

NEW TECHNOLOGIES, FAIRNESS, AND CROSS BORDER ISSUES

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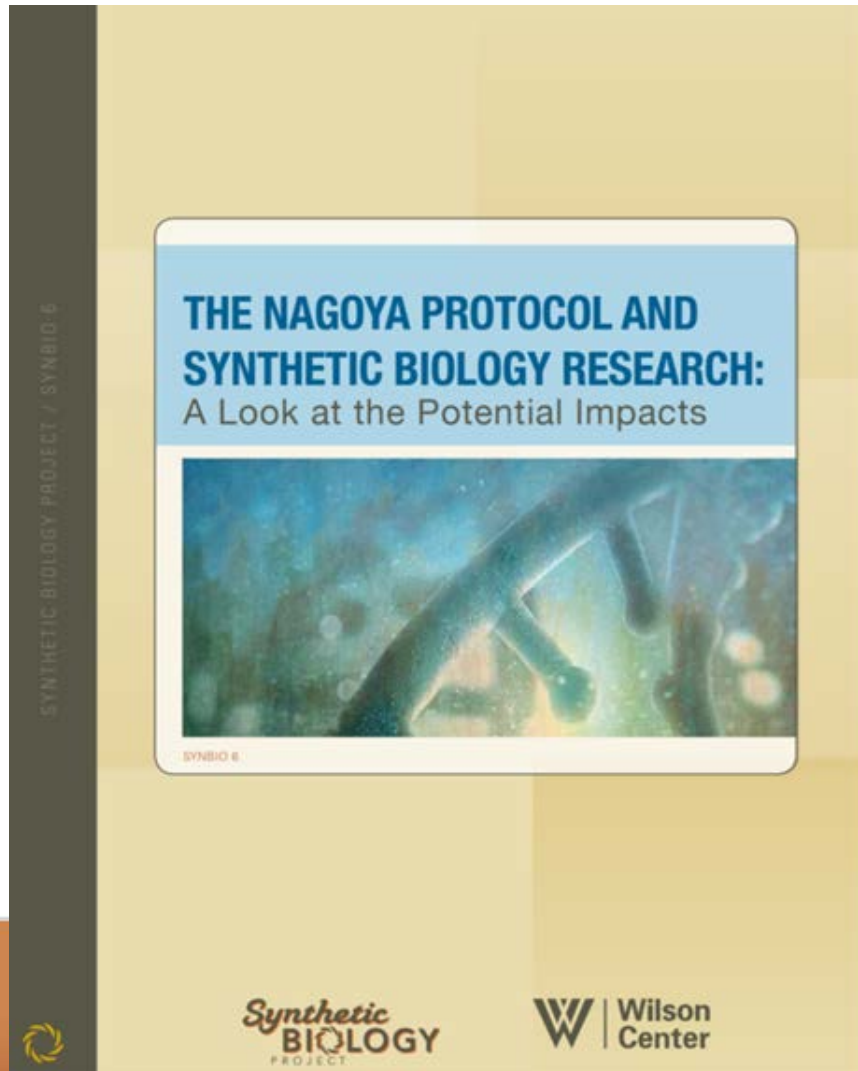
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OVERVIEW

- New Technology: Synthetic Biology
- Fairness: Access and Benefit Sharing Issues with Synthetic Biology

2013 WILSON CENTER REPORT (WITH ARTI RAI) ON THE NAGOYA PROTOCOL AND SYNTHETIC BIOLOGY: A LOOK AT THE POTENTIAL IMPACTS



- Synthetic Biology and Genetic Resources
- The Convention on Biological Diversity (CBD) and the Nagoya Protocol (NP)
- NP Implementation Issues
 - Pre-NP legislation
 - Temporal Scope
 - Breadth of Coverage



