Evaluation Report

Department of Biotechnology,

Universität für Bodenkultur

Vienna

October 8th – 11th, 2006

August Böck
Sven-Olof Enfors
Siegfried Neumann
Peter Raspor
Quentin Sattentau

1. Executive Summary

The Department of Biotechnology (DBT) of the "Universität für Bodenkultur" (BOKU) was evaluated by an international review panel between October 8 and11, 2006. During the site visit the committee had the opportunity to discuss intensively with the Rector of the University and the members of the steering committee of DBT and it received oral presentations of all working group leaders on the results and perspectives of their scientific projects. The evaluation included two detailed presentations on the education program and hearings of students, postdoctoral scientists and non-scientific staff. All these activities resulted in the general impression that DBT has thrived to become an institution of international recognition especially in the disciplines of animal cell culture technology and bioprocess engineering of major impact to industrial and medical applications.

In summary, the particular strengths of DBT are

a. a creative and liberal leadership generating a stimulating and collaborative spirit amongst scientific and non-scientific staff;
b. outstanding success in technology transfer activities having great impact on the development of biotechnical processes in Austria and abroad;
c. development of an excellent curriculum for the education of biotechnologist in the Diploma and now in the Bachelor/Master Program which represents an innovative combination of engineering science with bacterial and eukaryotic cell biology based on a strong fundament of chemistry, physical chemistry and mathematics and fortified with soft skills in order to prepare students for their professional careers
d. definition of DBT as a core centre for further exploitation of cellular biology for research and development on cell culture and downstream processes by a combination of interdisciplinary work and with cooperative partners both from other institutes and from industry.

Potential pitfalls and threats are

a. the instability of the financial situation which is not robust because of the dependency on rather short-term third-party contributions.
b. the predominant dependency on a small group of senior scientists to move the DBT into a future within a very rapidly expanding field.
c. high workload in teaching for the individual academic staff members and limitations in public financial resources for experimental work in master and diploma theses.

Measures which are recommended by the panel in order to make sure that DBT continues to enjoy success in research and education are

a. The recruitment of new full professorships both in areas of DBT´s existing particular strengths and in new fields, the provisions of the necessary infrastructure for the new staff and the adjustment of the management structure to the new faculty structure. The recruitment should be an open and competitive process with major contributions from international experts in the search and recruitment committees.
b. The encouragement of scientific staff members to increase their basic research activities and in applying for competitive grants for them from agencies like FWF and also to increase their publication record in quantitative and qualitative terms.
c. To increase the Federal budget to a level that it can cover the housekeeping and all teaching expenses including costs for Master theses work.
d. To consolidate the teaching success by implementing the optimisation measures proposed by the committee, which include re-introduction of a regular evaluation of the teaching performance.
e. To break down the clearly visible and apparently historical barriers between the management of the Department and of the University and to expand openness for the collaboration with other departments of the University..
f. To continuously review the policies for co-operations with industry in view of potential conflicts of interest and for consistency with the competition law.

2. Composition of the reviewing committee and reviewing procedure.

The committee was set up according to the "Guidelines for evaluating organisational units according to University Act of 2002 ". It consisted of the following members:

Prof. Dr. Sven-Olof Enfors
Royal Institute of Technology
Stockholm, Sweden

Prof. Dr. Siegfried Neumann
Merck KGaA, Darmstadt,
Germany

Prof. Dr. Peter Raspor, Dipl.eng. DDhc
University of Ljubljana
Ljubljana, Slovenja

Prof. Dr. Quentin Sattentau
University of Oxford, Oxford
United Kingdom

Prof. Dr. Dr. sc. h. c. August Böck (Chair)
University of Munich
Germany

Care was taken that the broad research portfolio of the Department of Biotechnology (subsequently termed DBT) was covered by the individual areas of expertise of the committee members. The attainment of this aim was fully substantiated during the presentations and discussions of the achievements of the staff members and in the hearings. All documents were provided by BOKU within the schedules fixed in the aforementioned guidelines.

The site visit took place from October 8th to 11th, 2006. It started with a briefing of the committee members by Mg. Thomas Guggenberger, which was integral to the smooth running of the site visit. For future evaluations, we recommend that more time should be allocated to this introduction. It should also be emphasised that Mg. Guggenberger was extremely helpful in coordinating the evaluation process, especially when the time frame was exceeded or when supplementary wishes of the committee had to be fulfilled.

3. Description of the DBT, its specific situation and the goals of the external evaluation.

DBT is one of the 12 departments of the "Universität für Bodenkultur" (subsequently termed BOKU). It was founded in 1945 as "Institut für Angewandte Mikrobiologie" (IAM) in a joint venture between BOKU and Austrian brewing industry branches in order to foster research in, and development of, yeast-based fermentation processes. In the university re-organisation act of 2003 IAM, which originally was one of the 40 institutes of BOKU, was carried over into one of the 12 departments without any significant structural changes. Thus, apart from the Department of Nanobiotechnology, DBT is the only organisational unit with a single full professorship. However, the Department of Nanobiotechnology is a predominantly research-oriented centre founded *ad personam* for Professor Uwe Sleytr. Professor Sleytr will retire at approximately the same time as Professor Herrmann Katinger, the head of DBT.

Because of the multidisciplinary character of biotechnology, DBT has many contact interfaces with other departments; particularly close contacts exist with the Department of Chemistry and the Department of Food Science and Technology, since they take share in the education of students in the Bachelor program and they offer expertise and facilities in technologies such as mass spectrometry and HPLC chromatography. Potential synergy can also be expected from cooperation with the majority of the other departments since BOKU is in the unique situation of concentrating research and teaching almost solely within the field of Life Sciences.

At present and within the next three years, DBT faces a number of stringent changes. First, the implementation of the University Act of 2002 will take many years for the transition of the old into the new system, which is connected with severe problems for young scientists who want to enter an academic career. Second, the well-established and accepted diploma curriculum is presently transferred into the Bologna Bachelor and Master education program. DBT has to cope with a dramatic increase in student numbers, which in a worst-case scenario may have negative consequences for the quality of teaching and research. Third, Professor Herrmann Katinger will retire in 2009. Professor Katinger is an internationally recognised pioneer in mammalian cell culture technology and in the exploitation of mammalian cell cultures for the production of biopharmaceuticals; a similarly qualified successor will not be easy to recruit.

In the context of these changes, BOKU expects the external evaluation to provide information on the present scientific and academic standing of DBT. This includes assessment of the management of the department, of the adequacy of research achievements, of education and technology transfer in relation to the resources provided, and of the success in raising third party funds. Most importantly, the perspectives of the future research options of DBT linked with the structural changes introduced by the recruiting of additional full professors were to be assessed. As a basis for the evaluation, DBT and BOKU provided the self-evaluation report, the plan for the development of BOKU, and supporting information including statements from the Departments of Chemistry and Nanobiotechnology.

