Foro sobre Nuevas Herramientas Biotecnológicas

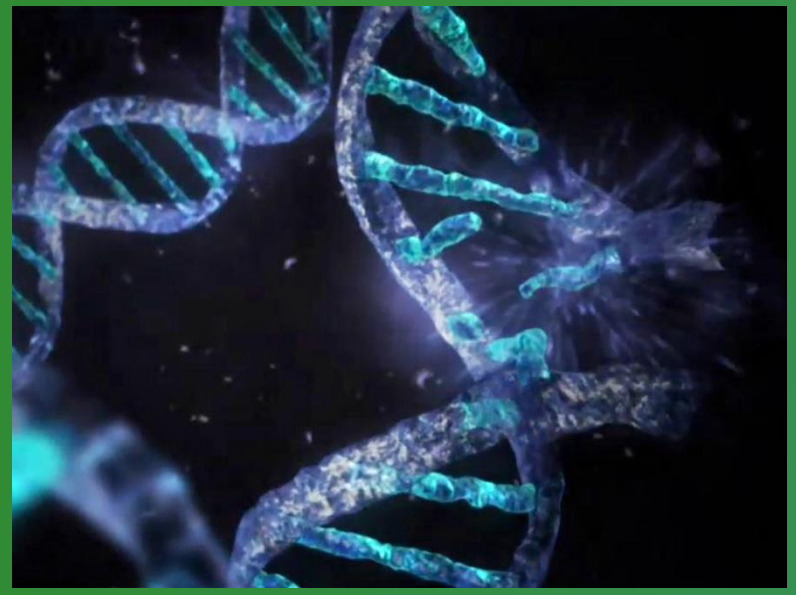
La biología sintética: Panorama global y nacional, avances, retos y riesgos

