EUROPEAN SCIENCE FOUNDATION
SETTING SCIENCE AGENDAS FOR EUROPE

Exploratory Workshop Scheme

Standing Committee for the European Medical Research Councils (EMRC)

Standing Committee for Social Sciences (SCSS)

ESF Exploratory Workshop on

In vitro meat: Possibilites and realities for an alternative future meat source

Gothenburg (Sweden), 31 August – 2 September 2011

Convened by:
Julie Gold and Stellan Welin

SCIENTIFIC REPORT

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1. Executive summary

This ESF Exploratory Workshop on Invitro meat – or cultured meat - marks the second time an international gathering has been held on the subject, the first being a meeting organized in 2008 in Norway by Prof Stig Omholt. This is a truly emerging field, with only a handful of researchers actively working in the area, but the number of people interested to work in the area is increasing rapidly. These individuals are active in the social sciences as well as the engineering sciences, biology/biotechnology and animal sciences/agriculture. When looking beyond the Netherlands, where the R&D activities on growing meat started, these individuals are quite isolated in their activites and dispersed. As this is a community just being formed, many of the participants at the workshop had never met before. In an attempt to begin to overcome this barrier, each speaker provided a "Participant Profile", that contained a description of their main area(s) of expertise, their involvement in invitro meat, their publications in the field (or relevant fields), what they view as the most significant short term and long term challenges to creating cultured meat, and what ideas they have to attract research funding. The Participant Profiles were distributed to the workshop participants well in advance of the meeting so that people would have the possibility to learn about the others joining the workshop.

The workshop was held at Hindåsgården Konferens & Spa, located on a small lake on the outskirts of the city of Gothenburg, Sweden. Hindåsgården is low-key facility that is rather isolated in the Swedish woods. This was highly conducive to participants attending the entire workshop, and focussing on the event and on each other. We met for ca 50 hours over the duration of 3 days, August 31 – September 2, 2011. Twenty-five participants, including ESF Rapporteur Prof. Giovani Pacini, represented 8 ESF countries and the United States. Hindåsgården is located at the entrance to a series of marked hiking/cross-country skiing trails. Several participants enjoyed going for walks or jogging together on these woody paths. The lake provided the opportunity for at least one participant to fish and a few others to go for a swim. Those not brave enough to dare the lake relaxed in the spa facilities of the center. During the first evening we had a casual barbeque dinner at the boathouse with a wonderful view over the lake and the sunset. On the second evening, one participant spontaneously arranged a speaking competition, where each competitor had a minute or so to present an argument on the "natural-ness" of cultured meat. These events, in addition to the different group works and discussions of the workshop, gave us an opportunity to begin to get to know each other.

Overall, the atmosphere of the workshop was wonderful –people were very excited to be there, eager to get to know each other, hopefull for the possibility to form new collaborations, and were willing to share and discuss their thoughts, plans and visions on the future of cultured meat. Our plenary sessions took place in a room with U-shaped seating plan to encourage discussion and facilitate communication.

There were several objectives of the workshop. One of the main objectives was to aid in building this new and highly interdisciplinary community of scientists, engineers, entrepreneurs and supporting organizations. Directly coupled to this is the aim to create new collaborations and networks of individuals. Scientifically, we aimed to describe the state-of-the-art of the field by addressing historic and recent activities in the various sub-areas of cultured meat. Since cultured meat does not exist today, we have the opportunity to discuss and define our goals with cultured meat – where are we headed and where do we want to end up? Coupled to this was the intention to identify the main questions and problems that need to be addressed in order to progress towards the reality of cultured meat. And finally,

we aimed to map out potential sources of research funding and possibly sketch ideas for joint research applications.

In order to achieve these objectives, we started the meeting with lectures / oral presentations on the history of cultured meat, followed by invited summaries of the current status and future directions in six sub-topics required for the realization of cultured meat.

