European Group on Ethics in Science and New Technologies (EGE)

# GEE Avis sur l'éthique de la Biologie synthétique

Diapos de Anne Cambon-Thomsen et Pere Puigdomènech

# Groupe européen d'éthique des sciences et des nouvelles technologies

Le Groupe est une instance neutre, indépendante, pluraliste et pluridisciplinaire, composé de quinze experts nommés par la Commission européenne pour leur expertise et leurs qualités individuelles.

- Le Groupe a pour mission d'examiner les questions éthiques liées aux Sciences et aux Nouvelles technologies et sur base de son travail, de soumettre des avis à la Commission européenne dans le cadre de l'élaboration de législations ou de la mise en place de politiques communautaires.
- 15 membres - http://ec.europa.eu/european_group_ethics/index_fr.htm

# Groupe européen d'éthique des sciences et des nouvelles technologies

- Afin de faire face aux questions éthiques soulevées par les rapides avancées de la science et des nouvelles technologies, les Membres représentent un éventail très élargi des compétences professionnelles dans différentes disciplines telles que, entre autres, la biologie et la génétique, la médecine, la pharmacologie, l'agronomie, les TIC, le droit, l'éthique, la philosophie et la théologie.
- Pour chacun des avis qu'il doit délivrer, le Groupe organise une table ronde publique, avant que l'avis ne soit adopté. Des représentants des Institutions de l'Union européenne, des experts dans les domaines concernés, et des personnes représentant différents intérêts sont invités à participer au débat.
- 25 avis de 1991 à 2009

- **ETHICAL ASPECTS OF SYNTHETIC BIOLOGY**
- EGE Opinion 25
- adopted on November 18th 2009

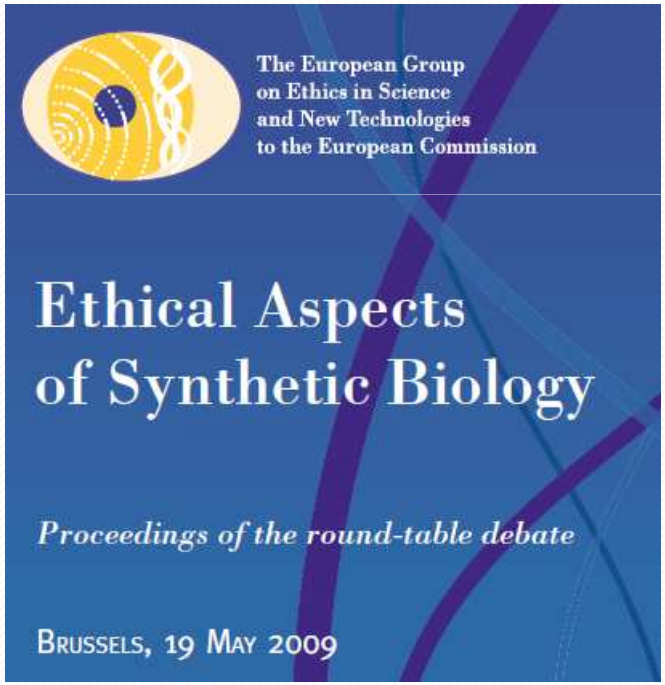
# A letter

In May 28, 2008 President José Manuel Barroso asked the EGE for an Opinion on the ethical, legal and social implications that may derive from Synthetic Biology

'(…) the debate about the legitimacy of engineering new life forms has mainly focused on safety issues and a work on the ethical, legal and social implications that may derive from this specific use of biotechnology is still missing….'

