D expenditures within a number of research areas, among them biotechnology. We estimate biotech R&D for each firm as this biotech percentage times the firm's total R&D. In order to make the set of firms covered here as comprehensive as possible, we utilize the following conventions.

- For firms that did not answer the research area question in a given year, but reported biotech R&D in at least two out of the five surveys over 1995-2001 (1995, 1997, 1998, 1999 and 2001), biotech percentages were estimated based on data from other years. Estimates were made in the same way for public research institutions active within biotechnology (for the public sector: 1997, 1999, 2000, 2001, 2002).
- Sampling procedures imply that small and medium sized firms may not be included in the survey sample each period. If biotech firms were not included in a given year, then data was estimated based on data from the previous period.
- We have also identified (based on other sources: firm websites, biotech organizations, etc.) a number of core biotech firms in the R&D sample that have not answered the 'focus area' question (or have responded, for example, that research was within the area of health, as opposed to biotechnology). These firms were included in the biotech R&D sample and biotech percentages were estimated to be 100%.
- Finally, we have examined annual reports for all core biotech firms with ten or more employees. For those firms that report R&D expenditures in their annual reports, these R&D figures were used, and

shares of total R&D that were intramural and extramural (which includes intramural R&D conducted outside Denmark) were estimated based on similar biotech firms in the R&D sample.

This approach allows us to form a rough estimate of biotech R&D in Denmark. Based on the information at our disposal, we believe this estimate both to be a reasonable and helpful measure of biotechnological activity in Denmark.

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