The committee wants to express concern regarding the difficulty in obtaining insight into certain aspects of personal statistics and its budgeting of the DBT because the numbers of staff members provided by BOKU and DBT differed, and the allocation of the budget positions to the funding sources and to the working groups was not always transparent. This may have been a consequence of the fact that this external evaluation was the first one for a department of BOKU, therefore reflecting institutional inexperience in the presentation process. The committee also felt a certain barrier in the proper information flow between DBT and the central administration, which needs to be alleviated. Most of the open questions were resolved, however, during the honest and frank discussions with the staff members of the department, and the committee explicitly wants to acknowledge this cooperativeness.

4. Assessment of the performance of the DBT

Management and management support

Formatted: Bullets and Numbering

The complementary and collaborative leadership styles of Prof. H. Katinger and the other members of the steering committee (Prof. K. Bayer, Prof. A. Jungbauer and Prof. M.. Laimer) have clearly been central to the success of DBT so far. The claim of governance by confidence within a flat hierarchy appears to fully suffice in solving internal problems, as repeatedly pointed out by staff members in several hearings. Prof. Katinger presents the competent and creative head of the department who leaves the working group leaders freedom to choose and develop their projects including their own efforts for acquisition of external funding for their projects. The topics of Masters and Doctoral theses are proposed by the working group leaders, who also supervise and monitor the experimental work. Altogether, the committee got the impression of a harmonious atmosphere in which Prof. Katinger fulfils the role of scientific and organisational coordinator, who shares mentorship with the steering committee members, and also provides a significant level of moral support and pastoral care.

Discussions with the secretaries and selected technicians of the department did not uncover any major complaints apart from the high working load and the unbearable air conditioning of the building in summer times when the basement labs are cooled down to 18 ^{o}C and the 5th floor rooms simultaneously heated up to 34 ^{o}C. The non-scientific staff seems to accept readily to come in at off-hours or at weekends to conduct necessary operations for research and teaching like watering of experimental plants or inoculation of cultures.

4.2. Assessment of the academic and scientific achievements during the last four years.

4.2.1 Research activities

Operationally, biotechnology research spans a vast area ranging from the discovery of a new organism or a biological compound with promise for future application, to the development of a process for the analysis or manufacturing of a product of biological origin by means of cells or enzymes. The assessment of the quality and achievements is delicate. On the one hand work on the discovery side of biotechnological research promises to yield interesting information which can be published in journals aimed at a general audience, whereas on the other hand it uses to be a lengthy course with a high risk of failure to yield a useful product. By contrast, work on the manufacturing or diagnostic side is often initiated with prior knowledge of the compound which is to be produced or analysed. The publication of the outcome of such a process, however, is frequently in conflict with the interest to keep it confidential for exploitation. New compounds are usually well protected by patents while patents on methods and technologies are much more difficult to protect from violation. In the technology case, however, the work is more likely to yield a result. A further complication is that the size of the journal impact factor as a parameter for the assessment of the quality of publications is extremely dependent on the field of research and a comparison needs careful analysis.

In this context, the majority of the projects pursued in the working groups of DBT belong to the latter class, i.e. they are driven by technology objectives. In the following critical assessment the activities of working groups having related technologies or aims are combined.

- ***Virology and immunology (Working groups: H. Katinger, R. Grabherr, F. Steindl, K. Vorauer-Uhl)***

These four working groups span activities ranging from production of recombinant proteins from mammalian cell systems, including monoclonal antibodies, optimisation of liposome technology for vaccine and drug delivery, novel technologies associated with insect cell-expressed virus like particles and development of novel immunological tests including ELISA and cell-based assays. These areas are an emerging strength in the department: given the current international interest in vaccine development and the use of antibodies as therapeutic agents, this should be strongly supported.

The highest profile research area in this cluster concerns the generation and production of monoclonal antibodies against HIV-1, produced in a recombinant form by mammalian cell expression, that have been used worldwide and remain an essential resource in vaccine design. Numerous publications have emanated from internal and collaborative use of these reagents over the evaluation period, several of which are in high impact journals such as *Science* and *Immunity*.

Novel aspects of expression vector manipulation with vaccine design and development of new gene therapy vectors is another theme. Projects using insect cells and baculovirus vectors for generation of multi-subunit VLPs for influenza vaccine design were presented, as was the production of baculovirus-expressed material in mammalian cells. Other work was also presented in the context of an industrial partner (Biomin), which aims at developing new detoxifying enzyme systems. The committee was slightly puzzled by the diversity of themes in this area, but overall the projects seem to be novel and interesting, and integrate well into the departmental research areas.

Novel liposome production technologies are being exploited using proprietary technology. This technology allows the incorporation of biomolecules under gentle conditions, maintaining biological activity during incorporation and delivery. Several potential applications were presented, including incorporation of enzymes (e. g. SOD) and viral

glycoproteins (e. g. HIV-1 gp41). These applications show exciting possibilities for the fields of drug delivery and vaccination, and some applications are already in clinical trials by external partners. In addition, excellent analytical platforms for evaluation of processes and agent activity and release profiles have been developed.

Various immunological and immunochemical assays of central importance to the department have been developed, a good example of which regards the problem of samples containing immune complexes in which the reactants are sequestered. A novel technique in which the complexes are disrupted led to a greater availability of free reactants, allowing more precise quantification. Whilst such assay development technology is valuable to this department, it does not generally lead to a high publication output due to the nature of the work. The immunoassay group has also been implicated in the development of therapeutic creams, based on plant-derived products that have pain-relieving and other properties. Recent restructuring has led to a diminution in the size of the immunoassay group. We therefore recommend closer integration of this group into a larger cluster or working group within the department, the precise grouping to be left to the discretion of the steering committee.

Research output by this research cluster was in general respectable, with each working group having an average of one or more first or last author papers per year. With the exception of the HIV-specific antibody work, the work has generally been published in specialist journals, the impact factor of which is unknown to the committee.

The multiple collaborations, both within the department, outside the department and of an international nature, are testament to the dynamic and interactive nature of this cluster, and their desire to innovate and undertake entrepreneurial activities both in academia and industry. Indeed, some of the work emanating from this research cluster has an almost unparalleled record of excellence in translation from academia to industry, a situation that has benefited both sides enormously. The general recommendation is for this research cluster to continue as planned, with equivalent support from within and outside the department.