# Preparation of the Opinion

Hearing of experts
Commission services
Roundtable
Internal discussions



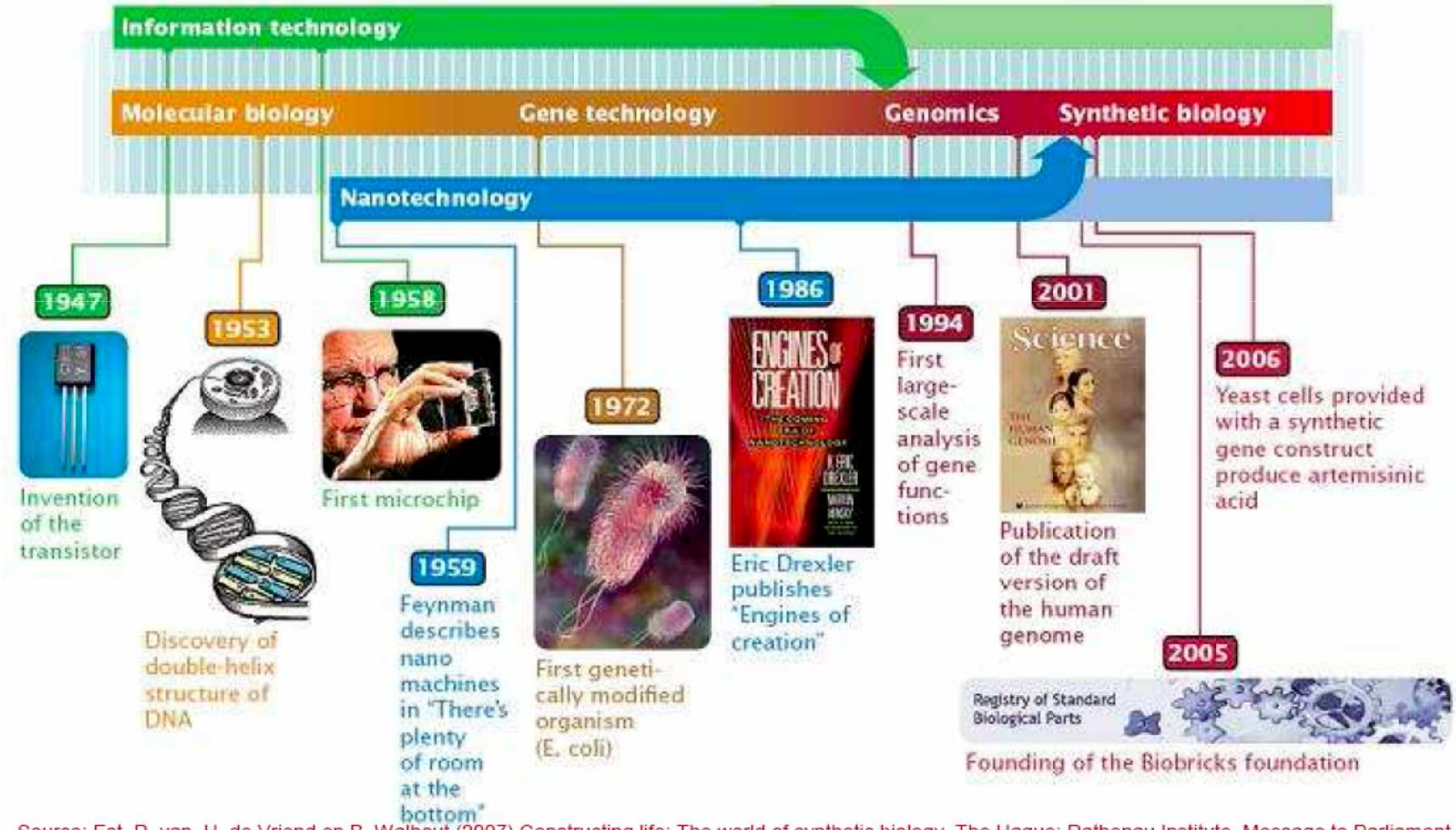

**Brussels, 19 May 2009**

| | |
|---|---|
| 13H30 | **Registration** |
| 14H00 | Welcome Address to the EGE Round Table by Professor **Göran HERMERÉN**, President of the EGE |
| 14H10 | ***The Ethics of Synthetic Biology*** **Hugh Whittall** (Dir Nuffield Council of Bioethics, UK) Followed by discussion (10 minutes) |
| 14H40 | ***Public Perception and Media: the Case of Synthetic Biology*** **Eleonore Pauwels** (Synthetic Biology Project, Woodrow Wilson International Center for Scholars, Washington, DC, USA), Followed by discussion (10 minutes) |
| 15H10 | ***Is This (the Good) Life? Engaging the World of Synthetic Biology*** **Bart Walhout** (Rathenau Institute, NL), Followed by discussion (10 minutes) |
| 15H45 | **Coffee break** |
| 16H00 | Discussion chaired by EGE – contributions from participants |
| 17H30 | EGE Members – Reactions to Stakeholders' Comments Closing Comments from EGE Members |
| 18H00 | **End of Round Table** |
| 18h15 | **Cocktail** |

# Définitions

- Pas encore de définition internationalement acceptée
- Mais nécessaire si la recherche et les applications dans ce domaine doivent être réglementées
- Le GEE considère que la notion de «biologie synthétique» recouvre au moins:
  - la conception de cellules ou d'organismes minimaux (y compris de génomes minimaux);
  - l'identification et l'utilisation de «parties» biologiques (la boîte à outils);
  - la construction de systèmes biologiques partiellement ou totalement artificiels.

# Technology key in shifting paradigms




Source: Est, R. van, H. de Vriend en B. Walhout (2007) Constructing life: The world of synthetic biology. The Hague: Rathenau Institute. Message to Parliament.

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# FIVE HARD TRUTHS FOR SYNTHETIC BIOLOGY

Can engineering approaches tame the complexity of living systems? **Roberta Kwok** explores five challenges for the field and how they might be resolved.

## THE HYPE
### The 'parts' work like Lego

Images such as these run in magazines *The New Yorker* (left) and *Wired* portray synthetic biology as simple design and construction. The truth is that many of the parts are not well characterized, or work unpredictably in different configurations and conditions.

