



EUROPÄISCHE AKADEMIE

zur Erforschung von Folgen wissenschaftlich-technischer Entwicklungen
Bad Neuenahr-Ahrweiler GmbH

Direktor: Professor Dr. Dr.h.c. Carl Friedrich Gethmann

NEWSLETTER

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EDITORIAL

■ The Sponsors' Club of the Europäische Akademie GmbH (Verein der Förderer) was founded on 15 November 2001 by companies and citizens of the Landkreis Ahrweiler, to support the Europäische Akademie in its scientific and regional activities. To this end, the members of the association support science in the field of ethics and technology assessment and the expansion of the regional activities of the Europäische Akademie. The club maintains close contact with the regional economy and its organisations. Other regional activities include permanent art exhibitions which are on display in the Europäische Akademie (autumn 2009–spring 2010: artist Christiane Stahl, Vulkaneifel), workshops of the Medical Ethics Working Group and the Ahrtal Talks. Recent activities of the Sponsors' Club were lectures in the Medical Ethics Working Group about baby drop-off boxes and anonymous births on 11 November 2009, about medical research in developing countries on 31 August 2009, about neuroenhancement on 11 May 2009 and a disputation about the financial crisis and its consequences (Ahrtal Talks at the Rathaus Bad Neuenahr-Ahrweiler on 18 November 2009).

New members are always welcome. Please contact Dipl.-Kff. Margret Heyen for application forms (phone: +49 (0) 2641 973-303, e-mail: foerderverein@ea-aw.de).

MH

FOCUS

Synthetic biology gets ethical

Margret Engelhard

Synthetic biology is a young and very dynamic discipline. Its high goals reach from attempts to create artificial life in the test tube to the search for new effective medicines, cheap biofuels and new methods to produce petrochemicals. With its systemic approach and its attempts to generate biological systems that might not have any counterparts in existing living systems it goes far beyond mere genetic engineering. Compared with other emerging technologies synthetic biology has prompted concomitant ethical research at a remarkably early stage. Here, the current ethical discourse is summarized, and it is suggested that ethical discourses should be better embedded in the daily routine of science.

Synthetic biology goes beyond genetic engineering

In the last six decades biology has been fast-paced from a descriptive to a predominantly applied discipline. The description of the genetic code set the foundation for the first artificial introduction of a gene into an organism, and in 1977 the first human gene was cloned into a microorganism in order to produce recombinant human proteins. This experiment is often referred to as the advent of biotechnology. Since then genetic engineering has generated numerous applications reaching from the production of single molecules like biopharmaceuticals to the development of transgenic crops that are for example resistant to herbicides. Synthetic biology extends beyond mere genetic engineering: Instead of modifying existing biological systems by adding a limited number of genes taken from another species, it seeks to generate new systems from scratch.

Synthetic biology envisions the assembly of novel – usually microbial – genomes from a set of standardized genetic parts. These genetic parts may be natural genomic sequences that are being applied to a new purpose, natural genomic

sequences that have been redesigned to function more effectively or artificial genomic sequences that have been designed and synthesized from scratch. In some cases even the genetic code itself is redesigned. In theory, these systems could have new features that have never been found in existing natural living systems, and they would serve the specified purposes and vision of their creators. In short, synthetic biology moves from *manipulatio* to *creatio*. Like genetic engineering synthetic biology has its conceptual roots in the 1970s, but only the new achievements of system biology and automated synthesis of DNA have enabled synthetic biology to flourish in recent years. There is no generally accepted definition of synthetic biology yet, and one aim of the accompanying philosophical research is to provide a problem-oriented definition in order to facilitate discourse. In the meantime the following working definition may serve its purposes: "Synthetic biology is the engineering of biology: the synthesis of complex, biologically based (or inspired) systems which display functions that do not exist in nature. This engineering perspective may be applied at all levels of the hierarchy of biological

