This response was submitted to the consultation held by the Nuffield Council on Bioethics on Emerging biotechnologies between April 2011 and June 2011. The views expressed are solely those of the respondent(s) and not those of the Council.

Consultation on „Emerging biotechnologies“

The members of the Federal Ethics Committee on Non-human Biotechnology (ECNH) have taken the occasion to respond to the consultation paper on emerging biotechnologies. It limited its considerations to those of your questions which touch the ECNH‟s mandate and where the committee was able to draw from its earlier discussions and experience.

The ECNH‟s mandate is to observe the field *of non-human biotechnology* and advise the Swiss government on legislation and enforcement of legislation from an ethical point of view. In its responses the ECNH refers mainly to its published reports

- The dignity of animals, 2001

- Patents on animals and plants, a contribution to discussion, 2001

- Gene Technology for Food, 2003
- Gene Technology and Developing Countries, 2004

- Research on Primates – an ethical evaluation, 2006

- The dignity of living beings with regard to plants, 2008

- Synthetic Biology – Ethical considerations, 2010

(www.ekah.admin.ch/en/documentation/publications/index)

3 What currently emerging biotechnologies do you consider have the most important implications ethically, socially and legally?

Within the ECNH‟s mandate the most important emerging biotechnologies are considered to be:

- Genetically modified animals and plants (including release into the environment)
- The combination of nana- and biotechnologies (nanobiotechnology)
- Synthetic biology

The most important ethical implications are:
- Concept of risk and considerations relating to the ethics of risk
- Moral status of living beings
- Considerations relating to justice (effects on food security, food sovereignty, biodiversity, “technological divide”, intellectual property, economic and research policy, with regard to GM-food: freedom of choice)

4 Are there examples where social, cultural and geographical factors have influenced the development of emerging biotechnologies (either in the past or currently)? and 7 How have political traditions (such as liberal democracy) and political conditions (e.g. war) influenced the emergence of biotechnologies?

Since 1992 the Swiss Constitution requires taking the dignity of living beings with regard to animals, plants and other organisms into consideration. The concept of dignity of living beings does not provide an absolute protection. The obligation is satisfied when the result of a weighing of goods shows that their interests in not being harmed weighs less than the (human) interests obtained from inflicting impairments on them.
During the seventies and early eighties several parliamentarian initiatives called for a legal regulation of genetic engineering. In 1987, a popular initiative (a change to the Constitution proposed by citizens) requested the introduction of a new article prohibiting the misuse of reproductive and genetic engineering applied to humans. The Federal Council (Swiss Government) reacted by proposing an alternative amendment in form of a new constitutional Article, which aimed to protect not only humans but also the environment from the misuse of gene technologies and to regulate the handling of genetic material of animals, plants and other organisms. Additionally, the parliament introduced the concept of dignity of living beings that is to be respected with regard to animals, plants and other organisms. Following this alternative proposal, the popular initiative was withdrawn. In the 1992 referendum vote, the Swiss people and the cantons approved the new constitutional article. After further years of controversial debates on the regulation of gene technologies, the Swiss Parliament adopted the Gene Technology Act in 2003, which confirmed the concept of dignity of living beings. The respect of the dignity of living beings forces to discuss and consider the moral status of genetically modified living beings that are used in research. It restricts other constitutional rights such as economic freedom and freedom of research.
Another consequence of the direct democratic tradition in Switzerland was a popular initiative in November 2005 enshrining a 5 year moratorium for the commercial release of genetically modified plants from 2005 until 2010. The moratorium was prolonged by the government for a period of three years until November 2013 to wait for the results of a National research programme on risks and benefits of GM-plants. The publications of the results are expected for summer 2012.

8 Are there ethical or policy issues that are common to most or many emerging bio-technologies? Are there ethical or policy issues that are specific to emerging bio-technologies? Which of these, if any, are the most important?