## THE HYPE
### Cells can simply be rewired

The magazines *Scientific American* (top) and *IEEE Spectrum* portrayed synthetic biology as being similar to microchip design or electrical wiring. Although computational modelling may help scientists to predict cell behaviour, the cell is a complex, variable, evolving operating system, very different from electronics.

**Variability crashes the system**

Synthetic biologists must also ensure reliably. Molecu- prone to random on in growth con- iour. And over the genetic mutations ltogether.

## THE HYPE
### A promise of unprecedented power

*Nature* has portrayed synthetic biologists as wielding the power to 'hack' life (right), and in its *Guide to Synthetic Biology*, the civil society organization ETC n likened their activity to playing God. But in field has yet to deliver much of practical use.

### 1 Many of the parts are undefined

A biological part can be anything from a DNA sequence that encodes a specific

### 2 The circuitry is unpredictable

Even if the function of each part is known, the parts may not work as expected when put together, says Keasling.

### 3 The complexity is unwieldy

As circuits get larger, the process of constructing and testing them becomes more daunting. A system developed by Keas-

### 4 Many parts are incompatible

Once constructed and placed into cells, synthetic genetic circuits can have unintended effects on their host. Chris

# European Union legislation of specific importance for ***risk assessment*** and ***risk management***

- **Directive 98/81** deals with the contained use of genetically modified micro-organisms. It regulates ***the contained use of genetically modified micro-organisms*** (GMM) and therefore has environmental and human health protection purposes
- **Directive 2001/18/EC** regulates the ***deliberate release into the environment of genetically modified organisms*** and therefore has environmental and human health protection purposes
- In addition, the Commission has recently prepared a replacement ***Draft Directive on the contained use of genetically modified micro-organisms (GMM)*** to amend Directive 98/81/EC. The above Directive aims to establish common measures to evaluate and reduce the potential risks arising in the course of all operations involving the contained use of GMMs and to set appropriate conditions of use. The Directive also seeks to lay down requirements for risk assessment and advocates that contained uses of GMMs should be classified in relation to the risks they present to human health and the environment.