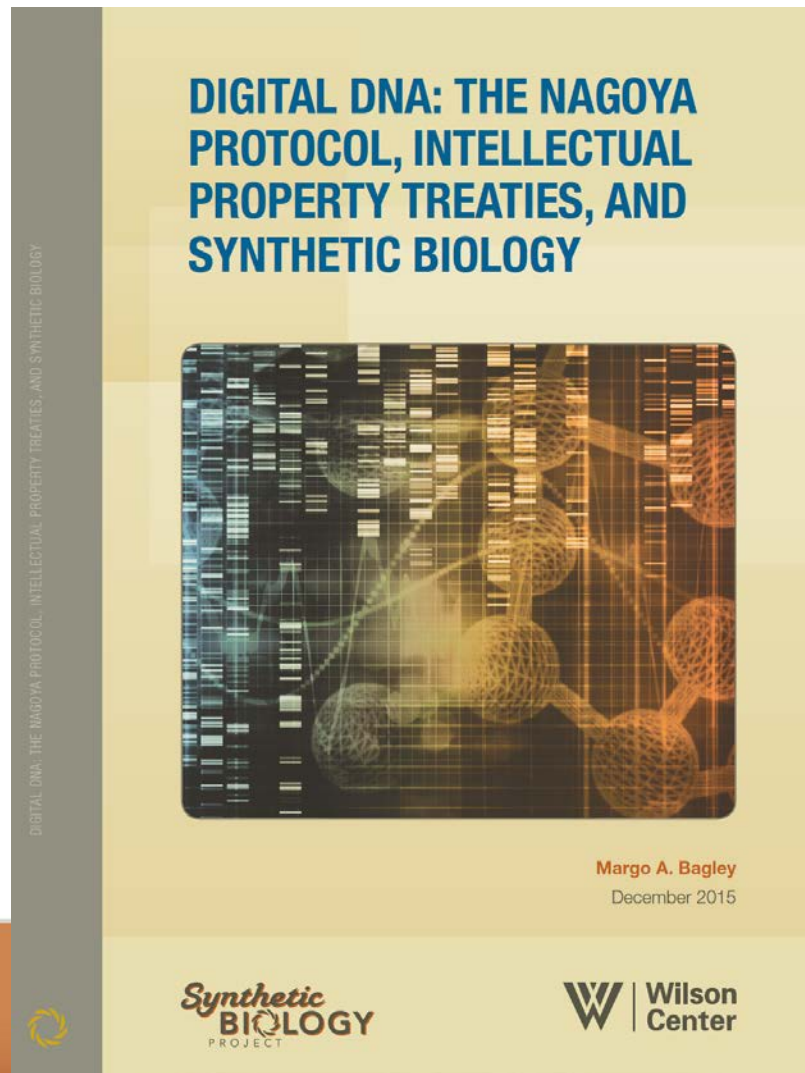
Synthetic
BIOLOGY
PROJECT

W Wilson
Center



UNIVERSITY of
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2015 WILSON CENTER REPORT ON DIGITAL DNA: THE NAGOYA PROTOCOL, INTELLECTUAL PROPERTY TREATIES, AND SYNTHETIC BIOLOGY



- Overview of Synthetic Biology
- Synthetic Biology and Intellectual Property Protection
- Synthetic Biology and the Nagoya Protocol
 - Use and Misuse of Digital Information
 - Synthetic Biology, The Nagoya Protocol, and Intellectual Property Treaties
 - Possible Future Treaty based ABS/DOO Obligations

ETHNOBIOLOGICAL RESEARCH AND “BIOPIRACY”

“[t]he patenting of plants, genes, and other biological products that are indigenous to a foreign country without compensating the keepers of those resources and the holders of knowledge appropriated during ethnobiological research processes.”



H. Schmidt, mobot.org

ACCESS AND BENEFIT SHARING: THE CONVENTION ON BIOLOGICAL DIVERSITY (CBD)

- Unauthorized utilization and patenting of genetic resources/traditional knowledge – based inventions (“biopiracy”) contributed to creation of the Convention on Biological Diversity (CBD). CBD has 196 Parties, in effect since 1993. Key Principles:
 - **States have sovereign control over biological resources within their borders** and shall ensure conservation of same
 - But states shall endeavor to create conditions to facilitate **access** on mutually agreed terms and subject to **prior informed consent**, **AND** there should be **fair and equitable sharing of benefits** of use of genetic resources with providing party (PIC/ABS)
- CBD provides for PIC/ABS but does not specify methodology
- Parties implemented widely varying legislation (or none at all) to comply
- Need for **uniform** framework, **enforceable** obligations on users, **reasonable** access provisions by providers

NAGOYA PROTOCOL TO THE CBD: ACCESS AND USER COMPLIANCE

- Adopted October 2010, came into effect October 2014
- **Framework** for **access** to genetic resources and traditional knowledge with **prior informed consent and on mutually agreed terms**, including terms on fair and equitable benefit sharing from *utilization* of genetic resources and associated traditional knowledge
- Among other things the Nagoya Protocol:
 - obligates Parties to **designate compliance checkpoints** (Art. 17); and
 - “provide that genetic resources utilized within [their] jurisdiction” have been **accessed in accordance with** the domestic ABS/PIC/MAT requirements of another Party, and to **cooperate** in cases where another Party’s domestic ABS legislation has been **violated** (Art. 15).
- Designed to increase legal certainty for users and providers
- Considerable flexibility remaining in national law (floors not ceilings)
- Progress is being made (e.g., ACH Clearinghouse)

