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Biotechnology R&D in Switzerland

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Section Economic Structures and Cycle

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1 Introduction

1.1 Scope of the analysis of biotechnology

As noted by the Forward Planning Staff of the Swiss Federal Administration in its report "Challenges 2007-2011" (p.103) modern biotechnology is now at the forefront of the international scientific, social and political scenes. Moreover, biotechnology is an innovative area of research and development (R&D), and it holds an important position in Switzerland. Information generated by R&D in general, and by biotechnology in particular brings knowledge, innovation and growth into new areas such as human and animal health, the agro-food industry and the environment business. Swiss industry is expanding in this innovative niche. Other R&D activities are taking part in this boom, but the subject of this study is private enterprises in Switzerland.

This field of activity is particularly important, and the Swiss Federal Statistical Office (FSO) wishes to contribute to studies carried out in this area, by exploiting the available official statistics to a maximum. Therefore the main objective of this publication is to present the profile and strategy of enterprises active in biotechnology R&D in Switzerland. This report attaches particular importance to enterprises that work only in this area. To do this, the results of the 2004 R&D survey (economiesuisse / FSO, 2006) conducted by the FSO among private companies are analysed thoroughly.

1.2 Statistical framework and methods for biotechnology

The results of this publication are set in a particularly dynamic international context. Indeed the Organization for Economic Cooperation and Development (OECD) recently developed a statistical framework to give guidance on assessing R&D and the production of goods and services in the area of biotechnology (OECD, 2005). Moreover, on an experimental basis, the OECD, with a few member countries is currently defining a method to identify characteristics of enterprises active in biotechnology, and their contribution to economic development. The present publication is largely based on this conceptual framework, so the results for Switzerland can be compared with those of other countries.

1.3 Field of biotechnology under six headings

This publication describes the field of biotechnology in private enterprises under the following six headings. Heading 2 presents the organisational set-up and the types of enterprise working in industrial biotechnology. Heading 3 gives a formal definition of biotechnology, and distinguishes between the different areas in which biotechnology is applied. The position that biotechnology occupies in Switzerland is analysed under heading 4, using various parameters, with these results set in an international perspective under heading 5. Heading 6 concentrates on the main characteristics of the enterprises specialised in biotechnology R&D in Switzerland; it presents the typical profile and the research strategy of these enterprises. Finally heading 7 summarises the main elements identified under the previous headings, and sets them in a longer-term context.

2 Organisation of biotechnology

2.1 Areas of activity in biotechnology

Preventing new diseases, improving the resistance of plants to harmful organisms, optimising the detection of diseases, treating human infertility, combating pollution, etc. are all areas that have developed as a result of new knowledge, recently-developed methods and new biotechnology products. Current discoveries in the area of life-sciences arise from innovations that contribute to transforming the economy and society.

Box I: Definition (OECD, 2005)

Biotechnology

To define biotechnology, the OECD uses both a single definition and also a list-based definition of biotechnology techniques.

The provisional single definition of biotechnology recommended by the OECD (2005) is deliberately broad. It covers all modern biotechnology but also many traditional or borderline activities: "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."

2.2 Action plan of biotechnology enterprises

In order to create value added to their scientific research and innovation, and to benefit from synergies, enterprises and institutions in the area of biotechnology are usually concentrated in a trans-national geographical area. This strategy is based on the principles of complementarities, cooperation, similarities and competition. The close relationships between sectors and geographical proximity facilitate exchanges between enterprises. This type of organisation is known as a cluster (Avenir suisse, 2006 and ODEC 2003) and in the area of biotechnology this provides particularly interesting conditions for invention, innovation and reaping profits.

2.3 Dynamics of biotechnology clusters

Switzerland has four biotechnology clusters, which have developed in the trans-boundary regions of Basel (Bio Valley), Zurich (Mednet), the Lake Geneva area (Bio Alps) and the Ticino (Bio Polo). These four clusters alone account for nearly 80 percent of Swiss biotechnology enterprises and for universities, research laboratories, non-profit institutions, venture capital companies and business angels. The clusters attract key knowledge, resources and highly competent people, reaching the critical mass necessary to encourage the creation of enterprises, to promote alliances and to develop networks of collaboration between the players in biotechnology.

2.4 Collaborative network of large groups

The major pharmaceutical groups occupy a specific position in R&D and in biotechnological innovation. They are increasingly driven to outsource part of their biotechnology work to young technology enterprises. In these companies most of the work is involved in innovative projects, exploiting the results of R&D and setting up innovations in the area of biotechnology.