- ***Mammalian cell culture technology (Working groups: N. Borth, W. Ernst, J. Grillari, R. Kunert, R. Voglauer)***

The basis of this evaluation were the data and facts presented in the self-evaluation report of DBT, then the oral presentations of the group leaders, a short visit to the cell culture laboratories, and reading their publication track record (as listed in the DBT web-page).
In reading their recent publication record and in viewing their presentations, it became evident that all the scientific staff members of DBT are strong team players by own confession, with a deep thrust into the interdisciplinary approach as the only way to solve complex biotechnology problems. DBT has a philosophy to solve problems by a continuous process in science and technology from molecular/cell biology, recombinant cell design, cell line optimization and culture condition optimization, leading towards large scale cell cultivation.

The multi-disciplinary approach of DBT to analyse and design mammalian cell culture techniques by a holistic attempt towards a rational workup of optimal cell lines, their cultivation and optimization of protein yields, has helped DBT to achieve a position among the world leaders in mammalian cell cultivation. This is highly relevant for industrial scale manufacturing of proteins as pharmaceuticals.

Students are involved in many studies in all aspects of these processes within DBT. This serves to prepare them to be problem solvers when they go into bio-industry. As mammalian cells require specific working rules with regard to sterile environmental working areas and as they need biological and microscopic quality assurance, DBT plays an important role in training a high-skilled high-tech working force for mammalian cell factories.

Both cost reduction by increase of product yields from mammalian cell cultures as well as consistent product quality including a reproducible glycosylation pattern of a given biopharmaceutical are of major concern to the biomedical industry. DBT is well positioned to contribute key experience to the art.

Regarding individual working units:

The laboratories which provide small scale quantities of monoclonal antibodies are working to international standards and are broadly acknowledged as a supplier of various valuable antibody preparations as research reagents. One major recent success was the development of an anti-idiotypic antibody, i. e. a structure which recognizes the binding site of an antibody against HIVgp-41and thus may be an equivalent to an surface antigen of the virus. Such antibodies may thus become the compounds in, or tools for, vaccines. The laboratory work flow and the organization as seen during the visit are professional. Individual workplaces and personal equipment were evident. Cell culture instrumentation and instruments such as confocal microscopy and flow activated cell sorting are in place allowing cutting-edge analysis. DBT carries out cooperative analysis on its FACS machine for other departments and receives cooperation from other analytical departments and protein structural analysis by Mass Spectroscopy from the Department of Chemistry.

On the molecular biology level, DBT is the first academic institute in the world to carry out successful transcription profile analysis of hamster cells (CHO) by reference to available oligonucleotide chips for mouse genome sequences. A DBT chip was designed with some 2300 6o-mers on gene sequences of DBTs interest. The hamster genome is not publicly available, and DBT discovered a 92 % homology between hamster and mouse of the 2300 genes of interest to DBT.

Bioinformatics will further facilitate screening of the selected sequences for quantitative follow-up of gene expression of CHO cells under different cell culture conditions. The stage for strain improvement by mRNA profiling seems to be set. This array-based approach has much technical potential, i.e. for host cell optimization, clonal selection, vector design and process optimisation.

Flow cytometry analysis is well developed at DBT and is used professionally for analysis of cellular heterogeneity in culture for a given cell line. This also allows detection of rare phenotypes and their selection for strain improvement. Productivity is also topic of scientific studies on the correlation between energy metabolism of mammalian cells or mitochondrial membrane potential vs. growth rate and antibody production rate.

Impressive basic scientific work is done in studies of the mechanisms of ageing in mammalian cells in the working groups of Voglauer and Grillari. Different routes are studied to understand and modify cell ageing in vivo and in culture.

- Transfection studies with vectors containing the human telomerase gene are on the way to establish long lived differentiated mammalian cell lines, e.g. human endothelial cells, CHO cells etc.
- Discoveries of new, previously unknown regulatory proteins like SNEV and its nuclear interacting protein partners are complete. They offer a highly attractive research area to further support DBTs recognition as a player in molecular biology. This is seen for research on mammalian cell senescence, maintenance of cellular differentiation and bypassing cellular crises (apoptosis). The groups are competitive with other international research groups. The DBT scientists have collaborations with major international research partners for the molecular biology of these regulatory proteins, and are in the process of defining a variety of their biological functions. A cooperation with the Department of Chemistry at BOKU will help to design small molecular weight compounds for use in modulation of the reaction pathways. SNEV, its dimers or its interaction with other nuclear proteins has a potential for

pharmacological discoveries beyond its application aspects for cell line maintenance in culture.

DBT thinks broadly enough to also consider the consequences of the discovery that SNEV is involved in repair of damaged DNA. They cooperate with external partners to work on analysis of SNEV as a prognostic marker in mammary tumour patients

In conclusion: The working groups on topics of mammalian cell culture technology cover both development work on cell line optimization and valuable classical technologies to provide monoclonal antibody portfolios for research and biomedical follow-up studies This work is indispensable for a department in this research area. Cell line improvement for yield optimization for biopharmaceuticals and for growth in serum-free or protein-free media is a future-oriented aim of high impact to the biopharmaceutical manufacturing art. Extension of this work is highly recommended. The working groups are also highly engaged in academic teaching of students in practical exercise in mammalian cell culture technologies and thus help them to prepare for future professional employments in the bio-industry. The high workload of some of the group leaders in general microbiology teaching for undergraduates should be reconsidered and reallocated to microbiologists in the staff.

The basic research on cell biology of ageing in some of these working groups is highly productive in inventive terms, building up international research co-operations and joint publications in renowned journals. From the point of view of the Peers it rewards further extension because of its impact on understanding the basic mechanisms of cell differentiation and growth. This is of high relevance both to animal cell design and for biomedicine.

For future restructuring of the DBT the Peers recommend to consider combining the working groups in mammalian cell culture into one unit.

FACS facilities could be virtually or physically reallocated to a central service unit for the DBT and be given tasks both for cooperative scientific work with all groups in DBT and in addition for further development of flow cytometry and sorting as a discipline on its own right.

Similar considerations apply for experimental and technical work to develop oligonucleotide arrays for transcriptome analyses and antibody arrays for protein pattern analysis and quantification.

.

- ***Bioprocess technology (Working groups K. Bayer, A. Jungbauer, D. Mattanovich, D. Müller, F. Rüker)***

The DBT has extensive competence in the process engineering of mammalian cells and *E. coli*. Furthermore, strategically important microbial cell design through metabolic engineering is carried out on yeast cells at DBT to make microbial bioprocesses for recombinant proteins and commodity chemical expression. There is also experience in plant tissue cultivation at DBT and vaccine production in plants is included in the goals of the plant biotechnology working group. This means that the DBT has both the equipment and the skills needed to cover biotechnical production with most of the currently relevant types of production organisms (only filamentous fungi are missing).