We then broke into our first round of group work, where participants were divided into three main thematic groups: Tissue engineering & stem cells; Large scale processing, industrialization, food and meat biotechnologies; and Social, ethical and environmental impact. The task was to identify the main issues within each thematic area that need to be addressed, and identify existing and potential bottlenecks to making cultured meat a reality. The problems identified within each group (23 problems in total) were presented and discussed in a plenary session, after which partipants voted for the five problems they felt most urgently needed to be addressed in order to move forward. The outcome of this process led to the identification of 8 main issues or bottlenecks that need to be addressed or solved in order for cultured meat to become a reality.

We then broke into our second round of group work, this time forming interdisciplinary groups in order to discuss each identified problem from a variety of perspectives. Each group then completed a set of questions that led to the formuation of a “Problem Statement”. The questions addressed included a description of what is the problem to be solved?, what expertise is needed for success?, What is the scope needed to address the problem?, what are the social, ethical and legal issues regarding this problem?, where to attract funding?, and an outline of ideas to address the problem. (The Problem Statement form is included in Appendix 1.) The intention with these Problem Statements is that we begin to formulate on paper the backbone for potential research and/or development proposals for the future funding calls.

The Problem Statements were presented and discussed in a plenary session, and feedback given from other participants. Subsequently, we discussed what we have agreed upon in terms of state-of-the-art, problems that need to be addressed in the near future, upon a strategy for applying for funding to create an interdisciplinary network of researchers and eventual EU research program, and finally about how to publish the outcome of the meeting. The most challenging task turned out to be the generation of – and agreement on – a message to the press / press release for the press conference which took place after the workshop concluded. Due to the tremendous efforts of our workshop communications team, we have received tremendous international media attention prior to, during and following the workshop, which needed to be managed in an effective and professional way. Besides trational TV, radio and newspaper coverage, attention has spread to the making of educational as well as popular science movies, students at all levels of education choosing cultured meat for their project work, and striking an interest in the general public, from young children (writing hand-written letters) to adults contacting us by phone and email.

The overall conclusions from the workshop are the following:
One of the most important roadblocks for cultured meat to become a reality is the lack of research funding. The research is poorly funded in all countries representated at the workshop, however this might be due to a common perception of grown meat, that it is something unnatural, disgusting or science fiction. But from the research perspective, many pieces of the puzzle are aleady falling into place. If we could produce meat in bioreactors, it would reduce the huge environmental impact that livestock from current meat production

produce. In addition, animal welfare issues would be solved, and the risk of diseases such as swine and avian flu, would be reduced. The advantages of cultured meat outweigh the disadvantages, which motivates continued development of the technology to grow meat in bioreactors.

2. Scientific content of the event

Brief summary of each presentation on current status and future direction of cultured meat

- Historical perspective – Stig Omholt

Description of the history of cultured meat, the organizations and consortia which have been created to support research and the spreading of information and knowledge of the field (New Harvest organization, the International In Vitro Meat Consortium, the Dutch In vitro Meat consortium), outcome of Norway meeting 2008: 3 industry segments need to be developed 1) serum free culture media, 2) cell source, 3) processing into meat product/fiber structures. Also presented were an update on patents, discussion of the potential use of genetically modified cells for increasing production, activities in Asia, and establishment of an In Vitro Meat Society (draft presented).

- Tissue engineering & stem cells – Henk Haagsman

Henk described the history of the companies that have been involved in the Dutch In vitro Meat Consortium, and that consortiums funding history and focus areas of research: stem cells, media development, bioreactors for forming muscle tissue. Discussed various challenges with deriving ESC's from animal that we eat, with getting stem cells to proliferate to large numbers of cells prior to differentiation to muscle cells, and with efficient differentiation of stem cells to muscle cells, with the formation fo mature muscle fibers.

- Large scale processing and industrialization – Nick Genovese

Nick provided a very comprehensive review of scientific and technological developments, mainly related to tissue engineering (scaffolds, formation of tissue submits). He described future issues that will arise in the regulatory approval process for cultured meat (USDA & FDA wil need to work together to develop regulations), customer acceptance, and the reuse of spent media/waste products from the culture process (filtration, dialysis).

- Food and meat biotechnologies- Mirko Betti *cancelled at the last minute. His presentation was shown by the workshop convenors, however*.

