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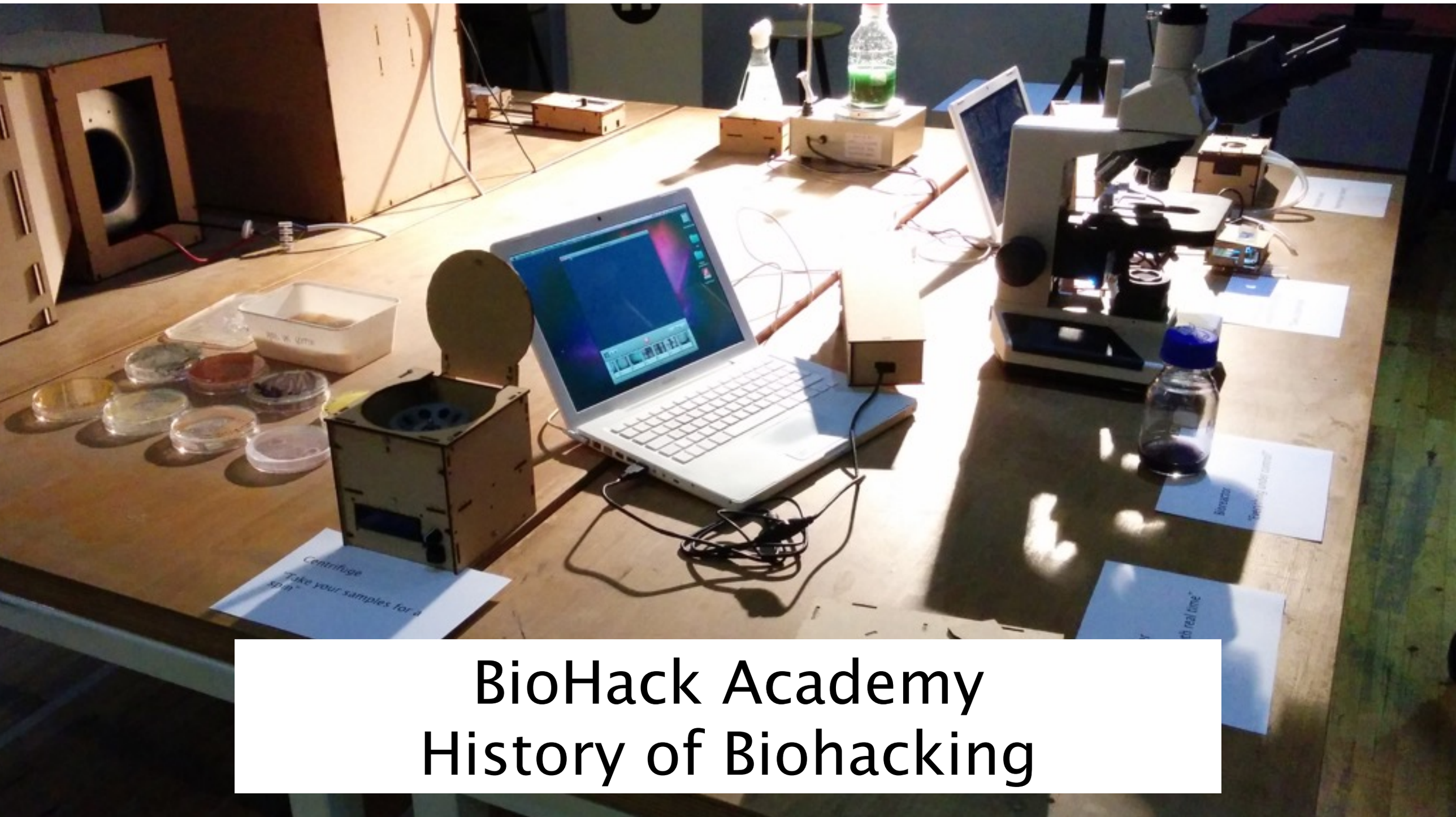
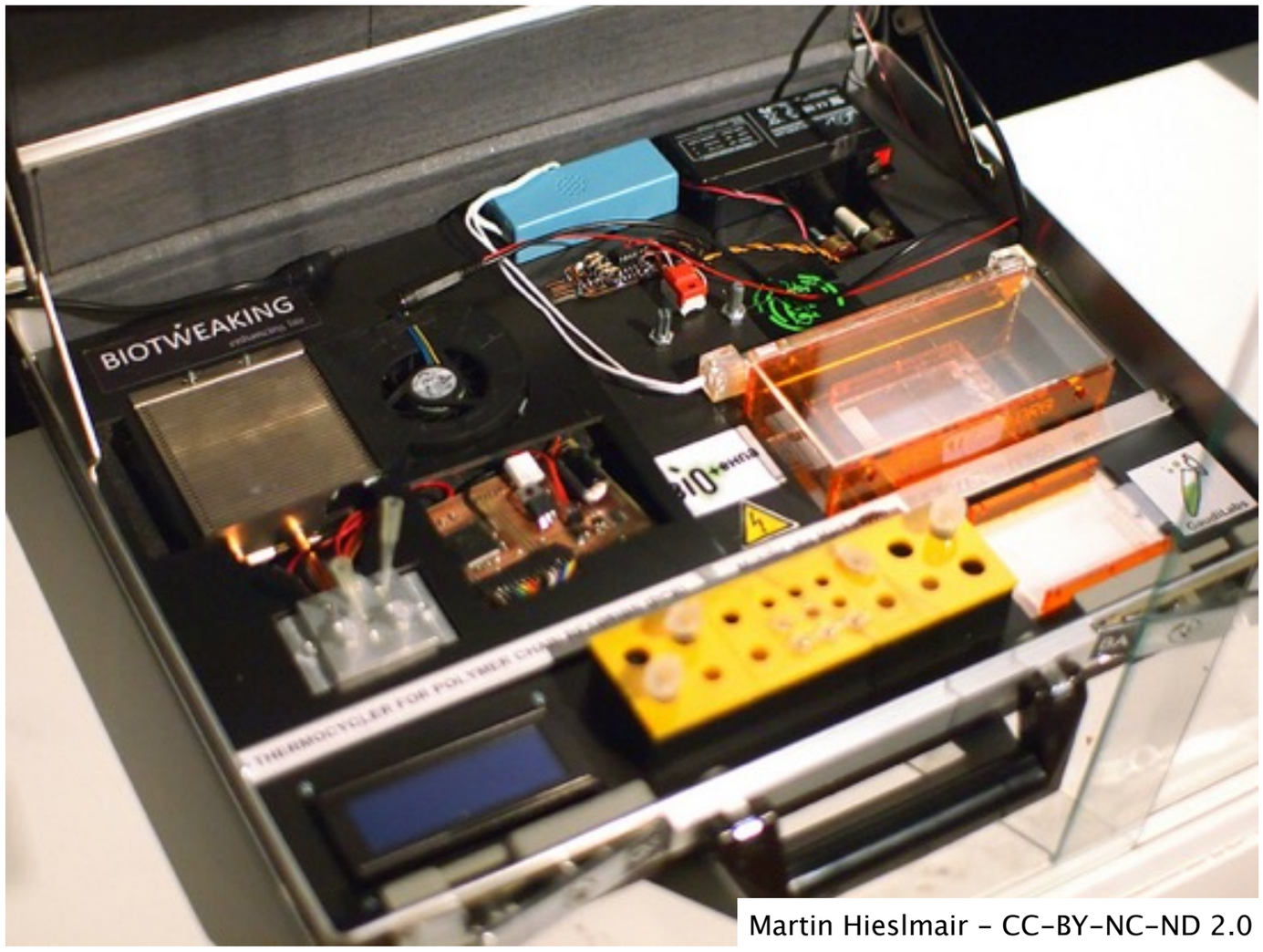
institute for art, science and technology



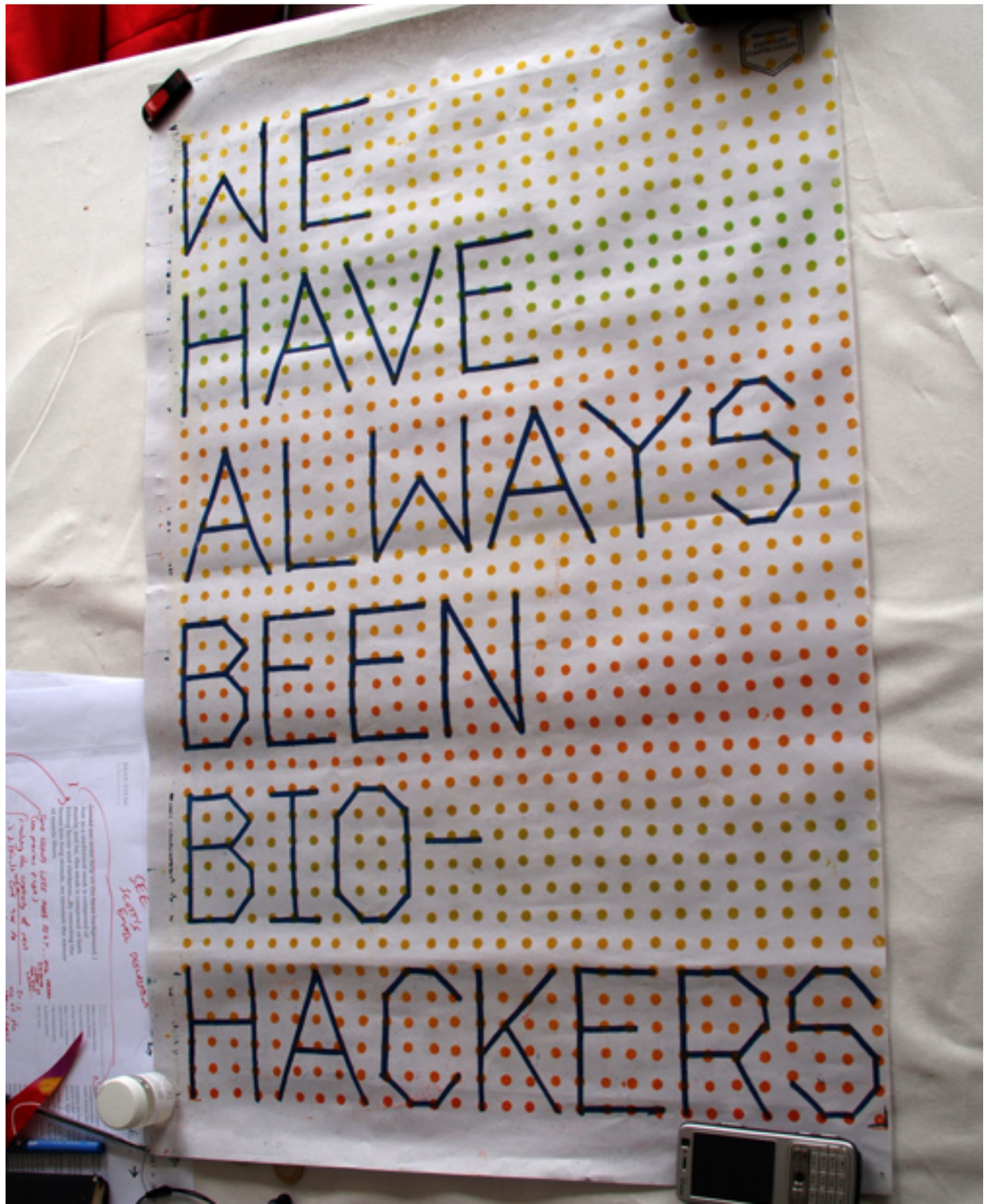
BioHack Academy
History of Biohacking

What it means to be a hacker

- Create & Share
- Freedom of inquiry
- Hostility to secrecy
- Sharing as ideology and strategy
- The right to fork
- Emphasis on rationality
- Distaste of authority
- Playful cleverness