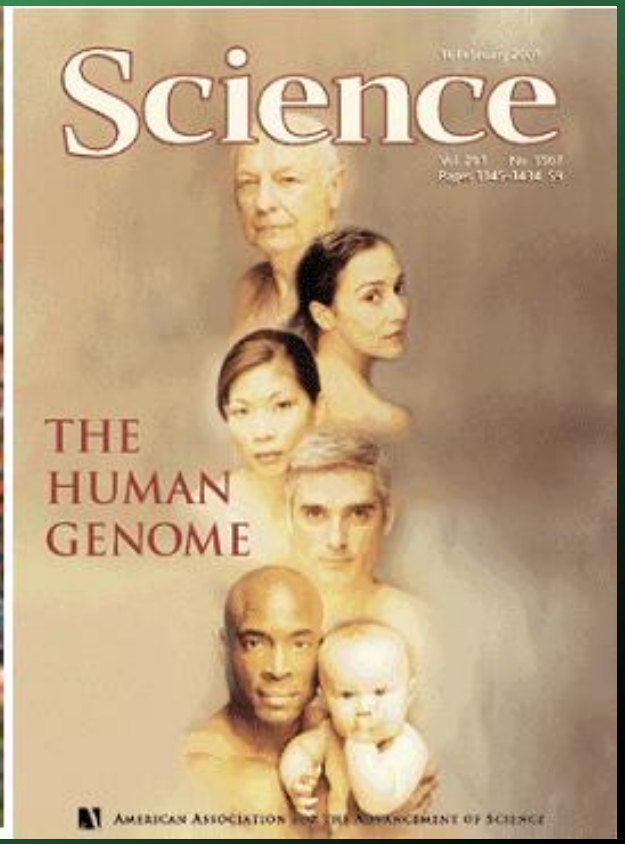
Dr. Julio E. Valdivia-Silva MD., PhD

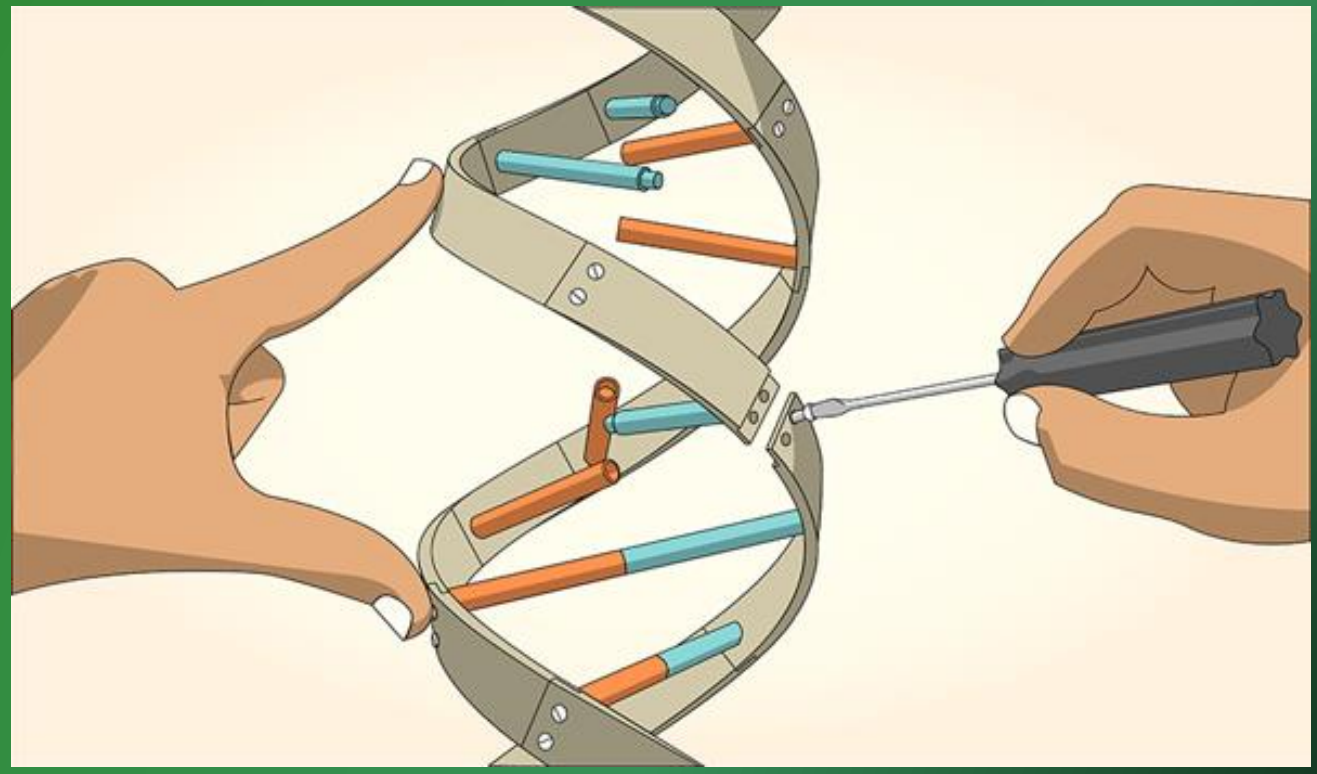
BIOLOGIA SINTETICA

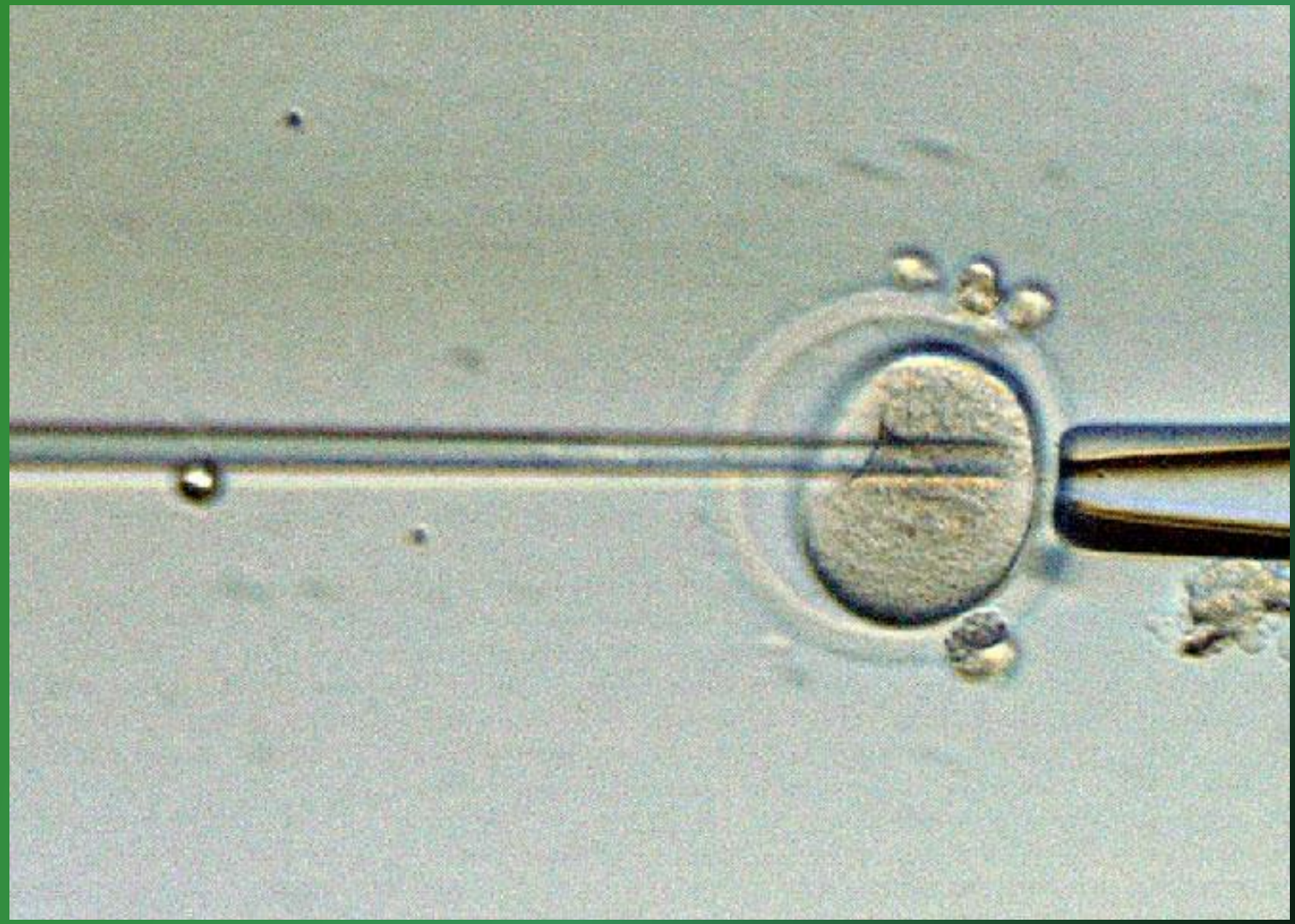
1

EL GENOMA HUMANO y LA INGENIERIA GENETICA

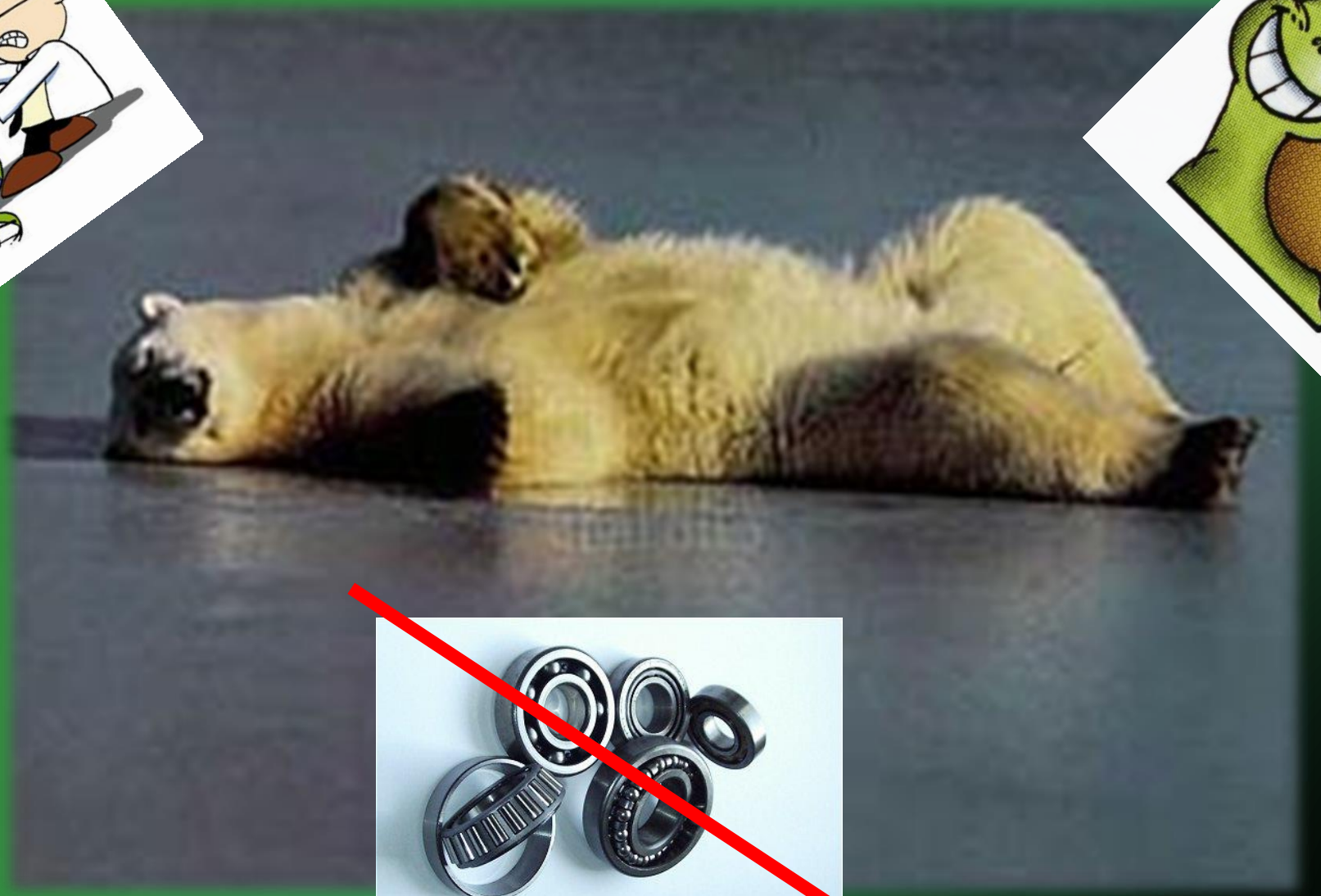


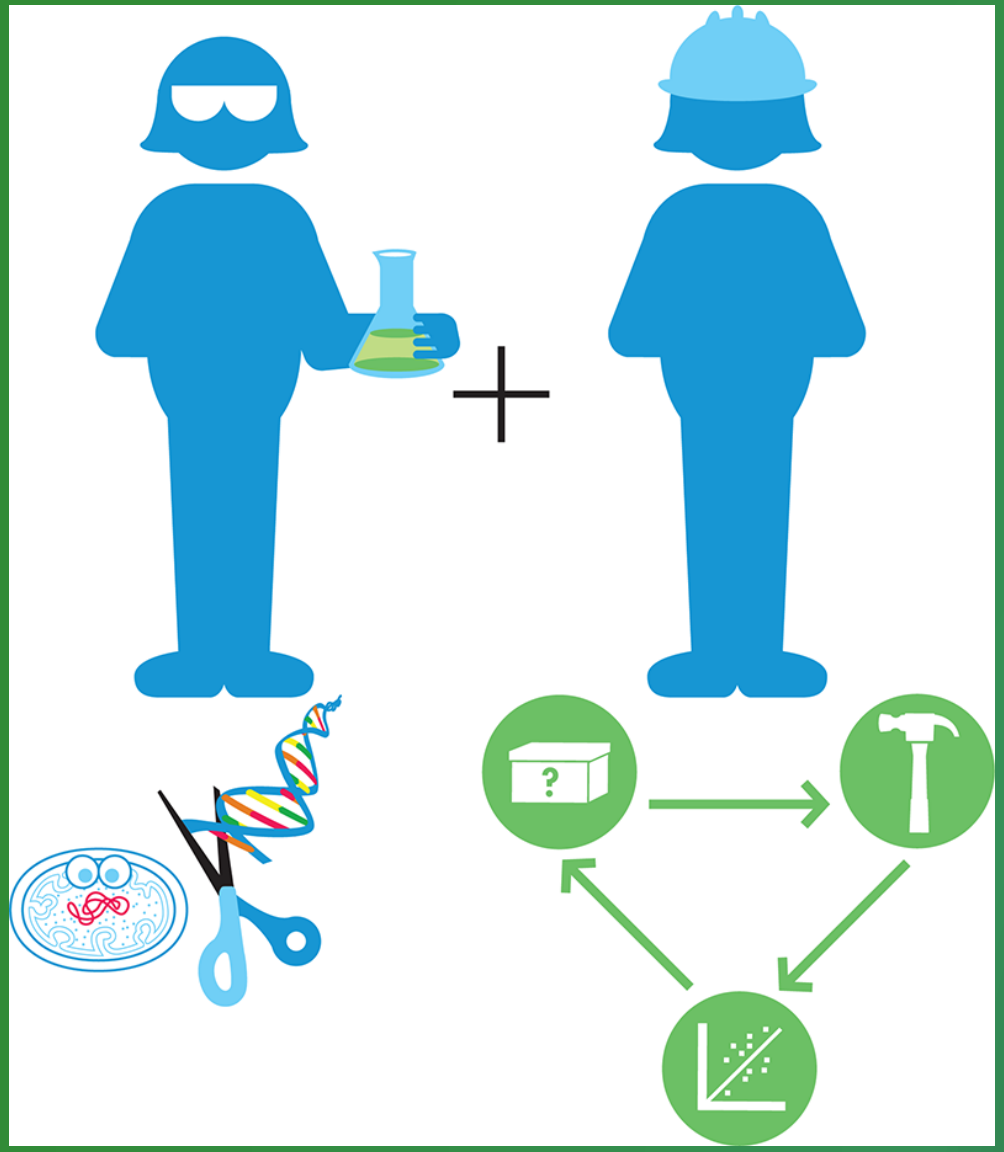




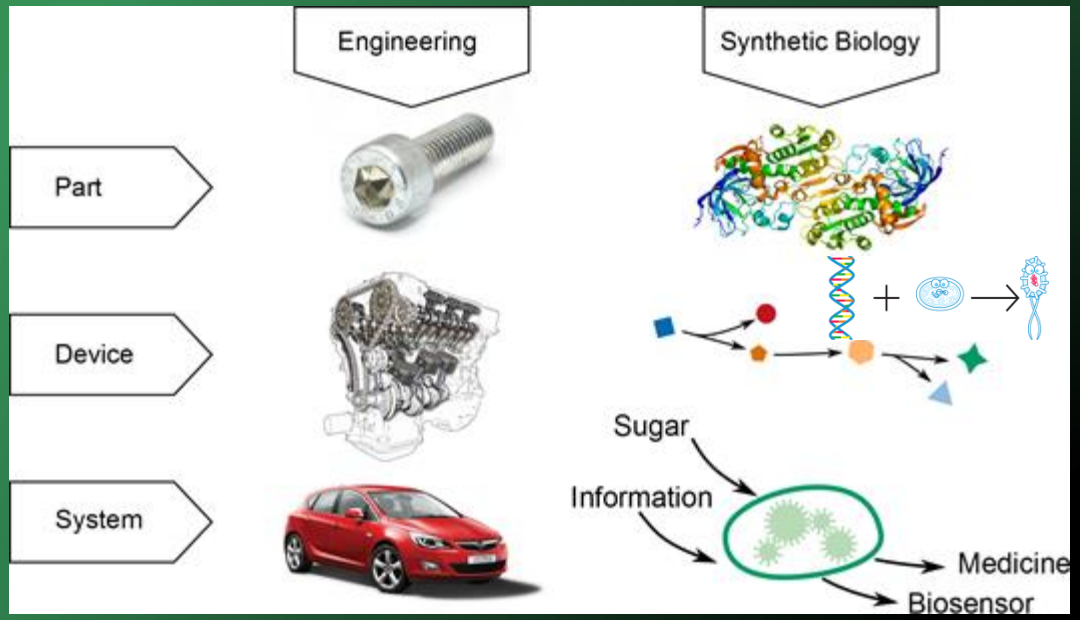


Ingenieria Genética …. Con poca Ingeniería





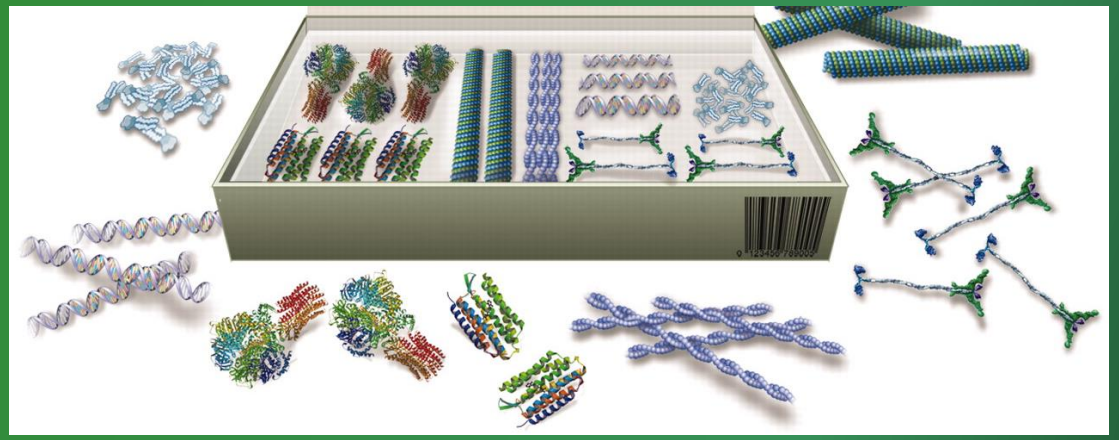
Diseño y construcción de nuevas partes biológicas, dispositivos y sistemas que no existen en la naturaleza o se rediseña los existentes para que cumplan una función determinada.



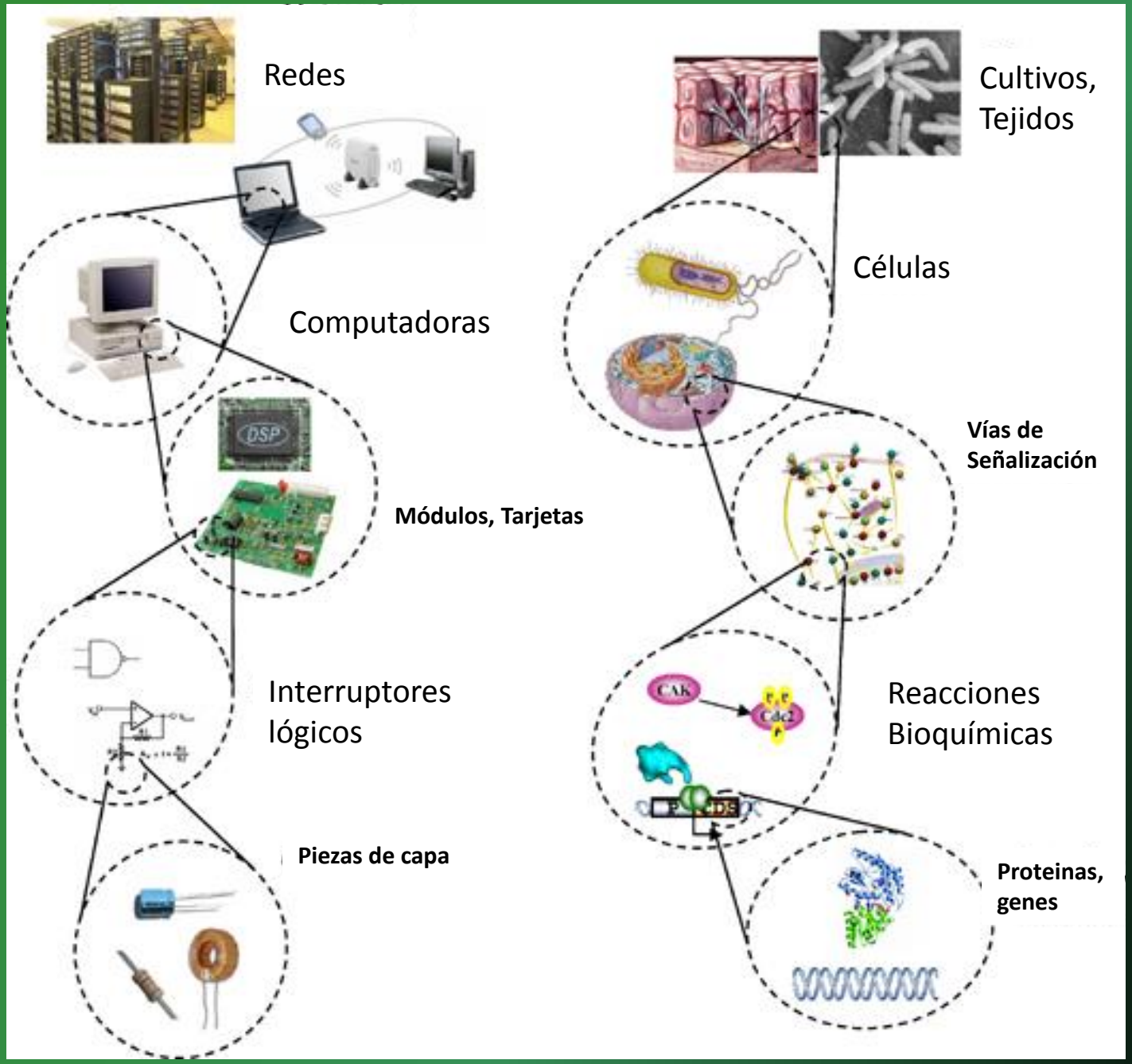
Ingeniería Genética

Ingeniería +

Biología Sintética



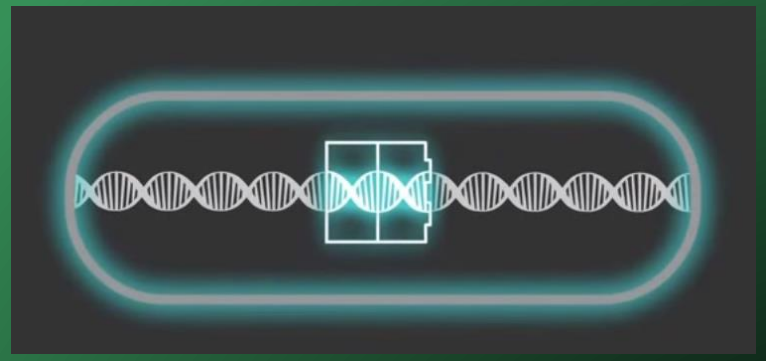
BUY ONLINE

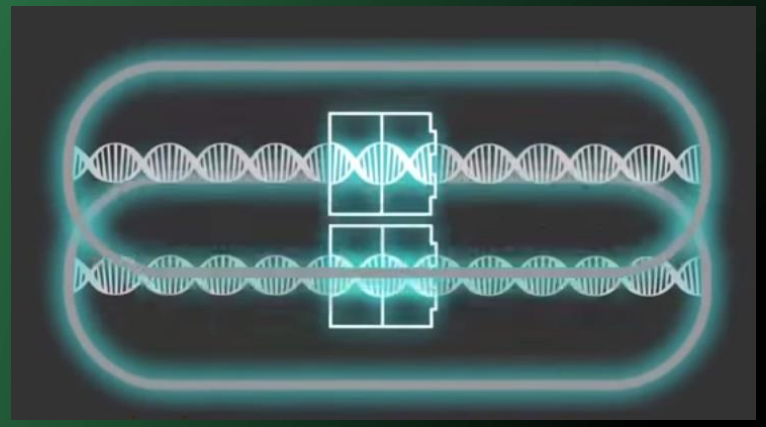

Redes
Cultivos,
Tejidos
Computadoras
Células
DSP
Módulos, Tarjetas
Vías de
Señalización
Interruptores
lógicos
CAK
Cdc2
Reacciones
Bioquímicas
Piezas de capa
Proteinas,
genes