WORLD INTELLECTUAL PROPERTY ORGANIZATION (WIPO) INTERGOVERNMENTAL COMMITTEE (IGC) ON INTELLECTUAL PROPERTY AND GENETIC RESOURCES (GR), TRADITIONAL KNOWLEDGE (TK) AND TRADITIONAL CULTURAL EXPRESSIONS (TCES)

- Three draft texts:
 - GR: Mandatory Disclosure of Origin (DOO) in patent applications
 - TK: Tiered protection (economic and moral rights)
 - TCES: Tiered protection (economic and moral rights)
- Parties working toward one or more international legal agreements

DISCLOSURE OF GR ORIGIN (DOO) IN PATENT APPLICATIONS

Why being pushed:

- “1. The fact that **patent claims** in various countries may incorporate biological and genetic material including life forms within their scope.
2. The conviction – widely held among developing countries and NGOs – that biodiversity and associated traditional knowledge have **tremendous economic potential**.
3. The belief, also shared by developing countries and NGOs, that this feature of the patent system enables corporations to **steal, misappropriate or unfairly free-ride** on genetic resources and associated traditional knowledge.
4. The ability of **modern intellectual property law** to protect the innovations produced by industries based mainly in the developed world and its **inability to protect** adequately those in which the developing countries are relatively well endowed.
5. The perception that as a consequence of reasons 1 – 4, the **unequal distributions and concentrations of patent ownership and the unequal share of benefits** obtained from industrial use of biogenetic resources are closely related.”

Queen Mary Institute Report (2004)

GENETIC RESOURCE DISCLOSURE OF ORIGIN (DOO) REQUIREMENT

- DOO requirements may facilitate GR utilization compliance:
 - Can provide information that can be used to **identify violations** of domestic genetic resource and associated traditional knowledge PIC/ABS/MAT laws
 - **Existence** of DOO requirements in multiple countries (more than 20 currently) could be a **deterrent** to non-compliance with national protection regimes (e.g., where domestic law requires obtaining permission from owner/creator before use)

THE NAGOYA PROTOCOL IS NOT AN IP TREATY, AND IS NOT UNDER WIPO, BUT

- Many WIPO members are party to CBD/NP
- Many WIPO members will be implementing CBD/NP
- IP office is a logical NP compliance checkpoint (with GR disclosure of origin requirement for patent applicants) Two of four countries identifying checkpoints identified industrial property offices
- **Cross-border cooperation** against violations of CBD/NP-based GR access and benefit sharing laws could affect grant/denial of patent rights or incur liability (e.g., Denmark law)

