Identifying the Fields for Mapping RTD Excellence in Life Sciences

First Approach

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Summary

In this study we identified the fields that play a crucial role in the leading-edge research within the life sciences. On the basis of considerations concerning impact and trends we propose the fields neuroscience, oncology, immunology, cell biology and genetics & heredity as 'candidate fields' for further mapping in order to identify centers of excellence within these fields.

At a lower aggregation level, we identified 'hot topic' research themes and topics. We propose to take these themes and topics into account as a special focus in the follow-up mapping studies of the above selected fields.

We also show first results on the role of countries, and in particular a number of EU member states, in the life sciences top-research.

Finally, we present preliminary results on the identification of centres of excellence, at the level of 'main organization' (mainly universities), particularly within the EU member states. We stress that this a first and preliminary bibliometric analysis, that ranking of excellence is a difficult problem due to the role of size and scale, and that therefore some of the indicators are still experimental.

1. Objective

This study concerns a pilot approach to 'screen' scientific areas in order to identify about 10 'hot' or 'emerging' fields, i.e., (new) fields of growing scientific as well as socio-economic importance.

This pilot approach will enable the Commission to select fields for a further procedure to map excellence in research and technological development. This study is designed to conduct the first task of a 'modulated indicators-based approach', i.e., a 'first-step' bibliometric analysis of 'hot fields' in the life sciences.

Mapping of excellence is one of the central objectives in the creation of the European Research Area strategy. In this study we focus on the life sciences.

2. General Considerations

Life sciences constitute a vast area within science as a whole. An indication of size: almost four hundred thousand publications per year. What are the emerging fields? If we identify 'emerging fields' on a relatively small scale (for instance: at the level of research 'themes'), the general reaction is that such a small-scale approach emphasizes over-specialization. Therefore, it will provide a representation of the

state-of-the-art of today. Tomorrow there might be other emerging themes. If we identify 'emerging fields' on a broader scale, we run the risk that the outcomes are too general, and present nothing new ('we already know').

We adopted the following strategy: 'emerging' are those fields / areas / themes in which *the best scientists* focus their research activities. Top-scientists do not *follow* important trends, they *create* trends. This means that identification of the centers of excellence is and remains the most crucial task (Van Raan 1999). This is particularly important as scientific breakthroughs are, be it in an unpredictable way (Airaghi *et al* 1999), the driving forces of socio-economic change en development.

3. Methodological Approach

3.1 General

Our approach is based on the following elements: (1) Definition of the life sciences; (2) Identification of excellent work.

We focus on scientific articles published in international journals covered by the Institute of Scientific Information's (ISI) citation indexes (CD-Rom versions of the Science Citation Index, SCI; Social Science Citation Index, SSCI; and Arts & Humanities Citation Index, AHCI) and all 'specialty' indexes such as Neurosciences, Biochemistry and Biotechnology, etc.).

For details of our methodology we refer to recent publications (Van Leeuwen *et al* 1996; Moed *et al* 1995; Van Raan 1996).

3.2 Definition of the life sciences

In order to define 'life sciences' we use a complete set of all fields of research that are generally considered as belonging to the biological and medical sciences, i.e.,

- Basic life science fields *(e.g., biochemistry, molecular biology)*
- Bio-medical fields *(e.g., immunology, virology, cell biology)*
- Clinical medicine fields *(e.g., cardio-vascular research, oncology, surgery)*
- Veterinary medicine
- Biology as a whole, and
- Application-oriented life science fields *(e.g., agriculture, food & nutrition)*

A field is a standardized set of journals (e.g., SCI 'journal category'), total amount of journals about 5,000. Again we refer for more details to recent publications (e.g., Van Raan 1996).

3.3 Identification of excellent work

In order to identify 'hot fields', and particularly the leading edge in these hot fields, it is important to focus on a *recent period of time*, thereby 'allowing' scientists to recognize important work and to let this important work 'take roots'. This means that this recent period should not be too 'short'. We take 1996-1999 as a suitable period.

All fields of science cover about 800,000 publications per year. The share of the Life Sciences is around 350,000 publications per year. This means that the top-10% (in terms of impact measured according to the methodology outlined in this report) of the published work within the Life Sciences covers about 35,000 publications per year.

The above means that our empirical material will consist of about 1,400,000 Life Sciences publications (four years in total, 1996-1999). It is clear that such a huge amount allows the discovery of *statistically significant* findings.

How is the top-10% core of Life Sciences determined? For the 4-year period 1996-1999 we calculated with newly developed advanced bibliometric algorithms for all 1,400,000 Life Sciences publications the *field-specific, normalized* impact ***CPPx/FCSmx***. We discuss this indicators in detail in the Appendix.

For all 1,400,000 publications the impact distribution function is calculated. Next, the top-10% of this distribution is determined. Thus, we identified the 140,000 publications with the highest impact.

4. Characteristics of Excellent Work in the Life Sciences

4.1 General

We can now analyze several important characteristics of these top-10% life sciences publications and answer the following 4 crucial questions:

1. *What fields are involved, i.e., the 'hot fields' in the Life Sciences?*

2. *What themes are involved?*

3. *What countries are involved?*

4. *What institutions are involved, i.e., what are the centers-of-excellence in the Life Sciences?*

4.2 Fields within the Top-10% of the Life Sciences

The central question of the Commission is: what scientific fields are involved in the Life Sciences top-10%? To answer this question we made a breakdown of all top-10% publications *into fields of research.*

Thus we detect all *fields that play a significant role in the top-work* of the life sciences. Next to the *breakdown* of the top-10% publications according to field, we calculated the average impact of these fields (as represented by their publications) and ranked these fields in size, i.e., the number of publications a field has in the top-10% of the life sciences.

This 'field-spectroscopy' of the life sciences top-10% yields results in the following figure (see next page, 'Research Profile, Output and Impact per Field of Life Sciences, 1996-1999, Top-10% most highly cited fields).

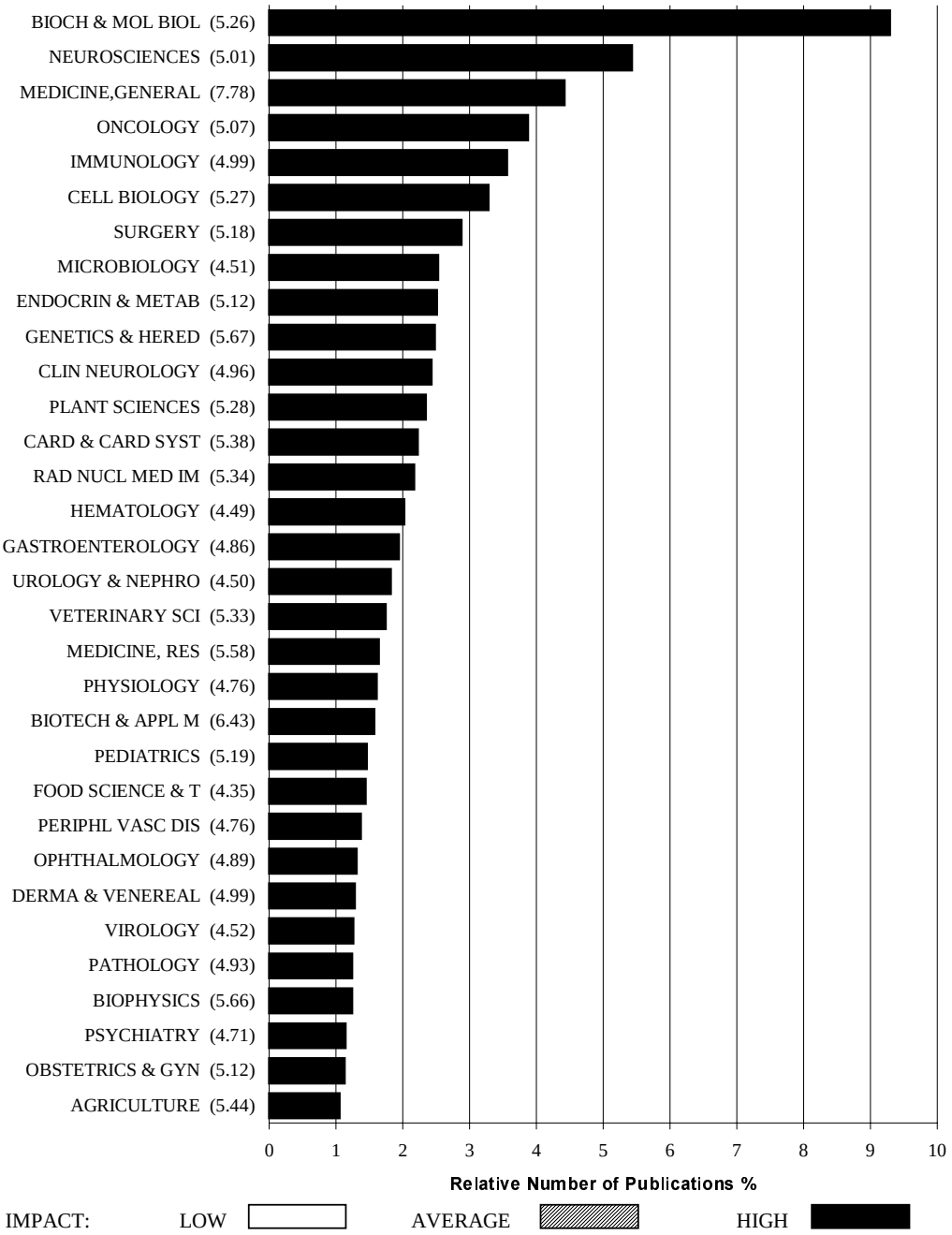
The length of the bars represents the share of publications within the life sciences top-10%; the 'color' of the bar represents impact level, but as we deal with the top-10% we only have 'high impact'. The numerical value of the measured impact (***CPPx/FCSmx***) is given in parentheses behind the name of each field. A detailed description[1] of the construction and the 'exegesis' of these research profiles are given in the Appendix.

Fields are included in the figure if they contribute more than 1% to the Life Sciences top-10% publications.

