



# Safety, ethics and governance of SynBio: concerns and challenges

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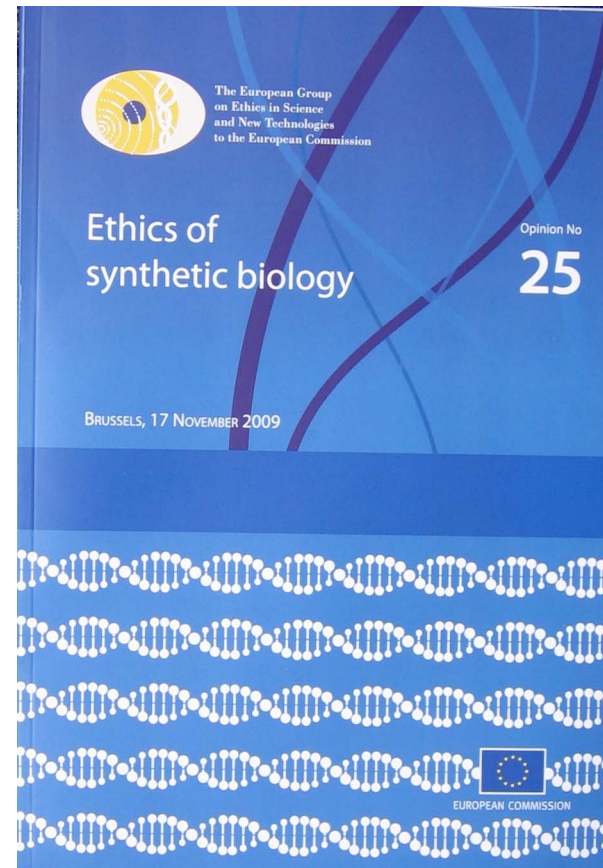
# Menue

- What is SB? Different avenues of research?
- Terminology and concepts
- Which are the ethical problems?
- Science-society interface?
- What ought to be done?
- Implications for risk assessment methods in the EU?
- Need for a follow up?



# EGE report

- Nov 17, 2009
- Preceded by a round table
- Hearings of experts
- And a web consultation
- Downloadable free of charge
- Google: EGE: publications



*... and beyond*

# A letter, May 28, 2008 to EGE



President José Manuel Barroso

- ‘(...) 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.’

# Synthetic biology

- "If the science truly succeeds, it will make it possible to supplant the world created by Darwinian evolution with one created by us."
- A Life of Its Own, by Michael Specter
- The New Yorker, Sept 28, 2009



# A reminder

- Convergence of emerging technologies, including infotech, biotech and nanotech, may lead to radical changes in our lives and create different ethical and societal problems from the ones raised by any these technologies separately



# What is SB? Obvious starting point



- Current state of the art in science – but no agreement on definition
- Different definitions pull in various directions and raise different borderline problems
- Rapidly developing research area, where stochastic processes play an important role

# Different avenues of research

- Roughly, minimal genome or top down approach taken by Venter and others,
- biological bottom up, using existing biological parts to create new cells,
- the protocell bottom up approach, with the same goal but starting with basic chemical compounds, and
- an approach aiming to create new genetic systems based on chemical modifications of nucleic acid bases



# Assumptions relevant for predictability and safety

- The notion of standard components that can be used as lego bricks is debated. If the standard components behave differently in different environments,
- this casts doubts on the analogy between biological and other engineering – and it could lead to safety risks, particularly if
- the same technology could be used to synthesize known pathogens based on their published DNA sequences.

# EU regulation: biosafety

- Directive 2001/18/EC on the deliberate release into the environment of genetically modified organisms
- replacing Council Directive 90/220/EC (92) Regulation (EC) No 1946/2003 on
- transboundary movements of genetically modified organisms.....



As well as global provisions: WHO, WTO...