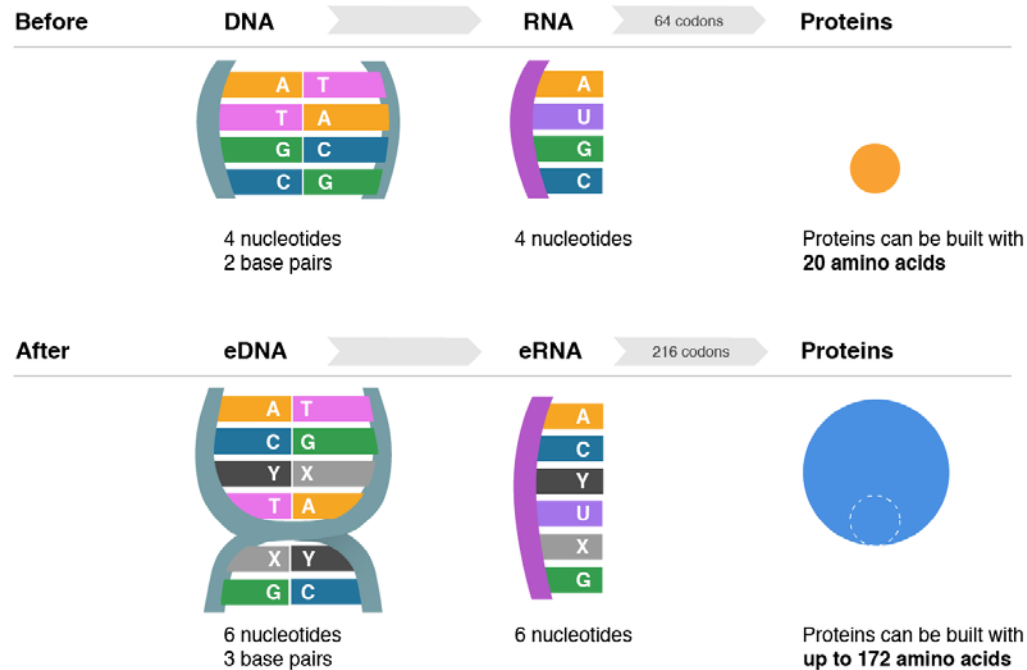
WHAT IS SYN BIO? NO SINGLE DEFINITION

- The creation of standardized biological parts that can be assembled into more complex modules to perform particular functions
- Fundamental (design principles for building systems) and Translational (redesigning sequences or organisms to achieve new functionality) approaches
- Synthetic biologists may eventually be able to construct entirely new biological systems; initial commercial applications, however, focus on replicating and modifying naturally occurring molecules.

“REVOLUTIONARY” SYNTHETIC BIOLOGY

Expanding The Genetic Alphabet

By adding a synthetic base pair—two new synthetic nucleotides—to DNA, the Romesberg lab has increased the number of possible amino acids a cell can use to construct proteins, opening up new possibilities for DNA and RNA and for the production of proteins containing new kinds of amino acids.



- “New” chromosome with synthetic nucleotides (new base pair)
- Could lead to creation of new proteins, cures

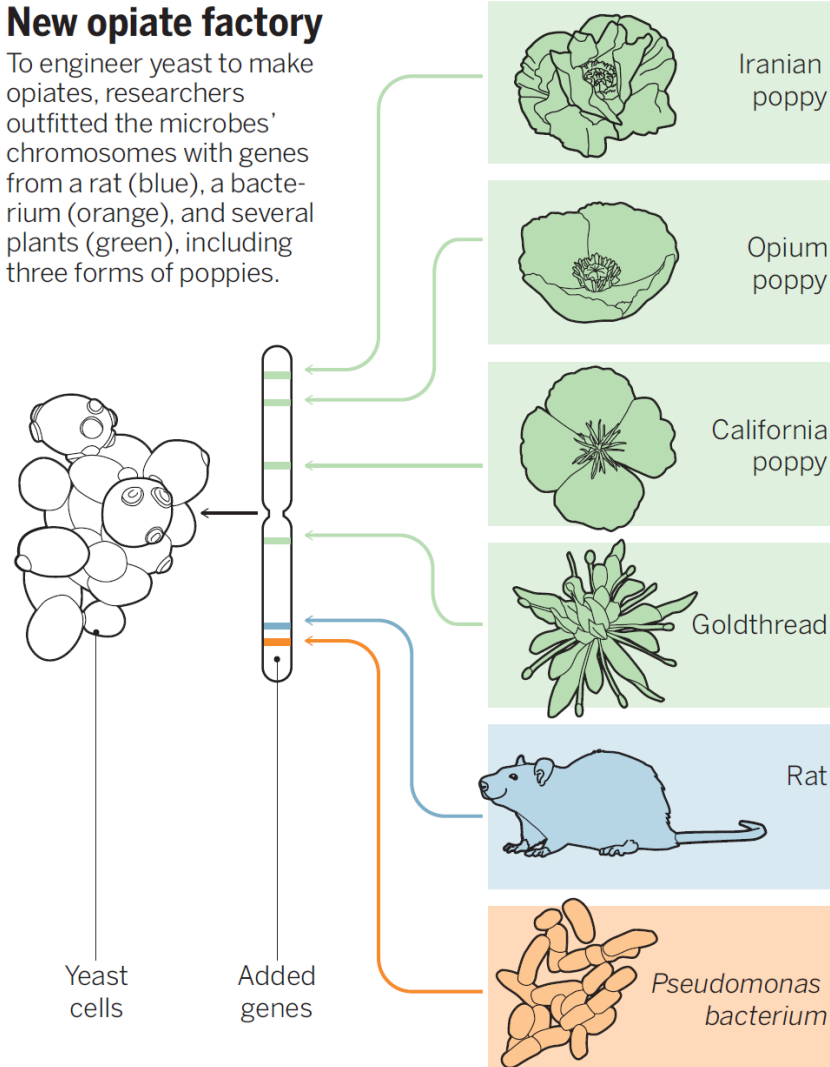
Applications

Anti-Counterfeiting	Research reagents	Faster drug discovery
Forensics	Diagnostics	New antibiotics
Nanomaterials	RNAi & siRNA	New macrocycles
Aptamers	MicroRNA	New cancer drugs/chemotherapeutics
Better vaccines		

PRODUCING OPIATES WITH YEAST

New opiate factory

To engineer yeast to make opiates, researchers outfitted the microbes' chromosomes with genes from a rat (blue), a bacterium (orange), and several plants (green), including three forms of poppies.