[1] In this analysis we focus on scientific publications published in international journals covered by the Institute of Scientific Information's (ISI) citation indexes: Science Citation Index (SCI), Social Science Citation Index (SSCI), Arts & Humanities Citation Index (AHCI) and all ISI 'specialty' indexes such as Biochemistry, Neurosciences, etc.

RESEARCH PROFILE
OUTPUT AND IMPACT PER FIELD
OF LIFE SCIENCES, 1996 - 1999

Top-10 % most-highly-cited fields



We immediately observe the dominating role of Biochemistry & Molecular Biology: the molecular base of the life sciences is without any doubt crucial to the further development of the life sciences. It is however a general and large field of science, and in the context of this study we therefore focus on the further 'dominating' fields.

Undoubtedly the strong interdisciplinary interaction between Biochemistry & Molecular Biology and these further 'dominating' fields should be a central element in further studies of excellence in the life sciences. We propose a bibliometric *mapping study* in order to identify these structural relations more precisely (Noyons and Van Raan 1998; Noyons *et al* 1999; Noyons 1999).

Not only the mere *ranking* of fields in the life sciences top-10% profile should be a criterion for selection of fields to be analysed in more detail, also the *dynamics* of fields is important. Therefore, we identified on the basis of a trend analysis of the top-10% publication numbers from 1996 to 1999, the fields with a strong increase (⇑, generally more than 10% increase in each two-years period, or a very strong increase (⇑⇑, more than 10% increase in each two-years period *and* in addition more than 30% increase in the last two years). The results are as follows:

- Immunology ⇑
- Endocrin. & Metabol. ⇑
- Hematology ⇑
- Virology ⇑⇑
- Biophysics ⇑
- Infectious Diseases ⇑⇑ (not included in the profile figure as this field contributes less than 1% to the Life Sciences top-10%)

We immediately see a particularly strong increase of activity in the infections-related medical research.

4.3 Themes and topics within the Top-10% of the Life Sciences

Next to the ranking and dynamics of *fields* within the life sciences top-10% it is important to focus also on an aggregation level lower than that of a field. Therefore we applied a computer-linguistic parsing algorithm (Noyons 1999) to the titles and the abstracts of all 140,000 top-10% publications. This enables us to find the keywords with the highest occurrence in the total set of top-10% publications. These keywords may represent research themes (such as a specific disease) or important but quite general topics (such as a specific virus or bacteria).

This is particularly important as the most topical research themes/topics are not necessarily part of the highest ranked or most 'dynamics' fields as identified in the above analyses. So the search for 'hot themes/topics' may provide additional information of the role of fields within the leading edge of the life sciences.

In addition we identified all the *citing* publications for each of the about 140,000 top-10% publications within the period 1996-1999 and carried out the same linguistic procedure as for the top-publications themselves.

This procedure allows us to determine the broader thematic scope 'around' the top-publications and, with that, linkages between the hot themes and further interdisciplinary linkages with these hot themes / topics (van Raan 2000).

Our keyword abstraction procedure of the Life Sciences top-10% publications *and* their citing publications combined with trend-analysis over the last four years, yields the following result (we list the themes ranked according to the number of publications involved; between parentheses we indicate in italics fields involved):

List of research themes/topics within the top-10% of the Life Sciences

1. Infarction *(cardio-vasc., hematol., clin.med.)*
2. Immunodeficiency *(mol.biol., virol., immunol., infectious dis., clin.med.)*
3. Saccharomyces *(mol.biol., cell biol., immunol., genetics)*
4. Caspases *(mol.biol., cell biol., immunol., oncol.)*
5. Interleukin *(mol.biol., virol., immunol., hematol.)*
6. Cerevisiae *(mol.biol., cell biol., immunol., genetics)*
7. Helicobacter (*gastroenterol., infectious dis., clin.med.*)
8. Hepatitis C (*virol., oncol.*)
9. Reperfusion (*mol.biol., hematol., cardio-vasc.*)
10. Obsessive compulsive disorder *(psychiatry, neurol., pharmacol., clin.med.)*
11. Esophagus *(gastroenterol., oncol., clin.med.)*
12. Type 2 Diabetes *(endocrinol., mol.biol., cell biol., genetics)*
13. Fibrillation *(cardio-vasc., hematol., surgery, clin.med.)*
14. Escherichia *(microbiol., mol.biol., veterin., cell biol.)*
15. Sceloris *(neurol., rheumatol., immunol., clin.med.)*
16. Salmonella *(microbiol., veterin., mol.biol., food & nutrit.)*
17. Panic disorder *(psychiatry, pharmacol., mol.biol., neurol.)*
18. Herpes *(virol., mol.biol., cell biol., hematol., dermatol.)*
19. Pancreatitis *(gastroenterol., surgery, endocrinol.)*
20. Antiretroviral therapy *(virol., immunol., infectious dis.)*

Again, we see the dominating role of field such as molecular biology, immunology, oncology and cell biology. Next to these typical biomedical concepts we find a high occurrence (similar frequencies as the keywords related to the above themes) of general, not typically medical / biological concepts such as 'pattern', 'data', 'database' and 'visualization', we *also* conclude that that within the life sciences the systematic

treatment of data and the 'creation of information' are crucial. This finding represents research activities in 'bio-informatics', a general and interdisciplinary area.

Similar to molecular biology, we are convinced that in a typical bibliometric *mapping study* the role of informatics / information science and its structural relations with the different life sciences fields will be identified more precisely. We recently developed a special bibliometric methodology for exploring and mapping interdisciplinary, 'unorthodox' fields of science, see Van Raan *et al* 2001.

On the basis of (1) their position in the profile figure, (2) the 'dynamics' of several fields, and (3) their role in the 20 main themes presented above, we suggest as candidates for further analysis:

- Neuroscience
- Oncology
- Immunology
- Cell Biology
- Genetics & Heredity

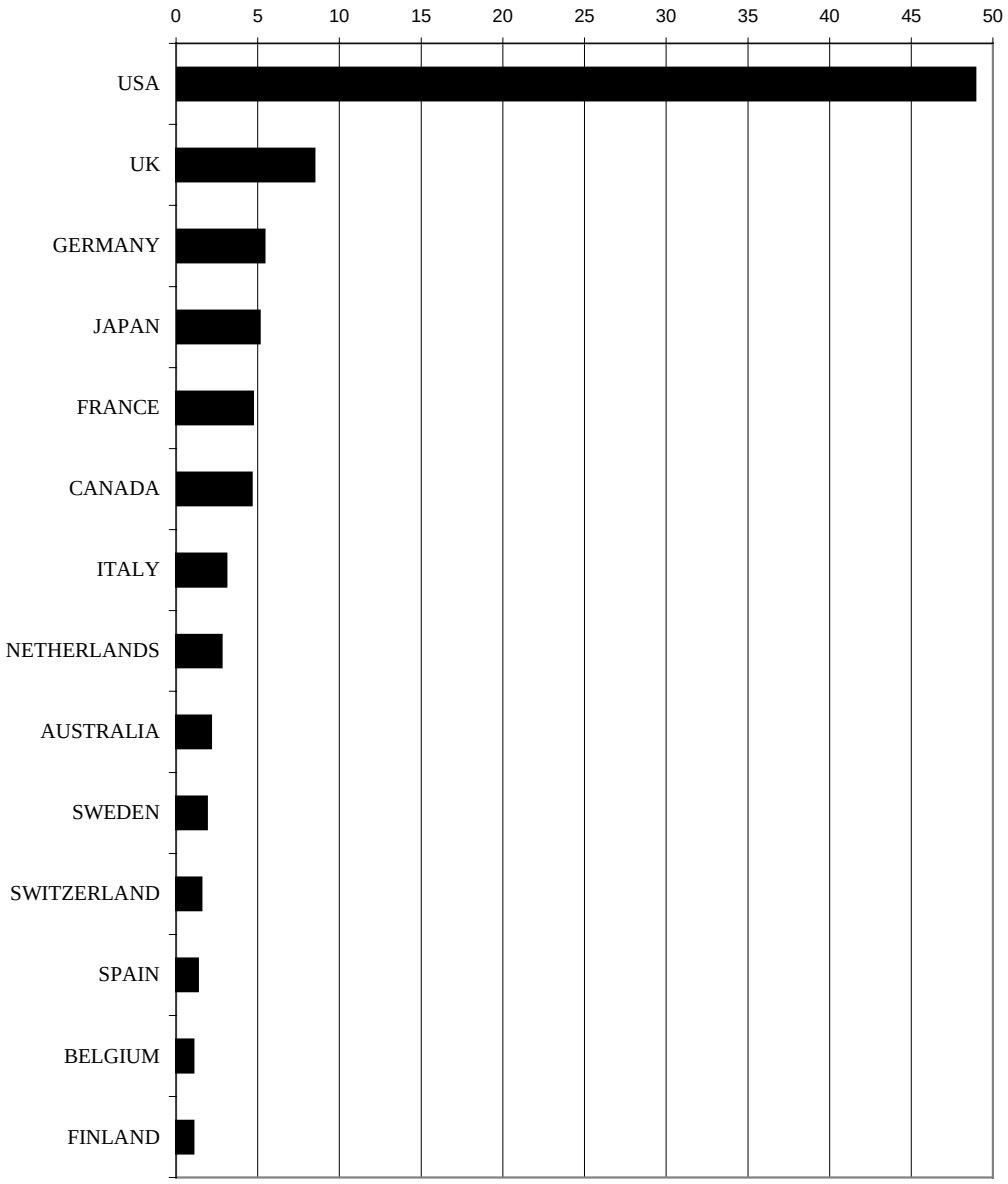
Again, we are convinced that an advanced bibliometric mapping procedure will reveal most of the major characteristics of these fields, particularly in terms of *interdisciplinary relations* and the identification of leading edge research groups. Such an advanced mapping procedure could particularly focus on the interdisciplinary relations of the above fields with each other *and* with fields that are not selected as a 'starting point' (like the above 5 fields) but that showed to be also very important, e.g., virology and infectious diseases, and cardio-vascular research.

