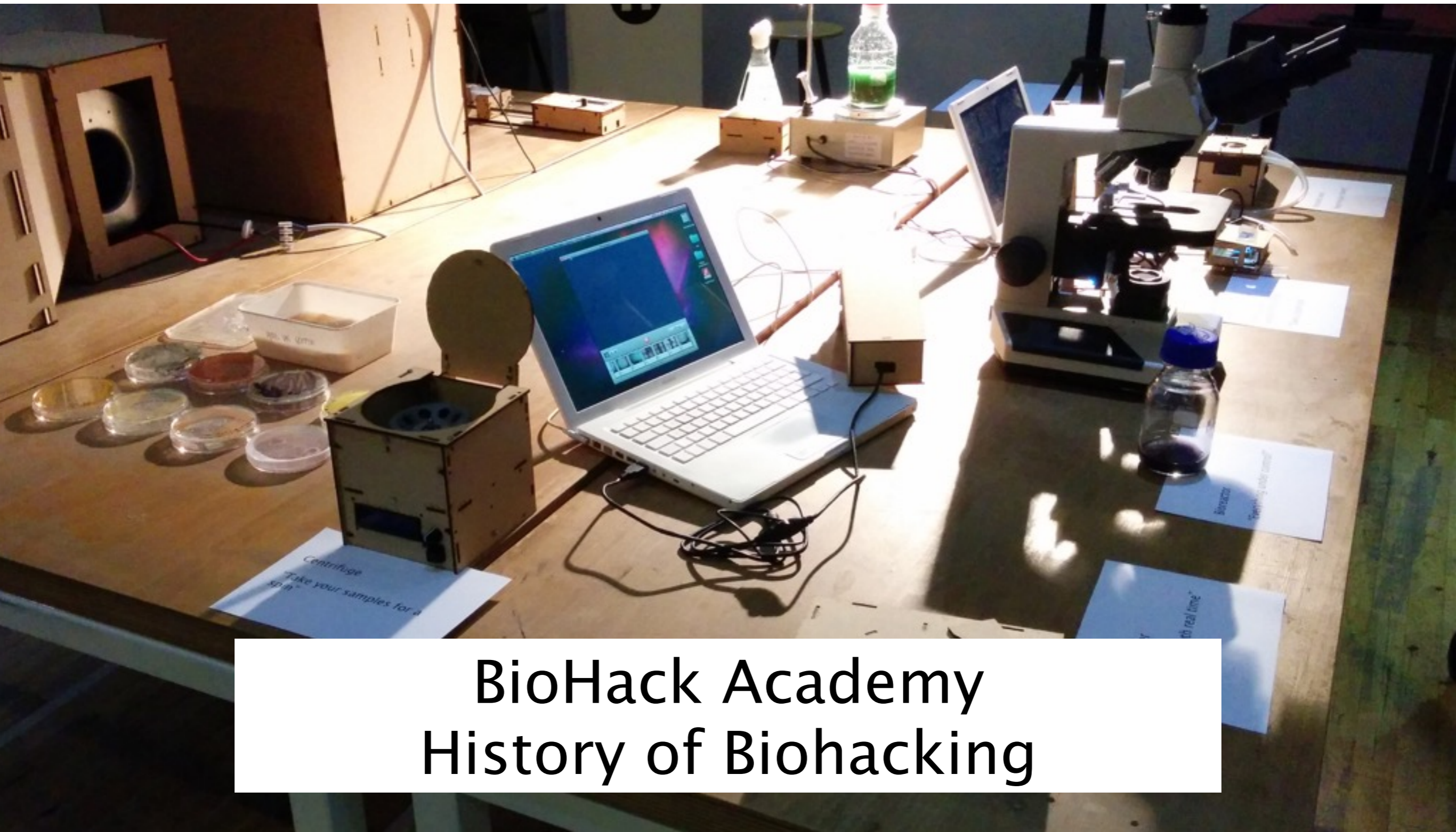




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institute for art, science and technology

