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Synthetic biology: Ethical considerations

I thank the organizers for inviting the Swiss Federal Ethics Committee on Non-Human Biotechnology (ECNH) to take part in this very interesting and stimulating summit. It is my pleasure to be here.

The ECNH is a governmental advisory committee which was established in 1998. It comprises a total of 12 members accounted by the Swiss Federal Council. It includes a majority of ethicists from the fields of philosophy and theology and representatives of biology, molecular biology, medicine and law. I am a geneticist specialized in human cytogenetics.

A few weeks ago, on May 10 this year, the ECNH presented publicly its ethical considerations on synthetic biology, just 10 days before Craig Venter and colleagues's last publication in Science.

The report assesses the ethical acceptability of synthetic biology, in particular its aspiration to produce new forms of life in a controlled manner. First, the nature of the products of synthetic biology was analyzed, then the existence of ethical obligations which may oppose synthetic biology was assessed, finally the ethics of responsibility was discussed.

The presentation of today will focus on 3 main points, aspirations of SB and ontological conceptions of life, moral status of synthetic life, and ethical evaluation.

For the ECNH, of particular interest were the ethical implications of the so-called Lego model, the "bottom up" approach of synthetic biology, whose aspirations are to create new living beings according to a controlled process and with controllable functions.

To answer the question whether it is possible, or impossible, to generate living beings in a controlled manner and, if yes, to what extent, depends on one's conception of life. The ECNH distinguished four fundamental ontological conceptions.

The monistic position is defined as the reduction of the world's processes and phenomena to a unique principle. In the vitalist position, the foundation of all living beings is a life force (the *vis vitalis*) in the sense of an autonomous principle which also accounts for the difference between the animate and inanimate. The dualist position is defined by the coexistence of two principles, substances or forces, not reducible to one another. Finally the sceptic position relates to the impossibility, at least at present, to give a true account on the nature of life.

According to the monistic position (intended as an ontological naturalism or materialism) life supervenes on physical and chemical properties. Life is or may be an emergent property of

material entities. In a vitalist position, organisms are not reducible to physico-chemical properties only. Life includes at least one property that is essentially unknown. In a dualist position, life comprises at least one non-material component. Finally, according to the sceptic position, no answer can be given to the ontological question of life nature.

In the ECNH, a monistic position was defended by the majority of the members, the other three positions by three distinct minorities.

With regard to synthetic biology a first set of conclusions could be drawn: None of the ontological positions exclude the possibility that the products of the Lego model may be living beings. Even someone who rejects in principle the possibility of the Lego model being successful, in a sense that producing living beings is beyond our power, has thereby not provided a justification for prohibiting any efforts in this direction. Worth noting is the fact that the differences between the ontological positions will be reflected in the way of speaking about the controllability, or non-controllability, of the process and products of synthetic biology and affect the discussion on responsibility ethics.

The present focus of synthetic biology is on microorganisms, either as tools or as products. In the longer term, at least according to certain visions of synthetic biology, attention could be enlarged to living beings of all kinds.

As the Swiss Constitution requires to take the “dignity of living beings” into account when handling animals, plants and microorganisms, the question had to be examined if microorganisms have an inherent value. Whether microorganisms have something that may be called an inherent value or “dignity”, and therefore deserve moral consideration in their own right, depends on one’s approach to environmental ethics.

With special reference to the question of intrinsic value, the members of the ECNH discussed the most common ethical approaches generally considered in the literature.

The majority of ECNH-members adopted a biocentric position: microorganisms have an inherent value because they are living beings and deserve moral consideration. Two minorities adopted a pathocentric or an anthroporelational position respectively: microorganisms do not belong to the circle of living beings that have to be morally considered. However, even the members who ascribe an inherent value to all living beings, accepted, on the basis of a hierarchical position, that the interests of microorganisms are negligible or inexistent in an ethical evaluation.

But does the origin of living beings affect their moral status or, in other words, is it morally relevant whether a being is a natural product or one produced by humans?

According to Mary Ann Warren “To have moral status [...] is to be an entity towards which moral agents have or can have moral obligations. If an entity has a moral status, then we may not treat it in just any way we please”. In the view of the ECNH, if a living being has a moral status, then the way how it came into life has no influence on its moral status.

In support of this thesis different arguments can be evoked.

A scientific argument: Following Robert Boyle "...Some of the things that chemists produce using fire are also given to us by nature, using fire ". Let us take an example. Natural volcanic glass and artificial glass are the same glass. Both of them consist of SiO₂ and additional elements. The human action has no effect on the nature of the substance produced unless it can improve its quality. It is glass, no matter how it was produced

A first philosophical argument: The moral status of a being depends on what it is, i.e., its intrinsic properties. "To be produced by humans" is not an intrinsic but a relational property, therefore "To be produced by humans" has nothing to do with the moral status of a being.

A second philosophical argument: The moral status of a being depends on its morally relevant properties, e.g. the manifestation of life in the biocentric position and the sensibility in the pathocentric position. Thus "To be produced by humans" has nothing to do with the moral status of a being.

These considerations brought us to a second set of conclusions: The natural and the synthetic *Mycoplasma mycoides* "created" by C. Venter's team are the same bacteria. They must be treated in the same way. The risk they arise is also the same.

As the producers of synthetic organisms, what responsibility do humans bear for the associated consequences?

The ECNH distinguished two levels of evaluation, a fundamental critique on synthetic biology and considerations concerning the ethics of responsibility and the ethics of risk.

One criticism, endorsed by a minority of the ECNH, is that synthetic biology conflicts with fundamental conceptions shaping society's attitude to technology, culture and nature. The way of thinking which underlies synthetic biology is shaped by engineering sciences and expresses an attitude which regards living beings as producible, controllable and at our disposal. Critics believe that this attitude changes the way we perceive (in worse, but could be in better) other living beings and our values and relationships with such beings and life in general, thus generating a risk of slippery slope. Ultimately it could change humans' conceptions of themselves and threaten the protection of human dignity.

In response to this criticism, a number of counterarguments were endorsed by the majority of the ECNH. A mechanistic/reductionist way of thinking does not rule out to take inherent values or interests of living beings into consideration. This line of criticism would need to show that these dangers are real.

The majority of the ECNH-members rejected the fundamental critique on synthetic biology. All members accept that slippery slope arguments are useful for highlighting possible consequences at an early stage, so that these can subsequently be monitored.

However they take the view that the concerns raised by critics in this regard do not at present justify a veto on synthetic biology projects.

As we have seen, for the Committee members, the moral status of microorganisms currently used in synthetic biology does not represent an obstacle to their synthetic production. Nor, at present, according to the majority view, do slippery slope arguments carry any weight. However one dimension of synthetic biology has to be considered: the ethics of risk.

The mere hope that all will be well should not be the guiding principle for the handling of potentially dangerous substances and organisms, any more than fears should be allowed to prevent any action. It is evident that, even though any technological development builds on what has gone before, what is being created is partly new. Moreover reference to what is already known does not provide grounds for claiming that something partly new is calculable. Uncertainties remain, it is a typical risk situation.

Until the empirical data required for an appropriate risk evaluation of release trials is available, the precautionary principle has to be applied. Synthetic organisms are only to be handled in contained systems, in accordance with the step-by-step principle, and taking into account the particular precautions required for each specific organism.

Before ending I would like to acknowledge the active and stimulating contribution of all members of the Committee and of the general secretary to the reflection I presented you.

I thank you for your attention.