# European Union legislation of specific importance for ***risk assessment*** and ***risk management***

- Other regulatory relevant frames would include:
- ***new medicinal products*** (Regulation (EC) No 726/2004, Directive 2001/83/EC, Directive 2003/94/EC and Directive 2003/63/EC);
- ***medical devices*** (Directive 93/42/EEC and 90/385/EEC);
- ***gene therapy, cell therapy and tissue engineering*** (Regulation (EC) No 1394/2007 amending Directive 2001/83/EC and Regulation (EC) No 726/2004, Directive 2001/83/EC, Directive 2004/23/EC and Directive 2002/98/EC);
- ***clinical trials*** (EC 2001/20 amended in 2003 and 2005);
- ***cosmetic products*** (Directive 1976/768/EC);
- ***chemicals*** (REACH rules);
- ***biological risks*** (Council Directive 82/894/EEC and Council Directive 2000/29/EC of 8 May 2000 );
- ***safety and health for workers exposed to biological agents at work*** (Directive 2000/54/EC)..

# Other relevant policy document

- ***The Cartagena Protocol:*** The EU and all EU Member States have ratified the protocol (Regulation 1964/2003). The risk assessment requirements of the Protocol are similar to those identified in the EU legislation identified earlier.
- ***Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction:*** 155 countries have signed the BTWC, including all 27 EU Member States. The BTWC does not cover research for defensive measures and dual use considerations.
- **Framework on ethics and human rights**
- (a) In 1997 the ***Council of Europe*** adopted the **Oviedo Convention** — Convention on Human Rights and Biomedicine. Its main purpose is to protect individuals against exploitation arising from treatment or research. The Convention is supplemented by a number of protocols.
- (b) The ***Universal Declaration on Human genome and Human Rights***, adopted by the ***UNESCO*** General Conference in 1997 and subsequently endorsed by the United Nations General Assembly in 1998, deals with the human genome and human rights. The UNESCO ***Universal Declaration on Bioethics and Human Rights*** (adopted on 19 October 2005) is not legally binding, but is a reference point for the protection of human rights and ethics.
- (c) The most recent version of the **World Medical Association (WMA) *Declaration of Helsinki, Ethical Principles for Medical Research Involving Human Subjects***, was adopted by the 18th WMA General Assembly in Seoul in October 2008. Concerning potential military uses of medicine, the WMA adopted in October 1998 (text amended by the WMA General Assembly, Seoul, Korea, October 2008) ***a*** *Statement on Nuclear Weapons.*
- (d) The ***European Charter of Fundamental Rights*** formulates a common set of basic shared values at EU level. Respect for human dignity, a ban on human reproductive cloning, respect for people's autonomy, non-commercialisation of biological components derived from the human body, prohibition of eugenic practices, protection of people's privacy and the freedom of science are examples of values enshrined in the Charter, which was adopted at the Summit of Nice in 2001 and is an integral part of the Lisbon Treaty.

# *Why SB should be addressed from an ethical perspective?*

- SB might have an impact on the following sectors: biofuels, antipollutants, textiles, cosmetics, diagnostic and therapeutic tools, vaccines, drugs food and feed ingredients. In its Opinion the EGE identifies and addresses ethical concerns particularly but not exclusively from the point of view of safety and security. Beyond this, the ethical reflection addresses justice, governance, science and society dialogue, intellectual property and concepts of life. As for other new technologies, synthetic biology must respect the international framework on ethics and human rights and in particular the respect for human dignity, which is conceived as not only a fundamental right in itself but 'the real basis of fundamental rights'. Other ethics principles that have to also be taken into account include, inter alia, the principles of safety; sustainability, justice, precaution, freedom of research and proportionality.