structures – from individual molecules to whole cells, tissues and organisms. In essence, synthetic biology will enable the design of ‘biological systems’ in a rational and systematic way.” (“Synthetic Biology: Applying Engineering to Biology”, report of an EU NEST High Level Expert Group 2005). The systemic approach of synthetic biology emphasized in this definition is the second main differentiating factor in comparison with genetic engineering. Also, despite having appropriated the term “engineering”, genetic engineering is by far not as influenced by the engineering disciplines as synthetic biology is; in fact, the engineering perspective in synthetic biology is currently changing the way of working in biotechnology significantly. At the moment scientists are developing a minimal cell that is stripped down to a few basic features onto which standardized genomic sequences can be mounted expressing the desired function. Some of the most prominent applications hoped for are the creation of bio-engineered microorganisms that can produce new medicines and diagnostics and generate petrochemicals, climate-friendly biofuels and hydrogen for the post-petroleum economy. In addition, synthetic biology will generate a vast amount of new information about life processes – from the role of specific genes or of genetic circuits to the metabolism and the functioning of a whole organism.

Ethical framework of synthetic biology

Compared with other emerging technologies, synthetic biology has prompted concomitant ethical discourse and research at a very early stage. Right from the beginning when synthetic biology emerged as a new field, ethical considerations (mainly risk issues) were taken into account by many synthetic biologists themselves and, on a more general level, by NGOs. Furthermore, funding institutions and several academies of sciences are currently getting involved in the discussion. Finally, among academic ethicists, the ethics of synthetic biology is a vivid emerging field. Most ethical challenges in synthetic biology are not ingenious to the discipline though. They have their parallels in ethics of other new technologies such as genetic engineering, nanotechnology or neuroprosthetics, but the specification in the context of synthetic biology is an important task. In addition, some authors argue that there are specific ethical challenges in synthetic biology, referring for example to the creation of new life. Most authors propose a risk-benefit and case-to-case evaluation of synthetic biology. Ethical challenges can be grouped into biosafety risks, biosecurity risks, and challenges to concepts of life, to human self-conceptions and to social justice.

So far, in most cases statements and discussions on the ethics of synthetic biology have

focused on the evaluation and management of direct biosafety and biosecurity risks. While biosafety risks comprise unintended risks, biosecurity risks are characterized by deliberate misuse. The biggest problem in the assessment of biosafety risks of synthetic organisms is their strong divergence from well-known natural systems. When there is no natural reference system, many proven methods of technology assessment are not applicable. Another challenge is that the precise characteristics of synthetic organisms remain “noisy” and hard to predict. In addition, genetic circuits tend to mutate rapidly and become non-functional or develop new unknown characteristics. In response to these problems an augmented utilisation of organisms that are not expected to survive outside the laboratory or organisms with an artificial genetic code are often cited as a good way of preventing synthetic organisms to intermingle with their environment. However, these scenarios have not been experimentally validated so far. Therefore, in summary, the rules of the precautionary principle are suggested to be applied, particularly in cases of high complexity and uncertainty. This includes, above all, the principle of containment and in some cases even a moratorium.

One main aim of synthetic biology is to make biology easier to engineer by the development of a toolbox to design biological systems. It is expected that this toolbox will spark a wave of innovation, as more and more people outside the traditional biotechnology community have the necessary skill and currently also access to material and information to engineer synthetic organisms. However, experimenters not sufficiently educated in biology may lack the biological foresight to judge risks scenarios and may never have attended biosafety training. In the case of biohacking, garage and do-it-yourself biology which are upcoming fashions, guidance from scientific supervisors is even missing altogether. The de-skilling agenda of synthetic biology and the possibilities of dual use also lead to enormous biosecurity risks, since outlaw states, terrorist organisations, or individuals may exploit synthetic biology for hostile or malicious purposes.

