

**Centre for Advanced Food Studies - LMC**

**Meeting of the  
International Advisory Board (IAB)  
June 6 - 10, 2005**

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# 1. Introduction

This is the report of the 7th IAB meeting since LMC has been formed in 1992. The 6th meeting took place in January 2002 in conjunction with the Annual Danish Food Conference. After that meeting it was agreed between the Board of LMC and IAB that the mode of operation and the terms of reference for IAB should be reviewed in order to make the contributions of the IAB to the future development of LMC as valuable and relevant as possible. For this purpose the Chairman of IAB met with the Director and with members of the Leader Group of LMC on two occasions in order to draft the new terms of reference and to prepare the next IAB meeting. It was felt in particular that the IAB should have more interactions with individual working groups in each department of LMC and that if possible the whole IAB should meet for a full week and preferably not in conjunction with any other official activity of LMC such as a symposium or conference. At the same time it was decided to extend the period between IAB meetings to three years and to allow flexibility in defining the number of IAB members and their scientific expertise.

The 7th IAB meeting was organized according to the new terms of reference and took place from Monday, June 5, to Friday, June 10, 2005. Three members of IAB, Felix Escher, Einar Risvik and Alfons Voragen, had already served on former meetings of IAB and therefore were familiar with LMC, while the other five members, Peter Fryer, Per Einar Granum, Oscar Kuipers, Hal MacFie, and Ann Prentice were new on the board. All members were provided well ahead of the meeting with the detailed schedule for the full week, with an in-depth documentation on all activities of LMC, and with a proposal on how the evaluation of individual working groups should be carried out and how the report could be structured. Where requested by individual IAB members, additional written information was provided by LMC during the meeting.

After an informal get-together on Sunday evening and the general introduction to LMC in the first part of Monday morning, the IAB split up for the next two and a half days for the visits with 21 individual groups at their respective sites in Frederiksberg, Lyngby, Aarhus, and Foulum. Of all research groups belonging to LMC, only those of the Danish Institute of Fisheries Research (DIFRES) were not visited as their activities were reviewed in 2003 by another team. The Department of Food Science at the Danish Institute of Agricultural Sciences (DIAS) was visited simultaneously by an international expert panel in compliance with the statutes of DIAS. Thursday was reserved for the whole IAB to prepare the draft report, and to attend the kick-off meeting for the project PathogenCombat within the EU 6th Framework Programme, and for a formal meeting followed by a dinner with the Chairman of the Board of Directors of LMC and members of the Industrial Board of LMC. The dinner was also attended by officials from both KVL and DTU. On Friday before lunch the IAB 2005 meeting was closed officially by a one hour debriefing session in which the IAB members presented their conclusions to the director of LMC, the head of institutes and the group leaders. The director of LMC wrote an executive summary from the conclusions drawn at this session by the IAB that was circulated the week following the IAB meeting.

On June 16, a preliminary draft report was submitted to the director of LMC. The preliminary version was subsequently complemented and revised to the final version. In the report, priority was put on the detailed account on the 21 groups, each written by those members of the IAB who visited the respective group. Accordingly, the format of the sections on the individual groups varies, as does the style and the wording for expressing the judgement on the qualifications of the groups.

## 2. Members of IAB

Prof. Dr. Felix Escher (Chairman)  
Swiss Federal Institute of Technology Zurich  
(ETH)  
Institute of Food Science and Nutrition  
LFO-Building  
Schmelzbergstrasse 9  
CH - 8092 Zürich, CH  
Telephone: (+41) 446323285  
Fax: (+41) 446321123  
E-mail: [felix.escher@ilw.agrl.ethz.ch](mailto:felix.escher@ilw.agrl.ethz.ch)

Prof. Alfons G. J. Voragen  
University of Agriculture Wageningen  
Dept of Food Technology and Nutritional  
Sciences  
Food Chemistry Group, P0 Box 8129  
Bomenweg 2  
6703 HD Wageningen, NL  
Telephone: (+31) 317483209  
Fax: (+31) 317484893  
E-mail: [Fons.Voragen@wur.nl](mailto:Fons.Voragen@wur.nl)

Dr.agric. Einar Risvik  
Matforsk AS  
Norwegian Food Research Institute  
Osloveien 1  
N-1430 Ås, NO  
Telephone: (+47) 64970181  
Fax: (+47) 91374880  
E-mail: [einar.risvik@matforsk.no](mailto:einar.risvik@matforsk.no)

Prof. Oscar Kuipers  
Molecular Genetics  
University of Groningen  
9750 AA Haren, NL  
Telephone: (+31) 503632093  
Fax: (+31) 503632348  
E-mail: [o.p.kuipers@biol.rug.nl](mailto:o.p.kuipers@biol.rug.nl)

Prof. Peter Jonathan Fryer  
School of Engineering  
Chemical Engineering  
The University of Birmingham  
Edgbaston, Birmingham  
B 15 2TT, UK  
Telephone: (+44) 1214145451  
Fax: (+44) 1214145324  
E-mail: [P.J.Fryer@bham.ac.uk](mailto:P.J.Fryer@bham.ac.uk)

Dr. Ann Prentice  
MRC Human Nutrition Research  
Elsie Widdowson Laboratory  
Fulbourn Road, Cambridge  
CB1 9NL, UK  
Telephone: (+44) 1223426356.  
Fax: (+44) 1223437505.  
E-mail: [ann.prentice@mrc-hnr.cam.ac.uk](mailto:ann.prentice@mrc-hnr.cam.ac.uk)

Prof. Per Einar Granum  
Norwegian School of Veterinary Science  
Department of Food Safety & Infection  
Biology  
P.O. Box 8146 Dep  
0033 Oslo, NO  
Telephone: (+47) 22964845  
Fax: (+47) 22964850  
E-mail: [Per.e.granum@Veths.no](mailto:Per.e.granum@Veths.no)

Dr. Hal MacFie  
Dr. Hal MacFie  
Hal MacFie Training Services  
43 Manor Road, Keynsham, Nr Bristol  
BS31 1RB, UK  
Telephone: (+44) 1179863590  
Fax: (+44) 1179863590  
E-mail: [hal@halmacfie.com](mailto:hal@halmacfie.com)

### **3. Terms of reference**

#### **Terms of Reference for the LMC International Advisory Board**

##### **1 Purpose**

- 1.1 LMC's International Advisory Board (IAB) is established in compliance with article 7, item 4 of the LMC bylaws.
- 1.2 IAB advises LMC on scientific, educational and administrative issues, both at the strategic and the operational level.
- 1.3 IAB shall support LMC in achieving goals as stated in the LMC strategy.

##### **2 Composition and appointment.**

- 2.1 The IAB consists of internationally recognised external scientists representing the area of food science, food microbiology, food technology and human nutrition, and with expertise in research and/or educational management.
- 2.2 The chairperson of IAB is appointed by the board of LMC after nomination by the director of LMC.
- 2.3 The individual members of IAB are appointed jointly by the director of LMC and the chairperson of IAB.

##### **3 Mode of Operation**

- 3.1 The IAB will fulfil its tasks by IAB meetings, scientific visits - including interviews, presentations and discussions – and submission of a final report.
- 3.2 LMC will in due time in consultation with the IAB chairperson prepare and set the programme for the IAB meeting.
- 3.3 Three year intervals between IAB meetings are preferable, and intervals should be at least two years.
- 3.4 IAB meetings shall produce an advisory report, which should be ready within one month after the IAB meeting. The chairperson of IAB shall in person present the finalised report to the board of LMC.

## 4. Acknowledgements

The IAB would like to express its gratitude to the following

- The Chairman, Members and Accessors of LMC's Board of Directors, and the Members and Accessors of LMC's Board of Representatives for their trust in the IAB
- To Lisbeth Munksgaard for developing the appropriate strategic and operational frame of the IAB meeting, for her most competent guidance and her personal commitment during the whole week of our stay in Denmark
- The Heads of the institutions visited for providing concise overviews on the scientific, educational and administrative setting of their institutes, and for their openness in discussing the various issues of LMC
- The Group Managers, staff and students who prepared documents for evaluation, made presentations and participated actively and open-minded in the discussion sessions
- The secretariat of LMC, especially Lisbeth Nannerup and Kirstine Dal for their excellent preparation for the IAB meeting, their continuing support in all administrative matters and their most kind hospitality during our visit.

The IAB enjoyed serving LMC and felt that IAB Meeting 2005 was indeed a rewarding experience.

## **5. General considerations**

### **Overall Development**

The IAB is generally impressed with the excellent growth and development over the last three years. In this context the board welcomes the arrival of new members and the fact that the LMC now represents almost 100 % of public food research in Denmark. This broad umbrella gives LMC the possibility to provide researcher-to-minister communication in terms of potential scientific opportunities and policy development.

The IAB was pleased to record the evaluation of a majority of good scientific endeavour, world leading in some areas, and on a track of progress in many others. Therefore, the overall impression of the scientific achievements and the current activities of LMC is positive.

The IAB observed a clear improvement in the management of LMC. The leadership by the new director of LMC is excellent and has earned respect by both the scientists within LMC and the external partners. The management style on the LMC, the institute and the group level is generally effective. An increasing interaction between groups has been observed. Of course, some interactions are less visible or more difficult due to the geographical distances between the respective groups and institutions. Interactions with new members of LMC also wait for further development.

The excellent management and the openness of the groups is contrasted by a still low visibility of LMC. Branding is weak when it comes to internet accessibility of information on LMC. Also, a LMC intranet is not in operation yet.

LMC has developed into a system of unique infrastructure both for research and education. At present, the national funding as well as the funding from EU is excellent. However, with the large proportion of external funding, there is the danger that long-term recruitment of the best scientists and investment into equipment and instrumentation is endangered. Therefore, the IAB expresses some concern regarding the future financial base for the development of LMC.

Although LMC has included both food science and nutritional science from its beginning, the two domains still appear to co-exist without increasing interactions. There is no doubt that human nutrition and health aspects need to have greater emphasis in the LMC portfolio.

### **Education**

The question of coordinating the education in food science on the Bachelor level between KVL and DTU has been solved.

MAPP and DIAS as new members of LMC offer new opportunities in the Master programmes. The role of MAPP in the Master programme is an essential contribution that will make the education more contemporary and attractive to students. This perspective can draw a lot of new students to the education, which is a priority articulated to us by the industrial representatives of LMC. Likewise, DIAS can provide expertise for Master programmes in areas such as meat science which are of high priority to the Danish agriculture and food industry.

The establishment of the Graduate School FOOD under the flag of LMC is a very promising initiative which will certainly increase visibility and impact of LMC both nationally and internationally.

### **View by industry representatives**

The IAB took note that Danish food and food ingredient industry is very supportive to LMC in principle. Industry acknowledges the increasing openness of LMC towards industries' needs and concerns. Industry perceives that food research does take place in LMC under a coordinated effort, in particular since the new members joined the centre.

Industry stresses that coordination of research efforts and increased visibility are even more important for LMC in the future because other research institutions outside the food and nutrition sector have detected 'food' as very attractive topic for high quality research. In addition, there is a trend in Denmark for regionalisation which also means that institutions other than LMC are being supported for their local activities in academic research and education. Therefore, LMC will have to compete more seriously for research funding.

As for any other research institution with partnership to industry, LMC is faced with the question as to how to find the balance between focussing projects on specific problems and being broad enough to keep a high level of scientific expertise, e.g. for teaching obligations. Likewise, LMC has to be aware of the type of industry partner in a country in which 80 % of the turnover is based on 10 companies. This does not imply that SME organisations are not attractive as industrial partners of LMC. Once SME are committed to basic research projects they can present indeed very stimulating partners. To create networks among SME enterprises could be one way for stimulating research collaboration.

Most of the scientific areas seem to be covered to the satisfaction of the food and food ingredient industry. Interaction with food industry is increasing in a positive way. Only minor shortcomings were expressed by industry representatives, as some industries apparently would like to see the microbiology domain having more contact with the food industry.

Industry representatives stress the need for more graduates on the Master level. At present, there seems to be a shortage of MSc graduates who would be available for an industrial career. Industry encourages LMC to take initiatives for increasing the enrollment for MSc students in food science and technology.

### **Strategy**

The IAB welcomes the new strategy and in particular the identification of the major competences in Danish food science. It appreciates the identification of the future joint focus areas and looks forward to further focussing activity in the next phase.