WILSON CENTER “SYN BIO MAP” 2013

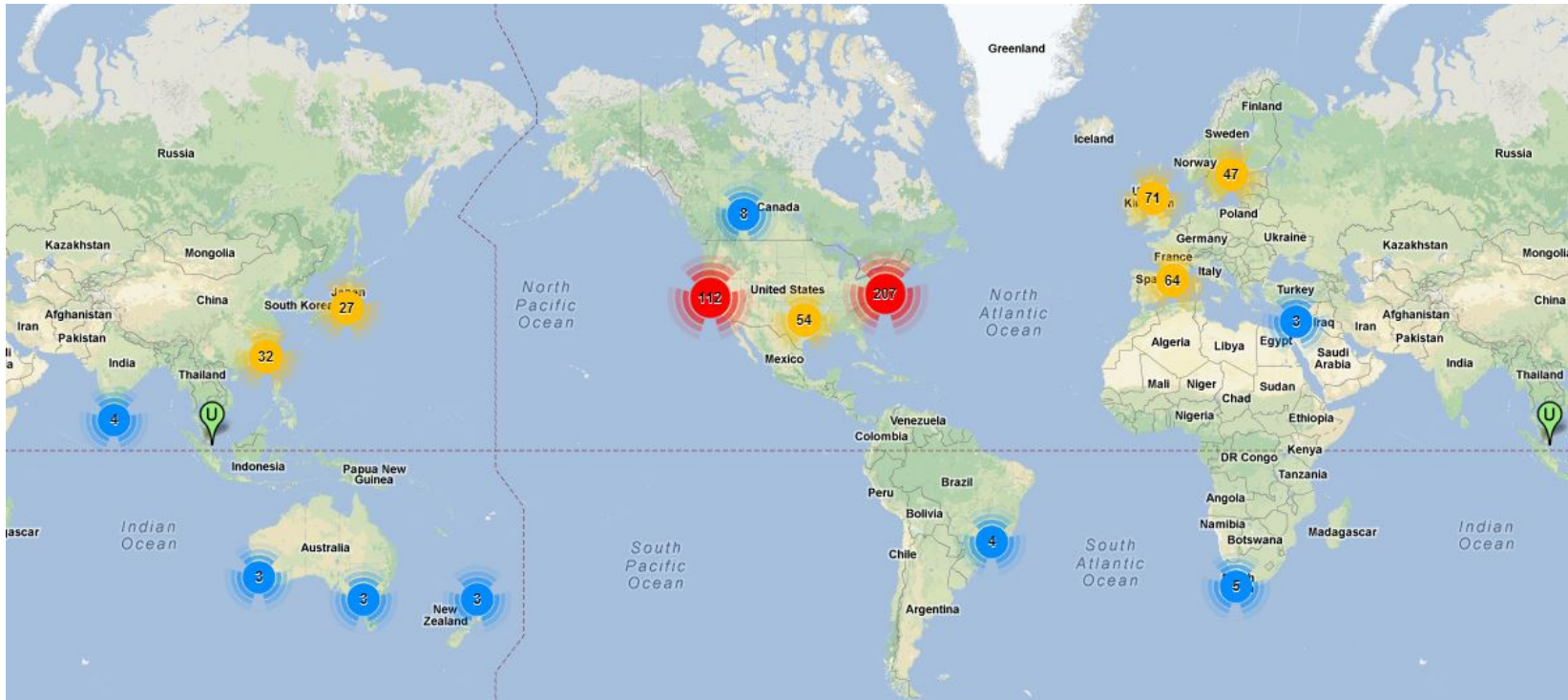