It is essential that the bioprocess technology development is research-based. This makes the technology more generic and the Bioprocess Technology platforms that DBT develops and intends to develop will create a basis for biotechnical production both for the so called "red biotechnology", which mainly deals with proteins and peptides, and for the "white biotechnology" which mainly deals with low-molecular-weight products from renewable resources like glucose and starch.

The process engineering for mammalian cells has been performed in an industrial network that includes the spin-off company Polymun and large international companies like

- in a recent contact - GE Health Care (on microcarriers) and the pharmaceutical company Sandoz. The scientific challenges include optimisation of processes so they become stable under scale-up and production. Development of protein-free production media is included to increase the safety of industrial production of pharmaceuticals. Most of the activity has been based on CHO cells and fed-batch techniques, but the current plans indicate a clear preference for development of the perfusion technique for animal cell bioreactors. As perfusion technologies are not yet fully established in the biopharmaceutical industry, DBT in this group offers pioneering work on optimization of product yield and in-process control of cell life in the reactor system. The publication output of this working group has not been high, but two patents have been filed and the activity is strategically important for DBT considering, its priority activities in exploitation of animal cell products.

The yeast bioreactor research deals with strain design rather than with process scale-up and control. Two parallel developments are being made. One line utilises metabolic engineering to alter the common baker's yeast for production of ascorbic acid (food additive) and lactic acid (monomer for biodegradable plastics). A flow cytometry method has been developed for high-throughput screening of lactic acid producing yeast strains which have been blocked in key enzymes (PDC, PDH) to force the cell to make more lactate from glucose at lower pH. The driving force for a low-pH process is that it would avoid the large by-product gypsum waste associated with the current technology for lactic acid production. The principles developed in this project are to a large extent generic for production of commodity chemicals from renewable sources. The other type of yeast bioreactor that is developed is aimed for production of antibody fragments with *Pichia pastoris*. Over-expression of genes of different helper proteins (PDI, transcription factors) is utilised, and 22 different promoters has been screened with respect to efficiency in the control of expression of the model protein GFP. Both transcription analysis with arrays and protein analyses are applied to screening in strain libraries for bottlenecks in the production. These techniques are also generic for design of protein producing cells. Eukaryotic micro-organisms are currently considered as realistic alternative future hosts for antibody production. A couple of patent applications have been filed. Metabolic engineering is strategically important for development of new biotechnical products and considered a bottleneck in the development of products from renewable resources. However, it is an interdisciplinary activity based on a combination of applied molecular genetics, metabolic flux analysis, and mathematical modelling of the metabolism. We recommend that the working group develops its activities in co-operation with such complementing expertise.

The microbial bioprocess engineering is mainly developed with *E. coli* as production host for recombinant proteins and plasmid DNA but most of the methods developed are also relevant for the emerging industrial use of *E. coli* for production of commodity chemicals from renewable recourses. Traditional on-line measurements (pH, DOT etc) are combined with chemometrics for on-line prediction of more complex variables. Non-traditional bioprocess control methods like fluorescence and dielectric spectroscopy and proton transfer mass spectrometry are developed for on-line data acquisition. Off-line analysis of the transcriptome and the proteome is applied for better understanding of the interactions between the cell and the bioreactor environment. Except for co-operation between groups within DBT this activity also utilises competences at the Technical University of Vienna, University of Vienna, and the Dept. of Chemistry at BOKU to cover the broad spectrum of techniques needed. This type of work, focusing on a better understanding and monitoring of the cell physiology under process conditions, is a red thread in FDAs Process Analytical Technology initiative (www.fda.gov/Cder/OPS/PAT.htm) which urges the industry to develop new and validated methods for better understanding and control of bioprocesses. The scientific productivity of this group is very good and the know-how is strategically important for all

kinds of fermentation processes, irrespectively of which organisms are used. Since the group leader is approaching his retirement, we recommend that DBT develops a plan for maintaining and further developing this competence.

The weakest link in the development of bioprocesses is often the downstream processing where the product is recovered and purified. DBT has a very strong and internationally recognised activity in this field, which is also documented in a very high publication rate and many patent applications. The focus is on affinity chromatographic methods including development of new affinity ligands based on peptide libraries. Efforts are made to introduce continuous chromatography. For inclusion bodies, which are common states of many recombinant proteins when produced in *E. coli*, an autoprotease fusion technique has been developed which in one column combines adsorption, refolding, and release of the pure product. More fundamental research is done in the field of mass transfer in conventional chromatography media and monoliths and molecular dynamics modelling for prediction of adsorption. The projects include a very large degree of cooperation with industries and other academic institutions. The research group is already one of the largest at DBT and we recommend that this successful activity is further supported to at least the same extent.

Protein engineering. Protein engineering techniques have been utilised for the design of proteins with new properties. This has been used for design of affinity ligands for downstream processing, but it also has wider applications. Based on the phage display technique and single-chain Fv libraries new antibody fragments are produced with specific binding properties against selected molecules which can be utilised also for visualisation of the binding site, e.g. with fluorescence. Additionally, complete antibodies with an extra binding site on the Fc-part of the molecule, i.e. additional to the native antigen binding site, have been designed. Such bi-functional antibodies are interesting candidates for therapeutic use in cancer treatment, provided the constructs have reasonable pharmacokinetic properties in the body. The successful result of this work was the basis for the establishment of the company *f-star* in 2005.

- ***Bioinformatics (D. Kreil)***

The new Chair of Bioinformatics constitutes a strategic resource, not only for the DBT, but also for other BOKU departments dealing with living cells. The activities can be grouped in 3 areas: Measurement, computation, and life science implications. The group is currently establishing itself in the DBT by setting up co-operations such as stress analysis in recombinant protein production. Many more projects/working groups can benefit from future co-operation and the balance between the efforts for development of bioinformatics techniques and the demand for bioinformatics supports from other research projects will be a delicate balance to achieve. The Peers strongly encourage a closer involvement of this chair with the projects of DBT, for instance in mathematical analyses for metabolic engineering studies in bacteria or yeast cells. This chair also has a strategic role in teaching. An inter-university co-operation in Vienna for this purpose is strongly recommended. Currently, a limiting factor for the development of bioinformatics at DBT is insufficient resources for advanced UNIX administration, which must be solved. The scientific activity of this chair will be evaluated in 2008.

- ***Plant biotechnology unit (Working group M. Laimer)***

The Plant Biotechnology Unit (PBU) has acquired extensive competence in plant engineering since 1985 when it started with the challenge for the production of healthy food for the development of methods for rapid detection of plant pathogens, and the reduction of the use of biocidal chemicals via the employment of strategies which improve the natural resistance of plants. After moving to new facilities in the Muthgasse building in 1990 these activities

continued and were complemented by the inclusion of strategically important viruses into the research portfolio. The experience of plant tissue cultivation and vaccine production in plants meanwhile has been included in the goals. Accordingly, the PBU possesses both the skills and the equipment needed to cover biotechnical production with plant cells. Recently, a program for allergen detection in fruit was also initiated.