1 Common issues to most or many biotechnologies:
- 1.1 Risk discussion: How to deal with risk situations in which we are confronted with in-complete or lack of knowledge
- 1.2 Discussion of moral status of the modified or (in case of synthetic biology) produced organisms
- 1.3 “Slippery slope” arguments
- 1.4 Issues of justice including patenting issues

2 Specific issues:
- 2.1 Synthetic biology: Conception of life and its impact on risk assessment
- 2.2 Genetically modified food: freedom of choice

1.1 Risk discussion
In all emerging (bio)technologies we are confronted with a lack of knowledge, thus with un-certainties, i.e. with a typical risk situation. The risk discussion is dominated by two different paradigms of what genetically modified organisms are. One paradigm assumes that e.g. a genetically modified plant is the sum of a known plant with an additional trait (a toxin or a protein for example). The risks are claimed to be calculable and manageable, because it is argued that there is already sufficient experience with regard to the original plant and the impacts of the new additional trait of the plant can be tested in the laboratory. When it can be

shown that the new trait has no unintended and unexpected adverse effects on the selected parameters, the GM-plant can be considered to be safe. The second paradigm considers a GM-plant as a new plant. We cannot refer to the experience and knowledge we already have of the original plant and of the new trait, but we are confronted with a different level of lack of knowledge and uncertainties. These two different paradigms have crucial impacts on what is considered to be necessary for an adequate risk assessment of these plants.
The first paradigm refers to the concept of substantial equivalence. This concept is applied in the safety assessment of foodstuffs and animal feed made of GMOs (usually plants), and components thereof and serves in the authorisation process as evaluation of safety. It asks whether a GM product is just as safe, or just as unsafe, as the corresponding original product. The original understanding of the concept of substantial equivalence is based on the assumption that a genetically modified foodstuff can be compared with a normal, non-genetically modified foodstuff, and is equivalent to it except for the additional properties inserted using gene technology. Selected properties of the GM products are compared with the corresponding properties of non GMO food. The question is whether or not the additional property, inserted using gene technology, substantially changes the character of the GM food compared with the normal product. The focus is on the biochemical and toxicological character of the new property. If the additional protein for the new property in a GM product is similar to the plant's own proteins, and is not toxic or allergenic – as far as can be determined – substantial equivalence of the whole product is assumed. The product then counts as „substantially equivalent", i.e. it is considered to be comparatively just as safe for consumption, or just as unsafe as the original non-GM-product. If the genetic modification causes a toxico-logically or immunologically significant difference, the products compared are no longer considered substantially equivalent.

It has to be kept in mind that the concept of substantial equivalence theoretically relates to the food safety of GM products only with regard to human health. Other values relevant to the ethical evaluation such as safety for the environment are not considered. Further, that a GM plant is the sum of the original plant's properties and the new genetically inserted property fails to recognise the complex regulatory and physiological relationships within a cell or an organism. The expression of a foreign gene, i.e. the presence of a new protein, may alter the overall physiological condition of a cell or an organism. In addition to the primary, desired and expected effect, this may have further, unintentional and unexpected effects on the organism as a whole. This concept is therefore no adequate basis for a comprehensive risk evaluation. The second paradigm enables a more comprehensive consideration of genetically modified plant since it accepts the assumption that a foreign gene in the genome of a plant could produce unintended and sometimes unexpected effects in addition to the desired ones, and that these may not be immediately recognisable.

What are the consequences for the risk assessment? Risk assessment is conducted in accordance with the available data. It involves weighting not only the expected effects, but also the gaps in knowledge. Since data availability in risk situations is characterised by gaps and uncertainties, it is also necessary to consider *plausible hypotheses* that differ from the majority view. One general criticism frequently levelled at risk assessment is that technocratic blinkers give rise to a restricted view of risks. It would need to be investigated whether and to what extent such a "reductionist" attitude and approach exists, and leads to an inadequate risk description. Probabilities and damage scenarios have to be determined. Then it has to be decided what (if any) action is required.

It is also important to consider whether there are any alternatives to the chosen course of action. Alternatives are relevant to the weighting because people are more inclined to accept higher risks in order to solve an urgent problem (e.g. satisfaction of basic needs) if no other less risky options are available.

Duties of care also influence risk assessment. Duties of care require the actor, in the light of the current state of knowledge, to be aware of the possible consequences of his actions and the associated damage potential. His responsibility encompasses whatever should have been foreseen given the current state of knowledge. He must anticipate possible consequences and the associated damage potential. He cannot, however, be held liable for what was unforeseeable. Duties of care also require the actor to take all necessary precautions to prevent the occurrence of the expected damage. How far he has to go to meet this requirement will depend on two factors: the likelihood of occurrence and the magnitude of the dam-age. The greater the likelihood and the higher the damage, the more stringent are the duty-of-care requirements. He must seek to ensure that the damage is prevented as far as possible and, if it does occur, is limited as far as possible.

