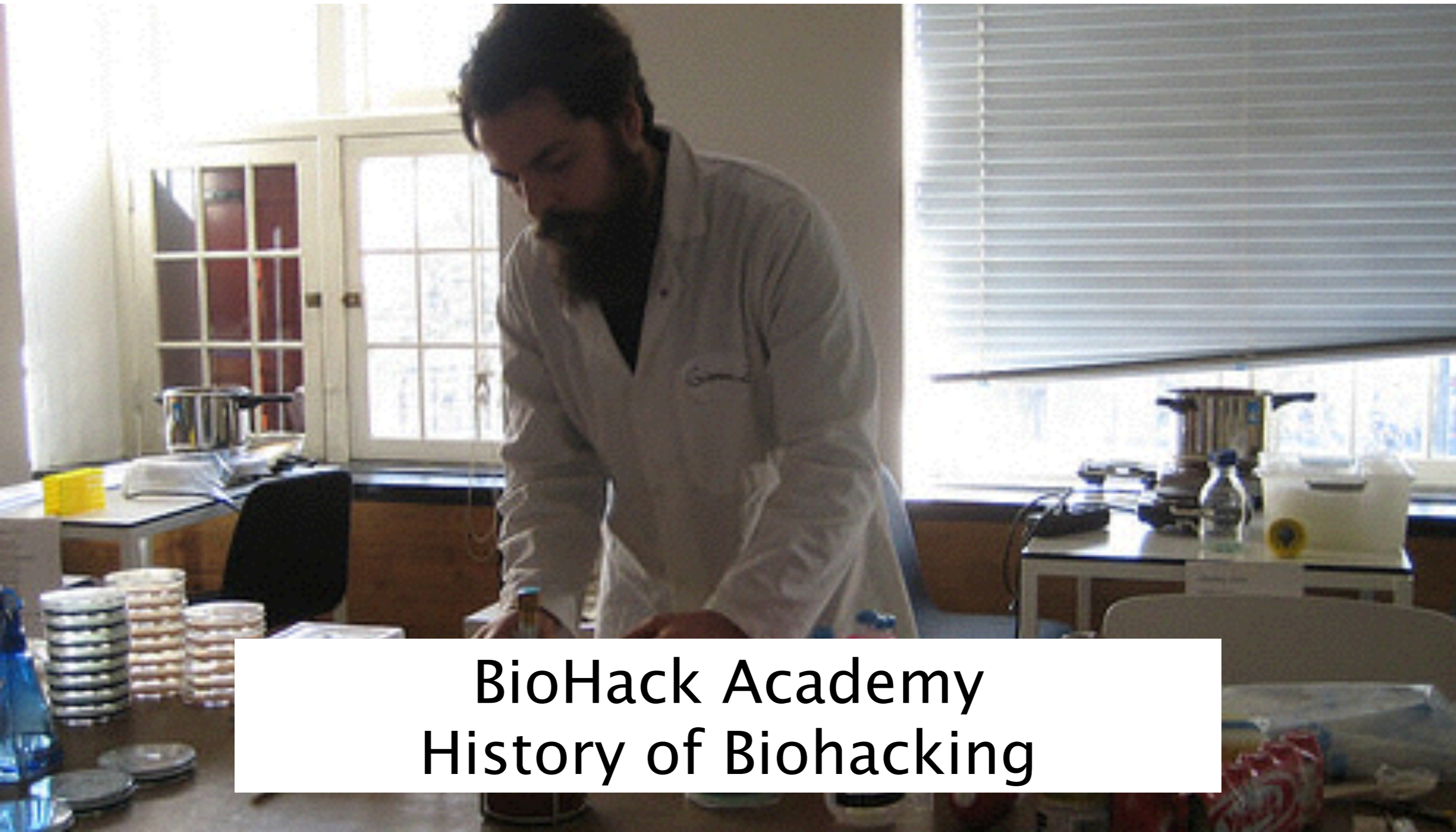




**waag society**

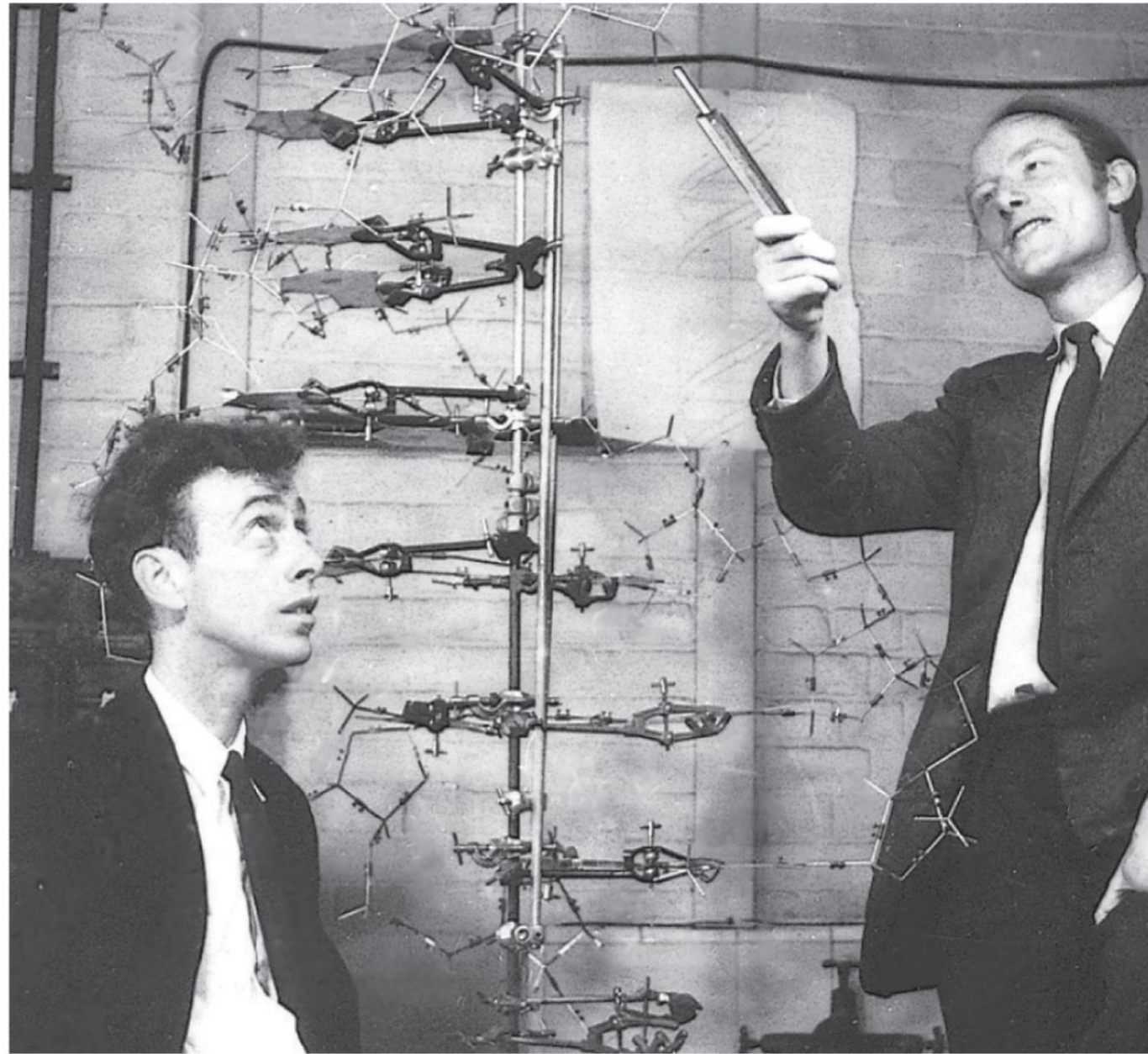