# Regulation: biosecurity



- The threat of a terrorist group acquiring chemical, biological radiological or nuclear (CBRN) materials has led governments to adopt far reaching regulations,
- and tackling terrorist access to CBRN material is currently considered a key priority for the European Union – EU Counter-Terrorism Strategy, 2005

# EU's basic ethics framework



- The point of departure is a number of conventions and declarations by the UN, Unesco, Council of Europe, EU (Lisbon Treaty, Charter of Fundamental Rights)

# CFR – Oviedo Convention on human dignity

- Article 1 in the Oviedo convention – can be seen as the basis for other rights and freedoms:
- "Parties to this Convention shall protect the **dignity and identity** of all human beings and guarantee everyone, without discrimination, respect for their **integrity and other rights and fundamental freedoms** with regard to the application of biology and medicine."
- "Human dignity is inviolable. It must be respected and protected".
- Article 1 of CFR
- Integrity is introduced in a separate article
- "Everyone has the right to respect for his or her physical and mental integrity."
- Article 3, CFR

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# Terminology and concepts


- From Life to life
- Avoid using 'life' with capital L – abstract, ambiguous and vague showstopper – as in debates on Patents on Life, Creating Life.
- Instead: be specific about which kinds of living organisms or forms of life of different complexity we are talking about.
- Higher forms of life here: not humans, not primates, but simple bacteria ...

# Manipulating nature?

- Little opposition to elimination of smallpox ...
- Or interventions to prevent suffering and dying
- Manipulation OK of mosquito genome but not of human genome?
- But **thin and value-loaded line** between stewarding for human purposes and exploitation
- The main difference usually value-based: exploitation is use that is morally not acceptable



# Comparing risks and benefits

- A well established but logically odd terminology - also benefits can be uncertain; four cases
  - Two relevant dimensions mixed: likelihood and nature of outcome (good or bad)
- 
- Harms and **benefits**
  - **Risks** and chances
  - *Dimensions mixed when risks are compared to benefits*
  - Harms, Benefits
  - **Certain, certain**
  - **Certain, uncertain**
  - **Uncertain, certain**
  - **Uncertain, uncertain**

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# Which are the main ethical issues?

- Identification of concerns and ethical issues are not neutral,
- they will depend not only on current and near-future trends in science
- but also on values, on what we want to achieve and avoid
- Safety
- Security
- Dual uses
- Environmental impact
- Justice: access
- Patents
- Commerce
- But also.....

# But also...



*Craig Venter patented the first artificial bacteria*

- Reductionism
- Hype and hubris, the Ikaros myth
- Impact on our conception of the man-machine distinction
- Transparency: conditions for a constructive dialogue involving the general public

# The dual use challenge

- Study of SB can lead to more efficient ways to produce medical treatments (e.g. vaccine against malaria),
- it may also lead to synthesis or redesign of harmful pathogens (e.g. smallpox) of terrorists.



# Specific ethical issues

- Raised by applications of SB in areas like biomedicine, chemistry, biopharmaceuticals,, biomaterials...
- Alternatives, assumptions, consequences, stakeholders... Values that can be promoted, protected or undermined...



# 'Bottom up' problems

- Protocells are autonomous forms of life, and their impact on environment and health (human and animal) hard to predict
- implications for possibility of assessing impact on health, welfare and environment



# Specific challenges

- Creating the first fully autonomous protocell in the lab,
- creating protocells that could survive outside the lab,
- actually releasing protocells outside the lab,
- creating protocells that are toxic or infectious
  - Bedau et al 2009





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# Science-society interface

- Not just a matter of finding out by **opinion polls** how the general public perceives SB or what risks they see
- Nor just a matter of **informing** the general public of what actually is going on in this field of research
- But of having a genuine **dialogue** where the different stakeholders and the general public participate in a debate
- about concerns and opportunities, about the direction and future development of this research

# Drew Endy, proponent, interview:

- "Programming DNA is more cool, it's more appealing, it's more powerful than silicon. You have an actual living, reproducing machine; it's nanotechnology that works. It's not some Drexlerian (Eric Drexler) fantasy. And we get to program it. And it's actually a pretty cheap technology. You don't need a FAB lab like you need for silicon wafers. You grow some stuff up in sugar water with a little bit of nutrients. ....
- Edge, Issue 237, Feb 19, 2008



# Question

- How do statements like these affect our views of the man-machine distinction?



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# What ought to be done?