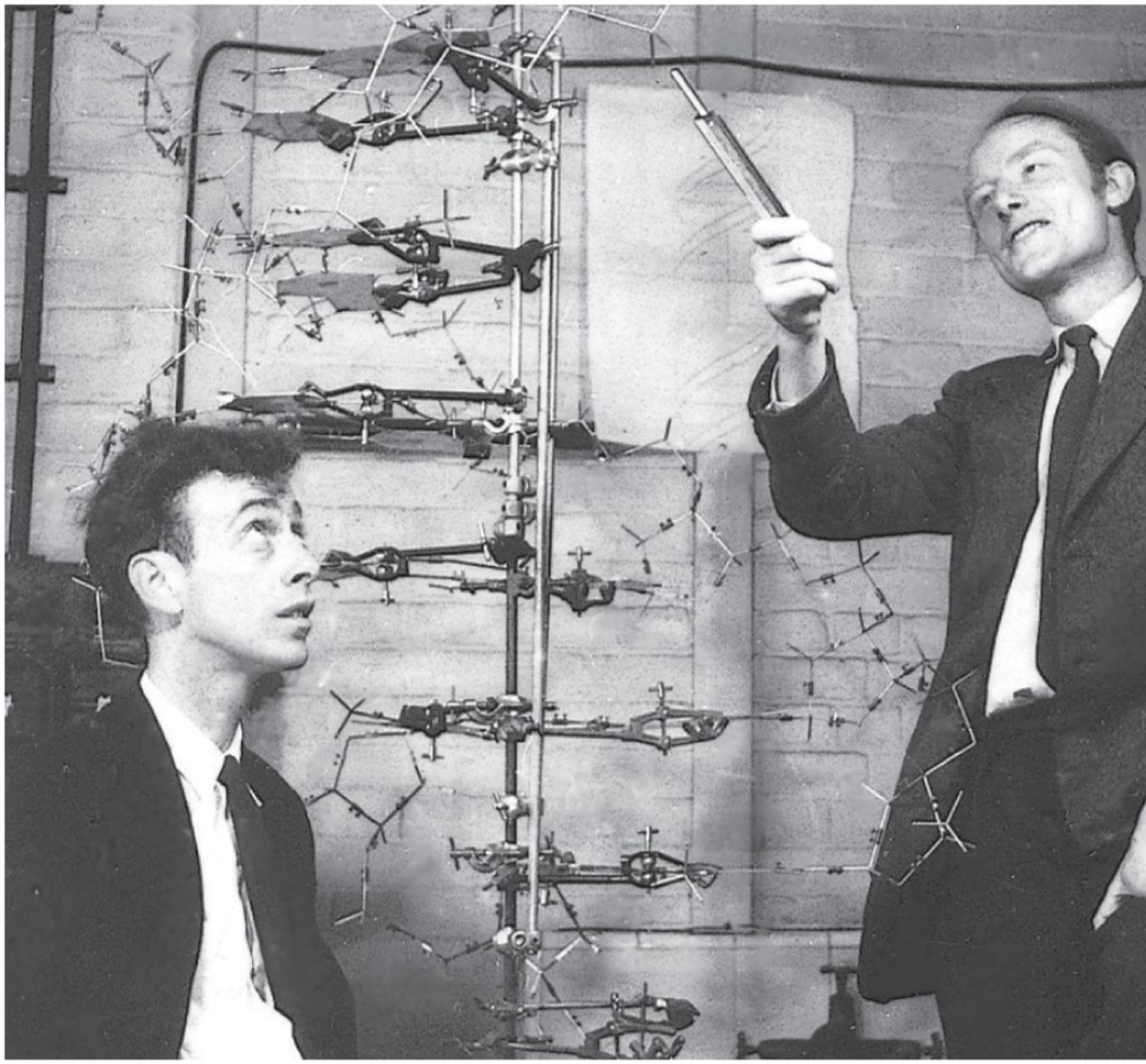


We have always been biohackers

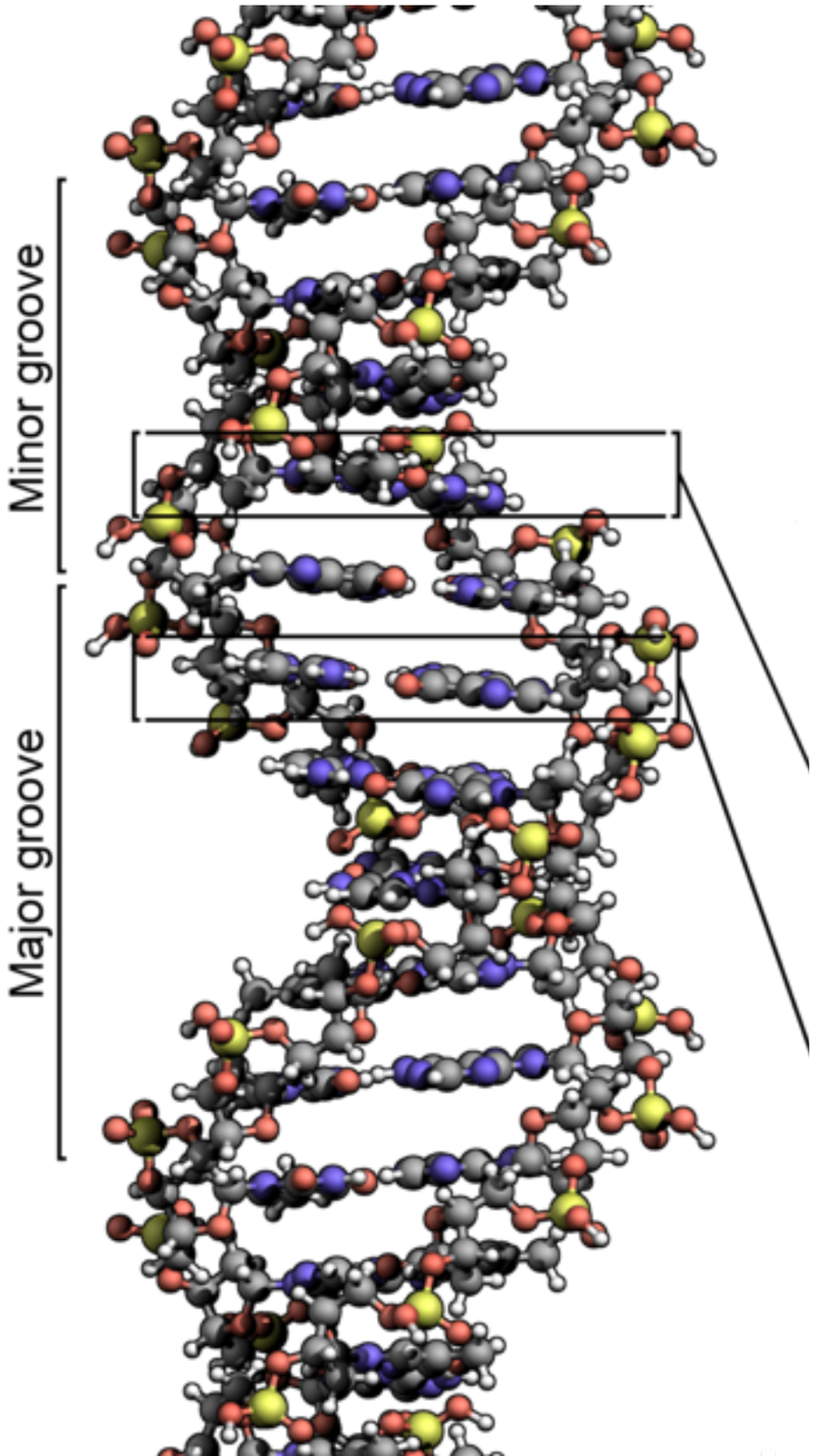


Center for Genomic Gastronomy

Discovery of Double Helix 1953



DNA Molecule



Living code:

AACATGACCTGACGA

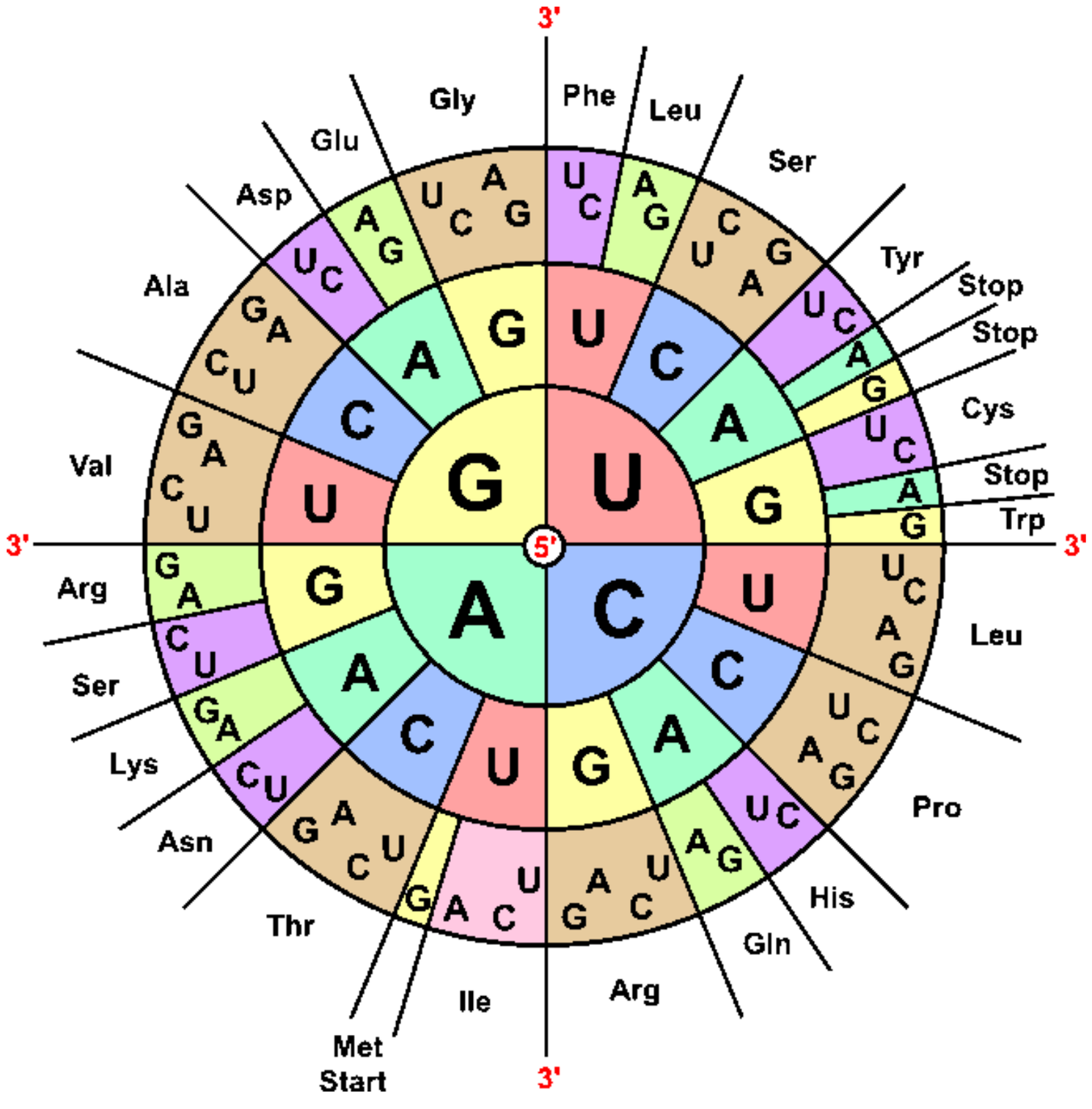
Digital code:

1001010011101010101010101010
0101010100101010100101010110
1101111001

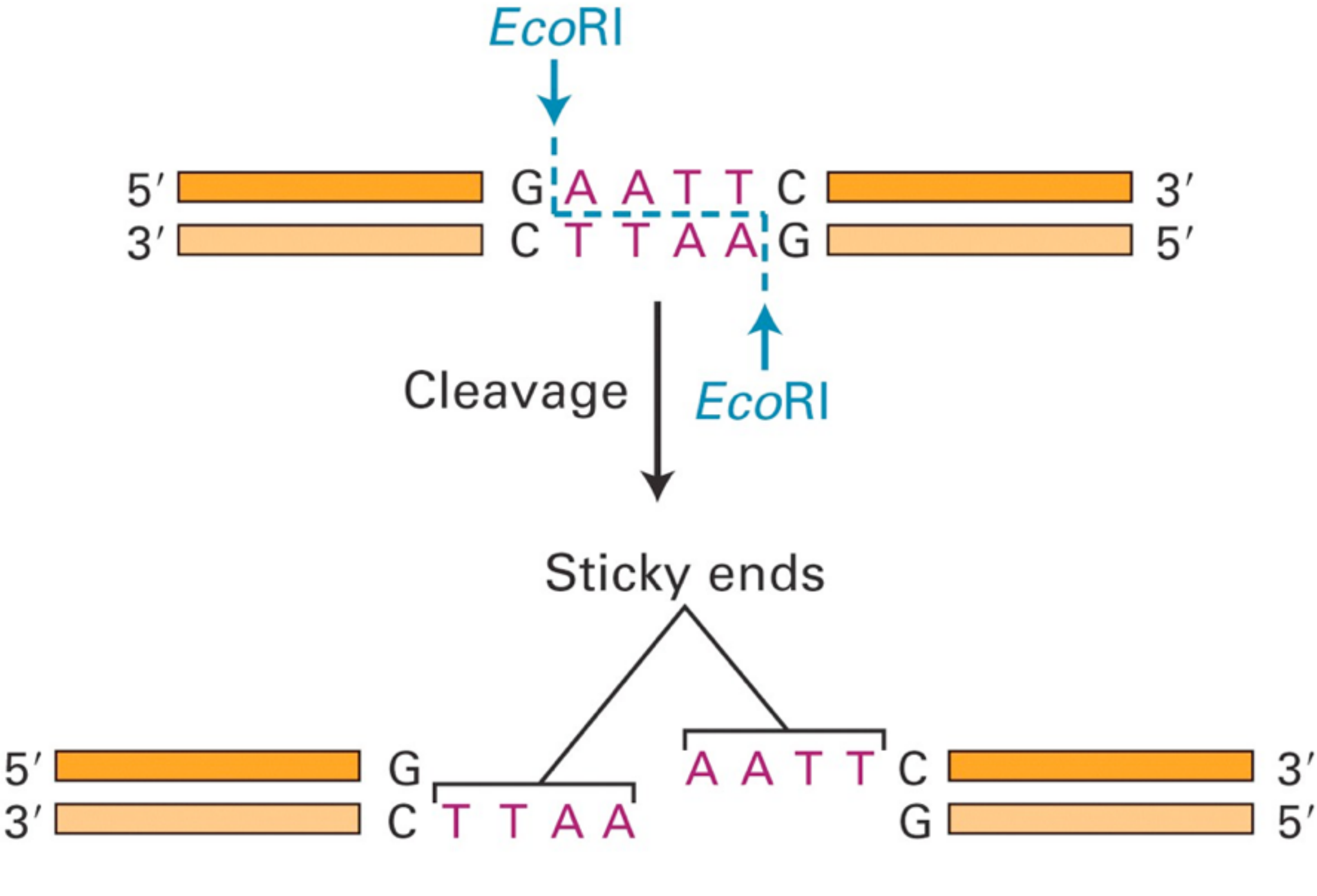
Robert W. Holley, Marshall Nirenberg, Har Gobind Khorana 1968

Nobel Foundation

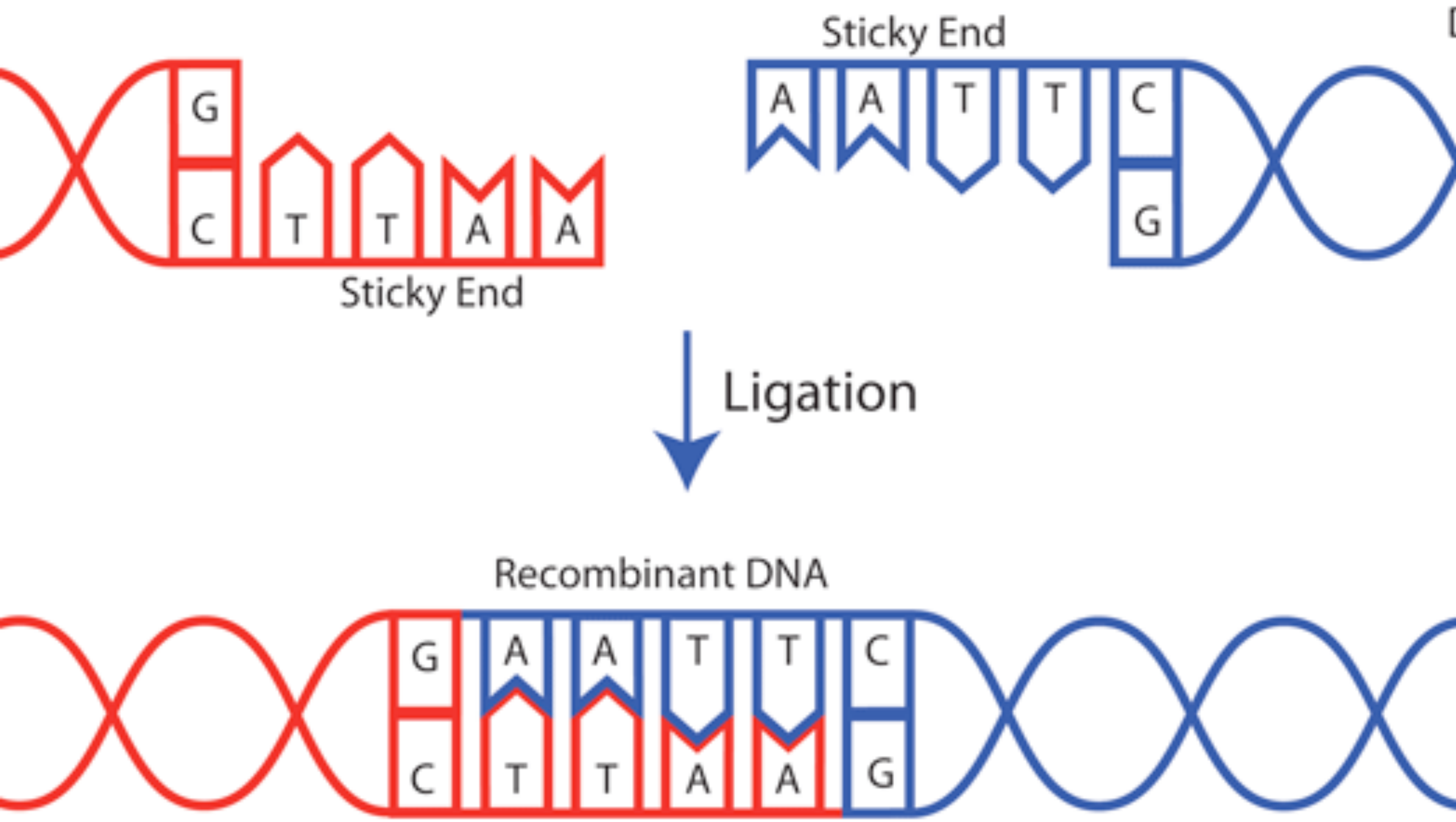
Amino acid rosetta stone



Restriction Enzyme 1970



DNA ligase, 1967



Reading DNA 1977

Courtesy of Dr. F. Sanger, MRC, Cambridge.
Noncommercial, educational use only.