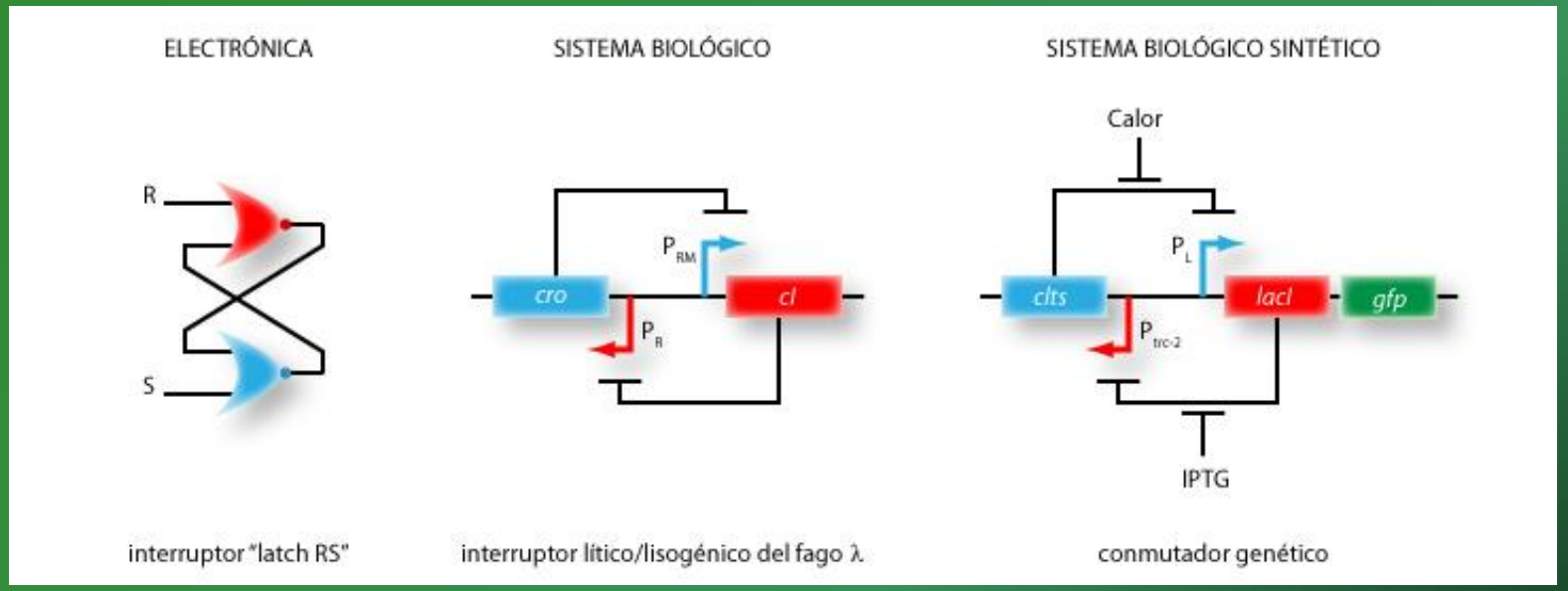
Reingenieria de la Ingeniería

A C A C T G A C G A G C T A G T A G

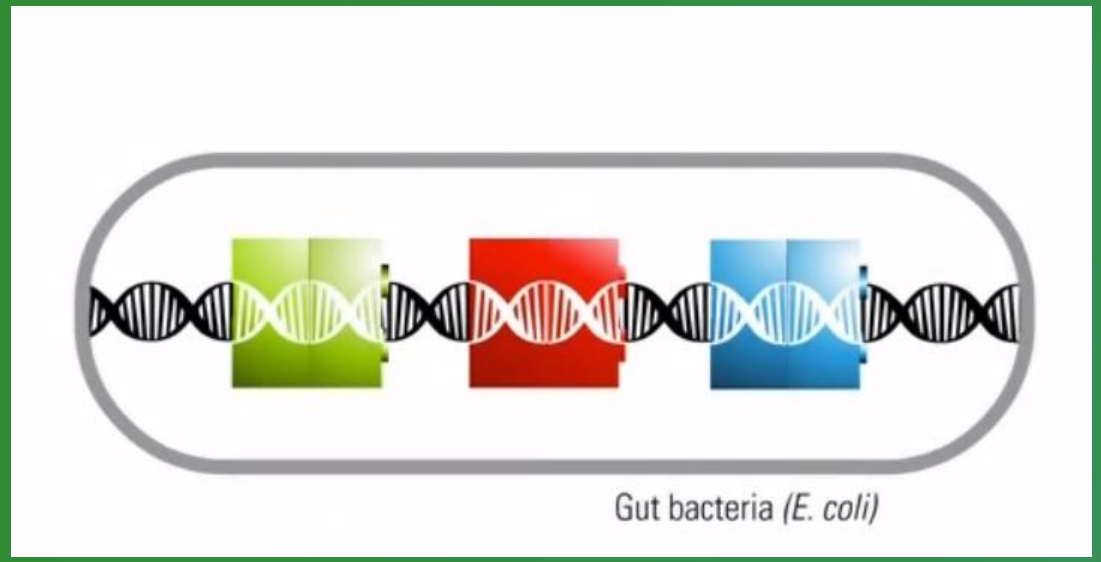
Bio-ladrillos



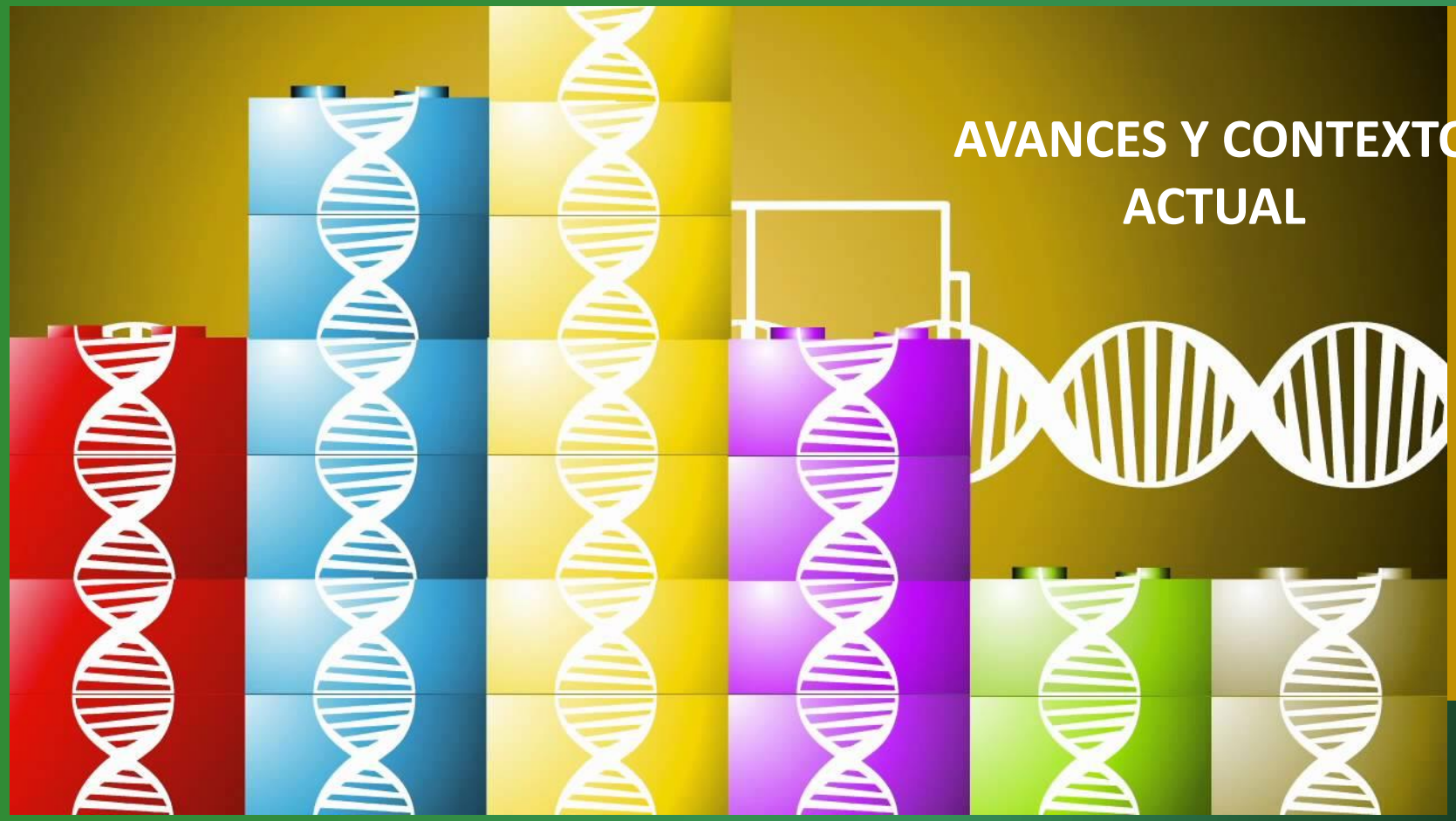




promoter	primer binding site
cds	restriction site
ribosome entry site	blunt restriction site
terminator	5′ sticky restriction site
operator	3′ sticky restriction site
insulator	5′ overhang
ribonuclease site	3′ overhang
rna stability element	assembly scar
protease site	signature
protein stability element	user defined
origin of replication	

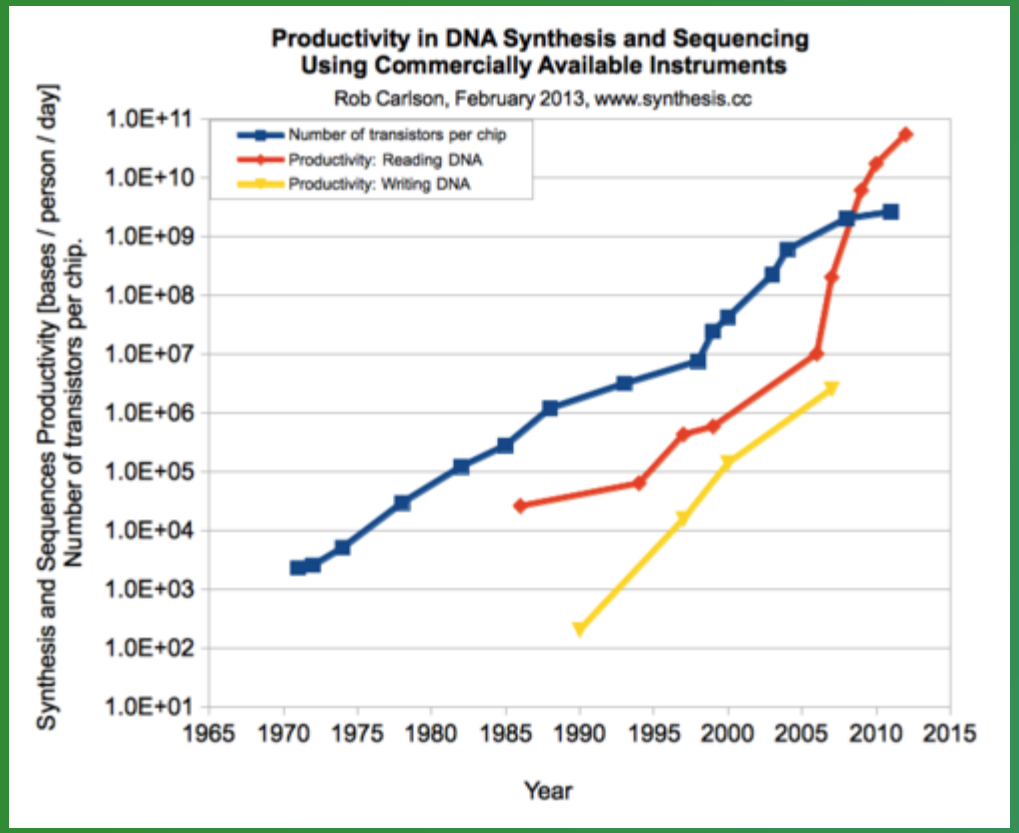


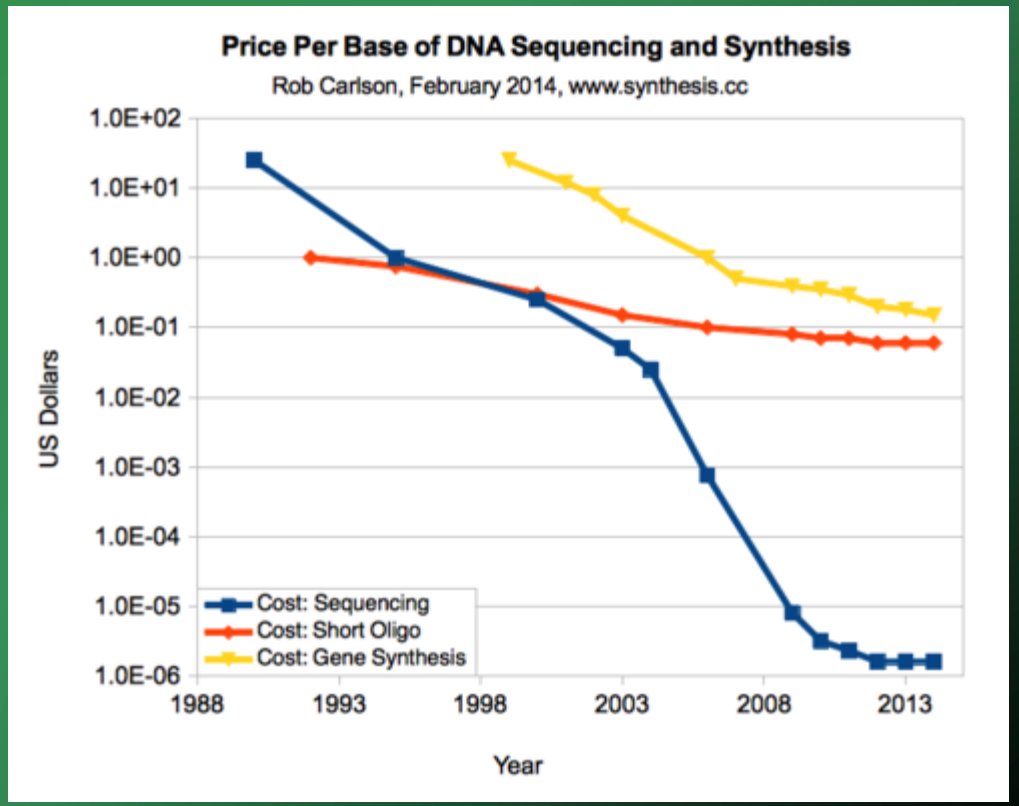
LA META DE LA BIOLOGIA SINTETICA

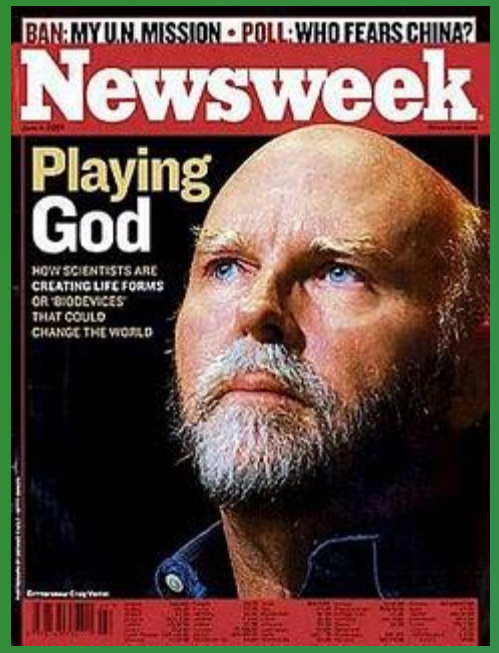


AVANCES Y CONTEXTO ACTUAL

2


Productivity in DNA Synthesis and Sequencing
Using Commercially Available Instruments
Rob Carlson, February 2013, www.synthesis.cc
Synthesis and Sequences Productivity [bases / person / day]
Number of transistors per chip.
Number of transistors per chip
Productivity: Reading DNA
Productivity: Writing DNA
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
1.0E+06
1.0E+05
1.0E+04
1.0E+03
1.0E+02
1.0E+01
1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015
Year


Price Per Base of DNA Sequencing and Synthesis
Rob Carlson, February 2014, www.synthesis.cc
US Dollars
1.0E+02
1.0E+01
1.0E+00
1.0E-01
1.0E-02
1.0E-03
1.0E-04
1.0E-05
1.0E-06
Cost: Sequencing
Cost: Short Oligo
Cost: Gene Synthesis
1988 1993 1998 2003 2008 2013
Year



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RESEARCH ARTICLE

Complete Chemical Synthesis, Assembly, and Cloning of a *Mycoplasma genitalium* Genome

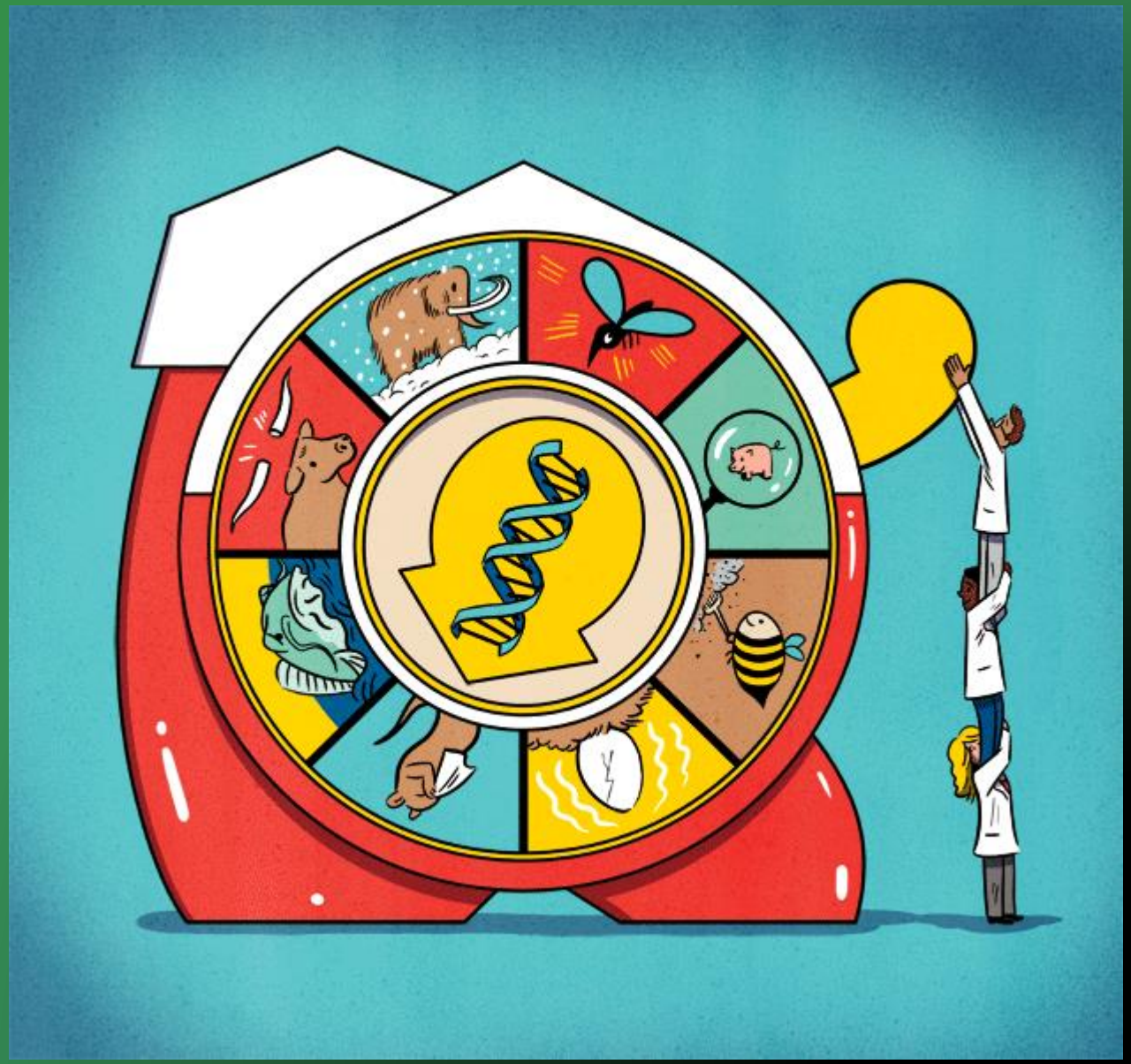
Daniel G. Gibson, Gwynedd A. Benders, Cynthia Andrews-Pfannkoch, Evgeniya A. Denisova, Holly Baden-Tillson, Jayshree Zaveri, Timothy B. Stockwell, Anushka Brownley, David W. Thomas, Mikkel A. Algire, Chuck Merryman, Lei Young, Vladimir N. Noskov, John I. Glass, J. Craig Venter, Clyde A. Hutchison III, Hamilton O. Smith*

The J. Craig Venter Institute, Rockville, MD 20850, USA.