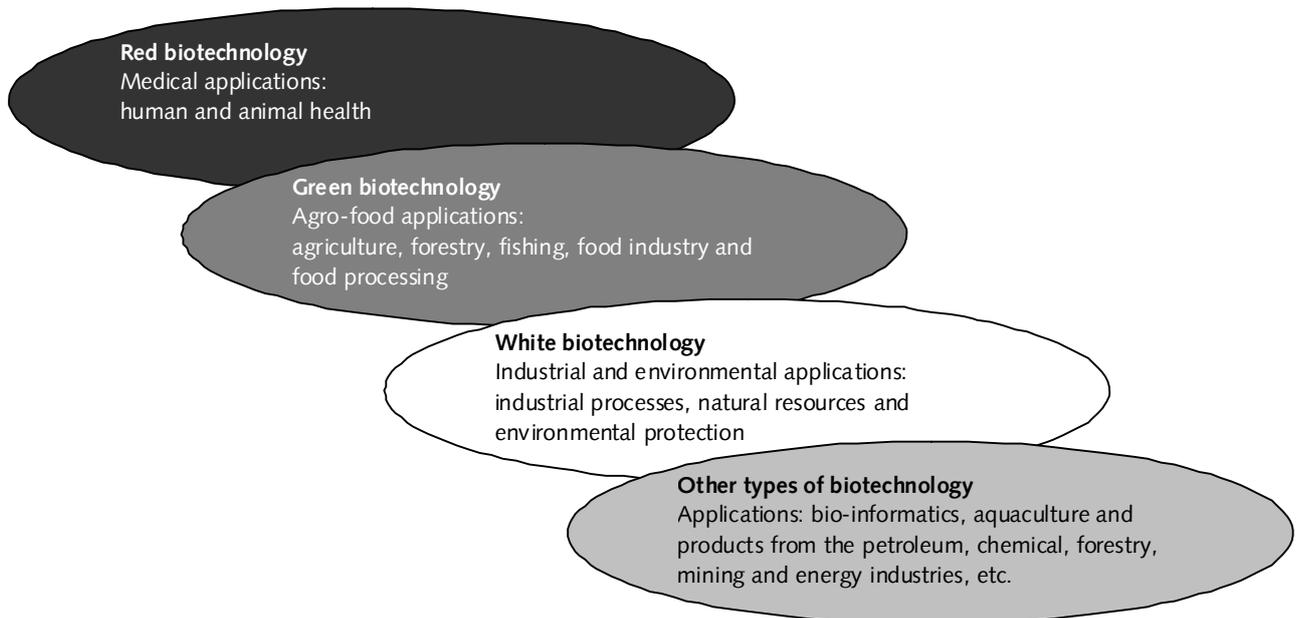
3 Types of enterprise in the industrial biotechnology sector

The industrial biotechnology sector consists of all enterprises active in biotechnology. The OECD (2005) defines an “enterprise active in biotechnology” as a firm that carries out key activities in the field of biotechnology, for instance applying of at least one biotechnology technique in the production of goods or services and /or carrying out R&D activities in biotechnology. The OECD (2005) distinguishes between enterprises active in different areas of biotechnology, here described as red, green, white and other types (see G1).

The areas of application of biotechnology correspond to groupings of industries.

An enterprise will be classified in the category of red, green, white or other types of biotechnology according to the industry in which it is involved¹ (OECD, 2006).

G1 Biotechnology applications



Source: OECD, Biotechnology Statistics

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¹ This delimitation of areas of application of biotechnology based on industries underestimates in particular enterprises active in red biotechnology because many companies active in the field of health are classified in the R&D industry and are therefore allocated to “other types of biotechnology”.

4 Situation of biotechnology in national R&D

4.1 Enterprises active in biotechnology R&D

Among enterprises active in R&D in Switzerland, some dedicate part or all of their efforts to R&D in biotechnology. In its 2004 R&D survey of the business enterprise sector, the FSO found 1 791 enterprises active in R&D, of which 156² were carrying out R&D work in biotechnology (enterprises active in biotechnology R&D).

Among the 156 enterprises involved in biotechnology R&D more than half are devoted exclusively to biotechnology R&D (86 enterprises specialising in biotechnology R&D i.e. ESBs), the others only devote part of their R&D effort to biotechnology (70 enterprises partially active in biotechnology R&D). 1 390 enterprises do not carry out any biotechnology R&D (enterprises not active in biotechnology R&D i.e. ENBs). However, the possibility cannot be excluded that some of these enterprises are in fact active in biotechnology, due maybe to biotechnological production or to sub-contracting in this area.

We have no precise information on the type of research carried out by the remaining 245 enterprises (see G2).

Box II: Definitions (OECD, 2002)