Different-length strands can be lined up by size to determine DNA sequence.

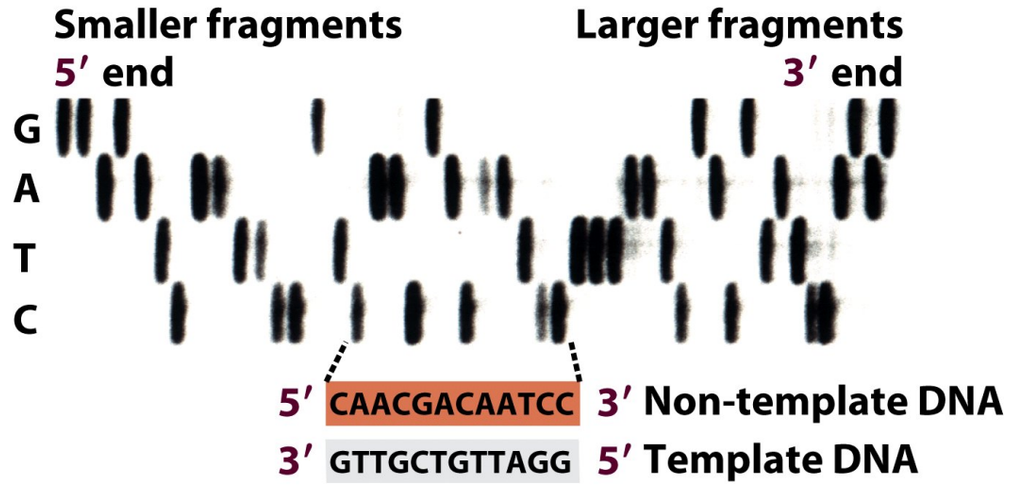
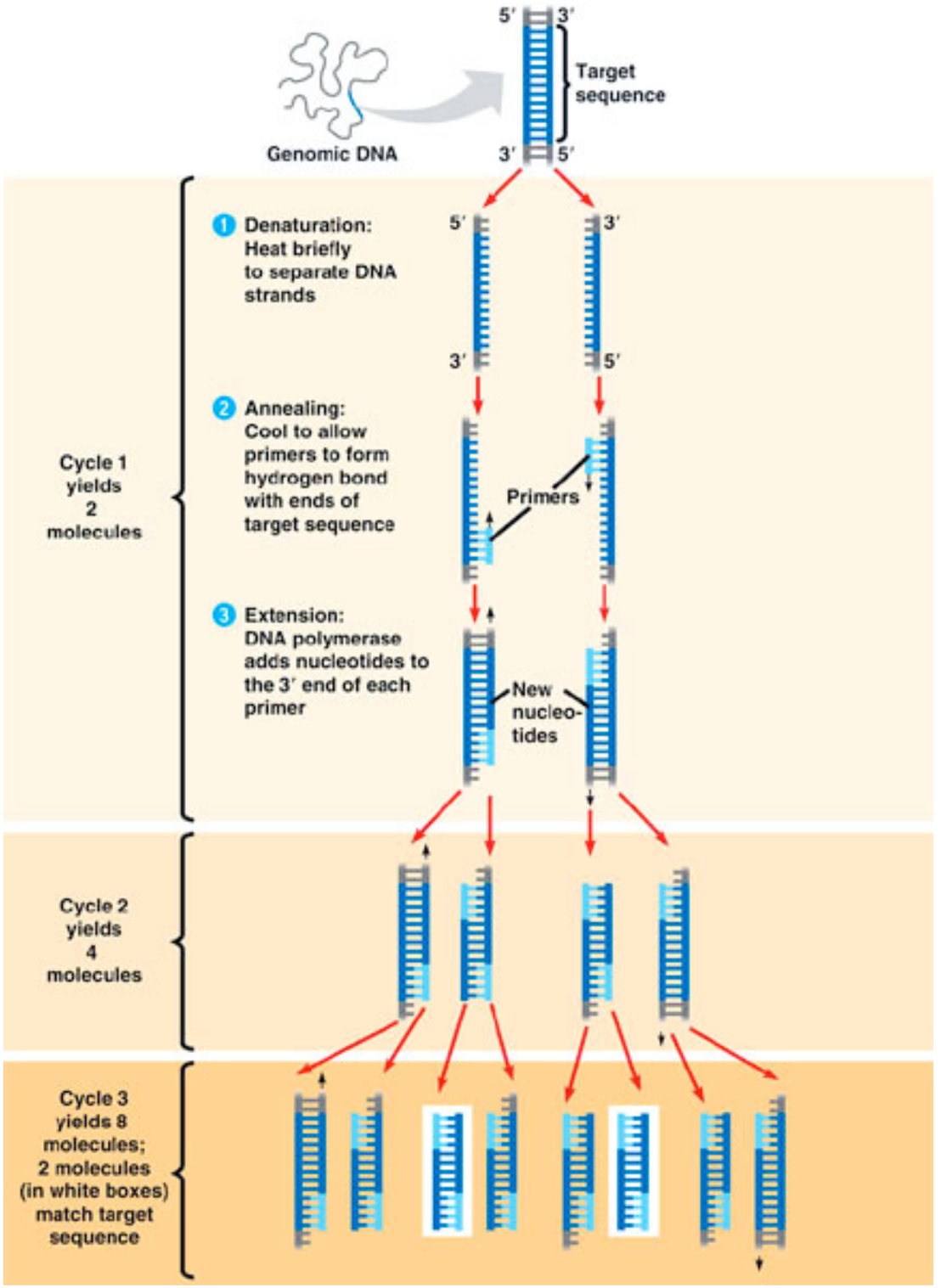