Examining the development goals for 2005 and 2006 of LMC at large, there is nothing the IAB would like to change or to add. On the other hand, the strategic ambitions for KVL under the LMC umbrella foresees increased activities under 18 areas, and this comprises the major part of the current effort. The economic ambitions amount to 3 mill DKK and this is insufficient for the proposed scientific programme. A revision is necessary taking into account the current financial situation to make scientific targets realistic and achievable.

In a more general way, the IAB did observe a degree of scepticism among scientists as to the value of LMC. A key objective over the next phase of its development should be to improve this perception by solid activities that clearly benefit scientists on the ground, as opposed to those in management positions in the board.

Key roles for the LMC in terms of serving the scientists it represents are threefold:

- Provide a highly visible marketing operation in terms of promoting national and international awareness of the research capabilities and graduate, post graduate and industrial courses being offered. In this regard we recommend the development of a more powerful web page and increased visibility and circulation of newsletters etc.
- Enhance the current communication channels to policy makers and research funding vehicles at the national and EU level. It is recommended that the director and the board consider carefully which committees should be targeted and to select the most effective LMC representatives to man these in terms of political and technical level. Dissemination of the implications of these committees in terms that individual scientists can comprehend will increase their perception of the value of LMC activities. Organisation of meetings that bring scientists into contact with industrial and policy makers may also be useful in this regard.
- Continue to encourage and promote multi-disciplinary project initiatives that target scientific initiatives and/or policy or industrial needs. These initiatives will involve LMC partners and will provide more impact considered in total than the sum of their parts.

## **6. The individual research groups**

### **6.1 KVL - Department of Food Science (IFV)**

#### **6.1.1 Overview**

The Department of Food Science is part of KVL and comprises six major domains. Four of them are discipline oriented, i.e. Food Chemistry, Food Microbiology, Quality and Technology, and Sensory Science, while the other two areas are oriented towards the two most important commodity groups in Danish agriculture and food industry, i.e. Meat Science and Dairy Technology.

The department has developed a clear profile for research and education which provides the necessary base for future development. Its organisation is in compliance with the new legislation for Danish universities of July 2004. The department issued straight-forward academic goals for the period of 2005 to 2006 and carried out a balanced SWOT analysis. With the support of the well visible leadership, the Department of Food Science is capable of bringing the six quite diversified groups together into an internationally competitive unit.

Within LMC, KVL is responsible for the education in food and nutrition on the Bachelor level. Accordingly, the Institute of Food Science is charged with considerable teaching responsibility in food science and technology. It is equally involved in the teaching obligations towards the Master Degree and in continuing education, and it plays a key role in the newly established Graduate School Food for the Ph.D. programme.

#### **6.1.2 Food Chemistry**

##### **General comments**

The Food Chemistry group aims at understanding the physical and chemical reactions determining the quality of food on a molecular basis employing disciplines like spectroscopy, kinetics and thermodynamics. They are very successful in carrying out this mission in an integrated way, in research as well as in education.

##### **Quality and quantity of the work**

This is an outstanding group that is among the leading groups in the world in the fields of oxidation kinetics and anti-oxidant mechanisms, high pressure technology particularly in relation to protein chemistry, phase transitions in food, food packaging including bio-packaging and catering, quality of meat and meat products and iron availability in which their leading position in application of ESR-spectroscopy in food science is instrumental. This is reflected in the international reputation of the group, the number and quality of publications, including prestigious review articles, published in international-quality journals, many of them with impact factors considerably higher than typical for this research area.

The group has established state of the art facilities for studying physical changes and chemical reactions in foods and food systems that allow study of all stages of the chemical processes on relevant time scales and the different effects on the food (model systems). However, the group may be hampered in their work in the near future by the fact that some crucial and expensive equipment is getting obsolete. The group urgently needs to replace its ESR-spectroscopy facilities and to update the Laser Flash Photolysis. These replacements are not only essential for the Food Chemistry group but also for the many other groups within LMC who rely on this infrastructure in collaborative research projects with this group.

The group has an extensive network, nationally as well as internationally: in the region (Sweden, Øresund) in Europe and in the world. Their scientific reputation and the MRI platform have been instrumental in this.

### **Management of the group**

The group is organizationally well structured with the following substructure:

Physical Food Science,  
Minimal Processing, Food Biotechnology and Chemical Food Safety  
Oxidative Changes in Foods  
Molecular Gastronomy as a new initiative

Each subgroup is headed by an associate professor who, together with the group manager, forms an advisory group. The goal in their research is to understand the physical and chemical reactions determining the quality of food on a molecular level employing disciplines like spectroscopy, kinetics and thermodynamics. All members of the team can contribute according to their competences and expertise and everyone take his share of the responsibilities. They form a dynamic team with high, but realistic ambitions and are very responsive to new developments in science and in society. An example of this is the new initiative for molecular gastronomy.

### **Recommendations**

We recommend that:

- The infrastructure of the group is updated, which will benefit the group as well the many others with whom they have collaborations.

### **6.1.3 Food Microbiology**

#### **General comments on the research group**

This research group has two full professors, 6 associate professors and 2 lecturers. In total about 40 people is involved. About 10 of these are PhD students.

Relevant and strong program focusing on functionality of food associated microorganisms, health, food fermentation and food safety. The group has a strong link to Africa on indigenous food fermentations to improve food security and safety in Africa. Good publication record with

good/very good papers. The group is also active in using eukaryotic cell lines to study host-microbe interactions, gut microbiota and probiotics. They have various national and international collaborations. Teaching load is on average 40% for permanent staff.

### **Quantity and quality of the research**

- The scientific goals are clear and are largely met.
- The group intends also to fulfil new goals, including a very large EU project lead by professor Mogens Jakobsen
- The publication level is good to very good
- The dissemination of knowledge is adequate by general publications
- Their research has a very high input on increasing scientific expertise of the department especially in food safety, probiotics and food fermentation.
- Results achieved certainly add to existing knowledge.
- The use of optical tweezers, interactive optical trapping, single cell analysis, African indigenous food fermentations, non-quorum sensing systems in cell-cell communication are quite unique in food research
- They have strength in providing a complete spectrum of food relevant research approaches in educating new scientists
- They are very well suited to solve problems for the food industry

### **Relevance of the research in the group**

- Very well chosen and relevant subjects for food research
- For a large part the major challenges are attacked
- Focus is both on national and international (3<sup>rd</sup> world) problems. The three major areas are indeed very important

### **International standard of the research**

- The quantity of the research is well positioned internationally. The quality is good to very good. Some more focus on the most interesting and promising areas (e.g. host-microbe interactions, probiotics, food safety) could further enhance and improve the research. Further collaborations in Systems Biology are advised.
- Very well funded by EU (new IP granted by coordinator Jakobsen). Other international funding is also available
- Research areas internationally in front: single cell microbiology, indigenous African Foods, food safety, novel (meat) probiotics
- They could come in front on the single cell microbiology, influence of microbiota on human health
- Some areas exist where funding is hard to obtain, due to a decreased industrial interest. These areas could be considered for redirection (phage biology, classical fermentations)

### **Plans for the next 2-5-years period**

- Well thought-out plans for next period: functionality of starter cultures, probiotics, food safety by new intervention strategies, indigenous food fermentations in Africa

- Choices could be made in the field of food fermentation to further sharpen the focus (population dynamics vs. single strain studies). System Biology could be further strengthened
- Techniques for studying host microbe interactions might be further developed, e.g. IVET, conditionally essential genes

### **Relevance for industrial application or public aspects**

Well supported by public services and industry. Ten patents filed over the last 5 years, very good industrial innovations (new strains selected). The new EU project is closely linked to the industrial needs.

### **Benefit of collaboration possibilities**

- The group uses other facilities frequently (also proteomics in future)
- Lots of national international collaborations
- They have used various contacts to apply for funding which has been quite successful.

### **Management of the group**

- Management structure is adequate, although internal communication could improve (e.g. joint lunches, more meetings). There is substantial permanent staff who all have own research teams. Merging of some teams could be considered to increase critical mass in most important areas. Also number of PhD students per staff member could increase to 2-3 per scientist.
- Effective reporting internally has improved due to starting a strategy team. External reporting via reports and publications also in popular journals.
- The research led very effectively to the goals set, and complied with planning and budget, as far as can be judged.

### **Recommendations**

#### Major strengths:

- Many scientific competences
- Cooperation with industries
- Good social environment
- International environment
- Well equipped (but is also concerned to keep up)

#### Weaknesses:

- Internal communication could be improved
- Physical separation between the group members
- Too many subgroups

#### Opportunities:

- Further scientific developments also in biotechnology (genetics)
- Threats: Decreasing numbers of students

### Recommendations:

- Consider merging some small research teams into larger with common focus (max 3-4 teams).
- Future collaborations could be extended in the fields of assessing probiotic health effects, GI tract ecology, antimicrobial agents and systems biology.
- Fund raising is a strong point of the group (continue with good industrial relations).
- Improvements in quality of publications still possible although it is already good/very good. One way would be to attract more PhD students.
- Should focus more on spore forming bacteria (needed by industry)

## **6.1.4 Meat Science**

### **General comments**

Denmark is a country where meat science should be very important. The challenges for the Danish meat industry should be reflected in the long-term goals of the Meat Science group. For Denmark it will be essential, to meet increasing competition from countries with lower production costs, to meet competition with the best possible available knowledge to generate products with increased added value. This is the only possible strategy to compete with countries where competence is not at the same level as in Denmark. The long term strategy must therefore reflect the role of research based knowledge in improved industrial competitive ability for long term survival

The group is still recovering from the long period without a professor, but improvements are already visible after the arrival of the new professor. Financial support from LMC and KVL is still the primary source for research activity. There is considerable potential for growth through external financial support. The group still suffers from being below critical mass. The adopted strategy of seeking extensive external funding will hopefully bring in support for additional scientific staff. That one of the strong activities in the group is currently moving to the formation of a Centre of Excellence in Advanced Food Imaging makes even more important. There is no reason not to support the Advanced Food Imaging Centre, but the consequences for the meat science group could be severe if the link is not preserved through firm collaboration.

### **Quality and quantity of the work**

The scientific and technical standard of the work is high, with publication record greatly improved from 2004 and above the LMC average. Meat science is a very small science area internationally, and so is the group at KVL, but the group is still among the strongest. However, the group size is small and thus vulnerable. Therefore, it is important that national and international collaboration is encouraged.

Education is important and its role should be expanded. With the unique position of a Master programme in Meat Science, LMC must now consider taking a lead role in providing Europe with a comprehensive graduate programme in meat science. The established graduate school provides for a leading role, in collaboration with other European partners. Europe has no graduate programme in meat science, as far as the IAB is aware of, and Denmark should take a lead in this.

The research in meat tenderisation is close to several other international teams but of comparable quality. It is important to evaluate the direction and extent of this to ensure that KVL is making a

unique contribution and to avoid unnecessary overlap in a well established field, and several long standing groups.

There is strong work on imaging and visualisation within the group. It is proposed to expand this through the creation of a Centre of Advanced Food Imaging to act as a focus for both academic and industrial research in a range of imaging methods. This is a very powerful concept which should be developed with the aid of LMC to establish as wide a skill base as possible. Once established, a centre of this kind could easily evolve towards very interesting applications in other areas of food science and human medical applications. It is critical to do this without losing the links to meat science or the consequences for the group could be severe; if the links are preserved a Centre of Advanced Food Imaging could be a large asset for meat research at LMC.

The Meat Science group, has strengths through close collaboration with other groups in LMC, such as Sensory Science and Quality and Technology, this is very positive. As consumer demands will increase in importance for value added creation in the meat industry, the link to consumer and sensory science will increase in importance for strategic choice of directions of the group. The link with the DIAS meat group is obviously also of critical importance and must be maintained and deepened.

The strategy of the group suffers from being very ambitious and not coherent. A plan for further focus could be encouraged; at this stage a range of applications have been made in a wide range of areas, as the first priority is to establish the group on a more secure financial basis. Once this is done the strategy of the group should be reassessed and a more realistic approach taken.

International collaboration is well established in the team, but national cooperation towards industrial partners is not as strong. The meat industry is not as competence-intensive as other parts of the food sector (such as dairy), so there is a need for increased strategic communication and collaboration with the industry to be established. Better industry links will provide feedback to the group of the strategically important knowledge base that is needed to build national strength for continuing meat production in Denmark.