Possible measures to reduce the likelihood of occurrence and the magnitude of damage include systematic monitoring programmes. Another measure is to require a step-by-step approach, progressing from experiments at various safety levels in the laboratory, through restricted and controlled field trials, to the placing of organisms on the market. The rationale for this approach lies in the fact that the knowledge required for appropriate risk assessment in the case of new technologies has to be generated step by step. If the required data is not available from a risk assessment of a previous step, no conclusions can be drawn concerning the likelihood of damage occurring in a subsequent step. Without a risk assessment it is not rational to proceed to the next step and thus not permissible to expose others to risks.

1.2 Discussion of moral status of living beings

With regard to the concretisation of the constitutional requirement to take the dignity of animals into consideration it was possible to refer to some extent to moral intuitions, at least as a starting point of the discussion (see the ECNH *reports The Dignity of Animals*, 2001 and *Research on Primates – an ethical Evaluation*, 2006; http://www.ekah.admin.ch/en/documentation/publications/index.html.). In the case of plants our moral intuitions about the extent and justification of moral responsibilities towards plants are highly heterogeneous. In a theoretical approach to analyse the issue (ECNH-report *The dignity of living beings with regard to plants – Moral consideration of plants for their own sake, 2008;* http://www.ekah.admin.ch/ en/documentation/ publications/index.html) the ECNH concluded that the constitutional and legal concept, when applied to plants, is reduced to a moral appeal to the researchers to be aware that they are handling living beings. There are no further consequences. Even more than with regard to plants it may be asked whether a discussion of inherent value is necessary in connection with microorganisms. However, the concept of dignity of living beings in the Swiss Federal Constitution refers also to microorganism.

Beings with an inherent value are morally significant in their own right. If one concludes that they do have an inherent value, one then needs to consider what *direct* obligations we have towards these beings. Whether animals, plants or microorganisms deserve moral consideration based on an inherent value depends on the ethical position adopted (discussed were theocentric, anthropocentric, anthroporelational, pathocentric, biocentric, ecocentric and holistic positions). Some ethical systems do without the concepts of “inherent value” and “dignity”. Therefore, the possibility of moral claims being ascribed independently of inherent value or dignity as ontological requirements was also discussed. If moral claims are to be ascribed, two conditions need to be met: firstly, interests must be present, and secondly it must be possible for these interests to be represented at least in an advocatory manner. However, interests are bound up with the concept of self: they can only meaningfully be ascribed in the presence of some form of self.

The consequences that follow from the ethical positions ascribing inherent value or interest to living beings also depend on the weight attached to this value or these interests in an evaluation of interests. If these living beings merit moral consideration on the basis of an

inherent value or interests, the question arises how such value or interests are to be weighted in the handling of these beings. The *egalitarian position* maintains that all living beings de-serve moral respect and are of equal status. Here, the possibility is conceded that equal interests are to be given equal consideration with regard to all living beings. According to the *hierarchical position*, although all living beings deserve moral respect, they are not all of equal status. Species membership may be taken to be the decisive factor, in which case greater weight is attached to the interests of humans than to those of animals, to the interests of animals than to those of plants, and to the interests of plants than to those of micro-organisms. Alternatively, certain capacities and characteristics may be taken to be decisive, but here, too, the moral weighting usually increases with the degree of similarity to human capacities and characteristics. The majority of Committee members adopt a hierarchical bio-centric position. According to this majority, animals, plants and microorganisms have an inherent value because they are living beings. However, in line with the hierarchical position, the weight attached to this value in an evaluation of interests is gradual and in the case of plants and microorganisms negligible. In the view of the ECNH, the way in which living beings arise – via a natural or an artificial process – has no influence on their moral status.