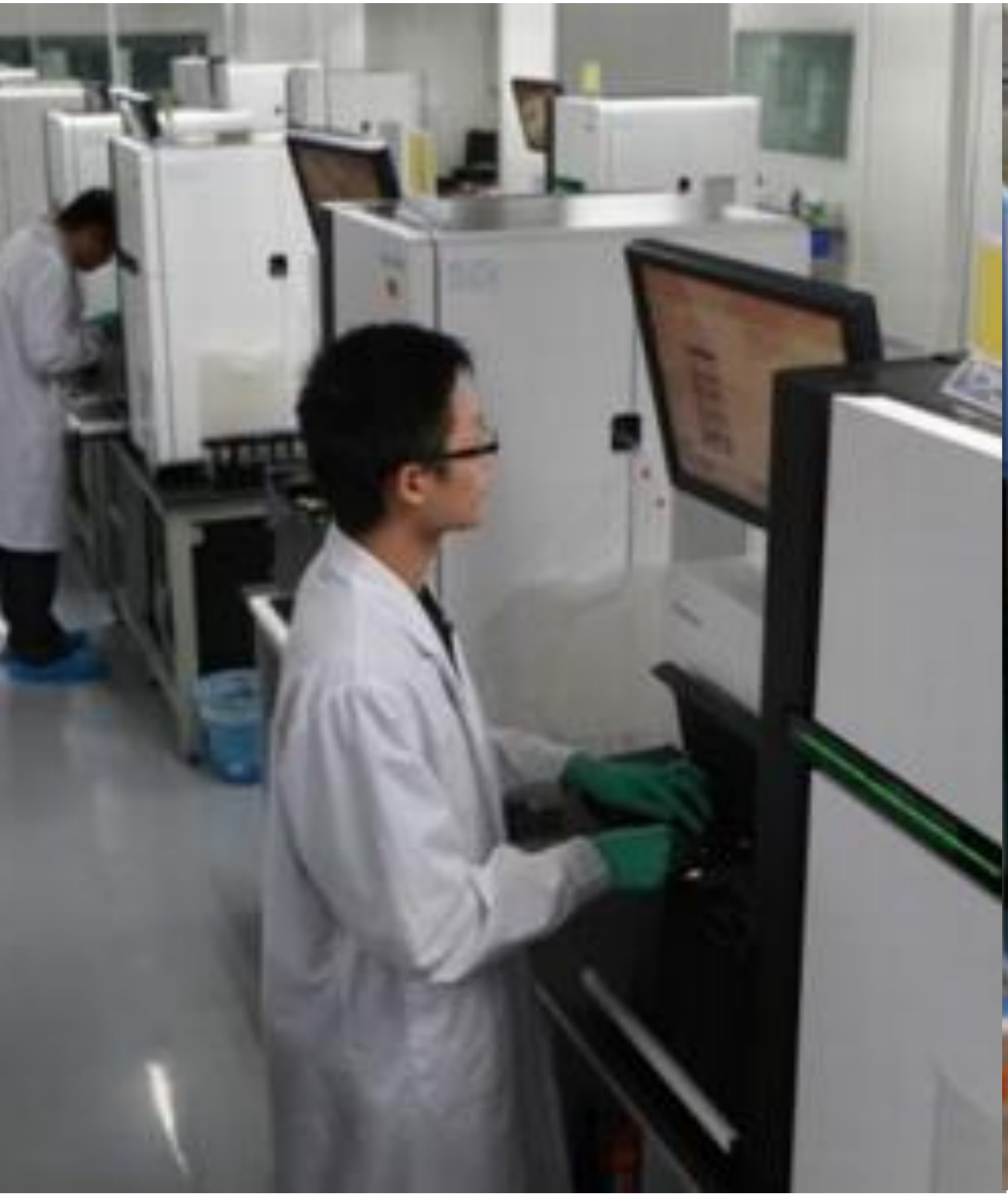
Figure 19-6c Biological Science, 2/e

Polymerase Chain Reaction, 1983

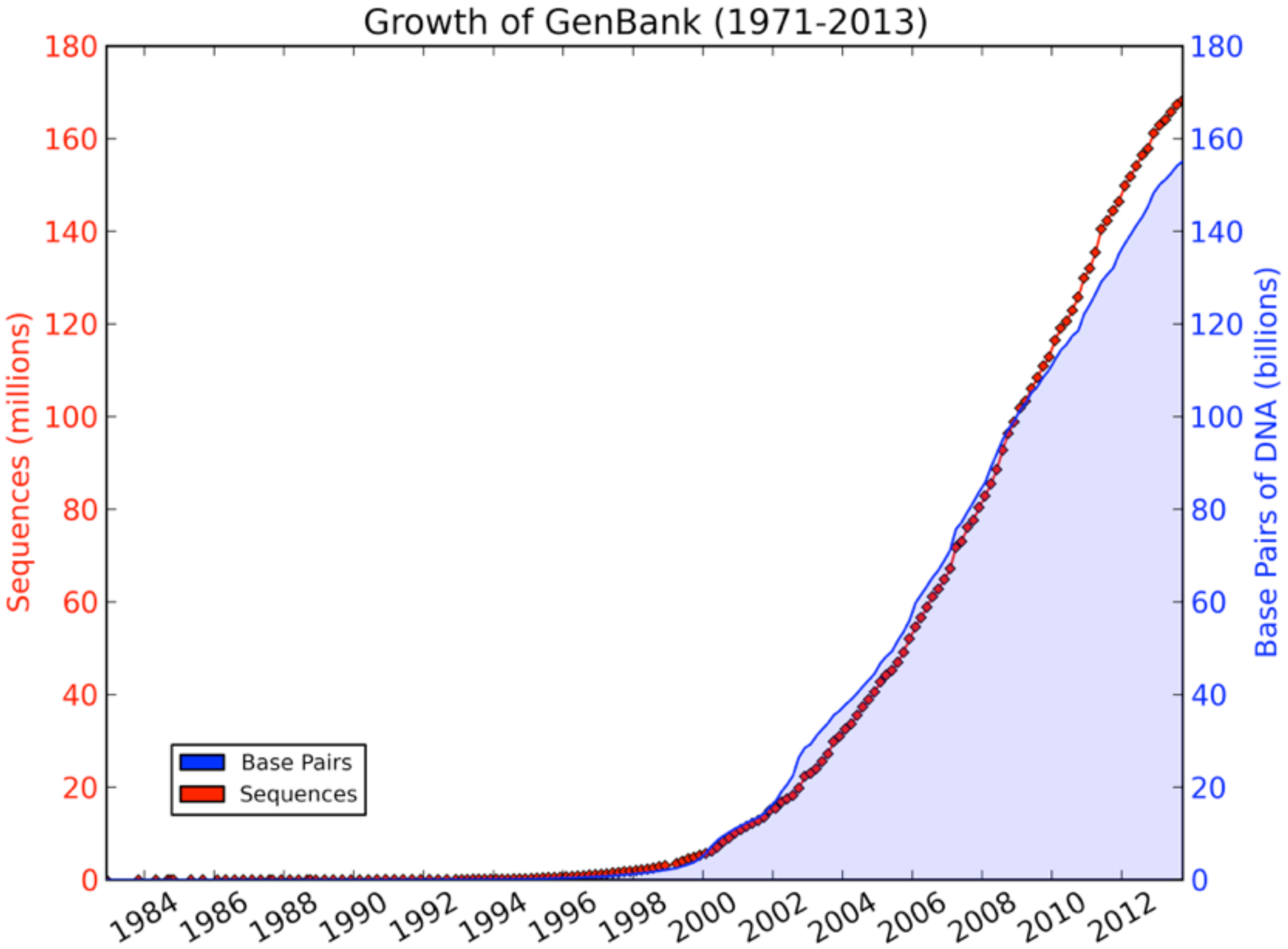


Reading DNA 2014

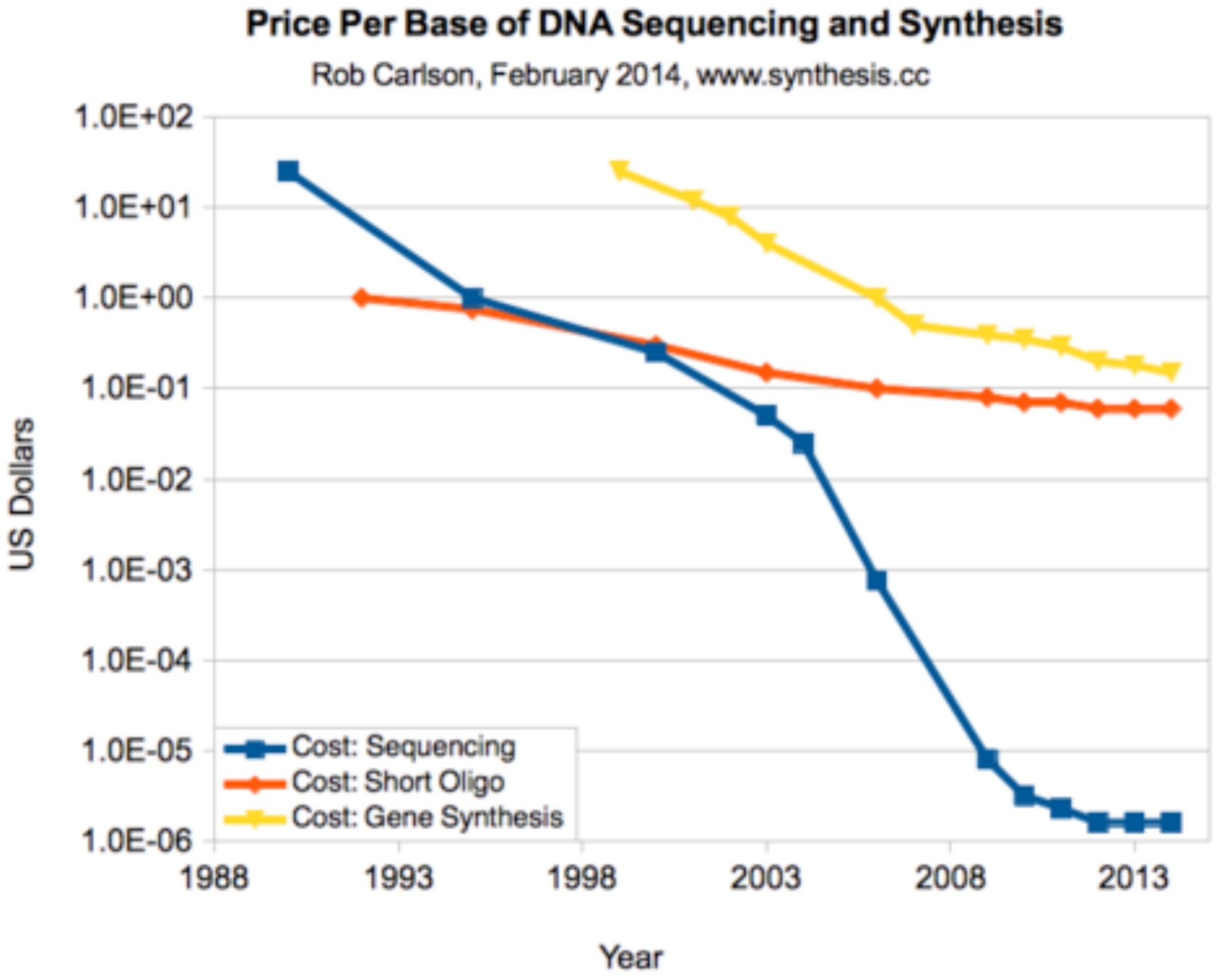
Bejing Genomics Institute



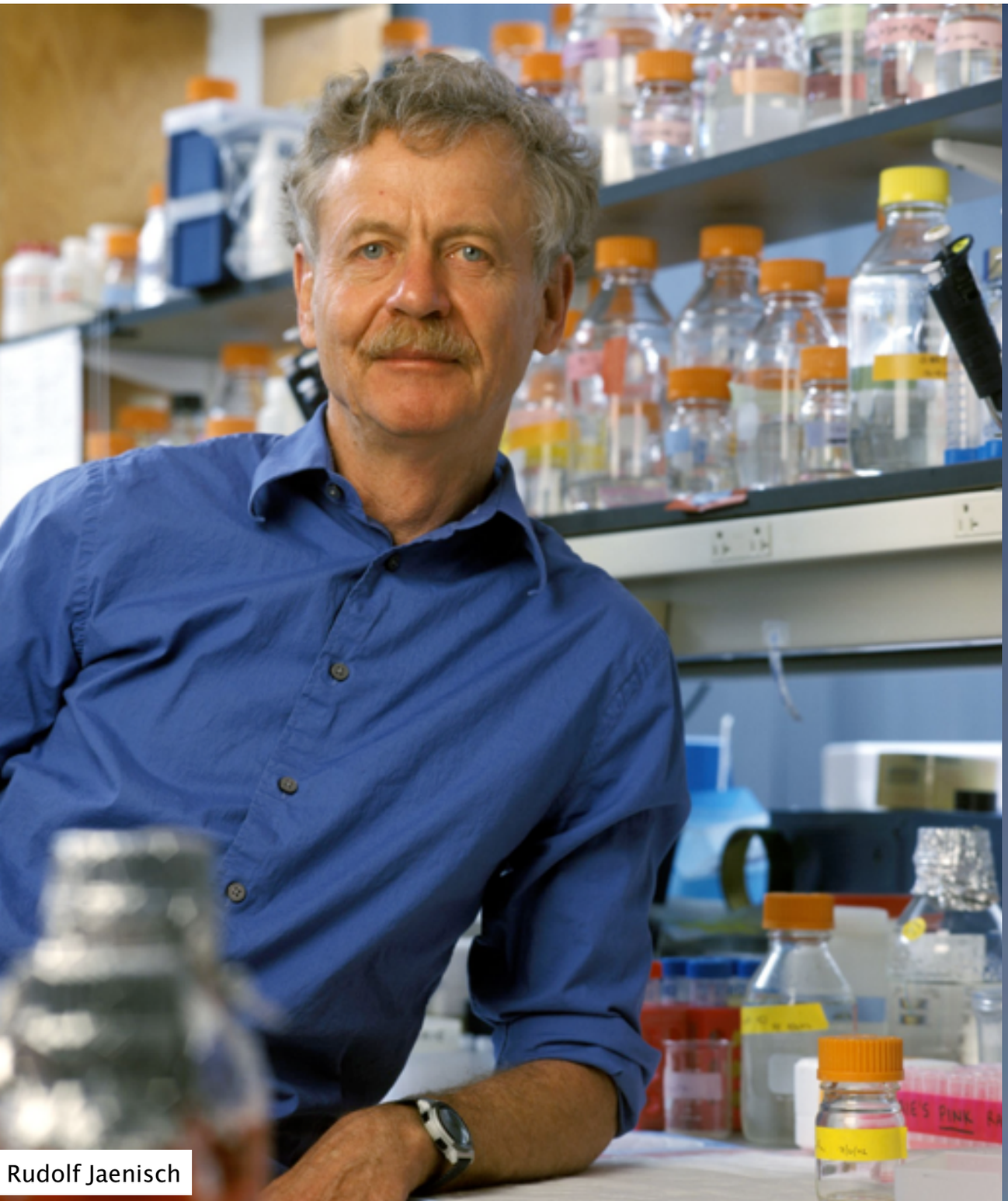
Growth of Genbank



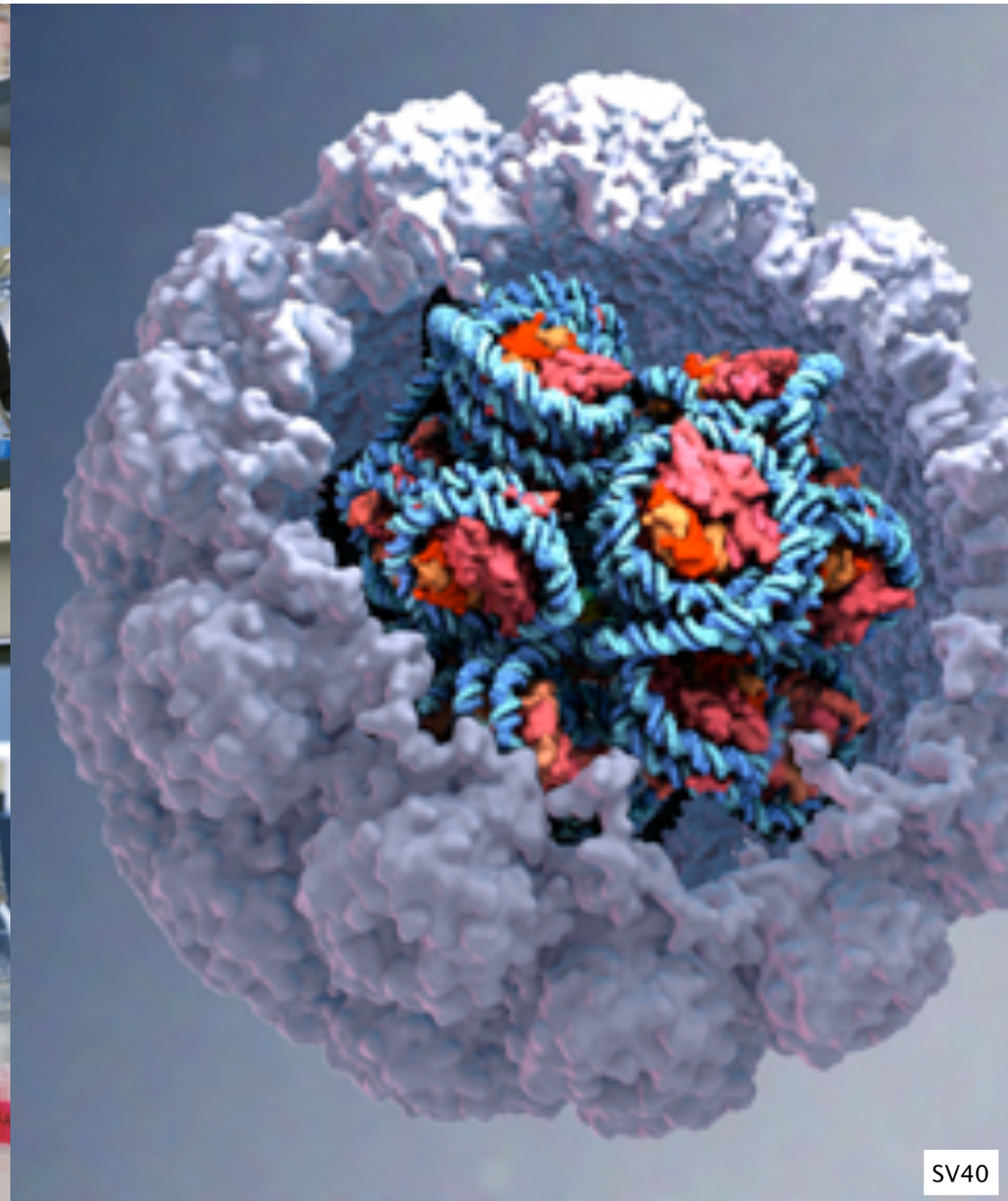
Cost of DNA


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
1988
1993
1998
2003
2008
2013
Year
Cost: Sequencing
Cost: Short Oligo
Cost: Gene Synthesis

Transgenic Mouse, 1973



Rudolf Jaenisch



SV40

Transgenic Plant, 1983

letters to nature

Nature **304**, 184 - 187 (14 July 1983); doi:10.1038/304184a0

A chimaeric antibiotic resistance gene as a selectable marker for plant cell transformation

MICHAEL W. BEVAN*, RICHARD B. FLAVELL* & MARY-DELL CHILTON†

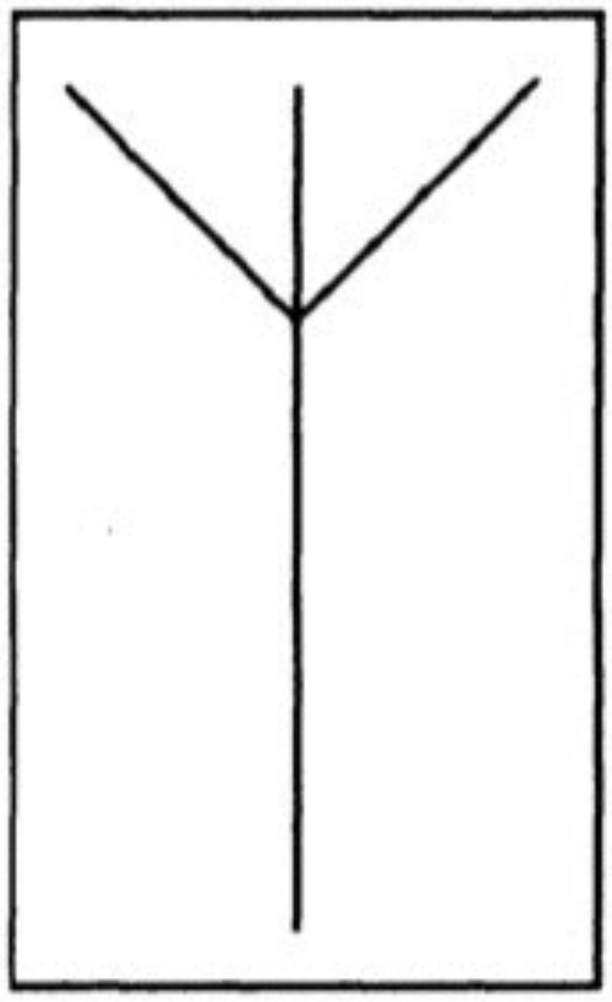
*Plant Breeding Institute, Maris Lane, Trumpington, Cambridge CB2 2LQ, UK
†Department of Biology, Washington University, St Louis, Missouri 63130, USA

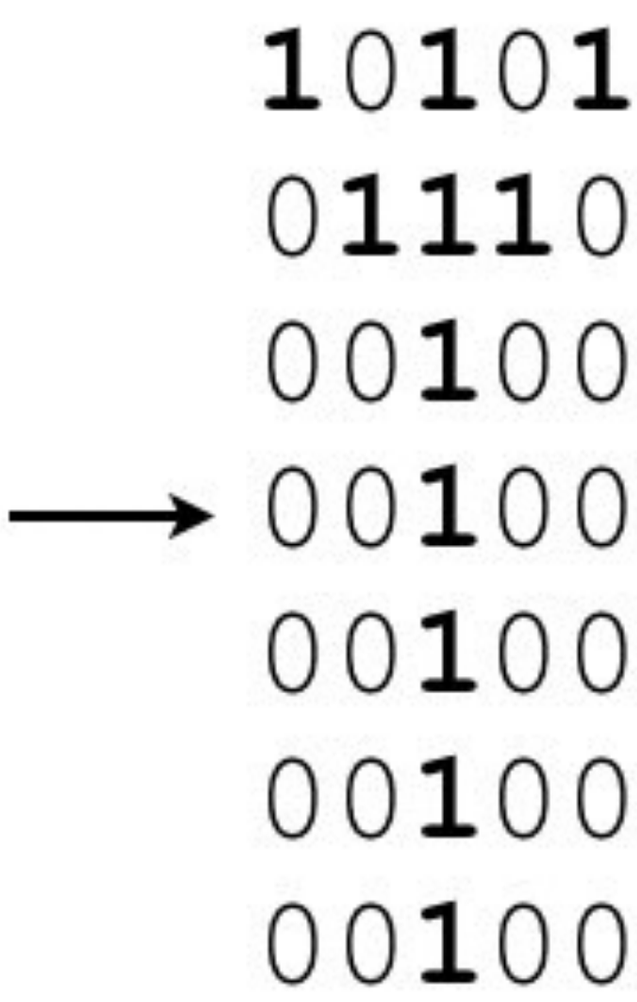
The T-DNA region of *Agrobacterium tumefaciens* tumour-inducing plasmids of the nopaline type[1] contains a gene coding for the enzyme nopaline synthase. This gene is expressed constitutively in host plant cells to which it is transferred during tumour induction[2]. We have exploited the regulatory elements of this gene to construct a chimaeric gene that confers antibiotic resistance on transformed plant cells. The chimaeric gene encodes the expected chimaeric transcripts in plant cells, and confers on transformed cells the ability to grow in the presence of normally lethal levels of the antibiotic G418 (ref. 3). Experiments using *in vitro* transformation techniques on single plant cells indicate that this antibiotic resistance can be used as a selectable marker, and can therefore be used in selecting cells transformed by T-DNA vectors that have had the genes for hormone autotrophy deleted[4]. Plant cells transformed by such 'disarmed' T-DNA vectors can be regenerated into entire plants, whose sexual progeny contain unaltered copies of the inciting T-DNA[5]. The availability of this dominant selectable marker should allow a wider range of experiments to be under taken using different host plants.