The PBU consists of three permanent employees and nine employees on third party funding which illustrates the success of the group in fund raising, but also documents the fragility of the financial status. Most of the projects which are followed by the PTU are research based. Although PBU is facing a high fluctuation of staff and is active in a relatively complex research area, the members of the group have published a series of highly relevant scientific manuscripts in renowned plant and horticulture journals and they were extremely active in contributing to conferences. They have also invested considerable time in communicating issues connected with GMO technology to the general public in Austria and in Europe .

Having assessed this group within the study program, it is clear that their knowledge is transferred properly and enthusiastically to students of biotechnology in a total of 15 courses.

PBU was the first unit to concentrate on plant biotechnology within the BOKU environment. When the PBU activities are compared with those of relevant units in other departments of BOKU, it is clear that the PBU deserves a high ranking. The panel therefore recommends that the bright prospects for this unit has are realized within the DBT. On the other hand, it also sees the necessity for closer and more intensive interaction with other relevant institutions, including DALSPB.

- ***Environmental biotechnology/Geomicrobiology and Mycology/ACBR (Working groups P. Holubar, K. Sterflinger and H. Prillinger)***

The project followed by the "Environmental Biotechnology" group aim at the development of processes for the remediation of pollutants in water, for the controlled treatment of solid waste in biogas plants and in landfills, and for the modelling of fermentation reactions in order to achieve an optimised composition of combustible biogas. It is stated that novel neural-network-based control software is to be developed as well as new gas sensors. Whereas there was a report of a successful project for the cleaning of oil-polluted water by aerobic treatment, the latter activities are still in their initial stages. It was unclear to the panel which innovations were introduced into aerobic treatment of oil-containing effluents above the standard procedures and which aims are to be reached in the control of biogas formation from municipal sludge and agricultural waste extending beyond those already implemented in commercially established small and large scale plants.

Apart from the BOKU-financed group leader there are two doctoral students and four technicians employed and supported by third party funds. As is the case with other groups of DBT, the panel could not confirm whether these are funds raised by the projects or originating from "cross-working-group" sources. The group has published about one manuscript per year in specialised journals and there is one patent (1998). The panel noticed that the group leader is actively engaged in university politics, an activity which should be taken up by more members of the DBT.

The projects followed within the frame of the ACBR are decided upon at three levels. First, over the years the group has collected an enormous number of yeast and lower fungi strains and classified them by employing procedures of classical taxonomy and by the more quantitative method of comparative sequencing of lead macromolecules. All these isolates are deposited in a culture collection which is open for other scientists upon requests. Third, and this is unique and very important for the visibility of DBT and BOKU in the public domain , the group has experience in analysing microbial participation in the deterioration of

monuments, paintings and exhibits containing organic matter in museums. This is the heritage of one of the project leaders from her activity in the group of the well-known geomicrobiologist W. Krumbein from the University of Oldenburg.

As to the culture collection, the panel agrees that such a collection is of high value, but only when it is actually used. Numbers for requests from outside for deposited strains were not given. One practical spin-off was that a mycotoxin-degrading strain was detected but its application is unclear. Since the maintenance of such a collection is very labour-intensive plans should be developed for how the sources will be exploited in a more intensive manner.. The group has a low work-force for all its work in strain maintenance and in application projects. If the main goal is to establish an Austrian collection for the deposit of patent strains along the Budapest treaty, it should be funded by Federal money to guarantee continuity. The group has published continuously but at a low frequency with a sudden increase in 2006.The research area of this group touches the fields followed in other departments of BOKU especially with the department of Forestry and Soil Sciences. Surprisingly, this department does not possess a group working in the important field of soil microbiology (citation of Prof. Gerzabek). The establishment of a soil microbiology chair with the ACBR as a crystallisation appears very attractive to the panel.

4.2.2 Education

The committee was informed of the teaching activities by detailed reports presented by Dr. Bayer and Dr. Vorauer-Uhl in addition to the documentation presented in the self-evaluation report of DBT. Very valuable information was also retrieved from two focus meetings, one with undergraduate and graduate students (about 40 attendees) and another one by postdocs and lecturers (about 20 attendees). There are at present two groups of students, one in the (expiring) diploma study “Food and Biotechnology” reformed in 1999 and terminating in the Diplom-Ingenieur Award, the other one in the Bachelor and Master Program of the Bologna Framework which started in 2003. The diploma curriculum has now been fully transformed into the framework of the Bachelor/Master program and a few students are currently in the first years of the Master study. A forthcoming problem will be that the Batchelor program is realised as a joint education in Food Science and Biotechnology, which splits into the two Master curricula in “Food Science and Technology” and “Biotechnology” and that the vast majority apparently chooses Biotechnology. This may necessitate the acquisition of additional personnel and financial support, but an estimate of its magnitude must be preceded by a quantitative comparison of the teaching capacity of the departmental staff with the teaching load. Future evaluation reports, therefore, should contain the individual teaching performance of each single staff member, (title of course and contact hours per semester) which also must include the type of elective courses actually given in the present situation. It is improbable that all these courses can, in reality, be offered.

A correction with respect to the high drop-out numbers must be taken into consideration. Drop-out obviously occurs mainly after the first two semesters in the Bachelor stage, reasons for the loss rate have to be discussed together with the Department of Chemistry, as students see their main deficits in this discipline.

As in other disciplines, there is considerable concern with respect to the value of the Bachelor´s qualification from a professional perspective, especially since a similar curriculum is also offered by six Colleges of Higher Education (Fachhochschule) in Austria. To avoid competition between the graduates in the job market, DBT motivates graduates to continue into the Master´s studies. By this DBT aims in sharpening their profiles as specialists with some training in research work. This is fully supported by the committee; it is also seen, however, that considerable financial support will be required in future to maintain the high quality of teaching. As pointed out by Dr. Vorauer-Uhl in her presentation, there is already a

dramatic shortage of lecture room and laboratory practical course space which limits, for example, the possibility to integrate elective courses into the teaching plan because the space is already allocated for parallel compulsory courses.

The committee is very supportive of the strategy of DBT to offer a high proportion of the curriculum in the form of practical courses and of laboratory courses combined with seminars. It enables a shift from fact-related learning to problem-related learning. Quite intriguingly, one of the students in the focus meeting stressed that he changed from the University of Vienna to BOKU precisely because of the high proportion of experimental work. Altogether, the committee was impressed by the high proportion of the curriculum concerning "hard" skills (chemistry, physics, mathematics etc), by the interdisciplinary character and by the inclusion of soft skills. It also felt a very positive spirit amongst the students who consider themselves not as "clients" but as "participants" (citation of a student). Others emphasised the spirit of openness, the ease of communication with staff, and the conveniently short distances between the study areas.