1.3 Slippery slope argument

A particular slippery slope argument is brought forward in the context of emerging biotechnologies: such technologies would conflict with fundamental conceptions shaping society's attitudes to technology, culture and nature. They help to promote a mechanistic conception of life. This conception, it is claimed, influences and determines not just research, but all areas of life. It is an expression of an attitude which regards living beings as producible, controllable and at our disposal. The dominance of this attitude is attributable to its close association with technological and economic exploitation interests. It changes the way we perceive all living beings and our values and relationships vis-à-vis such beings and life in general. Ultimately, it will change humans‟ conception of themselves and threaten the protection of human dignity.

In response to this criticism, it is argued that a variety of fundamental conceptions shaping cultural attitudes coexist. To be effective, this line of criticism would need to show e.g. in the case of synthetic biology why its specific approach of distinguishing between living beings and artefacts is correct, while others – which evaluate this distinction differently – are incorrect. It is also pointed out that „mechanistic‟ is often used as a pejorative term. This depreciation overlooks the fact that mechanistic constructions may also be highly complex, and inherent value or interests are not ruled out. To lend weight to the slippery slope argument, it would need to be demonstrated whether and to what extent the way of thinking underlying biotechnologies changes our perceptions of other living beings and of humans. And if changes did occur in our perceptions, and in our relations and dealings with other living beings, it would need to be shown why these would be morally undesirable. It would also need to be shown that these changes threatened not only our perception of ourselves but also, as a result, the protection of human dignity.

The members of the ECNH accept that slippery slope arguments are useful for highlighting possible consequences from an ethical perspective at an early stage, so that these can subsequently be monitored. However, the majority of the ECNH does not consider slippery slope arguments as decisive.

1.4 Issues of justice including patenting issues

All technological applications must also be examined from the standpoint of justice. This en-compasses how these technologies influence the political or social order and procedures, including the treatment of individuals in accordance with his or her rights, needs and merits and the distribution of a society's material and non-material goods.

Justice is linked to equality. People who are in essentially the same situation must be treated as equals, and people in essentially different situations must be treated differently. Equality is also a key factor in the distribution of social goods. There is consensus on one point: One essential criterion for human existence and evolution is that basic human needs such as shelter, food and clothing must be met. There is universal agreement on the individual's needs at this fundamental level, despite major differences on other aspects. The discussion on equality focuses in particular on the question of how comprehensive the rights of the individual are: The greater the gap between the poor and the rich, the more a life in poverty is regarded as a violation of the right to dignity. A community is regarded as just if it respects the special nature and uniqueness of every person and treats him or her accordingly. Every member of a community must be granted equal opportunities to live a life in dignity, occupy an acceptable position within the society, and participate in processes that build the political will.

E.g. with regard to the effects of gene technology on developing and newly industrialized countries on the aspects of justice, a key is the manner in which the use of such technologies impacts the extent to which the following fundamental rights are upheld:

- The basic right to life and personal integrity imply a moral right to food, i.e. access to an adequate, healthy diet through food security. An ethical evaluation of gene technology must assess the opportunities and risks posed by gene technology for food security. This evaluation must be made based on available data and careful estimates.

- Autonomy: This includes the concept of food sovereignty. At the level of the individual, food sovereignty refers to the freedom of the individual to make his or her own decision on how he or she wishes to be nourished. On a collective level, sovereignty is about the right of countries to decide, on their own, how they wish to govern trade in agricultural produce i.e. access to markets. Moreover, this collective level also implies the moral right of communities to feed themselves in accordance with their own traditions and cultures. An additional aspect of food sovereignty is the right of developing and newly industrialised countries to participate on an equal footing in the legal integration of gene technology at the international level. The structures whereby the associated international agreements are negotiated must also be measured by whether or not they permit developing and newly-industrialised countries to have an equal say with economically dominant nations. In view, in particular, of the ongoing obstacles to the participation of developing and newly industrialised countries in the international legislative process, it is essential to conduct a normative evaluation of the underlying systems in this process. Regulations governing the protection of intellectual property or investments, provisions governing the restriction and opening of international trade, or agreements on the use of natural resources must therefore be measured according to the criteria of justice.

- The concept of justice also requires ensuring that future generations enjoy life opportunities (generally it is argued that they must be the same as are currently in place). To this end there is a moral obligation to a sustainable lifestyle. The protection of biodiversity constitutes an integral part of this obligation. To obtain a meaningful evaluation of the effects of gene technology on developing and newly-industrialised countries, it is necessary to determine, on the basis of available experience, whether the use of gene technology poses a risk to biodiversity.