References

Oncogene mouse, Phil Leder, Tim Stewart 1984

Joe Davis, 1987





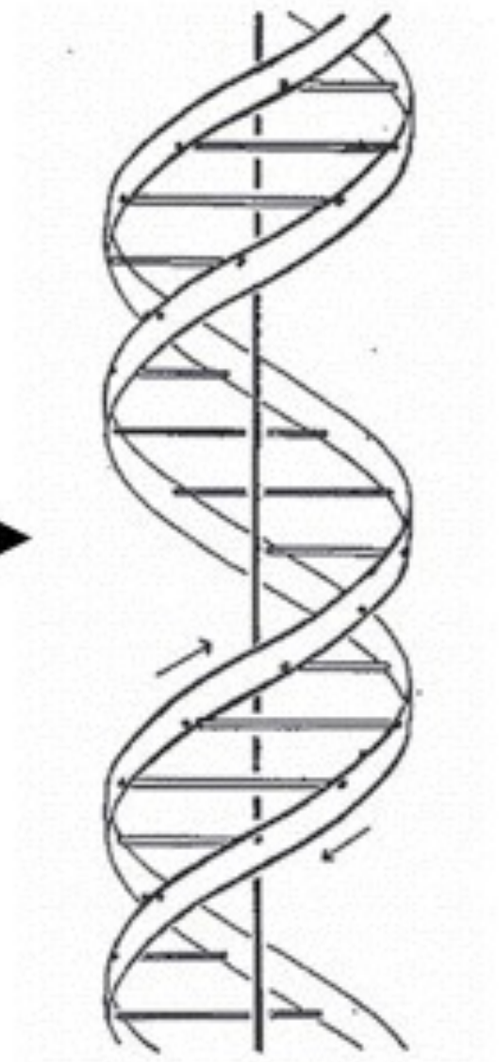


FIG. 1 *Microvenus* icon.

CCCCCCAACGCGCGCGCT

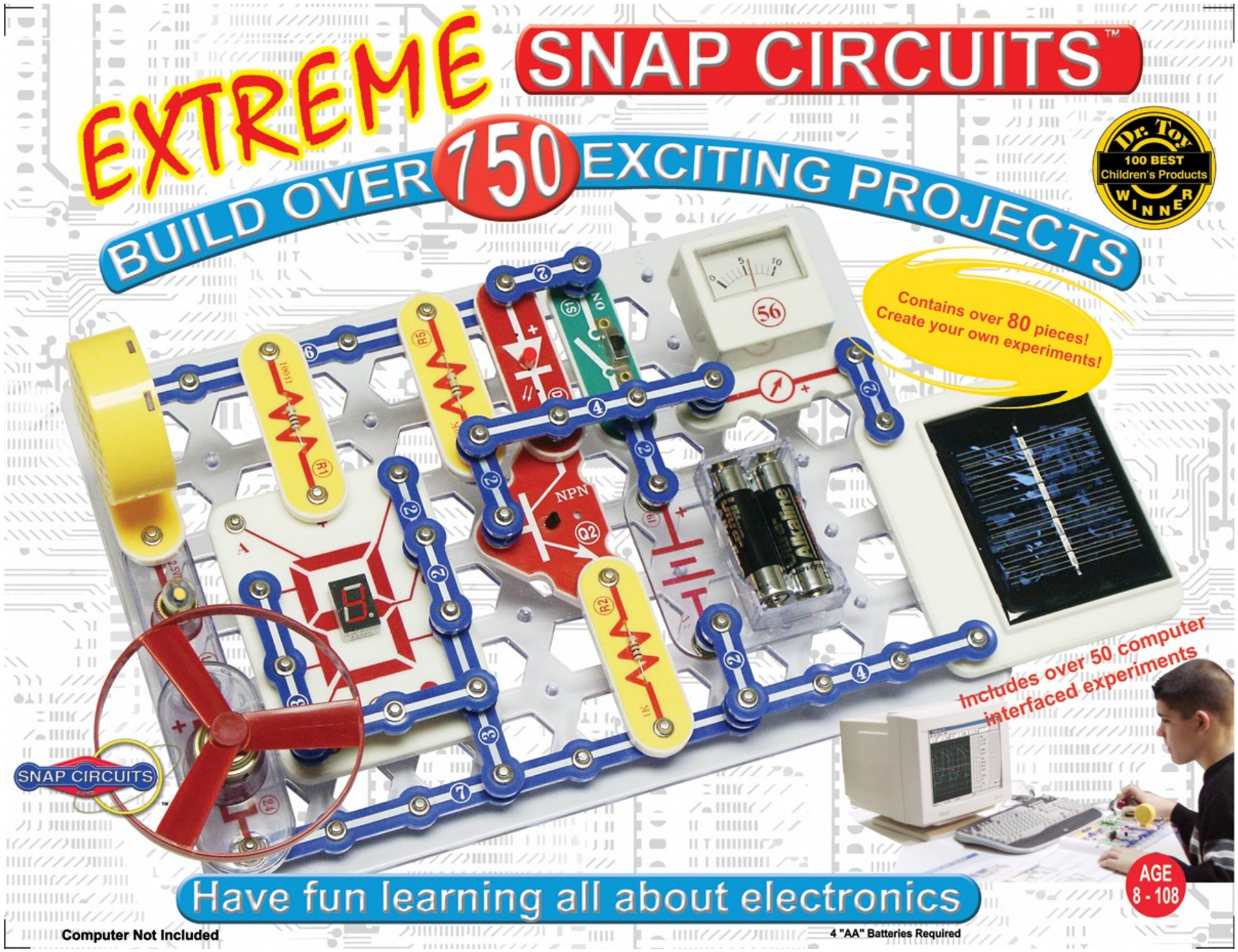
Bull Herman, Leiden 1990

Life finds a way, Jurassic Park 1993

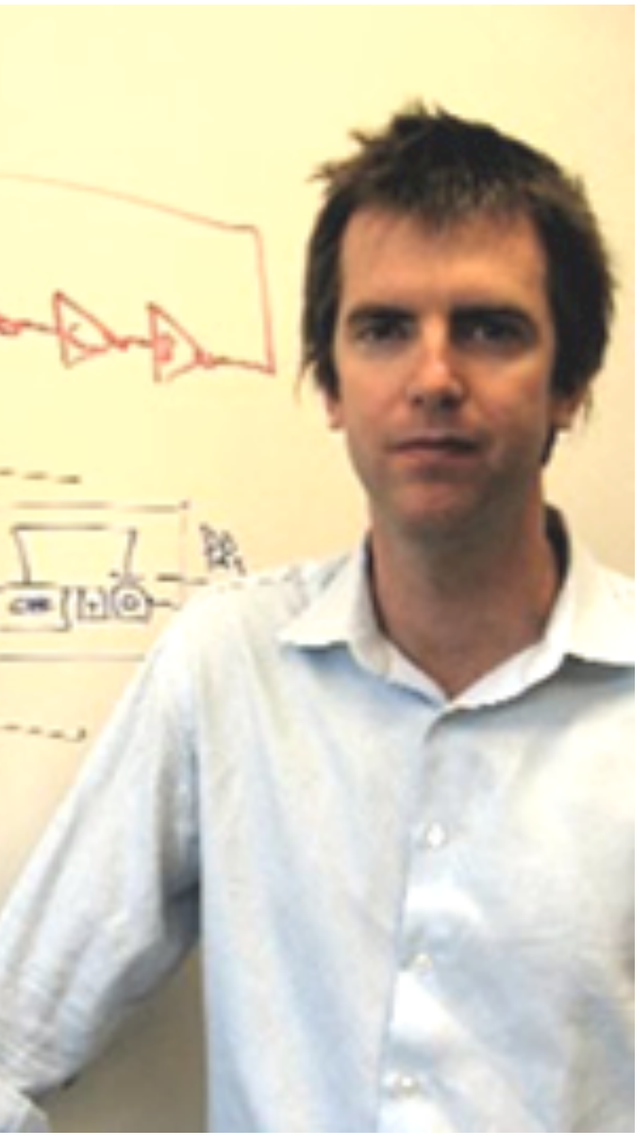
Dolly the Sheep, Edinburgh 1996

Eduardo Kac – GFP Bunny, 2000

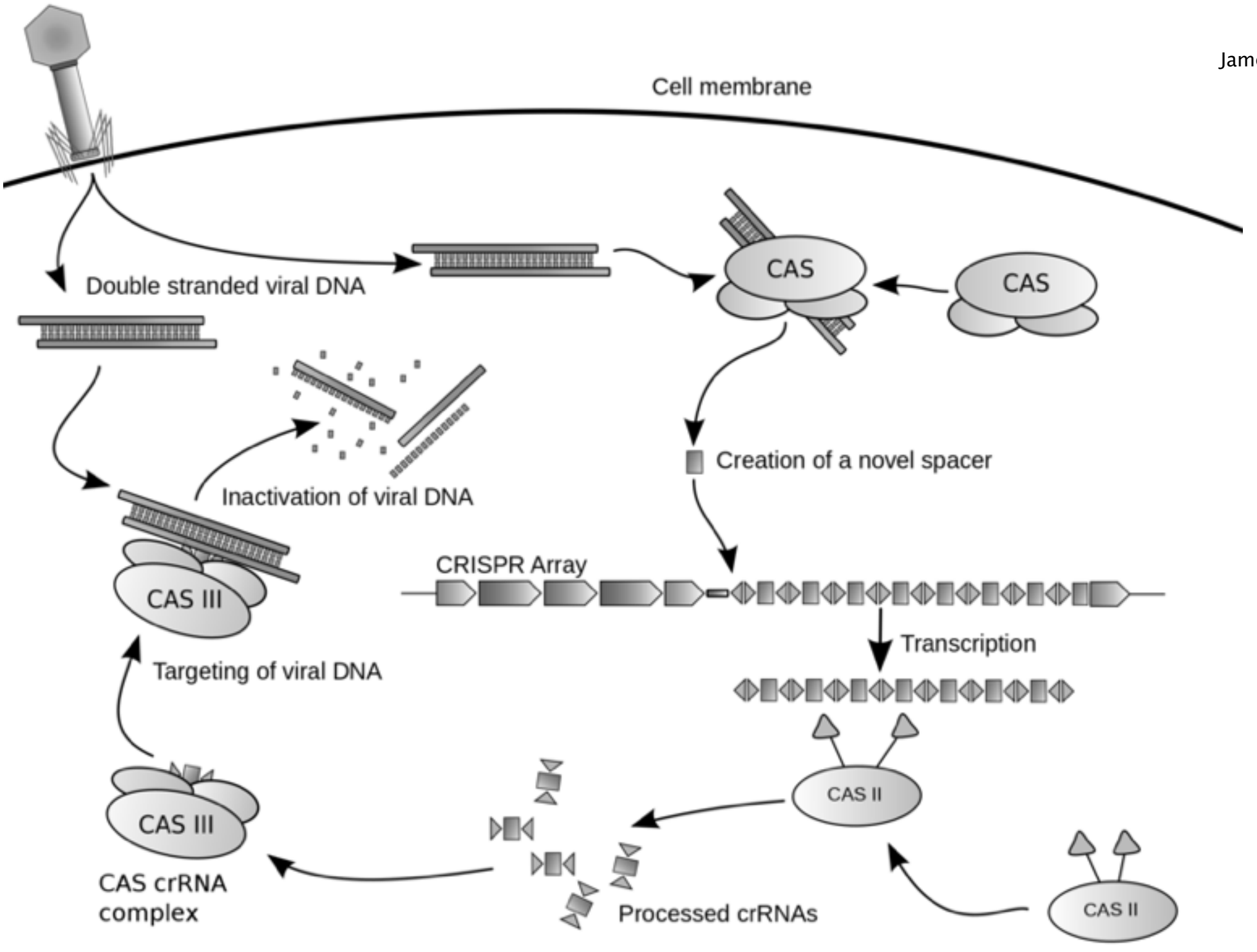
Science turned into technology



Drew Andy, Tom Knight



CRISPR - Cas9



Labs as a service

23andMe

μBiome

Personal Genome Project

www.personalgenomes.org

DNAFit®

ACHIEVE YOUR GENETIC POTENTIAL

Center for Postnatural History – Rich Pell

Conclusions

- Biology:
  - No longer framed by the possible
  - From study to engineering
  - Changing:
    - Value chains
    - Business models
    - Design process

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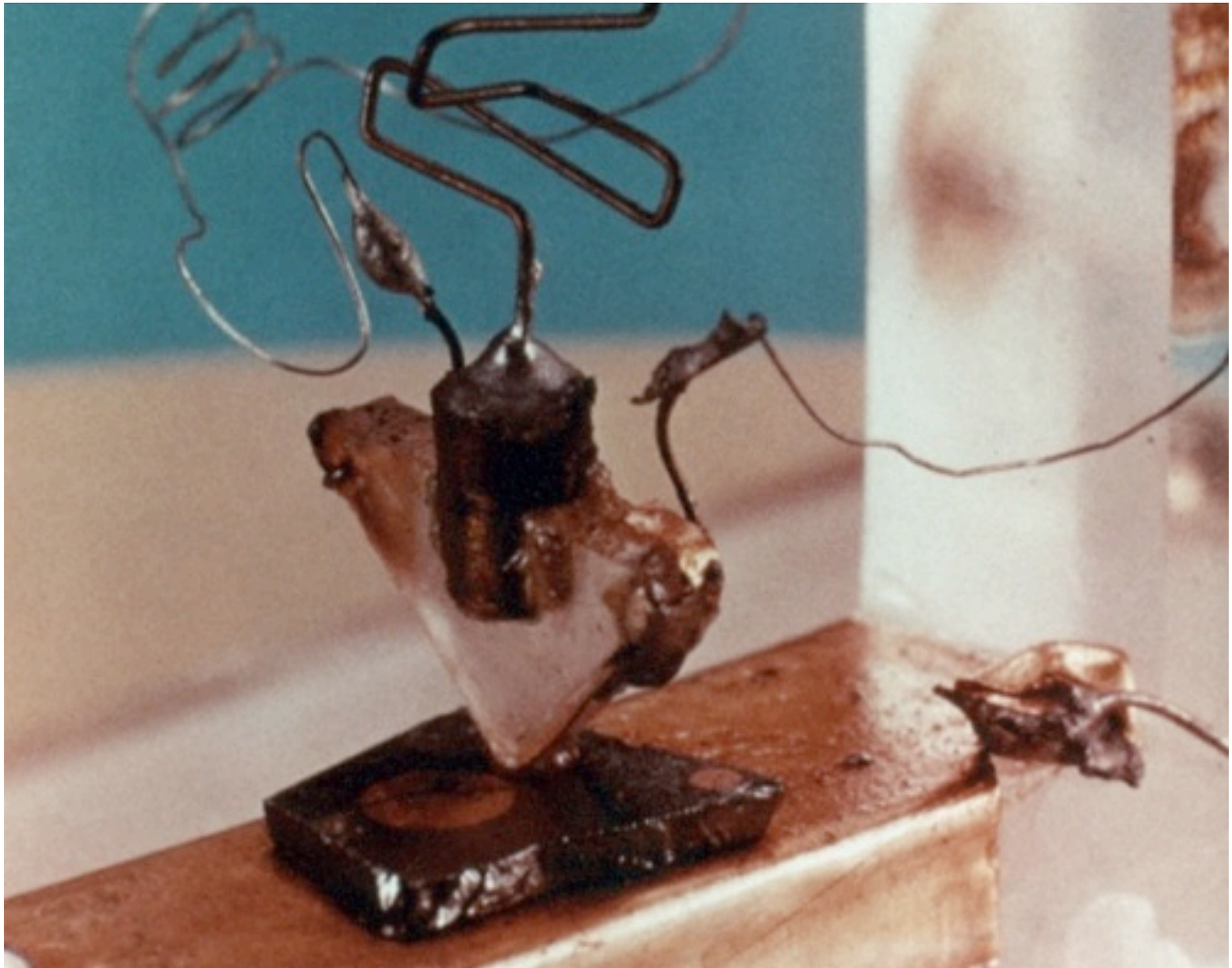
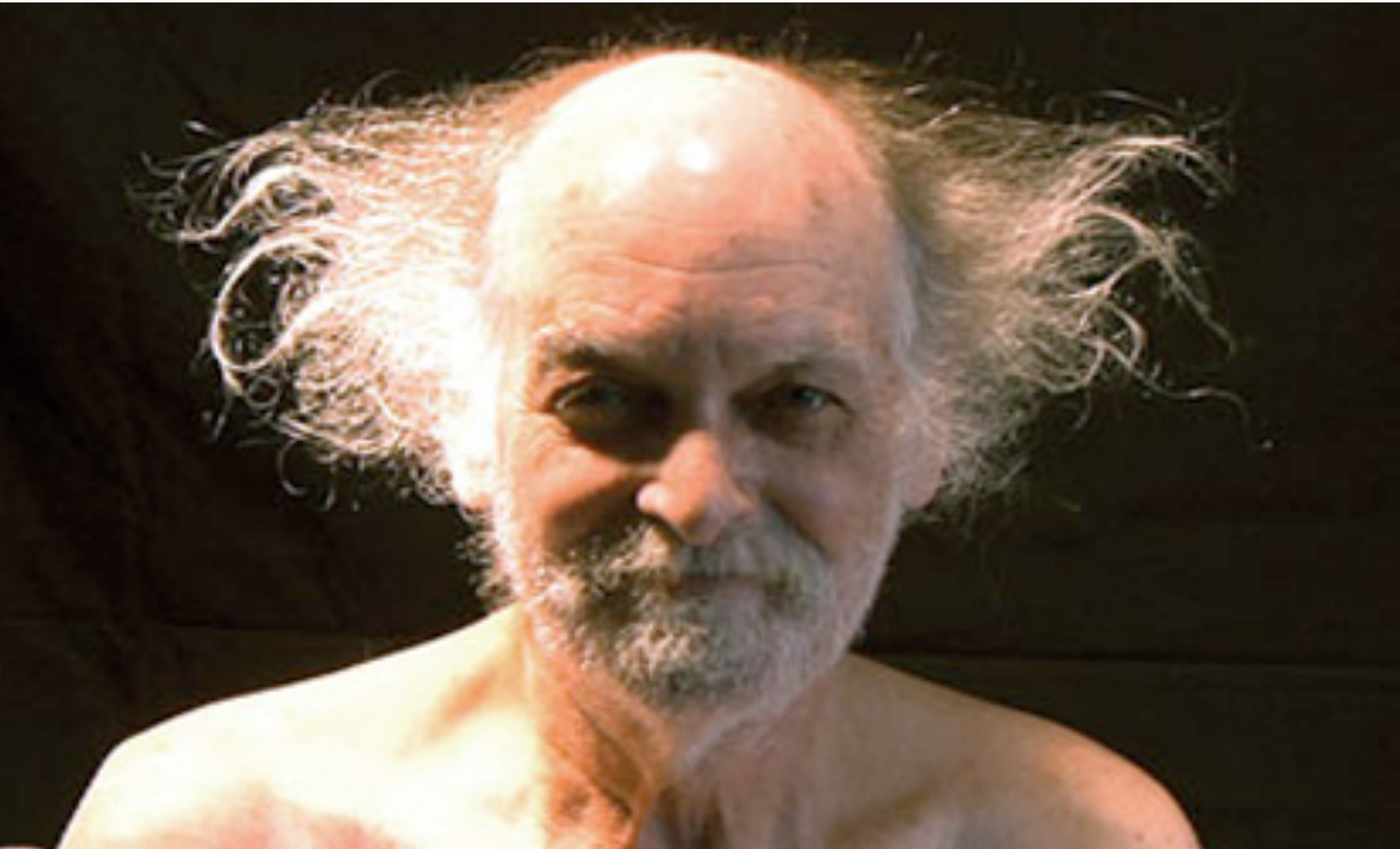
Biology & hacking