4.4 Countries within the Top-10% of the Life Sciences

A second breakdown of the above top-10% concerns the national level on the basis of the addresses of the research groups as given in the headings of the publications. In the figure (next page) we present the results ('Relative share of the output in Top-10% Life Sciences').

We observe the strong dominance of the United States, as can be expected. Nevertheless, European Union countries are well-represented in this country-profile and we can conclude that Europe is certainly active in the top-10% of life sciences research.

Relative share of the output in Top-10 Life Sciences



4.5 Institutions within the Top-10% of the Life Sciences

The breakdown of the top-10% publications of the Life Sciences into addresses can be taken one step further in order to identify the *institutions* at a higher aggregation level, the 'main organisation', such as universities as a whole, large research organisations, and large research institutes.

We here present the results of a first analysis. We emphasizes that these results are *preliminary*, as a detailed analysis is not within the scope of this small, first study and should be part of a larger follow-study.

Our preliminary analysis is carried out as follows:

(1) Identification of the 250 *most active* (in terms of publications) 'main organization' *world-wide* (number of publications ***P*** > about 200/year), ranking according to number of publications ***P*** and calculation of all CWTS standard indicators (see Appendix). These results are presented in Table 1 (added to this report; *we stress that the findings presented in Table 1 are preliminary and that the reader must take into account all cautionary remarks given hereafter*!);

(2) Ranking of the 100 largest (in terms of publications) of the above top-250 according to the most important impact indicators, particularly ***CPPx*** and ***CPPx/FCSmx*** (see Appendix). The results for both indicators, top-25 *European* main organizations, are presented in Lists 1 and 2, respectively.

(3) From the results of the above procedure, it will become clear that the ranking of institutions according to top-performance is no sinecure. Therefore we iontroduce in this report a further, new approach in which institutions are ranked according

- (i) to the total number of citations (corrected for self-citations, ***Cx***) received by the publications within the life sciences top-10%;
- (ii) to the field-normalized indicator multiplied by the number of publications within the life sciences top-10%, this is equal to ***CPPx/FCSmx * P***.

Although these indicators have some 'brute force' characteristics, we think that they value *both* 'size' (number of publications within the life sciences top-10%) *as well as* impact. *Please notice that these indicators are experimental, and that they have to be tested further in practice!* The results, again in terms of the top-25 European institutions, are presented in Lists 3 and 4, respectively.

To put it simply: in Lists 3 and 4 we present the measurement of 'brute force in top-research'.

Cautionary Remarks!

This analysis is a first and preliminary identification of life sciences top-research institutions at the 'main organization' level. Readers have to be aware of the following:

- *This analysis is NOT designed for the identification of small groups. It is, again, a first step: the identification of major institutions, particularly those with more than 200 publications per year within the top-10% of the life sciences. This means that we focus on the identification of major universities with an excellent position in the broad spectrum of the life sciences. Most of these universities will have large natural science as well as large medical faculties and university hospitals. As a consequence, smaller and perhaps excellent groups within universities that, as a whole, do not meet our 'start-threshold' cannot be find this way;*

- *But even at the level of large main organizations we have to be careful. Universities are complex organizations with many linkages to related institutions. It is far from a simple task to 'define' universities in terms of all their institutes, (affiliated) hospitals, auxiliary branches in suburbs and even in more remote towns, and so on. Although CWTS puts a great deal of effort to make these definitions as good as possible, we have not arrived yet at the best possible sets of university system definitions and 'unifications' of institutional names for all countries. This particularly the case for the large academic complex of the University of California; work is currently going on to improve the unification of the different universities within this complex.*

So the reader should not consider these findings as 'the final word'. To our experience, in most cases smaller uncertainties in the definition of large institutions such as universities do not significantly affect the overall results. This study intends to provide an as best as possible broad survey.

A more accurate performance analysis of a university is possible along the lines of a university-specific study in which detailed information on the infrastructure of the university in terms of departments, institutes and their staff is available (e.g., provided by the university commissioning the study). CWTS applies a special approach for such a detailed research performance assessment study.

No part of this report should be used without having in mind these cautionary remarks as well as the remarks given in the headings of List 1 and 2!

Our above approach brings us a step further in the identification of centres of excellence, the most crucial element in the European Research Area strategy. But again, as clearly stipulated in the 'Cautionary remarks', a more extended follow-up study is necessary to identify centres of excellence more precisely, i.e., not only at the level of large institutions, but also and more particularly at the level of research groups.

List 1:

Top-25 European universities / large autonomous institutes ranked according to the impact indicator ***CPP***.

Please notice:

- *This ranking is based on the data in Table 1 (added to this report), whereby the results for large national research organizations (e.g., CNRS, MRC) are left out, as they cannot (in this study) be 'localised' to specific universities/institutes;*
- *Again, also this list should not be used without having in mind our above stated cautionary remarks!*
- *We selected from the 250 institutions in Table 1 the first 100 in terms of 'size', i.e., number of publications within the life sciences top-10%. This means that a university with a ranking of 101 and above in terms of publication output (in the top-10%) but with a* ***CPPx****-value similar to universities with ranking 1-100, would not appear in this Top-25 European Universities list (given in bold) for resaons of 'size'. We have add these universities in italics to the list;*
- *We emphasize again that this analysis is a preliminary one, see the cautionary remarks made earlier in this chapter!*

University	*Country*	***CPPx***
Eur.Mol.Biol.Lab.	*D*	*27.29*
German Cancer Res. C.	*D*	*26.85*
Neth. Cancer Inst.	*NL*	*21.56*
Univ. Geneva	**CH**	**19.77**
Univ. Dundee	*UK*	*19.39*
Univ. Strasbourg	*F*	*18.99*
Free Univ. Brussels	*B*	*18.55*
Univ. Heidelberg	**D**	**17.23**
Univ. Leiden	**NL**	**16.79**
Univ. Lausanne	*CH*	*16.71*
Univ. Basel	*CH*	*16.21*
Univ. Toulouse 3	*F*	*15.91*
Karolinska Instit.	**S**	**15.63**
Instit. Pasteur	**F**	**15.59**
Univ. Leicester	*UK*	*15.57*
Univ. Oxford	**UK**	**15.42**
Univ. Mainz	*D*	*15.36*
Univ. Freiburg	*D*	*15.13*
Erasmus Univ. Rotterdam	**NL**	**15.07**
Univ. Cambridge	**UK**	**15.06**
Univ. Paris[2]	**F**	**15.04**
Univ. Zürich	**CH**	**14.95**
Univ. Padua	*I*	*14.86*
Univ. Aix-Marseille	*F*	*14.49*
Univ. Bern	*CH*	*14.47*
Univ. London	**UK**	**14.41**

[2] We combined the results for three major universities: Paris 5, 6 and 7. We decided to do this in order to make comparison possible with the University of London as one main organization not formally split in different autonomous universities (although it covers quite independent parts such as Imperial college and University College).

Univ. Hamburg	*D*	*14.39*
Univ. Würzburg	*D*	*14.33*
Univ. Cath. Louvain	*B*	*14.31*
Univ. München	**D**	**14.22**
Univ. Utrecht	**NL**	**14.12**
ETH Zürich	*CH*	*13.99*
Univ. Hannover	*D*	*13.94*
Univ. Edinburgh	**UK**	**13.80**
Univ. Amsterdam	**NL**	**13.70**
Univ. Naples	*I*	*13.69*
Univ. Turin	*I*	*13.61*
Univ. Innsbruck	*A*	*13.57*
Cath. Univ. Nijmegen	*NL*	*13.52*
Free Univ. Amsterdam	**NL**	**13.50**
Univ. Lyon 1	*F*	*13.49*
Univ. Stockholm	*S*	*13.46*
Univ. Cologne	*D*	*13.45*
Univ. Milan	**I**	**13.29**
Humboldt Univ. Berlin	**D**	**13.08**
Univ. Rome 1	*I*	*12.96*
Univ. Essen	*D*	*12.85*
Univ. Düsseldorf	*D*	*12.81*
Univ. Maastricht	*NL*	*12.80*
Univ. Kuopio	*SF*	*12.79*
Univ. Marburg	*D*	*12.78*
Univ. Erlangen-Nurnberg	*D*	*12.74*
Univ. Copenhagen	**DK**	**12.70**
Univ. Helsinki	**SF**	**12.70**
Univ. Bologna	*I*	*12.70*
Univ. Uppsala	**S**	**12.67**
Univ. Antwerpen	*B*	*12.44*
Free Univ. Berlin	*D*	*12.30*
Univ. Lund	**S**	**12.23**
Univ. Nottingham	*UK*	*12.18*
Univ. Göttingen	*D*	*12.08*
Univ. Vienna	**A**	**12.07**
Univ. Giessen	*D*	*12.05*
Univ. Florence	*I*	*12.03*
Univ. Frankfurt	*D*	*12.00*
Univ. Gent	*B*	*11.99*
Univ. Groningen	*NL*	*11.98*
Cath. Univ. Leuven	**B**	**11.96**
Univ. Glasgow	**UK**	**11.71**
Univ. Manchester	*UK*	*11.71*

List 2:

Top-25 European universities / large autonomous institutes ranked according to the impact indicator ***CPPx/FCSmx.***

Please notice:

- *This ranking is based on the data in Table 1 (added to this report), whereby the results for large national research organizations (e.g., CNRS, MRC) are left out, as they cannot (in this study) be 'localised' to specific universities/institutes;*
- *Again, also this list should not be used without having in mind our above stated cautionary remarks!*
- *We selected from the 250 institutions in Table 1 the first 100 in terms of 'size', i.e., number of publications within the life sciences top-10%. This means that a university with a ranking of 101 and above in terms of publication output (in the top-10%) but with a* ***CPPx/FCSmx*** *-value similar to universities with ranking 1-100, would not appear in this Top-25 European Universities list (given in bold) for resaons of 'size'. We have add these universities in italics to the list;*
- *We emphasize again that this analysis is a preliminary one, see the cautionary remarks made earlier in this chapter!*