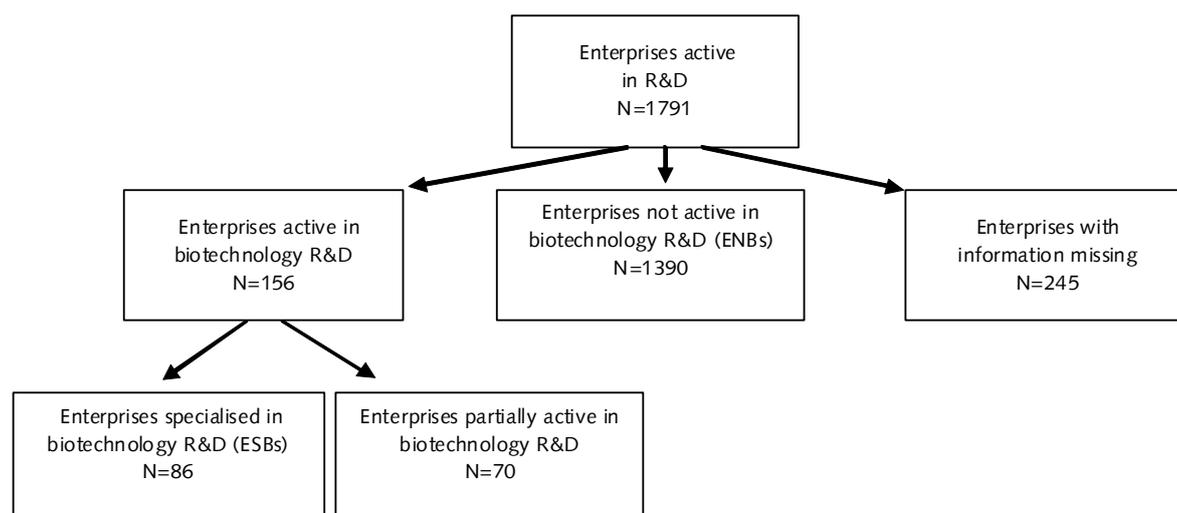
Research and experimental development (R&D)

Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.

Intramural R&D

Intramural R&D refers to all R&D activities carried out by the company (including its workplaces and subsidiaries) on its own premises (laboratories) in Switzerland, irrespective of how this R&D was funded.

G2 Enterprises active in biotechnology R&D in Switzerland, 2004



Source: economieuisse / FSO

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² This number can change depending on extrapolation methods.

Box II (continued):**Extramural R&D**

Extramural R&D includes all R&D activities that the company has outsourced to third parties (external research units) in Switzerland or abroad. Therefore, total company expenditure for extramural R&D is equal to the sum of all contracts and contributions given to third parties. The acquisition of know-how is regarded as R&D conducted outside the enterprise.

Biotechnology R&D

According to the definitions of biotechnology given in box I, biotechnology R&D is on biotechnological techniques, products and processes.

Basic research

Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.

Applied research

Applied research is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.

4.2 Resources in biotechnology R&D

In 2004, private enterprises in Switzerland spent a total of 9 659 million Swiss francs on intramural R&D (see box II, pages 8 and 9) and for this purpose they employed 37 819 people. The 156 enterprises active in biotechnology R&D injected 5 147 million Swiss francs into their intramural R&D, of which 830 million Swiss francs was for their biotechnology R&D only. The R&D personnel of these companies consisted of 12 970 people (see T1) (economiesuisse / FSO, 2006).

T1 Personnel and intramural expenditure for biotechnology R&D, 2004

In headcounts and in million Swiss francs

	R&D personnel	Researchers	Intramural expenditure on R&D	Intramural expenditure on biotechnology R&D
Business enterprise sector	37 819	13 965	9 659	830
Enterprises active in biotechnology R&D (N = 156)	12 970	5 691	5 147	830
Enterprises specialised in biotechnology R&D (N = 86)	1 463	581	255	255
Enterprises partially active in biotechnology R&D (N = 70)	11 507	5 110	4 893	575

Source: economiesuisse / FSO

4.3 Structure of enterprises active in biotechnology R&D

The greatest proportion of expenditure on intramural R&D in biotechnology is concentrated in enterprises with 100 employees or more (651 million Swiss francs out of a total of 830 million Swiss francs, i.e. 78.4%).

Enterprises with 100 employees or more in the “pharmaceuticals” industry, and enterprises with fewer than 100 employees in the “research and development” industry are particularly active in this area (see G3), (economiesuisse / FSO, 2006).

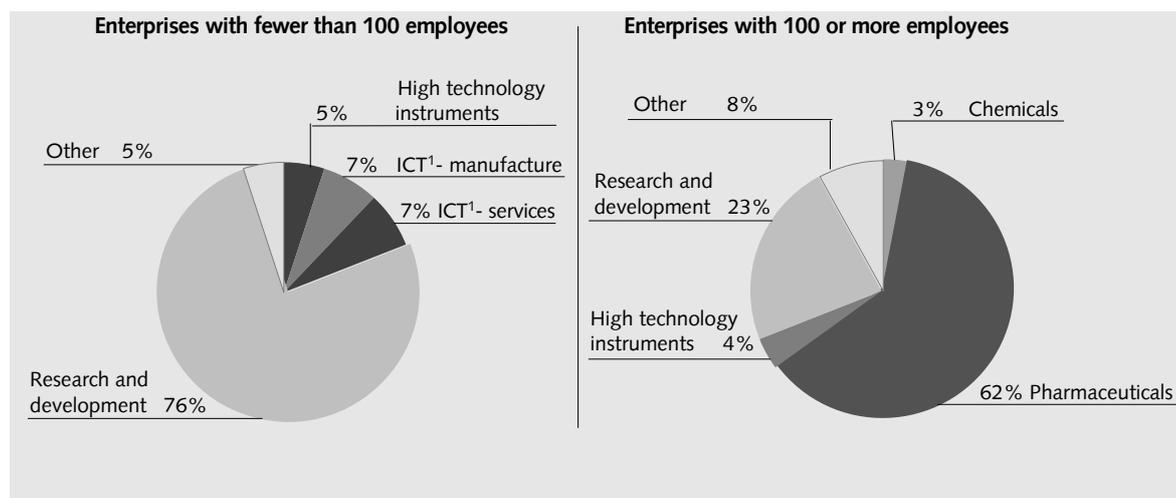
Box III: List of industries for the purposes of R&D statistics