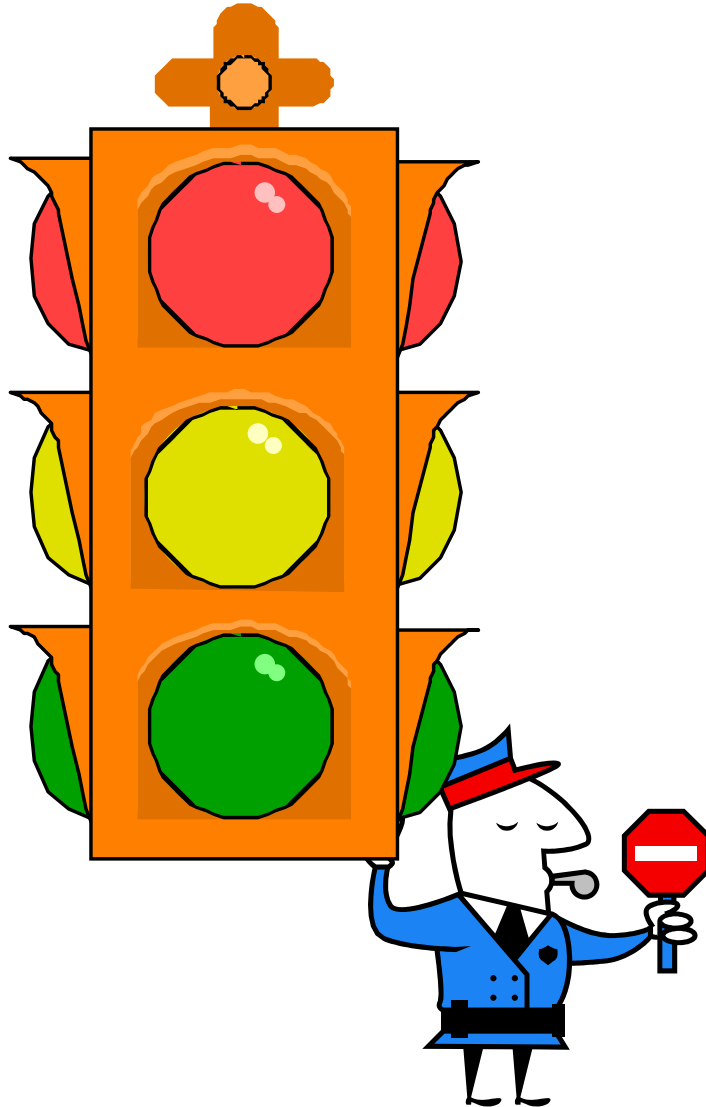
- SB is not a homogenous field; different subfields need to be separated for this discussion
- Many ethical issues are raised by SB, which should be related to the subfields and the time frame (now, near future, within 5-10 years, further ahead)
- Some of these issues, such as, safety, environmental impact, patenting or fair access to benefits are not specific to SB, also raised by other emerging technologies, and can at least in principle be dealt with by regulation,
- Others, such as accountability, reductionism, hype and hubris, involving the public, require other approaches

# Possible solutions?

- Not one answer– but several, depending on the problem
- Is existing regulation sufficient? Overlaps? Gaps?
- Monitoring, certifying, registration, labelling?
- Public dialogue, the role of media?



# Precautionary approaches



- The principle of precaution is often referred to in this context.
- It presupposes the existence of serious, unknown and possibly irreversible risks
- It changes the burden of proof from those who are exposed to the risks to those who want to introduce the new technology



# Possible strategies

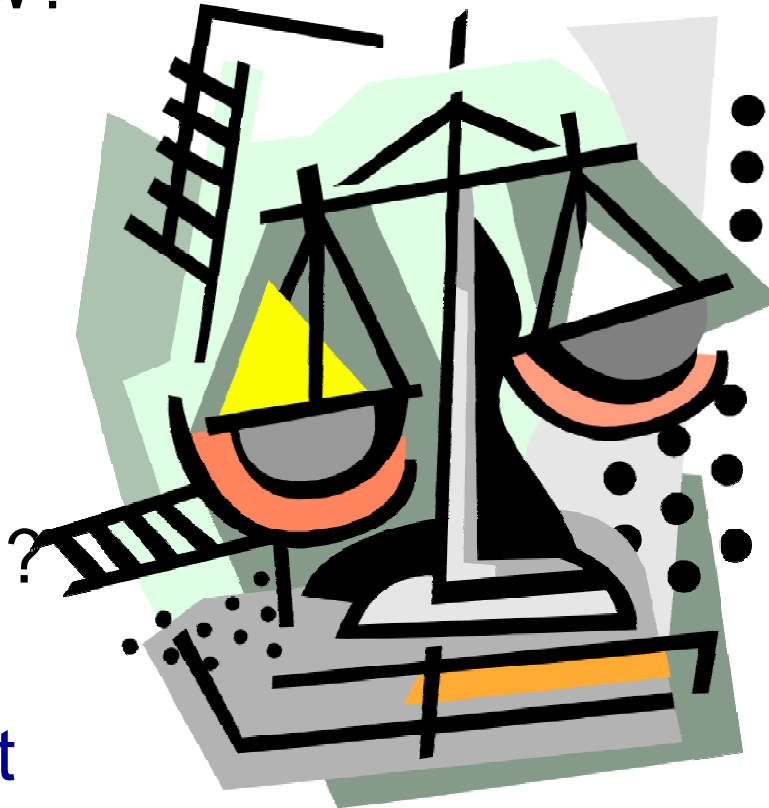
- Is EUs *Chemical, Biological, Radiological or Nuclear (CBRN)* policy enough or does it need to be supplemented?  
*Valuable but not yet sufficient*
- Should centralised databases be considered with registration of all DNA synthesizers? *Yes*
- Should all institutes and research groups dealing with applications of SB within biosecurity and biodefence be required to be licensed? *Yes*
- Should existing conventions on development, production and storage of biological weapons be revised and supplemented? *Yes, incorporate provisions on SB*