Focus on biological reactions occurring in muscle tissue after slaughter and the transition/conversion from muscle to "meat".

- Social Science and economics – Neil Stephens

Neil described the need to gauge potential consumer responses and how to lead them to acceptance of a new product like cultured meat. He has conducted 27 intervies with policy makers, funders, scientists and advocated of invitro meat, and defines invitro meat "as a yet undefined ontological object".

- Environmental imact – Hanna Tuomisto

Hanna presented the results of her recently published life cycle assessment study of cultured meat vs. current farm raised meat, together with Joost Teixeria de Mattos, in Environmental Sci & Technology, 45:6117, 2011. The cultured meat production process (which does not exist to date) is based on the use of cell culture media produced from blue-green algae. Some interesting outcome of their analysis is that the bioreactor function has a

large influence over the calculated environmental impact, and that inhouse production of recombinant molecules will be necessary in order to keep the costs down for defined media that will be used as replacement for animal serum-containing media.

- Ethics, values and legal issues – Stellan Welin

Stellan addressed issues on what is the goal that we need to achieve – to make meat ? or to make a better protein source ? Another topic elaborated on is the concept of natural – is cultured meat natural ? He argues that cultured meat would be more natural than meat produced in current factory conditions. Various ethical and moral issues associated with eating meat (raising animals, killing animals) were presented, and how cultured meat could eliminate or modify many issues.

<u>Synopsis of the subsequent discussion (agreements/disagreements/highlights):</u>

- **The following is a list of main issues that need to be addresses, and that were raised during the group work**:

Cell types (embryonic vs adult vs. IPS stem cells)

Different cell sources need to be investigated for later comparision
More people are needed to work in this area in order to progress more quickly
Which species of food animal to focus on (fish, bird, mammal)
Isolation and characterization of clonal adult stem cells from animals
Generate a first proof-of –principle with rodent cells

Cell culture setup

Large scale expansion of undifferentiated cells
Efficient ways to differentiated cells into muscle fibers
Scaffold systems to use
Length of muscle fibers needed from a cultured product
What should the end product look like
Design of bioreactor to create muscle fibers / tissue

Cell culture media

Characterization of what is minimally needed in the culture media
Maintanence of sterility
Different media compositions needed for each cell type and production stages (proliferation vs. differentiation)

Starting cell type

Which cell type should be used the first trials of cultured meat product / actual production ?
Adress production issues and cost issues specific to the choice of cell type

End Product

Which species should we use and what would be the source of the cells
High-end vs. low-end product ?

Production costs

This is a function of the cell type, the cost of the culture media which needs to be developed, and the feedstock conversion (reuse of media)

Business model/plan

How to make the cultured meat into commercial product ?

Production scale

Issues on upscaling of processes which are mainly being developed at the lab bench

Genetically modified cells

Can we use genetically modified cells ? Will we need to do that ?

Funding !!

How to succeed in obtaining funding for basic & applied research ?
Where to look for funding

Future of food systems

What is/could be in vitro meat?
How will it be produced?
What would be the market structure and the competition ?
How to address IP issues
How to sell the concept – need for narratives and visions relating to effect on land use, sustainablility, etc.

Resistances

What are the current infrastructure and embedded interests giving rise to a resistance to the formation of cultured meat?
How to deal with the public reactions of disgust, distrust and dismissal

Network formation

The need to form allies with companies, policy makers, and other natural interest groups in order to gain acceptance and support to aid in obtaining funding and moving forward.

Communication

How to communicate this novel technique / product

- **Top 8 issues identified**
  1. Cell source/type
  2. Production costs (dependence on scientific and technical solutions identified)
  3. Network formation
  4. Funding
  5. Future of food systems
  6. End product
  7. Business model
  8. Resistance against cultured meat

  Only issues 1, 2, 3, 5 and 6 were elaborated on Problem Statements.