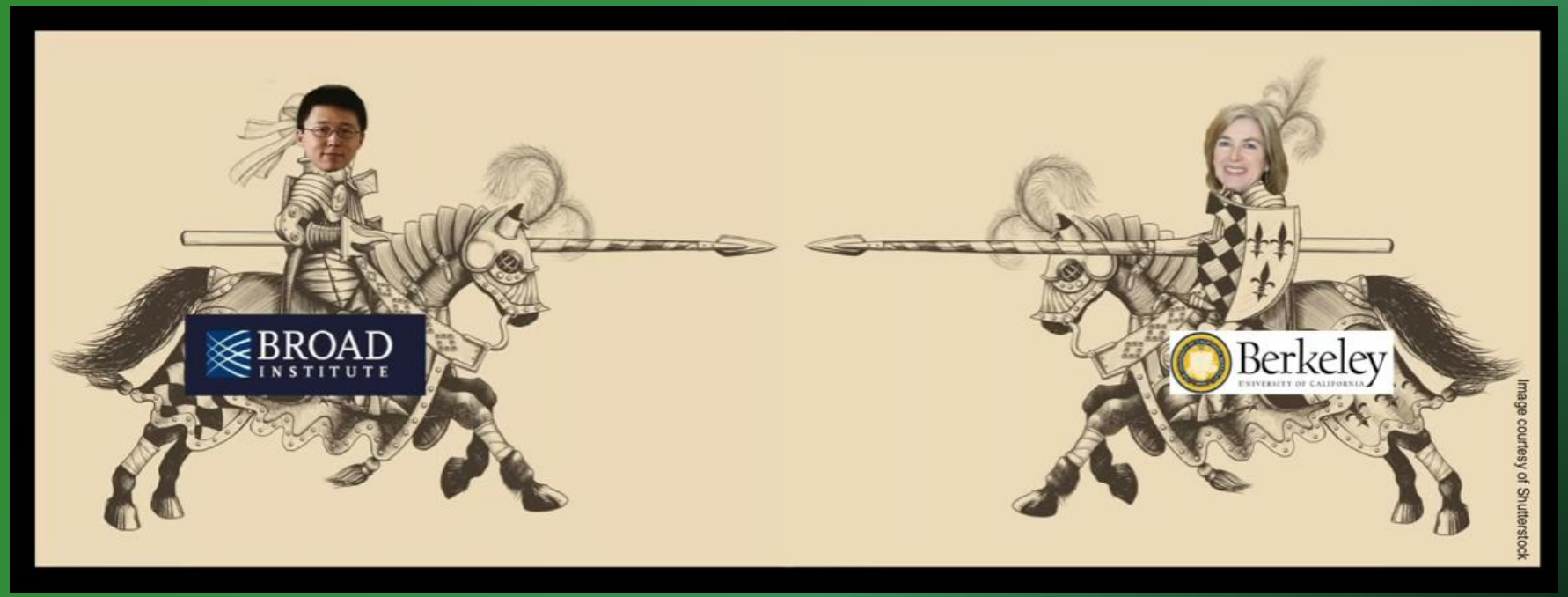
* To whom correspondence should be addressed. E-mail: hsmith@jcvi.org

– Hide authors and affiliations

Science 29 Feb 2008:
Vol. 319, Issue 5867, pp. 1215-1220
DOI: 10.1126/science.1151721

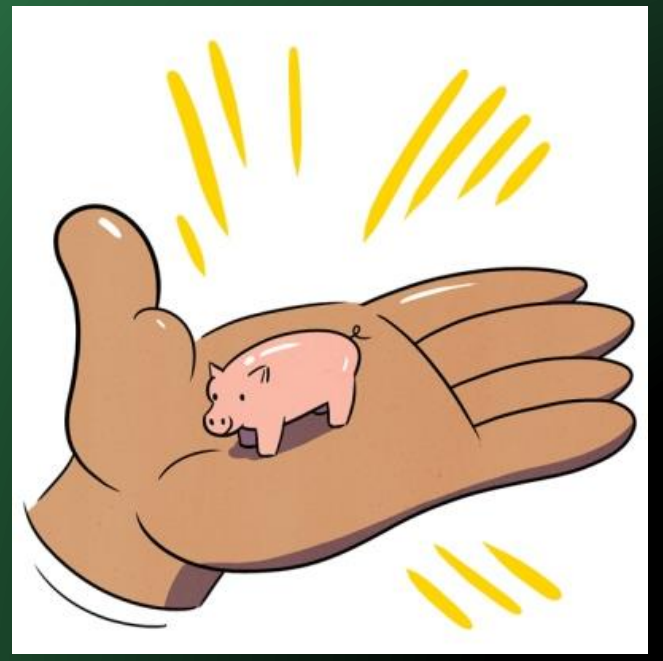


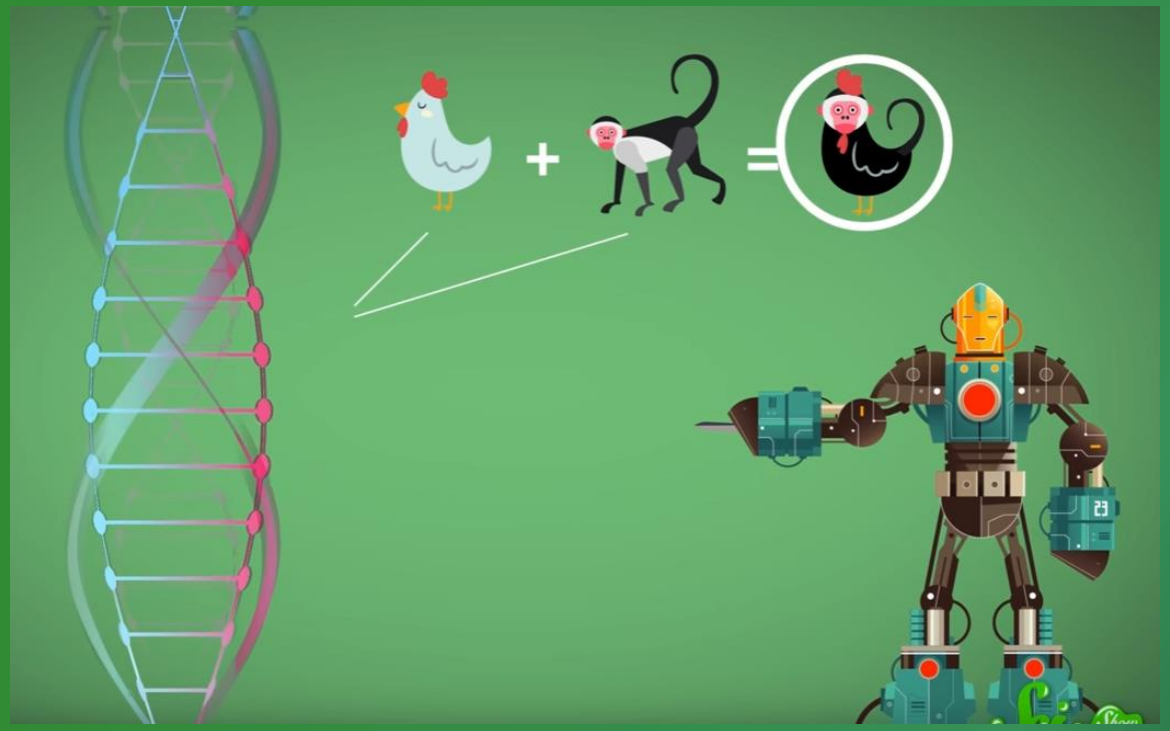
La batalla del CRISPR-CAS



Feng Zhang

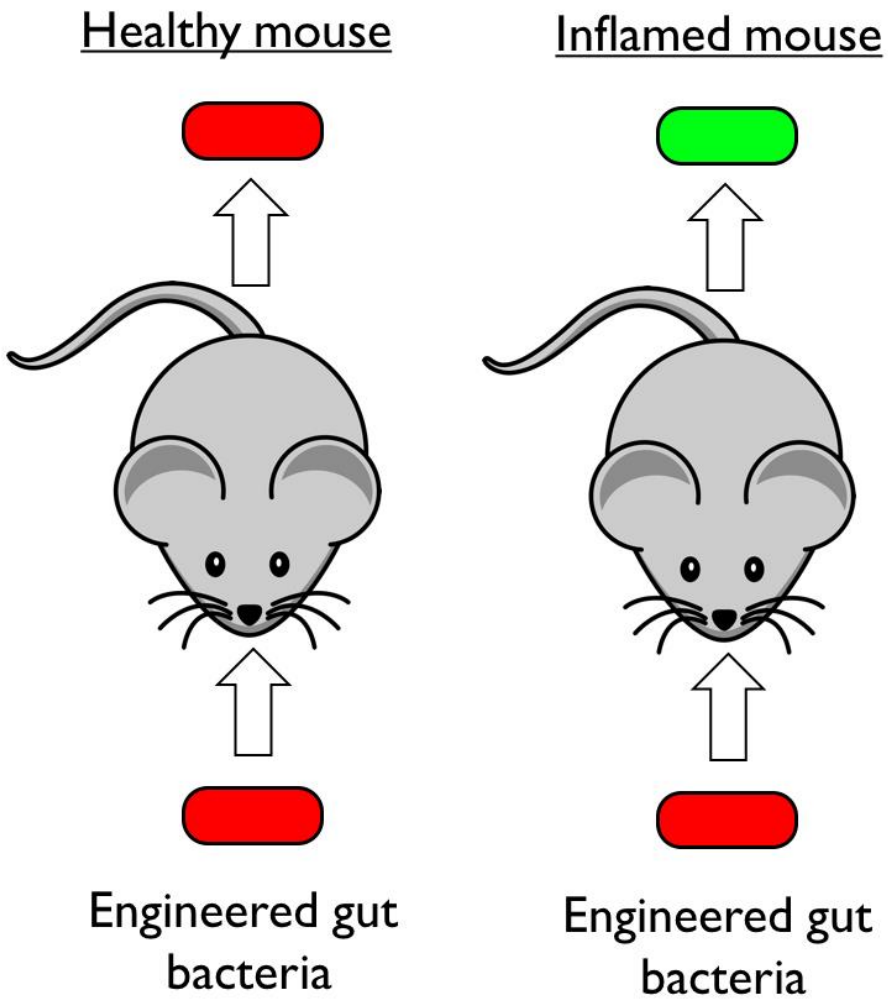
Emmanuelle Charpentier &
Jennifer Doudna