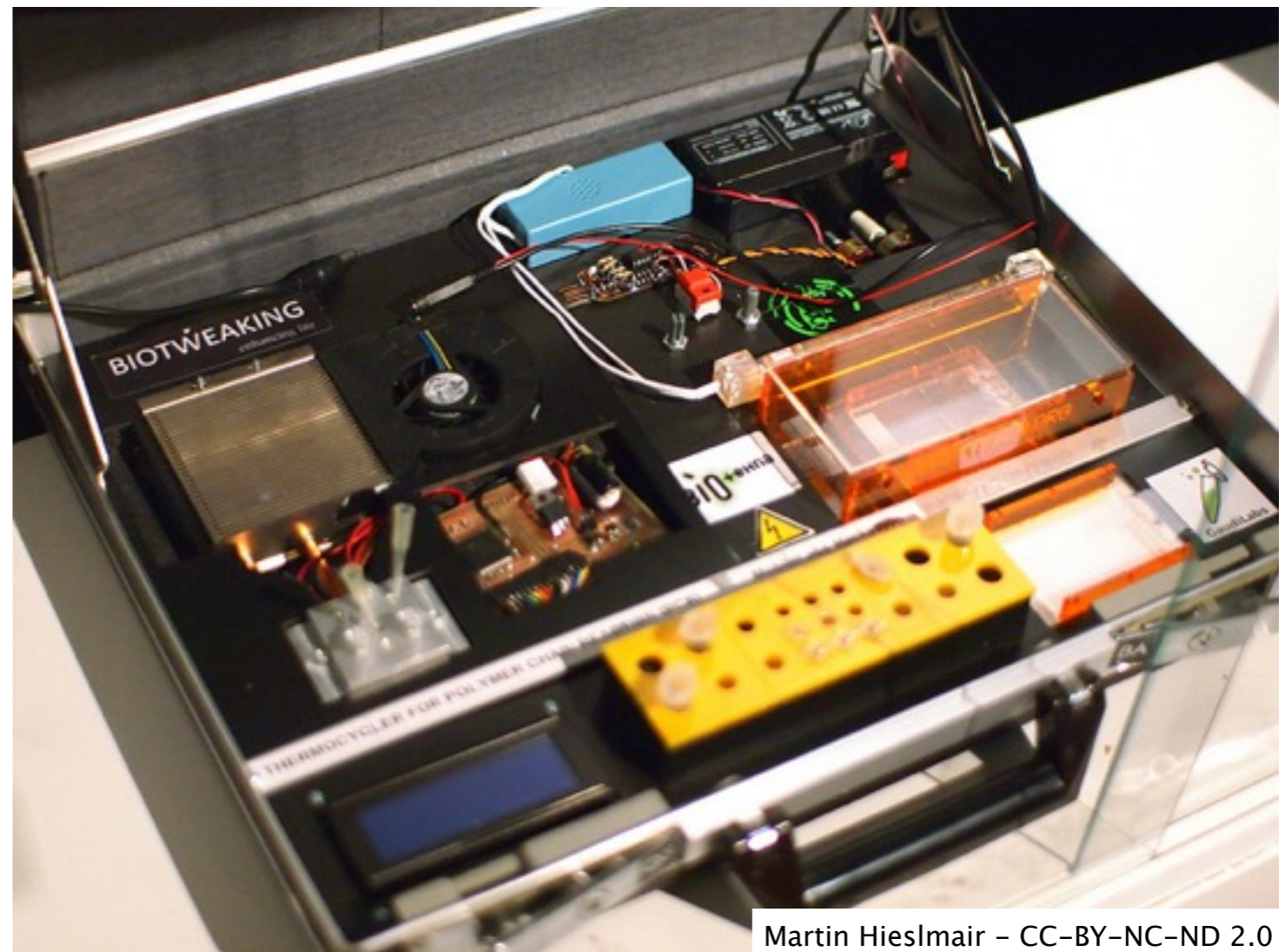


BioHack Academy History of Biohacking



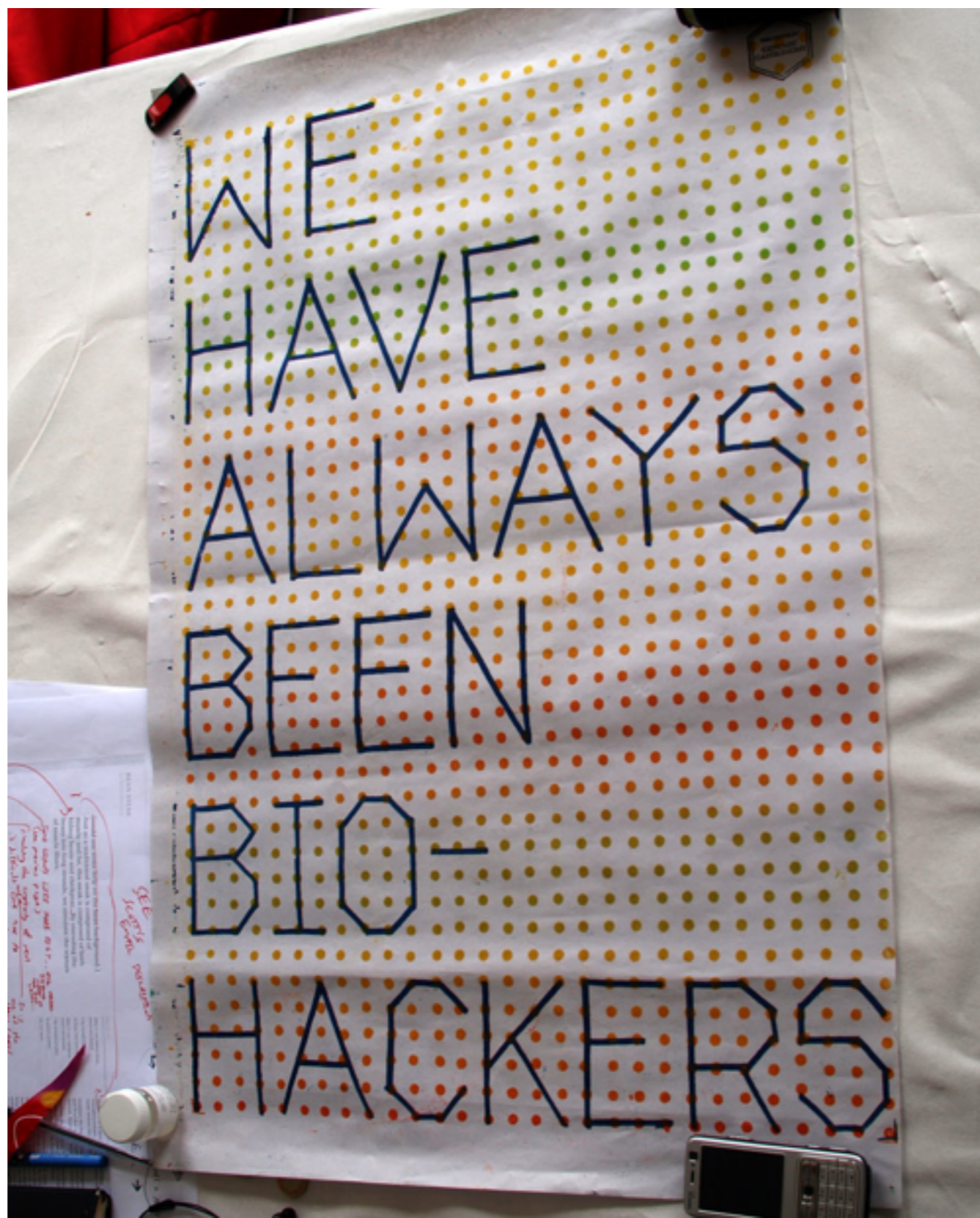
What it means to be a hacker

- 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



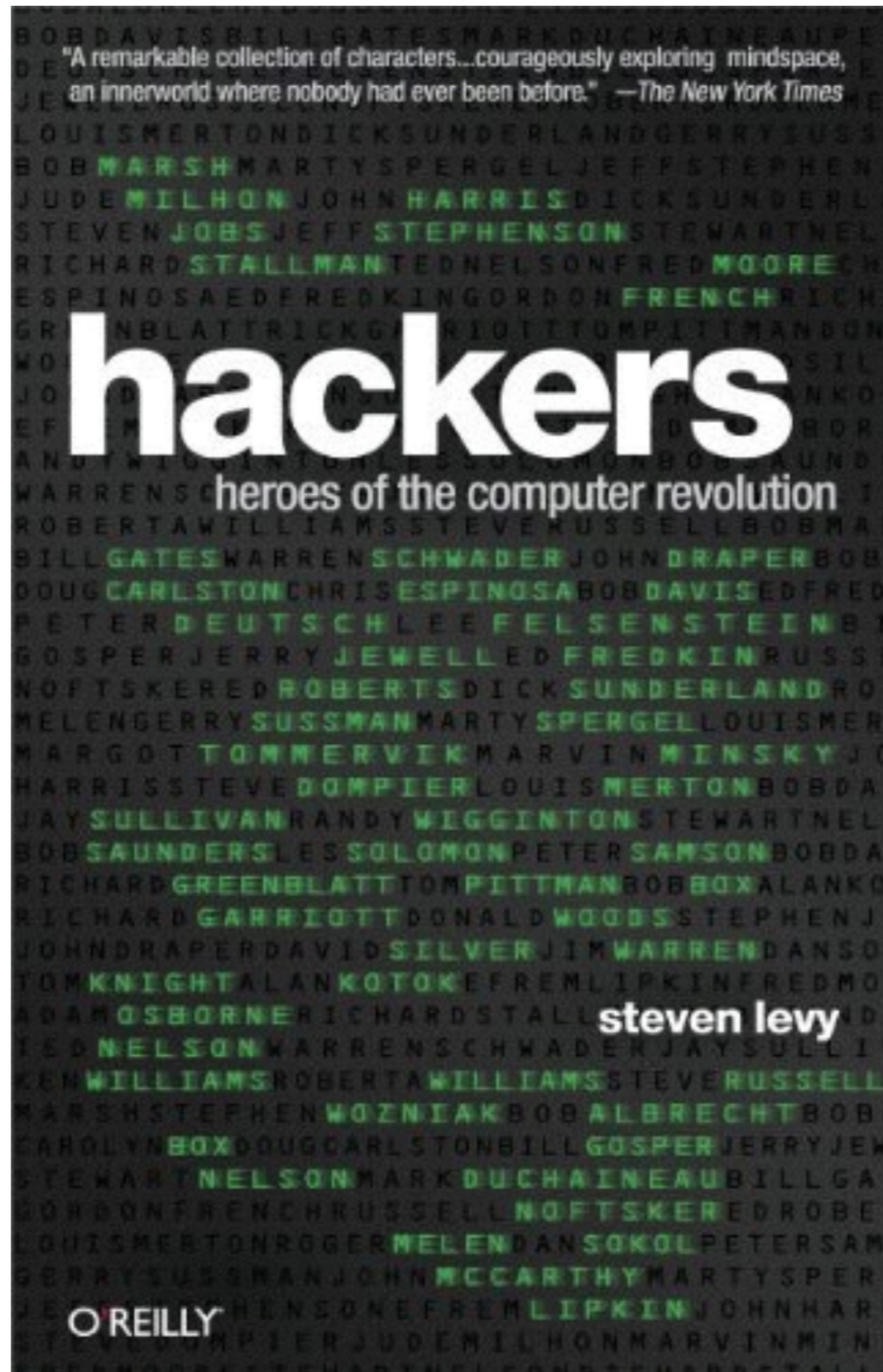


We have always been biohackers



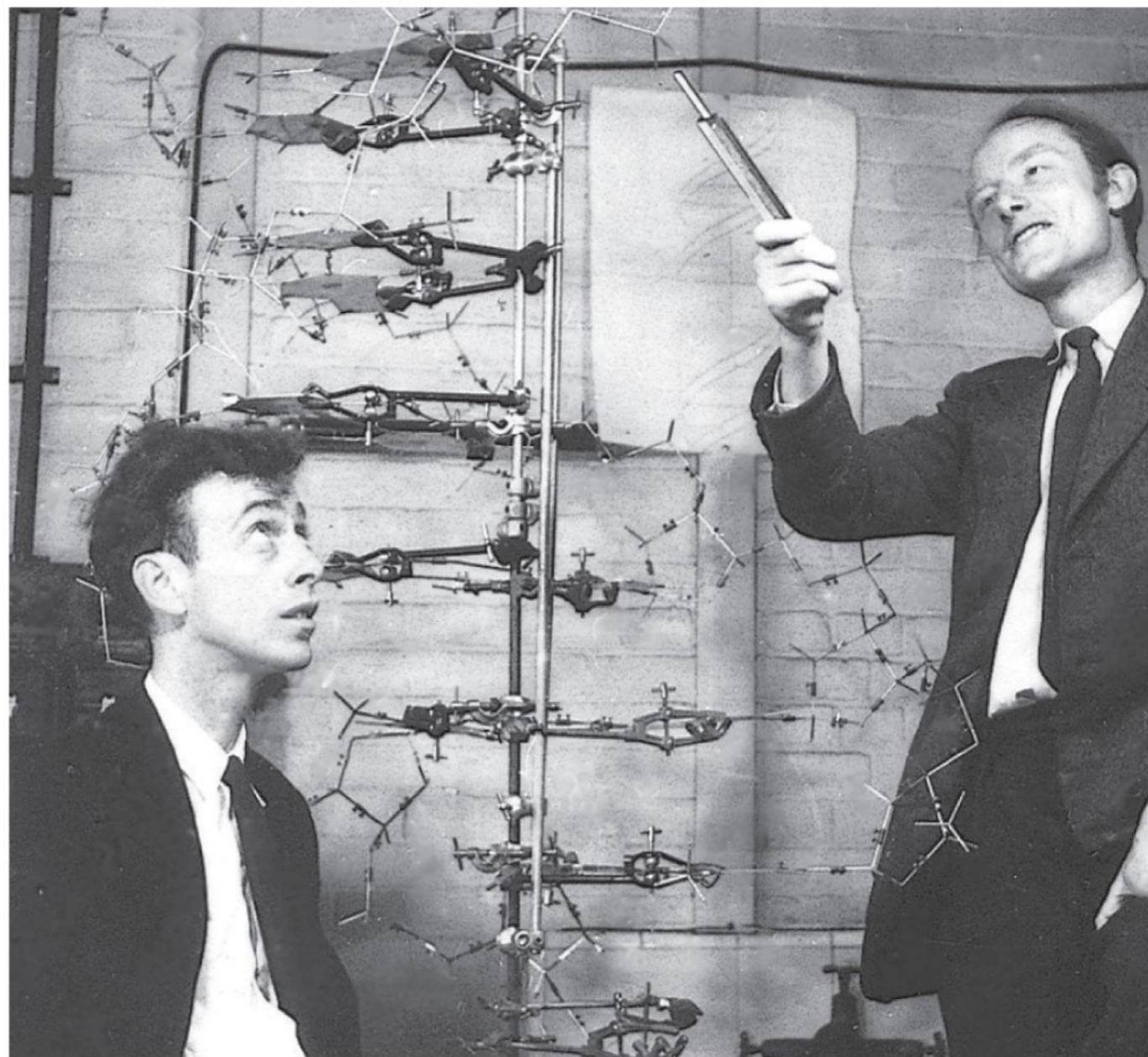
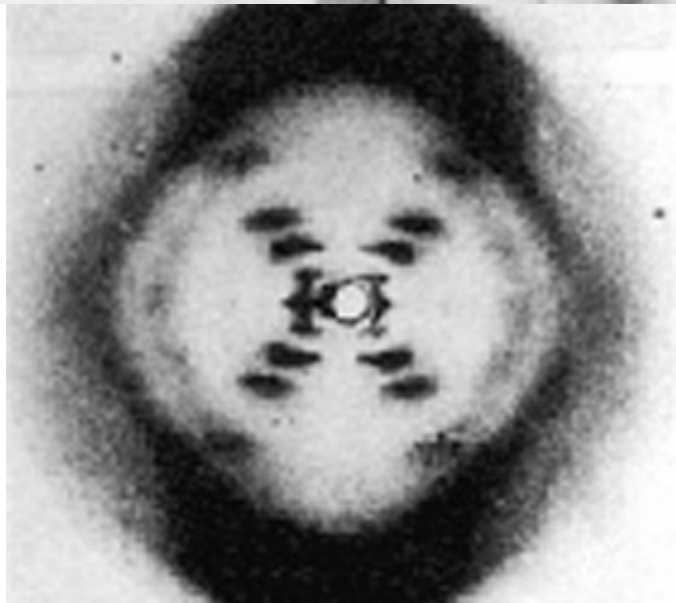


Steven Levy – Hackers





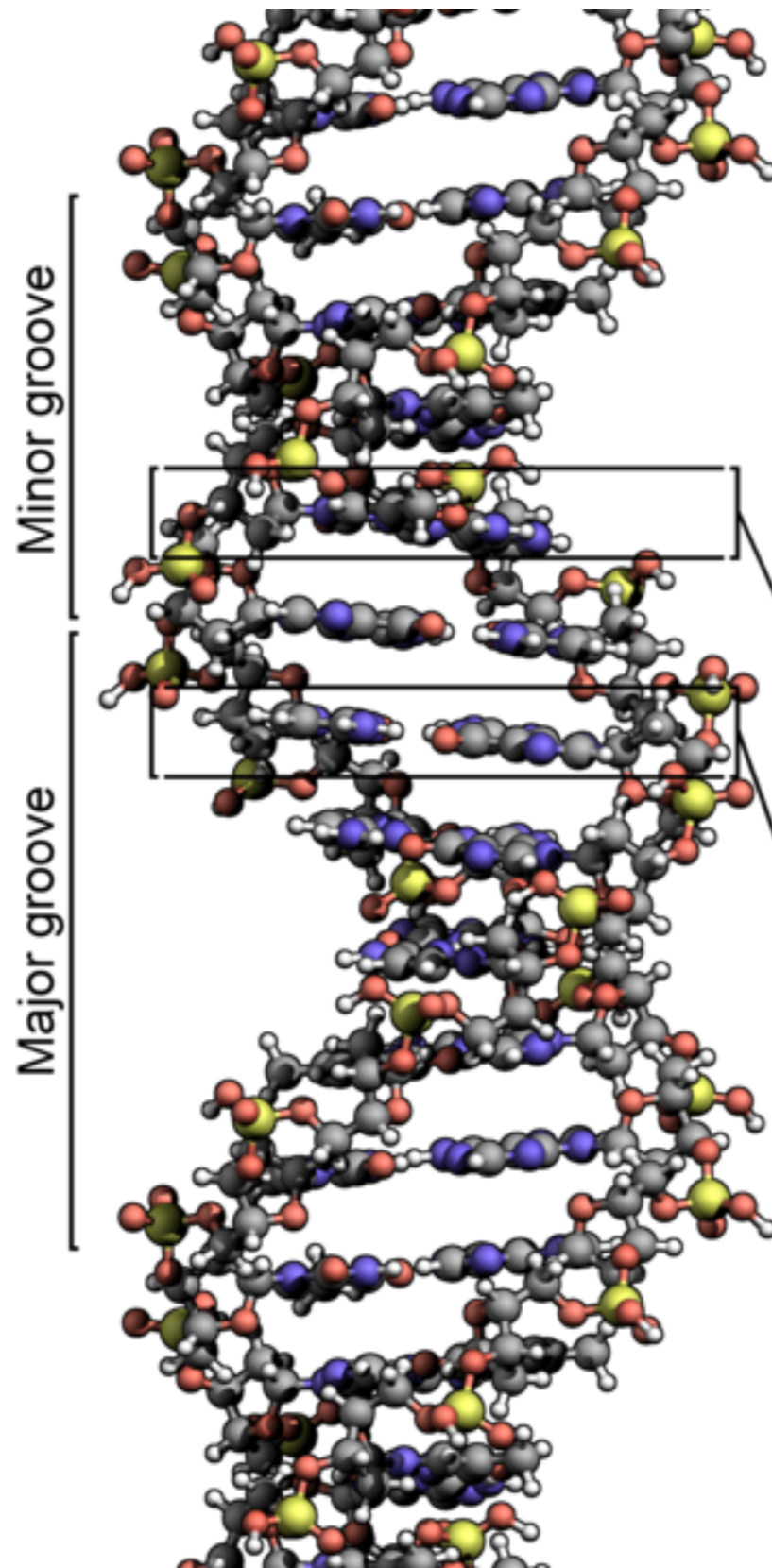
Discovery of Double Helix 1953



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DNA Molecule



Living code:

AACATGACCTGACGA

Digital code:

```
100101001110101010101010  
01010101001010101001010110  
1101111001
```