Besides these biosafety and biosecurity risks, ethical problems of synthetic biology arise from conceptual questions. Synthetic biology has made the first steps to cross the borderline to create new life from small parts, and it will be only a matter of time before the first *Organismus syntheticus* will come into existence. That the creation of life is a realistic option is new to philosophy. A number of concepts are challenged by this new development: the concept of life, our understanding of nature and the human self-conception (as creator) – to name only a few. In many ethical theories, entities that are described as alive are assigned different values

or moral standing than artefacts and machines. Consequently, the way in which newly created organisms are conceptualized has an ethical impact on how life in general is understood and valued. Therefore, a properly managed debate with understandable and reliable communications that addresses the challenges of synthetic biology requires a problem-orientated and sufficiently consistent definition of living matter with the clearest possible borderline to non-living matter. Semantic problems currently arise, because many representatives of synthetic biology use terms and metaphors (for example “living machines”) that appear to blur the boundary between living and non-living matter. Similar to this example our understanding of nature and, therefore, our way of dealing with nature is likely to be changed. When we assume a dichotomy of nature and culture, one can expect that a change in technical prospects will influence the conceptualization of nature, too.

Finally, synthetic biology brings along challenges to social justice. Synthetic biology will add to the rising demand for agricultural raw material and might lead to competition with food production and promote forest destruction. In addition, synthetic production of otherwise naturally derived molecules is likely to have huge effects on trade, particularly in the developing countries. On the one hand, this could – as in the historic example of rubber in Malaysia – destabilize southern economies and employment. On the other hand, this could lead to a higher independence of countries where the production has been dislocated to which is often regarded as a factor of national security. In this context the question of access to the benefits of the technology and intellectual property rights need to be discussed. However, in most cases these factors are hard to assess and difficult to predict. Thus, in a risk-benefit analysis they can currently only be integrated on a very generalized level.

Plea for a benchside ethical discourse

Against the background that synthetic biology is a quickly developing field with potentially huge impact, and that social conflicts are likely to arise, the concomitant ethical discourse should not lag behind. Here it is proposed that this is best achieved when the vivid culture of interdisciplinarity in synthetic biology widens to one further discipline – to philosophy. Such large interdisciplinarity would, however, ideally be achieved when research is done at the same location. A continuous ethical discourse at the scientist’s benchside might eventually change lab culture by an augmented integration of ethical considerations in the daily routine of science and, last but not least, it could help to prevent that ethics is reduced to the role of a fig leaf.

Dr. phil. Margret Engelhard, Dipl.-Biol., is member of the scientific staff of the Europäische Akademie GmbH. She was involved in the joint statement on synthetic biology by the German Research Foundation, the German Academy of Science and Engineering and the German Academy of Science Leopoldina. Engelhard is currently co-ordinating the project group "Clinical research on vulnerable populations" and was co-ordinator of the academy projects groups on organ donation and pharming.

PROJECT GROUPS

■ Project group "Power plants for the integration of renewable energies into the power supply. Potentials, innovation barriers and implementation strategies": 29/10/2009, Bad Neuenahr-Ahrweiler

■ Project group "Radioactive waste. Technical and normative aspects of its disposal": 18/12/2009, Bad Neuenahr-Ahrweiler

Memorandum on neuroenhancement

■ On 12 October 2009 the memorandum "Das optimierte Gehirn – Chancen und Risiken des Neuroenhancements" was presented to the public in Berlin. It contains advice on how to responsibly use pharmaceutical drugs for the enhancement of cognitive performance and emotional well-being in healthy people. These recommendations were worked out by an interdisciplinary team of authors who collaborated in a research project from 2006 to 2009, funded by the German Federal Ministry of Education and Research. The expert group deliberately decided to make their research results accessible to the wider public by publishing the memorandum in the November edition of the popular journal "Gehirn&Geist". Currently, public debate on pharmaceutical neuroenhancement is dominated by media reports on "brain doping" which tend to focus on the risks of drug consumption.

The team of authors challenges this overly critical approach by rebutting many of the standard objections against pharmaceutical means to improve cognitive abilities or the emotional state beyond what is considered "normal". At present, the best reason not to use prescription drugs like Ritalin® or Prozac® for enhancement purposes probably is the lack of evidence both for their effectiveness and their long-term safety in healthy people. This was established by the medical experts of the working group in a systematic review of the research literature the most important results of which are summarised in the memorandum. If safe and effective neuroenhancement drugs were available, there would be no sufficient reason to ban their

usage. However, their widespread consumption may quite well lead to undesirable social consequences like an exacerbation of inequality which would require adequate regulation. Consequently, the authors plead for a liberal but by no means uncritical attitude towards the evolving possibilities of pharmaceutical neuroenhancement.