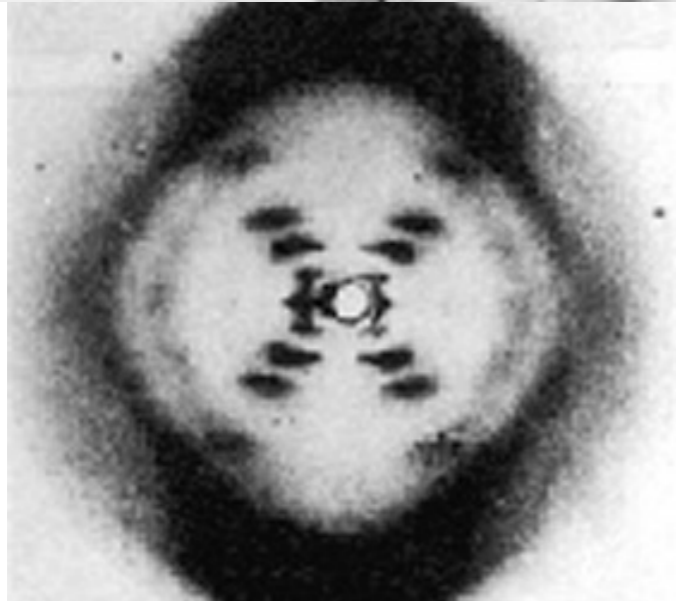
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# BioHack Academy History of Biohacking