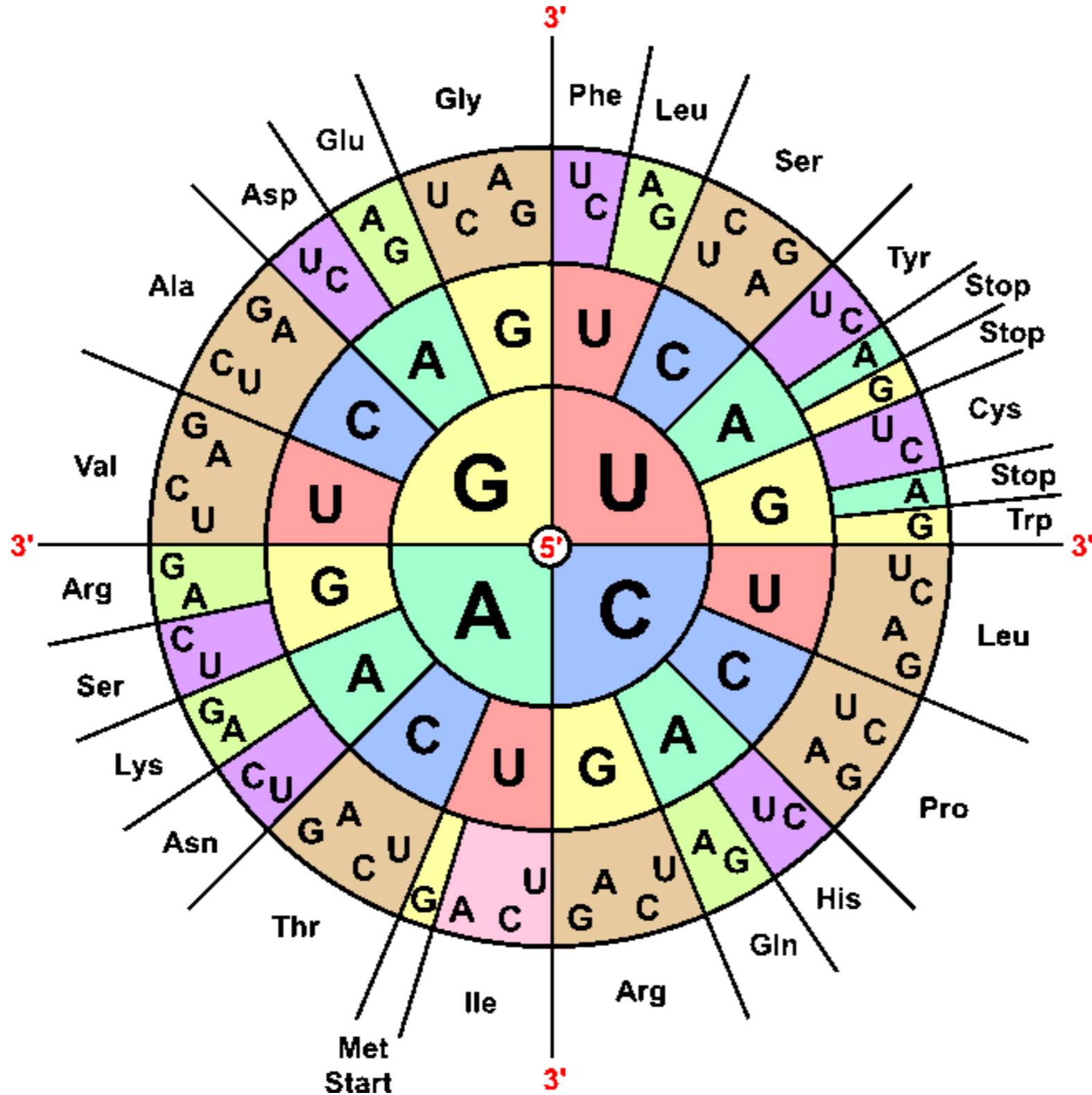



Robert W. Holley, Marshall Nirenberg, Har Gobind Khorana 1968



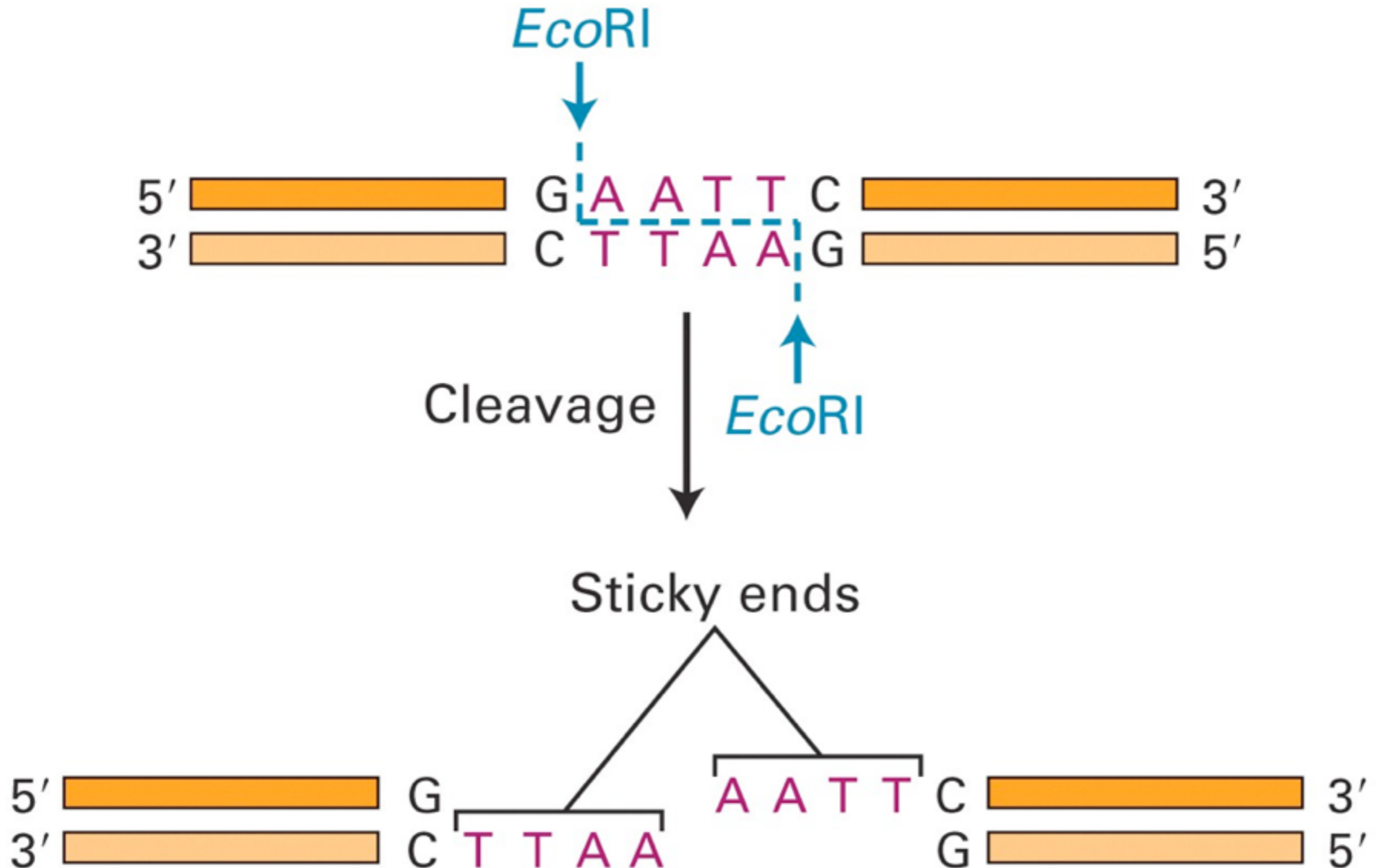


Amino acid rosetta stone



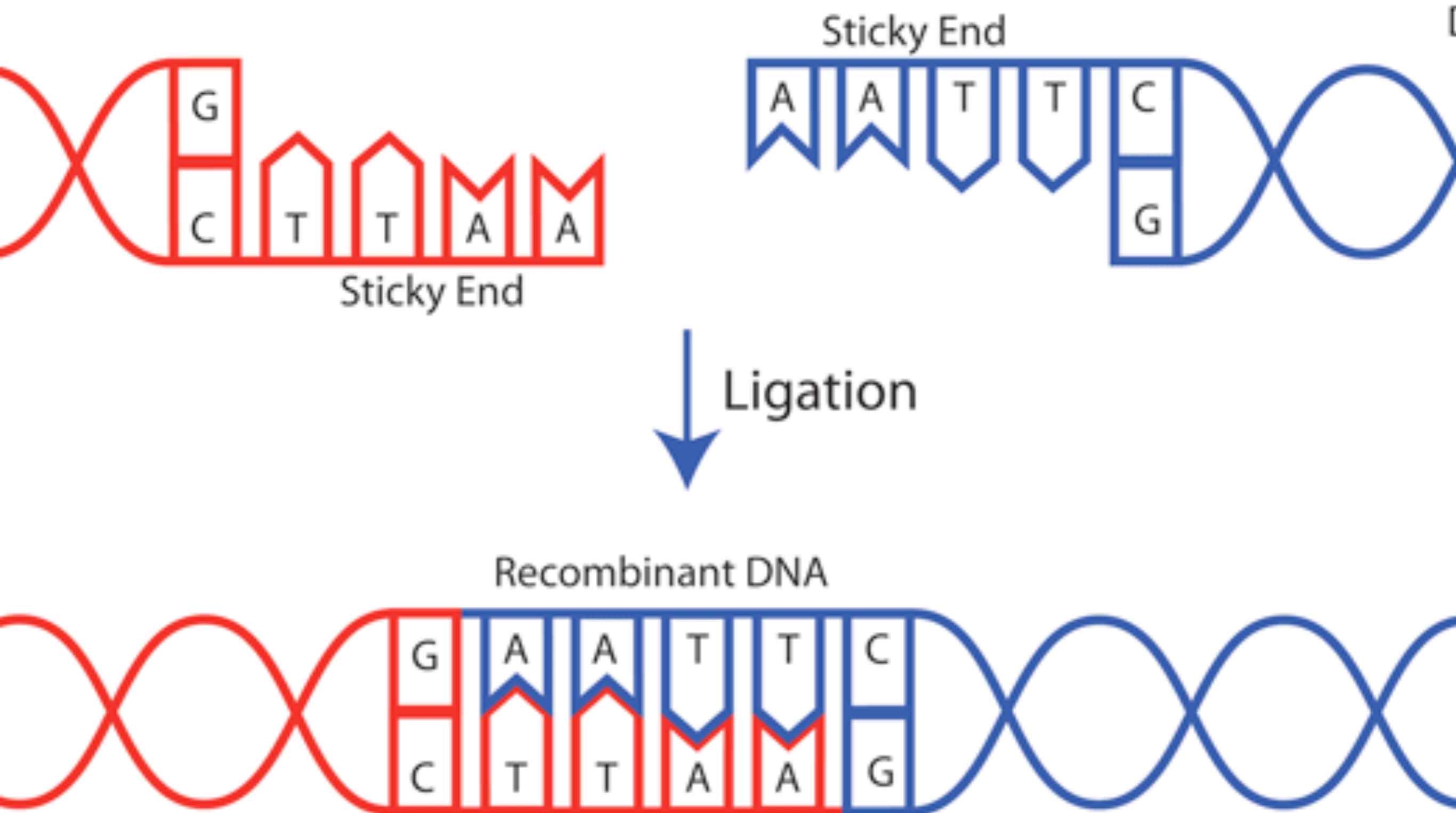


Restriction Enzyme 1970





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.

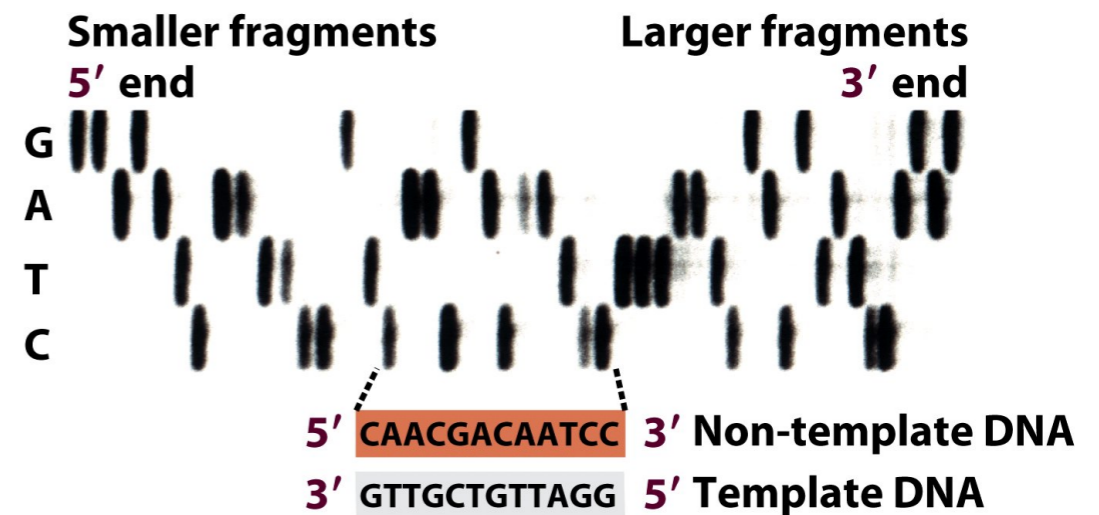
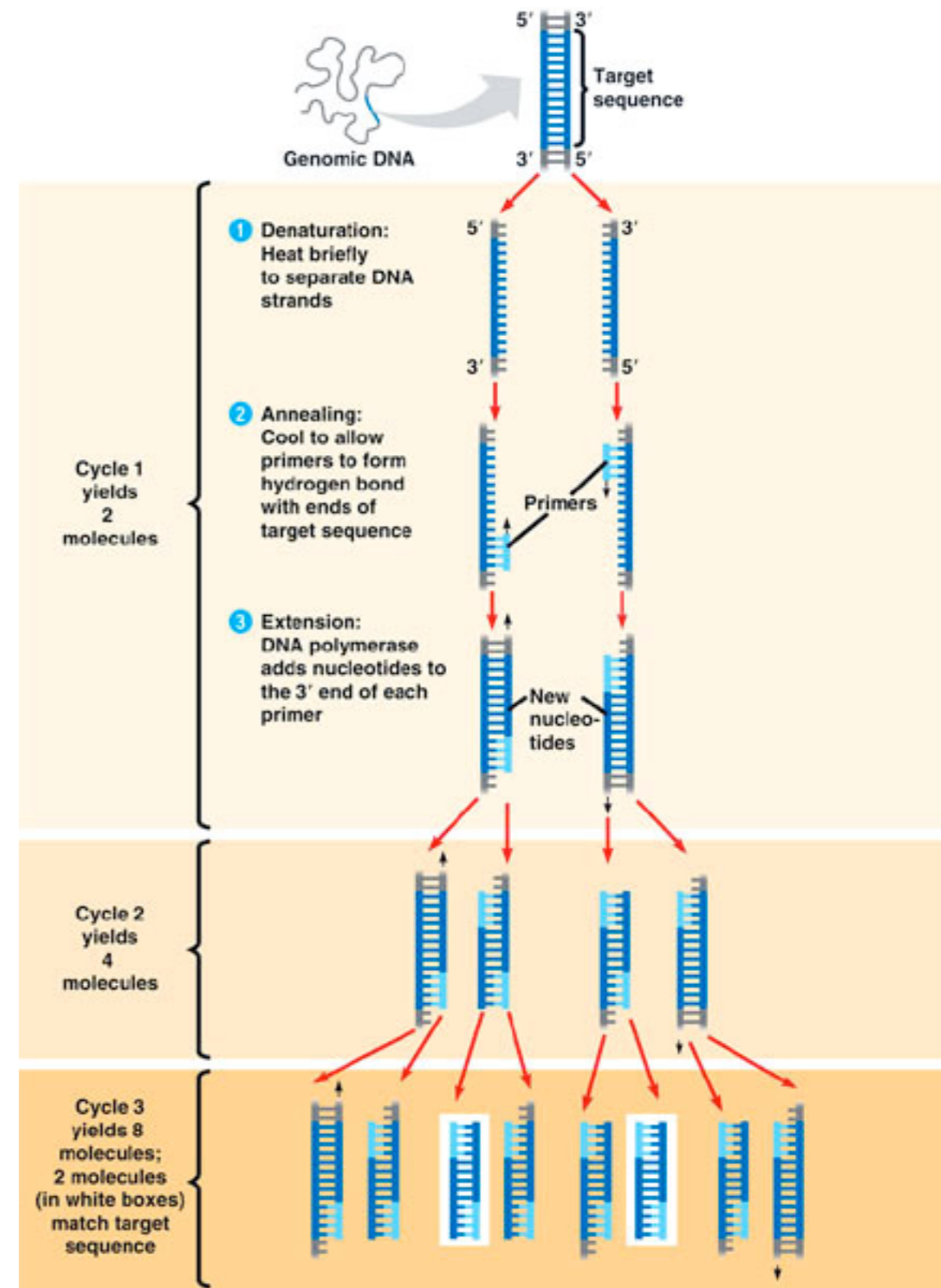