University	*Country*	***CPPx/FCSmx***
Free Univ. Brussels	*B*	*6.93*
German Cancer Res. C.	*D*	*6.82*
Eur.Mol.Biol.Lab.	*D*	*5.99*
Nat.Univ. Ireland	*IRL*	*5.97*
Univ. Lausanne	*CH*	*5.87*
Univ. Nottingham	*UK*	*5.80*
Erasmus Univ. Rotterdam	**NL**	**5.79**
Univ. Dundee	*UK*	*5.79*
Univ. Geneva	**CH**	**5.74**
Univ. Heidelberg	**D**	**5.68**
Univ. Utrecht	**NL**	**5.68**
Univ. Leiden	**NL**	**5.67**
Univ. Bern	*CH*	*5.65*
Univ. Göttingen	*D*	*5.62*
Univ. Munich	**D**	**5.57**
Univ. Edinburgh	**UK**	**5.57**
Univ. Cath. Louvain	*B*	*5.56*
Univ. Maastricht	*NL*	*5.50*
Univ. Essen	*D*	*5.47*
Univ. London	**UK**	**5.46**
Univ. Basel	*CH*	*5.44*
Univ. Leicester	*UK*	*5.44*
Univ. Toulouse 3	*F*	*5.43*
Cath. Univ. Nijmegen	*NL*	*5.42*
Univ. Milan	**I**	**5.41**
Univ. Strasbourg 1	*F*	*5.41*
Univ. Lyon 1	*F*	*5.41*
Karolinska Instit.	**S**	**5.40**
Univ. Stockholm	*S*	*5.40*
Neth. Cancer Inst.	*NL*	*5.37*

Univ. Innsbruck	*A*	*5.37*
Univ. Würzburg	*D*	*5.34*
Univ. Frankfurt	*D*	*5.33*
ETH Zürich	*CH*	*5.32*
Univ. Paris[3]	**F**	**5.31**
Univ. Erlangen-Nurnberg	*D*	*5.31*
Univ. Münster	*D*	*5.31*
Univ.Giessen	*D*	*5.28*
Univ. Oxford	**UK**	**5.26**
Humboldt Univ. Berlin	**D**	**5.26**
Univ. Aix-Marseille 2	*F*	*5.26*
Univ. Antwerpen	*B*	*5.26*
Univ. Gent	*B*	*5.24*
Univ. Gothenburg	**S**	**5.21**
Univ. Freiburg	*D*	*5.22*
Univ. Padua	*I*	*5.22*
Univ. Naples	*I*	*5.20*
Univ. Hamburg	*D*	*5.16*
Univ. Cambridge	**UK**	**5.14**
Univ. Bologna	*I*	*5.14*
Univ. Hannover	*D*	*5.13*
Free Univ. Berlin	*D*	*5.13*
Univ. Bonn	*D*	*5.13*
Techn. Univ. Munich	*D*	*5.10*
Univ. Kiel	*D*	*5.10*
Univ. Amsterdam	**NL**	**5.09**
Univ. Vienna	**A**	**5.09**
Univ. Florence	*I*	*5.09*
Univ. Groningen	*NL*	*5.07*
Univ. Sheffield	*UK*	*5.07*
Univ. Mainz	*D*	*5.06*
Free Univ. Amsterdam	**NL**	**5.05**
Univ. Helsinki	**SF**	**5.05**
Univ. Düsseldorf	*D*	*5.05*
Univ. Kuopio	*SF*	*5.05*
Instit. Pasteur	**F**	**5.03**
Univ. Cologne	*D*	*5.02*
Univ. Lund	**S**	**4.99**
Univ. Turku	*SF*	*4.98*
Univ. Uppsala	**S**	**4.97**
Univ. Birmingham	*UK*	*4.96*
Univ. Aarhus	*DK*	*4.93*
Cath. Univ. Leuven	**B**	**4.92**

[3] We combined the results for three major universities: Paris 5, 6 and 7. We decided to do this in order to make comparison possible with the University of London as one main organization not formally split in different autonomous universities (although it covers quite independent parts such as Imperial college and University College).

Univ. Zürich	**CH**	**4.91**
Univ. Newcastle upon Tyne	*UK*	*4.87*
Univ. Copenhagen	**DK**	**4.86**

List 3:

Top-25 European universities / large autonomous institutes ranked according to the impact indicator ***Cx*** (measurement of 'brute force in top-research')

Please notice:

** This ranking is based on the data in Table 1 (added to this report), whereby the results for large national research organizations (e.g., CNRS, MRC) are left out, as they cannot (in this study) be 'localised' to specific universities/institutes;*

** Again, also this list should not be used without having in mind our above stated cautionary remarks!*

** We emphasize again that this analysis is a preliminary one, see the cautionary remarks made earlier in this chapter!*

University	*Country*	***Cx***
Univ. London	**UK**	**69,859**
Univ. Paris[4]	**F**	**33,808**
Univ. Oxford	**UK**	**22,349**
Univ. Cambridge	**UK**	**15,944**
Karolinska Instit.	**S**	**14,643**
Univ. Heidelberg	**D**	**11,288**
Univ. Edinburgh	**UK**	**10,864**
Erasmus Univ. Rotterdam	**NL**	**10,579**
Univ. Geneva	**CH**	**10,498**
Univ. Leiden	**NL**	**10,191**
Univ. Zürich	**CH**	**9,927**
Univ. Munich	**D**	**9,785**
Eur. Mol. Biol. Lab	**D**	**9,716**
Univ. Utrecht	**NL**	**9,631**
Instit. Pasteur	**F**	**9,618**
Univ. Milan	**I**	**9,478**
Univ. Helsinki	**SF**	**9,019**
Univ. Amsterdam	**NL**	**8,658**
Univ. Lund	**S**	**8,108**
Germ. Cancer Res. C.	**D**	**8,002**
Univ. Copenhagen	**DK**	**7,587**
Univ. Manchester	**UK**	**7,503**
Free Univ. Brussels	**B**	**7,086**
Univ. Vienna	**A**	**7,002**
Univ. Freiburg	**D**	**6,658**

[4] We combined the results for four major universities: Paris 5, 6, 7 and 11. We decided to do this in order to make comparison possible with the University of London as one main organization not formally split in different autonomous universities (although it covers quite independent parts such as Imperial college and University College).

List 4:

Top-25 European universities / large autonomous institutes ranked according to the impact indicator ***CPPx/FCSmx * P*** (alternative measurement of 'brute force in top-research')

Please notice:

** This ranking is based on the data in Table 1 (added to this report), whereby the results for large national research organizations (e.g., CNRS, MRC) are left out, as they cannot (in this study) be 'localised' to specific universities/institutes;*

** Again, also this list should not be used without having in mind our above stated cautionary remarks!*

** We emphasize again that this analysis is a preliminary one, see the cautionary remarks made earlier in this chapter!*

University	*Country*	***CPPx/FCSmx * P***
Univ. London	**UK**	**26,455**
Univ. Paris[5]	**F**	**12,114**
Univ. Oxford	**UK**	**7,626**
Univ. Cambridge	**UK**	**5,440**
Karolinska Instit.	**S**	**5,062**
Univ. Edinburgh	**UK**	**4,383**
Erasmus Univ. Rotterdam	**NL**	**4,062**
Univ. Utrecht	**NL**	**3,873**
Univ. Milan	**I**	**3,857**
Univ. Munich	**D**	**3,833**
Univ. Heidelberg	**D**	**3,721**
Univ. Helsinki	**SF**	**3,585**
Univ. Leiden	**NL**	**3,443**
Univ. Lund	**S**	**3,309**
Univ. Zürich	**CH**	**3,259**
Univ. Amsterdam	**NL**	**3,218**
Univ. Manchester	**UK**	**3,107**
Instit. Pasteur	**F**	**3,103**
Univ. Geneva	**CH**	**3,047**
Univ. Vienna	**A**	**2,953**
Univ. Copenhagen	**DK**	**2,870**
Univ. Gothenburg	**S**	**2,818**
Free Univ. Brussels	**B**	**2,647**
Univ. Glasgow	**UK**	**2,596**
Univ. Wageningen	**NL**	**2,560**

[5] We combined the results for four major universities: Paris 5, 6, 7 and 11. We decided to do this in order to make comparison possible with the University of London as one main organization not formally split in different autonomous universities (although it covers quite independent parts such as Imperial college and University College).

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Appendix

A1: Standard Research Performance Indicators

In this analysis we focus on scientific publications published in international journals covered by the Institute of Scientific Information's (ISI) citation indexes (CD-Rom versions of the Science Citation Index, SCI, and all 'specialty' indexes such as Chemistry, Materials Sciences, etc.). For details of our methodology we refer to recent papers of our group (Van Leeuwen et al 1996, Moed et al 1995, Van Raan 1996).

We calculated the following indicators. The *first* indicator is the total number of papers published (***P***). We considered *normal articles*, *letters*, *notes*, and *reviews*. Meeting abstracts, corrections and editorials are *not* included. In a few cases we found papers published in a journal for which no citation data are available, or in a journal that is not assigned to any field of science[7]. Such papers are not considered in the calculation of the indicators.

The *second* and *third* indicator concern the total number of citations received (***C***), and the average number of citations per publication (***CPP***), respectively. In these figures self-citations are included. A self-citation to a paper is a citation given in a publication of which at least one of the authors (either first author or a co-author) is also an author of the cited paper (again either first author or a co-author).

The *fourth* indicator is the average number of citations per publication corrected for self-citations (***CPPx***). It is an important impact indicator, as it represents the 'visibility' of an organization normalized to its output. The *fifth* indicator is the percentage of articles *not cited* during the time period considered, self-citations included (***Pnc***).

The *sixth* indicator is the mean (world-wide) citation rate of the journals in which the article is published (the mean **J**ournal **C**itation **S**core), taking into account the type of paper (e.g., normal article, review) as well as the specific years in which the paper was published. For instance, the number of citations received in 1996-2000 by a *letter* published by a research group in 1996 in journal X, is compared to the average number of citations received during the *same* period (1996-2000) by *all letters* published in the *same* journal (X) in the *same* year (1996). At the level of research fields many journals are involved. Therefore, we calculated a weighed average indicated as ***JSCmx***, with the weights determined by the number of papers published in each journal. Even on this worldwide scale, this indicator is corrected for self-citations!