Despite the overall very positive impression, the committee recommends DBT to take measures in the following issues:

- The duration of diploma studies is still extremely high. Although there will be an inherent decrease in the duration with the full transformation into the Bologna frame the matter nevertheless needs careful attention.
- According to the students there is a 50% drop-out rate during the first two semesters. The committee did not go into a detailed analysis of the reasons but it urges DBT and BOKU to alleviate this enormous waste of human capital.
- Students claim that the transition from the Bachelor to the Master is not smooth; an interlude of several months was criticised. This leaves them without health assurance coverage for a couple of months. Again, although the reason is not immediately apparent to the members of the committee, the situation needs improvement. There were several claims that credits from studies in other universities are not acknowledged properly by BOKU. An objective procedure should be set up to facilitate the acknowledgement of such credits, especially also since the Vienna science area presents a fantastically rich environment to obtain education in special topics not taught in BOKU. In this context, one master student claimed that her off-time for a study term at a foreign university creates problems in a smooth continuation of her master study program at DBT later on. A clearance office at DBT for special problems like this is recommended
- Students in biotechnology expressed a need to learn more in mathematics as an enabling discipline for systems biology. Also there was uttered an interest to increase teaching for scientific English.
- Both staff members and students in the hearing emphasised that the feedback from the students on the teaching performance of staff members is disappointingly low. It was argued that this represents a consequence of the change from a hard copy evaluation form to a web entry. The committee encourages DBT to reinforce this important type of information by going back to the original custom and publishing the summary of the results in the form of a booklet in each academic year. An annual award for "best teacher of the DBT" based on the students vote might be taken up.

In the hearing of the committee with the postdoctoral fellows, two extremely important issues were raised: first that confidentiality agreements in projects with external funding partners can delay or prevent publication of results, a matter which will be dealt with under 4.2.3, and secondly the lack of skilled labour for operation and maintenance of high tech equipment which will be discussed under 5.2.2 below.

4.2.3 Technology transfer

In Western countries there is a common understanding that basic research is generally curiosity-driven, whereas applied research transfers knowledge from basic research to technical achievements or products of commercial use or societal benefit – or both. Both basic and applied research enable acquisition of novel knowledge, which is then published for the advancement of science, or patented for incorporating proprietary rights on inventions with technical potential ("Lehre zum technischen Handeln"). They may also be kept for the exclusive disposition of the inventors as so-called proprietary know-how (protected by laws on Trade Secret).

DBT is extremely successful in technology transfer as indicated by continuous requests for R+D cooperation from industry. This is direct evidence for the recognition by commercial partners for DBT´s scientific and technological potential for problem solving. DBT and BOKU receive considerable benefit from funding by governmental resources and by industry in ACBT, a public private partnership. Additionally financial support is separately provided by industry in a variety of projects. Without these resources DBT would not be in a position to run its basic research to the extent that it does. ACBT alone has financed 10 PhD theses and 15 diploma theses up to now.

DBT combines activities in basic research in various working groups with application-driven research and development projects. These application projects involve biological and engineering solutions either on behalf of DBT or within cooperative projects worked out with external partners. DBT gave the information on the external partners in a more global way to the Peers. This helped us at least to understand that partners from both public organisations and companies were involved. However, the information given to the Peers did not allow us to identify individual partnerships. The only exception is the public-private partnership ACBT. It was presented in such a way that the public funding partners and the members of the industrial financing group were identified. The topics in research and development work were also demonstrated. Two commercial partners, Polymun GmbH, and f-star GmbH, are co-located with DBT and have the benefit of daily face-to-face contact.

F-star GmbH was founded in 2005 and has now 9 employees. ACBT was evaluated by an independent panel only recently, got a positive result and won continued financial support by public money until June 2009. Both ACBT and f-star gave evidence to the Peers that they are able now to create intellectual property by their own activity and thus to acquire industrial customers and future returns by business.

Partnerships between academic groups and public organisations or commercial entities like those exercised by DBT are not unusual in most developed nations, and similar partnerships may also be running in other departments of BOKU or in other institutions in the country. Therefore, this chapter will make some comments on the results of our evaluation at DBT, and will make some recommendations for improvements at DBT and some general suggestions for BOKU.

- ***Transparency of technology transfer activities***

The Peers signed a contract ensuring confidentiality regarding the information obtained by all activities involved in the evaluation process. The Peers also see themselves bound by the rule of the evaluation regulations to declare any conflict of interest, which could endanger a neutral evaluation of DBT's work. The Peers therefore felt themselves unnecessarily restricted by missing information in the Report of the DBT, which was omitted on the basis of confidentiality agreements between DBT and third parties.
Such as:

- The Peers did not obtain a full list of the patent applications and approved patents as achieved in the reporting period by DBT alone or by DBT together with its partners.
- There was no list of transferred know-how knowledge to commercial partners.

- There was no documentation on consultant contracts of DBT scientists with external partners.

In this situation we are obliged to refrain from giving judgment on this highly relevant criterion for the scientific and technological efficacy of DBT.

- ***Sharing with or providing intellectual property rights to external partners***

The Peers did not see written guidelines from DBT or BOKU relating to handling intellectual property rights by the scientific members of DBT. Such guidelines should be available and be accessible to every scientific employee of DBT.

These guidelines should cover principal directives on handling inventions with respect to:

- technical knowledge generated solely by resources supplied by BOKU;
- inventions by R+D partnerships of BOKU jointly with partners;
- inventions from BOKU, but fully funded and directed by external partners.

Also, these guidelines should give directives on access and use of prior intellectual property before the start of a project developed by DBT on behalf of BOKU.

The Peers felt that they did not see sufficient transparency in these aspects, based upon the documents available for evaluation.

- ***Confidentiality in R+D projects for industrial partners***

During the course of the on site evaluation, DBT members explained that a confidentiality agreement with an external cooperation partner is binding for all members of DBT. DBT is said to sign for all members of its staff. This broad personal coverage is against professional practice, because in this way confidentiality can not be properly controlled, and extends non-disclosure aspects to individuals who either would not be involved, or who may choose to investigate a similar subject area independently and because of their own initiative and on their own and independent invention potential.

It may cover the well-meant institutional interest to have undisturbed scientific information flow within the DBT. However, it raises the risk of uncontrolled demands on individual and institutional intellectual properties. Rather, confidentiality agreements should be restricted to each singular project by definition of the special working topic and only include those persons who are especially involved in the given project.

As a consequence, the Peers see a need for the preparation of appropriate guidelines for those within DBT who work for commercial projects.