Figure 19-6c Biological Science, 2/e



Polymerase Chain Reaction, 1983



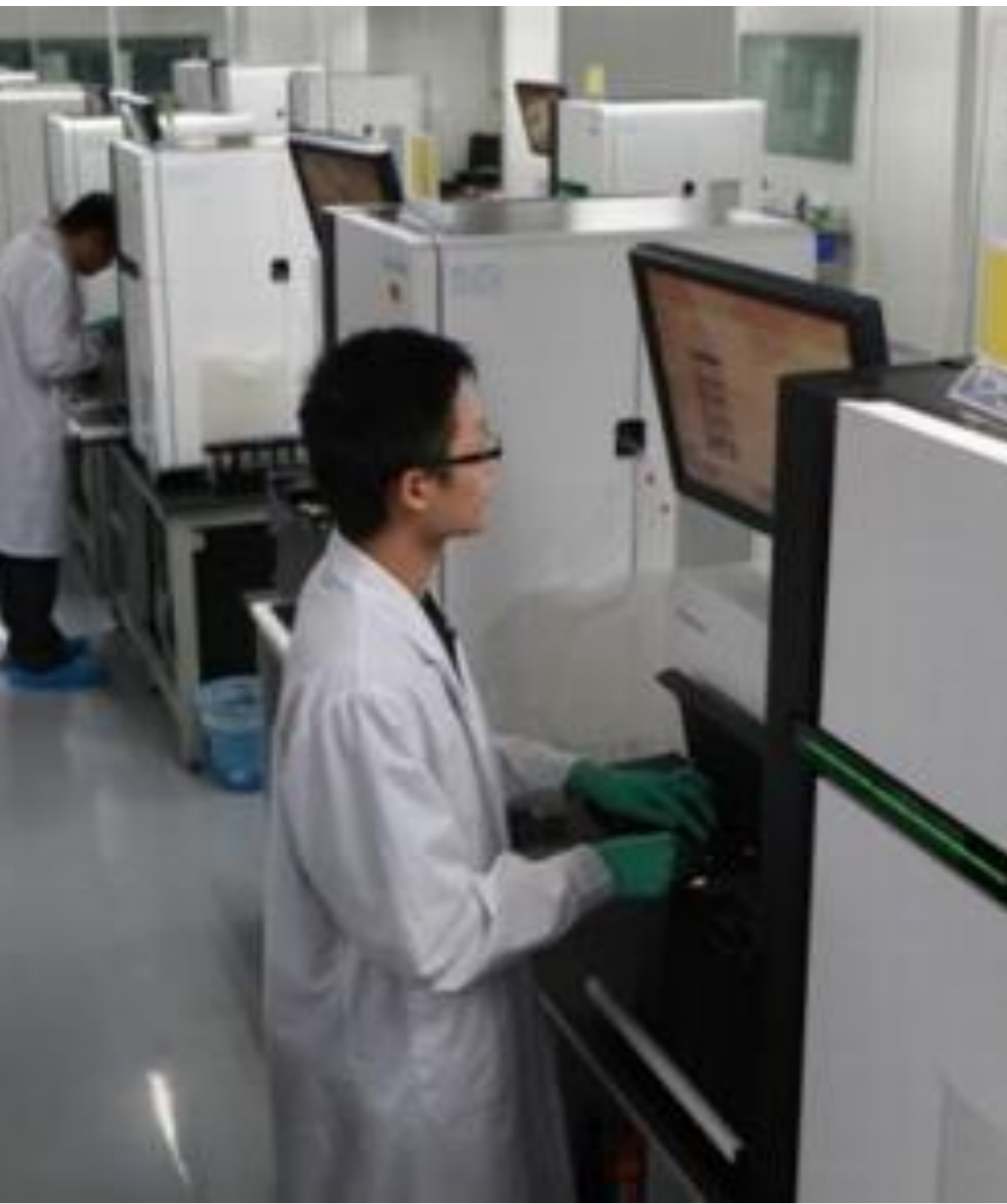


Reading DNA 2014



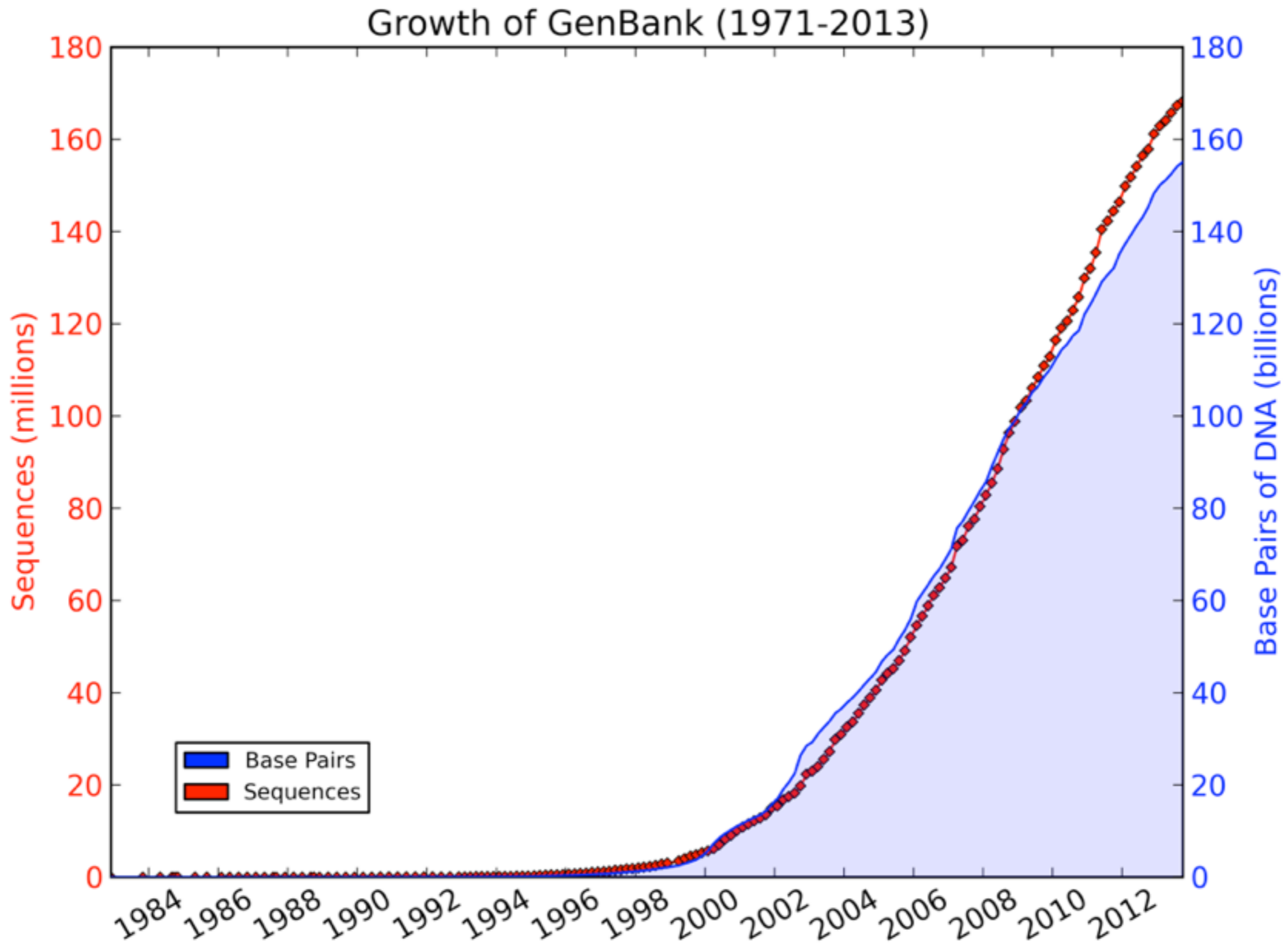


Beijing Genomics Institute



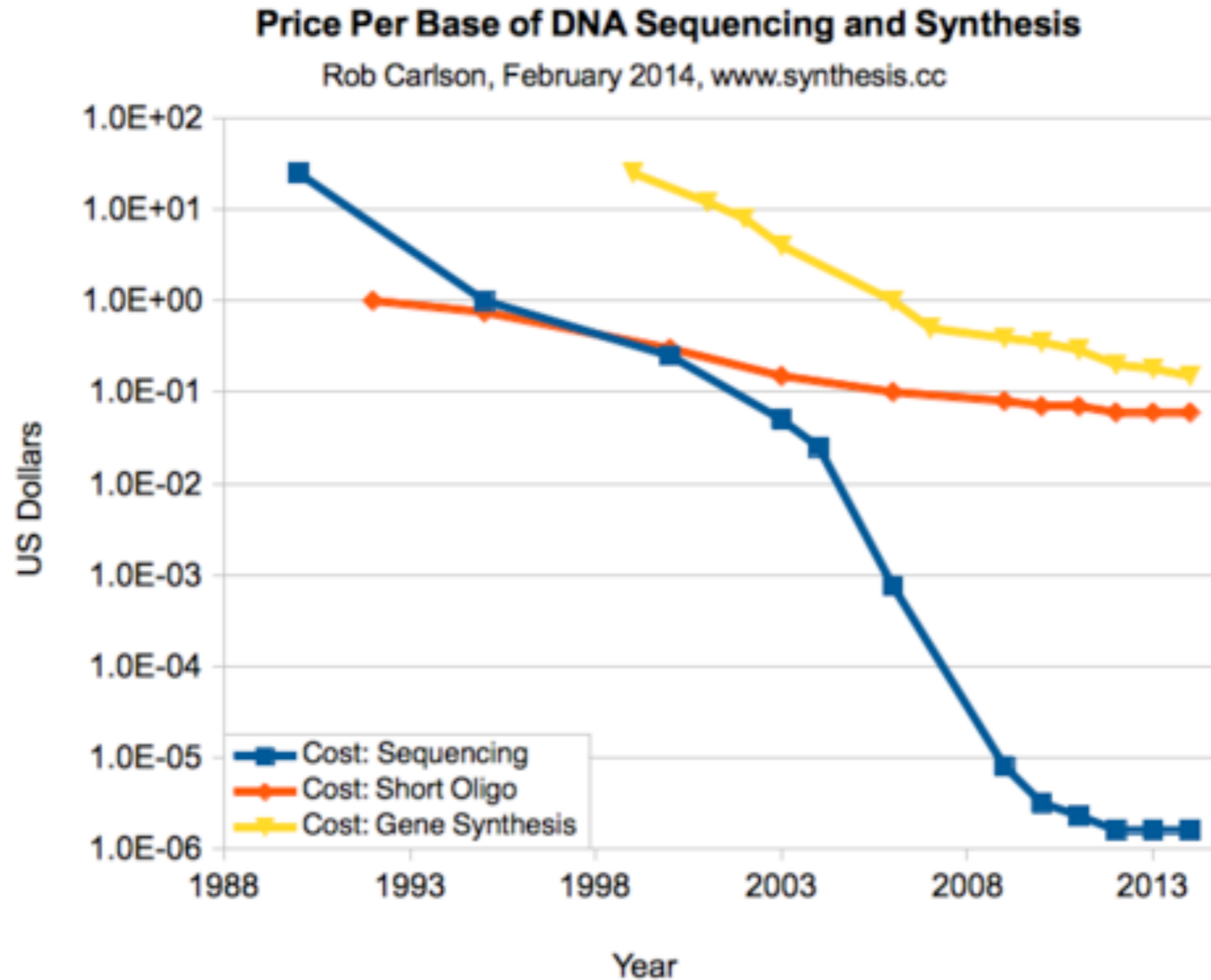


Growth of Genbank



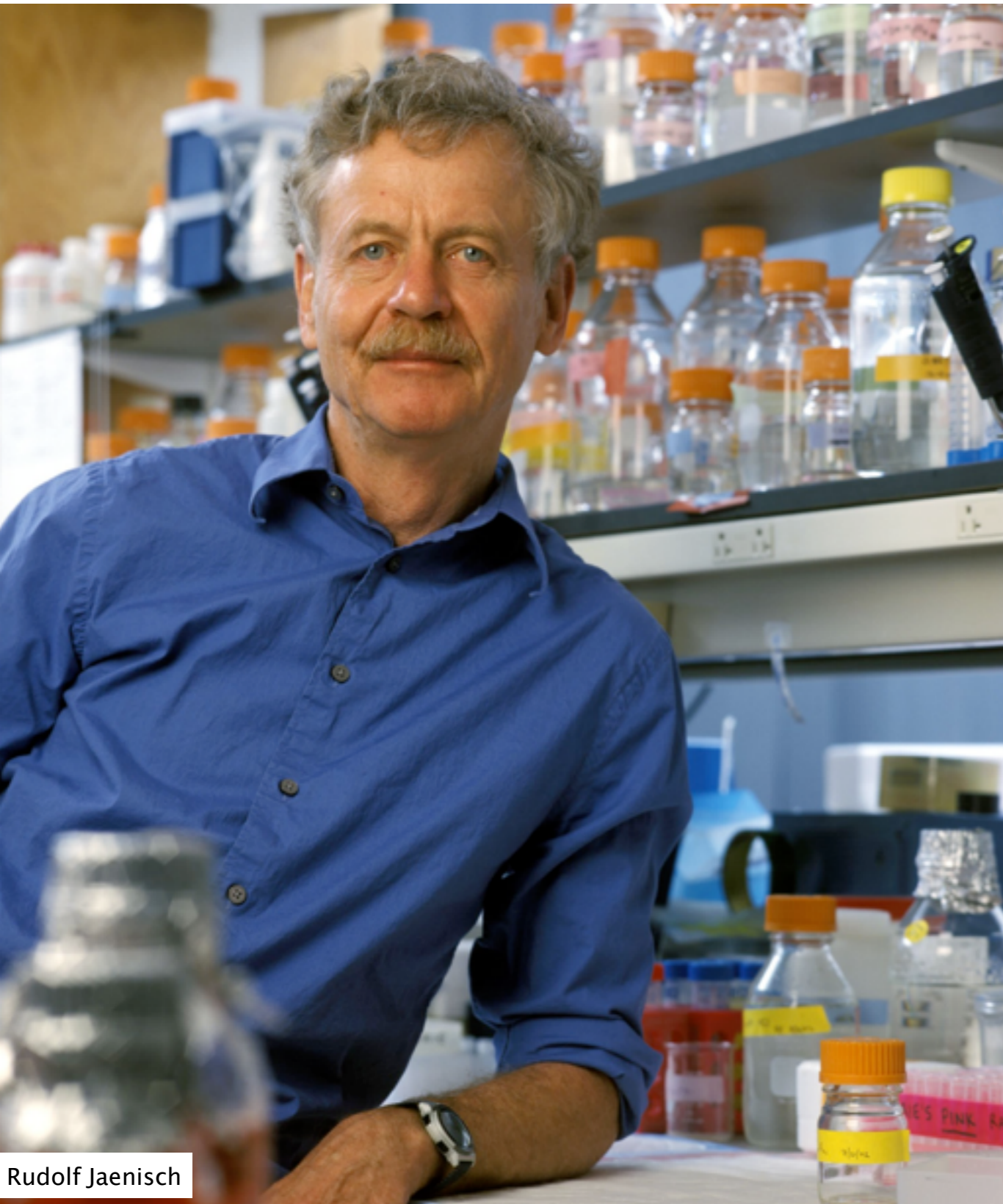


Cost of DNA

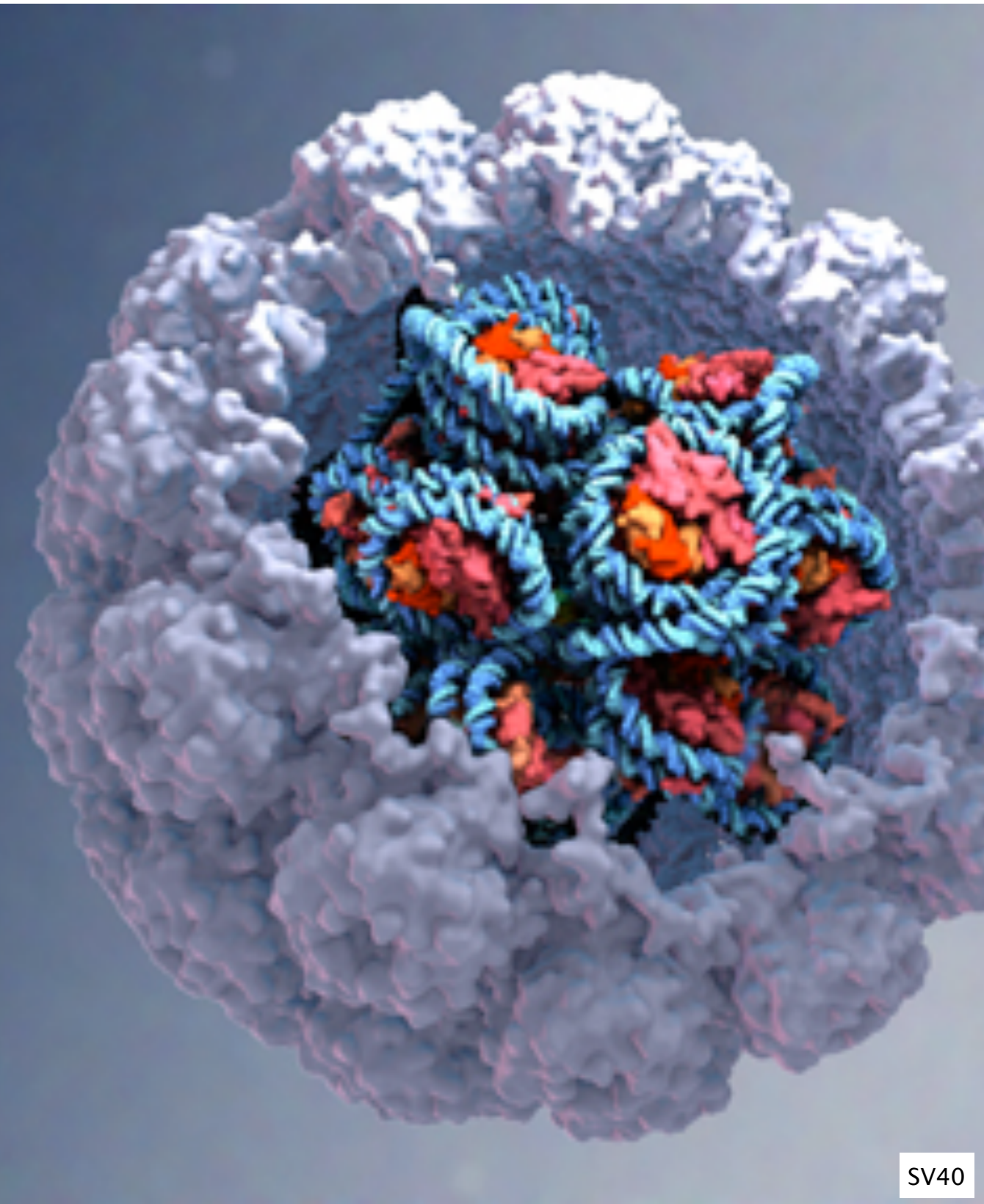




Transgenic Mouse, 1973



Rudolf Jaenisch



SV40



Transgenic Plant, 1983

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letters to nature

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

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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 type¹ 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 induction². 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 deleted⁴. 