- Finally, peace is incontestably an essential requirement for food security, food sovereignty and the long-term securing of natural resources. At the national as well as international level, the ability and willingness of parties to resolve conflicts peacefully is an essential criterion in any legal system. This is, in turn, dependent on the existence of fair rules and can be threatened by serious violations of elementary basic rights and gross economic inequality. In

the international context, therefore, a normative evaluation of gene technology must also focus on the objective of peace.

2.1 Specific to synthetic biology: Conception of life and its impact on risk assessment
How one answers the question to what extent it is, in principle, possible or impossible to produce living beings in a controlled manner depends on how one conceives of life and what conception of life one's assessment is based on. The differences between the ontological positions adopted with regard to the conception of life are reflected in different ways of speaking about the controllability of the process and products of synthetic biology and, therefore, of the risks they pose.

On the one hand, a biological language is used, describing life as a set of functions: organisation, reproduction, metabolism, response to environmental stimuli. On the other hand, a systems-oriented language is used, favouring a hermeneutical approach. On this view, a description of functions alone provides an inadequate account of life. Additional knowledge is required in dealing with living organisms.

Proponents of a monistic ontology take living beings to be of a purely material nature. Life is or may be an emergent property of material entities. For those who hold this position, there is in principle no reason why the bottom up approach of synthetic biology („Lego model") should not succeed in producing life. Those who subscribe to a vitalistic or dualistic ontology assume that life comprises at least one essentially unknown, non-material property. Proponents of these positions will perhaps doubt whether it is possible to "assemble" living beings from non-living components. On this view, the nature and origins of life are not amenable to the methods of natural science. Accordingly, the aspiration to be able to produce life in a calculated, controlled manner is to be rejected. Adherents of a sceptical view, holding that one comes up against (possibly temporary) epistemological limits in dealing with living beings, assume that we cannot know what life is. Therefore, no answer can be given to the ontological question concerning the nature of life. These positions and the associated conceptions of life cannot be reconciled. Nor, however, can they simply be left to coexist, for each approach makes the same claim to be able to answer the question of what life is. (The majority of the ECNH holds a monistic position.)

All the ontological positions considered leave open the possibility that the "Lego model" (bottom up) approach of synthetic biology may be successful, with living beings arising as products. The differences between these positions are reflected in different ways of speaking about the controllability or non-controllability of the process and products of synthetic biology. These different viewpoints and ways of speaking affect the discussion on what risks these products pose.

2.2 Specific to genetically modified food: Freedom of choice

As a consumer's right we normally understand freedom of choice, i.e. being able to choose between several options, to be a *claim right*. Although freedom of choice is not a general right – for example, we do not have the right to drive both ways on a one-way street – many hold that food is important enough that in the case of being able to choose between GM and non-GM products, such a right is appropriate. In this case, two claims are connected with freedom of choice. First, the State should ensure that the products are appropriately labelled. This duty of declaration is usually justified by saying that consumers should be able to inform themselves in order to be able to make an autonomous choice. Second, the State should ensure that it is possible in practice to choose between GM and non-GM products.

If the food market were to develop such that only GM products were available, we could refer to freedom of choice to require the State to intervene and ensure that non-GM products are also available. Conversely, it would mean that the production and marketing of GM

products is also required. The State is obliged to guarantee that, in addition to non-GM products, GM products are always available on the market.

We can also understand freedom of choice not just as a right to claim something, but also as a *liberty right*. In this case, the consumer right means that nobody should be *compelled* to consume GM products. The State accordingly has a duty to protect consumers from this compulsion. It can only do this by ensuring that, even if GM products are on the market, consumers also have access to *non*-GM products. This liberty right is based on the consumers‟ belief that the GM products are hazardous, or rejecting them for other reasons. It would then not be ethically justifiable to place consumers in a situation where they are forced to buy GM products. Proponents of GM products may base their argument on their belief that GM products are just as safe as ordinary foodstuffs. However, respect for persons requires that individual risk assessments and ethical positions be taken seriously. Asserting one's own perception of safety is incompatible with the principles of freedom and autonomy. It does appear justifiable to require the proponents of GM products to renounce GM products. The State should ensure that non-GM products are always available; but the State is not obliged to guarantee access to GM products.