(economiesuisse / FSO, 2006)

- 1 Food
- 2 Chemicals
- 3 Pharmaceuticals
- 4 Production of metals
- 5 Machines
- 6 High technology instruments
- 7 ICT - manufacture
- 8 ICT - services
- 9 Research and development

G3 Intramural expenditure on biotechnology R&D according to the industry and the size of the enterprise, 2004

In %, figures rounded



1 ICT: Information and communication technologies

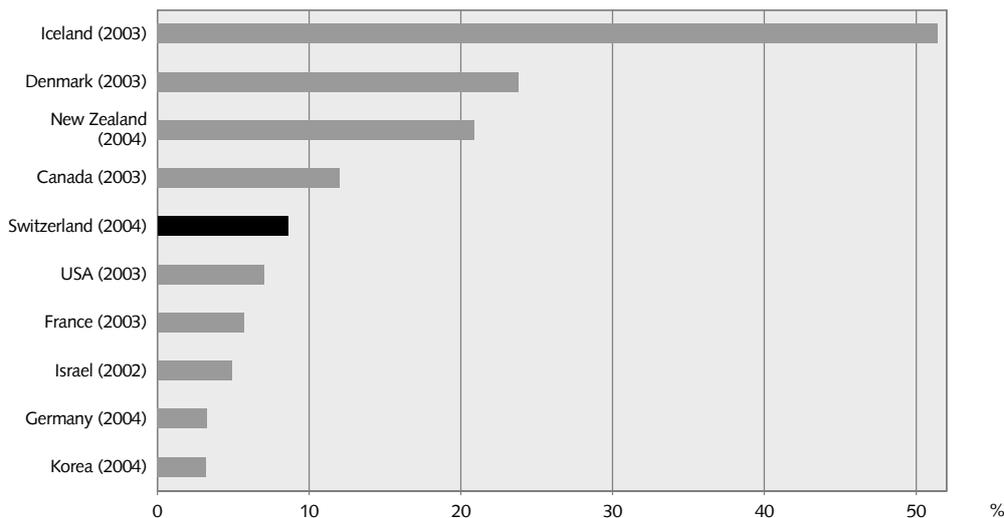
5 Swiss biotechnology R&D in the international context

The amount that private enterprises spend on biotechnology R&D (830 million Swiss francs or 469 million PPP \$³) means that within the OECD Switzerland is among the countries with the best resources for R&D, but in this classification Switzerland is well behind the United States (OECD, 2006). However, this classification is deceptive, as it does not take account of the sizes and structures of the different economies. In contrast, the comparison between expenditure in relative values gives a more relevant indication of the importance of biotechnology. The proportion dedicated to biotechnology in Switzerland represents 8.6% of all intramural spending on R&D by the private sector, placing Switzerland among the leading group of countries in the OECD: 5th behind Iceland, Denmark, New Zealand and Canada, but in front of the United States (see G4).

An analysis of the distribution of enterprises in red biotechnologies (medical applications), green biotechnologies (agro-food applications) and white biotechnologies (industrial and environmental applications) shows that Switzerland ranks among the OECD countries with the largest share of enterprises active in red biotechnology⁴.

G 4 Intramural expenditure on biotechnology R&D by the business enterprise sector, international comparison, 2004

In % of total intramural expenditure on R&D by the business enterprise sector



Source: OECD, Biotechnology Statistics

© Federal Statistical Office (FSO)

³ Purchasing power parities (PPPs) are conversion factors that allow comparisons to be made between different currencies.

⁴ A relatively high proportion of national firms could not be attributed to one of these three types of biotechnology (39% in the case of Switzerland).

Switzerland is among the countries less active in green biotechnology, as is also the case for Denmark, the United Kingdom and Sweden (see T2). As for white biotechnology, Switzerland is also among the countries with a low level of activity, together with Denmark, Norway and Canada (OECD, 2006).

T2 Enterprises active in biotechnology by area of application

In % of the total number of enterprises active in biotechnology

Country (year)	Medical applications (red biotechnology)	Agro-food applications (green biotechnology)	Industrial and environmental applications (white biotechnology)	Other applications
Germany (2004)	66	21	14	..
USA (2003)	65	12	12	11
China (2003)	63	17	15	4
Denmark (2003)	58	4	3	35
Canada (2003)	54	28	8	11
UK (2003)	53	8	10	30
Norway (2003)	53	19	3	25
Finland (2003)	52	18	25	5
Sweden (2003)	52	8	12	28
Israel (2002)	49	24	16	11
Switzerland (2004)	49	6	6	39
Australia (2003)	47	23	24	6
Ireland (2003)	46	10	17	27
France (2003)	41	17	..	41
Belgium (2003)	33	15	..	52