The *seventh* indicator represents the mean citation rate of the fields involved (the mean **F**ield **C**itation **S**core). Our definition of sub-fields is based on a classification of scientific journals (as indicated in footnote 2). Although not perfect, it is at present

[7] Fields of science are defined as sets of journals, the SCI (SSCI, AHCI) 'journal categories'.

the only classification that can be automated consistently in our data-system. In calculating this indicator, we used the same procedure as for the calculation of ***JCSmx,*** with journals replaced by fields (i.e., sets of journals). At aggregation levels higher than one specific field, we calculate a weighed average value, ***FCSmx***, the weights being determined by the total number of papers published in each field. As in the case of ***JCSmx***, we also corrected ***FCSmx*** for self-citations.

Thus, ***JCSmx*** and ***FCSmx*** constitute a well-defined *international average* of a specific (combination of) journals or field(s), respectively. In this way, we obtain a reference value for the international position of any specific collection of papers (e.g., a research group, a university, a specific community within a field), in terms of its impact compared to a worldwide average.

This brings us to the *eighth* and *ninth* indicators. Here we compare the average number of citations (***CPPx***) of any collection of papers to the relevant journal and field mean citation scores (***JCSmx*** and ***FCSmx***, respectively), by calculating the ratio for both.

If the ratio ***CPPx/JCSmx*** is above 1.0, the mean impact of a (set of) publication(s) exceeds the mean impact of all articles published in the journals involved. And similarly, if the ratio ***CPPx/FCSmx*** is above 1.0, a (set of) publication(s) is cited more frequently than an 'average' publication in the field(s) concerned. About 80 percent of all indexed papers is authored by scientists from the United States, Canada, Western Europe, and Japan. Therefore, the worldwide average is dominated by the Western world.

The *tenth* indicator of our standardized set of bibliometric indicators is ***JCSmx/FCSmx***. If the value of this indicator is above 1.0, the mean citation score of the journals in a (set of) publication(s) is published, exceeds the mean citation score of all papers published in the field(s) to which the journals belong. In this case, one can conclude that the (set of) publication(s) is published in journals with a relatively high impact. Finally, the *eleventh* indicator is the percentage of self-citations ***(Self Citations***), relative to the total number of citations received.

In List A1 we give an overview of all standard indicators.

We applied a statistical test to establish whether the average impact of a set of publications ***(CPPx)*** differs significantly from the average impact of all papers in the journals concerned ***(JCSmx)***, or from the world citation average ***(FCSmx)*** of the field(s) concerned. For instance, a set of publications has a citation-per-publication ratio (***CPPx***) significantly above (below) the average field (***FCSmx***) or journal citation score (***JCSmx***) *with 95% confidentiality*. We refer for further details in Glänzel 1992.

List A1: Overview of bibliometric indicators

P	Number of articles (normal articles, letters, notes and reviews) published in journals processed for the CD-ROM version of the ISI Citation Indexes (CI).
C	Number of citations recorded in CI journals to all articles involved. Self-citations are included.
CPP	Average number of citations per publication, i.e., citation per publication ratio. Self-citations are included.
CPPx	Average number of citations per publication without self-citations.
Pnc	Percentage of articles not cited during the time period considered.
JCSmx	Average citation rate of all articles published in the journals in which a (set of) publication(s) has been published. Self-citations are not included.
FCSmx	Average citation rate of all articles in the fields in which a (set of) publications has been published., i.e., the world citation average in those fields. Fields are defined by means of ISI journal categories. Self-citations are not included.
CPPx/JCSmx	Impact of a (set of) publication(s) compared to the average citation rate of the journals concerned.
CPPx/FCSmx	Impact of a (set of) publication(s) compared to the world citation average in the (sub)fields concerned.
JCSmx/FCSmx	Impact of the journals in which a (set of) publication(s) has been published, compared to the world citation average based on all journals in the fields concerned.
SelfCitations	Percentage of self-citations. A self-citation is defined as a citation in which the citing and the cited paper have at least one author in common (first author or co-author).

A2: The 'Crown' Indicator

All above discussed indicators are important in a bibliometric analysis as they relate to different aspects of publication and citation characteristics. Generally, we consider ***CPPx/FCSmx*** as our 'crown' indicator. This indicator relates the measured impact of a (set of) publications, to a worldwide, field-specific reference value. Therefore, it is a powerful *internationally standardized impact indicator*.

This indicator enables us to observe immediately whether the performance of a research group, university, etc., responsible for the set of publications, is significantly far below (indicator value < 0.5), below (0.5 - 0.8), around (0.8 - 1.2), above (1.2 - 2.0), or far above (>2.0) the international (western world dominated) impact standard of the field.

We stress however that the meaning of the numerical value of the indicator is related to the *aggregation level of the entity* under study. So it is necessary to give some 'exegesis' of the crown indicator. The higher the aggregation level, the larger the volume in publications and the more difficult it is to have an average impact significantly above the international level.

At a high aggregation level such as in this study, a ***CPPx/FCSmx*** value significantly above 1 (generally 1.2 or higher), means that the set of publications can be considered as scientifically strong, with a high probability to find very good to excellent groups.

At a lower aggregation level, e.g., research groups and departments, smaller communities within fields (such as in this study: 'the community of excellent researchers'), a ***CPPx/FCSmx*** value above 2 indicates a very strong group, and above 3 the group can be, generally, considered as excellent and comparable to top-groups at the best US universities.

Similar explanations hold for ***CPPx/FCSmx*** values for individual researchers. Here these values can span even wider ranges. For instance, top-researchers (e.g., the recent Physics Nobel Prize winners in the Netherlands) have ***CPPx/FCSmx*** values ranging from 3 to 7. But it is clear that, although formally the individual scientist represents the lowest aggregation level, there can be large differences in the output (number of publications) between individual scientists.

Thus similar considerations apply as for institutional aggregation levels: the larger the oeuvre of an individual scientist, more, generally, the ***CPPx/FCSmx*** value for this entire oeuvre will tend to lower values.

A3: Construction of Research Profiles

The central part of this study is the breakdown of the *output and impact* of a set of publications into research fields. This 'spectral analysis' yields a *broad research impact profile* of the collection of papers. It is based on phenomenon that journals in which publications appear, can be characterized with one or more research fields.

For each research field we calculate the values of our 'crown indicator' ***CPPx/FCSmx***. Thus the research profile immediately shows in what fields the set of papers has a high (or very high) performance.

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TABLE 1: BIBLIOMETRIC STATISTICS 1996 - 1999

Preliminary results, see cautionary remarks on pages 11 and 12 of the report!)

	Research Organization	P	C	CPP	CPPx	Pnc	JCSmx	FCSmx	CPPx/ JCSmx	CPPx/ FCSmx	JCSmx/ FCSmx	Self Citations
1	HARVARD UNIV	5.366	134.894	25,14	21,57	0%	10,59	3,46	2,04	6,23	3,06	14%
2	UNIV LONDON	4.848	84.140	17,36	14,41	0%	5,62	2,64	2,56	5,46	2,13	17%
3	NATL INST HLTH	4.255	103.905	24,42	20,65	0%	9,59	3,54	2,15	5,84	2,71	15%
4	UNIV CALIF	3.807	84.410	22,17	19,15	0%	9,76	3,30	1,96	5,80	2,96	14%
5	UNIV WASHINGTON	3.127	69.811	22,33	19,17	0%	8,65	3,17	2,22	6,04	2,73	14%
6	UNIV TEXAS	2.802	60.687	21,66	18,47	0%	7,82	3,09	2,36	5,98	2,53	15%
7	VET ADM MED CTR	2.141	44.706	20,88	17,91	0%	7,21	3,06	2,48	5,85	2,36	14%
8	JOHNS HOPKINS UNIV	2.127	46.634	21,92	18,52	0%	8,74	3,05	2,12	6,07	2,86	16%
9	UNIV PENNSYLVANIA	1.685	36.005	21,37	17,90	0%	8,49	3,14	2,11	5,70	2,70	16%
10	UNIV TORONTO	1.606	33.275	20,72	17,83	0%	8,79	2,99	2,03	5,96	2,94	14%
11	UNIV CALIF LOS ANGELES	1.508	30.401	20,16	17,21	0%	7,77	3,06	2,21	5,63	2,54	15%
12	STANFORD UNIV	1.504	36.345	24,17	21,03	0%	10,54	3,38	1,99	6,23	3,12	13%
13	YALE UNIV	1.464	32.508	22,20	19,08	0%	10,34	3,29	1,85	5,81	3,15	14%
14	UNIV OXFORD	1.449	27.269	18,82	15,42	0%	7,18	2,93	2,15	5,26	2,45	18%
15	UNIV MICHIGAN	1.369	28.892	21,10	18,03	0%	7,53	3,12	2,39	5,77	2,41	15%
16	DUKE UNIV	1.329	28.504	21,45	18,23	0%	8,03	3,15	2,27	5,79	2,55	15%
17	COLUMBIA UNIV	1.313	32.148	24,48	21,11	0%	10,80	3,34	1,95	6,33	3,24	14%
18	CORNELL UNIV	1.223	23.324	19,07	16,17	0%	7,32	2,86	2,21	5,65	2,56	15%
19	UNIV PITTSBURGH	1.187	22.741	19,16	16,17	0%	6,39	2,77	2,53	5,83	2,30	16%
20	UNIV MINNESOTA	1.119	20.513	18,33	15,75	0%	6,34	2,52	2,48	6,26	2,52	14%
21	MAYO FDN	1.102	18.868	17,12	14,22	0%	6,46	2,63	2,20	5,40	2,45	17%
22	MCGILL UNIV	1.080	21.135	19,57	16,24	0%	7,13	2,89	2,28	5,61	2,47	17%
23	UNIV WISCONSIN	1.062	16.203	15,26	12,83	0%	6,10	2,55	2,10	5,03	2,39	16%
24	UNIV CAMBRIDGE	1.059	19.347	18,27	15,06	0%	6,83	2,93	2,20	5,14	2,33	18%
25	STATE UNIV NEW YORK	1.039	19.187	18,47	15,70	0%	6,85	2,85	2,29	5,52	2,41	15%
26	BAYLOR COLL MED	998	22.605	22,65	19,25	0%	9,38	3,22	2,05	5,97	2,91	15%
27	UNIV CALIF SAN DIEGO	998	26.434	26,49	22,92	0%	10,69	3,60	2,14	6,36	2,97	13%
28	TOKYO UNIV	956	17.115	17,90	14,92	0%	6,90	2,97	2,16	5,02	2,32	17%
29	BRIGHAM & WOMENS HOSP	946	23.859	25,22	21,58	0%	9,54	3,26	2,26	6,62	2,92	14%
30	KAROLINSKA INST	937	17.647	18,83	15,63	0%	6,37	2,89	2,45	5,40	2,20	17%