Inspiration & justification



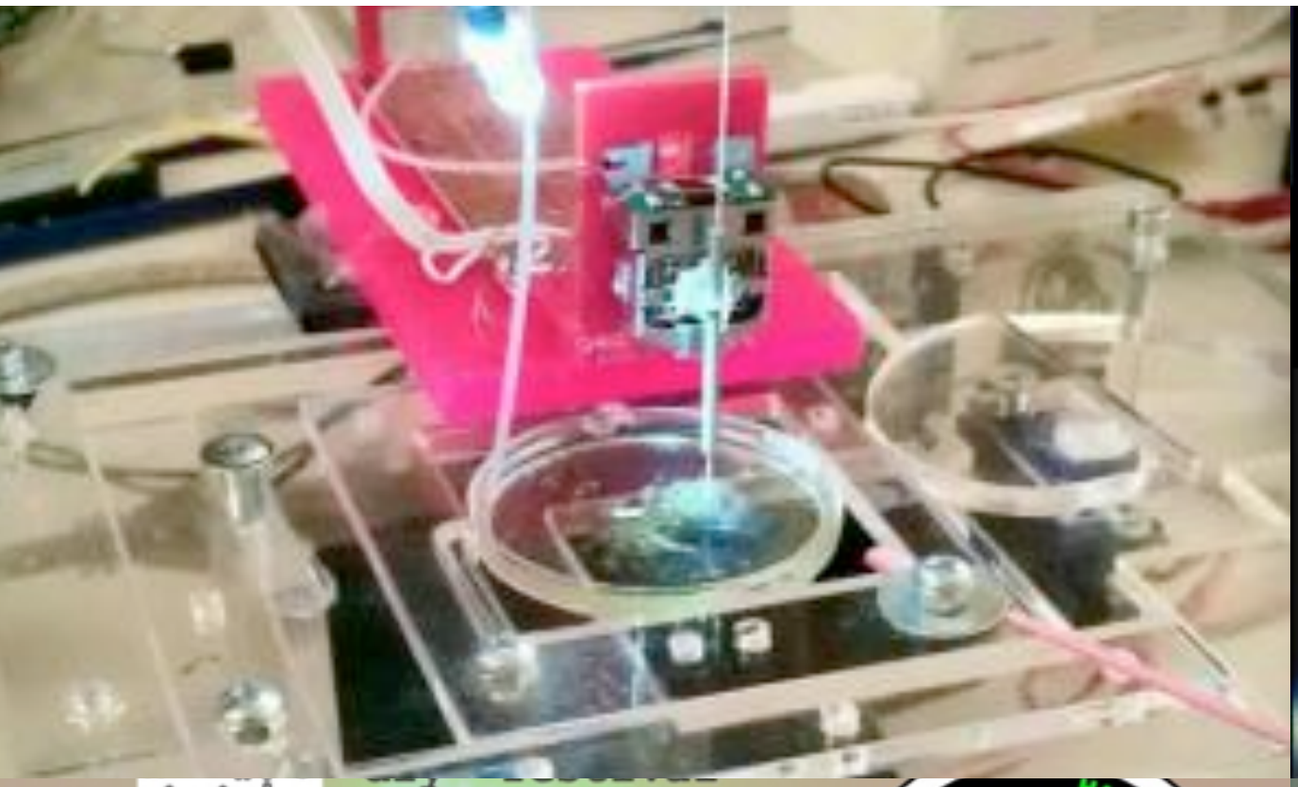
Joe Davis

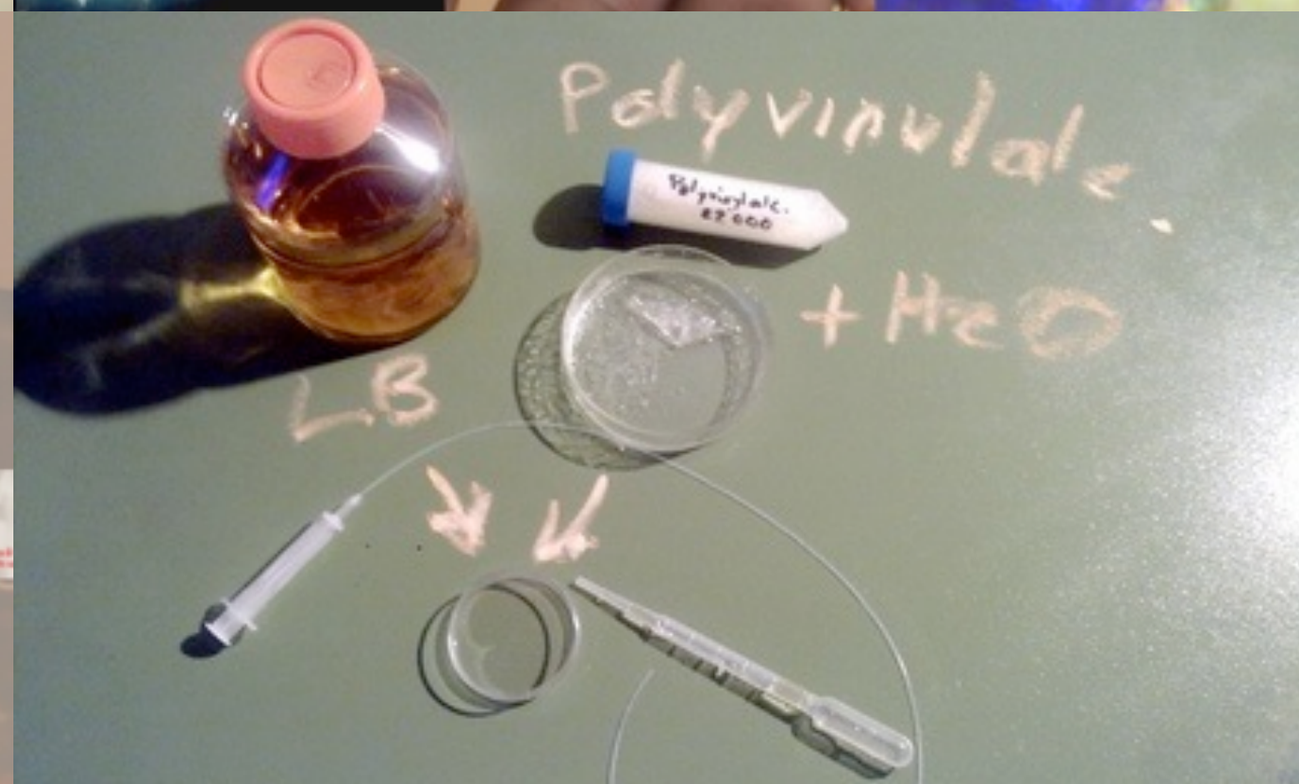


Critical Art Ensemble - Free Range Grain 2003

DIYBio 2008

Hackteria, 2009

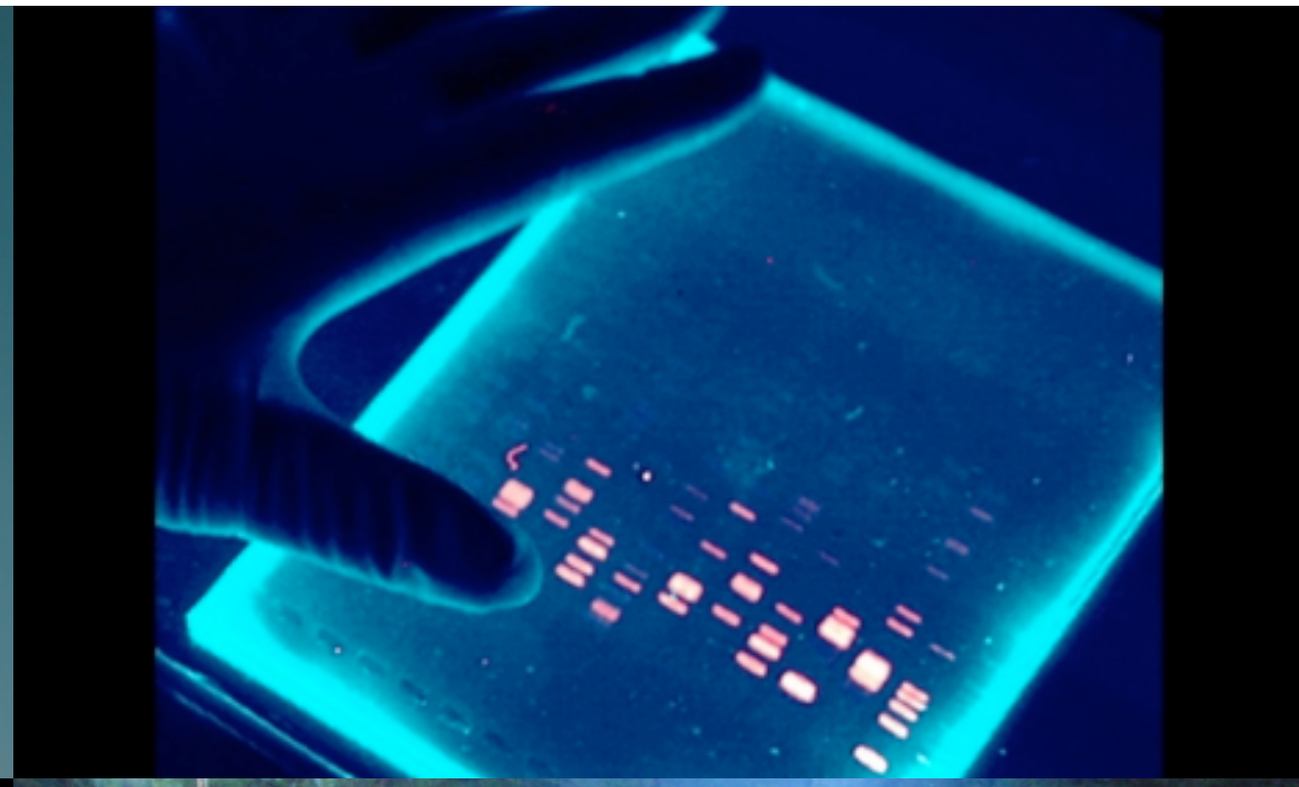


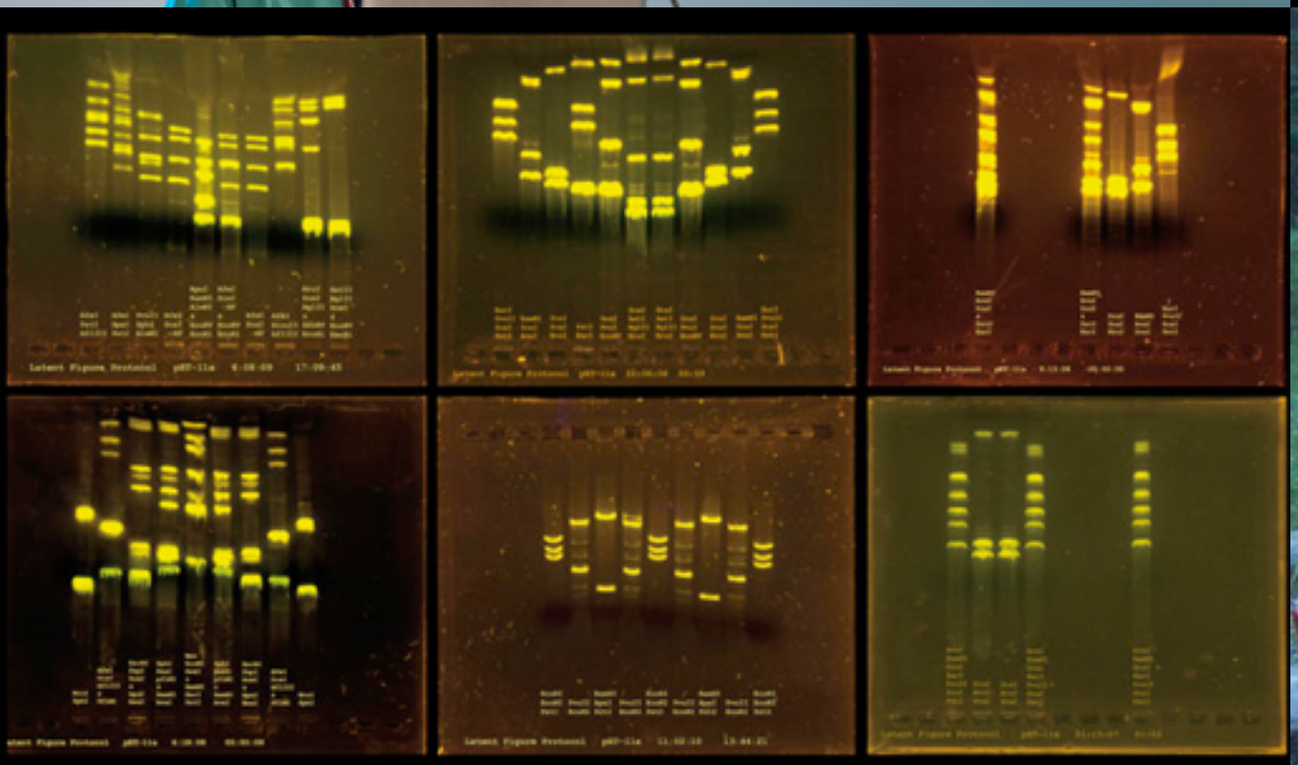


“We thought that a lot of the art and science stuff was too academic and not accessible to the geek artists and, at the same time, the DIYbio was too geeky and not critical or artistic enough,”

- Marc Dusseiller at Interactivos

Paul Vanouse 2009





Kay Aull

Ellen Jorgensen – Genspace 2010

Code of Ethics 2011

Transparency
Emphasize transparency and the sharing of ideas, knowledge, data and results.