<u>Additional highlights of the discussions:</u>

- There was a consensus on the need for a more positive and easy to understand term describing the concept of growing meat in a bioreactor, rather than “invitro meat”. One lead suggestion was “cultured meat”, however there was not a consensus on which term to replace “invitro meat” with.
- Discussion on the end product or goal towards which we should focus our research and development activities: There were two main end points identified. One was that cultured meat would be a “high-end product”, expensive, exclusive, served in avant-garde restaurants or sold in exclusive stores to persons who are willing to pay more for an unusual yet environmentally friendly product. The other was cultured meat for the “low-end market” – something that could supplement or replace minced meat in processed food products or those products sold in mass quantities (eg hamburgers), in order to make a rapid impact on reducing the environmental impact of current meat production.

- There are a few patents in the field, the majority arising from researchers, yet no company or industry with the intention to produce cultured meat is in ownership of the patents. The lack of patent pooling is a problem for the field.
- There was a consensus that the cell culture media to be used for cultured meat production must be produced in a sustainable manner, both environmentally, ethically and economically. The medium must be produced without animal serum. The best way to achieve this appears to be through the use of a photosynthetic organism that produces the nutrition for the cell culture at the same time that it produces energy for the production process (eg cyanobacteria).
- The use of conventional antibiotics in cell cultures for cultured meat must be avoided. The growth environment must be sterile. If further protection is needed, one should use methods that will not create resistance.

3. Assessment of the results, contribution to the future direction of the field, outcome

The intention of the workshop was not to present latest research findings per se. The focus was rather on identifying ways to go forward in the research and development of creating cultured meat. However, we have realized that several technology components needed to realize the concept of cultured meat are now in place:

- A cell line that can be used – a muscle stem cell line from pig
- A nutrient solution based on blue-green algae (cyanobacteria) can be used for muscle cell culture.
- Several alternative processes to create muscle cells from stem cells have been identified
- Knowledge exists on the growth of mammalian cells in large scale bioreactors (eg biotechnology industry production of antibodies)

In addition, a life cycle assessment of cultured meat compared to traditionally produced meat has been published for beef, pork, sheep and chicken. The results show a decrease of energy use up to 45%, reduction of greenhouse gas emisions by up to 96%, reduction of land area usage by up to 99% and reduction of water consumption by up to 96%.

Among those present at the workshop, and their research organizations, only 5 FTEs (full time employees) are currently being paid to work for a limited time on cultured meat, the majority being doctoral students. There is a clear and urgent need for a greater work force, meaning more funding, so that we can run complementary research activites in different laboratories in parallel.

We have recognized the need of establishing a dialogue with the food industry, specifically the meat industry, in order to gain input that will help us to more clearly defining specific research and development goals for the development of cultured meat.

Concrete actions planed as a follow up:

- Formal reporting to ESF
- Immediate: Submission of COST network proposal OC-2011-2-11019 for formation of a formal scientific network to support meetings, travel, exchange between laboratories (submitted Sept 31, 2011)
- Immediate: Lobby for getting the topic of cultured meat in future EU research programs

- Immediate: Publication of a short summary of the workshop in a high impact, interdisciplinary scientific journal (eg news or communication)
- Longer term: Submission of a proposal for a research program under FP8, or for a Eurocores direct project funding, if such opens up
- Formation of a professional society for researchers, industry and stakeholders interested in working towards the realization of cultured meat – a professional and legal entity
- Increase public awareness and initiate discussions with stakeholders, decision makers and non-governmental organizations
- Updating of the In Vitro Meat Consortium and New Harvest websites with summary from the workshop
- Updating information on Wikipedia webpage for in vitro meat
- Distribution of all presentations and problem statements to all participants at the meeting
- Presentation of the outcomes from the meeting at the WWF's and Swedish Dept of Agriculture meeting "Food or climate?" on Sept 28, 2011 in Stockholm