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CONFERENCES

Conference on energy economics

■ From 7 to 10 September 2009 the 10th conference organised by the European branch of the International Association for Energy Economics (IAEE) took place in Vienna. About 370 international experts of energy economics presented and discussed topics on the design of future energy systems. These are of specific importance for the current academy project "Energy storages and virtual power plants for the integration of renewable energies into the power supply" in which options, perspectives, potentials and barriers of energy storages are investigated in order to develop concepts to overcome the obstacles found. The most interesting themes were scenarios for paths towards sustainable energy systems, efficient exploitation and use of resources, energy and climate policy strategies, adaptation technologies for climate change, and strategies for increased energy supply security. Furthermore, updated results originally worked out for the academy project "Fuel cells and virtual power plants as elements for a sustainable development" (completed in 2008) were presented and discussed by Dr.-Ing. Bert Droste-Franke (Europäische Akademie) in the parallel session "Heating" (Droste-Franke co-ordinated the project on fuel cells and is co-ordinating the current project on energy storages). The conference proceedings including abstracts, presentations and full papers can be found at the official conference page (<http://www.aace.at/2009-IAEE/>).

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Interdisciplinary discussion about concepts of animal welfare

■ Scientists representing animal welfare science, ethics, law, and philosophy of science came together at the invitation of the Europäische Akademie in Bad Neuenahr-Ahrweiler on 8 and 9 October 2009. Professor Donald M. Broom (Cambridge University) who became the first professor of animal welfare worldwide in 1986

presented a historical analysis of this field. As Dr. Ian Robertson (Ministry of Agriculture and Forestry, New Zealand) and Professor Tjard de Cock Buning (VU Amsterdam University) pointed out, results of animal welfare research are now often consulted to guide processes of development in legislation concerning animal protection. Other moral concepts, e.g. that of integrity, also play an important role in animal protection though, and Dr. Kirsten Schmidt (University of Bochum) analysed how such different ethical concepts relate to the concept of animal welfare. Dr. Christine Leeb (University of Natural Resources and Applied Life Sciences Vienna) illustrated this with practical dilemmas: for example, pigs kept in "natural" conditions are not necessarily the happiest ones. Professor Lennart Nordenfelt (Linköping University) in fact argued against inclusion of naturalness in a definition of animal welfare. In this respect he agreed with Broom whose biological coping theory of animal welfare, however, he rejected. Instead, he put forward a theory of welfare based on happiness. The precise meaning of animal welfare was, thus, not agreed on. However, Professor Colin Allen (Indiana University) questioned the usefulness of a precise definition of animal welfare and suggested to identify morally relevant aspects of animals species-specifically – an endeavour at the interface of science and humanities. Professor Dr. Hanno Würbel (University of Gießen) summarized the field's methodological challenges. Proceedings of the conference which was partially funded by the German Research Foundation are in preparation.

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NEWS

International study on the public perceptions of pharming published in EMBO reports

■ A comprehensive survey of the public perceptions of pharming was published in the October edition of the journal "EMBO reports" (Pardo et al., vol 10(10), 2009, pp 1069–75, Epub 2009 Sep 18). First author is the Spanish sociologist Professor Raphael Pardo Avellaneda (BBVA Foundation Madrid), while Dr. Margret Engelhard, Dr. Kristin Hagen and Priv.-Doz. Dr. Felix Thiele of the Europäische Akademie are amongst the seven co-authors.

'Pharming' is the branch of biotechnology that is using genetically modified plants and animals such as maize, tobacco, goats, and chickens as new production platforms for medicine. One example of this form of medicine production is ATryn® (alfa-antithrombin), produced in the milk of genetically modified goats. ATryn® is

used to treat patients with blood clotting disorders.