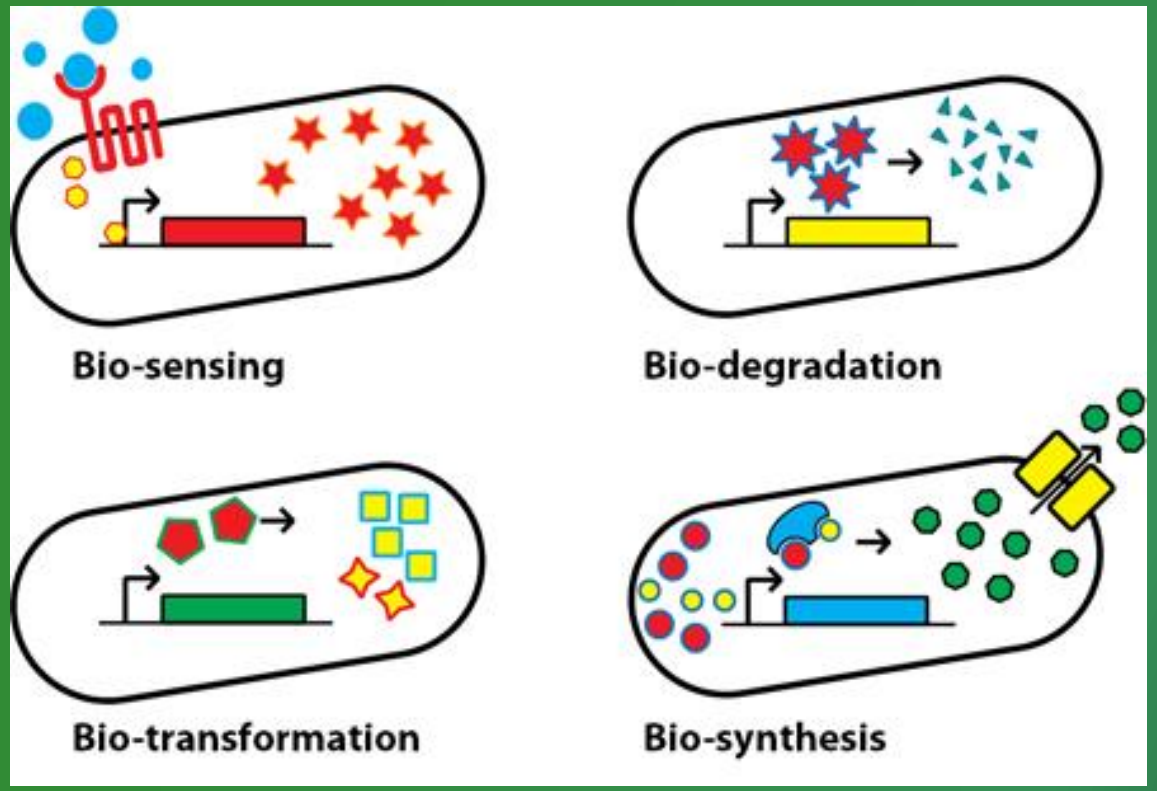


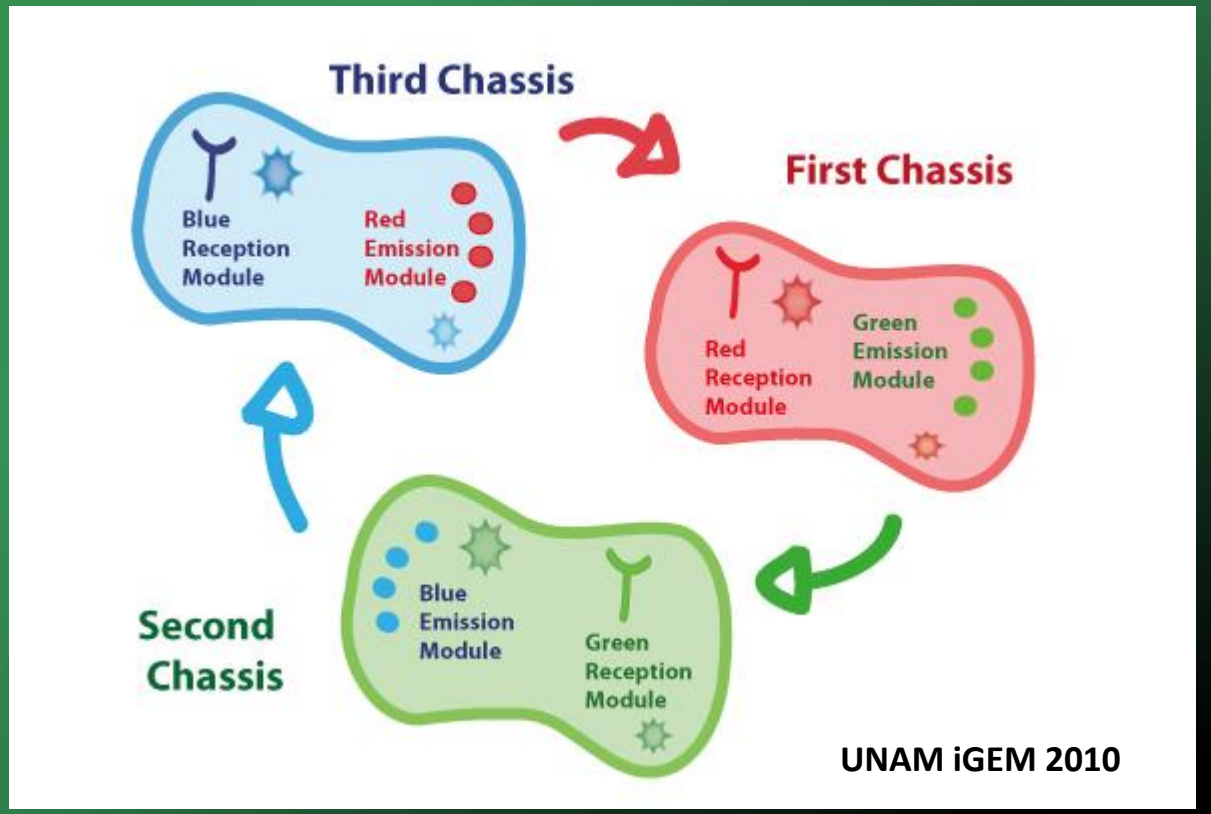


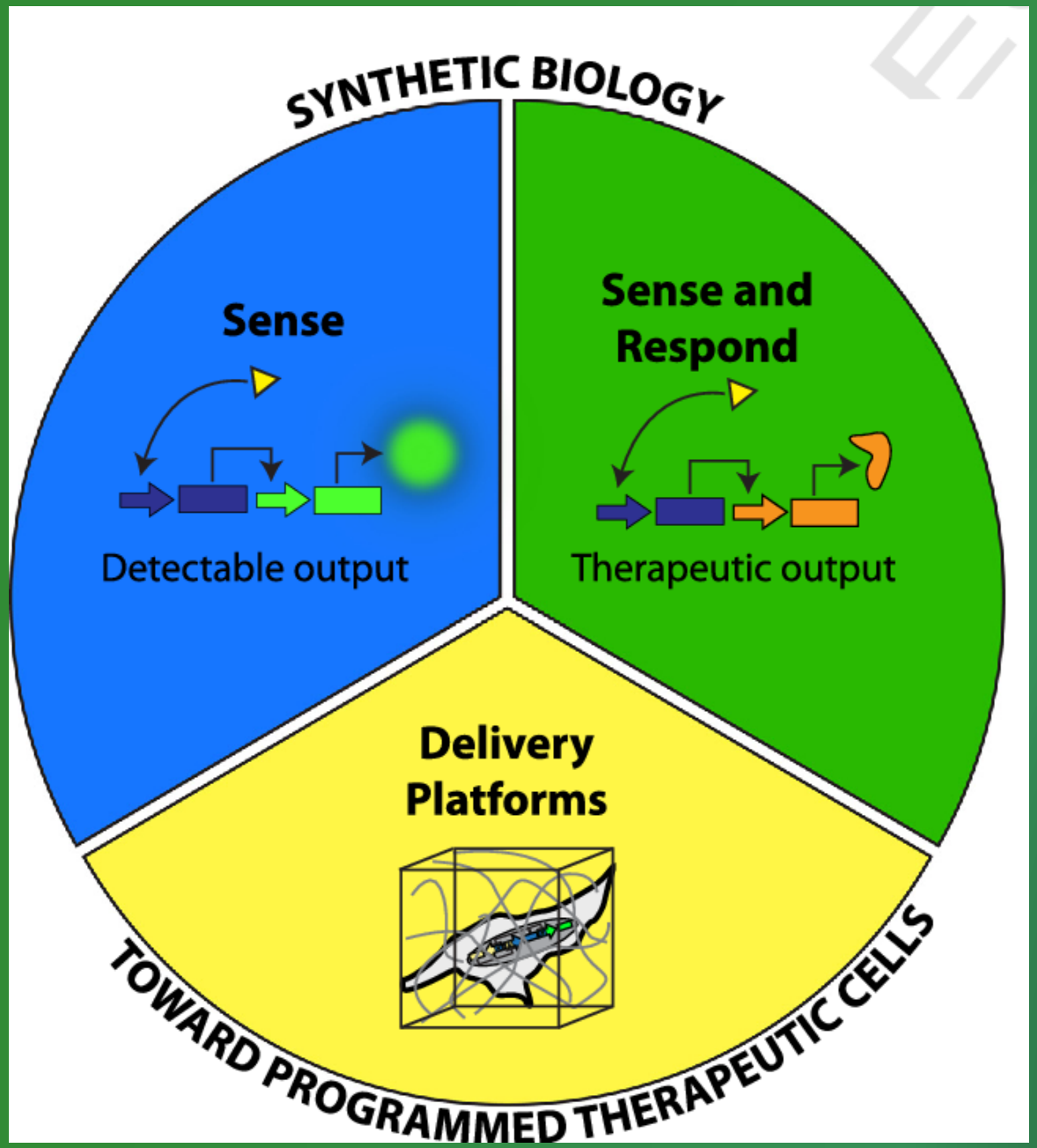
CRISPR

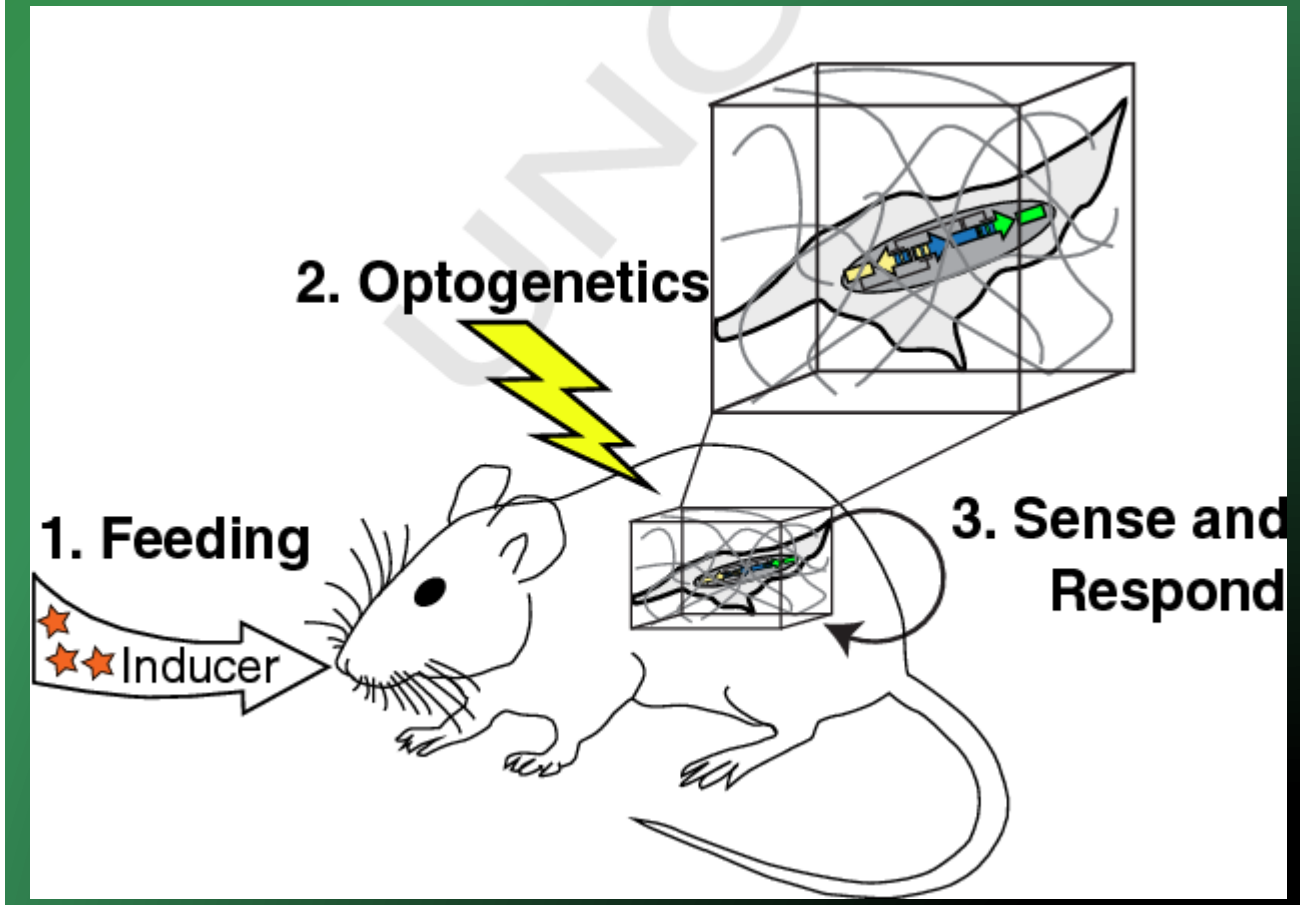
Non-invasive gut inflammation biosensor




Bio-sensing
Bio-degradation
Bio-transformation
Bio-synthesis

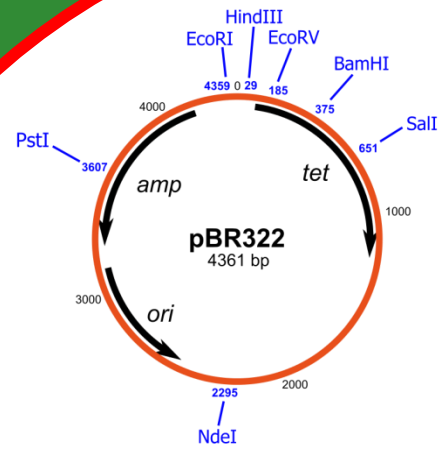

Third Chassis
Blue Reception Module
Red Emission Module
First Chassis
Red Reception Module
Green Emission Module
Second Chassis
Blue Emission Module
Green Reception Module
UNAM iGEM 2010

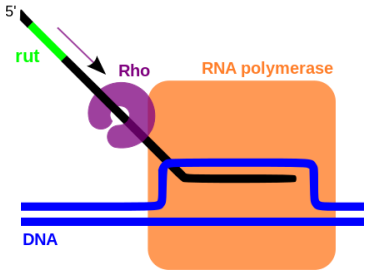

SYNTHETIC BIOLOGY
Sense
Detectable output
Sense and Respond
Therapeutic output
Delivery Platforms
TOWARD PROGRAMMED THERAPEUTIC CELLS

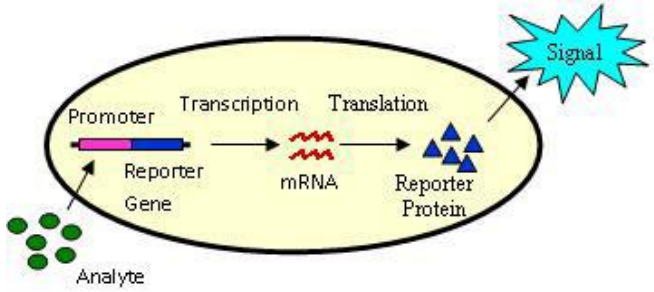

2. Optogenetics
1. Feeding
Inducer
3. Sense and Respond

2016

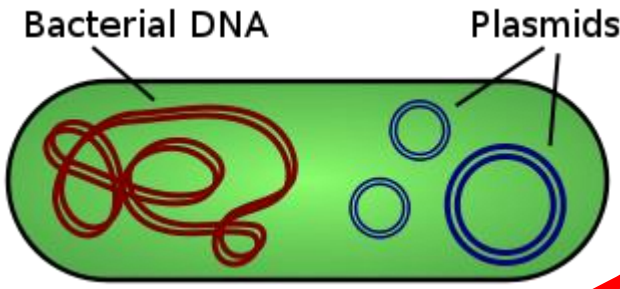
iGEM Registro





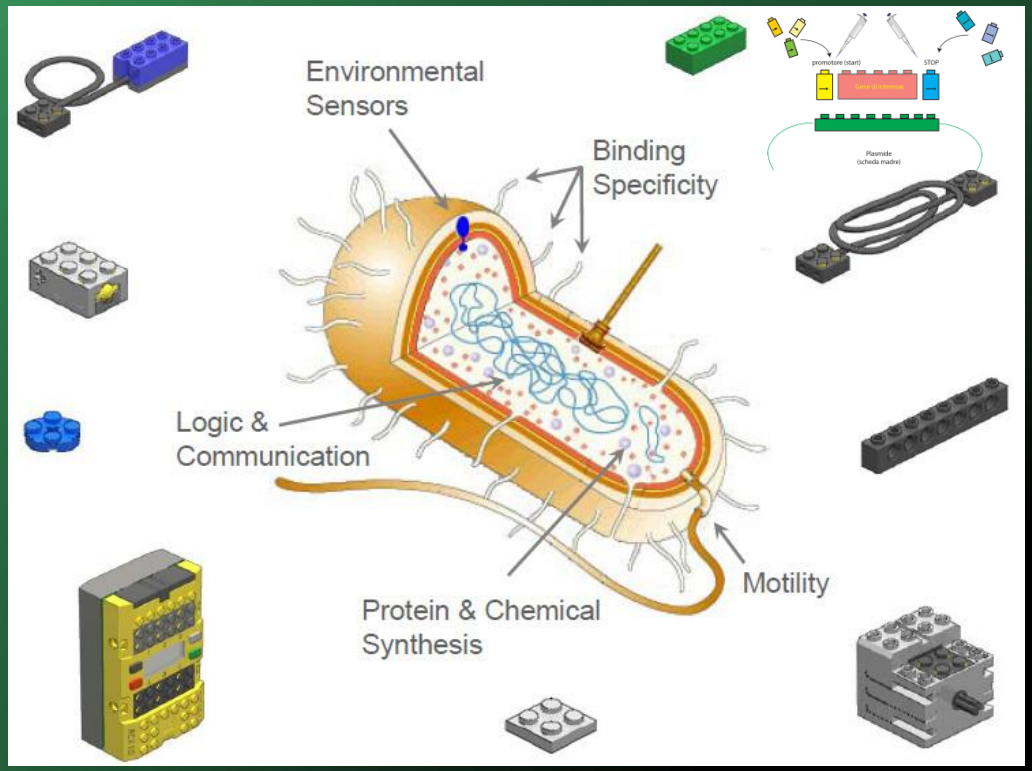


Plásmidos
Promotores
Terminadores
Reporteros



Sistemas Biológicos Simples

Partes estandar
Partes intercambiables
Partes operativas



BIOINGENIERÍA EN EL PERU DESDE EL 2017

Bioingeniería en la FIUBA

Bioingeniería
Facultad de Ingeniería

Bioingeniería Médica

BIO INGENIERIA & ROBOTICA C.A.
RIF. J-29504624-3

TEKVO®
Bioingenieria

Instituto de Bioingeniería

Lbio

BIOMEX
EXPERTOS EN BIOINGENIERÍA Y ELECTROMEDICINA

Bio ingeniería
INGENIERÍA AMBIENTAL

Sociedad Argentina de Bioingeniería

UNIVERSIDAD DE ANTIOQUIA
Bioingeniería

UPRM
BIOEngineering

ciber-bbn
Centro de Investigación Biomédica en Red
Bioingeniería, Biomateriales y Nanomedicina

Bioing
GRUPO DE INVESTIGACIÓN EN BIOINGENIERÍA

ESTADO ACTUAL DE LA BIOLOGIA SINTETICA

- La Biología Sintética no es solo la síntesis de ADN NI SOLO SU MODIFICACIÓN
- La Biología Sintética ya es posible en Eucariontes (células nucleadas de plantas)
- La Biología Sintética aun esta lejos de diseñar un nuevo organismo, esta se basa en los existentes

Industrial SynBio: Fabricating At Scale With Biology

Renewable Chemicals

genomatica
greenlight BIOSCIENCES
Arzeda.
LYGOS
INDUSTRIAL MICROBES
SYNTHETIC GENOMICS

Multi-Product

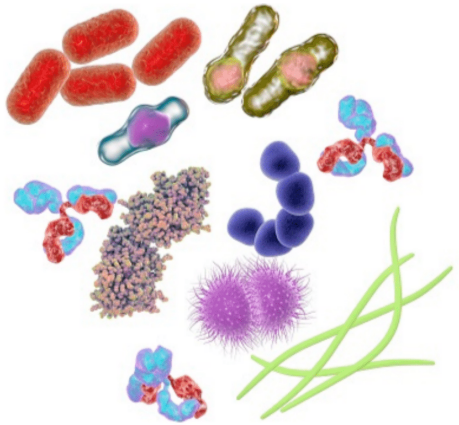
zymergen
GINKGO BIOWORKS™ THE ORGANISM COMPANY
SYNTHACE
CARIBOU BIOSCIENCES