31	UNIV N CAROLINA	870	19.529	22,45	19,33	0%	8,30	3,32	2,33	5,82	2,50	14%
32	USDA ARS	857	6.726	7,85	5,92	0%	2,19	1,30	2,71	4,54	1,68	25%
33	UNIV COLORADO	851	17.532	20,60	17,53	0%	7,61	3,00	2,30	5,84	2,53	15%
34	UNIV CHICAGO	850	18.019	21,20	18,47	0%	9,44	3,24	1,96	5,71	2,92	13%
35	UNIV ILLINOIS	832	12.339	14,83	12,33	0%	5,08	2,37	2,43	5,20	2,14	17%
36	EMORY UNIV	801	16.563	20,68	17,65	0%	7,57	2,81	2,33	6,29	2,70	15%
37	UNIV ALABAMA	801	16.312	20,36	17,11	0%	6,52	2,87	2,62	5,96	2,27	16%
38	UNIV EDINBURGH	787	13.027	16,55	13,80	0%	5,93	2,48	2,33	5,57	2,39	17%
39	CASE WESTERN RESERVE UN	773	14.971	19,37	16,24	0%	7,66	2,99	2,12	5,44	2,56	16%
40	UNIV PARIS 06	769	13.433	17,47	14,48	0%	5,63	2,62	2,57	5,54	2,15	17%
41	UNIV MARYLAND	764	12.845	16,81	14,01	0%	5,75	2,47	2,44	5,68	2,33	17%
42	NEW YORK UNIV	763	17.403	22,81	19,73	0%	9,60	3,30	2,06	5,98	2,91	13%
43	UNIV SO CALIF	743	14.220	19,14	16,42	0%	7,00	2,88	2,34	5,70	2,43	14%
44	VANDERBILT UNIV	737	15.331	20,80	17,55	0%	7,38	3,04	2,38	5,78	2,43	16%
45	UNIV IOWA	726	13.171	18,14	14,72	0%	6,61	2,86	2,23	5,14	2,31	19%
46	UNIV CALIF DAVIS	713	9.094	12,75	10,44	0%	4,19	1,97	2,49	5,30	2,13	18%
47	UNIV MILAN	713	11.848	16,62	13,29	0%	5,40	2,46	2,46	5,41	2,20	20%
48	UNIV HELSINKI	710	11.204	15,78	12,70	0%	5,43	2,52	2,34	5,05	2,16	20%
49	NORTHWESTERN UNIV	704	15.947	22,65	19,40	0%	8,85	3,12	2,19	6,22	2,84	14%
50	ERASMUS UNIV	702	12.762	18,18	15,07	0%	6,75	2,60	2,23	5,79	2,59	17%
51	UNIV MUNICH	688	11.944	17,36	14,22	0%	6,69	2,55	2,12	5,57	2,62	18%
52	CTR DIS CONTROL & PREVEN	687	11.411	16,61	14,18	0%	5,70	2,30	2,49	6,16	2,47	15%
53	UNIV BRITISH COLUMBIA	687	12.959	18,86	15,83	0%	6,92	2,80	2,29	5,66	2,48	16%
54	UNIV FLORIDA	685	8.719	12,73	10,57	0%	4,49	2,08	2,36	5,09	2,16	17%
55	UNIV UTRECHT	682	11.642	17,07	14,12	0%	5,86	2,49	2,41	5,68	2,36	17%
56	UNIV PARIS 05	664	12.471	18,78	15,73	0%	7,76	3,05	2,03	5,16	2,55	16%
57	UNIV ZURICH	664	12.196	18,37	14,95	0%	7,53	3,05	1,98	4,91	2,47	19%
58	TUFTS UNIV	663	13.878	20,93	17,89	0%	8,09	2,97	2,21	6,03	2,73	15%
59	UNIV LUND	663	9.896	14,93	12,23	0%	4,47	2,45	2,74	4,99	1,82	18%
60	UNIV UTAH	663	13.240	19,97	16,90	0%	7,61	2,90	2,22	5,83	2,62	15%
61	UNIV HEIDELBERG	655	13.760	21,01	17,23	0%	7,78	3,03	2,21	5,68	2,57	18%
62	UNIV CALIFORNIA SAN DIEG	649	16.522	25,46	21,69	0%	11,22	3,98	1,93	5,45	2,82	15%
63	MEM SLOAN KETTERING CAI	648	16.700	25,77	22,36	0%	10,81	3,40	2,07	6,57	3,18	13%
64	INDIANA UNIV	647	12.794	19,77	16,77	0%	6,93	2,89	2,42	5,80	2,40	15%
65	UNIV MANCHESTER	643	9.108	14,16	11,71	0%	5,16	2,42	2,27	4,83	2,13	17%
66	KYOTO UNIV	637	11.881	18,65	15,56	0%	6,83	3,01	2,28	5,17	2,27	17%
67	UNIV AMSTERDAM	632	10.583	16,75	13,70	0%	5,76	2,69	2,38	5,09	2,14	18%
68	BOSTON UNIV	630	12.151	19,29	16,54	0%	7,23	2,84	2,29	5,83	2,55	14%
69	MIT	618	18.124	29,33	25,40	0%	15,85	4,20	1,60	6,05	3,78	13%
70	INST PASTEUR	617	11.757	19,06	15,59	0%	8,16	3,10	1,91	5,03	2,63	18%
71	INRA	616	6.065	9,85	7,63	0%	3,00	1,69	2,55	4,52	1,77	22%
72	UNIV VIRGINIA	610	12.642	20,72	17,85	0%	7,49	3,10	2,38	5,75	2,41	14%
73	LEIDEN UNIV	607	12.228	20,14	16,79	0%	6,74	2,96	2,49	5,67	2,28	17%
74	CNRS	598	14.050	23,49	19,36	0%	8,25	3,24	2,35	5,97	2,54	18%
75	UNIV COPENHAGEN	591	9.340	15,80	12,84	0%	5,54	2,64	2,32	4,86	2,09	19%

76	UNIV NEW S WALES	589	7.462	12,67	10,34	0%	3,78	2,03	2,73	5,10	1,87	18%
77	OHIO STATE UNIV	583	8.076	13,85	11,70	0%	4,80	2,22	2,44	5,26	2,16	16%
78	UNIV VIENNA	580	8.749	15,08	12,07	0%	5,11	2,37	2,36	5,09	2,16	20%
79	UNIV PARIS 07	573	10.277	17,94	14,99	0%	6,35	2,90	2,36	5,18	2,19	16%
80	CLEVELAND CLIN FDN	569	10.945	19,24	16,16	0%	6,71	2,79	2,41	5,80	2,41	16%
81	ROCKEFELLER UNIV	565	16.688	29,54	25,46	0%	12,92	3,99	1,97	6,38	3,24	14%
82	OREGON HLTH SCIENCES UN	562	11.733	20,88	18,00	0%	8,35	3,01	2,16	5,98	2,77	14%
83	WAGENINGEN RES CTR	553	5.235	9,47	7,37	0%	2,73	1,59	2,70	4,64	1,72	22%
84	UNIV GLASGOW	548	7.847	14,32	11,71	0%	5,00	2,47	2,34	4,74	2,02	18%
85	UNIV MASSACHUSETTS	548	11.401	20,80	18,08	0%	7,82	2,93	2,31	6,17	2,67	13%
86	YESHIVA UNIV	544	11.533	21,20	17,74	0%	8,96	3,22	1,98	5,51	2,78	16%
87	UNIV GOTHENBURG	541	7.088	13,10	10,93	0%	4,13	2,10	2,65	5,21	1,97	17%
88	UNIV GENEVA	531	12.450	23,45	19,77	0%	9,65	3,45	2,05	5,74	2,80	16%
89	MRC	523	11.498	21,98	18,37	0%	8,78	3,54	2,09	5,18	2,48	16%
90	THOMAS JEFFERSON UNIV	518	14.405	27,81	23,69	0%	8,16	3,37	2,90	7,03	2,42	15%
91	BETH ISRAEL DEACONESS MI	501	11.979	23,91	20,62	0%	9,20	3,28	2,24	6,29	2,80	14%
92	UNIV TENNESSEE	492	7.539	15,32	12,90	0%	5,54	2,54	2,33	5,09	2,18	16%
93	KATHOL UNIV LEUVEN	491	7.479	15,23	11,96	0%	4,50	2,43	2,66	4,92	1,85	22%
94	FREE UNIV AMSTERDAM	488	8.283	16,97	13,50	0%	5,87	2,67	2,30	5,05	2,20	20%
95	UNIV WALES	480	5.774	12,03	9,77	0%	3,82	2,05	2,56	4,77	1,86	19%
96	UNIV UPPSALA	477	7.271	15,24	12,67	0%	5,36	2,55	2,36	4,97	2,10	17%
97	UNIV ROCHESTER	467	10.463	22,40	19,16	0%	7,59	3,08	2,52	6,21	2,46	14%
98	HUMBOLDT UNIV	466	7.562	16,23	13,08	0%	5,86	2,49	2,23	5,26	2,36	19%
99	UNIV MIAMI	459	8.768	19,10	16,43	0%	6,20	2,62	2,65	6,28	2,37	14%
100	UNIV BRISTOL	458	5.922	12,93	10,66	0%	4,01	2,22	2,66	4,80	1,80	18%
101	UNIV ARIZONA	454	7.703	16,97	14,28	0%	6,23	2,68	2,29	5,34	2,33	16%
102	UNIV ALBERTA	446	7.603	17,05	14,26	0%	5,84	2,78	2,44	5,13	2,10	16%
103	UNIV FREIBURG	440	7.979	18,13	15,13	0%	6,73	2,90	2,25	5,22	2,33	17%
104	CATHOL UNIV NIJMEGEN	429	6.971	16,25	13,52	0%	5,50	2,50	2,46	5,42	2,21	17%
105	MCMASTER UNIV	427	8.081	18,93	15,94	0%	7,06	2,75	2,26	5,80	2,57	16%
106	PENN STATE UNIV	424	8.347	19,69	17,00	0%	6,14	2,65	2,77	6,41	2,31	14%
107	STATE UNIV GRONINGEN	424	6.277	14,80	11,98	0%	4,74	2,36	2,53	5,07	2,01	19%
108	INSERM	420	7.985	19,01	15,50	0%	7,05	3,05	2,20	5,08	2,31	18%
109	GEORGETOWN UNIV	419	7.296	17,41	14,48	0%	5,91	2,60	2,45	5,57	2,27	17%
110	OSAKA UNIV	416	9.741	23,42	20,10	0%	8,49	3,50	2,37	5,74	2,43	14%
111	UNIV GEORGIA	411	4.105	9,99	8,10	0%	3,42	1,76	2,37	4,60	1,94	19%
112	LOUISIANA STATE UNIV	409	5.550	13,57	11,26	0%	4,65	2,19	2,42	5,13	2,12	17%
113	UNIV CINCINNATI	407	7.205	17,70	14,80	0%	7,03	2,78	2,11	5,32	2,52	16%
114	UNIV MONTREAL	407	6.819	16,75	14,22	0%	5,84	2,60	2,43	5,48	2,25	15%
115	CSIRO	406	3.431	8,45	6,64	0%	2,13	1,42	3,12	4,68	1,50	21%
116	HEBREW UNIV JERUSALEM	405	6.402	15,81	12,96	0%	6,65	2,82	1,95	4,59	2,36	18%
117	UNIV MELBOURNE	405	5.593	13,81	11,12	0%	4,79	2,23	2,32	4,98	2,14	19%
118	UNIV BERN	402	7.025	17,48	14,47	0%	5,61	2,56	2,58	5,65	2,19	17%
119	UNIV ERLANGEN NURNBERG	400	6.254	15,64	12,74	0%	4,91	2,40	2,59	5,31	2,05	19%
120	UNIV TUBINGEN	397	5.676	14,30	11,46	0%	5,13	2,49	2,24	4,60	2,06	20%