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-DNA⁵. The availability of this dominant selectable marker should allow a wider range of experiments to be undertaken using different host plants.

References

1. Leemans, J. et al. *Science* 218, 1419-1421 (1981). | [Open PDF](#) |



Oncogene mouse, Phil Leder, Tim Stewart 1984





Joe Davis, 1987

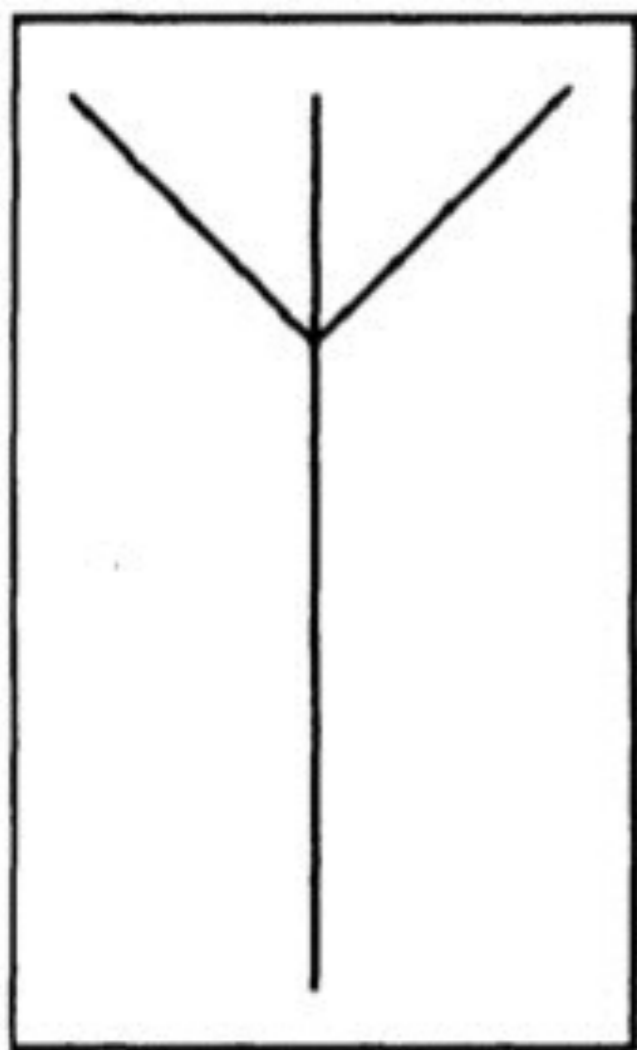


FIG. 1 *Microvenus* icon.



```
10101
01110
00100
00100
00100
00100
00100
```



CCCCCAACGCGCGCT



Bull Herman, Leiden 1990





Life finds a way, Jurassic Park 1993





Dolly the Sheep, Edinburgh 1996





Eduardo Kac – GFP Bunny, 2000





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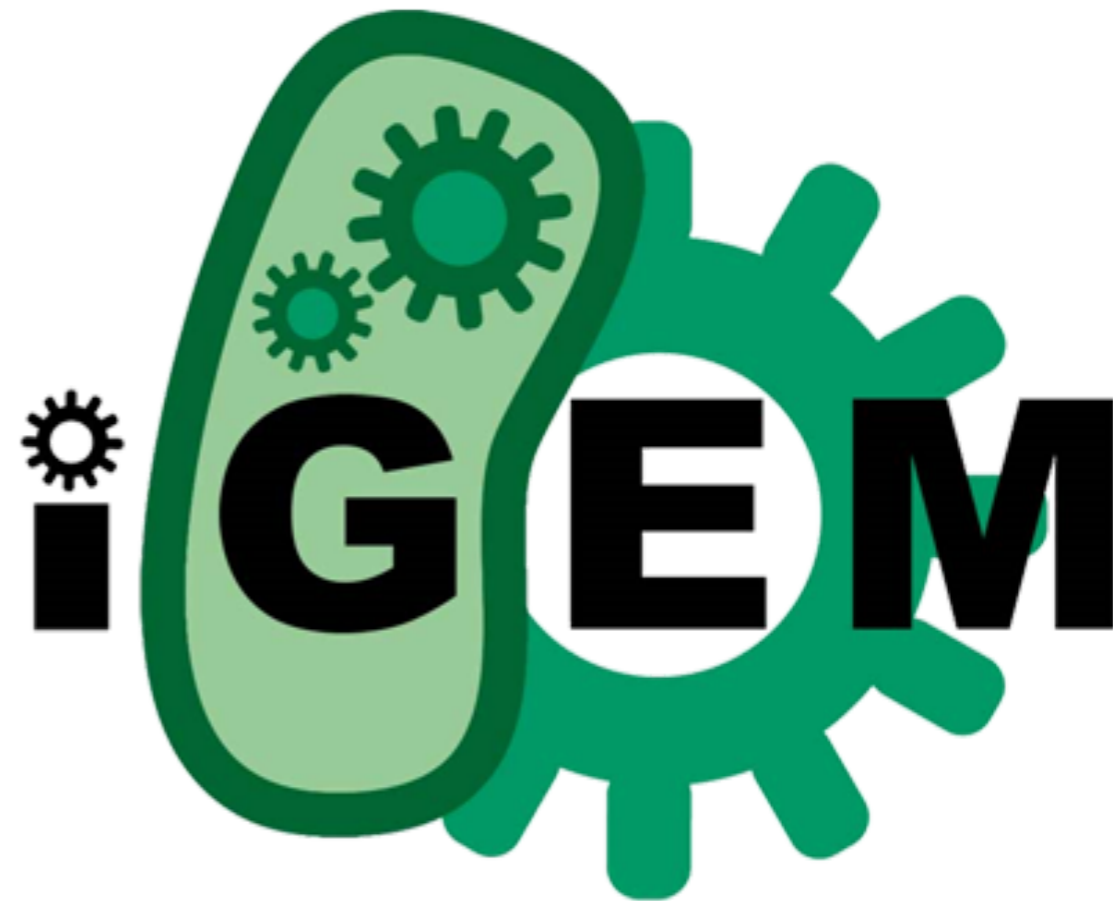
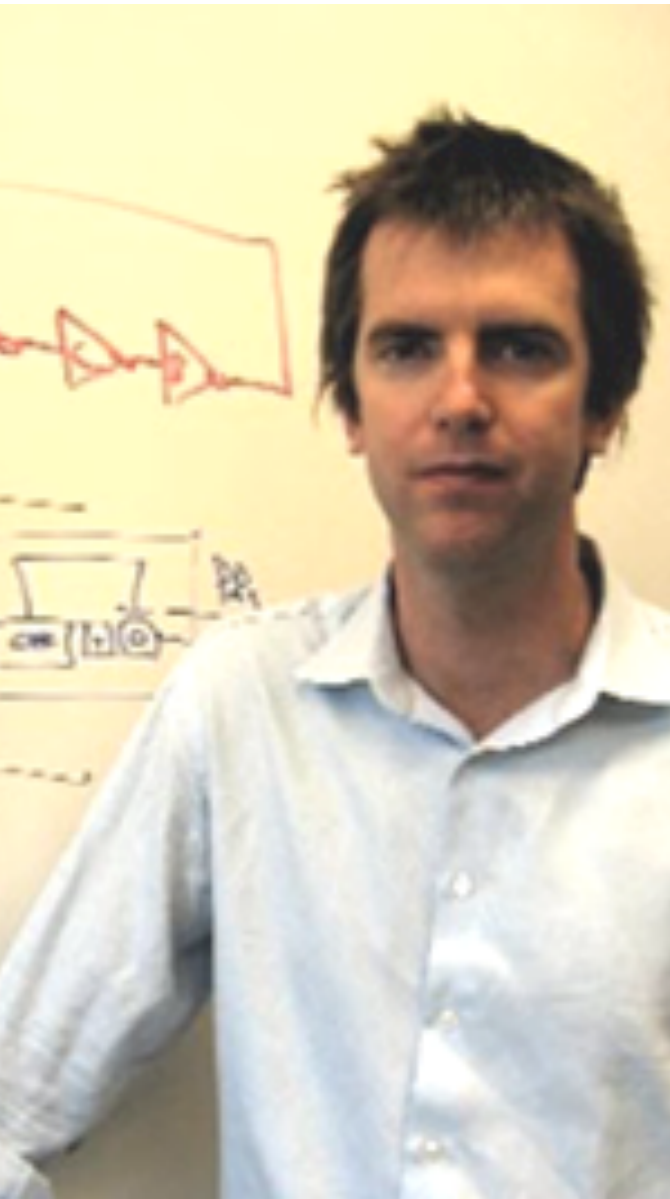
Computer Not Included