Materials, Fabrics, & Fibers

Bolt Threads
BENTHIC LABS
Modern Meadow
glowee enlightened by the sea

Biofuels & Oils

LanzaTech
novvi
C16 BIO
JOULE



Alternative Plastics

AMBERCYCLE
BioCellection

Fertilizer

PIVOT BIO
Plant Sensory Systems

Protein & Feed

GELTOR
CALYSTA
TRITON
NOBLEGEN
GEA enzymes

Lab Ops

ELEMENTAL MACHINES
CYRUS BIOTECHNOLOGY
iXpressGenes
SYNVIVIA

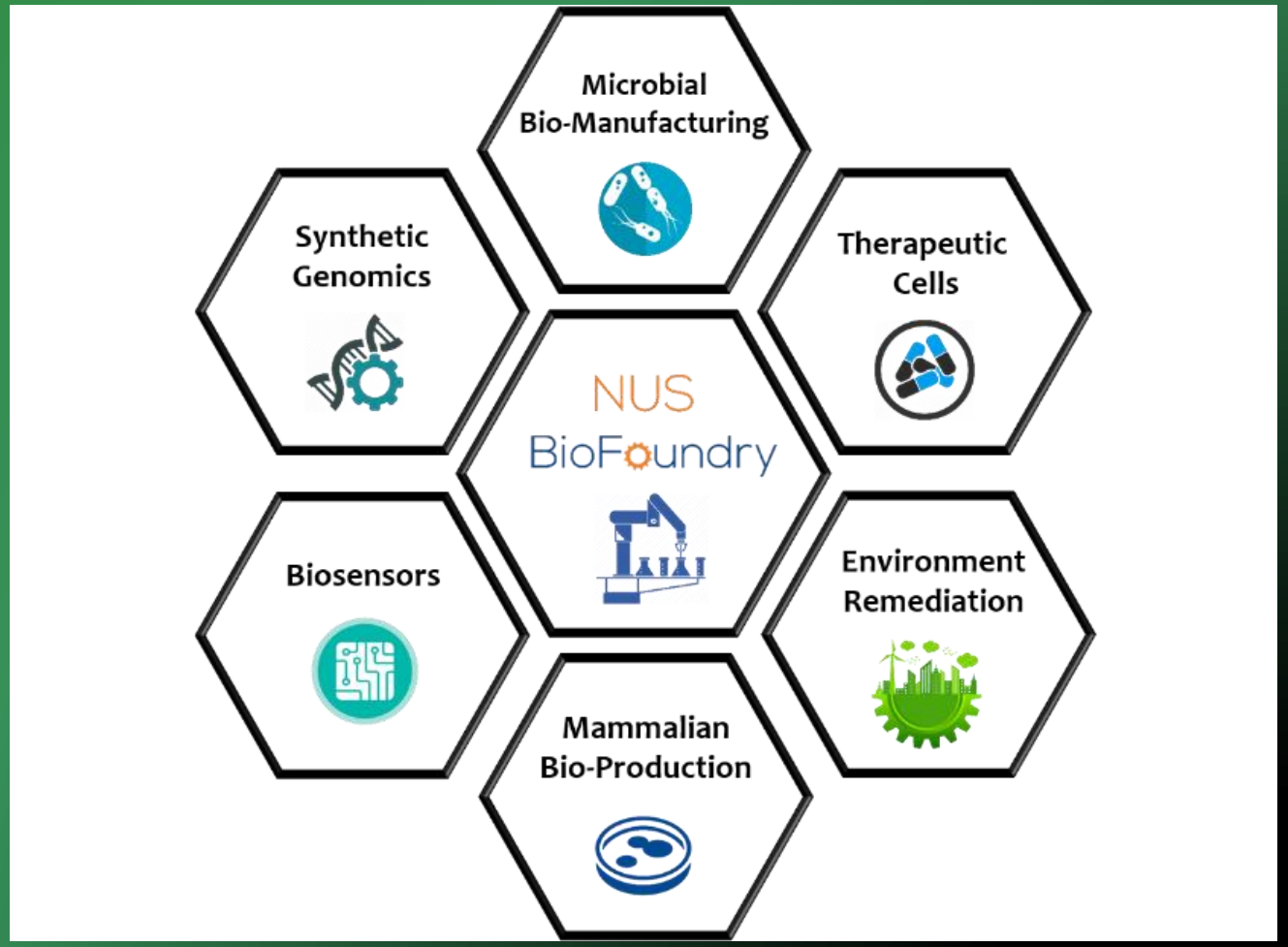
Cannabinoids & Alternative Pharma

DEEP CELL
hyasynth
TEEWINOT LIFE SCIENCES
CB Therapeutics

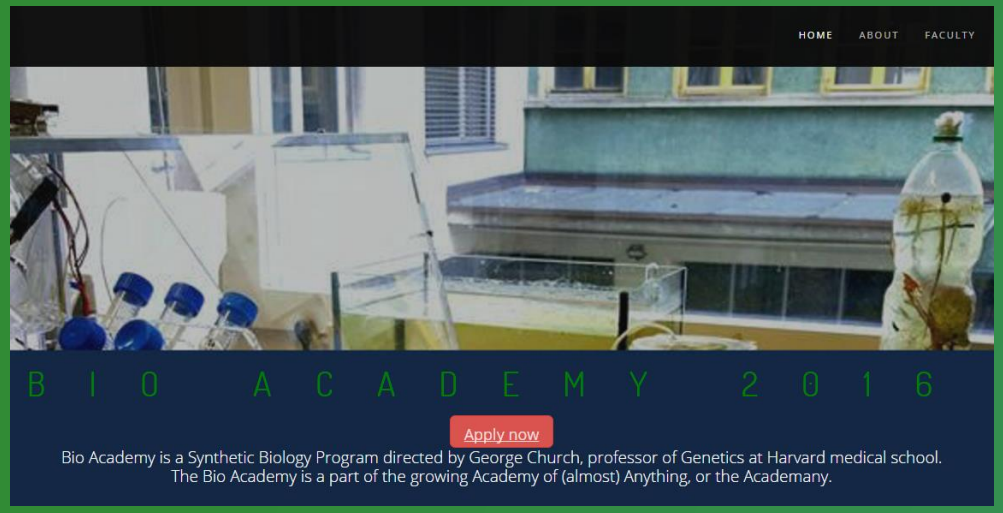
Patenting Activity in Syn Bio

Assignee	Location	Syn Bio Business Area	Nb of Patent Families
Ambrx www.ambrx.com	La Jolla CA, USA	Develops biopharmaceuticals utilizing artificial amino acids	81
Amyris Biotechnologies www.amyrisbiotech.com	Emeryville CA, USA	Developing synthetic microbes to produce pharmaceuticals, fine chemicals, nutraceuticals, vitamins, flavors and biofuels	35
Codexis www.codexis.com	Redwood city CA, USA	Employs directed evolution to produce customized biocatalysts for drug and biofuel production.	153
EraGen Biosciences www.eragen.com	Madison WI, USA	Develops genetic diagnostic assays based on artificial base paring.	20
Genencor www.genencor.com	Rochester NY, USA	One of the pioneer in the field of industrial biotechnology. Now part of Dupont. Develops and manufactures a wide range of industrial enzymes, including for generation of biofuels.	700
Gevo www.gevo.com	Engelwood CO, USA	Developing biobased alternatives to petroleum-based products using a combination of synthetic biology and chemistry.	19
Intrexon www.dna.com	Blacksburg VA, USA	Developing synthetic biology platform with applications in human therapeutics, protein production, industrial products, agricultural biotech and animal sciences	52
LS9 www.ls9.com	S. San Francisco CA, USA	Designs microbial factories for the production of biofuels and sustainable biochemicals	18
Mascoma www.mascoma.com	Waltham MA, USA	Developing microbes to convert agricultural feedstock into cellulosic ethanol	26
Sangamo Biosciences www.sangamo.com	Richmond CA, USA	Produce engineered "zinc finger" proteins for controlling gene expression	81
Synthetic Genomics www.syntheticgenomics.com	La Jolla CA, USA	Designing metabolic pathways for the production of biochemicals and next generation biofuels	27
Verenium www.verenium.com	San Diego CA, USA	Created from the merger of Diversa and Celunol in 2007. Developing specialty enzymes products for the production of cellulosic ethanol	133

FASKEN MARTINEAU
www.fasken.com



Hágalo Usted Mismo



JELLYFISH BIOROBOTICS

BOSSLAB

GENSPACE

bio CURIOUS

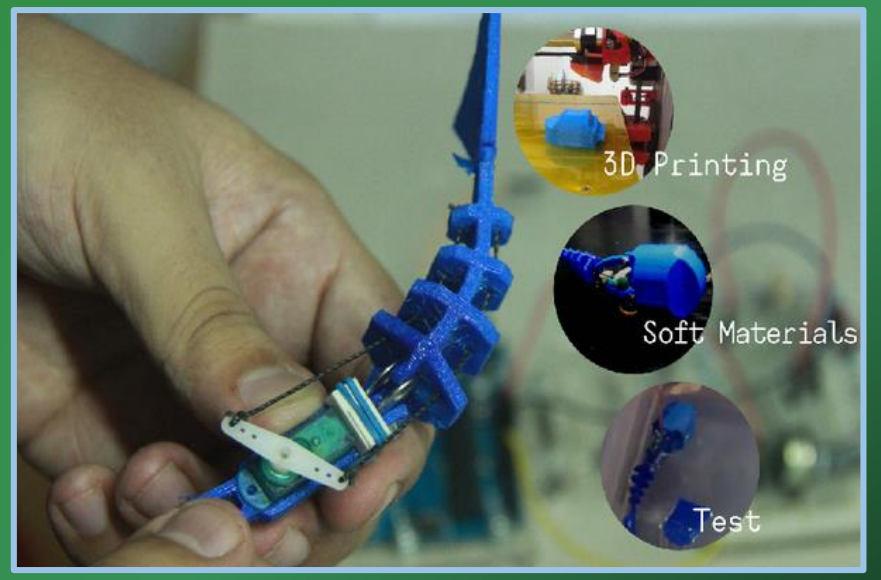
BIO TECH & Beyond

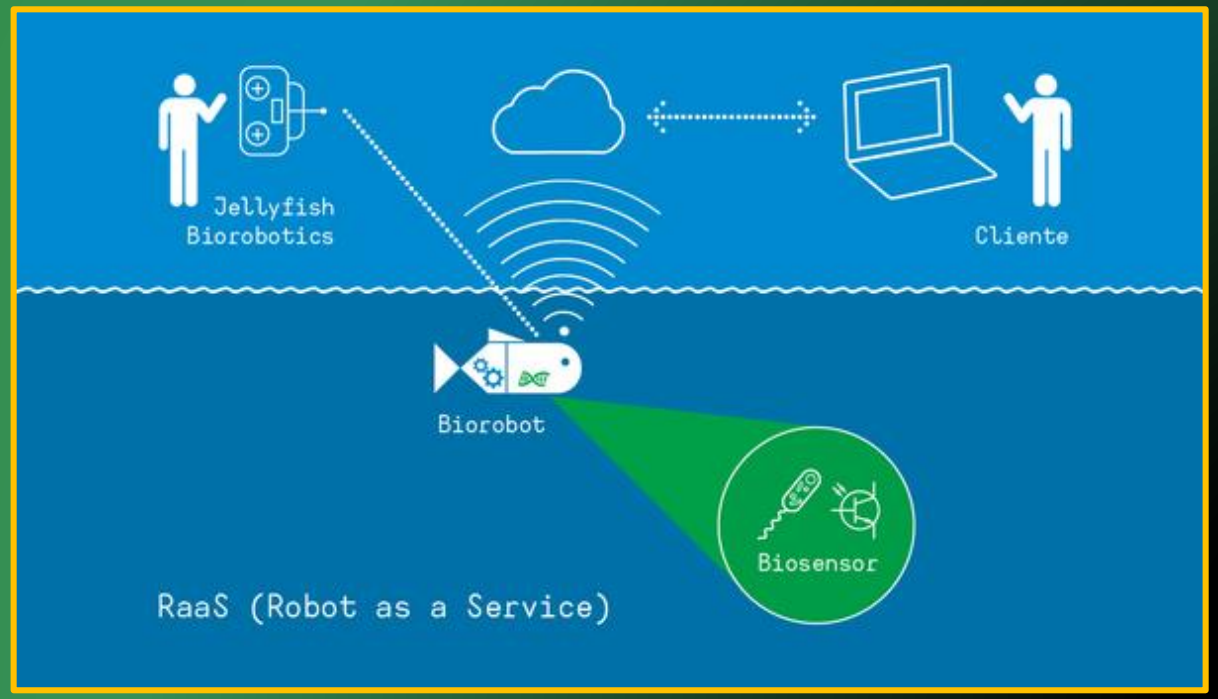
iGEM + DIYBIO

PERÚ Ministerio de la Producción

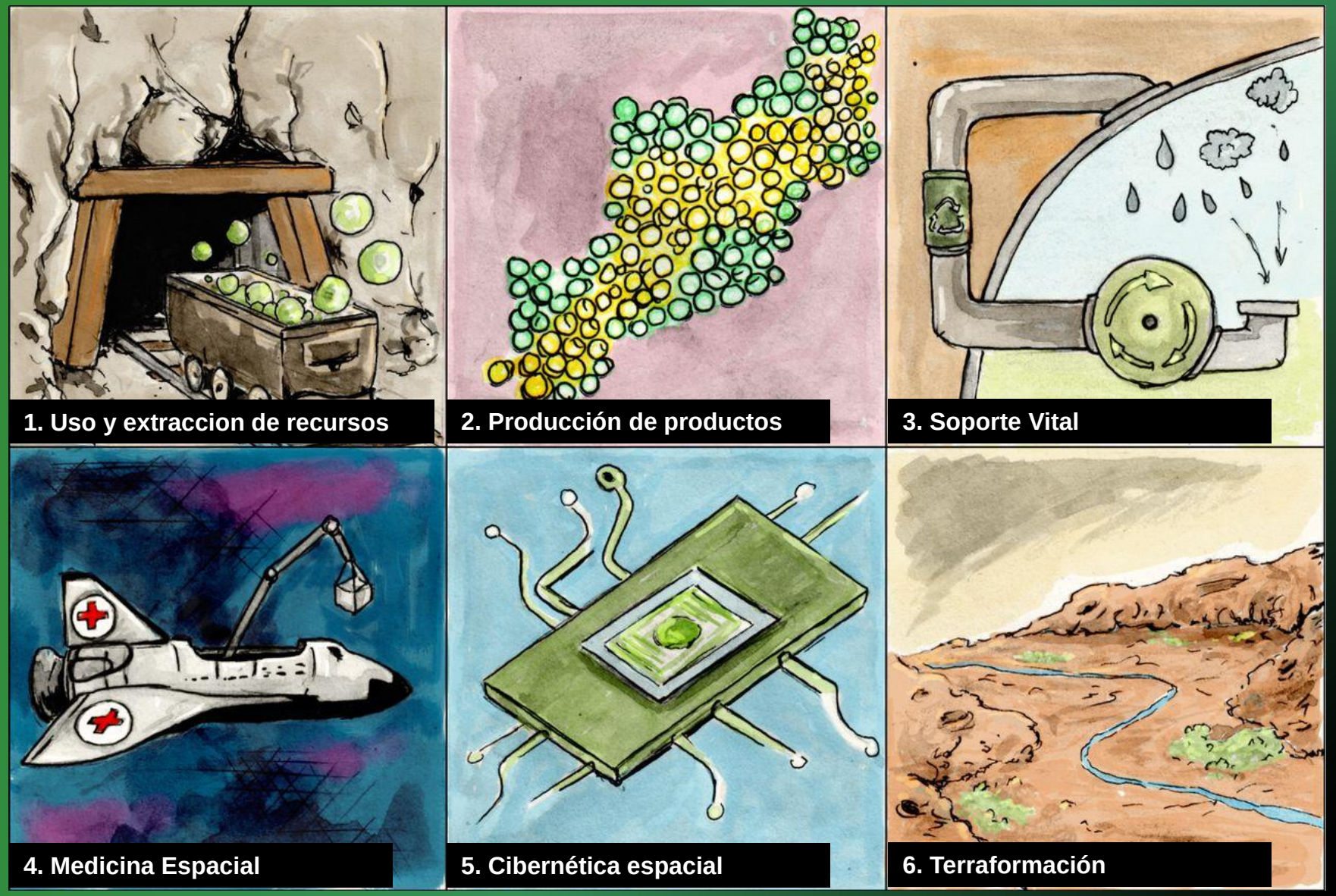
STARTUP PERÚ

JELLYFISH BIOROBOTICS





DESAFIOS Y OPORTUNIDADES DE LA BIOLOGIA SINTETICA EN EL ESPACIO



Gráfica de Hugo Texeira

National Aeronautics & Space Administration
NASA
EL POTENCIAL DE LA BIOLOGIA SINTETICA EN EL ESPACIO
Biocementación
Transmisor de secuencias de ADN y síntesis *in situ*
Producción de alimentos
Producción biomateriales
Biomineria
Bioreactores microbianos multiproposito
Habitats Rad-resistentes
Biosensores ambientales
Tratamiento de Agua
Biofabricación y formación de patrones programados
Tratamiento de Aire
Tratamiento de basura
www.nasa.gov
http://syntheticbiology.arc.nasa.gov

XPRIZE®

ASTROBIOLOGIA SINTETICA:

Diseñar un organismo capaz de restir las condiciones de Marte y pueda producir algun producto util para los colonizadores