This claim may theoretically be fulfilled in two ways: either through the import of GMO-free products, or through the domestic cultivation of such products. For domestic cultivation, there is the question of whether it is feasible for traditional forms of production and those based on gene technology to coexist. If this is not possible this may mean refraining from production based on gene technology.

(ECNH-report *Gene Technology for Food – Ethical considerations for the marketing of genetically modified foodstuffs and animal feed*, 2003)

9 Do you think that some social and ethical themes are commonly overlooked in discussions about emerging biotechnologies? If so, what are they?

Not generally overlooked but sometimes not treated with the necessary attention are the impacts of patents on new biotechnologies, especially the ethical implications of the scope of patents.

From the outset, the ECNH explicitly recognizes that intellectual achievements in the field of biotechnology deserve to be protected, since it regards as ethically justified the goal of promoting research in the interests of all members of society. By granting a patent, the state accords monopoly rights to the possible commercial exploitation of an invention for a limited period. This gives inventors an opportunity to recoup their research investments and, in addition, to make a profit. In return, the invention is made accessible to the public for the benefit of society as a whole. This balancing of interests needs to be implemented in a fair manner.

As the system was originally developed for inventions involving inanimate material, the ECNH believes that in the biotechnological and biomedical field – i.e. when dealing with living material – particular attention needs to be paid to a number of ethical considerations and concerns. In its discussion, the ECNH focused in particular on the patenting of genes and gene sequences. The ECNH unanimously rejects the patenting of unmodified genes in their natural environment or in an isolated form. The ECNH takes the view that, even when they are isolated, genes are not inventions but discoveries. The distinction between discovery and invention is significant. Patent law is a system designed to offer rewards and incentives for inventive achievements. Discoveries should not be patentable since the element of inventive achievement is lacking. For the overwhelming majority of the Committee, genes and genetic resources are part of the human heritage and therefore not subject to any kind of exclusive rights. Even if they are classified as inventions under patent

law, they should be deemed non-patentable on the basis of other criteria (lack of novelty, insufficient level of inventiveness, lack of commercial applicability). Despite these considerations, the political climate is in favour of allowing patents on genes. This being so, the ECNH is concerned at least to restrict the scope of patent claims to a precisely defined function of a gene, since *absolute* protection of genes or gene sequences cannot be justified from an ethical perspective. The ECNH therefore supports utility-based substance protection. Utility-based substance protection for gene sequences – as opposed to absolute substance protection in the case of chemical sub-stances – does not amount to technological discrimination, since genes and chemical sub-stances differ in essential respects. What are comparable to chemical substances are not genes, but the proteins coded for by gene sequences. While for synthetically produced chemical substances all applications are covered by absolute substance protection, patent protection for gene sequences should be restricted to clearly defined applications of proteins. This is justifiable insofar as proteins – unlike chemical substances, which can be produced synthetically – are finite in number. Allowing such patents would soon unduly restrict re-search, with all the attendant adverse consequences.

Another key goal of patent acts is to promote research. Patent regulations have sometimes been perceived as obstructive by researchers in the field of biotechnology, especially at public-sector research institutions. This perception is partly due to inadequate awareness of the researchers‟ own rights. The ECNH therefore supports the adoption of an explicit research privilege, which should be as broad as possible. Other important concerns for the ECNH are to secure the farmers‟ and breeders‟ privilege. The farmers‟ privilege allows farmers to reuse material harvested from protected varieties for propagation on their own farm. The diversity of existing crops and farm animals, which makes today’s breeding efforts possible, was created by farmers and is based on exchanges of propagating material among farmers. The farmers‟ privilege is also designed to protect farmers from dependency on suppliers. For the ECNH, enshrining the farmers‟ privilege in patent legislation – also covering the sharing of small amounts of materials and not excluding any plant species – is an ethical requirement, so as to ensure the maintenance of diversity, despite the fact that in Switzerland today this privilege is not of major importance economically. Free access to and exchange of biological material among breeders (breeders‟ privilege) has also made a vital contribution to the existing diversity of livestock and crop plants. Preserving and promoting the greatest possible diversity is an important ethical objective.