4. Final programme

Wednesday, 31 August 2011

Morning	*Arrival*
12.00-13.00	*Lunch buffet*
13.00-13.15	**Welcome by Convenors** **Julie Gold & Stellan Welin** (Chalmers & Linköping Universities, Sweden)
13.15-13.30	**Presentation of the European Science Foundation (ESF)** **Professor Giovanni Pacini** (ESF Standing Committee for the European Medical Research Councils (EMRC))
13.30-14.00	**Historical perspective** **Stig Omholt** (Norwegian University of Life Science, Aas, Norway)
14.00-15.00	**Introductions in small groups**
	Coffee / tea break
15.00-18.30	**Session 1: Statements on current status & future direction of invitro meat**
15.00-15.30	**Tissue engineering & stem cells** **Henk Haagsman** (Utrecht University, Utrecht, The Netherlands)
15.30-16.00	**Large-scale processing and industrialization** **Nicholas Genovese** (University of Missouri-Columbia, Columbia, USA)
16.00-16.15	Leg stretch
16.15-16.45	**Food and meat biotechnologies** **Mirko Betti** (University of Alberta, Edmondton, Canada)
16.45-17.15	**Social sicence and economics** **Neil Stephens** (Cardiff University, Cardiff, UK)
17.15-17.30	Leg stretch
17.30-18.00	**Environmental impact** **Hanna Tuomisto** (University of Oxford, Oxford, UK)

18.00 -18.30	**Ethics, values and legal issues** **Stellan Welin** (Linköping University, Linköping, Sweden)
19.00	*Dinner at the boat house*

Thursday, 1 September 2011

08.30-12.30	**Session 2: Identification of bottlenecks & issues to be addressed**
08.30-08.45	**General introduction and instructions for the group work** **Stellan Welin** (Linköping University, Linköping, Sweden)
08.45-11.00	**Discussion in thematic groups and formulation of specific problems to be addressed** **Group work**
10.00-10.30	*Coffee / Tea available*
11.00-12.30	**Summary of group discussions & analysis of identified problems**
12.30-14.00	*Lunch (buffet available until 13.30)*
14.00-18.30	**Session 3: Addressing main problems to overcome**
14.00-14.30	**Prioritization of problems** **Patric Wallin** (Chalmers University of Technology, Göteborg, Sweden)
14.30-15.00	**Formation of problem-oriented groups and instructions for group work** **Patric Wallin** (Chalmers University of Technology, Göteborg, Sweden)
15.00-15.30	*Coffee / tea break*
15.30-18.30	**Preparation of *Problem statements*** **Group work**
19.00	*Dinner*

Friday, 2 September 2011

08.30-12.00	**Session 4: Discussion of follow-up activities & collaborations**
08.30-10.30	**Presentation of *Problem statements*, discussion & feedback** **Julie Gold** (Chalmers University of Technology, Göteborg, Sweden)
10.30-11.00	*Coffee / Tea Break*
11.00-12.00	**Synopsis** **Julie Gold & Stellan Welin** (Chalmers & Linköping Universities, Sweden) Strategies for future funding Preparation of Workshop Report and publication of proceedings Message to the press Summary of Workshop
12.00-13.00	*Lunch buffet*
13.00	*End of Workshop*
14.00	*Press conference*

5. Final list of participants

See following page for table with participant list.

#	First Name	Last Name	Institute	Country	Gender
1	Kedar	Challakere	Stanford University/ Mokshagundam Biotechnologies	USA	M
2	Marinus	F.W. te Pas	ASG-VH	Netherlands	M
3	Nick	Genovese	Medical University of South Carolina / Charlem LLC	USA	M
4	Julie	Gold	Chalmers University of Technology Gothenburg	Sweden	F
5	Bert	Gordijn	Dublin City University	Ireland	M
6	Henk	Haagsman	Utrecht University	Netherlands	M
7	Fredrik	Hedenus	Chalmers University of Technology Gothenburg	Sweden	M
8	Marloes	Langelaan	TNO Innovation for Life	Netherlands	M
9	Josh	Balk	Humane Society of the United States / New Harvest	USA	M
10	Niels	Oksbjerg	Aarhus University	Danmark	M
11	Stig	Omholt	Norway University of Life science	Norway	M
12	Giovanni	Pacini	ESF Standing Committee of the European Medical Research Councils		Rappateur
13	Iva	Pashkuleva	Minho University	Portugal	F
14	Bernard	Roelen	Utrecht University	Netherlands	M
15	Marc	Sellenthine	Centre for European Economic Research	Germany	M
16	Neil	Stephens	Cardiff University	UK	M
17	José	Teixeira	Minho University	Portugal	M
18	Joost	Teixeira de Mattos	Amsterdam University	Netherlands	M
19	Hanna	Tuomisto	Oxford University	UK	F
20	Patric	Wallin	Chalmers University of Technology Gothenburg	Sweden	M
21	Cor	van der Weele	Wageningen University	Netherlands	F
22	Stellan	Welin	Linköping University	Sweden	M
23	Daisy	WJ van der Schaft	Eindhoven University	Netherlands	F
24	Peter	Fyhr	Magle Life Science AB	Sweden	M
25	Robert	Zweigerdt	Medical School Hannover	Germany	M