# Applications et débats

- Ses applications potentielles dans les domaines de la biomédecine, des biomédicaments, de l'industrie chimique, de l'environnement et de l'énergie, de la production de matériaux intelligents et de biomatériaux donnent lieu à des **préoccupations** spécifiques notamment, mais pas exclusivement, du point de vue de la **sécurité et de la sûreté**
- Le débat porte sur des aspects juridiques, de gouvernance, de dialogue entre la science et la société, de propriété intellectuelle et de discussions philosophiques sur le vivant

# Principes éthiques

- Respecter la dignité humaine
- Les principes
  - de *sécurité,*
  - de *durabilité,*
  - *de justice,*
  - *de précaution,*
  - *de liberté de la*
  - *recherche*
  - *de proportionnalité*

# The concept of life

**3.1.2. Conceptual-ethical issues**

The debate on synthetic biology addresses issues concerning or related to the ethical legitimacy of manufacturing living organisms. Some have advocated the ethical legitimacy of fabricating life while critics have expressed serious concerns about the radical nature of this intervention.

In 1999, a group of bioethicists studied Venter's goal to fabricate a minimal genome organism. They argued that the prospect of constructing minimal and new genomes did not violate fundamental moral precepts or boundaries, but did raise questions about the possible consequences of synthesising new free-living organisms in relation to the concept of life and our relation to it.

The concept of *life* has many interpretations according to the theoretical context in which it is used. Thought must be given to the terminology used to discuss ethical aspects of synthetic biology and its products, for instance, 'artificial cells,' or 'living machines'.166 The terminology used to address the ethics of synthetic biology therefore needs to be ethically analysed in order to provide critical answers to questions concerning the difference between *life* and *non-life* 167 or between the *natural* and the *artificial*.

# Safety challenges

- **Safety:** The EGE advocates that safety is a pre-requisite to any use of synthetic biology. A further concern relates to unknown risks to the environment and public health, determined by unexpected interactions between synthetic microorganisms and the environment or other organisms in it.
- Biosafety concerns regarding synthetic biology also affect risk assessment methods existing in the EU in relation to biology. The assessment methods for GMOs are based on a comparison of the altered organism with the natural organisms on which they are based, considering each individual trait introduced. Synthetic biology will produce organisms with multiple traits from multiple organisms, and therefore it may be difficult to predict their properties.
- The EGE recommends among other things that the **EC initiates a survey on relevant risk assessment procedures in the EU and identify possible gaps in the current regulations and how identified gaps are to be filled; and that a Code of Conduct for research in synthetic biology should be prepared by the EC**.

# Recommandation « sécurité »

- *Que toute utilisation de la biologie synthétique soit subordonnée aux questions spécifiques de sécurité définies dans le présent avis.*
  - *étude sur les procédures actuelles d'évaluation des risques au sein de l'UE*
  - *déceler les lacunes*
  - *indiquer le mécanisme permettant de combler les lacunes*
- *Que la procédure d'évaluation des risques ainsi déterminée soit ensuite mise en oeuvre par les autorités compétentes au sein de l'UE et par les autorités nationales*
- *Que le financement de la recherche en biologie synthétique et la commercialisation de produits issus de la biologie synthétique dans l'UE soient subordonnés à ces conditions*

# Environmental concerns

- **Before an organism, fabricated or modified via synthetic biology, is released into the environment, ecological long term impact assessment studies must be carried out. Data resulting from such studies should then be evaluated taking into account the precautionary principle and the measures foreseen in the EU legislation (EC/2001/18). In the absence of a favourable assessment the release of organisms fabricated or modified should not be authorised.**
- **A Code of Conduct for research on synthetic microorganisms should be prepared. The Code should, for example, assure that synthetic biology organisms are manufactured in a way that they cannot autonomously survive if accidental release into the environment would take place.**

# Recommandations 2 , 3, 4

- *Que la Commission lance un débat international avec les parties concernées*
- *Que la Commission prépare un code de conduite pour la recherche sur les microorganismes synthétiques.*
- *Que préalablement à la dissémination dans l'environnement d'un organisme fabriqué ou modifié par l'intermédiaire de la biologie synthétique, des études d'évaluation d'impact à long terme soient réalisées (et prises en compte dans décision)*