To study the public perceptions of pharming a survey including interviews with 22,500 citizens was conducted: in 12 European countries each, Israel, Japan and the USA 1,500 citizens were interviewed. They were asked about their opinion of genetically modified plants and animals producing pharmaceutical proteins. The survey shows a very nuanced picture of people's attitudes towards genetically modified organisms for pharmaceutical purposes. The results demonstrate that even a biotechnology subset such as pharming elicits markedly different responses from the public, depending on both the goals and the specifics of the means. In addition, the public does not adhere to ideological or undifferentiated arguments, but is rather open to different scenarios and, accordingly, to argumentation and dialogue.

In the same context the Europäische Akademie published a memorandum on pharming in 2008 which is the result of the work of an interdisciplinary research project.

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LECTURES

Bert Droste-Franke

23/10/2009

■ "Interdisziplinäre Aspekte von Netzdienstleistungen durch Mikro-KWK und andere dezentrale Stromerzeuger"

Workshop "Dezentrale Netzstützung", Energie-Forschungszentrum Niedersachsen, Goslar

Carl Friedrich Gethmann

15/10/2009

■ "Substanzialistischer vs. prozeduralistischer Würdebegriff"

Conference "Neue Methoden der Medizin und ihre ethischen Implikationen", Center for Interdisciplinary Research (ZIF), Bielefeld

30/10/2009

■ "Bewusstsein als Sprache"

Public Conference "Die Herausforderung der Neurowissenschaften – Ein interdisziplinärer Dialog", Nordrhein-Westfälische Akademie der Wissenschaften und Künste, Düsseldorf

24/11/2009

■ "Wissen und Macht – und die akademische Bildung"

Fachschaft Lehramt, Universität Mainz

4/12/2009

■ "Gibt es ein moralisches Recht auf Mobilität und wo sind seine Grenzen?"

Symposium "Zehn Jahre Forschungsverbund Leiser Verkehr", BBAW Berlin

Stephan Lingner

12/11/2009

■ "Space technology as an identity-shaping tool? The societal view"

Conference "European Identity through Space", 12/11–13/11/2009, European Space Policy Institute, Vienna

19/11/2009

■ "Ethische und anthropologische Aspekte von Ambient Intelligence"

Workshop "Die Zukunft der Räume. Gesellschaftliche Fragen auf dem Weg zur 'Ambient Intelligence'", 19/11–20/11/2009, Europäische Akademie, Bad Neuenahr-Ahrweiler

Felix Thiele

1/10/2009

■ "Ethics and Scientific Policy Consulting"

Philosophy of Science in Use, European Science Foundation Conference, 28/9–2/10/2009, Linköping, Sweden

PERSONALITIES



■ Helen S. Mayberg, M.D., is Professor of Psychiatry and Neurology and holds the Dorothy Fuqua Chair in Psychiatry Imaging and Therapeutics at Emory University School of Medicine, Atlanta/GA, USA.

Her neuroimaging studies over the past twenty years have systematically examined neural mechanisms mediating depression pathogenesis, as well as antidepressant response to various treatments with a goal towards identification of brain biomarkers predicting treatment response and optimized treatment selection. Her long-term interest in network models of mood regulation led to the development of a new intervention for treatment resistant patients using deep brain stimulation.

Mayberg is a Board Certified Neurologist, trained at Columbia's Neurological Institute in New York, with fellowship training in nuclear medicine at Johns Hopkins. She received a B.A. in Psychobiology from the University of California, Los Angeles, and a M.D. from the University of Southern California.

Mayberg is active in a variety of scientific organisations including the Society for Neuroscience and the Society of Biological Psychiatry. She is a current member of the Dana Alliance and the NARSAD Scientific Advisory Board, and serves on the editorial boards of several journals such as Neuroimage and Human Brain Mapping. She was elected to the Institute of Medicine of the National Academies in 2008.

Professor Helen S. Mayberg, M.D., is Professor of Psychiatry and Neurology at Emory University School of Medicine in Atlanta/GA, USA, and member of the academy's project group "Deep Brain Stimulation in Psychiatry. Guidance for responsible research and application" (duration: 10/08–9/11).

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