Source: OECD, Biotechnology Statistics

6 Enterprises in Switzerland specialised in biotechnology R&D

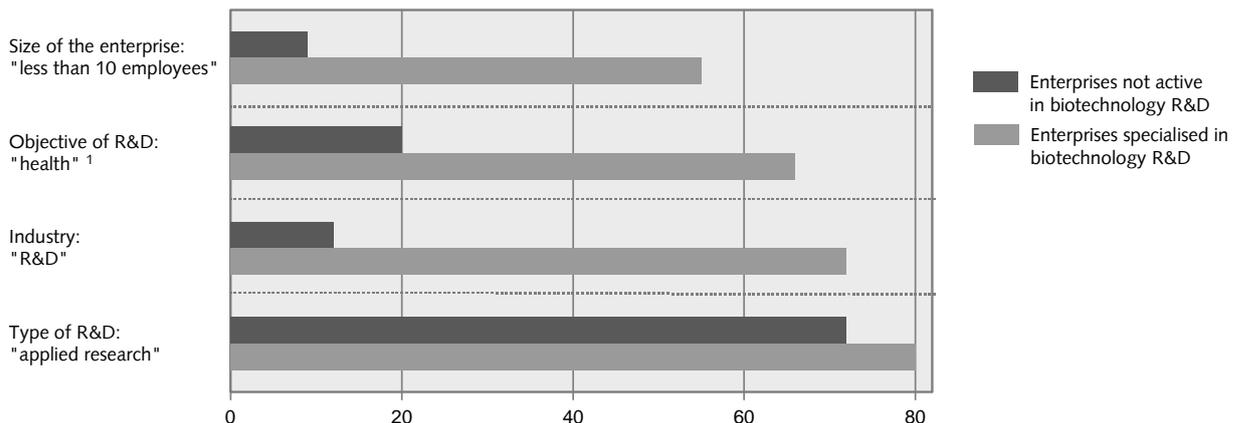
Enterprises specialised in biotechnology R&D (ESBs) are mostly young technology companies, stemming from institutions of higher education, and developing in science parks. These enterprises, which devote their entire research activities to biotechnology, are important participants in the development of this area. The FSO sought to describe these enterprises and to show their peculiarities, by means of specific analyses. The study is based on the assumption that these ESBs have a specific profile and a research strategy that differs from enterprises carrying out research in other areas.

Enterprises specialised in biotechnology R&D are not compared with all other enterprises in the biotechnology sector, but specifically with those that do not carry out R&D in biotechnology (ENBs).

ESBs are mostly small enterprises with fewer than 10 employees, while the group of ENBs mainly comprises enterprises with 100 employees or more. Thus, the results obtained in this study are inevitably affected by a size effect, the differences between the two groups being partly due to the disparity in size between the two groups of enterprises. However, this effect is not sufficient to wipe out the impact of other variables tested.

G5 Profile of enterprises specialised in biotechnology R&D (ESBs) and of enterprises not active in biotechnology R&D (ENBs) according to the size of the enterprise, the objective of R&D, the industry and the type of R&D, 2004

In % of the total number of ESBs or ENBs



¹ Objective of R&D "protection and improvement of human health"

From the analyses carried out⁵, it appears that the typical profile of enterprises is determined by four variables: industry, size, type of R&D and objective of the R&D (see box IV). The typical research strategy can be defined using variables pooled into three categories: collaboration, the financing of R&D and the recruitment of R&D personnel.

Box IV: Objectives of R&D
(economiesuisse /OFS, 2006)

- 1 Exploration and exploitation of the Earth
- 2 Infrastructure and general planning of land-use
- 3 Telecommunication systems
- 4 Control of environmental pollution
- 5 Protection and improvement of human health
- 6 Production, distribution and rational utilisation of energy
- 7 Agricultural production and technology
- 8 Industrial production and technology
- 9 Electronics and related industries
- 10 Chemical industry products
- 11 Vehicle manufacturing
- 12 Social structures and relationships
- 13 Exploration and exploitation of space
- 14 Non-oriented research (general promotion of knowledge)
- 15 National defence, armaments
- 16 Research not allocated specifically to 1-15

6.1 Profile of enterprises specialised in biotechnology R&D

As shown in graph G5, 72% of the enterprises specialised in biotechnology R&D (ESBs) are concentrated in the "research and development" industry; so they stand out clearly from companies not active in biotechnology R&D (ENBs), which comprise only 12% of enterprises in this industry. The remaining 28% of ESBs are spread mainly between the "chemicals", "pharmaceuticals", "high technology instruments" and "ICT (manufacture and services)" industries (see box III).

While the majority of ESBs (55%) are enterprises with fewer than 10 employees, only 9% of ENBs have fewer than 10 employees.

Although the expenditure of ESBs on intramural R&D reach 255 million Swiss francs, in absolute terms this figure is low compared with that for ENBs (3 916 million Swiss francs). In contrast, in relative terms, (average expenditure per enterprise), the gap between the two groups is virtually zero (nearly 3 million Swiss francs in both groups).