6. Statistical information on participants

No age information for the participants is available, but an estimate of the age distribution of the participants is under 35/40 years old (10) versus over 35/40 (14).

Countries: Holland (7), Sweden (5), USA (3), United Kingdom (2), Portugal (2), Germany (2), Norway (1), Denmark (1), Ireland (1)

Gender: 19 males / 5 females. The original list of participants had a higher percentage female participants, however due to cancellations and the various

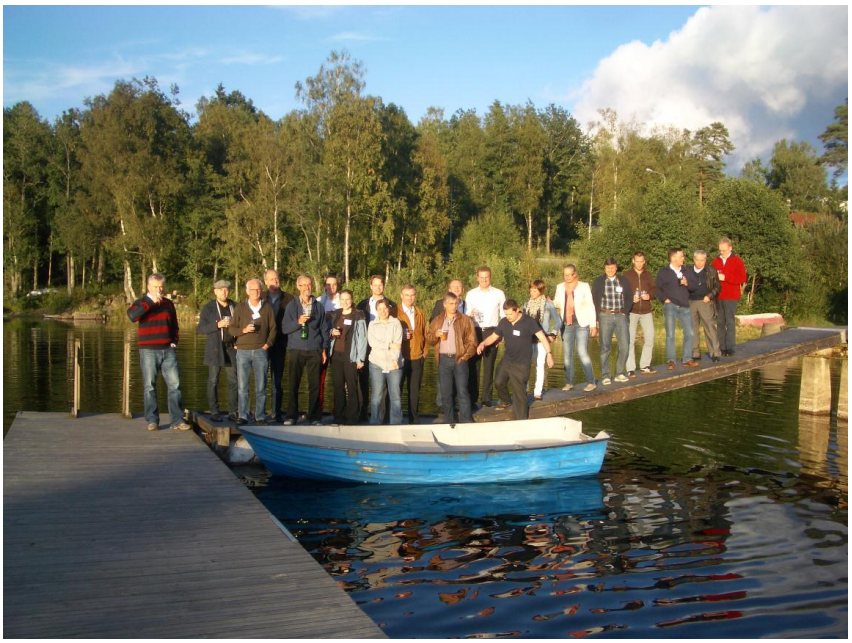
We identified a few main subject areas covered by the participants at the workshop. The distribution of people in this areas is as follows:

- Tissue engineering and stem cells (6 participants)
- Large scale processing and industrialization (6 participants)
- Food and meat biotechnologies (3 participants)
- Social, ethical and environmental impact (9 participants)

Appendix to the Scientific Report

Appendix 1 Press release
Appendix 2 Problem Statement form

Photograph of workshop participants on the dock extending from the boathouse:



View from the boathouse during the relaxing barbeque dinner:

PRESS INVITATION 2011-09-05 Contact: press@chalmers.se

Scientists initiate action plan to advance cultured meat

Gothenburg, Sweden: Late last week, an international group of scientists took a step closer to their goal to produce cultured meat. They agreed on important common positions about how to bring the research forward during a workshop arranged by Chalmers University of Technology and the European Science Foundation. Many technology components are now coming into place in order to realize the concept of cultured meat. This includes a cell source that is possible to use, several alternative processes to turn these cells into muscle cells for meat, and nutrients free of animal components which can be produced from sunlight and carbon dioxide.