4 "AA" Batteries Required

AGE 8 - 108

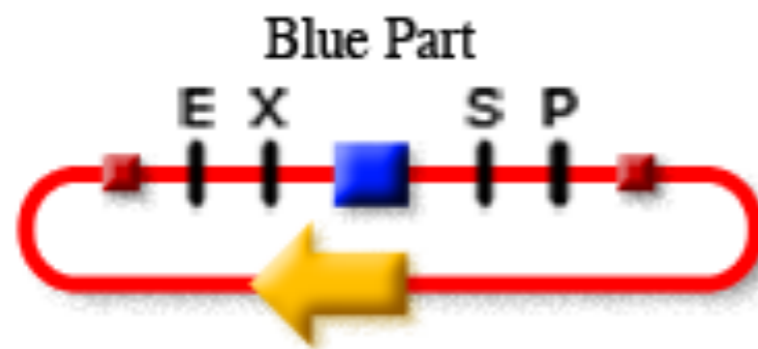


Drew Andy, Tom Knight

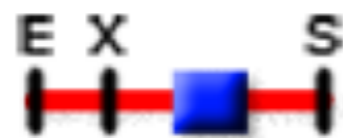




Biobrick standard 2003



Cut with
EcoRI and SpeI



Cut with
EcoRI and XbaI



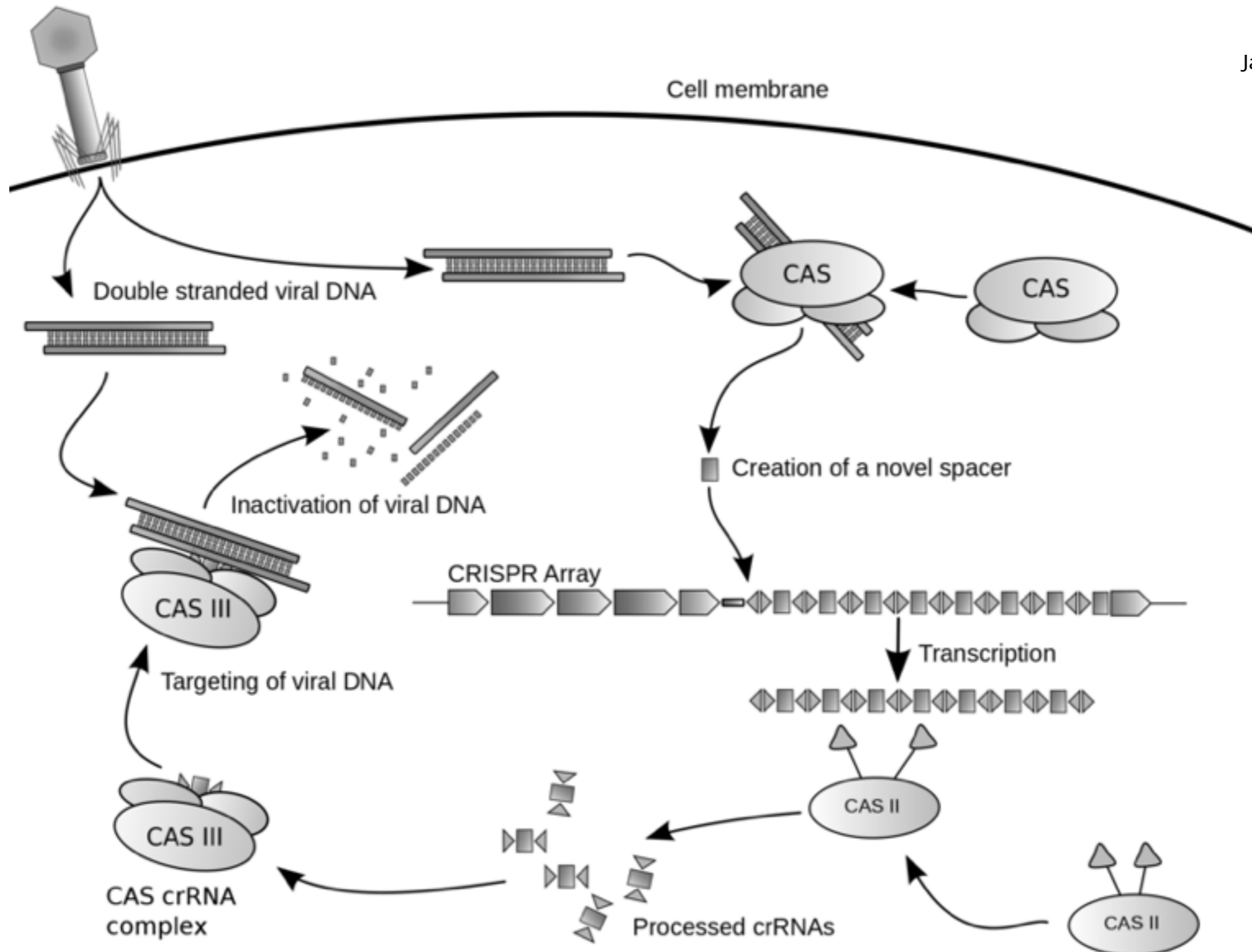
Mix and Ligate
(Blue-Green Part)





CRISPR – Cas9

James Atmos – CC-BY-SA 3.0





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



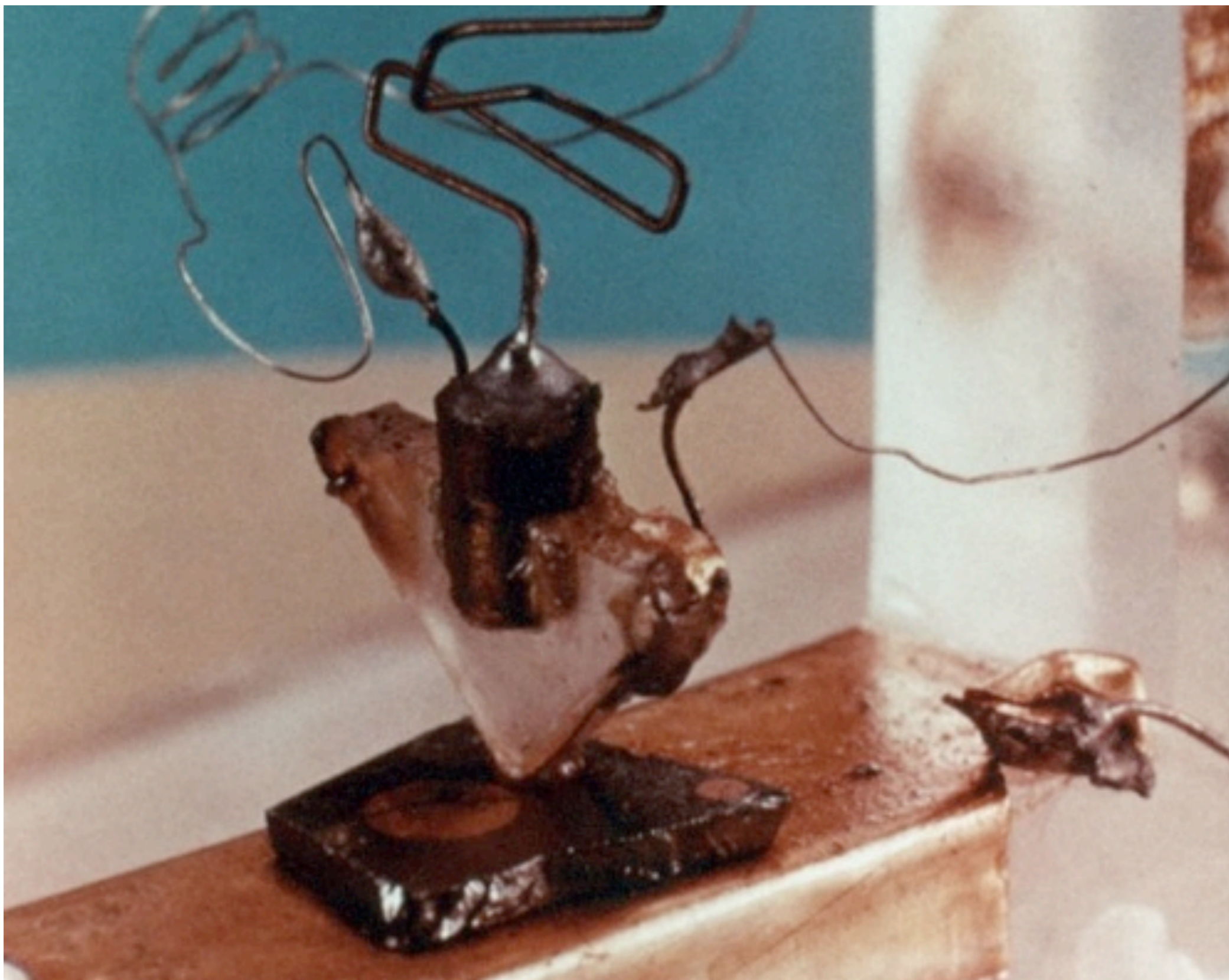
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Biology & hacking