- ***Impact of technology transfer on scientific freedom***

In the hearings during the evaluation, members of DBT raised concerns because of delays in publication by intervention of external partners. Moreover, it was claimed that the individual publication output from joint projects with industry was hampered or delayed because of a requirement to withhold specific knowledge with commercial sensitivity. This would be justified for projects funded completely by industry. However, the Peers advise to reconsider this policy in the case of partially externally-funded projects, and particularly in the case of doctoral studies and postdoctoral research positions.

4.2.4. Comparative rating of academic and research activities

Without doubt, the technology transfer activities of DBT are outstanding, and are at the cutting edge of such activities at an international scale, considering the university setting. The DBT has been in focus for the international animal cell culture network since the establishment in 1976 of the European Society for Animal Cell Technology (ESACT), with Prof. Katinger as one of the initiative-takers. This international focus on BOKU-DBT was

further emphasised by the instrumental role of Prof. Katinger in the establishment of the first industrial large-scale production plant for animal cell-based products: the α-interferon production at Boehringer Ingelheim Austria in 1980.
The teaching efforts are excellent, widely acknowledged by the students because of the logical and straightforward curriculum, the excellent relation with the teaching staff and the bright perspectives on the job market. We suggest, however, that some optimisation is nevertheless required to further strengthen the educational role of the department.
We also propose that the departmental publishing activity can be somewhat improved both in quantity (there are only 38 SCI-indexed publications per year for a scientific staff of about 80), and perceived quality by stimulating the ambition to publish more manuscripts in higher-ranking journals. Peer-reviewed publications (Originalarbeiten) of DBT often have several of the group leaders as authors in the middle of a series of authors. This makes it difficult to attribute singular discoveries to individual researchers in DBT. A fair evaluation of the individual scientist, say in case of an application for an external position, may turn out not be too easy. Moreover, their publication listings do not make a difference between publications in peer-reviewed journals of international recognition, congress lectures, poster presentations or abstract publications.

5.0 Future development of the DBT

5.1 Definition of research priorities

A central core of the DBT activities is the use of genetic information for discovery and production of new products, mainly recombinant proteins. The slogan "from gene to product" was heard several times during the evaluation. This concept has been very successful but it requires the integration of a range of scientific knowledge and technologies. Some of these must be incorporated through co-operation, but a certain critical mass of competence must be available in-house for a successful development. The Peer group has identified a number of these core competences which have good prospects for continued successful development at DBT and should be considered for establishment of permanent chairs.
The committee recommends to the steering committee of DBT to identify the working areas with a focus on technology development, and by the same token also identify the working groups where basic research is kept and identified as a safeguard to keep DBT in a technology lead position in coming decades. Existing in DBT are areas of high need for continued basic research and intensified efforts such as research work in molecular and cellular biology of differentiation and growth regulation in animal cell lines on one hand and, second example, theory and practice of novel chromatographic processes in the downstream phase.
Recruitment of new professors should take care to integrate complementary research potential and forward looking topic portfolios in the selection of applicants.

These are the areas of high importance for DBTs future as the Peers see it:

"**Animal cell design**" to which several working groups contribute today. This is a necessary activity for a continued successful development of animal cell technology for production of vaccines, antibodies and other biopharmaceuticals which require the more advanced posttranslational modification machinery of higher eukaryotic cells. Considering that more than 50% of the new biopharmaceuticals that are registered by FDA are based on animal cell hosts, further focusing on this area should be fruitful.

"**Microbial cell design"** which at DBT today mainly is focussed on metabolic engineering of yeast cells for production of recombinant proteins or commodity chemicals. Large expectations are currently raised on the so called white biotechnology as a means of

developing processes, for production of commodity chemicals from renewable sources, and with less environmental impact than that of traditional chemical synthesis. This technology builds on a combination of applied molecular genetics and physiology, metabolic flux analysis and mathematical modelling. It is expected to be a major focus on this technology in ECs Framework 7 program, and the probably best show-case is DuPont´s new giant production plant for 1,3-propane-diol from corn-derived glucose for synthesis of polyesters for textile manufacturing.

"**Macromolecular interaction and design**", often in practice applied as "protein engineering" is a key competence not only for design of proteins with specific properties for analysis/diagnostics, pharmaceutical use, and separation purposes, but it can also be a fruitful tool for nanotechnology. The strategic importance of this technique is illustrated by the fact that most proteins that are commercially produced today are modified versions of native proteins.

"Bioprocess reaction engineering" for design, modelling, and control of bioreactors, including animal cells and micro-organisms as well as enzymes. At BOKU there is a very high competence in this area for animal cell- and *E. coli* bioreactors. Continued focus not only on animal cells but also on *E. coli* as a host for recombinant protein production seems strategically relevant since most of the new non-animal cell derived biopharmaceuticals are based on E. coli. The FDA initiative on Process Analytical Technology is expected to put a large demand on a scientific understanding of the reaction process, which will make this competence, which is today very well established at DBT, strategic for future commercialisation of biopharmaceutical processes.

"Downstream processing" is a bottleneck in most biotech processes, and especially in the biopharmaceuticals production. DBT has a unique and highly recognised competence in this area, which must be consolidated together with the strain design and reaction engineering activities in order to enable DBT to keep its successful position in industrial biotechnology.

“Phytobiotechnology” has attracted increasing attention recently because of the potential to generate plants which overproduce technical enzymes or therapeutic proteins like antibodies. The DBT has a broad technical experience in plant transformation and the use of tissue-specific promoters which should be of advantage in establishing a plant cell technology platform for the production of biopharmaceuticals or vaccines.

The focus areas above depend deeply on a number of other sciences/technologies. Among these are the **Bioinformatics,** which we see as an important part of DBT. It was, however, not clear to the Peer group to what extent the applied activities in the working groups of DBT could rely on support from the Chair of Bioinformatics. This discipline has of course its own interdisciplinary goals but is important for a successful development in several of the areas mentioned above that sufficient resources are allocated to Applied bioinformatics.

5.2 Measures to be taken

5.2.1 Recruitment of new professorships

The research priorities discussed above are examples of areas and directions into which biotechnology will move or continue to move in future, and the committee leaves it to the discretion of DBT and BOKU to assign the new professorships to these fields. It supports the contention made during the evaluation that the new positions should not only be announced

by advertising in journals, but a search committee should be set up which directly approaches potential candidates. Both the search committee and the recruitment committee should be reinforced by members from outside BOKU, and should include international experts as major contributors. The recruitment should be an open and competitive procedure.

The advertising of the new chairs which are to be installed (discussion with the Rector Professor Dürrstein) must be preceded by an agreement between the DBT and BOKU managements on the infrastructure (personnel, space, budget) which is available for each of these professorships. Instalment of a new full position without such support is not advisable since sufficient basic support must be provided to attain a critical mass for the research and teaching obligations and for fund raising.