121	UNIV KENTUCKY	388	7.044	18,15	14,03	0%	5,46	2,62	2,57	5,36	2,09	23%
122	UNIV LAUSANNE	388	7.739	19,95	16,71	0%	6,94	2,85	2,41	5,87	2,44	16%
123	WAYNE STATE UNIV	388	5.763	14,85	12,31	0%	5,77	2,54	2,14	4,85	2,27	17%
124	UNIV WURZBURG	384	6.664	17,35	14,33	0%	7,05	2,68	2,03	5,34	2,63	17%
125	F HUTCHINSON CANCER RES	382	11.478	30,05	26,49	0%	12,75	3,88	2,08	6,83	3,29	12%
126	FREE UNIV BRUSSELS	382	8.523	22,31	18,55	0%	5,80	2,68	3,20	6,93	2,17	17%
127	MICHIGAN STATE UNIV	381	5.717	15,01	12,71	0%	4,52	2,20	2,81	5,77	2,05	15%
128	WAKE FOREST UNIV	381	6.353	16,67	14,09	0%	5,32	2,48	2,65	5,69	2,15	16%
129	TEXAS A&M UNIV	373	4.474	11,99	9,70	0%	4,79	2,14	2,03	4,54	2,24	19%
130	CSIC	370	4.370	11,81	9,55	0%	4,30	1,88	2,22	5,08	2,29	19%
131	UNIV BIRMINGHAM	366	5.251	14,35	11,64	0%	5,53	2,35	2,11	4,96	2,36	19%
132	UNIV HAMBURG	366	6.602	18,04	14,39	0%	6,59	2,79	2,18	5,16	2,36	20%
133	BROWN UNIV	364	5.725	15,73	13,25	0%	5,85	2,30	2,26	5,75	2,54	16%
134	IMPERIAL CANC RES FUND	364	12.199	33,51	29,13	0%	15,11	5,03	1,93	5,79	3,00	13%
135	UNIV MED & DENT NEW JERS	364	6.143	16,88	14,57	0%	6,99	2,51	2,08	5,79	2,78	14%
136	UNIV NOTTINGHAM	364	5.263	14,46	12,18	0%	3,94	2,10	3,09	5,80	1,88	16%
137	RUTGERS STATE UNIV	362	6.293	17,38	14,52	0%	6,71	2,80	2,16	5,19	2,40	16%
138	UNIV LAVAL	358	7.822	21,85	17,96	0%	6,40	2,97	2,81	6,05	2,16	18%
139	EUROPEAN MOLEC BIOL LAB	356	11.463	32,20	27,29	0%	15,41	4,56	1,77	5,99	3,38	15%
140	UNIV LIVERPOOL	352	3.719	10,57	8,62	0%	3,45	1,80	2,50	4,77	1,91	18%
141	UNIV DUSSELDORF	351	5.466	15,57	12,81	0%	5,61	2,54	2,28	5,05	2,21	18%
142	UNIV MISSOURI	349	4.214	12,07	9,96	0%	4,17	1,90	2,39	5,24	2,19	17%
143	FREE UNIV BERLIN	348	5.194	14,93	12,30	0%	5,14	2,40	2,39	5,13	2,14	18%
144	UNIV SHEFFIELD	347	4.816	13,88	11,51	0%	4,43	2,27	2,60	5,07	1,95	17%
145	GLAXOSMITHKLINE	345	10.464	30,33	26,85	0%	8,82	3,44	3,04	7,81	2,57	11%
146	MERCK & CO INC	345	10.123	29,34	26,08	0%	7,90	3,22	3,30	8,10	2,45	11%
147	UNIV LEEDS	344	4.058	11,80	9,62	0%	3,68	1,99	2,61	4,84	1,85	18%
148	UNIV STOCKHOLM	343	5.513	16,07	13,46	0%	4,49	2,49	3,00	5,40	1,80	16%
149	UNIV AARHUS	341	4.930	14,46	11,66	0%	4,14	2,37	2,82	4,93	1,75	19%
150	UNIV LYON 1	341	5.585	16,38	13,49	0%	5,18	2,49	2,60	5,41	2,08	18%
151	STATE UNIV GHENT	336	4.952	14,74	11,99	0%	4,76	2,29	2,52	5,24	2,08	19%
152	TECH UNIV MUNICH	335	4.870	14,54	11,57	0%	4,50	2,27	2,57	5,10	1,99	20%
153	UNIV MUNSTER	334	4.787	14,33	11,54	0%	3,89	2,17	2,97	5,31	1,79	19%
154	UNIV QUEENSLAND	334	4.590	13,74	11,15	0%	4,63	2,30	2,41	4,84	2,01	19%
155	UNIV NEBRASKA	332	4.229	12,74	10,18	0%	4,53	2,06	2,25	4,94	2,20	20%
156	UNIV ROME 1	332	5.367	16,17	12,96	0%	6,78	2,78	1,91	4,66	2,44	20%
157	MED COLL WISCONSIN	329	5.624	17,09	14,48	0%	5,92	2,80	2,45	5,17	2,11	15%
158	UNIV BASEL	328	6.338	19,32	16,21	0%	7,51	2,98	2,16	5,44	2,52	16%
159	UNIV CALGARY	327	6.205	18,98	16,44	0%	6,61	2,66	2,49	6,19	2,49	13%
160	UNIV CATHOL LOUVAIN	326	5.858	17,97	14,31	0%	5,98	2,57	2,39	5,56	2,32	20%
161	UNIV GOTTINGEN	326	4.880	14,97	12,08	0%	4,41	2,15	2,74	5,62	2,05	19%
162	SALK INST BIOL STUDIES	324	10.480	32,35	28,78	0%	15,44	4,44	1,86	6,48	3,48	11%
163	CITY UNIV NEW YORK	318	6.148	19,33	16,44	0%	7,24	2,89	2,27	5,69	2,50	15%
164	CNR	316	4.884	15,46	12,18	0%	6,22	2,74	1,96	4,44	2,27	21%
165	VIRGINIA COMMONWEALTH	314	5.208	16,59	13,68	0%	6,13	2,72	2,23	5,04	2,26	18%