In addition, a life cycle assessment of cultured meat compared to traditionally produced meat was recently published. It shows that the environmental benefits of cultured meat are very large (*see attached fact sheet*). For example, compared to the rearing of cattle, cultured meat would entail dramatic reductions of greenhouse gas emissions, land use and water use.

Despite these obvious advantages, the area is still very poorly funded. The interdisciplinary group of scientists has decided to form a community to try to attract more funding and to create a faster development in the area of cultured meat. During the workshop last week, they also reached consensus about important issues in the research field. For instance, the nutrients for growing the cells for meat must be produced with renewable energy and without animal products. The best source for this is to use a photosynthetic organism, such as blue-green algae. Many important decisions remain about how to proceed in the research and development on cultured meat, and the scientists now feel that it is time to spread the discussion outside the research community.

“We want to invite all stakeholders into discussions to tackle these issues and identify in which directions to go,” says Julie Gold, associate professor in biological physics at Chalmers, and one of the convenors of the workshop. “To date, there are only limited dedicated research

activities in cultured meat. To move forward, research activities have to increase substantially." The workshop in Sweden engaged an interdisciplinary group of 25 scientists who all have special interest in cultured meat. Some of them have specialties in tissue engineering, stem cells and food technology. Others are environmental scientists, ethicists, social scientists and economists. All of these areas have been discussed during the workshop. The result is encouraging regarding the possibility to actually be able to supply consumers with cultivated meat in the future, and the scientists have not found any crucial arguments against cultured meat.

"On the contrary, several ethical problems would be solved, especially concerning animal welfare issues," says Stellan Welin, Professor in Biotechnology, Culture and Society, one of the convenors of the workshop.

A European Science Foundation representative took part in the workshop and appreciated the energy from all involved.

"The proposal for sponsoring the exploratory workshop on In vitro meat was enthusiastically accepted by the European Science Foundation, which recognizes in this topic a brand new scientific field, to be deeply explored, given the great potentiality for improving human welfare," says Giovanni Pacini, ESF.

More information on ESF Exploratory Workshop - In vitro meat: Possibilities and Realities for an Alternative Future Meat
Source: http://www.chalmers.se/en/areas-of-advance/lifescience/Pages/ESF-Exploratory-Workshop.aspx

Press images are available here. (Scroll down!)

For more information, please contact: Julie Gold, Assoc. Prof. Biological Physics, Chalmers University of Technology, julie.gold@chalmers.se Stellan Welin, Prof. Biotechnology, Culture, and Society, Linköping University, stellan.welin@liu.se Patric Wallin PhD, Biological Physics, Chalmers University of Technology, wallinp@chalmers.se Christian Borg, Manager of Media Relations, Chalmers University of Technology, christian.borg@chalmers.se

Chalmers University of Technology performs research and education in technology, science and architecture, with a sustainable future as overall vision. Chalmers is well-known for providing an effective environment for innovation and has eight Areas of Advance – Built Environment, Energy, Information and Communication Technology, Life Science, Materials Science, Nanoscience and Nanotechnology, Production, and Transportation. Situated in Gothenburg, Sweden, Chalmers has 13,000 students and 2,500 employees.

Problem Name

Names of the group members

What is the problem to solve?

Description and clarification of the problem to solve

Why is this a problem?

Why is it important to solve?

What expertise is needed for success?

What technologies and competences need to be combined?

Are there any research groups that can be identified at this time?

What is the scope needed to address the problem?

Would it be a small collaboration or large network?

Is new infrastructure needed?

What time frame is required to address the problem?

Is it depending on other developments?

What are the social, ethical and legal issues regarding this problem?

Are there any particular legal frameworks that need to be considered?

What are the ethical, social and cultural aspects of the problem?

Where to attract funding?

Is one of the instruments presented by the ESF Rapporteur suitable?

Is there any other particular funding agency or program that would be suitable to approach with a proposal (EU, National/Multinational programs)?

Outline of ideas to address the problem:

What needs to be done?