Safety
Adopt safe practices.

Open Access
Promote citizen science and decentralized access to biotechnology.

Education
Help educate the public about biotechnology, its benefits and implications.

Modesty
Know you don’t know everything.

Community
Carefully listen to any concerns and questions and respond honestly.

Peaceful Purposes
Biotechnology must only be used for peaceful purposes.

Respect
Respect humans and all living systems.

Responsibility
Recognize the complexity and dynamics of living systems and our responsibility towards them.

Accountability
Remain accountable for your actions and for upholding this code.

Meredith Patterson

Biopunk Manifesto 2011

“we assert that the right of freedom of inquiry, to do research and pursue understanding under one's own direction, is as fundamental a right as that of free speech or freedom of religion”

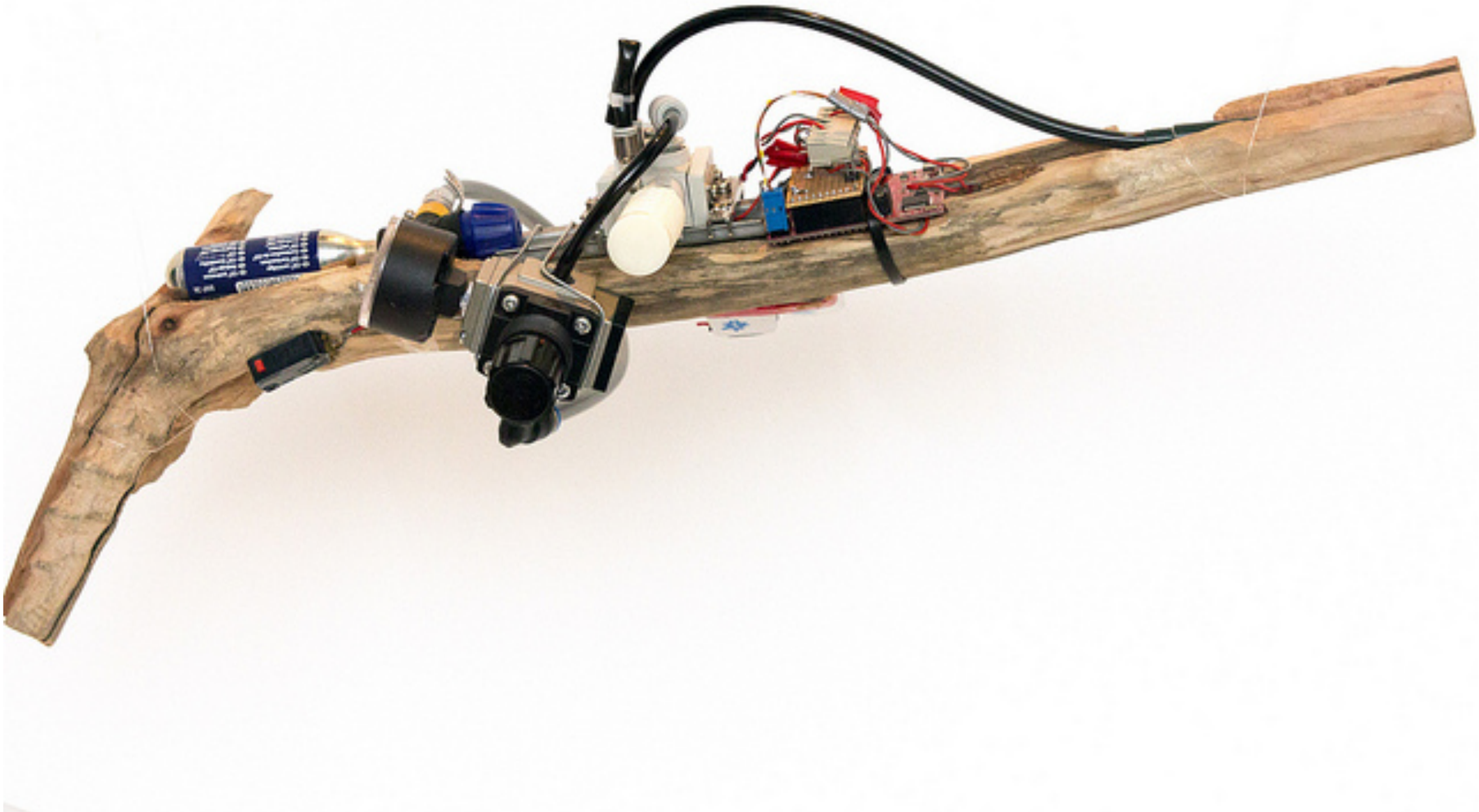
Cathal Garvey, Ireland 2012

Doing Biotech in My Bedroom

A new generation of biologists embraces the do-it-yourself ethic of computer programming.

By Antonio Regalado on February 14, 2012 View full report Download Purchase a print copy

DIY GeneGun 2012



Trojok

Labs everywhere

NORTH AMERICA (MAP)

Baltimore	MD	http://www.bugssonline.org/
Berkeley	CA	http://berkeleybiolabs.com/
Bethesda	MD	http://www.meetup.com/CapitalAreaBioSpace/
Boston	MA	http://bosslab.org/
Brooklyn	NY	http://genspace.org/
Cambridge	MA	http://openwetware.org/wiki/MIT_DIYbio
Carlsbad	CA	http://biotechnbeyond.com/
Chicago	IL	https://groups.google.com/forum/#!forum/diybio-chicago
Columbus	OH	https://www.facebook.com/diybiocolumbus
Denver	CO	http://denverbiolabs.com
Guanajuato	MX	https://www.facebook.com/groups/DIYbioMexico/
Houston	TX	http://www.brightworkcoresearch.com/
Jackson	MS	http://www.diyneurotech.com/
La Jolla	CA	http://lajollalibrary.org/your-library/bio-lab/
Los Alamos	NM	http://biodidact.net/
Los Angeles	CA	http://www.biohackers.la/
Montreal	QC	http://bricobio.org/
New York City	NY	http://www.meetup.com/Biohackers-NYC/
New York City	NY	http://harlembiospace.com/
Norfolk	VA	http://www.biologiklabs.org/
Oakland	CA	http://counterculturelabs.org/
Orlando	FL	https://famillab.org/
Portland	OR	???
San Diego	CA	http://www.meetup.com/DIYbio-San-Diego/
Seattle	WA	http://hivebio.org/
Sunnyvale	CA	http://biocurious.org/
Toronto	ON	http://www.meetup.com/DIYbio-Toronto/
Vancouver	BC	http://www.meetup.com/DIYBio-Vancouver/
Victoria	BC	http://www.biospace.ca/

EUROPE

Barcelona	ES	http://www.diybcn.org/
Berlin	DE	https://www.biotinkering-berlin.de/
Budapest	HU	http://biodisplay.tyrell.hu/
Copenhagen	DK	http://biologigaragen.org/
Cork	IE	https://groups.google.com/forum/#!forum/diybio-ireland
Eindhoven	NL	http://bioartlab.com/
Graz	AT	https://www.facebook.com/OpenBioLabGraz
Groningen	NL	http://www.diybiogroningen.org
Kiev	UA	https://groups.google.com/forum/#!forum/diybio-kiev/
Lausanne	CH	http://www.eprouvette.ch
London	UK	https://groups.google.com/forum/#!forum/diybio-london
Manchester	UK	http://diybio.madlab.org.uk/
Munich	DE	http://biogarage.de/
Namur	BE	http://www.diybio.be/
Nottingham	UK	http://opengenx.wordpress.com/
The Hague	NL	http://www.meetup.com/Dutch-DIY-Bio/
Paris	FR	http://www.lapaillasse.org/
Prague	CZ	http://brmlab.cz/project/biolab
Renens VD	CH	http://hackuarium.strikingly.com/
Stockholm	SE	http://www.bionyfiken.se/

Ontology

- Biohacking / DIYBio is a mix of:
  - 1960 Do It Yourself culture
  - 1980 Open Source movement
  - 1995 Internet powered Citizen science
  - 2003 Synthetic biology

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Online communities

Biohack spaces as distributed knowledge hubs

Networks

- hackteria.org
  kitchen mailing list:
  - http://lists.hackteria.org/cgi-bin/mailman/listinfo

- biohacklabs.org
  European biohacker list:
  - http://www.biohacklabs.org/Europe
  List of labs:
  - http://www.biohacklabs.org/List

- diybio.org
  International mailing list:
  - https://groups.google.com/d/forum/diybio

Events

- Announced on the mailing lists
  - Hackteria Lab
  - CCC Hamburg
  - Pixelache Helsinki
  - Biofiction film festival

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Market & non-market rationales

“Do it without”: pharma, agrotech

vs

Bio innovation

OpenPCR 2010

KICKSTARTER Discover Start Search projects Sign up Log in

OpenPCR - open source biotech on your desktop

by http://OpenPCR.org -- Tito and Josh

Home Updates 11 Backers 158 Comments 22 San Francisco, CA Hardware

Funded! This project was successfully funded on July 23, 2010.

