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Synthetic Biology: Challenges and Debates

New developments within biotechnology and genetic engineering

- We may not see the results until 15-20 years from now*** > ***Synthetic biology involves promising solutions to a number of mankind's major problems. This incipient technology, however, is still in its embryonic stages and much remains uncertain. We will not be able to tell whether these visions have become reality until 15-20 years from now.***
- Lack of interdisciplinary cooperation*** > ***Denmark is in good position to play a prominent role in this area. Danish companies and researchers are in the vanguard of synthetic biology, and Denmark offers a scientific environment promoting joint public and private research. All we need now, says Danish biotech scientist Birger Lindberg Møller "is for Danish researchers to begin to collaborate across institutions."***
- A democratic debate on synthetic biology*** > ***If the predictions put forward by researchers and scientists come true, synthetic biology will clearly alter our organization of society and change the conditions of our lives. Consequently, we need a democratic debate where politicians and ordinary citizens alike take a position on synthetic biology – and hence on the direction in which they want society to develop, says risk communication consultant Thomas Breck.***

This newsletter is based on a project entitled "Synthetic biology – uses, risk assessment and ethical aspects" and will be published June 10th 2011 along with the final project report available at the websites of The Danish Board of Technology and The Danish Council of Ethics.

In many ways, synthetic biology constitutes an embryonic research field. It remains uncertain what results the ongoing research will produce in the decades to come. In the spring of 2010, U.S. president Barack Obama set up a committee tasked to account for the future perspectives of synthetic biology. This commission has since come to the conclusion that synthetic biology indeed holds great promise as far as clean energy, pollution control, medicine and 'green' chemistry is concerned. In Denmark, we find the same high

expectations to the possible results of research in synthetic biology. New forms of energy that are not based on fossil resources, new ways to control and remove pollution, improved medical products, innovations in sustainable materials and substitutes for harmful chemical substances; within all these areas Danish researchers are clearly in the vanguard.

Synthetic biology is akin to traditional disciplines such as biotechnology and genetic engineering that typically seek to modify the heredi-

ty of various organisms by moving a single or a few genes from one species to another. Synthetic biology is more radical in its approach, however. Biology becomes indistinguishable from engineering when parts of living organisms such as genes, proteins and cell membranes are combined with electrodes, metal surfaces and nanofibres. In order to be able to manipulate so many aspects at the same time, research in synthetic biology is typically undertaken by interdisciplinary teams comprised of bioinformaticians, engineers, biologists, molecular biologists, chemists, physicists and medical doctors.

Denmark may come to play key role

Peter Olesen, chairman of The Danish Council for Strategic Research, makes it clear that Denmark may come to play a key role as a global leader in synthetic biology.

"With companies such as Novozymes, Novo Nordisk, Chr. Hansen, CP Kelco, LEO Pharma and Danisco (recently sold to American DuPont), Denmark has some of the world's strongest commercial platforms for an efficient production of bio-fuel, for bio-products, organic agriculture and an up-to-date production of food and medicine. On top of that, we have world-class research environments for synthetic biology," says Peter Olesen and points out that Denmark offers an extremely fertile setting for collaboration between public and private research partners which he considers a crucial precondition for the successful conversion of knowledge into innovation within the field of synthetic biology.

"However, if we are to come out ahead in today's fiercely competitive innovation society, we need to further stimulate the interplay between public and private research enterprises. We need massive innovation within both domains if we want to continue to lead the field. That is why we are so determined to make sure that projects supported by The Danish Council for Strategic Research involve public-private collaboration," says Peter Olesen.

He is certain that Denmark has a considerable first-mover advantage and a real chance to assume a leading position in synthetic biology – not least in relation to 'green' energy, sustainable food production and pharmaceutical breakthroughs.

The necessity of interdisciplinary cooperation

The Danish Council for Strategic Research considers increased interdisciplinary collaboration a decisive step towards improving Denmark's position in synthetic biology. According to Peter Olesen, it is easier to generate and develop new knowledge with an interdisciplinary approach based on synergy.

Professor Birger Lindberg Møller from the Department of Plant Biology and Biotechnology at the University of Copenhagen, leading biotech researcher and member of the work group on synthetic biology set up by The Danish Board of Technology and The Danish Council of Ethics, is of the same opinion. He points out that cooperation between the various research environments will probably determine whether Denmark is able to produce results 15-20 years from now – which, in his assessment, is the time it will take for synthetic biology to begin to really make a difference.

"Today, Denmark has no projects that span several universities. I hope new public funding of cross-institutional research projects will enable us to combine the knowhow found at the universities in Copenhagen, Århus and Odense while continuing our close collaboration with the relevant Danish companies. That would really give Danish research in synthetic biology some serious get-up-and-go," he says.

What are these researchers working in different areas of synthetic biology supposed to collaborate on, then? Would it not be necessary to select specific areas to focus on?

"The thing about synthetic biology is that we are all basically working on the same technological platform. That makes it quite natural to collaborate across disciplines and institutions focussing on several areas concurrently. In my lab, for instance, we are working on the development of natural colouring agents for food, new medicine and green energy at the same time," explains Birger Lindberg Møller.