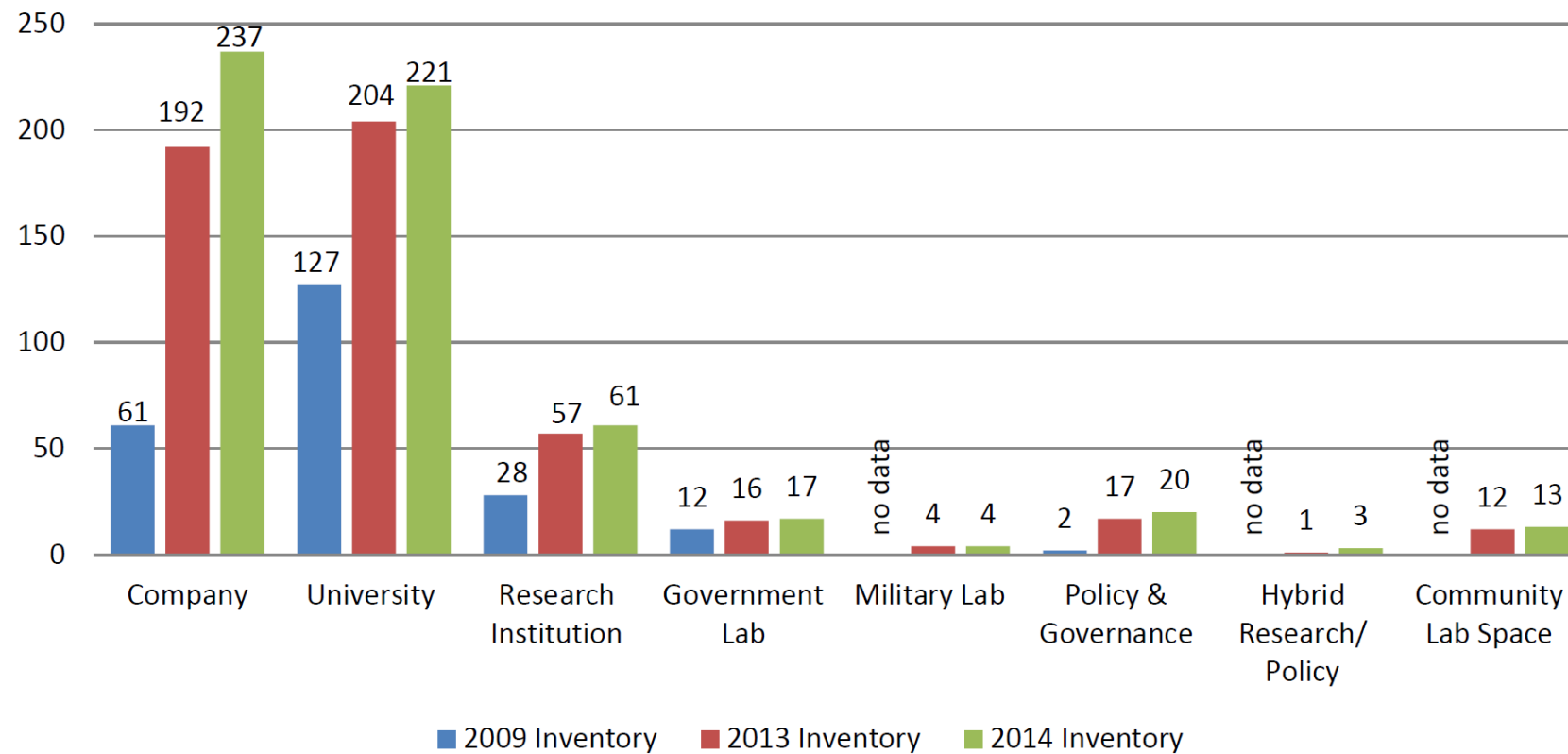
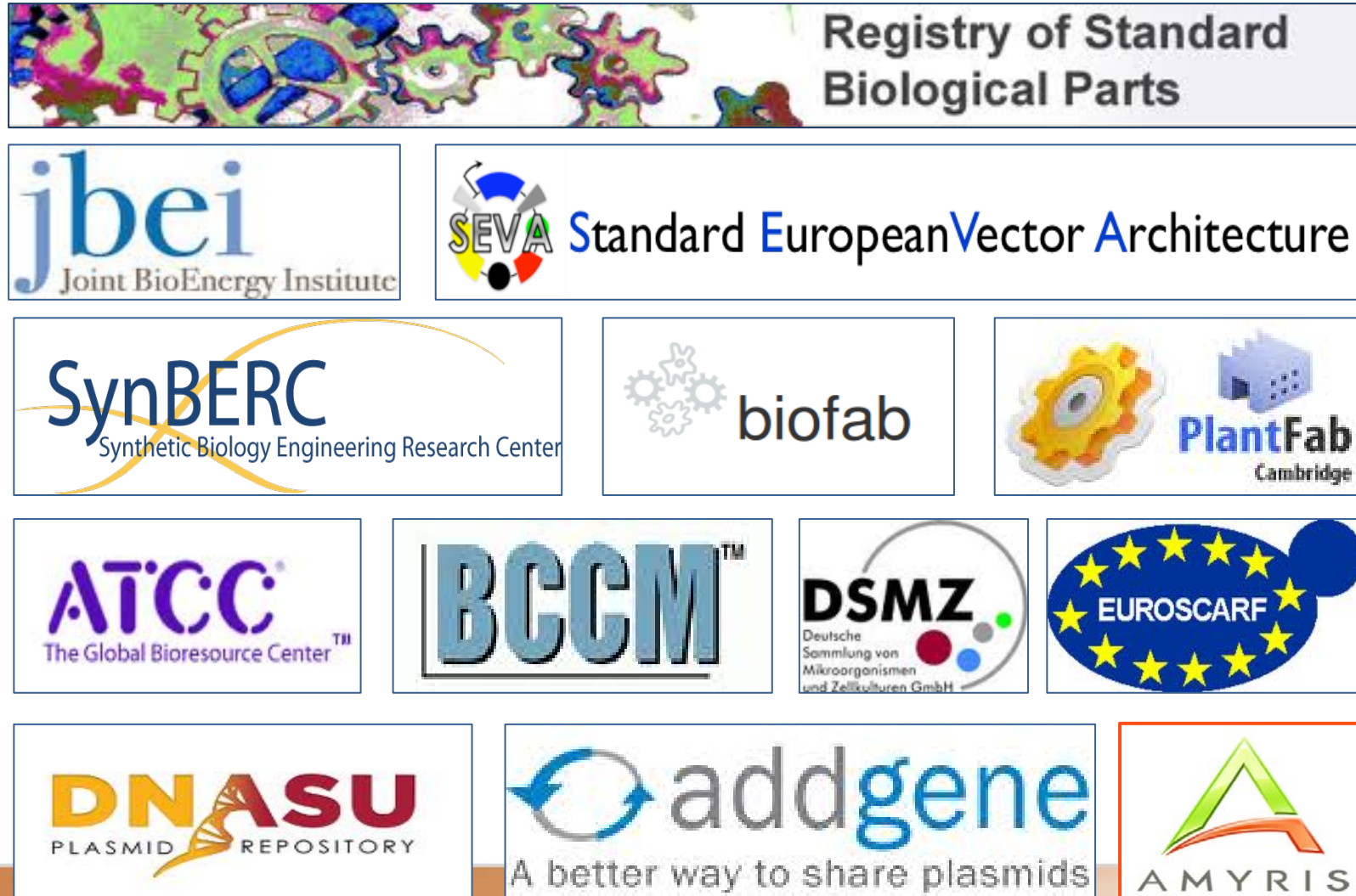