### **Management of the group**

Management is in place and taking effect following the (relatively recent) professorial appointment.

It is important that the group establishes critical mass. Currently there would be large setbacks if single individuals chose alternative careers to that of the group strategy.

### **Recommendations**

We recommend that:

- links to the Danish meat industry are strengthened, through communication and collaboration, and a strategy established in line with long term competence needs of the industry
- the group establish a portfolio of externally funded projects in line with that strategy
- the feasibility of establishing the Centre of Advanced Food Imaging be investigated; if established, strong links must be kept between the Centre and the Meat Research Group
- education activities are strengthened, and the scope for running a European graduate school/programme in Meat Science in collaboration with other European groups investigated.

### **6.1.5 Dairy Technology**

#### **General comments**

In view of the eminent role of the dairy industry in Denmark the activities in dairy technology at KVL have a long standing tradition and play a very important role both in research and teaching. Therefore, it is justified that dairy technology continues to have its own commodity oriented research group within the Department of Food Science of KVL in the same way meat science does. Of course, the food safety and microbiological aspects of dairy technology are taken care of at other units of LMC.

The group has an operable size staff-wise and is presently being complemented by an industry sponsored professorship in dairy processing which clearly reflects the commitment and interest which the Danish dairy industry puts into the activities in dairy technology. Also, the group expects that the vacant full professorship of dairy technology will be filled again by August 2005.

#### **Quality and quantity of the work**

At the moment, research activities can be grouped into two major areas, i.e. cheese technology and ripening on one side, and functionality and microstructure of dairy products and ingredients on the other side. In both areas results are published regularly in the major peer-reviewed journals of the dairy science community. In addition some publications appeared in more generically oriented peer-reviewed journals (e.g. 'Langmuir') in particular when the respective projects were carried out in close collaboration with other research groups.

The research on cheese technology and on cheese ripening clearly focuses on the substrate and aims at basic and applied problems in the context of cheese manufacturing. It involves research on protein metabolism in relation to texture and flavour, but also to cheese quality in general terms. It is based on sound experimental expertise and obviously contributes successfully to the elucidation of ripening processes as one of the most critical steps in cheese manufacturing. Internationally, research on the cheese ripening aspect by this group stays in forefront. Cheese technology continues to be on the priority list for the coming years.

The research on functionality and microstructure seems more driven by the array of methodology and experimental competence available. This is probably one of the reason why the respective part of the group is about to start an industry collaboration on the effect of particular enzyme activities (lipase) on cereal dough rheology. Also, food rheology and microstructure and the dynamic analysis of complex food systems in more general terms is on the list of future priority areas. Although such a move to more generalised research on food microstructure could be a potential for future development the group would nevertheless have to see that a balance is kept between method and system driven activities. Therefore, in the project on dough rheology it will be important that the group establishes a close liaison with LMC groups competent in cereal science.

Other research aspects mentioned by the dairy technology group are syneresis effects, gastrointestinal proteolysis, and on-line and in-line quality control.

The dairy technology bases its experimental work on four types of facilities, i.e. a pilot plant, chemical-analytical facilities, microscopy, and rheology. While the latter three facilities seem to meet modern standards, the group is concerned about the pilot plant facilities. The present pilot

plant is still very valuable for teaching and used accordingly. For research, the group wishes to have small-scale 'high-tech' equipment available so that advanced techniques for specific dairy processing could be introduced. Although such a request is justifiable in the context of the planned research activities, a respective investment nevertheless would need to be evaluated and coordinated with other LMC groups so that more than one group can profit of the financial commitment. Such coordination should include at least the group of food biotechnology and processing at DTU and the group of milk and egg science at DIAS.

In more general terms the record on collaboration with other LMC groups and with national and international institutions is substantial and ensures sufficient exchange of expertise.

### **Management of the group**

At present, the group is managed effectively. The full professorship will be able to further contribute to the scientific leadership and the management for the future development.

### **Recommendations**

We recommend:

- That the excellent work on cheese ripening be continued
- That the activities in microstructure and rheology are focussed and carefully balanced in priority setting between system and methodology driven research
- That new research topics are taken-up by the new industry-sponsored professorship
- That the necessity to invest into the infrastructure of the pilot plant is carefully reviewed in close collaboration with other LMC groups.

## **6.1.6 Sensory Science**

### **General comments**

For Danish food production to survive in an increasingly competitive food market, where low cost countries may compete on production of food commodities, added value is critical for future success. User driven innovation is a national science priority. In this context, the application of sensory science within the food industry is an important component. The sensory group at KVL has made a major contribution to increasing competence in this in Denmark, with an estimated output of more than 300 candidates with training in sensory science, and a significant number of industrial training courses continue to ensure strong industrial contacts and interest in the field. The group certainly has the opportunity to become the major source of sensory training in Europe and one of the major research units with some more support from the LMC.

In terms of research output the group has had a strong international presence, strengthened by the synergies with the mathematical and chemometric scientists at KVL. However the departure of Magni and Harald Martens during a difficult financial period has meant the group has had to apply for almost all funding opportunities and lost some research momentum. This gives a fragmented

structure to the current project portfolio, reflecting opportunities rather than strategic aims. The Board welcomes the approval of the new sensory professorship and looks for a strategic focus to the programme to be swiftly established. One difficulty for the group has been the limited support within LMC and KVL supported projects, currently around 10% of funds needed to maintain the activity level of the group. The Board supports the view that at least 20% would be a minimum level to establish a scientific momentum.

### **Quality and quantity of the work**

The output of the group over the last three years has gone down and is diverse and shows the value of collaboration with the chemometrics group.

The sensory teaching programme offered by this group is most likely the biggest and best programme in Europe and is competing with UC Davis as to which is the most comprehensive program available. The programme is much needed in order to generate candidates for the European food industries with market oriented focus, to compete with the long standing US superiority in this field. The heavy workload on the staff related to teaching does not reflect permanent support, as resources to course teaching exceeds this.

The current strategy reflects the accumulated capabilities of the individuals rather than a planned direction. The strategy needs focusing and the group needs to narrow down the wide range of projects. The split between segments of the group towards meat science, human nutrition and the relationship between sensory perception and chemical composition is too diverse with the current manpower to make a significant contribution to sensory science. In fact the group is too small and should aim to expand if it is to achieve its aim to become the primary source of training in sensory science.

The strategy for the sensory science group reflects missing permanent leadership and this has put considerable strain on intermediate management functions in order to maintain expected and earlier high levels of activity. The missing resources are in process of being recruited; this is extremely important to get coherence and energy to overcome current fatigue, and the Board urges the LMC to ensure that an early appointment is made.

### **Openness and cooperation**

The group is very open for internal and international collaboration. This is strongly reflected in their list of publications and partners in their projects.

For the future the group must continue to seek European collaborations and networking to ensure that they are well placed to participate in the next round of EU research funding. LMC can assist with this as the LMC strengthens its visibility and influence in the EU research funding community.

### **Management of the group**

Management resources are strongly needed for this group to survive as a group. The extra strain due to the lack of these resources is apparent. Should the professorship not be filled, the management arrangements for the group will need to be addressed to enable teaching and research objectives to be met.

## **Recommendations**

We recommend that:

- The process of finding a new professor should take as little time as possible
- With a new professor in place the group must review the current strategy and aim for more coherent research focus in the group
- A proportion of about 20% of the established research should be in long term basic funded projects
- With assistance from LMC, European links are strengthened with a view to participation in the future EU funding initiatives.
- The group should expand the number of senior researchers to achieve its aim to become the primary source of sensory training in Europe.

### **6.1.7 Quality and Technology**

#### **General comments**

This is a very high-quality group that is world-class and probably world-leading in the application of chemometric and statistical methods to food and biological problems. This is reflected in both the high number of publications in international-quality journals (we estimated about 4.6 per academic staff member per year, much higher than the LMC average) and in the level of industry and academic collaboration.

Our primary concerns, as noted below, are to ensure:

- that the work of the group is better integrated, both physically and in project terms, and that
- a plan for long-term strategy is in place which includes ways of managing what could be a significant expansion in the size and scope of the group.

#### **Quality and quantity of the work**

The scientific and technical standard of the work is very high, with an excellent publication record and proven ways of dissemination via a range of methods, including undergraduate, masters, PhD and short course training as well as a high quality website from which algorithms can be downloaded.

The strengths of the group are in data analysis and measurement, and in modelling and the application of chemometric methods. It is one of the half-dozen best in the world in this area. It would be worth doing a citation analysis of the papers produced to confirm this.

The focus on new modelling methods and algorithm development is correct and will enable the group to maintain and perhaps enhance its position. The strong focus on techniques has led to the group being involved in a wide range of application areas. It might be useful to focus on fewer applications in the future.

The group has only just been formed and is still attempting to integrate its disparate parts, which are still in three different parts of the building. There are significant opportunities here, especially in

linking the aroma and chemometrics work, which would generate work of high international quality. We recommend that LMC funding should be used to fund projects which integrate the component parts of the group, to ensure that it becomes unified as quickly as possible.

The short terms plans for the group were impressive; we were concerned that the long term plans were over-ambitious, involving links across a wide range of subject areas. It is critical that the group does not become too diverse; it would be best to focus on a number of areas in which the link between the chemometric method and fundamental understanding could be made.

There are an impressive range of links between the group and national and international scientists and industry. LMC is adding value through facilitating linkage and through funding of (for example) nutri-genomics posts.

### **Management of the group**

Members of the group felt that the change of name had been useful.

It is likely that the group will continue to expand; a plan for this is needed which takes account of the need to put management structures into place to cope with this expansion. This may involve support to academics and a substructure of management rather than the current single head.

### **Recommendations**

We recommend that:

- the work of the group is better integrated, both physically and in project terms, using LMC funding for projects which connect different parts of the group
- focus on new modelling methods and algorithm development is maintained,
- the long term strategy of the group is reviewed, and a shift to focus on fewer application areas is considered to avoid the work becoming diffuse.
- a plan for management is made to cope with the possible significant expansion in the size and scope of the group.

## **6.2 KVL - Department of Veterinary Pathobiology (IVP)**

### **6.2.1 Veterinary Bacteriology and Food Microbiology**

#### **General Comments on the research group**

They have 2 full professors, 13 associate professors, and about 55 people in total, with 9 PhD students. The program is highly relevant and strong, focusing on general food microbiology and microbial food safety. They have clear strategies on employing basic bacterial genetics and physiology, food relevant models and farm to fork approaches. They have very good external funding. Well organized and communicative group. The publication record is very good to excellent. Within LMC they are strong in colonization, disease and stress adaptation. There is a very

good integration of scientific approaches including bioinformatics throughout whole research program. The group has many highly relevant national and international collaborations and is well-positioned within LMC. They are strong in basic research on food pathogenic bacteria, both with in vitro and in vivo models.

### **Quantity and quality of the research**

- Scientific goals are reached effectively, by well-structured approaches.
- The group sets ambitious goals in a broad field, emphasizing on own strengths.
- Very good to excellent publication record
- Good communication skills result in effective dissemination of results via publications, popular publications, invited talks etc.
- Scientific expertise of group is certainly beneficial to KVL and LMC, especially in food borne pathogens
- Results are largely innovative and exciting and expand current knowledge
- The research is unique in some respects because of the well organized combination of approaches in relevant areas (e.g. microbial food safety) building on areas of own strengths (combination ecology, virulence, physiology and diversity)
- Topics covered by the research group are very relevant for teaching and will also attract students with a 'basic science' interest.

### **Relevance of the research in the group**

- The research on food pathogens is extremely relevant for food research. Combination with basic research makes research very strong
- Farm to fork approaches and integrated approaches on food pathogens in all relevant areas, without being scattered.
- The focus of the research is very well reasoned and assesses very important questions. All relevant technologies are in place

### **International standard of the research**

- Quantity and quality range among the best in the world.
- There is good EU funding specifically in training networks. IP and STREP possibilities could further be explored because the group has a lot to offer.
- Basic research on food pathogens is a competitive field but the group positions at the forefront of science. The group is highly creative and dynamic and is expected to even further strengthen the program and output.
- Various, if not all, subprograms have very good perspectives. The use of in vitro and in vivo models is expected to add essential knowledge about host-pathogen interactions.
- No weak areas were identified.

