Code of Conduct for Scientists in Life Sciences: Thoughts and experience from Chinese scientific community

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Rapid progress of biotechnologies

**Synthetic Biology**
- **2000-2003** Foundational years of synthetic biology
- **2004-2007** Rapid expansion period of synthetic biology
- **2008-2013** A dramatic mature of synthetic biology
- **2014-present** Application transformation of synthetic biology

**Genome editing**
- **2013-2016** The emergency of new genome editing method-CRISPR/cas
- **2016-present** Clinic application of CRISPR/cas

**Genome editing for various organisms using Cas9/Cpf1**
- **2013-2016** The emergency of new genome editing method-CRISPR/cas

**Commercial production of artemisinin using engineered yeast**

**Redesigning and synthesizing five yeast (eukaryotic) chromosomes**

**First synthetic circuits—toggle switch and repressilator**

**Creation of a microbial cell with a synthetic genome**

**First international conference for synthetic biology held at MIT**

**First international conference for synthetic biology held at MIT**

**Commercial production of artemisinin using engineered yeast**

**Virus RNA detection using Cas13a**

**Gene therapy**

**Cong, et al. Science (2013): 1231143.**

Synthetic biology revolutionized traditional biotechnology industry

Biopharmaceuticals

Sustainable chemicals

Gene Therapy

Cost of gene sequencing dropped from $1/base pair in 1990 to 34 cents/million base pairs in 2016.

CRISPR/Cas9 provided revolutionary solutions for genome editing of cells

Correction of a disease gene mutation

Generation of novel virus-resistant crops


Artificial design and chemical synthesis of highly pathogenic virus genome can be easily achieved by synthetic biology.

Genetic modification of pathogens can rapidly expand host range and dissemination capabilities

- H5N1 mutants can spread through air in ferrets.
- H7N9 virus can achieve human-to-human transmission by mutating three bases.
Potential risks of misuse or destructive use of gene drive

1. Causing damages to selective species
2. Breaking the nature balance of ecosystems

Rapid increase of amateur/do-it-yourself (DIY) biology groups
Major initiatives in Synthetic Biology

1. Since 2005, ~1 billion dollars invested in synthetic biology research in USA.
2. From 2004 to 2013, ~450 million euro was invested into synthetic biology field in EU.
3. Since 2007, over 300 million pounds have been invested into synthetic biology in UK.
Fast growth of biotechnology R&D in China

The latest five-year plan, China’s thirteenth, stipulates that the biotechnology sector should exceed 4% of gross domestic product (GDP) by 2020 and that there should be 10 to 20 life-science parks for biomedicine with an output surpassing 10 billion yuan (US$1.5 billion).

Biotech Booms in China (Career guide, Nature, Jan 2018)
Fast growth of new biotechnology research and industry in China

- Beijing as center
- Shanghai as center
- Guangzhou as center

- 4 major clusters of innovation
- 7,500 life science companies
- 500 universities & institutes
- 2500 top researchers
- 200+ life science incubators
- 100+ life science parks
- 3200 novel drugs patented
- 250,000+ industry staff

150,000+ life science graduates this year

Central development cluster

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How to balance the rapid development of biotechnology and biosafety requirements?

Key issues need to be considered:

1. What and where are the real threat when dual-use technology is applied
2. Roles and responsibilities when conducting science and publishing scientific outcomes
3. Education and training for a rapidly expanding populations who engage in life science
4. Regulatory mechanisms of institutes or entities
5. Public engagement
6. …..
Goals:

I. To standardize biotechnology research and development activities

II. To promote and ensure the healthy and orderly development of biotechnology research and development activities

III. To safeguard national biosafety

Issued by Ministry of Sciences and Technology of China on July 12, 2017

“Safety Management Guidelines for Biotechnological R&D”
I. Relevant research activity and its commercialization should be systematically assessed according to risk levels of the proposed research.

II. Relevant ethics and law should be applied throughout the research process.

III. Responsibility of the State Council, institutions and individual researchers is defined. For example, roles of State Council includes development of management practices, recommendation of risk level list, the presentation of countermeasures and disposal procedures; and role of Institutes includes inspections and supervision etc.

IV. Risk and accident reporting and management protocol proposed.

V. Policy related to international collaboration should follow biosafety related policies and laws.
Chinese government and scientific community pay great attention to biosafety issues of dual-use biotechnology

Biosafety Key Technologies Research and Development Key Program (2016-2020)

This key program has been a sub-program of National Key Research and Development Program funded by Ministry of Science and Technology since 2016. "Building scientific, technological and policy support capability for national biosafety system"

Synthetic Biology Key Program (2018-2022)

It is also a sub-program of National Key Research and Development Program. A project entitled "Synthetic Biology Ethics Assessment, Policies and Regulations and Public Education Popular Science System Construction" has been added into this key program this year.
International Level - Code of Conduct for Scientists

Recommendations and Principles

1. Ethical conduct
2. Law constraint
3. Scientific Integrity
4. Respect to scientific objects
5. Research establishment and process
6. Constraints on the dissemination of results
7. Scientific research dissemination
8. The institution
9. International exchange

Code of conduct for scientists provide an important step towards the governance of dual-use biotechnology.
The proposed code of conduct a positive contribution to the Convention.

Aspirational codes have been used successfully in other scientific fields to encourage a culture of responsible conduct and reinforce important norms.

The field of biological sciences would benefit from its own code, as would the Biological Weapons Convention.
Participants were divided into four groups and asked to consider the following six key questions:

1 Who should be the target audience for the code?

The target audience for the code was individual life scientists and managers engaged in all steps of life science research.

2 What should be the basic principles of the code?

General approval of the elements within the code, but with agreement that education and awareness-raising should be added.
3. What type of code should it be?
The code was seen by all groups as an Aspirational Code that could set an internationally agreed standard to be adjusted to fit varying national and professional circumstances in Advisory Codes and Enforceable Codes.

4. How should the code be promoted?
Various routes were put forward that could be used to promote the code, in particular the BTWC meetings in 2018. Other include working through the National Academies, Scientific Association or InterAcademy Panel etc.

5. What measures should be taken to sustain the code?
To reach that goal, the implementation of the code may need measures such as education and regulatory oversight where necessary.

6. How should the impact of the code be evaluated?
Evaluation was seen as a difficult problem by all of the groups, but one idea suggested by all groups was for States Parties to add a section on the implementation of the code in their annual Confidence Building Measures return to the ISU.
“I am one of those who think like Nobel, that humanity will draw more good than evil from new discoveries”

Pierre Curie

Speech upon acceptance of the Nobel Price in Physics in 1903, with Marie Curie and Henri Becquerel for “their discovery of spontaneous radioactivity”
Thanks!

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