It is also inevitable that the implementation of new full professorships leads to a change in the structure of the management of DBT. A steering committee headed by a rotating chair might be a solution which is not too intrusive for the present structure.

Finally, since the retirement of Professor Sleytr from the Department of Nanobiotechnology takes place at around the same time as that of Prof. Katinger, the discussion of the future of this department should be included in the considerations of shaping a "new DBT".

5.2.2 Need for new skilled technical staff

One of the major complaints brought forward by almost all postdoctoral researchers and lecturers who participated in the hearing, was that there is a severe lack of skilled staff for the maintenance and operation of high-tech equipment. Biology and biotechnology becomes more and more technology-driven and the availability of such equipment will be one of the major selective forces for competitive cutting-edge science. Whereas university chancellors and research funding agencies are readily convinced to buy such equipment, they usually are reluctant to provide the necessary but expensive human resources to back up the operation. It requires stable and attractive contracts to recruit and retain the operators since they are also sought by industry, which generally offers much higher salaries. BOKU as a life science university is in the unique position to set up such core facilities. They should be established as independent units that function between departments and serve all working groups of the university on a cost-effective basis Also core facilities jointly financed by the three Vienna universities could be considered. This is the only way to guarantee easy access at fair costs, to take full advantage of the potential of the equipment and technologies, and at the same time obtain expert advice on the analysis and interpretation of the data generated.

In the documents and during the hearing, steering committee members expressed the need for one additional administrative staff member and one additional technical staff member. In the discussion between the head of peers and selected staff members, convincing data were presented that the secretarial and the IT offices are under-staffed. The committee recognises this fact but believes that no immediate action is necessary prior to installation of the new professorships. The reason is that the number of non-scientific staff members listed in the self-evaluation document does not match the number in the list provided by BOKU. Moreover, problems with the handling of the SAP software are certainly not permanent, and will be fixed. Additionally, the handling of student affairs has become much less labour-intensive because of the introduction of the web-based Blis (citation of a staff member). The committee suggests that dealing with this issue should be postponed until the new full professors have been recruited, and who will then negotiate their personnel with BOKU.

5.2.3 Facilities

A visit of the research areas at Muthgasse convinced the committee members that the DBT possesses an impressive assembly of modern and high-tech equipment. This is due not only to the extremely successful external fund raising activity of the department, but also to the

provision of federal resources. Temperature regulation in the air conditioning has to be reworked. No additional necessity for immediate action is seen under the present financial situation.

In contrast, however, the library situation is unsatisfactory. The change from a traditional library to a fully electronic system is proceeding rapidly everywhere, and will obviate central library rooms and the positions of traditional librarians. It necessitates, however, the full access to electronic journals from publishing companies (like Springer Verlag) whose journals are not accessible at all at BOKU (comment of a staff member) and the purchase of databases such as SciFinder. Such subscriptions must probably be made at the BOKU (or national) level. For the SciFinder database, the costs can probably be shared between DBT and Dept of Chemistry: they should not be prohibitive and would pay off in terms of increased efficiency in both education and research. Quick and efficient access to the global scientific and technology literature by electronic services has become a standard at all relevant life science research institutes in the world. BOKU has to quickly react, as the committee sees it.

5.2.4 Budget

The committee was unable to gain a clear overview of the sources of the budget and on the allocation for teaching, for the research of the working groups, and for 'house keeping'. It appears that all funds (federal, competence centres, working group projects) are "networked" and cannot be broken down. Many staff members are listed in their "working group" and also in one of the centres. The committee is therefore obliged to refrain from making specific suggestions apart from the very relevant one that teaching and administration costs must be covered entirely from Federal funds. Teaching costs also include expenses for the preparation of Master theses (the Bachelor theses do not require experimental work), whereas it is customary (internationally) that the expenses for doctoral and postdoctoral studies must be solicited via grant applications. The expenses for teaching are easy to extract by taking the average expenditure per working place in the lab courses and for a Masters thesis. Usually the per month costs of a Masters thesis are much less than those of a doctoral thesis. The form on the "Verordnung über das formelgebundene Budget der Universitäten" is so complex that it lacks transparency and consequently acceptance. The expenses for travel should be paid from project funds since travel is mainly research related.

The fact that the DBT raises an impressive amount of third party funding does not fully justify its claim that a proportionally higher ratio of Federal funds must be provided by BOKU. Although it documents the extraordinary activity and success of the staff, one must accept that disciplines naturally less close to industrial partners must not be disadvantaged.

A major concern of the committee connected with budgeting is that the financial situation is very labile. Industry may draw back its support at very short notice (e. g. Rutgers Institute, Miescher Institute) which leads to insolvency within weeks since, according to Professor Katinger, about 75 % of the total expenses of DBT are acquired via ACBT. The financial resources of ACBT will hold until May 2009. What comes then? Some agreement with BOKU must be sought to cover periods of "scarce money".

6.0 Outreach Activities

The previous name of this department at BOKU, namely Institute of Applied Microbiology (IAM), was very well recognised in the scientific biotechnology community. We noticed that DBT to a large extent still uses the IAM logotype in its presentations. This makes a confusing image of the DBT and we recommend that the DBT develops a strategy for how to introduce the new name in the scientific community without loosing the historical reputation of IAM.

The DBT and BOKU are in an excellent position to raise and foster public awareness of life science, because of their research agenda in biopharmaceuticals, vaccination, nutrition

and with regard to genetically-modified organisms. Members of the staff regularly present research topics in special life science issues of “Die Presse” or contribute to round table discussions on Austrian television. The engagement of Prof. Sterflinger in the conservation of frescos and stone monuments of public historical property is an absolute highlight of an activity which catches public attention. Professor Laimer has set up a website intended for the public to express questions and opinions, especially in relation to transgenic plants, but so far the responses have been very few. Perhaps this should be advertised in some manner to increase public awareness.

On the professional side, a series of advanced training courses was offered during 2004, namely on:

- Animal Cell Culture Technology
- Bioprocess Development for Mammalian Cell Cultures
- Basic Flow Cytometric Methods for Biotechnology
- Advanced Flow Cytometry and Cell Sorting for Biotechnology

These courses create awareness of DBTs expertise both in academia and the biotechnological units of national and international companies. The courses are a highly efficient tool for networking and acquisition of collaborations.

The Peers applaud to all these activities and encourage an increase if possible in order to promote the public visibility of DBT and BOKU. One strategy for visibility in the society and recruitment of talents which works well in German and UK universities, is that staff members go out to schools and present their work in comprehensible lectures to those students who are considering applying to university. Catchy CDs with the main research and application fields of biotechnology could be distributed.