166	UNIV DUNDEE	313	7.474	23,88	19,39	0%	7,95	3,35	2,44	5,79	2,37	19%
167	UNIV S FLORIDA	313	6.586	21,04	18,03	0%	5,74	2,58	3,14	6,97	2,22	14%
168	UNIV SOUTHAMPTON	310	3.799	12,25	9,95	0%	3,90	2,16	2,55	4,60	1,80	19%
169	US ARMY	309	6.009	19,45	16,93	0%	6,42	2,44	2,64	6,93	2,63	13%
170	UNIV FRANKFURT	308	4.420	14,35	12,00	0%	4,15	2,25	2,89	5,33	1,85	16%
171	UNIV STRASBOURG 1	307	6.944	22,62	18,99	0%	10,41	3,51	1,82	5,41	2,96	16%
172	UNIV NAPLES	305	4.967	16,29	13,69	0%	5,75	2,63	2,38	5,20	2,18	16%
173	UNIV MAINZ	304	5.726	18,84	15,36	0%	6,49	3,03	2,37	5,06	2,14	18%
174	UNIV PARIS 11	304	4.367	14,37	11,95	0%	6,11	2,48	1,96	4,81	2,46	17%
175	UNIV WESTERN ONTARIO	301	4.864	16,16	13,67	0%	5,93	2,58	2,30	5,29	2,30	15%
176	UNIV CONNECTICUT	299	4.689	15,68	13,29	0%	5,97	2,59	2,23	5,13	2,30	15%
177	GERMAN CANCER RES CTR	298	9.658	32,41	26,85	0%	10,61	3,94	2,53	6,82	2,70	17%
178	NAGOYA UNIV	295	4.735	16,05	12,49	0%	5,61	2,55	2,23	4,89	2,20	22%
179	KYUSHU UNIV	294	4.695	15,97	13,13	0%	6,08	2,73	2,16	4,81	2,23	18%
180	UNIV PADUA	294	5.312	18,07	14,86	0%	6,24	2,85	2,38	5,22	2,19	18%
181	UNIV NEWCASTLE UPON TYN	291	3.892	13,37	11,11	0%	5,14	2,28	2,16	4,87	2,25	17%
182	UNIV OSLO	287	3.589	12,51	10,18	0%	4,20	2,11	2,43	4,83	1,99	19%
183	UNIV BARCELONA	280	3.863	13,80	11,14	0%	4,90	2,42	2,28	4,61	2,03	19%
184	UNIV BONN	279	3.687	13,22	10,89	0%	4,15	2,12	2,62	5,13	1,95	18%
185	GLAXO WELLCOME SMITHKI	277	5.817	21,00	18,27	0%	6,22	3,26	2,94	5,61	1,91	13%
186	MED UNIV HANNOVER	277	4.727	17,06	13,94	0%	5,17	2,72	2,70	5,13	1,90	18%
187	NORTH CAROLINA STATE UN	277	2.639	9,53	7,84	0%	2,99	1,73	2,62	4,52	1,72	18%
188	RUSH PRESBYTERIAN ST LUK	276	4.499	16,30	13,96	0%	5,84	2,48	2,39	5,63	2,35	14%
189	SWISS FED INST TECHNOL ET	270	4.790	17,74	13,99	0%	6,45	2,63	2,17	5,32	2,45	21%
190	UNIV GUELPH	270	1.998	7,40	5,92	0%	2,07	1,32	2,86	4,47	1,56	20%
191	HOKKAIDO UNIV	269	3.505	13,03	10,54	0%	4,74	2,26	2,22	4,67	2,10	19%
192	ST JUDE CHILDRENS HOSP	269	6.664	24,77	20,80	0%	10,39	3,58	2,00	5,80	2,90	16%
193	GENENTECH INC	267	8.821	33,04	28,84	0%	10,42	3,72	2,77	7,76	2,81	13%
194	UNIV ARKANSAS	267	3.206	12,01	10,00	0%	3,83	2,21	2,61	4,53	1,73	17%
195	UNIV PURDUE	267	3.056	11,45	9,22	0%	3,82	2,18	2,42	4,22	1,75	19%
196	UNIV TURKU	262	3.527	13,46	10,63	0%	4,13	2,13	2,57	4,98	1,94	21%
197	ELI LILLY	259	7.746	29,91	26,21	0%	5,81	3,19	4,51	8,22	1,82	12%
198	SWED UNIV AGR SCI	259	2.278	8,80	6,93	0%	2,33	1,52	2,97	4,57	1,54	21%
199	TEL AVIV UNIV	254	3.814	15,02	12,28	0%	5,73	2,59	2,14	4,74	2,21	18%
200	MED UNIV SOUTH CAROLINA	253	3.919	15,49	12,78	0%	5,53	2,53	2,31	5,05	2,18	18%
201	WASHINGTON STATE UNIV	252	2.837	11,26	8,99	0%	3,30	1,92	2,73	4,69	1,72	20%
202	DARTMOUTH COLL	251	4.805	19,14	16,28	0%	9,93	3,24	1,64	5,02	3,06	15%

203	UNIV ULM	251	3.251	12,95	10,53	0%	4,76	2,24	2,21	4,70	2,13	19%
204	TOHOKU UNIV	250	3.046	12,18	10,01	0%	4,53	2,25	2,21	4,45	2,01	18%
205	UNIV MAASTRICHT	250	3.794	15,18	12,80	0%	4,63	2,33	2,76	5,50	1,99	16%
206	ST LOUIS UNIV	249	4.792	19,24	16,83	0%	6,62	2,61	2,54	6,46	2,54	13%
207	UNIV ESSEN	246	3.914	15,91	12,85	0%	5,25	2,35	2,44	5,47	2,24	19%
208	UNIV OTTAWA	246	3.967	16,13	13,76	0%	5,46	2,62	2,52	5,25	2,08	15%
209	UNIV KIEL	245	3.398	13,87	11,05	0%	4,68	2,17	2,36	5,10	2,16	20%
210	CHILDRENS HOSP	243	4.211	17,33	13,65	0%	6,77	2,64	2,02	5,18	2,57	21%
211	UNIV KANSAS	243	3.775	15,53	12,79	0%	5,02	2,70	2,55	4,74	1,86	18%
212	UNIV INNSBRUCK	237	3.908	16,49	13,57	0%	4,65	2,52	2,92	5,37	1,84	18%
213	IRCCS SCI INST RES HOSP HL	236	3.469	14,70	12,15	0%	5,08	2,20	2,39	5,51	2,30	17%
214	UNIV ABERDEEN	236	3.040	12,88	10,32	0%	3,63	2,20	2,84	4,70	1,65	20%
215	UNIV COLOGNE	235	3.840	16,34	13,45	0%	7,29	2,68	1,84	5,02	2,72	18%
216	UNIV LEICESTER	235	4.419	18,80	15,57	0%	5,86	2,86	2,66	5,44	2,05	17%
217	COLORADO STATE UNIV	234	2.290	9,79	7,80	0%	3,38	1,72	2,31	4,52	1,96	20%
218	MT SINAI MED CTR	233	4.284	18,39	15,72	0%	7,02	2,68	2,24	5,86	2,62	15%
219	WEIZMANN INST SCI	233	6.730	28,88	25,18	0%	11,77	4,45	2,14	5,66	2,65	13%
220	MASSACHUSETTS GEN HOSP	231	7.232	31,31	27,32	0%	12,20	3,77	2,24	7,25	3,24	13%
221	UNIV MARBURG	231	3.725	16,13	12,78	0%	5,64	2,72	2,27	4,70	2,08	21%
222	DALHOUSIE UNIV	230	3.588	15,60	13,32	0%	5,25	2,42	2,54	5,52	2,17	15%
223	IOWA STATE UNIV	230	1.906	8,29	6,68	0%	2,59	1,51	2,58	4,43	1,72	19%
224	UNIV NEW MEXICO	230	3.360	14,61	12,35	0%	5,79	2,42	2,13	5,10	2,39	15%
225	UNIV TOULOUSE 3	230	4.432	19,27	15,91	0%	6,57	2,93	2,42	5,43	2,24	17%
226	UNIV VERMONT	230	4.170	18,13	15,04	0%	5,79	2,58	2,60	5,82	2,24	17%
227	NETHERL CANC INST	229	5.873	25,65	21,56	0%	11,96	4,01	1,80	5,37	2,98	16%
228	AUSTRAL NATL UNIV	228	3.378	14,82	12,54	0%	5,62	2,45	2,23	5,12	2,30	15%
229	UNIV AIX-MARSEILLE 2	228	3.943	17,29	14,49	0%	6,45	2,76	2,24	5,26	2,34	16%
230	HENRY FORD HLTH SYST	227	3.522	15,52	13,31	0%	5,69	2,42	2,34	5,50	2,35	14%
231	CALIF INST TECHNOL	226	6.308	27,91	24,42	0%	15,20	4,12	1,61	5,93	3,69	13%
232	GEORGE WASHINGTON UNIV	222	3.535	15,92	13,52	0%	6,02	2,45	2,25	5,53	2,46	15%
233	UNIV FLORENCE	221	3.281	14,85	12,02	0%	5,17	2,36	2,32	5,09	2,19	19%
234	UNIV GIESSEN	221	3.259	14,75	12,05	0%	4,70	2,28	2,57	5,28	2,06	18%
235	UNIV TURIN	221	3.719	16,83	13,61	0%	7,35	2,97	1,85	4,58	2,47	19%
236	UNIV KUOPIO	219	3.400	15,53	12,79	0%	5,51	2,53	2,32	5,05	2,18	18%
237	NATL UNIV IRELAND	215	3.056	14,21	11,40	0%	3,26	1,91	3,49	5,97	1,71	20%
238	OSAKA SANGYO UNIV	212	3.310	15,61	12,92	0%	5,73	2,54	2,25	5,09	2,26	17%
239	UNIV ANTWERP	212	3.288	15,51	12,44	0%	4,35	2,36	2,86	5,26	1,84	20%
240	MONASH UNIV	211	2.610	12,37	9,99	0%	4,31	1,94	2,32	5,15	2,22	19%
241	NATL INST CANC RES	209	4.962	23,74	19,33	0%	9,57	3,27	2,02	5,91	2,93	19%
242	UNIV BOLOGNA	207	3.147	15,20	12,70	0%	5,42	2,47	2,34	5,14	2,19	16%
243	HOSP TORONTO	206	3.610	17,52	15,01	0%	7,34	2,42	2,05	6,22	3,04	14%
244	HOWARD HUGHES MED INST	205	6.723	32,80	28,44	0%	18,56	4,49	1,53	6,33	4,13	13%
245	RUSSIAN ACAD SCI	205	2.241	10,93	8,57	0%	3,61	1,95	2,37	4,39	1,85	22%
246	TULANE UNIV	203	3.216	15,84	13,10	0%	5,32	2,39	2,46	5,48	2,23	17%
247	BRISTOL MYERS SQUIBB CO	200	6.407	32,04	28,25	0%	11,97	4,47	2,36	6,32	2,68	12%