As regards their type of research and their R&D objective, ESBs stand out from ENBs (see box IV). Proportionally more ESBs conduct applied research (80% for ESBs compared with 72% for ENBs). In contrast, as far as average expenditure per enterprise is concerned, ESBs spend 2.5 times more on basic research (see box II). ESBs are specialised in red biotechnology: 66% of them carry out work with the object of "protection and improvement of human health", compared with only 20% of ENBs. R&D in the area of health uses 87% of the total expenditure of ESBs on R&D, compared with 7% of the R&D expenditure of ENBs.

In contrast, proportionally more ENBs are carrying out research for the objective of "industrial production and technology" (59% of ENBs; 23% of ESBs). In addition, the share of R&D expenditure aimed at this objective is greater for the group of ENBs (36%) than for the group of ESBs (4%). The other research objectives (see box IV) only represent a tiny part of the R&D expenditure of ESBs (see G5).

The differences between ESBs and ENBs in terms of the type of research and the objective of R&D may have many causes. One reason could be that the ESBs benefit from their small size to innovate and invent products that are bought by ENBs, which then sell them, after having developed new industrial technologies. This argument favours the hypothesis that there is a sequential distribution of tasks between different players in the field of biotechnology. However, this is only one possible cause amongst others. The statistical material available does not allow one to decide, so these differences in behaviour cannot be explored further for the present.

⁵ Detailed data pertaining to these analyses are available on request.

6.2 Research strategy of enterprises specialised in biotechnology R&D

The variables analysed in section 6.1 (industry, size, type of R&D and objective of R&D) have allowed the main characteristics of enterprises specialised in biotechnology R&D (ESBs) to be presented from a structural point of view. However, the dynamic characteristic of these enterprises is not evident in this profile. To describe the behaviour of enterprises, other variables from the R&D survey of private enterprises are used (extramural spending, financing of intramural spending and R&D personnel). The results of these analyses, presented in this section, show the specific behaviour and the particular R&D strategies of enterprises specialised in biotechnology R&D.

6.2.1 Collaboration

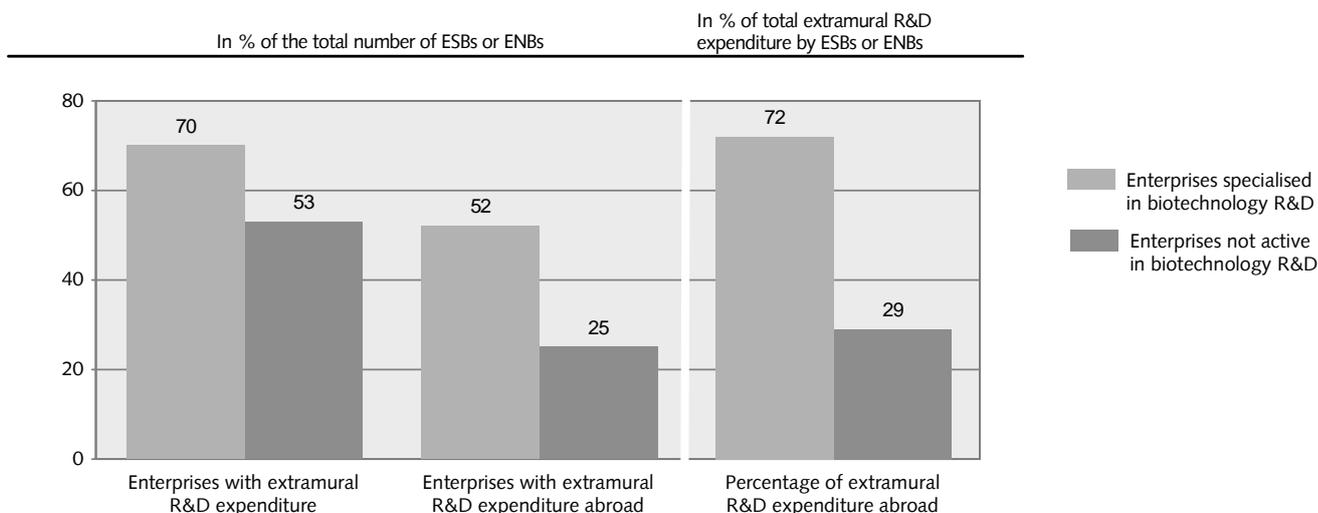
To identify research collaborations that enterprises specialised in biotechnology R&D have with other enterprises or other organisations involved in R&D we analyse their spending on extramural R&D. This is the amount that an enterprise pays other enterprises or organisations (universities, laboratories, research centres etc.) to carry out R&D work. This extramural expenditure includes purchase of R&D performed by other enterprises or organisations as well as financial support for carrying out this R&D work. Spending on extramural R&D reveals

a more or less intense form of collaboration between enterprises or between enterprises and other partners. In fact, enterprises that wish to buy R&D work or to have it done according to their needs have to get in contact with the firms and organisations, which could carry it out or sell it to them. In that case, a form of collaboration is set up between these institutions.

Spending on extramural R&D has been developing rapidly over the last few years, reflecting the growing need for collaboration between the different players in biotechnology (enterprises, institutions of higher education, private non-profit institutions, etc.). In 2004, the priorities of enterprises were in general contracts with and contributions to other private enterprises in Switzerland but also, increasingly often, to institutions abroad. This way of externalising R&D is necessary to obtain access to new knowledge in technological fields such as biotechnology, which are developing very rapidly abroad.