Fig 1. Entities Conducting Research in Synthetic Biology Worldwide



Registries of “standard” biological parts

(courtesy of Linda Kahl)



DIGITIZATION OF GENETIC INFORMATION

- [Registry of Standard Biological Parts]: “Although the registry **currently contains physical DNA**, its developers believe that, as DNA synthesis technology becomes increasingly inexpensive, the registry will be composed largely of **information and specifications that can be executed in synthesizers** just as semiconductor chip designs are executed by fabrication firms.” Rai and Boyle (2007)
- “Sequencing genomes has now become routine, giving rise to **thousands of genomes in the public databases**. In essence, scientists are **digitizing biology** by converting the A, C, T, and G’s of the chemical makeup of DNA into 1’s and 0’s in a computer.” J. Craig Venter Institute

Symbol	BioBrick parts
	Promoter
	Coding sequence
	RBS
	DNA
	Inverter
	Plasmid backbone
	Terminator

NO NEED FOR TANGIBLE GENETIC STARTING MATERIAL

“Gene synthesis . . . is like typing the phrase on a word **processor**. Scientists specify the sequence of the desired gene and have it “**printed**” at the foundry. They can do this because the complete genome sequences of humans and many other species are available in **[online]** **databases.**”

Andrew Pollack, New York Times

Market Players in Decoupling Design from Synthesis

(courtesy of Linda Kahl)

Computer-Aided Design (CAD)



GeneDesigner



GenoCAD

**GENOME
COMPILER**



DNA synthesis and assembly



BlueHeron
The Gene Synthesis Company

BIONEER
Innovation • Value • Discovery

DNA 2.0

**Desktop
Genetics**

GENEWIZ
Solid science. Superior service.