### **Plans for the next 2-5-years period**

- Continuation of strong areas foreseen and perhaps novel activities in studying host-microbe interactions, bioinformatics and antimicrobial resistance
- Research is already very sharply focused and very LMC-relevant
- Further exploration of good models for host-pathogen interaction is desirable

## **Relevance for industrial application or public aspects**

- Research is highly supported by EU and to a lesser extent directly by industry. This latter activity could increase.
- Patent portfolio is limited. Help from LMC to assist in recognizing and initiating patent possibilities could be beneficial
- No spin-off companies were founded, to our knowledge

## **Benefit of collaboration possibilities**

- Group has several collaborations within LMC e.g. bioinformatics: DFVF, DTU
- External networking has been highly successful. Several EU projects have been granted.
- The group developed several research contracts (not known whether this was via MRI)

## **Management of the group**

- Management structure is excellent. Group leaders are inspiring, team-builders and dynamic.
- Internal communication is very good. Team building events are taken seriously. External reporting is via publications, talks and regular interactions with industry
- Work is carried out in a very efficient way, well organized and focused. Result oriented research with very good output.

## **Recommendations**

- Major strengths are in integrated research on host-pathogen interactions, in vitro and in vivo models, farm to fork approaches, food models and nice integration of ecology, physiology, virulence and diversity themes relevant to food borne pathogens, focusing on existing strengths in these areas. Weakness and opportunities are in patenting and extension of industrial contacts. Threats could be decreasing student numbers and finding good funding for extension and replacement of instrumentation
- All relevant areas are included already. The research program is highly ambitious as it is.
- Future collaborations can be foreseen with other academic groups of high reputation working on molecular biology of pathogenic bacteria. Also increasing collaborations with bioinformatics could be beneficial when more and more high-throughput approaches are being implemented (e.g. microarrays, proteomics, metabolomics)
- Links with industry could be further strengthened
- Ambition level for publication quality could be higher than indicated (impact >2.3). The group has the quality to reach even higher average impact.

## **6.3 KVL - Department of Human Nutrition (IHE)**

### **6.3.1 Overview**

The Department of Human Nutrition is a world-class department for research into diet, nutrition and health. The following gives a brief overview of the evaluation of the strengths and weaknesses of the Institute as a whole.

#### **Strengths/opportunities**

- High-quality novel research of international standing, particularly in the groups specialising in obesity, paediatric nutrition and, until recently, micronutrient bioavailability, that focuses on areas of high strategic priority in nutrition and health both for Denmark and globally;
- Energetic, productive scientists at associate professor, research assistant and PhD student level with the potential to develop further and become internationally recognised;
- Consistently impressive publication rate in journals with a high impact factor on a level with other leading institutes in nutrition research internationally;
- Excellent involvement in collaborations in Denmark, Europe and internationally;
- Consistent success in attracting external funding from EU, industrial and public sources;
- Good relations with industry throughout the Institute;
- Continuing strategic evolution of group structure and senior appointments in recognition of changing scientific priorities; the recent appointments of Professors of Preventive Nutrition and Biomedicine being important developments for the future;
- A professional, collegiate spirit throughout the Institute, producing an excellent environment for collaborative, cross-cutting, multi-disciplinary research involving the expertise and technologies of most of the groups in the Institute.
- A highly effective and high-profile public communications and dissemination strategy.

#### **Weaknesses/threats**

- The necessary emphasis on external funding and collaborative research mitigates against long-term studies, development of strong research programmes, continuity of staffing, replacement of outdated equipment, and initiation of new lines of research. This is not a criticism of the Institute but a comment on the current funding environment within Denmark. Were the competition for external funds to increase such that the likely success rate of funding applications falls below the current 1 in 3 quoted by many scientists, then this resource structure may be unsustainable.
- Emphasis on funding through short-term projects also mitigates against addressing long-term scientific objectives, a particular weakness when health outcomes are being considered;
- The move towards a 3-year PhD training which expects 3 peer-reviewed publications before defence is possible further encourages the emphasis on short-term projects.

#### **Role within LMC**

- The Institute is an active member of LMC and supportive of its aims and developments. It is well placed to continue to provide expert nutrition and health input and research expertise within the umbrella of LMC and the Graduate School.

### **6.3.2 Preventive Nutrition**

This Group is a consortium of researchers working on various aspects of food in relation to health. There are several research themes, each led by an Associate Professor: trace element, vitamin and phytoestrogen nutrition; lipids and cardiovascular disease; iron absorption studies; and food-based strategies for dietary improvement in developing countries, focussing predominantly on vitamin A, iron and zinc. Four members of the Group, including the Group Manager, made presentations.

#### **General comments**

The Group was formed less than 2 years ago. This was partly a consequence of the untimely death of Professor Britte-Marie Sandstrom, a world-renowned scientist in trace element and mineral nutrition. The new Group Manager is to be congratulated for taking up the reins in these difficult circumstances, ensuring the completion of the international projects that Professor Sandstrom was leading and forging this new alliance of research groups. A new Professor of Preventive Medicine has been appointed and will take up his position this August.

#### **Quality and quantity of research**

The scientific aim and goals of the Group as articulated in the document are very ambitious and embrace an enormous area of scientific endeavour. The aspiration to be internationally leading in research on the prevention of diet-related illness in developing and industrialised countries, with the specific aim of preventing risk of cardiovascular disease, osteoporosis and iron-deficiency anaemia, is not realistic for such a small research group, and reflects more the scope of the entire Institute. The aim and goals for the Group would be better re-defined in terms of the focus on the bioavailability and function of micronutrients, with an emphasis on human intervention studies.

Although it was clear that there was good-will between the various teams, it was difficult to discern that the Group has yet formulated a robust coherent research programme, with each component working together to a common scientific purpose and building on each other's expertise. This was acknowledged by the participants in the presentation, but the Group has set up management processes that enable synergies to develop and for closer working to be encouraged for the future.

Less evident were processes to encourage collaboration and joint working with other groups in the Institute. This was a particular concern with respect to the nutritional and public health implications of the projects in the group, which would benefit from a greater interaction with experts elsewhere in the Institute. The recent appointment of the new Professor of Preventive Medicine will also strengthen the Group and it is anticipated that he will bring greater cohesion into the research focus, and enhance opportunities for interactions with other groups in the Department.

The evaluation team was concerned about the 'fit' of the research team focussing on food security in the developing world in this group. There is little obvious link with the work of the other research themes in the Group, other than a common interest in minerals and vitamins. However, these are viewed from very different standpoints and there is little, if no overlap, between methodologies or scientific interests. The Food Security Team, while it has been involved in some strategically important studies with respect to food-based strategies to improve nutritional status in developing countries, appears to be lacking strong leadership at the present time, and to be somewhat isolated from the current international controversies surrounding the health benefits of attempts to redress traditional micronutrient deficiencies. This team would benefit from being part of a larger consortium within the Institute that focuses specifically on developing world nutrition.

At present, such a consortium does not exist, but there is expertise within the Institute in food, nutrition and health in relation to the developing world that could be pulled together for such an initiative. If the resources were available, such an initiative would benefit from strong leadership at Professorial level.

### **Scientific quality, relevance, international standing**

Because the Group is new, with much of the work reflecting that initiated or conducted under Professorial leadership before the restructuring, and because each strand is essentially separate, it is not possible to easily assess past performance, publications or to dissect out where the strengths and weaknesses lie at the present time. It is also difficult to assess the international standing of the Group as currently constituted.

The ongoing and future research, with the exception of the fatty acid area, is focussed predominantly on the supply, absorption and bioavailability of micronutrients and other minor components of food, and would benefit from a greater emphasis on the functional, metabolic and health implications of these factors. For a small research group, with limited expertise in the biochemistry and metabolism of these minor components, a large number of different factors are being studied, from selenium and iron through vitamins A and D to isoflavones, carnitine and n3 fatty acids, with many others in between. All are of high priority to industry and health policy makers, and there appears to be pressure on the Group to participate in such projects because of their skills in human intervention studies. However, the great variety of factors being studied makes it likely that each is researched relatively superficially and there would be merit, both for the quality of the research and for the development of the scientific careers of the individuals concerned, if they were to concentrate on fewer micronutrients and bioactive factors in more depth.

### **Training**

The group is heavily involved in teaching and is currently hosting 6 PhD trainees. One of the PhD students is conducting a collaborative project jointly with the Nutritional Immunology Group at Bio-Centrum, and there was general enthusiasm for LMC and the co-ordinating role that it plays in promoting graduate education.

### **Industrial involvement, networking and the role of LMC**

The group is very active in seeking funding from industrial and public sources, and in collaborating with external partners. The scientists were very positive about the role of LMC and felt it was an excellent catalyst for collaboration, citing the recent MRI application round as an example. There was a discussion during the presentation about the potential difficulties of different managerial policies among the participating institutes in LMC, especially with respect to intellectual property rights, technology transfer and publication strategy. There might be benefits from common policies being negotiated by LMC in these areas, to bring clarity and to protect the scientists.

### **Management**

The Group presented a clear framework for internal management.

## **Recommendations**

We recommend that:

- the Group should reconsider the written definition and focus of its aims and goals;
- the Group should focus on fewer, well-defined, scientific questions, which combine an interest in food and nutrient supply with function/health research, that can be built on in future projects to produce a solid body of work in a few, selected specialist areas;
- the Group should work towards greater integration within the Group and with other Groups within IHE, especially with respect to metabolic and health considerations;
- the Group should continue the excellent collaborations outside IHE that have already been developed and to expand the network, but to be selective about involvement in new projects in order to retain a discrete focus for the Group's activities.
- The Head of the Institute, with LMC's support, should consider, if the opportunity arises, relocating the team working on food security in developing countries to a consortium within the Institute that can provide leadership in developing world nutrition in relation to food and health issues. In the interim, it would be beneficial to provide the members of the team with expert mentorship, either by a senior member of the Institute or one closely connected with it, who has experience in developing world nutrition in relation to health.

### **6.3.3 Prevention and Treatment of Obesity - Appetite and Energy Metabolism**

This Group conducts research on appetite, energy metabolism and obesity. Projects are focussed into several inter-linked main lines of enquiry. Main themes include prevention of obesity and type 2 diabetes, dietary composition and the role of genes in appetite regulation, energy metabolism and disease risk. Currently, the research is led by one Professor and one part-time Associate Professor. The presentation was made by the Head of the Group and there was no opportunity to interact with other members of the Group.

#### **General comments**

This is an impressive group of international standing. The Head of the Group is a world authority on obesity and related issues. In addition to its scientific expertise, the Group has a repertoire of techniques that are sought after by others in the obesity field. These centre around the conduct of human intervention studies, the measurement of genetic and biochemical indices, and methods for the non-invasive study of healthy volunteers. An investment in a PET scanner would open up greater possibilities for the study of appetite regulation and satiety that would enhance the research capabilities of the Group. The Group is very active in both LMC and in international collaborations, including several projects involving large consortia funded by the EU.

#### **Scientific quality and quantity, relevance, international standing**

The work of the Group is of international quality. It conducts novel research in high priority areas of obesity research and has outstanding productivity, in terms of both peer-review publications, contributions to scientific knowledge, and impact into nutrition policy and practice. The Group is to be congratulated for its consistently high performance and important contributions. The scientific aims and goals are realistic.

The productivity of the Group is especially noteworthy given the relative small number of senior staff at the present time. This is a large group with 4 research assistants, 7 PhD students and 16 technical staff, all requiring senior scientific mentorship. In addition, EU projects are particularly burdensome in senior staff time and project management. It is impressive that the Group is contributing to several ongoing EU projects and is actively engaged in the design of the new Diogenes project. On discussion, it was reassuring that the Head of the Group has developed an appropriate strategy for future developments in terms of senior staffing. A large number of future strands of research and projects are being considered and it is likely that either these will need to be focussed down, or some postponed, until this temporary difficulty has been resolved.

## **Training**

The Group is actively involved in teaching and is currently hosting 7 PhD trainees. It was not possible to judge directly the quality of the training environment or the role of the Graduate School because there were no post-doctoral scientists or PhD students present at the evaluation. However, one of the PhD students of this Group had attended the Graduate School evaluation and had expressed enthusiasm for the School but with some reservations about the relevance of the courses currently available for students in nutrition and health.