# Industrial applications

- New sources of energy and sustainable chemical industry
- Competent authorities should monitor authorization of SB based production of chemicals and other products, taking into account risk-assessment factors, environment protection, safety of workers exposed
- EU Biosafety standards for SB products should be adopted as minimal standards for EU import-export of SB products
- In view of the importance to protect consumer rights the possibilities to label certain SB products, like textiles and cosmetics, should be explored

# Governance problems

- Encourage beneficial use and prevent misuse – how?
- Encourage transparency without creating risks of misuses – how?
- Prevent misuse without introducing unwanted censorship on publication?
- Such issues need to be discussed also in relevant global fora by the EU commission



# Governance – by which means?

- Pros and cons of self-regulation: a flexible instrument or a way to prevent legislation
- Self-regulation and a code of conduct for responsible SB research is a good start but not enough
- Independent monitoring and some regulation is also needed



# Governance – challenges?

- To identify areas where soft law will provide sufficient protection and areas where hard law is necessary
- The responsibilities of the various stakeholders need to be clarified and the commission should take initiative to a Code of conduct for research on synthetic microorganisms



# Intellectual Property Rights, IPR

- Can new forms of life, organisms manufactured or modified by SB, be patented?
- Do they satisfy current requirements of patentability? Should they be patentable?
- Implementation of art 7 of the Patent directive?
- Are there good reasons to distinguish between three categories of biological inventions or discoveries?
- Those which belong to our 'common heritage', not patentable
- Those which for different reasons ought to be placed in the domain available to all, 'the commons', 'the public domain'
- Those which ought to be protectable by patents
- But where are the borders? Which criteria?

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# Impact on risk assessment methods in the EU?

- Safety challenges – in sports, clinical trials – prerequisite for any use of SB
- At the same time, safety is not a black or white issue, either or, there are degrees, more or less...
- and the degrees acceptable have to be related to other variables and what you want to achieve and avoid





# In general focus

- Are the risks ethically acceptable?
- Is the distribution of risks and benefits arising from various applications equitable?
- In particular from applications requiring interaction of natural and synthetic organisms?
- What are the implications of such interaction for human health, animal health and welfare, and for the environment?



# Simplifications to be avoided

- Artificial separation of safety, security and ethical issues
- *Standards of safety and security are not ethically neutral, particularly if/when they impose restrictions on the freedom of others*
- The same holds for the separation of ethics and IPR issues
- Take knowledge gaps into account