# Recommandations 5, 6

- *Que l'utilisation de la biologie synthétique en tant que source d'énergie de substitution pour les États membres de l'UE soit complémentaire au plan d'action de l'UE en matière d'énergie renouvelable,*
- *Que les autorités compétentes suivent de manière appropriée les procédures d'autorisation de la production de matériaux et de produits chimiques dérivés de la biologie synthétique en prenant en considération*
  - *a) les facteurs d'évaluation des risques,*
  - *b) la sécurité des travailleurs exposés aux agents chimiques provenant de la biologie synthétique*
  - *c) la protection de l'environnement.*

# Recommandations 7, 8

- *La protection des droits des consommateurs est un élément crucial à prendre en considération*
- *L'étiquetage de produits spécifiques issus de la biologie synthétique, tels les cosmétiques et les textiles, devrait être exploré*
- *Que, outre l'application de cadres scientifiques et juridiques, des considérations éthiques spécifiques soient également prises en compte par les autorités compétentes (telles que l'EMA) lorsque paraîtront des médicaments et des produits médicaux résultant de protocoles fondés sur la biologie synthétique*

# Biosecurity

- Biosecurity: Security and military applications of synthetic biology must not contravene the fundamental rights. One way of dealing with the dual use dilemma is through control mechanisms such as licensing and registering the tools used by synthetic biology.
- Examples of actions that may be used to prevent unacceptable military or terrorist actions include: 1) a centralised database be developed at least at EU level, or preferably at international level where all DNA synthesisers would be registered by competent authorities; 2) departments or research groups dealing with biosecurity and biodefence use of synthetic biology should be licensed in the above registry; 3) criteria for the publication of data on highly pathogenic viruses or toxic agents be defined at Member State and EU level (See also Art. 7 of EC/98/81)
- **the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction should incorporate provisions on the limitation or prohibition of research in synthetic biology.**
- **the Commission should define a comprehensive security and ethics framework**.

# Biosecurity

- Could the current environment enable bioterrorism?
  - Biosecurity governance and laboratory research
  - Access to DNA sequences
  - Research published on sequence and synthesise of viruses
  - Availability of DNA synthesisers
  - Biosecurity awareness amongst synthetic biologists
- The rise of “garage biology”
  - A lone operator
- How real is the risk?
  - Difficulties in developing and ‘weaponising’ existing / new pathogens
- Where should we focus?
  - Bioterrorism or state-sponsored biowarfare?

# Recommandations 9, 10,

- *Intégrer des dispositions sur la limitation ou l'interdiction de la recherche en biologie synthétique dans la convention sur l'interdiction de la mise au point, de la fabrication et du stockage des armes bactériologiques (biologiques) ou à toxines et sur leur destruction.*
- *Définir un cadre éthique et de sécurité complet en matière de biologie synthétique*

# Recommandations 11, 12

- *Que la Commission européenne*
  - *1) garantisse que les bases de données sont accessibles à tous leurs utilisateurs;*
  - *2) fournisse aux entreprises les systèmes juridiques leur permettant de faire rapport aux autorités compétentes*
  - *3) détermine la chaîne des responsabilités pour l'intégration de séquences particulières dans la (les) base(s) de données et leur identification comme potentiellement nocives*

# Governance challenges

- ***Governance:*** The existing fragmented regulatory framework may not be sufficient, and the EGE urges the EC to propose and put in place a robust framework for synthetic biology, identifying the relevant stakeholders and indicating their responsibilities. The EGE proposes that the EU takes up the question of governance of synthetic biology in relevant global fora.
- ***Patenting and common heritage:*** The EGE proposes that debates on the most appropriate ways to ensure the public access to the results of synthetic biology is launched. The EGE stresses that general ethical issues raised by patent applications have to be addressed properly in the patent allocation system. The EU legal patent system defines the EGE as the body to assess ethical implications related to patents. The EGE urges the European Patent Organisation and national patent offices to take account of Article 7 in the EU patent directive 98/44 and implement this article.