## **Industrial involvement, networking and the role of LMC**

The Group is very active in obtaining funds from industrial and public sources, and collaborating with external partners. It is actively involved in EU projects as a partner and work-package leader. The Head of the Group is very positive about the role of LMC and felt it is an excellent catalyst for collaboration.

## **Management**

There were no other members of the group present at the evaluation and it was not possible to judge the framework for internal management, or the specific roles of each Group member.

## **Recommendations**

We recommend that:

- the Institute and LMC continue to recognise the high-quality and contribution of the research of the Group by the provision of long-term infrastructure and staffing support;
- the Institute and LMC consider the resourcing of a PET scanner to enhance the repertoire of the Group in the study of appetite and satiety, and consider whether this might have applicability to the research of other members of LMC;
- the Graduate School considers how best to cater for the training needs of students in human nutrition and health.

### **6.3.4 Clinical Nutrition**

This Group specialises in research aimed at improving the nutritional care of patients in hospitals. The presentation was made by the Head of the Group.

## **General comments**

The Group was formed 2 years ago. It is small, consisting of one Professor, one Associate Professor and 1.5 TAP research support. There are currently no PhD students or collaborative projects within LMC, and the Group is not engaged in basic research at present. It is therefore not appropriate to evaluate this Group in terms of the quantity or quality of research.

## **Scientific quality, relevance, international standing**

The Group is primarily focussed on the development and evaluation of screening tools for defining nutritional risk and on considering strategies to improve the nutritional care of hospital patients, both in Denmark and internationally. This is the most applied group within LMC in terms of nutrition policy and practice. Its current work is strategically and politically important but cannot be assessed in terms of the traditional scientific yardsticks. At present, the Group has few resources either in terms of staff or equipment. The Head of the Group has ambitions to establish a programme of more basic research, focussed on protein requirements in disease, which will provide opportunities for PhD students and for development of research collaborations. It is clearly important for a strong research direction to be developed and articulated to provide a basis for attracting external funding and building up the group.

## **Training**

The Group has had no PhD students since its inception. This is partly a reflection of the problem of attracting medical trainees into nutrition research, but also of the small size of the Group and the applied nature of its work. We did not have a detailed discussion about the Graduate School because the Group has no experience of it, but the Head of the Group was positive about the concept.

## **Industrial involvement, networking and the role of LMC**

The Group currently has funding from only one major industrial source, with respect to the acceptance of a nutritional screening tool by hospital staff in different countries. This reliance on one source of funding is a potential concern and a mixture of external funding sources would minimise possible problems of conflict of interest. The Head of the Group is currently applying for funding for his basic research plans. He was not very familiar with the role of LMC but felt it could act as a valuable catalyst for collaboration, once he has established a more basic research programme, and that it might provide some interaction in terms of expertise in advanced statistics. The Group has considerable experience in applied human nutrition especially as it relates to disease, and has strong clinical contacts. Other groups in LMC may therefore benefit from greater interaction with this Group and from its incorporation into collaborative projects.

## **Recommendations**

We recommend that

- the Group is encouraged to develop a strong research direction on which to base its collaborative and funding strategy, and to provide a strong environment for research scientists and PhD students;
- the Head of the Group and LMC consider how best to involve the Clinical Nutrition Group more closely within the umbrella of LMC in order to promote collaborations, funding opportunities and the sharing of expertise.

### **6.3.5 Sociology of Food Consumption Group**

#### **General comments**

This is a fairly unique group in Denmark, as there are very few, if any, sociologists specialising in food issues. The group has been very successful in winning external funds from both Industry and Public sources. The projects are fairly applied and have contributed to changes in policy and communications with regard to hospital feeding, role of gender in dietary guideline communication among others. The publication strategy of the social sciences disciplines tends more towards publishing in books or monographs and this group has traditionally followed that direction. However in recent times the group has moved towards more publication in refereed journals. These have tended to be in journals of the basic disciplines that are interested of consumer perceptions of microbiological, chemical or biotechnological safety or health rather than mainstream sociological journals. The group has participated in a number of international initiatives, and works particularly closely with Nordic Institutes interested in ethics and consumer perceptions of safety and health.

#### **Quantity and quality of the research**

The group proposes three main themes and each of the research leaders takes main responsibility for a particular theme, although there is cross theme communality. The themes are:

Meaning: The role and meaning of food in the food practices of every day life

Health: The place of health in every day eating practices

Technology perception: The source of controversies and social conflicts regarding food products, food production and processing methods.

The Meaning theme contained the most fundamental sociological content, a new theory that explains meanings in terms of gradient distinctions using goods as the medium and these are related to events, people or consumption activities. The full publication of the theory in reviewed journals and its validity in application to food based activities, such as organic food purchase, is in progress. A Nordic project on meals was based on the premise of testing the "grazing hypothesis", and the gradient mapping. It was novel in methodology and has produced a unique and valuable body of data. The experiment is planned to be repeated elsewhere.

The Health theme has been running the longest, and the group has a good track record across a period of years. The projects are fairly applied and have contributed to changes in policy and communications with regard to hospital feeding, role of gender in dietary guideline communication.

The Technology Perception theme is probably the most applied, and attracts industrial as well as public funding and is topical. Results are probably very specific to Danish culture and publications have tended to be in journals of the basic disciplines that are interested of consumer perceptions of microbiological, chemical or biotechnological safety or health rather than mainstream sociological journals.

The scientific level of the publications is therefore judged to be at the applied level, although the implications of their work are important for policy development in health communication, risk management and long term agricultural policy. In a Danish context the group provides a distinctive sociological contribution to the debates on consumer perceptions of food. There is clearly good

communication with policy makers. The relevance of the work is therefore judged to be high. The group responds to changing priorities and is winning research funds in competitive arenas. The work is reaching an international audience through refereed journals, and there has been participation in EU programmes. The meal pattern project, in particular, is recognised as unique.

Forward plans include a desire to move towards social causes of ill health and marginalised groups.

The Board would like to see some clear research directions that address some more basic sociological questions in relation to food behaviour, leading to some publications in the more mainstream literature. As with the gradient theory, we look to see these advances underpinning the approaches to the applied research. We believe the group has the potential to do this, particularly if they strengthen their current relationships with other sociology academics.

A point made by the group is that they do work in joint projects with other members of LMC but more in parallel rather than true collaborative efforts. The group appears rather isolated in the Department of Human Nutrition and has asked to be moved to the Department of Food Economics. This seems a logical move and will put them in a community more sympathetic to their discipline and objectives. The move is therefore supported by the Board. Within LMC there is scope for joint projects with the MAPP group, particularly as the latter starts to focus on the family as a unit of food choice and we look for increasing collaboration between these two groups.

### **Recommendations**

- That the group address some more fundamental questions that will lead to methodological advances, recognised beyond just the food community, that will raise the scientific level of their contribution to the applied projects.
- That the group moves to the Department of Food Economics and strengthens their contacts with Sociology Departments in Denmark.
- That the group brings their sociological perspectives together with the MAPP group to address questions regarding the role of family in food choice and perceptions of food technologies.

### **6.3.6 Paediatric Nutrition Group**

This Group conducts research on paediatric nutrition in relation to human growth and development. Projects are focussed into several inter-linked main lines of enquiry in infants and children, led by one Professor and one Associate Professor. Main themes include nutrition for gastrointestinal, bone, and cardiovascular health. A second Associate Professor was also an active part of this group until the restructuring of the Department two years ago. Presentations were made by 6 members of the Group, including the two senior scientists, 2 research assistants and 2 PhD students.

### **General comments**

This is an impressive group of world-class standing. The enthusiasm and commitment to the aims of the Group across all members was evident at the presentation.

## **Scientific quality and quantity, relevance, international standing**

The work of the Group is of international quality. It conducts novel research in high priority areas of paediatric nutrition and has outstanding productivity, in terms of both peer-review publications, contributions to scientific knowledge, and impact into nutrition policy and practice. The Group is to be congratulated for its consistently high performance and important contributions. One of the strengths of the Group is the emphasis placed on pursuing collaborative research and funding opportunities that build on and contribute to the overall research aims of the Group. This results in an admirably close integration of projects and methodologies across the different strands of the work. The scientific goals of the Group are realistic and its future plans achievable. The recent appointment of the new Professor of Preventive Nutrition will provide scope for an expansion of work in the Paediatric Nutrition Group through collaborations in the area of infant gut development.

The Head of the Group is a world authority in infant and complementary feeding in relation to developing countries. Whilst much of the work of the Group is focussed on developed world research, much is of relevance to the understanding of paediatric nutrition in developing countries. However new research projects specifically addressing developing world nutrition are currently not being pursued by the Group because of the lack of a senior researcher to drive the work. This is an area of continuing high international priority and there would be merit, if the possibility arises, for the Institute to consider creating a new Group, or a 'virtual' grouping/consortium, that pulls together developing world food, nutrition and health, preferably under Professorial leadership, with input and collaboration from the Paediatric Nutrition Group.

## **Training**

The Group is actively involved in teaching and is currently hosting 2 PhD trainees. It also provides a creative environment that promotes the career development of its junior scientists and associate professors. The group is involved with the Graduate School and is supportive of its development. The relevance of courses currently available or being developed in the Graduate School, which tends to focus on the basic food sciences, to students studying applied nutrition in relation to health was questioned, because of the need for such students to have specialist training in areas such as epidemiology, advanced statistics, human biology, intermediate metabolism and clinical nutrition.

## **Industrial involvement, networking and the role of LMC**

The Group is very active in obtaining funds from industrial and public sources, and collaborating with external partners. They have also been involved in EU projects as partners. The majority of funds come from pre-competitive and competitive awards. This is an appropriate strategy for a group specialising in the sensitive area of paediatric nutrition. The scientists are very positive about the role of LMC and felt it is an excellent catalyst for collaboration, giving the recent MRI application round as an example.

## **Management**

The group has an effective internal management strategy and a good team spirit. As with other groups in IHE, there is a concern about the lack of long-term infrastructure funding for the Group, in terms of both staff and equipment. A major piece of instrumentation for the group, which is key to their work, is a DXA scanner. The group currently have an Hologic QDR/1000w, a pencil beam scanner that is the best instrument for the research they are conducting in children's bone health and body composition. This machine, however, is now ageing and will soon be obsolete because the

manufacturer no longer supports it. There is no doubt that in the next few years the instrument in the Group will need to be replaced by a modern instrument which matches as far as possible its capabilities (most common DXA systems are wide fan-beam and are not optimal). It is essential that the funds for this are identified in advance to allow a phased transition, in order not to compromise ongoing and future studies.

## **Recommendations**

We recommend that:

- the Institute and LMC continue to recognise the high-quality and contribution of the research of the Group by the provision of long-term infrastructure and staffing support;
- the Institute and LMC assist the Head of Group to identify the funds for a phased transition from the old DXA scanning system to a new one that uses pencil-beam or narrow fan-beam capability;
- the Head of the Institute, with LMC's support, should consider, if the opportunity arises, setting up a grouping within the Institute that can provide leadership in developing world nutrition in relation to food and health issues, and that has a strong interaction with the Paediatric Nutrition Group;
- the Graduate School to consider how best to cater for the training needs of students in human nutrition and health.

## **6.4 DTU - BioCentrum-DTU (BiC)**

### **6.4.1 Overview**

The BioCentrum was created in 2000 and now presents the largest department at DTU. The activities of the centre go beyond the key area "food" and also comprise the key areas "energy", "biotechnology" and "medicine". In order to strengthen the food area, an additional strategic alliance called DTU-Food was formed. It comprises all DTU research groups interested in the food issue. DTU-Food in particular ensures the link between the food oriented research with the basic research disciplines at DTU such as mathematics and mechanics. In this setup BiC with its motto "for life and technology" and its span "from genes to industrial products" has become a well organised unit with clear leadership and high visibility in both academia and industry. It not only places itself successfully in a front position of academic research in the Nordic Countries, but also compares very well with other university institutions internationally.

Presently, an adjustment in the grouping within BioCentrum are discussed with a demerger in the group of Food Biotechnology and Engineering and the the creation of the centre of excellence in enzyme biotechnology (further details see section 6.4.4).