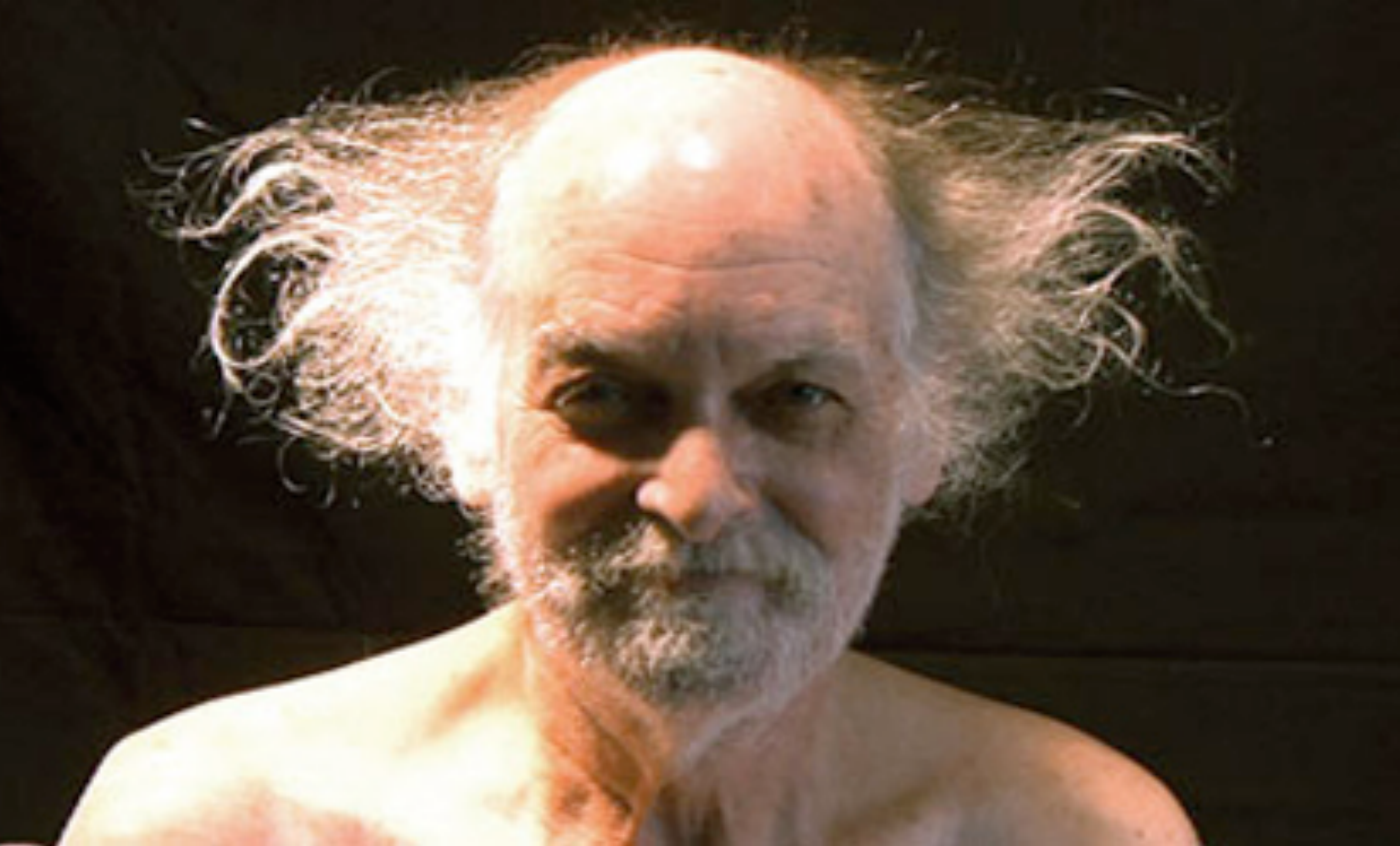


Inspiration & justification





Joe Davis





Critical Art Ensemble – Free Range Grain 2003



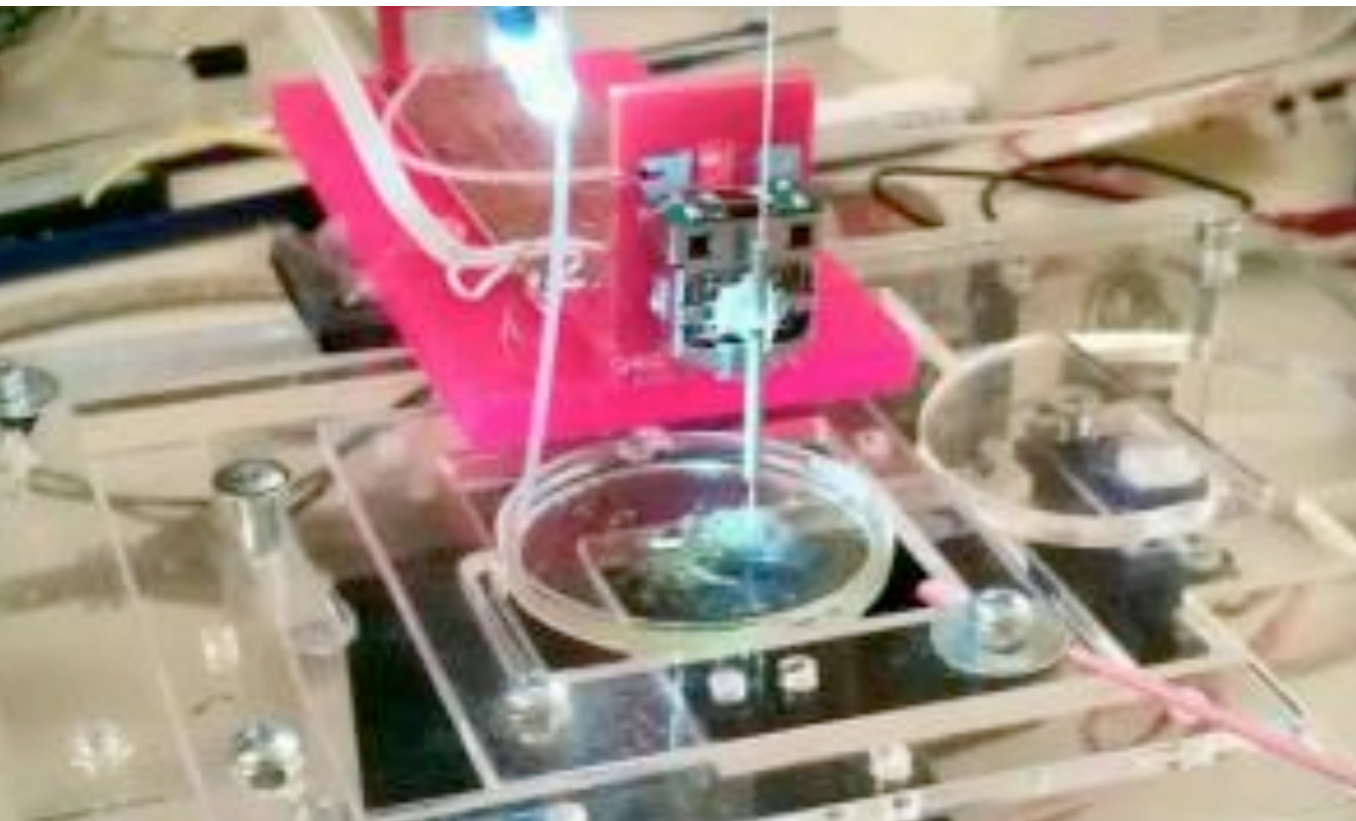


DIYBio 2008

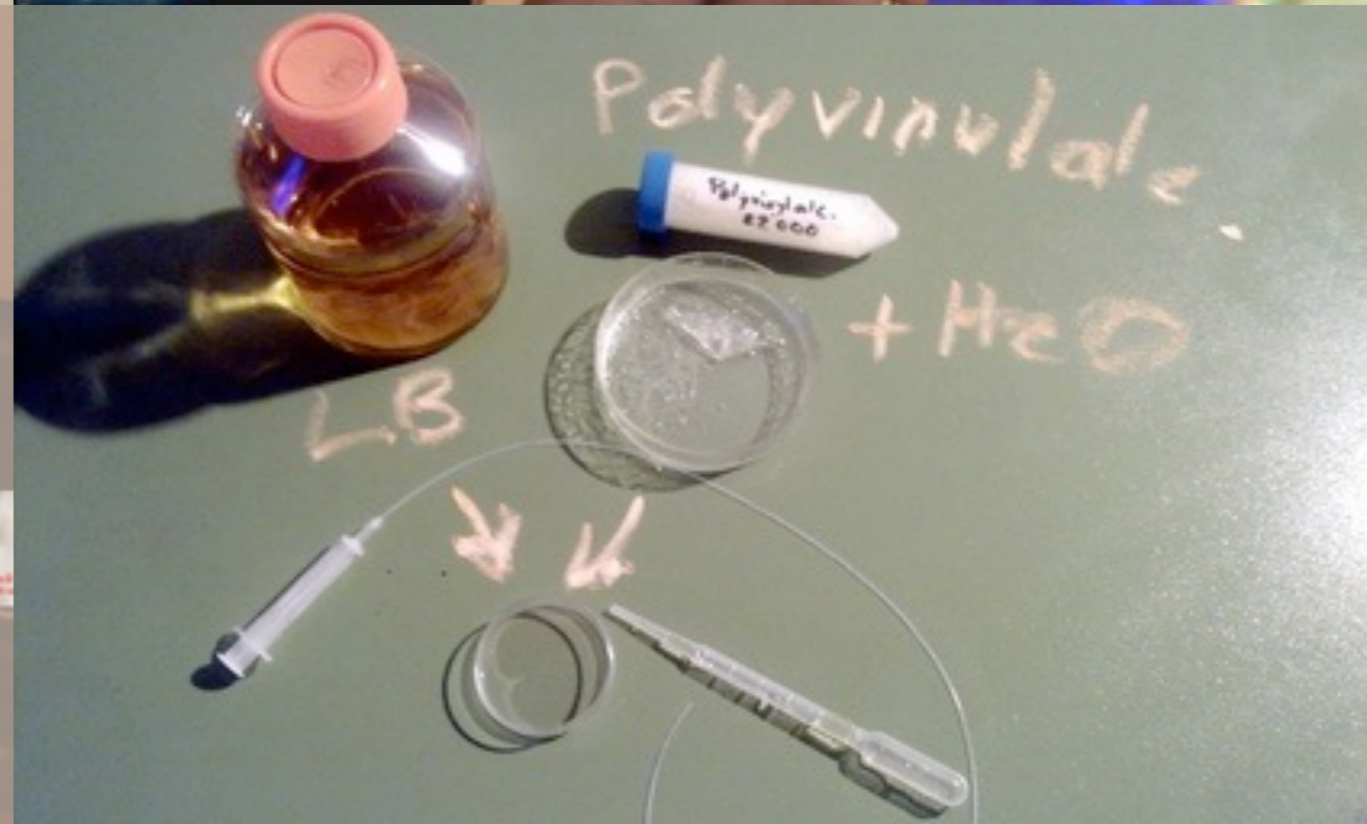




Hackteria, 2009



Biology|LifeSciences|Biotechnology



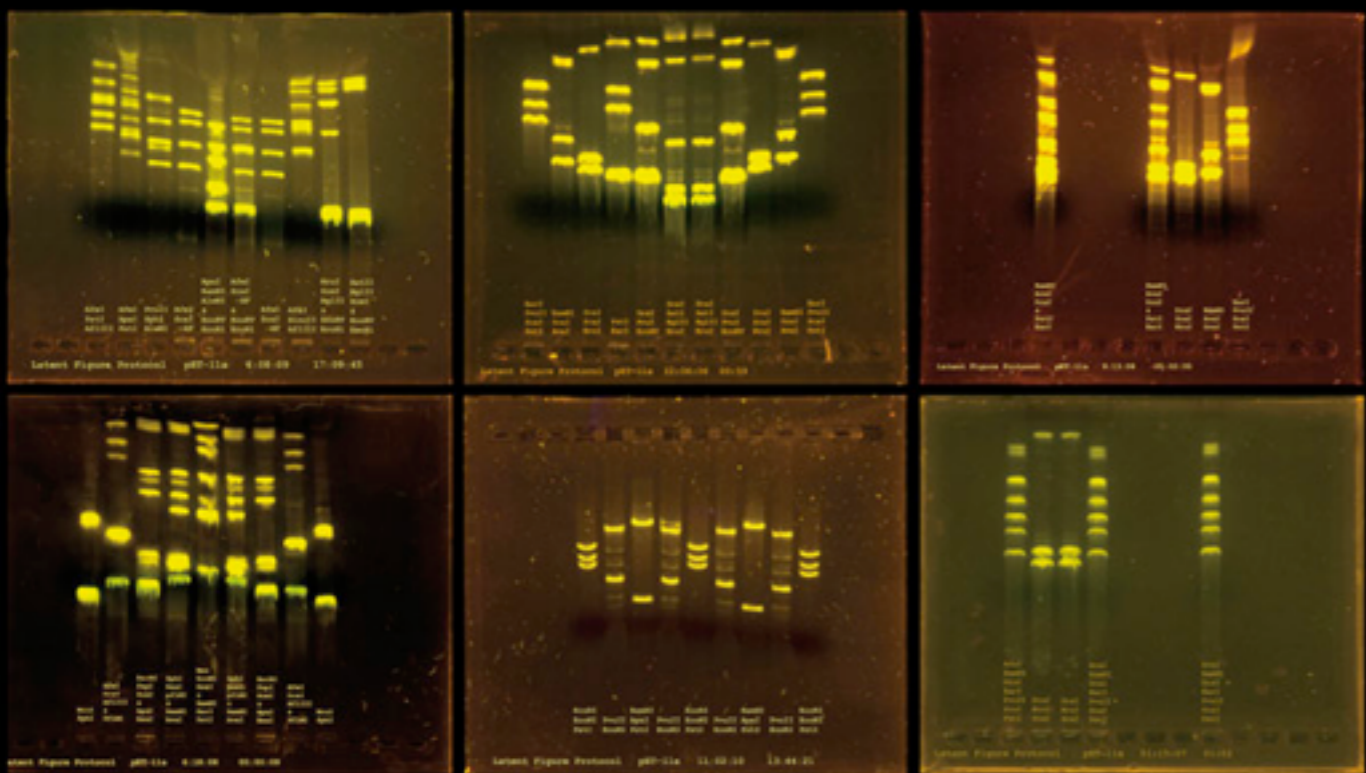
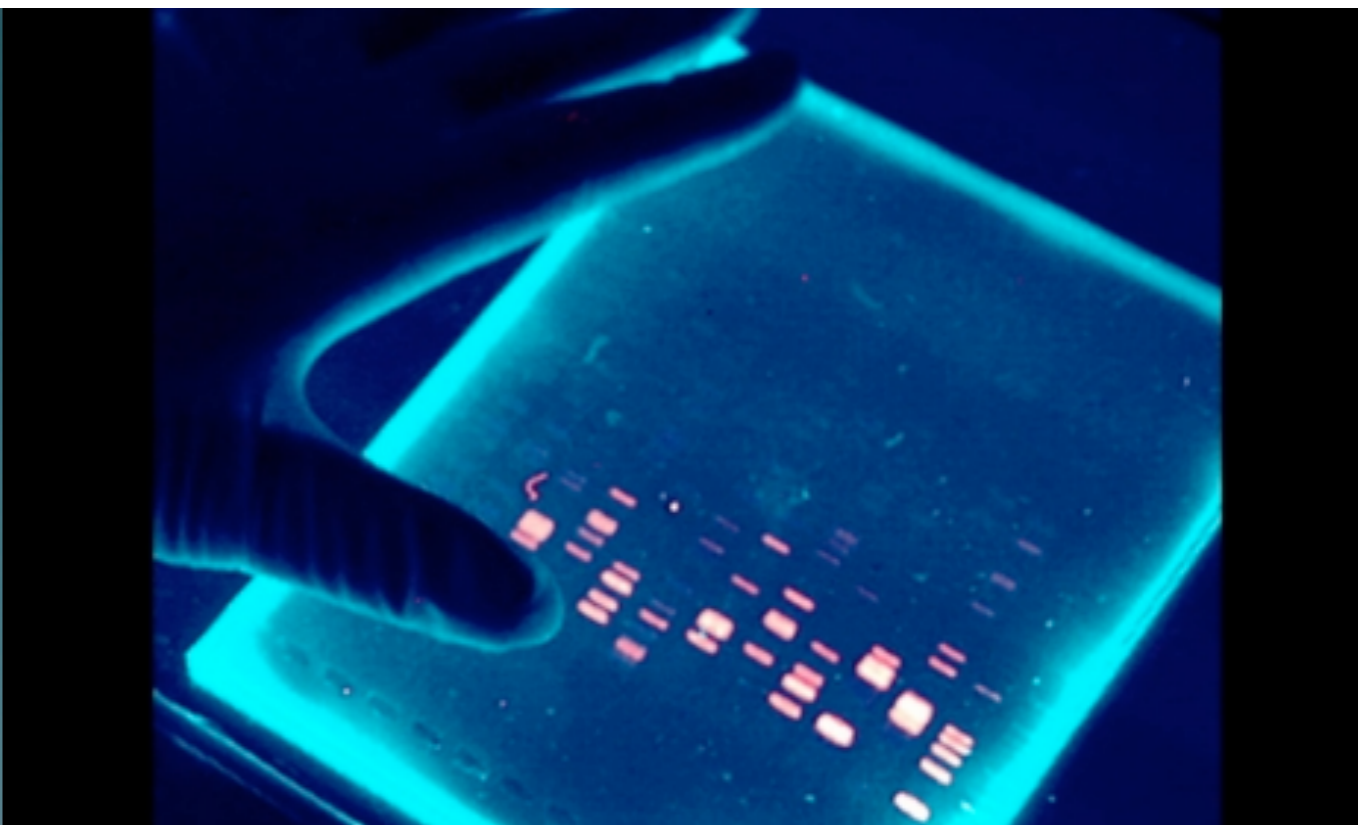


“We thought that a lot of the art and science stuff was too academic and not accessible to the geek artists and, at the same time, the DIYbio was too geeky and not critical or artistic enough,”

- Marc Dusseiller at Interactivos



Paul Vanouse 2009





Kay Aull



Ellen Jorgensen – Genspace 2010





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”



Stallman – Free Software Foundation



FREE SOFTWARE
F O U N D A T I O N



Linus Torvalds





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

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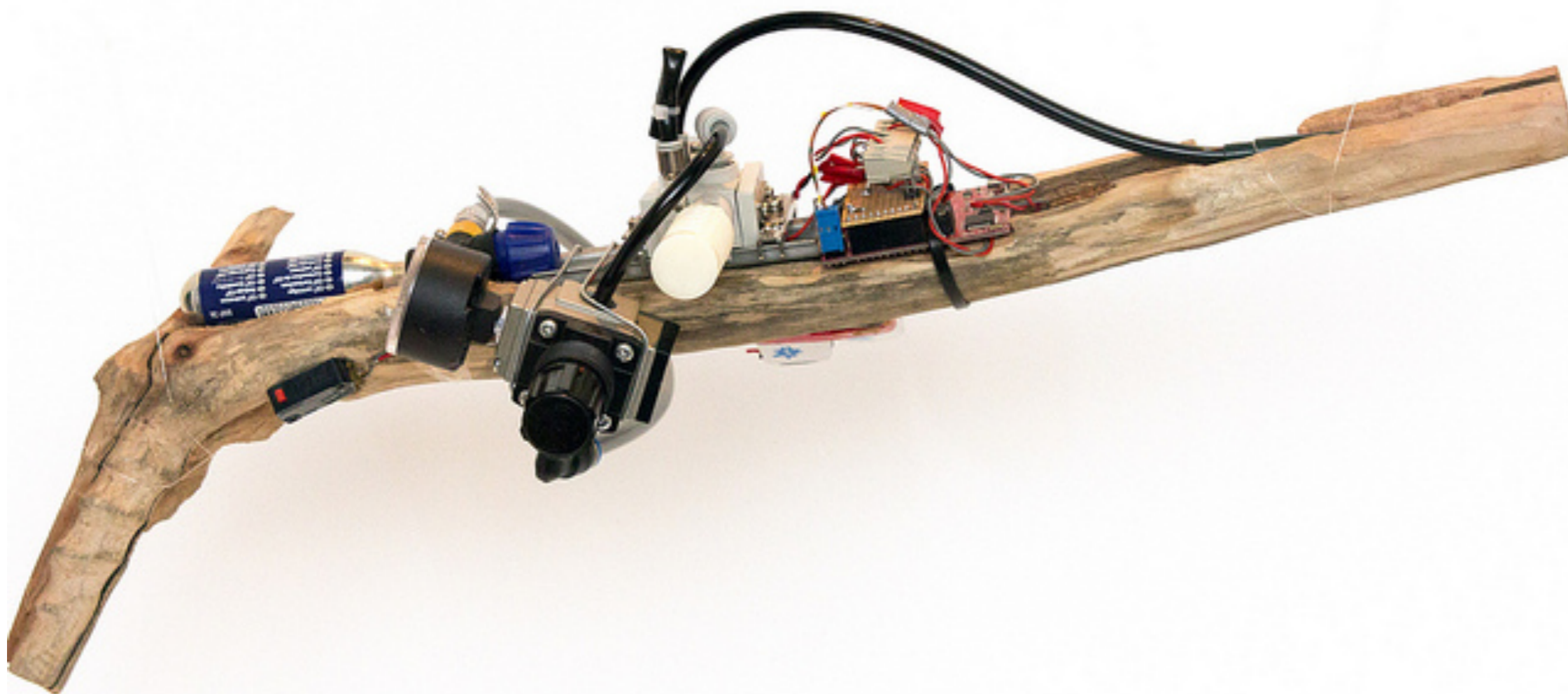
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DIY GeneGun 2012