The integration of ethical considerations

All is not well, however, in the world of synthetic biology. Research developments unfold faster and faster – and sometimes a little too fast, according to Thomas Breck from The Danish Centre for Risk Communication. He is also a member of the work group on synthetic biology set up by The Danish Board of Technology and The Danish Council of Ethics. Thomas Breck stresses that research teams within synthetic biology, in Denmark as well as abroad, often fail to integrate crucial aspects in their research – especially risk assessment and ethical considerations. In order to ensure a tenable foundation for a democratic technology debate, however, it is essential to integrate such aspects in the research itself rather than confining them to particular forums.

Birger Lindberg Møller agrees. He acknowledges that this is an area we need to focus on henceforth. He has hired a philosopher to take part in one of the research projects he manages – and this arrangement works really well, he says.

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"It is incredibly important to work with a qualified person with another background. To have someone to ask about things, but also someone who can question our research. Generally, it is quite challenging to integrate ethicists and risk researchers in these projects, and this is because both sides tend to be rather firmly rooted in their own knowledge culture. Scientists devote a great deal of their time to actual research feeling that this is what matters the most, whereas sceptics are apt to entrench themselves and demand more rules and regulations. Both sides clearly need to be more willing to listen so we can have a positive and productive dialogue and reach some compromises," says Birger Lindberg Møller.

Peter Olesen concurs. "Personally, I learned a lot from the debate on genetically modified organisms. This debate showed us how difficult it is to create a common language and link the debates on technology and ethics. But there really is no alternative. In the GMO debate, we saw myths arise and witnessed the emergence of mutual distrust between citizens and the science/business community. It is imperative, therefore, to integrate ethical aspects in synthetic biology which will enable an exchange of ideas on uses and risks right from the start," says Peter Olesen.

A democratic debate on technology

Thomas Breck also calls for a broad debate on synthetic biology in society at large. He is generally opposed to an autonomous development and spread of new technologies. On the contrary, he feels we need to have a debate where politicians, opinion-makers and ordinary people alike make up their mind and take a position.

"If the predictions put forward by researchers and scientists come true, synthetic biology will clearly alter our organization of society and change the conditions of our lives. On the other hand, we know from previous experiences that new technologies can have undesirable as well as desirable consequences – they involve advantages, but also risks. Finally, our choice of technology reflects a political prioritization of how to spend the funds allocated to research and development and – in the final analysis – a political decision on what kind of society we want to live in. Such political prioritizations ought to be undertaken on an enlightened and democratic basis," says Thomas Breck.

He goes on to say that we need a broad public discussion to determine what societal problems to solve, in what order and which technologies to use. Thomas Breck also points out that the GMO debate has shown us that when you present a new technology that solves a particular problem, but also constitutes a certain risk and thereby

creates other problems, then the acceptance of this technology and the risk it involves will depend on the public understanding of the underlying problem. If the use-value and the positive results are sufficiently big, people will be willing to accept a greater risk.

"Unless we want the debate on synthetic biology to end in mudslinging and mutual criminalizations, we must cultivate a democratic technology debate focusing, not only on the technical side of the matter, but also on values and problems. A debate in which the authorities actively launch a structured effort to ensure that all social groups have the opportunity to chip in and voice their opinions and concerns. A debate where you listen to the points of view that the debate gives rise to. A debate where you are truly prepared to change existing agendas and modify established prioritizations."

Project Manager/The Danish Board of Technology
Gy Larsen

Facts about the project

This project on synthetic biology, undertaken by The Danish Board of Technology and the Danish Council of Ethics in collaboration, took place from April 2010 to April 2011. The project has included a workshop where the participants contributed input to the debate material. The project seeks to elucidate the perspectives in synthetic biology, which is a particularly dynamic area within biotechnology and genetic engineering, and submit this incipient research area to debate while it is still in its embryonic stages. This project is an attempt to impart knowledge on synthetic biology, to present examples of the potential uses of synthetic biology and some of the dilemmas and challenges inherent in synthetic biology within areas such as research priorities, ethics, democratic handling, risk assessment and public regulation.

The work group behind the project consists of:

- Birger Lindberg Møller, The Faculty of Life Sciences, University of Copenhagen
- Gunna Christiansen, The Danish Council of Ethics
- Maja Horst, Department of Organization, Copenhagen Business School
- Morten Andreasen, The Secretariat of the Danish Council of Ethics
- Steen Rasmussen, Faculty of Science, University of Southern Denmark
- Sune Holm, Department of Media, Cognition and Communication, University of Copenhagen
- Thomas Breck, The Danish Centre for Risk Communication

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The previous five issues of the newsletter

No. 280: Citizens on user fees, wait times and patient requirements in healthcare

No. 279: Unequivocal citizen demands for climate adjustments

No. 278: The public school system could benefit a lot more from IT

No. 277: Countdown for online elections

No. 276: Pathways to sustainable transportation

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