In education on the Bachelor level, the BioCentrum is primarily responsible for the two tracks "Biotechnology" and "Health and Production". The BioCentrum also participates actively in the teaching on Bachelor level for food science and technology, while the academic responsibility for this track lies with KVL. The BioCentrum is involved in programmes towards degrees on the Master level. Finally, the centre is very positive about the newly founded Graduate School Food for the Ph.D. level and considers this new educational structure as a very fortunate development. It sees

promising opportunities in the area of microbiology, biochemistry and biotechnology as applied to food science and technology.

## **6.4.2 Microbial Physiology and Genetics**

### **General comments on the research group**

They have 1 full professor, 6 associate professors and are about 32 people in total. Nine of them are PhD students. MPG has a highly relevant program with original approaches. They have a very high level of basic science with a keen eye on application possibilities. The main focus is on biocontrol analysis of bacterial model systems and systems biology mainly on *Lactococcus lactis*. MPG also has a high level and important research in nucleotide metabolism, stress and phages of *L. lactis* and replication in bacteria. Part of the research is highly food relevant. Part on *Bacillus* (very high quality) is separated and is not done as part of LMC research. MPG has an excellent publication record both in quantity and quality. Group is also active in some yeast research (ethanol production), which seems a minor activity. They have many international and national collaborations, also within LMC and with several industries. The teaching load is slightly above average at DTU.

### **Quantity and quality of the research**

- Scientific goals are certainly met and sometimes enhanced by serendipity events (e.g. diploid *L. lactis* finding)
- The group sets clear goals for the future in systems biology of *L. lactis*, incl. nucleotide metabolism and energy metabolism. MPG also has aspirations in studying host-microbe interactions in collaboration with KVL.
- Excellent publication record
- Dissemination of results very good by publications and popular publications, invited talks etc.
- Scientific expertise of group is certainly beneficial to DTU, especially in Gram-positive bacteria.
- Results are largely very exciting and expand current knowledge
- The work on nucleotide metabolism and biological control analysis is quite unique and of high value
- Topics covered by the research group are very relevant for teaching and could further extend the important role of this group in science by educating new scientists in this tradition.

### **Relevance of the research in the group**

- The work on *L. lactis* and phages is highly relevant for food research. The *Bacillus* work is related to industrial applications in e.g. enzyme production.
- The Systems Biology and functional genomics approach has original angles and is well focused also on solving industrial questions. Milk fermentation research is included and very relevant.
- Coupling focuses on energy metabolism, carbon fluxes; nucleotide metabolism is an excellent focus. Phage biology has gained renewed interest e.g. by phage therapy methodologies. Main models are Gram positive organisms which make tool exchange very easy.

## **International standard of the research**

- Quantity and quality range among the best in the world.
- EU funding has decreased over the years due to other focuses of the EU programs. This is however a point of attention for the group, which should still look for opportunities e.g. in Systems Biology in the 7<sup>th</sup> FW program. Funding by companies and Dairy Council is extremely good
- Nucleotide metabolism, phage biology, biological control analyses, industrial fermentation are internationally in front. Focus is maintained in these areas the coming years
- Potentially research in phosphoproteome could come in front. Could be extended to *L. lactis*.
- Yeast research is somewhat unclear and needs decision concerning need of either new impulses or reallocation.

## **Plans for the next 2-5-years period.**

- Continuation of strong areas foreseen and perhaps novel activities in studying host-microbe interactions
- Thought could be given to further combine the interesting but limited areas of research in *B. subtilis* with *L. lactis* research (e.g. phosphoproteome)
- Protein interaction networks; extension of mathematical modelling could be relevant new activities

## **Relevance for industrial application or public aspect**

- Research is highly supported by industry and public services.
- Very good patent portfolio, with some actual financial benefits via selling and licensing.
- Not known whether spin-off companies were founded

## **Benefit of collaboration possibilities**

- Group has several cooperation within DTU, in e.g. mass spectroscopy, bioinformatics, KVL chemometrics and KVL pathogen research
- External networking has been highly successful. EU projects have decreased over the years due to difficulties to comply with calls on human health. This has been a general phenomenon felt by groups working on G+ and lactic acid bacteria in particular.
- The group developed several research contracts (not known whether this was via MRI)

## **Management of the group**

- Management structure is clear. New group leader is inspiring, well-skilled and communicative.
- Internal communication is very good. Team building events are taken seriously. External reporting is via publications, talks and regular interactions with industry
- Work is carried out in a very efficient way, with an open eye for unusual findings which yield sometimes highly original findings (diploid lactococcus, phage therapy). Budget is spent well.

## Recommendations

- Major strengths are in integrated research on lactococci: nucleotide metabolism, carbon metabolism, flux analyses, artificial promoter systems (also high-throughput adjustment of gene expression on program), and phage infection. Opportunities to link phosphoproteome research also to *L. lactis*. Threat could be the decrease in EU support. Opportunities in FW6 and 7 are in gene regulation, systems biology and perhaps phage therapy. Group should carefully consider the goals for yeast and bacillus research. Further integration could create new possibilities. New avenues and collaborations should be considered related to systems biology, making use of the current strengths.
- Protein-protein interaction research could fit in very well.
- Further international collaborations in systems biology and national and international collaborations in host-microbe interactions. Also further collaboration within DTU (Centre for Microbial Biotechnology) could be beneficial, especially in technological and modelling approaches.
- Fund raising is very strong except for EU projects. More activities could be planned here.
- Group indicates wish to extend research to study of host microbe interactions. Careful attention should be given to finding an appropriate niche in this competitive field. Further collaborations foreseen with KVL.

### 6.4.3 Centre for Microbial Biotechnology

#### General comments on the research group

This is an extremely enthusiastic group that appears to function optimally.

Staff: One professor and 10 assistant and associate professors. Totally involving 80-90 people involved. About 12 are PhD students. The teaching load is 40-50%.

A relevant and very strong program focuses on the four areas Metabolic Engineering, Functional Genomics and Systems Biology, Discovery, and Fermentation and Purification Technologies.

#### Quantity and quality of the research

- Scientific goals are clear and are well met
- The group has original and creative views for the future
- Publication level is excellent
- Results are very important both scientifically and for the industry they serve (not only food industry)
- The four research groups are well managed and composed optimally
- CMB has a lot to contribute to the scientific community and to industry
- Very well suited to solve problems within eukaryote microbiology

#### Relevance of the research in the group

- Very well chosen and relevant subjects for basic and for food research
- The output is impressive

- Focus could hardly be better

### **International standard of the research**

- The quantity of the research is internationally highly competitive. Quality is excellent.
- Very well funded by EU, but they could probably also be part of EU programs involving foods.
- Several research areas internationally in front

### **Plans for the next 2-5-years period**

- Very well funded strategies to meet the future.
- Could probably be of help to other LMC associated groups with expertise and facilities
- This research group does hardly need any suggestions. We are sure they will manage to perform frontline and creative research.

### **Relevance for industrial application or public aspects**

CMB is very well supported by EU grants, research councils, LMC and industry. At least 15 patents filed over the last years, and with good industrial innovations.

### **Benefit of collaboration possibilities**

- They use other facilities frequently
- They have lots of national/international collaborations
- They use these contacts to apply for funding which has been very successful.

### **Management of the group**

- Management structure project leadership is excellent. There is good balance between permanent staff and PhD students/postdocs.
- We can see no problems regarding effectiveness and scheduling to reach goals.

### **Recommendations**

#### Major strengths:

- A winning scientific team, with an optimal organization
- Intense cooperation with industries
- Very good social environment
- Excellent international environment
- Very well equipped

#### Weaknesses:

We did not find any

#### Threats:

- The group leader is exceptionally dynamic, skilled and proactive. Other team leaders could be trained to replace with similar strength during absence of group leader, e.g. during a sabbatical

- Decreasing numbers of students?

Opportunities:

- Could probably cover even more topics. Links to bacterial research at DTU possible

Recommendations:

- Keeping up the excellent scientific level
- Could even do more for the food industry
- Continue to extend international collaborations

#### **6.4.4 Food Biotechnology and Engineering**

##### **General comments**

This is a large group (13 staff) whose work is split between Food Process Engineering and Food Enzyme Biotechnology. The work of the group is high-quality, well-linked to industry and to other academic centres and is being published in good-quality journals.

However, there is little synergy between the two halves of the group: it is proposed to demerge the group, with the enzyme part joining other parts of BioCentrum to create a centre of excellence in enzyme bioengineering. We are supportive of the proposed change subject to LMC and DTU ensuring:

- That care is taken to develop the strategy for the new Enzyme group to ensure that it is world-class and adequately resourced and linked to industry.
- That the Food Process Engineering group is kept within Biocentrum and encouraged to link with industry and other groups within LMC. Reinforcement of the group to provide further technical leadership should be considered.

##### **Quality and quantity of the work**

The work is of international quality and is published in high-quality international journals in the fields of food engineering, biotechnology and food science. Each of the two groups is active in teaching; dissemination to industry is also strong with links to Danish industry (such as Novozymes and Danisco), the Øresund Food Network and groups such as VTT and INRA. About 25% of funding comes from industry.

Research is focused on genuine scientific problems which link closely to industrial need, for example through basic work on modelling process hygiene. Denmark has a very strong food ingredient and enzyme industry that links well with the focus of the Enzyme group. The Food Process Engineering group have, in part through LMC, become focused on the delivery of health and nutritional benefits through processing; this work should be encouraged as it will be critical that benefits in the ingredients are not lost through incorrect processing.

The strategic direction of the group was discussed in detail. The group is based on two skill sets; process engineering and enzyme biotechnology. There are concerns that the enzyme work is below critical mass, and by dealing with commercial (mixed) enzyme systems, is limited scientifically. A reorganisation is proposed, with the enzyme group demerging to join Environmental Microbiology

and Biotechnology within BioCentrum with the aim of creating a world-class enzyme engineering centre based around using modern molecular biology and pure single-enzyme systems.

The enzyme work is already of high international quality. The wish to establish work at a more fundamental level is logical, especially given the concentration of world-class enzyme-based industry in Denmark. The Board supported the move; however, the detailed direction of the new centre was not discussed in detail. Care should be taken during and after the creation of the new centre to ensure that it has a strong strategic plan to develop world-class science and link to the industry, which should be done by DTU and LMC together.

The research direction of the Food Process Engineering is towards product engineering, modelling, hygienic design and flexible manufacture. This will require links to manufacturing and mechanical engineering; this should however be done without losing the focus of the group within LMC and Biocentrum. The Board felt that the presence of an engineering group within LMC was of critical importance, and that this should not be lost as a result of the demerger of the enzyme group. LMC should take steps to create better linkages between science and engineering skillbases (for example, some of the DIAS work). The move into design of processes and equipment is potentially very powerful given the unique concentration of equipment manufacturing industry in the Oresund area; the group have the potential to be genuinely innovative if they can link to equipment design.

### **Management of the group**

Currently the group is effectively managed at a scientific and practical level. Effective management of the demerged groups will be critical to ensure that they stay world-class. The Food Process Engineering group will require additional senior appointments to provide additional scientific and technical leadership.

### **Recommendations**

We recommend:

- That the separation of the two groups be pursued; the enzyme work is very important to Danish industry as well as academically, and there is a need to create critical mass in this area
- That the Food Process Engineering group remain in BioCentrum, building links with LMC and to engineering and mathematical groups. Consideration should be given to strengthening the scientific leadership within the group by appropriate new appointments.

### **6.4.5 Biochemistry and Nutrition**

This Group is a consortium of researchers working on protein biochemistry in plants, and on nutritional immunology. Presentations were made by 4 members of the Group, and the Group also provided the evaluating team with a tour of the Group's laboratories. The Group Manager was unable to be present for the evaluation but there was an opportunity for a brief discussion with her later in the week.

## **General comments**

The group was formed less than 2 years ago. This was partly a consequence of the appointment to DTU of the Professor of Plant Biochemistry, a scientist with an international reputation in her research field, and of the recent restructuring within BioCentrum\_DTU.

## **Quality and quantity of research**

The work of the Protein Biochemistry Team is of international stature and highly productive. Recent performance and publications are likely to reflect work initiated prior to the move of the team into BioCentrum-DTU and it is therefore difficult to comment on the current situation. However, the ongoing projects are impressive, recent publications are in high quality journals and there is no reason to doubt that the quantity and quality of research in this team will continue to be of the highest standard. The evaluation team was concerned that the future plans for this team are over-ambitious with too many divergent strands of research. There would be merit in the development of a more focussed, long-term vision to act as a framework for the development of future collaborative projects.