158
Backers

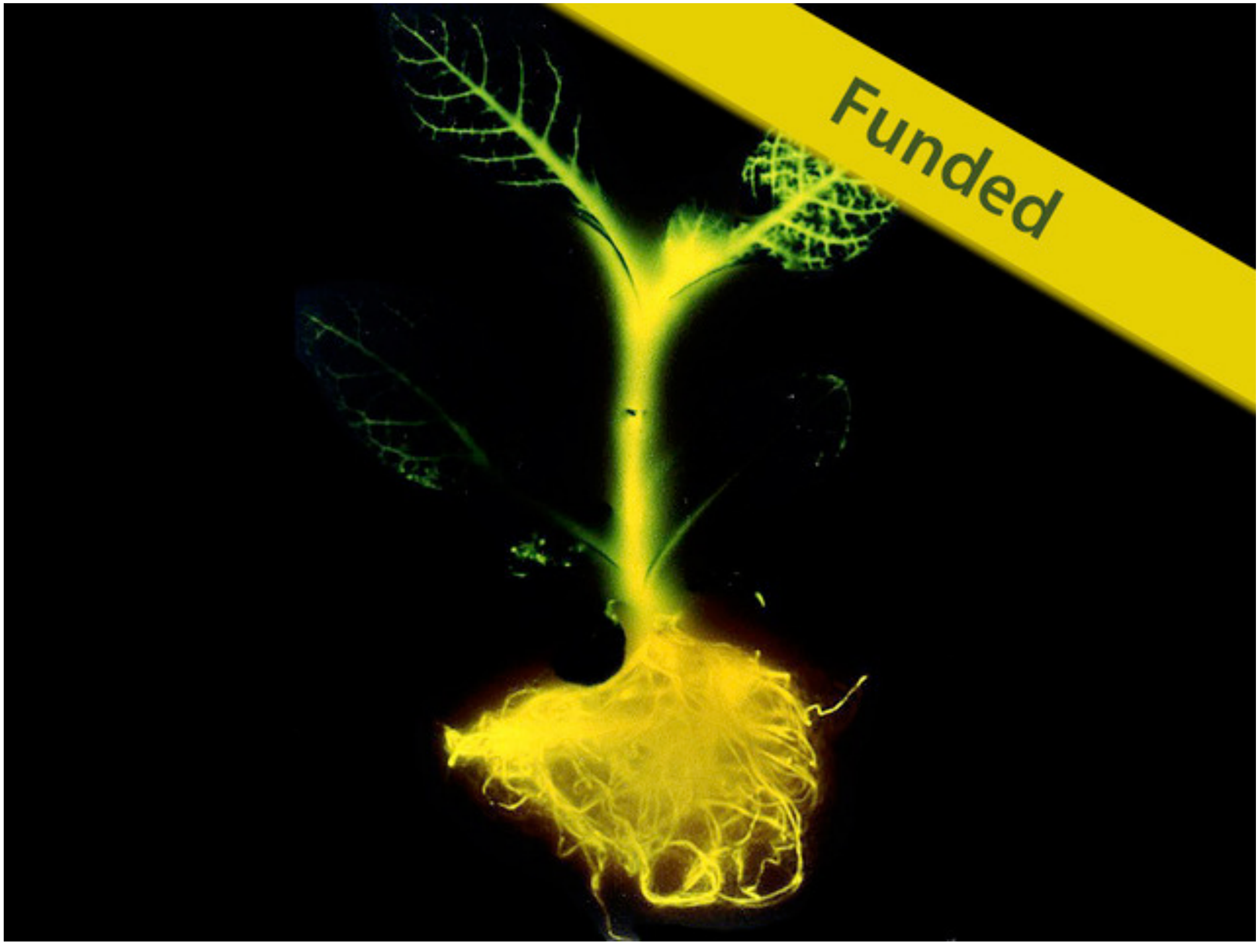
$12,121
pledged of $6,000 goal

0
seconds to go

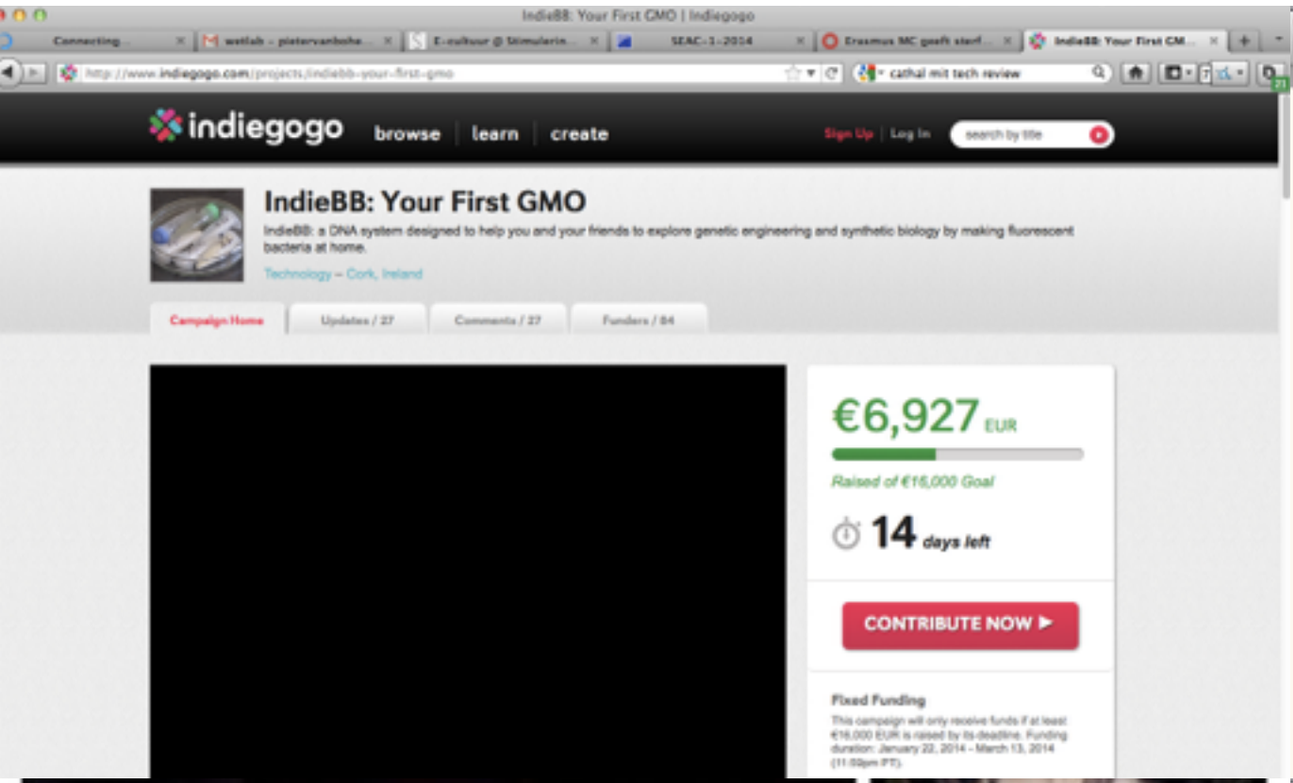
Project by

http://OpenPCR.org -- Tito and Josh
San Francisco, CA

Glowing Plant 2013



2014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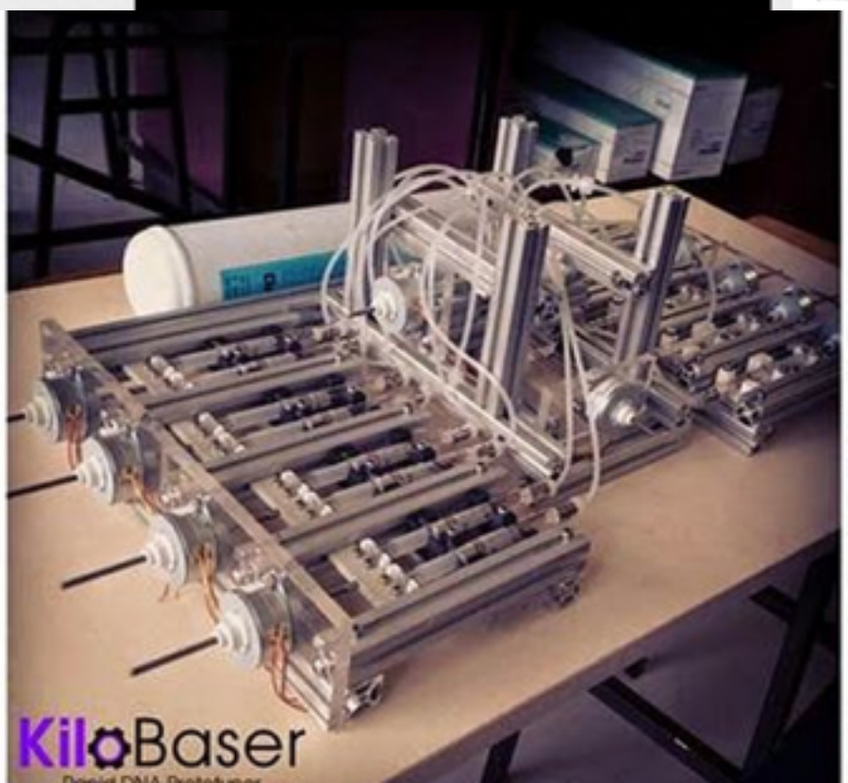
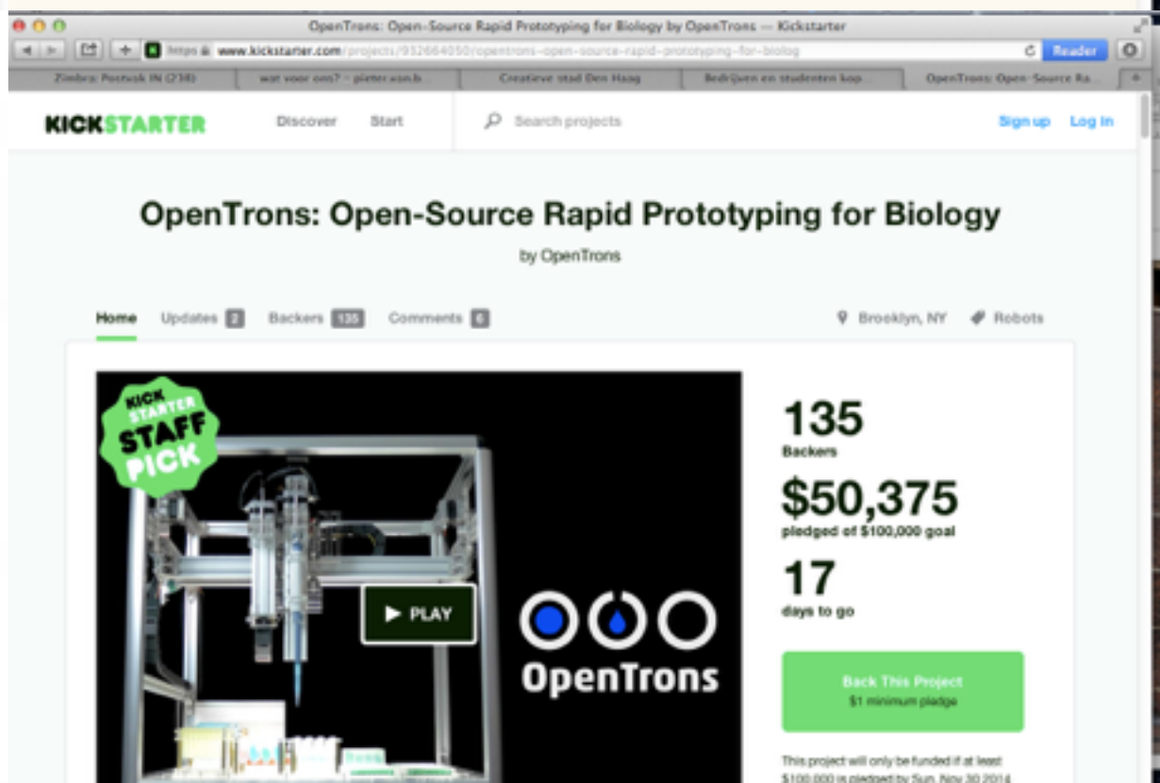
create
IndieBB: Your First GMO
€6,927 EUR
Raised of €16,000 Goal
14 days left
CONTRIBUTE NOW
Fixed Funding


real vegan cheese
Science
Ethics
Contribute
Community
Team
Press
Ask a Biohacker
Wiki
What's vegan cheese?
Real Vegan Cheese is a not a cheese substitute! It all starts with regular old baker's yeast. Through synthetic biology, we engineer our yeast to become milk-protein factories. Our milk proteins are then combined with water and vegan oil to make Vegan Milk which is ultimately converted into Real Vegan Cheese through standard cheese-making processes - just like cheese made from cow or goat milk!
LEARN MORE


KiloBaser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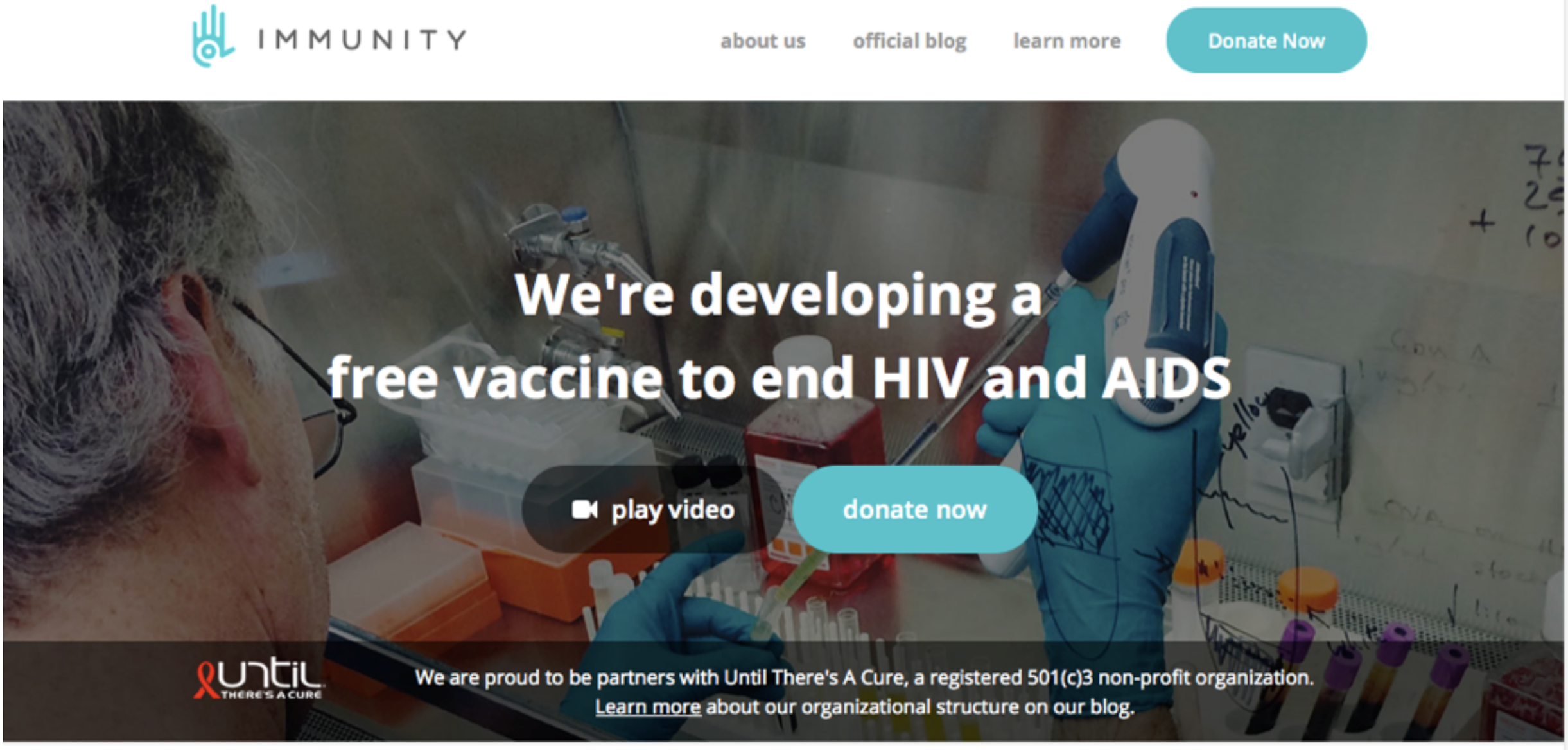
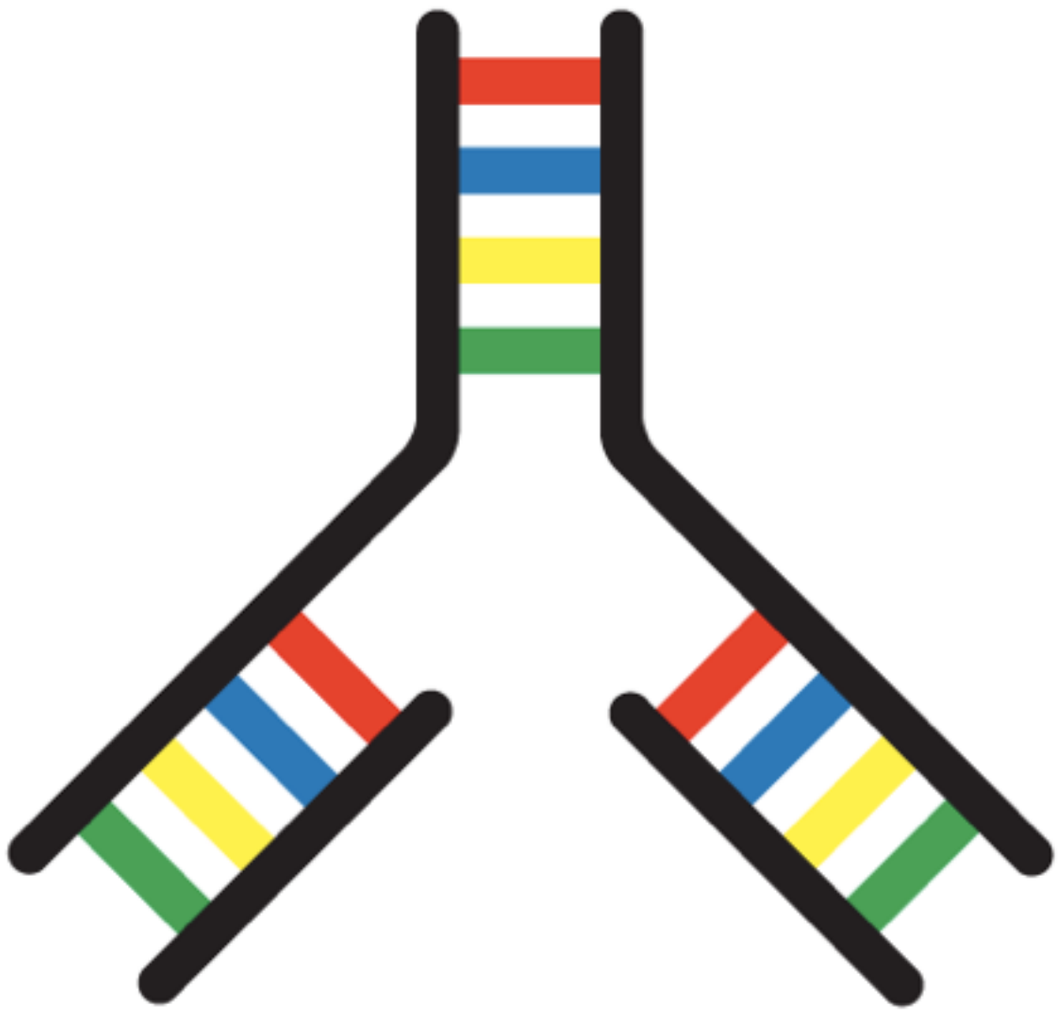
Comments
Brooklyn, NY
Robots
KICK STARTER STAFF PICK
PLAY
OpenTrons
135
Backers
$50,375
pledged of $100,000 goal
17
days to go
Back This Project
$1 minimum pledge

Immunity project 2014



We need your help to fund our first human clinical trial. Please donate now to help us end HIV/AIDS. Visit our blog to keep up to date on our progress. Read our FAQ to learn how our vaccine prototype works.

Indie Bio



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