RIESGOS Y RETOS

3

RIESGOS DE LA BIOLOGIA SINTETICA

Involucra organismos vivos que potencialmente pueden reproducirse

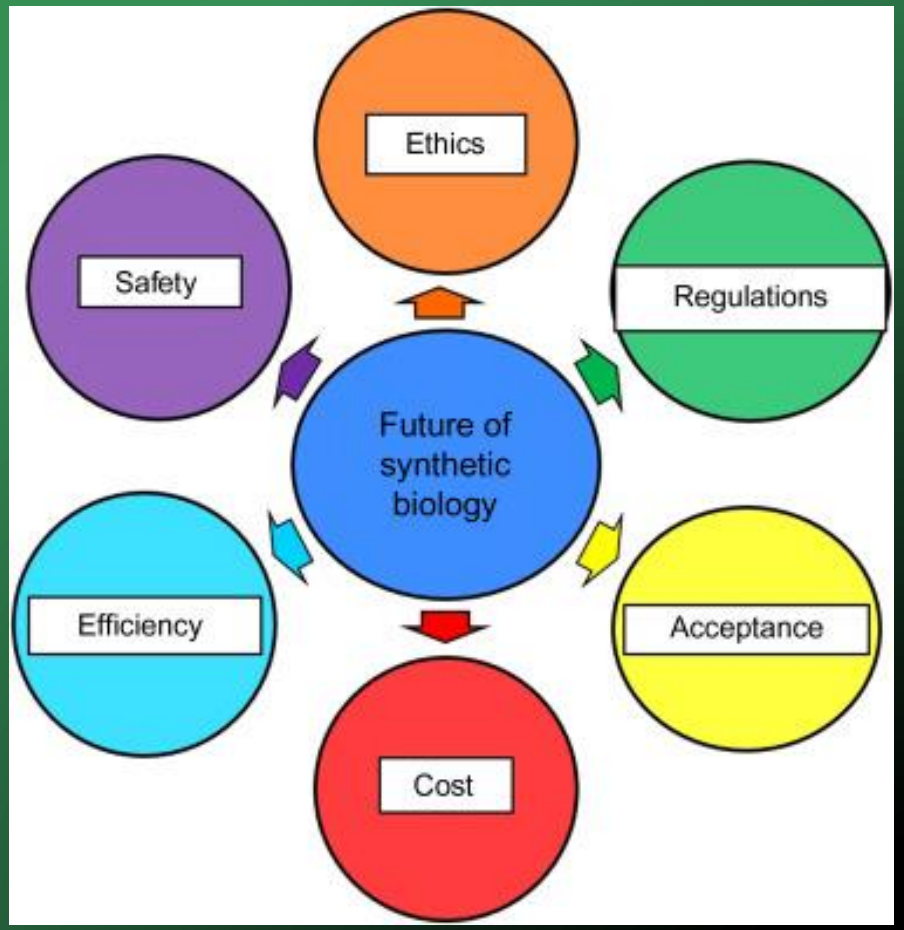
De Vriend et al., 2006

- Organismos con efectos nuevos al interactuar con otros organismos
- Organismos con nuevos comportamientos no predecibles

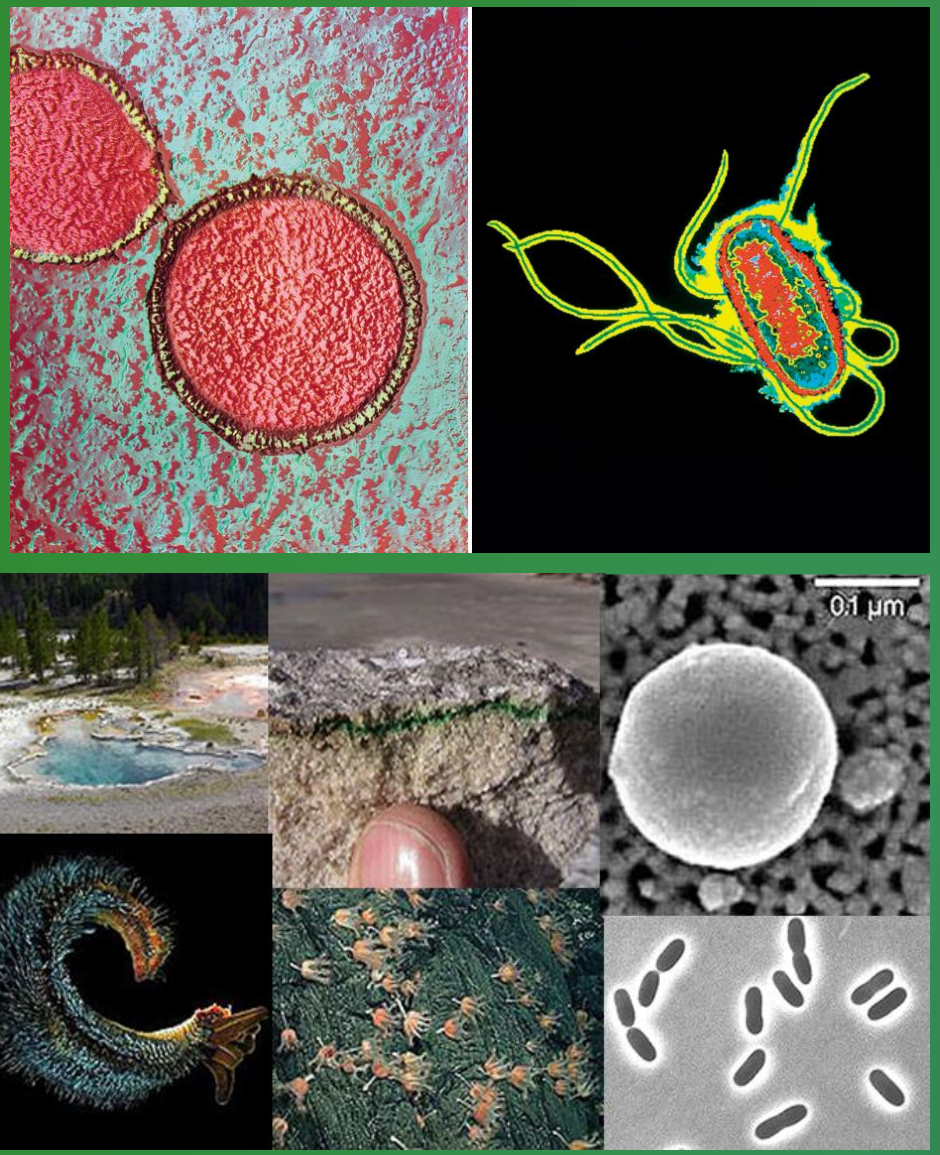
Tucker & Zilinskas., 2006

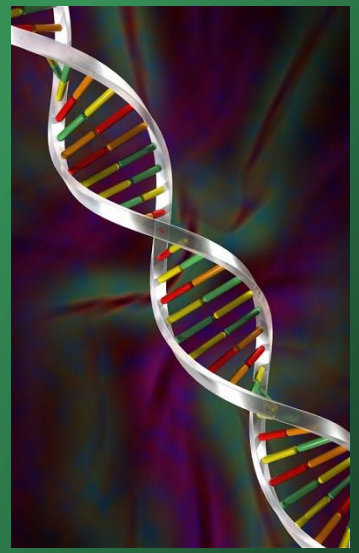
El crecimiento del internet y la disponibilidad de las tecnicas bio-nano tecnologicas son accesibles

Garfinkel et al., 2007



Buscando Bio-ladrillos





BASES DE DATOS

Miedo a los Piratas

Partes intercambiables

En hojas de papel

iGEM wiki tools search toc teams login

Registry of Standard Biological Parts

iGEM tools catalog repository assembly protocols help search BBa_

Help:An Introduction to BioBricks

BioBricks™

BioBricks™ is a standard for interchangable parts, developed with a view to building biological systems in living cells. The picture to the left shows BioBrick™ part BBa_B0034 within a plasmid. The part is flanked by a standard BioBrick™ prefix (P) and suffix (S). Click the image to find out more or alternatively see:

- Definition of a BioBrick™ part (Important! Please read)
- BioBrick™ Names
- Types of BioBrick™
- Plasmids Introduction
- BioBrick™ Prefix and Suffix

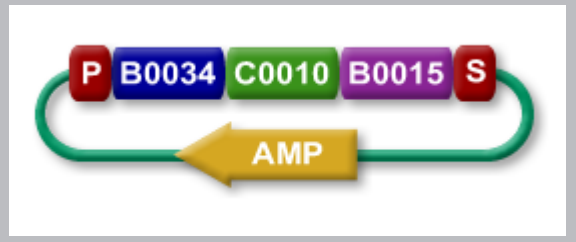
Building BioBrick™ Systems

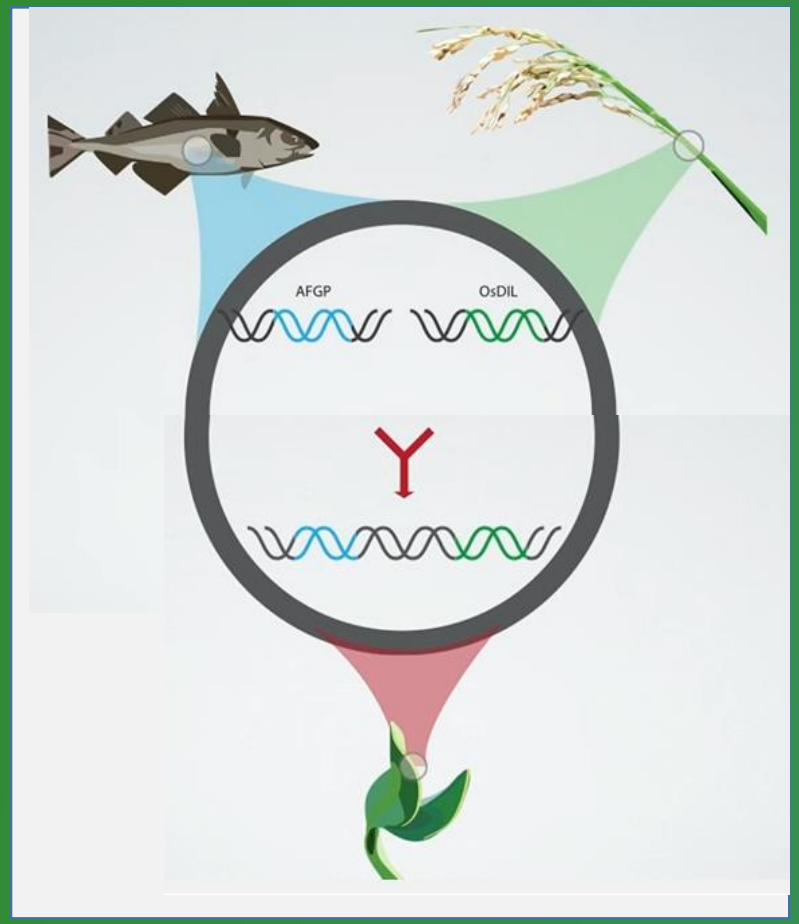
BioBrick™ parts can be assembled to form useful devices, through a process often referred to as 'Standard Assembly'. BioBrick™ parts are composable; allowing endless numbers of Biobrick™ parts to be pieced together to form complex systems.

The assembly to the left shows 3 BioBrick™ parts assembled to create a simple device. Find out more about BioBrick™ assembly.

Site Navigation

- Feature Box Archive
- News Archive
- Safety
- Videos
- New Features
- Report Bugs
- Request Features
- Registry API




AFGP
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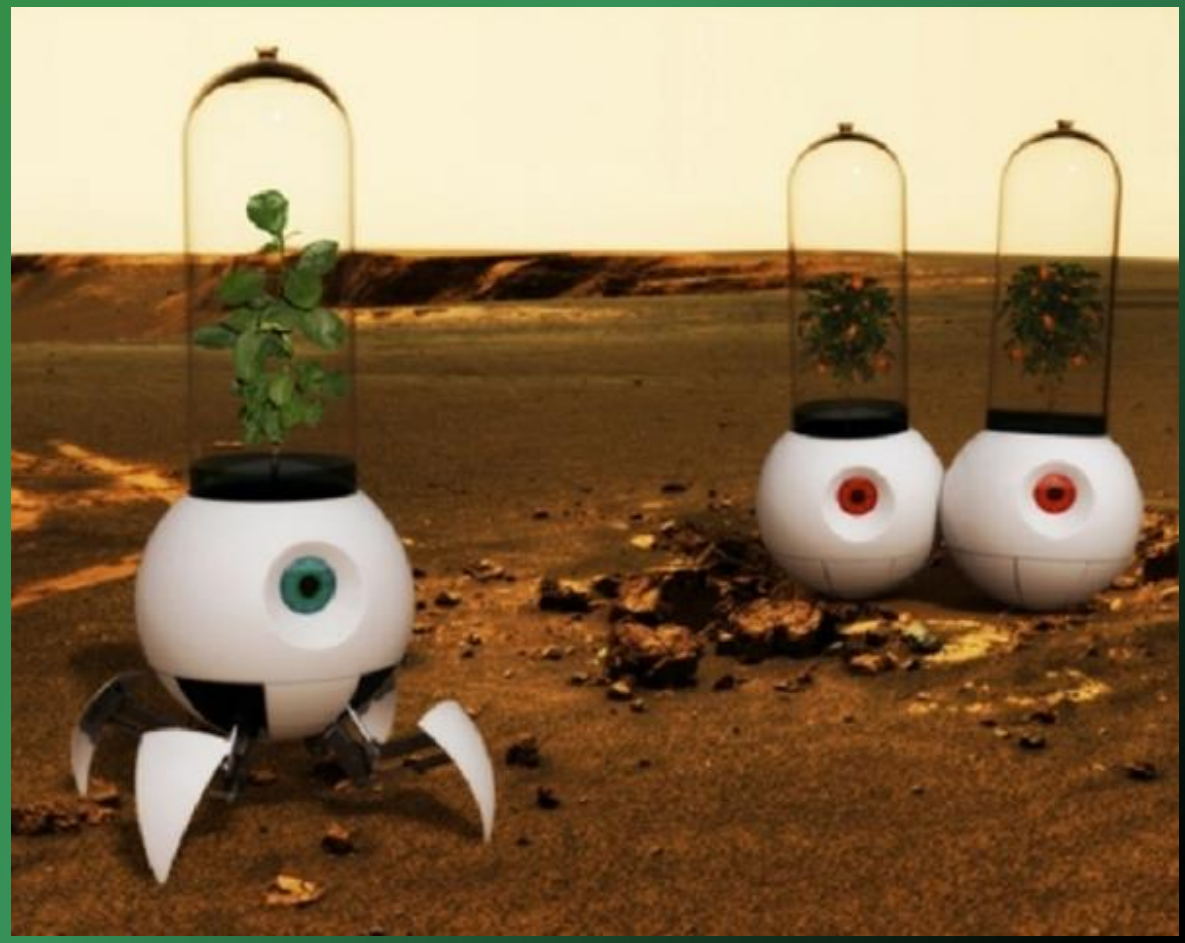


BIOETICA

Relacionada a las aplicaciones (¿potenciar humanos?)
Relacionada a la distribución de sus productos
Relacionada a los procedimientos (¿maquinas vivas?)

BIOSEGURIDAD

Manejo de riesgos de los productos, funciones y sistemas
Mejora de la seguridad a través de los procesos de ingeniería
Como manejar si hay un manejo no-profesional

Se podrían crear nuevos patógenos

“La evolución del ADN podría avanzar mas rápido en un laboratorio o una clínica que en la misma naturaleza”
Benner 2004

Science & Health

The Battle Over CRISPR Could Make Or Break Some Biotech Companies

STAT Sections Topics Multimedia Popular STAT Plus Job Board

FIRST OPINION

Is do-it-yourself CRISPR as scary as it sounds?

NATURE | NEWS

Second Chinese team reports gene editing in human embryos

Study used CRISPR technology to introduce HIV-resistance mutation into embryos.

Ewen Callaway

08 April 2016

NATURE | NEWS FEATURE

Where in the world could the first CRISPR baby be born?

A look at the legal landscape suggests where human genome editing might be used in research or reproduction.