The work of the Nutritional Immunology Team, which includes a growing interest in lipids and fatty acids in relation to human health, is less well developed at this stage. The team is headed by an Associate Professor who is highly respected by her collaborators for her knowledge and expertise in immunology, especially with respect to immune responses to food antigens. Her research until recently has been based primarily in mouse models. More recently, her team has collaborated with groups in IHE to expand towards research focussed on human nutrition and health. The evaluation team found it difficult to discern, both from the presentation material and the list of recent publications, the extent to which the Nutritional Immunology Team is actively pursuing a well-defined research theme through its own studies and collaborations, and how much it is providing expert scientific support for the research of others. Nutritional immunology, food allergy/tolerance and the functional role of n3 fatty acids are topics that are researched by many leading academic and industrial groups internationally, and it is important for the future success of the Nutritional Immunology Team to develop a specific scientific niche for which they can gain recognition in their own right.

Research on lipids is part of the portfolio of research with the Nutritional Immunology Team. The current lipid studies, although they may ultimately contribute to the research in the team with respect to the effects of n3 fatty acids on the immune system and other functionalities, currently concentrate on fatty acid absorption and compartmentation, and the links to the main aims of both the Nutritional Immunology Team and the overall Group are not obvious.

The work of the Nutritional Immunology Team appears somewhat isolated within Bio-Centrum with respect to work in human nutrition and health and, although it has developed several collaborations with IHE, it may be worth considering establishing a more formal mentorship of the team by a senior researcher specialising in human nutrition who can provide general input and updating about recent developments in the area. This would give the team greater insights into emerging priority areas for nutrition research. It also would allow better integration of the work of the team, which is concerned primarily with metabolism at the individual level, with population-based public health research. Attending international conferences with a human nutrition and health focus, in addition to specialist conferences in lipids and immunology, may also be useful in this respect.

Although it was clear that there was good-will between the two research teams, it was difficult to discern that the Biochemistry and Nutrition Group has yet formulated a robust coherent research programme, with each component working together to a common scientific purpose and building on each other's expertise. The Protein Biochemistry strand is aimed predominantly at food production and the agricultural industry; that of Nutritional Immunology on human health through studying responses to food. There is little overlap in these aims at present and these should either be developed, or a de-merger of these two very different groupings considered. There are also few common research methodologies to justify the formal linkage of these two teams.

## **Training**

The group is heavily involved in teaching and is hosting many PhD trainees. There was general enthusiasm about the development of the Graduate School and its potential.

## **Industrial involvement, networking and the role of LMC**

Both strands of the group are very active in seeking funding from industrial and public sources, and collaborating with external partners. The scientists were very positive about the role of LMC and felt it was an excellent catalyst for collaboration, and for introducing groups to one another, especially with respect to groups working in applied human nutrition. They were also appreciative of the opportunity of working through LMC to apply for funding for the MALDI-tof-tof-mass spectrometer, which the evaluation team recognised as an important capacity-building initiative that could benefit the Group, other groups in LMC and could contribute to the new LMC focus on nutrigenomics.

The BNG group contains expertise in advanced statistics and data-handling which while currently used to address proteomics data may have value to other groups within LMC that are handling complex datasets.

## **Management**

We did not have the opportunity to learn about the internal management of the Group.

## **Recommendations**

We recommend that:

- the Protein Biochemistry Team focusses on fewer, well-defined, scientific questions in their future plans;
- the Head of Nutritional Immunology is encouraged to develop a well-defined, focussed research programme, to promote the research of the team and to give her more opportunities to display leadership and to enhance her own career and international standing;
- for the Group Manager and BioCentrum-DTU, with LMC's support, to consider how best to prevent isolation of the Nutritional Immunology team within BioCentrum-DTU with respect to human nutrition and health;
- for BioCentrum-DTU, with LMC's support, to consider whether the Nutritional Immunology team, including the lipid work, is best located managerially with Protein Biochemistry.

## **6.5 DIAS - Department of Food Science**

### **6.5.1 Overview**

The Department of Food Science is a new member of LMC. It is one of seven departments within DIAS which is a public sector research institution under the Danish Ministry of Food, Agriculture and Fisheries. The research is mission driven with the aim to split the commitment into 30 % fundamental, 50 % strategic and 15 % applied research, while 5 % are left for product development. A full time Research Director is in charge of the Department of Food Science with full responsibility and complete authority in all areas in the department. In point of view of the research areas, the department is organised in three commodity oriented groups, i.e. Muscle Biology and Meat Science, Milk and Egg Science, and Plant Food Science. The first two groups are located at the Foulum centre, the third one at the Aarslev centre, approximately 100 km south of Foulum.

Collaboration of the Department of Food Science with KVL and DTU within the frame of LMC will help to fulfil the Danish national strategy in food research. In the scientific proximity of the agricultural oriented departments of DIAS the Department of Food Science is particularly apt to introduce the aspects of raw material to LMC. In turn, the Department of Food Science can profit of disciplinary core competencies available in the research groups of KVL and DTU. While contacts between the Department of Food Science and the research groups in KVL are already well established, there seems to be little interactions with the research groups of DTU.

### **6.5.2 Educational aspects**

An intensified involvement of the Department of Food Science in educational activities, in particular on the Master and Ph.D. level, will be important to the overall development of LMC. This could be realised by on-site experimental work for Master and Ph.D. theses, but also for practical training periods on the Bachelor level. The Department of Food Science would offer attractive experimental infrastructure to students. As the organisation of formal courses and lectures is more difficult due to the geographical distance of the different institutions, participation of staff of the Department of Food Science in teaching could be in short block courses on specialised topics, or in some distant learning programme.

In the special case of meat science, DIAS should join in the established Master programmes. DIAS has unique contributions, which would enhance the education in meat science, but the costs involved for KVL is at present preventive. LMC could take a leading role in finding economic support and defining a role for DIAS in this programme, which may contain the use of adjunct positions. This would benefit both DIAS and KVL and certainly the education.

### **6.5.3 Muscle Biology and Meat Science**

#### **General comments**

The group is world-class, and is carrying out basic meat science work which is well planned and executed and has challenging goals. It is structured around three themes; primary production, muscle biology and meat quality. The approach is realistic and the theme is well-structured, with a strong publication record, and especial excellence in the application of NMR and MRI techniques to meat science.

Given the critical importance of the meat industry to Denmark, it is vital that the work of this group be maintained. Competition from low-cost producers will increase. Danish industry cannot complete on price and so must concentrate on added-value products. This group is well-placed to lead in this area, and should be supported by DIAS and LMC.

#### **Quality and quantity of the work**

This is a world-class group producing output that is of high scientific quality, shown by the high publication level, and is relevant to the industry. The work is well-structured and the staff have a good mix of disciplines which is appropriate to the breadth of the research conducted.

Research is widely published through world-class journals both in the meat and food sector and outside; the publication record is very strong, comparable to the best University groups. There is a good mix of local and EU funding. Work on muscle science and the relationship between feed strategy and meat quality is excellent and of clear scientific and industry benefit. A very large number of publications have recently been produced describing world-leading work on the application of NMR and MRI techniques to meat research. Care should be taken to ensure that this work continues to be world-leading, through appropriate investment and support – links with other imaging groups within LMC might be strengthened. Dissemination to industry is also strong.

There is scope for closer involvement with education through increased involvement with teaching programmes, for example within the LMC graduate school. Given the need to reinforce Danish excellence in meat science, better educational links are very important or there will be a significant shortfall of staff in the near future.

The group collaborates widely both inside LMC, with groups such as KVL Meat Science, and outside, such as the Universities of Aarhus (vital for the NMR work) and Southern Denmark. The link to KVL is obviously critical and should be encouraged by LMC. It is also well connected to industry and farming groups. International links are also strong, for example with the University of Brisbane – these should be developed further (perhaps through visiting fellowships?) given the strength of the research at DIAS.

The group aims to be internationally leading at the border between primary production and meat quality. The major threat to the work – and to the Danish meat industry – is low-cost production. The focus of the group on product quality and the link to human health is correct, given the need for Danish industry to provide high added value products.

The intention to move into the medical field, using pigs as a model for human studies, for example in nutrition and muscle function, is laudable. However, there is strong competition in this area; there

is a need to establish where and whether DIAS can be effective and to establish the right plans and partnerships, or little progress will be made.

### **Management of the group**

The group appeared focused and to be well-managed. It was felt that the strategic direction was clear and the short-term goals of the group; we did however feel that there was a gap between the long-term strategic aims set out and the short-term work and aims of the group. This is not a serious problem given the quality of the work, but management should aim to get a closer match between long- and short- term goals.

### **Recommendations**

We recommend that

- Care be taken to make sure that the world-class work of this group continues through appropriate investment, especially in the NMR field
- The strategy of the group is examined to determine appropriate long-term goals and the feasibility of moving into pig model work

## **6.5.4 Milk and Egg Science**

### **General comments**

This group is a classic commodity driven research unit with respective disciplinary competence in chemistry, biochemistry and physical chemistry. The mandate is to foster research on milk and egg quality, primarily from a raw material point of view. The group is also investigating the potential of fractionating milk and egg components so that these fractions can be used as food ingredients with specific functional properties and bio-activity.

The egg science part of the group is unique in the sense that research on eggs in the integrated way is not carried out at any other place in Europe or North America. Only Japan seems to be active in a similar way. Obviously, this situation gives this group a great opportunity have a 'niche' function in research for the Danish egg industry, but also for the Danish food machinery industry.

The group, which is limited in size, is based on a well developed infrastructure in modern chemistry. There are no facilities for product processing available. Activities in microbiology are restricted to quality control of sample which is done by other units or service laboratories.

### **Quantity and quality of work**

In the field of milk quality, research projects centre on the classic topics of oxidation, proteolysis, and lipolysis and their influence on the quality of raw and processed milk. Due to the long-standing expertise in analysing and understanding oxidation reaction and the close connection to the food chemistry group of KVL, the researchers have gained considerable reputation. They also could make valuable practical recommendations to the dairy industry and the farmers associations for ways to improve raw milk quality.

In the development of novel functional and bio-active ingredients, the competence in protein chemistry again provides a sound base for several successful research projects. These projects could probably even be more successful if closer ties are drawn to the respective groups in the BioCentrum of DTU. Such a cooperation would provide access to modern tools of bio-processing and enzyme technology so that scale-up experiments in the fractionation of functional ingredients could be carried out.

The intended future research activity on milk from alternative production systems may certainly be important in context of the development of bio-farming. However, such research might have to depend on microbiological competence as much as on the biochemical competence built up so far in the group. In more general terms, the group might have to consider to establish closer collaboration with microbiology.

The research on egg quality and on the production of fractionated egg proteins offers a great potential for interesting development work not only in basic science but also in the application for the food and machinery industry. Obviously, the respective industry is interested. However, there is only one scientist plus one technician attributed to egg science. There is no processing equipment available outside industry. Therefore, although some interesting results have been obtained so far, there is no future for this work unless an expansion of scientific manpower and substantial cooperation with other groups in LMC can be ensured. Egg science indeed could be a strategic focus for LMC, and every effort must be made to save the future of this research.

In all activities, LMC might start to play an important role when establishing the necessary cooperation with both DTU and KVL.

### **Management of the group**

The group was newly formed after the general reorganisation of DIAS. The members express satisfaction on how the present group structure is. They are confident that they will further develop scientific interaction and cooperation within the group.

### **Recommendations**

We recommend

- That the group establishes, with the support of LMC, contact and cooperation with the BioCentrum-DTU and strengthens cooperation with KVL
- That a firm commitment to egg science as strategic focus of LMC is made and the necessary resources are provided and the respective collaborations are established
- That the question is reviewed whether microbiological aspects in the research on milk may have to be taken into account for future activities

## **6.5.5 Plant Food Science**

### **General comments**

The group aims at increasing understanding of how the quality of plant-based food (vegetables, fruits, cereals, potatoes and herbs/medicinal plants) can be controlled and improved through

production conditions, handling and modification in relation to the demands of the consumer and the relevant industry.

The group is of high quality but is spread very thinly; the focus and scope of the work should be examined to ensure that the group remains able to perform at a high level. We feel that the strategic direction and the links of the group be examined to ensure that it remains competitive.