This strategy of openness applies in particular among enterprises specialised in biotechnology R&D (ESBs). These enterprises are more open to the outside than are those not active in biotechnology R&D (ENBs). 70% of ESBs have expenditure for extramural R&D, whereas the figure for ENBs is only 53%. In addition, the strategy of ESBs is oriented towards international collaborations.

G6 Extramural R&D expenditure by enterprises specialised in biotechnology R&D (ESBs) and enterprises not active in biotechnology R&D (ENBs), 2004



Source: economiestat / FSO

© Federal Statistical Office (FSO)

More than half (52%) of ESBs have developed collaborations (contracts) with organisations in other countries. On average ESBs spend 1.04 million Swiss francs per company on extramural R&D in other countries, whereas ENBs spend an average of 131 thousand Swiss francs in contracts and contributions for R&D in other countries. For ESBs, contracts in other countries account for 72% of their total expenditure on extramural R&D, whereas for ENBs, the figure is only 29% (see G6).

6.2.2 Financing R&D activities

In general, enterprises draw on their own funds to cover their R&D expenditure. The most common way is through self-financing, which represented 89% of the financing of R&D in the sector of private enterprises in Switzerland in 2004. Enterprises specialised in biotechnology R&D (ESBs) use self-financing for a little more than 80% of their spending on R&D. This figure is not significantly different from that for enterprises not active in biotechnology R&D (ENBs).

However, the sources of external financing differ from one group to the other. For ENBs, the part of the expenditure on R&D that is not financed by the ENB itself is mainly provided by other enterprises and, to a lesser extent, by other sources (institutions of higher education, research laboratories or centres, private non-profit institutions, public authorities, etc.). In contrast, ESBs

benefit more from financing by private non-profit institutions and in particular from public-sector funding. State centres of technology transfer, such as the Commission for Technology and Innovation (CTI) are the main providers of external funding for ESBs. The political will to develop this advanced sector is apparent in this specificity of financing ESBs by the public sector.

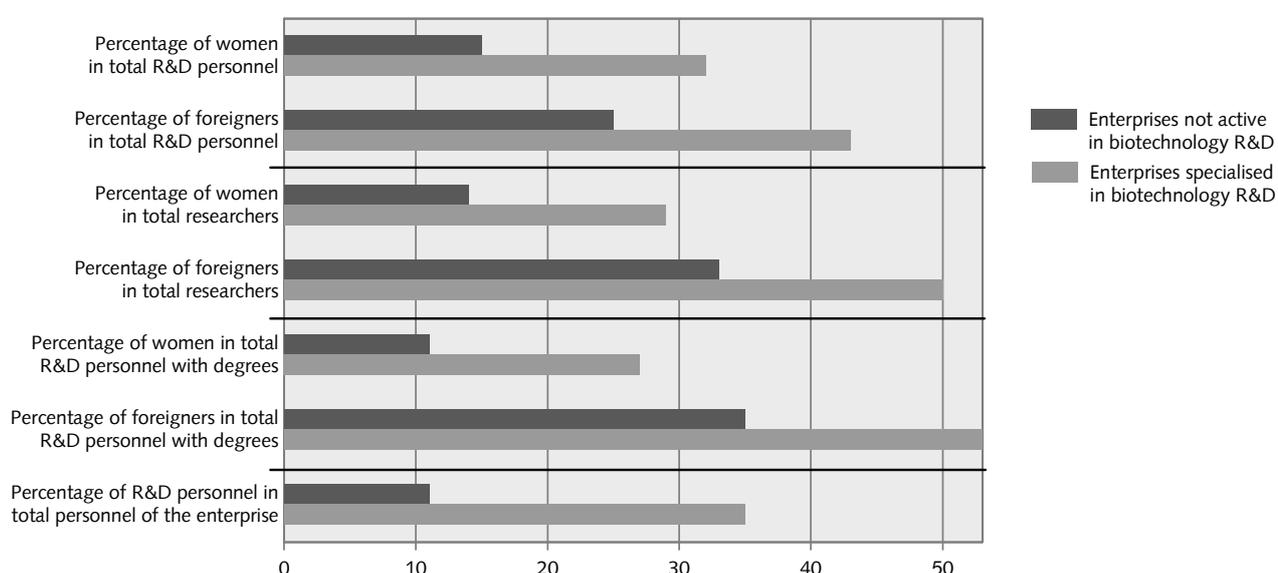
6.2.3 Recruitment of R&D personnel

As regards the recruitment of staff by private enterprises in Switzerland, R&D in general is still a privileged area for men: in 2004, women accounted for only 23% of all R&D personnel and 21% of all researchers. Moreover, the R&D personnel of the enterprises in Switzerland comprises 32% of foreigners and 40% of researchers are foreign.