# Recommandations 13, 14, 15

- *Proposer un solide cadre de gouvernance pour la biologie synthétique et de le mettre en place au niveau de l'UE*
- *Les communautés scientifiques concernées devraient être encouragées à établir des lignes directrices éthiques*
- *Que l'UE soulève la question de la gouvernance de la biologie synthétique au sein de forums mondiaux consacrés à ce sujet*

# Governance challenges

- ***Trade and global justice:*** The EGE recommends that when synthetic biology is discussed at international level, including the WTO, the ethical issues associated to the technology should be addressed. This should be taken into account in the Doha round negotiations. The EGE urges that EU Biosafety standards for synthetic biology products are adopted as minimal standards for EU import-export of synthetic biology products.
- ***Science and society dialogue:*** The Group asks the EU and EU Member States to take actions to promote public debates.
- ***Research:*** The Group invites the Commission to support basic research in the fields of biology, chemistry, energy, materials science, and engineering, as well as applied and interdisciplinary research, as identified in this Opinion. This should be reflected in the FPs budget. The Group notes that synthetic biology could lead, in the future, to a paradigm shift in understanding concepts of life. It therefore calls on the Commission to initiate an open intercultural forum to address the issues, to include philosophical and religious input.

# Recommandations 16, 17

- *Que soient lancés des débats sur les façons les plus appropriées de garantir l'accès du public aux résultats de la biologie synthétique*
- *Que l'Office européen des brevets et aux offices des brevets des différents États membres de tenir compte de l'article 7 de la directive sur les brevets et de rapporter les questions éthiques controversées d'ordre général au GEE afin que celui-ci les examine. Ce point est particulièrement important lorsqu'il s'agit de définir une classe d'inventions qui ne devrait pas être directement exploitée commercialement*

# Recommandations 18, 19

- *Que lorsque la biologie synthétique fera l'objet de discussions au niveau international, y compris au sein de l'OMC, les questions éthiques associées à cette technologie soient abordées*
- *Que les normes européennes de biosécurité pour les produits issus de la biologie synthétique, telles que définies dans les recommandations n° 1, 2 et 5 du présent avis, soient adoptées au titre de normes minimales pour les importations et exportations européennes*

# Recommandations 20, 21, 22

- *Que l'UE prenne des mesures spécifiques afin d'éviter de nouvelles fractures entre l'UE et les pays en développement et émergents*
- *Prendre des mesures pour promouvoir les débats publics entre parties prenantes*
- *Que les journalistes, les éditeurs, y compris les éditeurs de publications scientifiques, et les autres parties prenantes promeuvent une couverture responsable des sujets touchant à la biologie synthétique*

# Recommandations 23, 24

- *Afin de promouvoir une approche exhaustive des nouvelles technologies par les médias, le GEE demande à la Commission de favoriser des actions spécifiques telles que, par exemple, la création de forums, de séminaires et de cours abordant les implications de la biologie synthétique dans les médias.*
- *Soutenir la recherche fondamentale dans les domaines de la biologie, de la chimie, de l'énergie et de la science et de l'ingénierie des matériaux, ainsi que la recherche appliquée*

# Recommandations 25, 26

- *Financer de manière appropriée la recherche interdisciplinaire portant sur les aspects suivants de la biologie synthétique: -*
  - *évaluation des risques et sécurité,*
  - *utilisations de la biologie synthétique à des fins de sécurité,*
  - *implications éthiques, juridiques et sociales,*
  - *gouvernance;*
  - *science et société (y compris les médias et le public).*
- *Le GEE note que la biologie synthétique pourrait entraîner, à l'avenir, un changement de paradigme dans la compréhension du vivant. C'est pourquoi il invite la Commission à mettre sur pied un forum interculturel et ouvert où ces questions pourront être abordées et qui accordera également une place aux aspects philosophiques et religieux.*

European Group on Ethics in Science and New Technologies (EGE)

# Merci beaucoup
# Le texte complet en anglais est disponible
# Les recommandations en français aussi

**Remerciements particuliers à :**
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EGE homepage: http://europa.eu.int/comm/european_group_ethics/index_en.htm