Labs everywhere

NORTH AMERICA

(MAP)

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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://familab.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://opengenc.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.bionyliken.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





Hackterialab 2014 Yogya





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Market & non-market rationales

“Do it without”: pharma, agrotech

VS

Bio innovation



OpenPCR 2010

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OpenPCR - open source biotech on your desktop

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

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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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Technology - Cork, Ireland

Campaign Home Updates / 27 Comments / 27 Funders / 84

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Raised of €16,000 Goal

14 days left

CONTRIBUTE NOW

Fixed Funding
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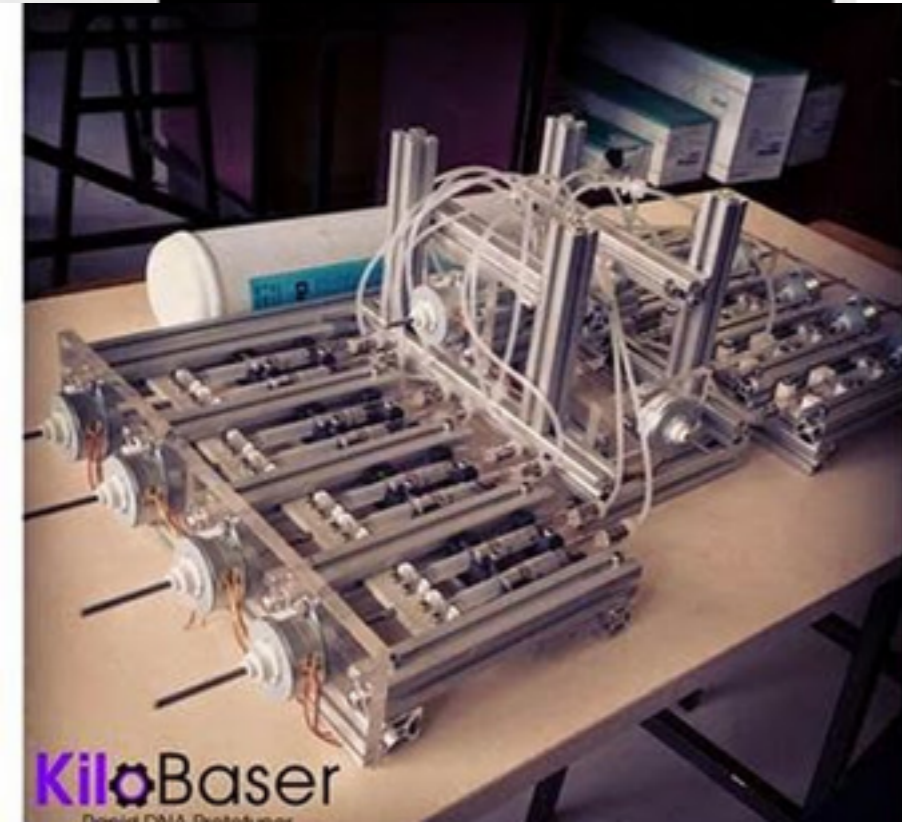
real vegan cheese

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What's vegan cheese?

Real Vegan Cheese is 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!

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OpenTrons

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Immunity project 2014

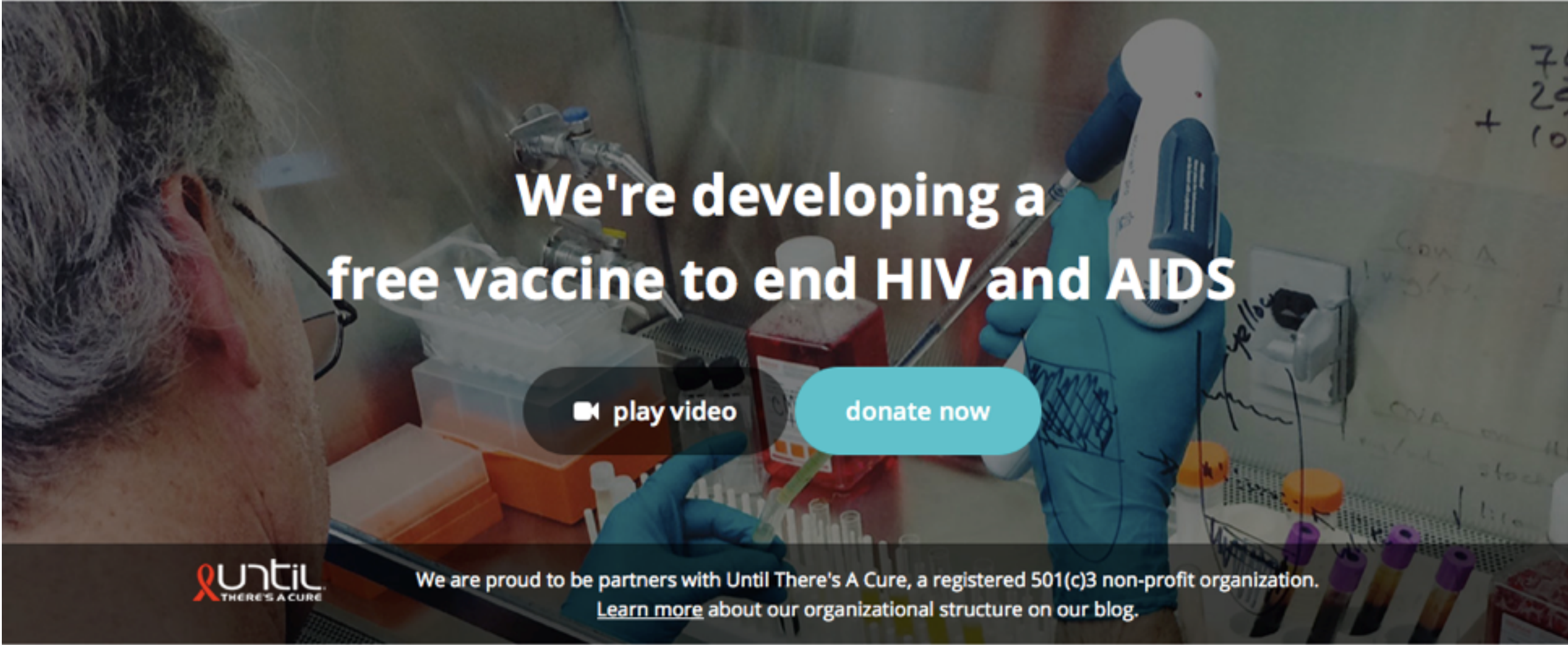


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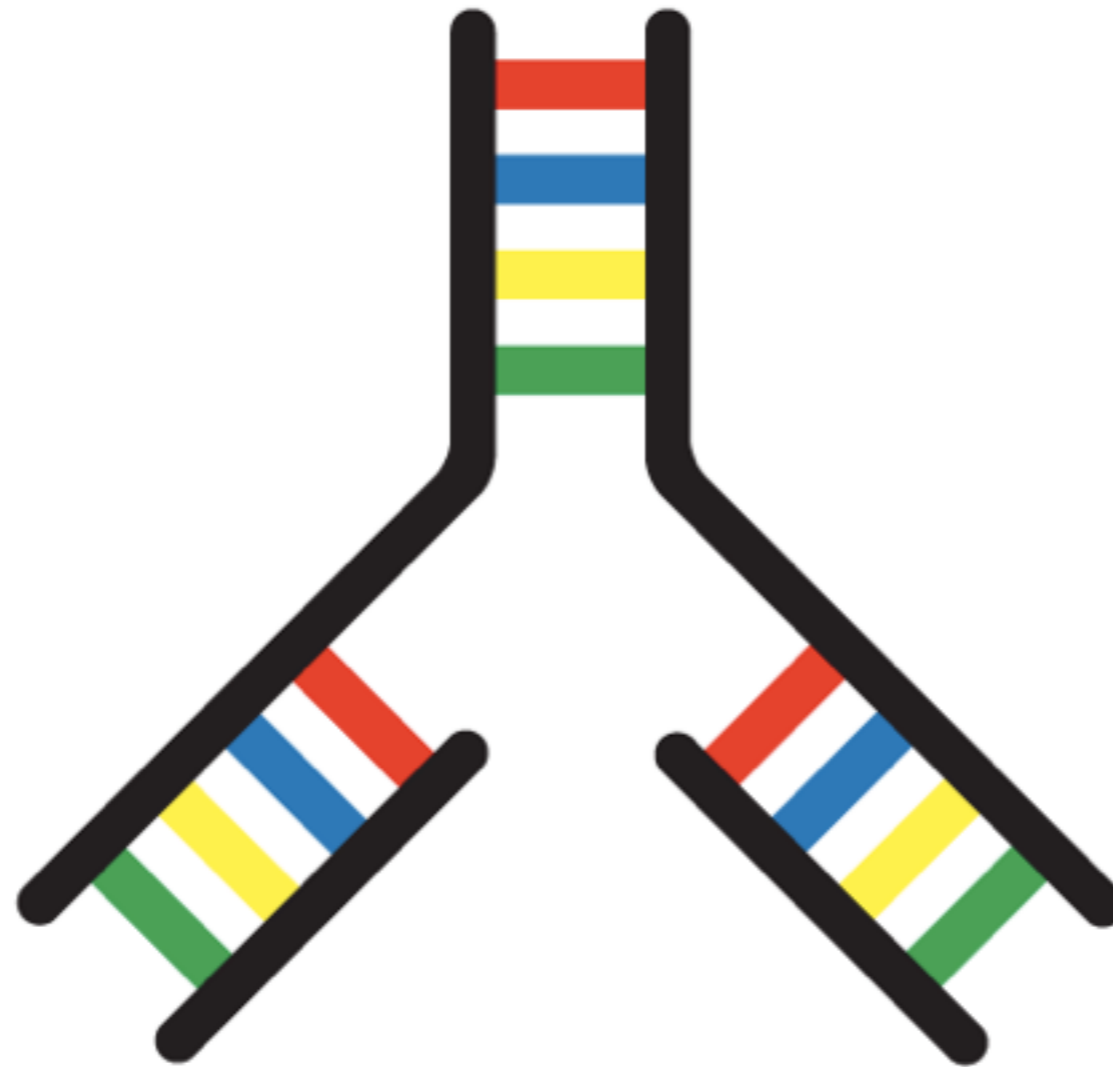


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BGI Micropig



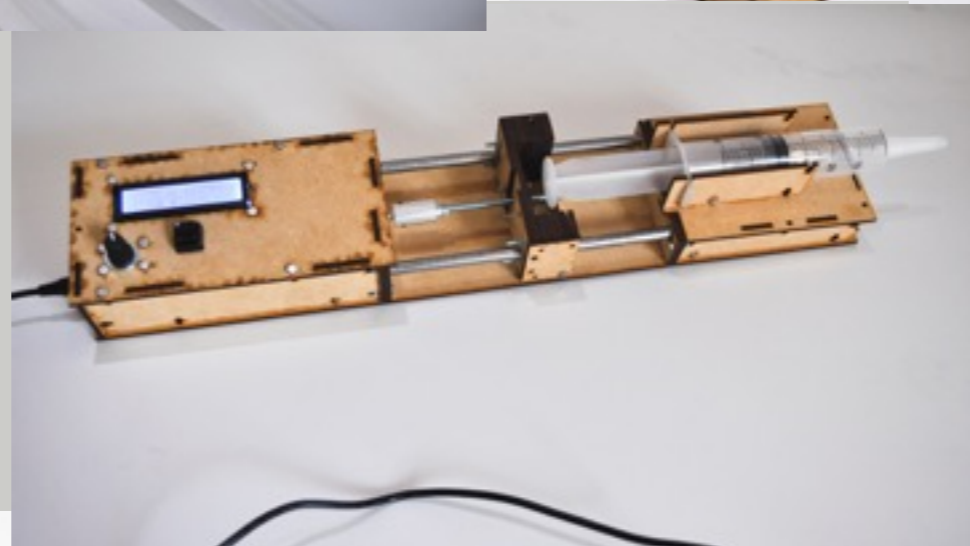
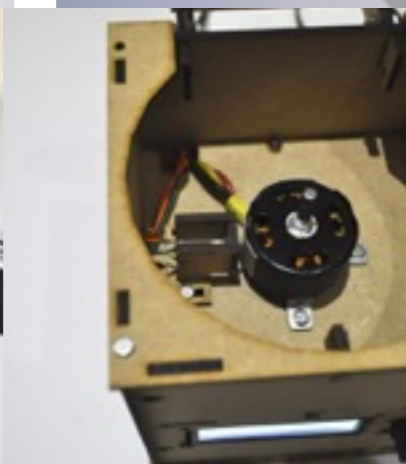
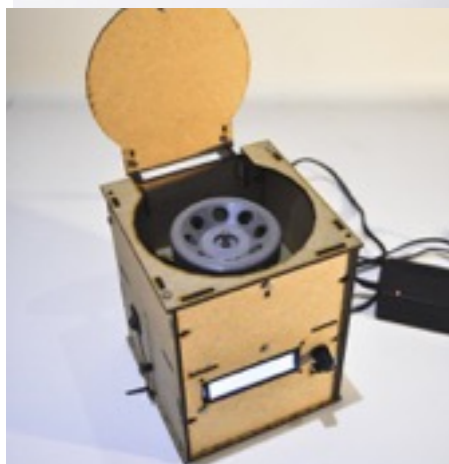
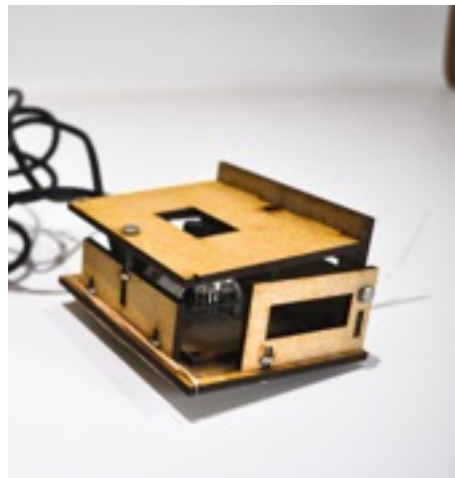


GFP pigs

<https://vimeo.com/82227865>



BioHack Academy





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