The strategy of enterprises specialised in biotechnology R&D (ESBs) is particularly open as regards the employment of R&D personnel, women, foreigners and well-qualified personnel. In ESBs the proportion of R&D personnel among the total number of employees is three times greater than in enterprises not active in biotechnology (ENBs) (35% and 11% respectively). The proportion of female R&D personnel is higher in ESBs (32% compared with 15%) and the proportion of foreigners is even greater (43% compared with 25%).

G7 Personnel of enterprises specialised in biotechnology R&D (ESBs) and of enterprises not active in biotechnology R&D (ENBs), 2004

Percentages



Lastly, the majority (83%) of ESBs employ researchers, while only 55% of ENBs have researchers among their staff. The proportion of women among these researchers is twice as great in ESBs (29% compared with 14%). In ESBs 50% of researchers are foreign, whereas in ENBs the figure is 33%.

Almost all ESBs (95%) employ R&D personnel with a further education qualification. For ENBs the figure is 77%.

In ESBs, the proportion of female R&D personnel with a further education qualification is greater than in ENBs (27% compared with 11%). The proportion of foreign R&D personnel with a further education qualification is also higher in ESBs than in ENBs (53% and 35% respectively) (see G7).

These characteristics of the composition of the personnel in enterprises specialised in biotechnology R&D reflect the particular structure of these enterprises, which are often still close to the realm of institutions of higher education. As seen earlier, ESBs are generally small enterprises in the R&D industry, which spend most of their time on research. Since they are usually hardly active in production and sales, they have little administrative staff. As a result, they have a greater density of researchers than other enterprises, where the diversity of activities requires much more administrative staff. The greater presence of women and the high proportion of well-trained personnel are also linked to the structure and obvious "scientific" character of the activities of ESBs. Similarly, the relatively small proportion of research with the objective of "industrial production and technology" suggests that production in the narrow sense is of lesser importance, and hence the structure is marked by a high level of further education among the staff. However, as things stand, it is impossible to be clearer about the particular behaviour of ESBs, because the R&D survey does not have a specific section concerning this area. A module complementary to the survey, covering these specific elements, would certainly make an important additional contribution to this analysis.

7 Summary and conclusions

This publication has highlighted different levels of analysis of biotechnology R&D. As stated in the introduction, these analyses are based on the results of the 2004 R&D survey of private enterprises. Such surveys have been carried out every four years since the reference year (1996). However, data on biotechnology R&D were recorded only in the 2000 and 2004 surveys.

Switzerland derives great benefit nationally from the dynamism of its four biotechnology clusters and from expenditure by large companies. Overall, Swiss enterprises tend to favour red biotechnology, in other words medical applications in the areas of human and animal health. This result can be explained mainly by the considerable expenditure on intramural R&D in biotechnology made by companies of 100 or more employees, providing opportunities in the area of pharmaceuticals. Enterprises with fewer than 100 employees, mainly concentrated in the “research and development” industry, also take part in the development of medical biotechnology, but their contribution is relatively not so great.

The analyses presented in this publication show that for enterprises specialised in biotechnology R&D a typical company is a small unit, with a significant proportion of its expenditure on R&D spent on basic research. The favourite area of research is medical biotechnology. Such enterprises depend on collaboration in R&D with other players in biotechnology, both to carry out their activities and to develop. Consequently, their expenditure on extramural R&D is relatively greater than that of other enterprises. Moreover, a typical enterprise is happy to award R&D contracts to research organisations in other countries.

Enterprises specialised in biotechnology R&D also stand out by the specificity of their external sources of funding. In particular they benefit more than other businesses from funding from the public sector and from private non-profit institutions. Finally, typical companies specialised in biotechnology R&D have relatively more, better-trained R&D personnel than other enterprises. They are also keener to employ women and foreigners for R&D work (especially as researchers).

Bibliography

Avenir Suisse (2006): Comtesse, Xavier and Van der Poel, Cédric, *Le feu au lac*, éd. du Tricorne, Genève.

Economiesuisse / OFS (2006): *La recherche et le développement dans l'économie privée en Suisse 2004*, Zürich / Neuchâtel.

Forward Planning Staff of the Federal Administration, *Challenges 2007–2011*, Report, 3 April 2007, Bern.

OECD (2002): *Frascati manual. Proposed standard practice for surveys on research and experimental development*, Paris.

OECD (2005): *A framework for biotechnology statistics*, Paris.

OECD (2006): Van Beuzekom, Brigitte and Arundel, Anthony, *Biotechnology statistics 2006*, Paris.

ODEC (2003): Ouimet, Mathieu, Amara, Nabil et Landry, Réjean, *Les « clusters » comme outil de développement régional - de l'idée aux outils d'intervention*, 3ème atelier annuel sur l'innovation, Observatoire de Développement économique Canada (ODEC), Montréal.

Abbreviations

CTI	Commission for technology and innovation
ENB	Enterprise not active in biotechnology R&D
ESB	Enterprise specialised in biotechnology R&D
FSO	Federal Statistical Office (OFS in French)
ICT	Information and communication technologies
ODEC	Observatoire de Développement économique Canada
OECD	Organisation for Economic Co-operation and Development
OFS	Office fédéral de la statistique (FSO in English)
PPP	Purchasing power parity
R&D	Research and experimental development