Heidi Ledford

13 October 2015

Chinese paper on embryo engineering splits scientific community

By Jocelyn Kaiser, Dennis Normile | Apr. 24, 2015 , 7:00 PM

The New York Times

RCH

Only a Rumbling Volcano Could Make North Korea and the West Play Nice

TRILOBITES

That Thing With Feathers Trapped in Amber? It Was a Dinosaur Tail

TRILOBITES

Rapid Evolution Saved This Fish From Pollution, Study Says

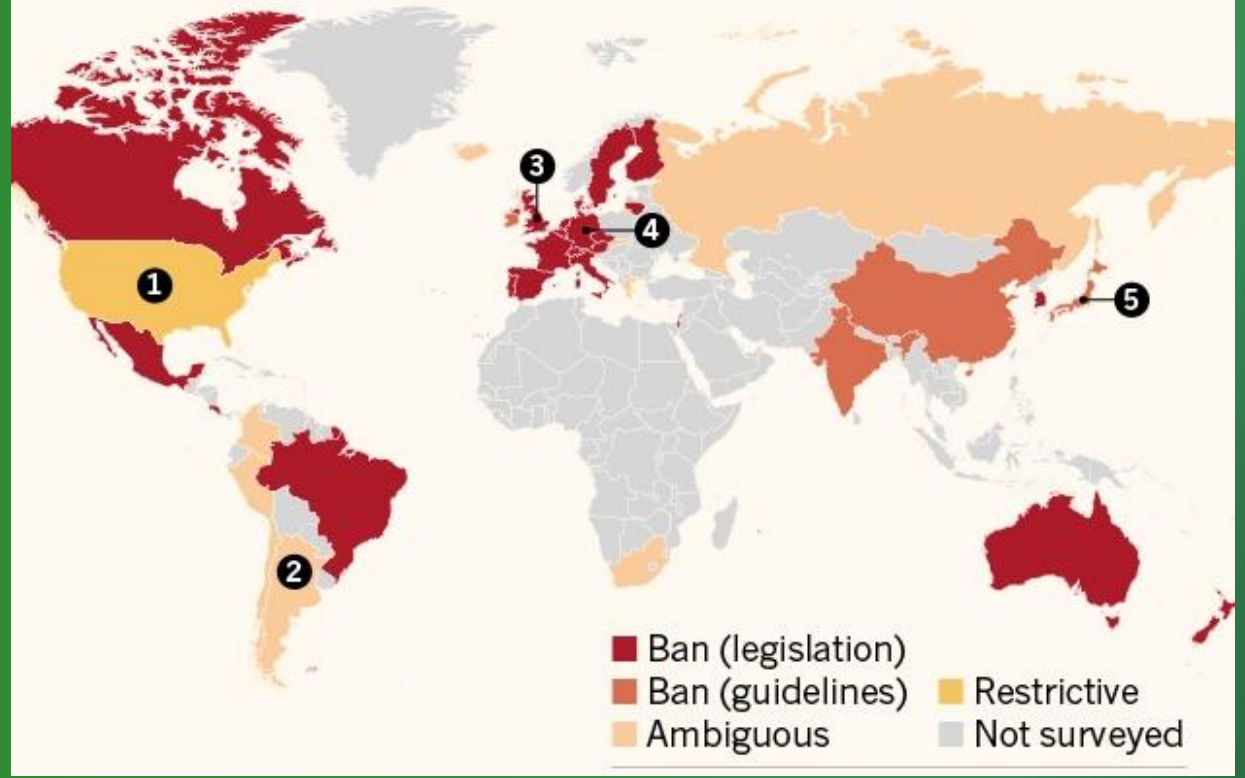
SCIENCE

Scientists Seek Ban on Method of Editing the Human Genome

By NICHOLAS WADE MARCH 19, 2015

CRISPR EMBRYOS AND THE LAW

Regulations governing genetic modification in human embryos vary. Some countries ban the practice through legislation that carries criminal penalties; others have unenforceable guidelines.



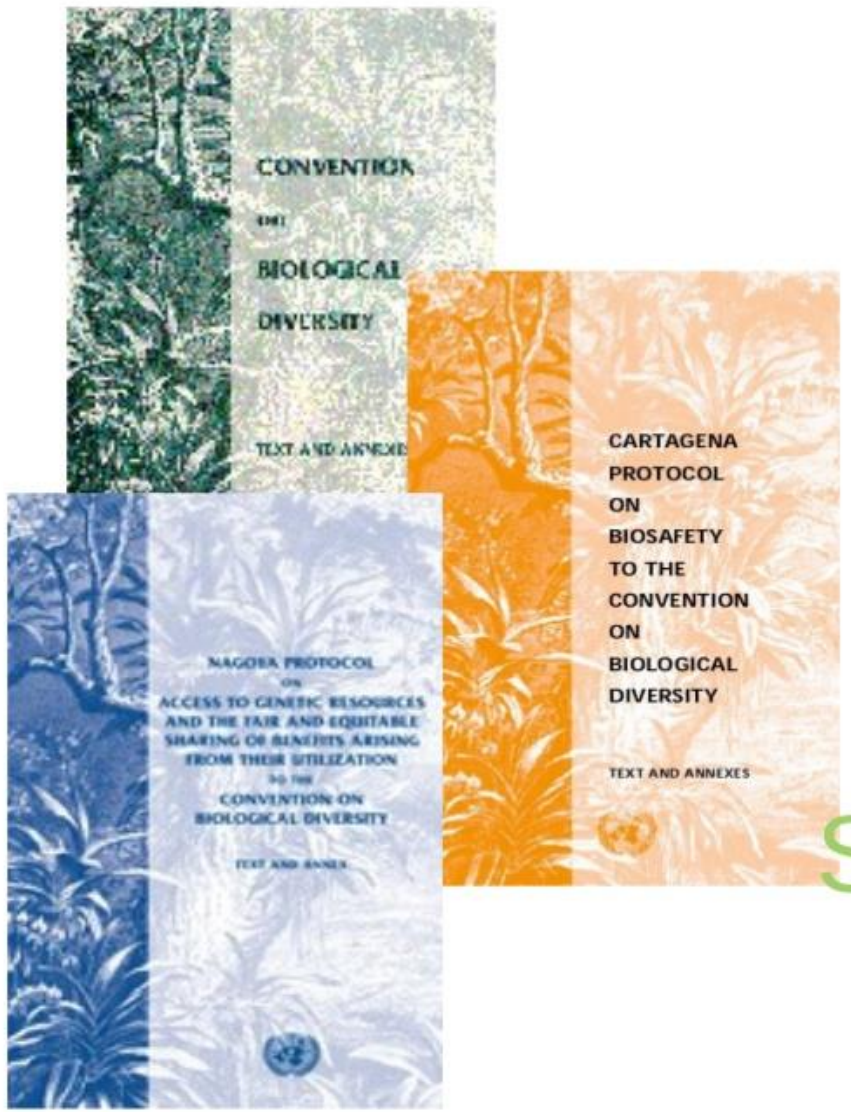
1. THE UNITED STATES does not allow the use of federal funds to modify human embryos, but there are no outright genome-editing bans. Clinical development may require approval.

2. ARGENTINA bans reproductive cloning, but research applications of human-genome editing are not clearly regulated.

3. THE UNITED KINGDOM's independent Human Fertilisation and Embryology Authority may permit human-genome editing for research, but the practice is banned in the clinic.

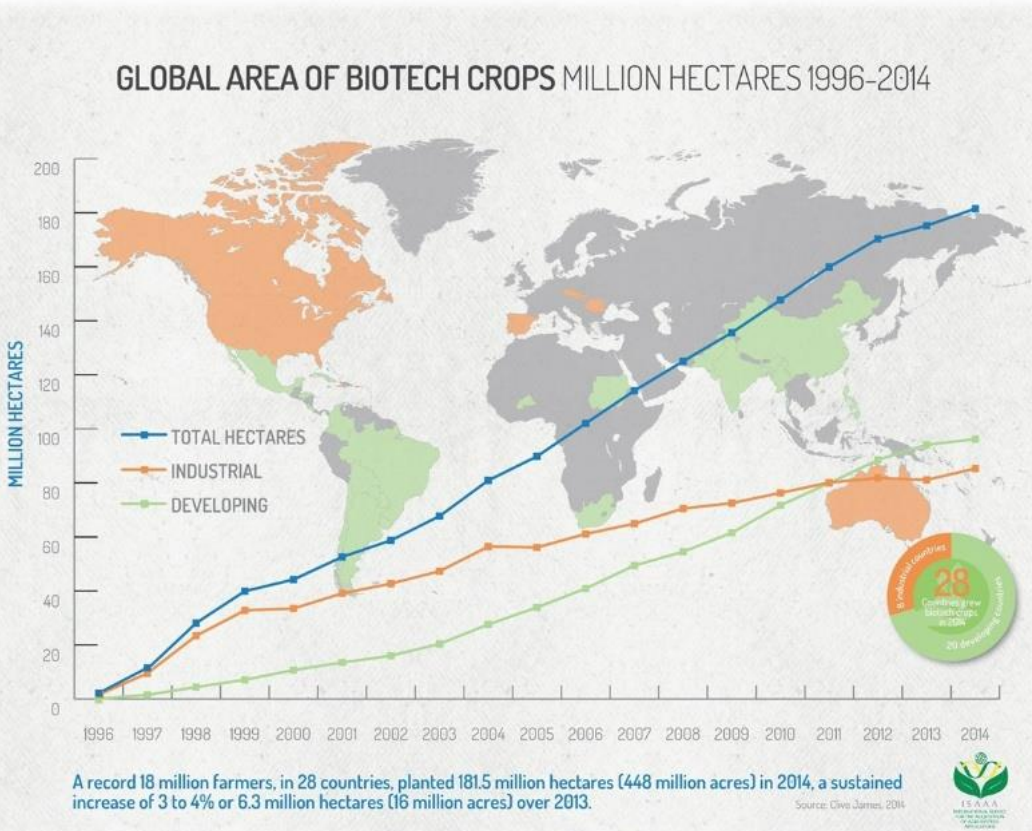
4. GERMANY has strict laws on the use of embryos in assisted reproduction. It also limits research on human embryos, and violations could result in criminal charges.

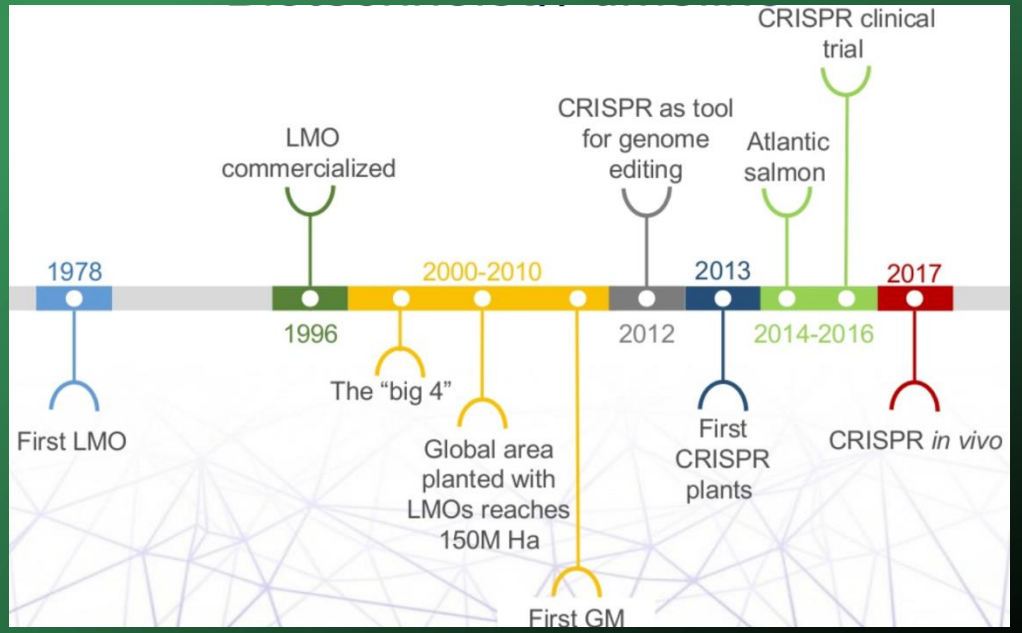
5. JAPAN, like China, India and Ireland, has unenforceable guidelines that restrict the editing of a human embryo's genome.



Synthetic Biology ?

https://www.cbd.int/conferences/2018/cop-14/documents


GLOBAL AREA OF BIOTECH CROPS MILLION HECTARES 1996-2014
MILLION HECTARES
200
180
160
140
120
100
80
60
40
20
0
TOTAL HECTARES
INDUSTRIAL
DEVELOPING
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
28
A record 18 million farmers, in 28 countries, planted 181.5 million hectares (448 million acres) in 2014, a sustained increase of 3 to 4% or 6.3 million hectares (16 million acres) over 2013.


1978
First LMO
LMO commercialized
1996
2000-2010
The "big 4"
Global area planted with LMOs reaches 150M Ha
First GM
CRISPR as tool for genome editing
2012
2013
First CRISPR plants
Atlantic salmon
2014-2016
CRISPR clinical trial
2017
CRISPR in vivo

EL PERU y SUS MAS DE 4500 variedades

Secuenció 150 genomas de gente nativa peruana
Se encontraron 3.3 millones de variantes de las 10,.1 millones de variantes conocidas

Dr. Heinner Guio

PubMed

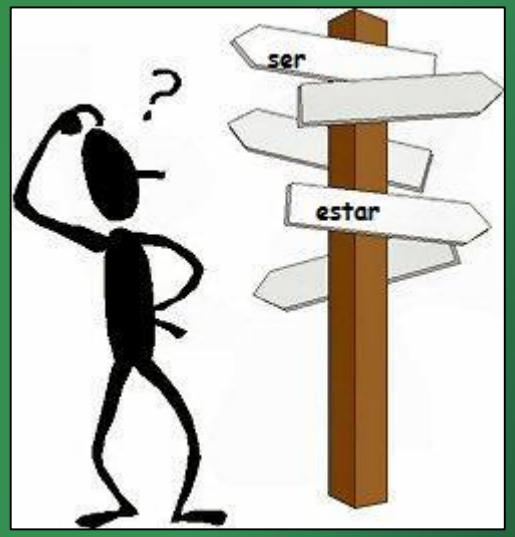
National Library of Medicine NLM

Google Scholar

SciELO

Scientific Electronic Library Online

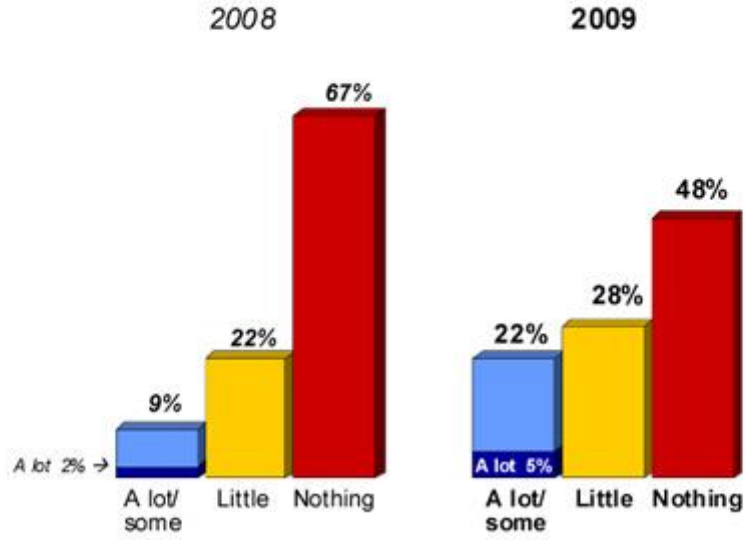
INFORMACION VERAZ, CIENTIFICA, CRITICA



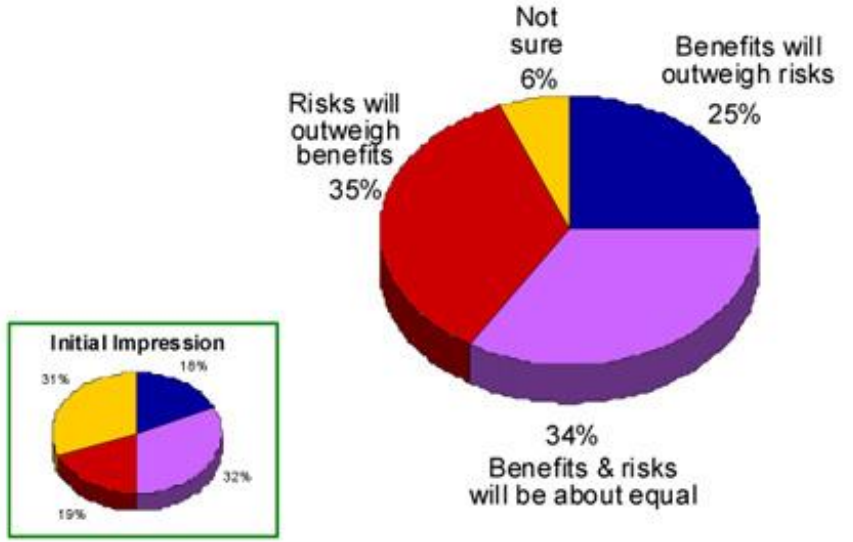
THOMSON REUTERS

Public Awareness Of Synthetic Biology Has More Than Doubled

How much have you heard about synthetic biology?



Informed Impression Of Risks And Benefits Of Synthetic Biology



Wilson Center Project on Emerging Nanotechnologies, 2009

Synthetic Biology

The question we all need to know…

Do the benefits outweigh the risks?

jvaldivias@utec.edu.pe