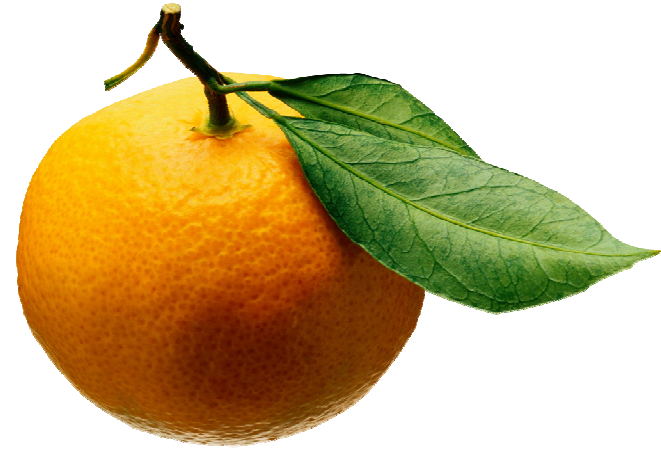
*What is in the bag?*

# Further simplifications (1)

- It is enough to identify the consequences of the various options available, evaluate their consequences from a moral point of view, estimate their probabilities, and then rank the alternatives, taking into account only the moral value and the probability of the consequences
- But it is important for the the ethical analysis to know also **who exposes whom for which risk and for what purpose**. There is a moral difference if I expose myself or others to a considerable risk in order to make a fortune for myself – or to save the lives of many people
-

# In other words...

- ... there are other problems to consider than the following ones, difficult as they are: If A is the consequence of one alternative, B is the consequence of another, A is better than B, but B is more probable than A, then which is to be preferred?



*Eating hamburgers every day?*



*Which are the possible consequences?  
How certain are they?*

## Further simplifications (2)

- A particular harm, or a risk to be exposed to a particular harm, can always be outweighed by a considerable benefit, regardless of who is exposed to the harm /risk or the benefit – and for what purpose
- In a society where we always have to accept to be exposed to a risk or a harm
- if it is outweighed by a greater benefit for others
- there would be very few individual rights

# In other words,...

- Basically, here is a complex of problems in moral philosophy about risks, distribution of risks, individual and collective rights and their relations to societal benefits



*Consent? Informed? Risks? Just distribution of risks?*

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# A need to follow up

- A follow up conference involving all important stakeholders and regulators, aiming at a code of conduct could be a useful first step
- **Why?**
- Research still in its infancy
- Particularly the bottom up approach to manufacture/create protocells
- Monitor what happens if and when the various stages are reached,...
- Global approach needed, not just EU-US



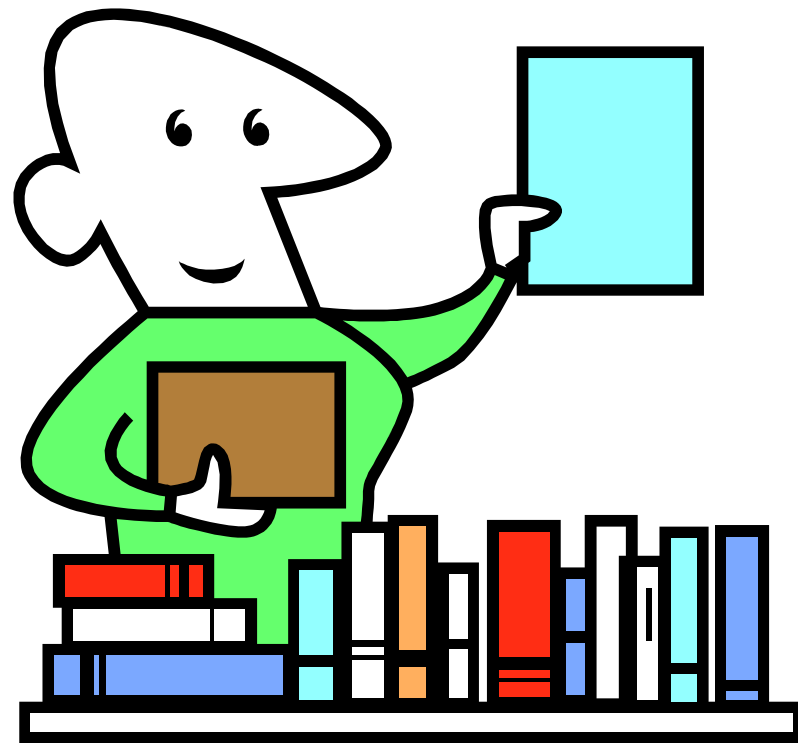
# Beginnings

- This work has to begin with an inventory of the problems, the current and near future trends, making uncertainties explicit,
- involving different stakeholders, and benefitting from, the many EU-funded projects in this area,
- clarifying an ethics frame where the values we want to protect, what we want to achieve and avoid in the short and long run, are made explicit



# Some references

- EGE Opinion 25, Brussels, Nov 2009
- Syst Synth Biol (2009) 3: special issue
- Both with extensive references to relevant literature



## Disclaimer

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