Gen9

generay.com.cn
GENERAY
Biotechnology

GenScript

IDT
INTEGRATED DNA TECHNOLOGIES

life
technologies™

ShineGene

<https://www.youtube.com/watch?v=nBmxkZEKCi0>

NAGOYA PROTOCOL ART. 8: NON-COMMERCIAL USE

“In the development and implementation of its access and benefit-sharing legislation or regulatory requirements, each Party shall:

- (a) Create conditions to promote and encourage research which contributes to the conservation and sustainable use of biological diversity, particularly in developing countries, including through **simplified measures on access for non-commercial research purposes**, taking into account the need to address a change of intent for such research”

NON-COMMERCIAL BIOPROSPECTING/

- Moorea Biocode Project (2006): UC Berkeley et. al., project to collect data (e.g. sequence DNA) on each species on the island
 - Developed ABS/PIC/MAT agreement with Government of French Polynesia
- Smithsonian DNA barcode project
- J. Craig Venter Institute sampling expeditions
- fewer than 15% of higher plant species are believed to have been examined for bioactivity



<https://www.aber.ac.uk/en/news/archive/2013/10/title-141883-en.html>

<http://www.ncbi.nlm.nih.gov/genbank/>

<http://biocode.berkeley.edu/>

“DIGITAL BIOPIRACY”

“While biopiracy has conventionally meant the **physical removal** of a material from a community into private hands, synthetic biology enables *digital biopiracy*, where the DNA of an organism is sequenced in situ, **uploaded to the internet as information**, and then transferred digitally to a DNA synthesizer so that copies can be rebuilt elsewhere. . . . most synthetic DNA sequences developed for synthetic biology are **near-copies of natural genetic code** that has ‘evolved’ through computer models.” ETC Group/Friends of the Earth 2010/2012

No need for MTA or PIC/ABS?



SIMILARITIES/DIFFERENCES TO ILLEGAL FILESHARING/DOWNLOADING OF COPYRIGHTED MATERIAL?

- Easier and cheaper to copy sequence info and create genes now
- Genetic resources not protected by IP (but may be subjects of national ABS/PIC/DOO obligations)
- Harder to detect improper use (DNA watermarking not foolproof)

SB OBLIGATIONS MAY COME FROM NATIONAL LEGISLATION, NOT NP ITSELF

Example: Brazil

- genetic heritage broadly defined as “*information* of genetic origin, contained in samples of all or part of a plant, fungal, microbial or animal species, in the form or molecules or substances originating in the metabolism of these living beings, and in extracts obtained from in situ conditions, . . .” Brazilian Provisional Act, No. 2,186-16, Title II, Art. 7, August 23, 2001 (also in new 2015 Act).

COMMERCIAL VS. NON-COMMERCIAL RESEARCH AND SYNBIO

- Sequences obtained from non-commercial research may be made available in databases and used (improperly) in commercial projects (copying easy, cheap).
- Concerns about digital misappropriation may inhibit access to tangible genetic resources for non-commercial research (e.g., 2014 planned Indonesian moratorium on foreign biodiversity research)

WIPO IGC AND NAGOYA PROTOCOL

ISSUE:

- Is there a DOO obligation with synthetic biology inventions using DNA sequences (no tangible GR used)?
- Not yet penetrated IGC discussions, Nagoya not explicit (but does not necessarily exclude)
- Preferable to address at international level
- Role for public databases

FURTHER FACILITATING DISCLOSURE OF ORIGIN AND BENEFIT SHARING: DOO IN PUBLIC DATABASES

- Persons submitting genetic information could include origin
- Example JCVI language (from public database):
- “This genetic information downloaded from camera.calit2.net may be considered to be part of the genetic patrimony of Madagascar, the country from which the sample was obtained. Users of this information agree to: (1) acknowledge Madagascar as the country of origin in any publications where the genetic information is presented and (2) contact the CBD focal point identified on the CBD website (www.biodiv.org/doc/info-centre.shtml) if they intend to use the genetic information for commercial purposes.”

CONCLUSIONS

- Synthetic biology research may raise ABS fairness concerns, especially for sequences in public databases
- Countries implementing Nagoya Protocol may impose its obligations on synthetic biology users (law and contract)
- Identification of sequence origin in public databases could facilitate compliance with DOO obligations