### **Quality and quantity of the work**

The focus of the research of the groups is being shifted to sensory quality and bio-active compounds (Healthy foods of high sensory quality) which we consider sensible and justified given the industry and consumer concerns. This shift also implies that the group is moving to consumer sciences at the expense of the agricultural sciences. They feel that this is justified because they have strong links with the Departments of Horticulture, Genetics and Biotechnology; however, we have some concerns as noted below. The number of scientists and their expertise seems appropriate.

Overall the group is of good quality and they appear to form a good team. With ca. 2 publications per year they score higher than rest of DIAS. The impact factor of the international-quality journals in which they publish is typical for the field they are working in, although lower than some other areas of food science.

We were concerned that the group has to rely to a large extent on the expertise of external groups. There is a risk in this; the collaboration with the external groups requires full commitment and responsibility from both sides. The group heavily relies on basic sensory research and support from sensory group KVL and on bio-assays and clinical trials from departments of the University of South Denmark and local hospitals (Aarhus, Odense). Care should be taken to ensure that the group does not become too diffuse, and that they are using the right techniques at the appropriate scientific level. The breadth of the projects being undertaken is probably too wide and needs more focus and choices. LMC can probably help here by encouraging links with appropriate University groups with a stronger skill base.

We were also concerned that the funding base is decreasing; about one third of the money is coming from DIAS, the rest is from EU projects, the Danish Research Counsel and from industry. Funding of research on plant-based foods by Industry, mostly small SMEs, is not strong enough and there is strong competition in acquiring money from government financed research programmes. The success rate of applications in these programmes is ca. 10% and they are considered as very bureaucratic and time consuming. We suggest that the group carry out a strategic analysis of the plant sector and identify areas of potential added value to which they could contribute; this will increase the relevance of the work to industry and the income to the group.

In the type of research carried out by the group study of microbiological aspects is a necessity and facilities for standard microbiological research should be available. We agree that the focus of the work should not be on microbiology but the research is endangered by its absence.

### **Management of the group**

The group seemed to form a good team. They felt that they were well equipped for their tasks with respect to expertise, infrastructure and facilities. They had concern about the increasing bureaucracy by the continuous introduction of new management systems and the excessive amount of time (25%) that goes into writing applications. They would like to have 6 PhD students on a continuous

base to better cover the needed expertise and in this way also secure collaboration with external groups (within LMC).

## **Recommendations**

We recommend:

- That the expansion of the group to consider the wider health and bio-activity agenda be supported
- That the focus of the group be examined in detail. The quality of the group is good overall, but the research field is probably too wide. The group needs new expertise (nutrition, pharmaceutical); hiring of new staff in the future should take this into account.
- That the group identify key areas for industry and high added value products that have the potential to become a base for (fresh) product innovation and development of new products. In these efforts establishing links to the main food retailers might be of interest.

## **6.6 MAPP - Centre for Research on Customer Relations in the Food Sector**

### **General remarks**

After losing some basic funding in 2001, the group downsized and restructured itself in 2002. However several key researchers opted to stay within the MAPP grouping and this has proved beneficial as the international reputation of the group as the primary European source of marketing research in the interface between consumer, retailer and producer has ensured its participation in a number of EU projects, to the point where this accounts for more than 50% of their research funds.

The group is pleased that it is collaborating closely with biological scientists in projects and looks for this process to continue with colleagues within the LMC. It is positive about being a member of the LMC and pleased to be making a unique contribution to the LMC portfolio. There are possibilities for the group to become a Centre of Expertise within Aarhus School of Business and the Board representative was pleased to discuss the review with the Rector and learn of his support for the group.

The group provides a marketing aspect to the teaching of the Masters courses and this broadens the competence of the students which the Board feels is very important.

### **Scientific Output and Relevance**

The group has a clearly defined strategy embracing consumer behaviour, retailer behaviour and the competence development in organisations to undertake successful new product development.

This strategy has been redefined following a downsizing in 2002 and the group is producing a good stream of publications and new developments in all three areas. There is scope to increase the number of generic publications in non-food based marketing and consumer behaviour journals.

Dissemination is excellent, with a continuous stream of international conference presentations and a well designed web site with a number of downloadable reports. The group also holds meetings to present results to local businesses.

The new developments in methodology and theoretical developments in terms of how attitudes develop are passed by research seminars into the main marketing department. All lead scientists and post doctoral workers contribute to teaching at the undergraduate level.

The vision of the group is to be the world's leading research institution in terms of both theory and methodology in the field that deals with the interface between food companies and their markets. They are certainly the premier European institution at this time in terms of consumer behaviour related to food quality and lifestyle, having been responsible for the introduction of Means End chain methods to European food community and the development of the Food lifestyle questionnaire. They share the lead position with Wageningen Marketing department in terms of new product development technologies in relation to food.

Each branch of the work focuses on issues of current interest to the food industry. For example the recent new emphasis on the family unit as a basis for food choice recognises the increasing role of children in contributing to brand choice, and the new emphasis on the mechanisms affecting consumer perceptions of pricing spring from the recent rise of discount retailing and the need to understand the implications of this for Danish production and retailing companies. Recent research programmes on consumer perception of new technologies have sought to understand why simple information programmes are not changing attitudes and to seek alternative communication strategies.

Almost all the research is funded externally and for the large part is co funded by food production, processing or retailing companies.

The group has a high international profile, publishing widely across European journals. Over half the externally funded research budget of 8.4 million kroner is EU funded and the group is managing a 2.8 million euro work programme in the SEAFOODPLUS project.

The senior researchers have strong international profiles and the group must be careful not to become overcommitted in taking on management roles within the EU programme.

## **Collaborations**

MAPP already collaborates closely with food scientists in EU workprogrammes and has learned to work with rather than alongside technical projects. Previous participation in EU concertation projects has led to the invitation to join integrated programmes and accounts for some of the recent success in EU.

The management of the group by Professor Grunert is effective, visionary and democratic. Individual researchers join MAPP voluntarily because they believe it benefits their research abilities and enhances their funding opportunities.

The group wishes to become a full member of LMC and this provides an essential link in LMC providing a fork-to-farm approach, with their interests in consumer and retailer and processor behaviour. The Board approves this action.

## **Recommendations**

- The current research strategy looks broad enough and should not be widened any more, unless the current permanent staff numbers are increased.
- LMC should actively support the proposal that the MAPP group should be recognised as a Research Centre of Expertise at Aarhus School of Business
- MAPP scientists should aim to increase the number of publications in generic Marketing and Consumer behaviour journals
- There is scope for collaboration with the IHE Sociology of Food section in relation to the recent initiative into the family and into perceptions of food technologies.
- MAPP should consider how the research in new product development competences may be directed towards the national priority of User-Driven Innovation.

## **6.7 DFVF - Department of Microbiological Food Safety**

### **General Comments on the research group**

This group has a staff of 29 people where 12 are scientific permanent and 3 are PhD students. There are two groups here of about equal size divided in two sites about 6 km apart. The staff uses about 50% of their time doing direct/indirect work for the Government.

They are mainly doing practical research directed to developing new and rapid microbial detection techniques for diagnostic use, monitoring and controlling pathogens in the food chain, virulence of microbes, and applied microorganisms and intestinal microbiology.

### **Quantity and quality of the research**

- Scientific goals are clear and are well met
- Publication level is good and related to the practical problems they are to solve
- The two research groups are well managed
- They are very well suited to solve practical problems

### **Relevance of the research in the group**

- Very well chosen and relevant subjects

### **International standard of the research**

- The quantity of publications is reduced last year (due to the fusion?). The quality is good.
- Well funded also by EU.

### **Plans for the next 2-5-years period**

- They have well funded strategies to meet the future, but would need to find partners (nationally and/or internationally) to be competitive on the studies on bacterial interaction in the GI tract.

- Would like to have more contacts with the food industry (Here LMC should help)

### **Relevance for industrial application or public aspects**

They could be of much more use for the food industry in the future. LMC should be involved. They do an excellent job on the surveillance parts of their program, and have developed several new methods for the public food laboratories.

### **Benefit of collaboration possibilities**

- They have several national/international collaborations, but could even be linked better to other institutions (specifically to KVL).
- They have been successfully involved in EU projects that have even lead to production of new instrumentation. Looking for patenting opportunities should be encouraged. LMC could assist in this.

### **Management of the group**

Management structure project leadership seems to be good, but the two research groups should be moved to the same site. There is good balance between permanent staff and technicians, but they could take more students (as they would also like to), not only PhD students.

### **Recommendations**

#### Major strengths:

- Well suited to solve the problems they are set to do
- Well equipped

#### Weaknesses:

- Working at two sites 6 km apart
- Too little contact with the food industry
- Afraid of being reduced in numbers and funding, due to recent problems

#### Opportunities:

- Could have new joint projects with the food industry (with the help of LMC)
- Facing interesting problems that the public is following (we eat 3-4 times per day)
- Public sees both pathogens and GMOs as threats in food. Objective information in both areas could be provided by this group also in popular journals

#### Recommendations:

- Move the two groups together
- LMC should help with finding industrial partners in the food industry
- Continue to seek international collaborations
- When possible look for patentable ideas
- Should be involved in at least one or two projects on a high scientific level that would benefit the practical work

## 7. The Graduate School FOOD

The Graduate School FOOD was started in 2003 as an academic graduate school on PhD level. It follows a model that is being introduced for all PhD research programmes for all Danish university institutions. The Graduate School FOOD is a collaboration of all members of LMC except for MAPP, of the Technological Institute and all major food and food ingredient industries. The programme starts on the Master level, lasts three years and follows the Danish general rules for Ph.D. education with research towards the PhD thesis, course work corresponding to 30 ECTS, and a limited teaching activity (approximately 10 % of the available time).

The development of the Graduate School FOOD has been impressive, as presently already 48 PhD students are enrolled. The impact of the school on the overall standing of LMC is already seen. There is now doubt that it will contribute further to the visibility of LMC. The goal to reach a minimum number of 120 PhD enrolled into the school is ambitious but realistic. As all institutions of LMC offer an attractive environment for excellent PhD research, the achievement of this goal is most probably not a question of having enough candidates for the programme, but rather of ensuring enough financial resources for scholarships.

The question of scholarships will be of particular importance if the Graduate School FOOD is viewed on the international scene. It seems clear that the programme is attractive for many foreign students provided that they receive the necessary financial backing. Exchange opportunities with similar programmes in other European universities may be an important part of the successful recruitment of foreign students. This would help meet the increasing competition within Europe for the best graduate students in science and technology.

One of the major tasks of the Graduate School FOOD lies in providing a range of courses that are suitable for laying a solid academic basis in the PhD training. The present programme contains mainly courses that are already available in the context of other educational programmes. For the future, there is a clear need to develop the programme of courses in such a way that the needs of society and industry are reflected. The programme should go beyond the disciplines that are covered by the PhD supervisors. Some courses may well involve other departments of KVL and DTU. For special topics, the institutions outside of these two universities could be included for courses. MAPP would be very interested to contribute to the course for the PhD education.

Also, the balance between the food science and the nutrition science oriented courses must be observed. So far, the courses offered are much more oriented towards food science than towards nutrition. The name of the school already implies the priority on food so that special efforts are necessary to increase visibility of nutrition and health.

In offering all these courses, the individual PhD student should be able to make selections on his or her own decision. This means that the PhD student might attend some courses fully outside the official programme as long as these courses meet the academic standard. With the increasing tendency to formalise European higher education it is important not to disrespect the need that any academic training must support self initiative of the student.

If LMC continues to be the banner holder and industry to sponsor scholarships, the Graduate School FOOD may well develop into one of the leading European institutions for PhD education in food science and nutrition.

## 8. Conclusion

Since the last IAB meeting, LMC has again taken a significant step forward to become one of the prominent centres of research and academic education in food science and nutrition. The various comments and recommendations expressed in the general part of this report, the many detailed observations and recommendations compiled for the institutes and the individual research groups, and the suggestions made for the development of the Graduate School FOOD should help to shape a successful future of LMC.

The IAB is looking forward to seeing LMC take the opportunities and meet the challenges lying ahead and to accompany its further development.

August 31, 2005

A handwritten signature in cursive script, reading "Felix Escher".

Felix Escher  
Chairman of IAB