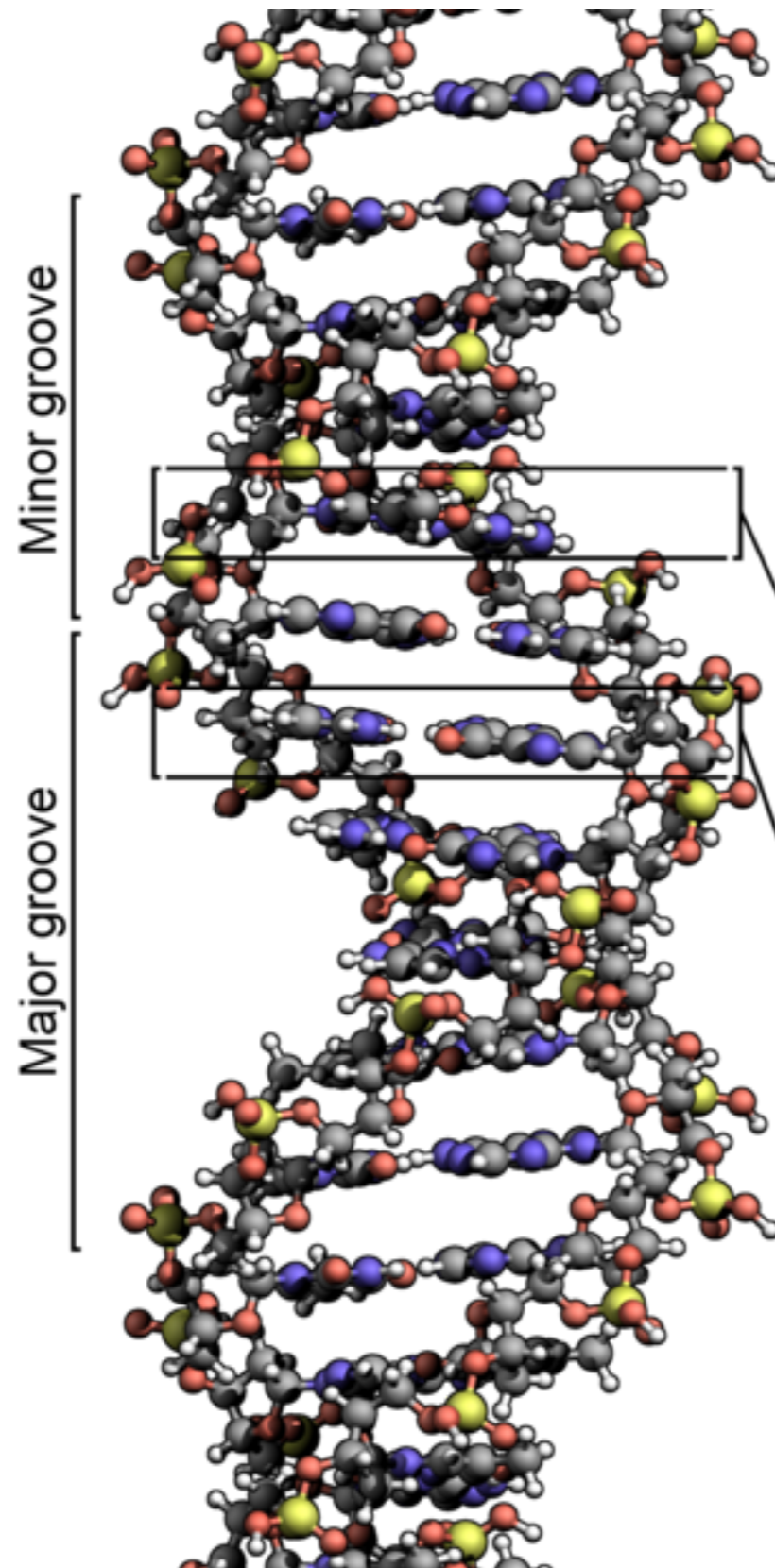
# Discovery of Double Helix 1953



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# DNA Molecule



Living code:

AACATGACCTGACGA

Digital code:

```
100101001110101010101010  
01010101001010101001010110  
1101111001
```



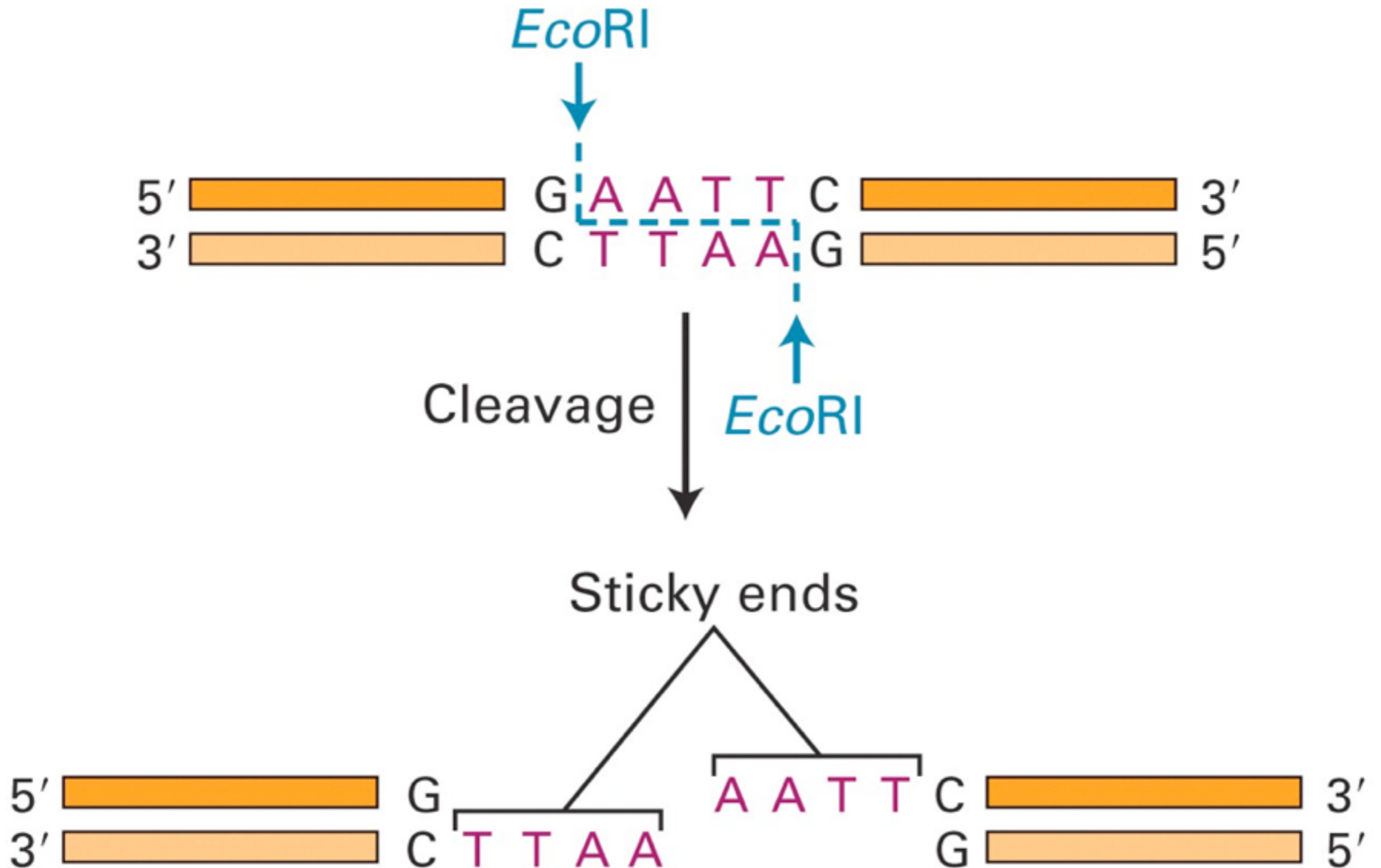
# Robert W. Holley, Marshall Nirenberg, Har Gobind Khorana 1968





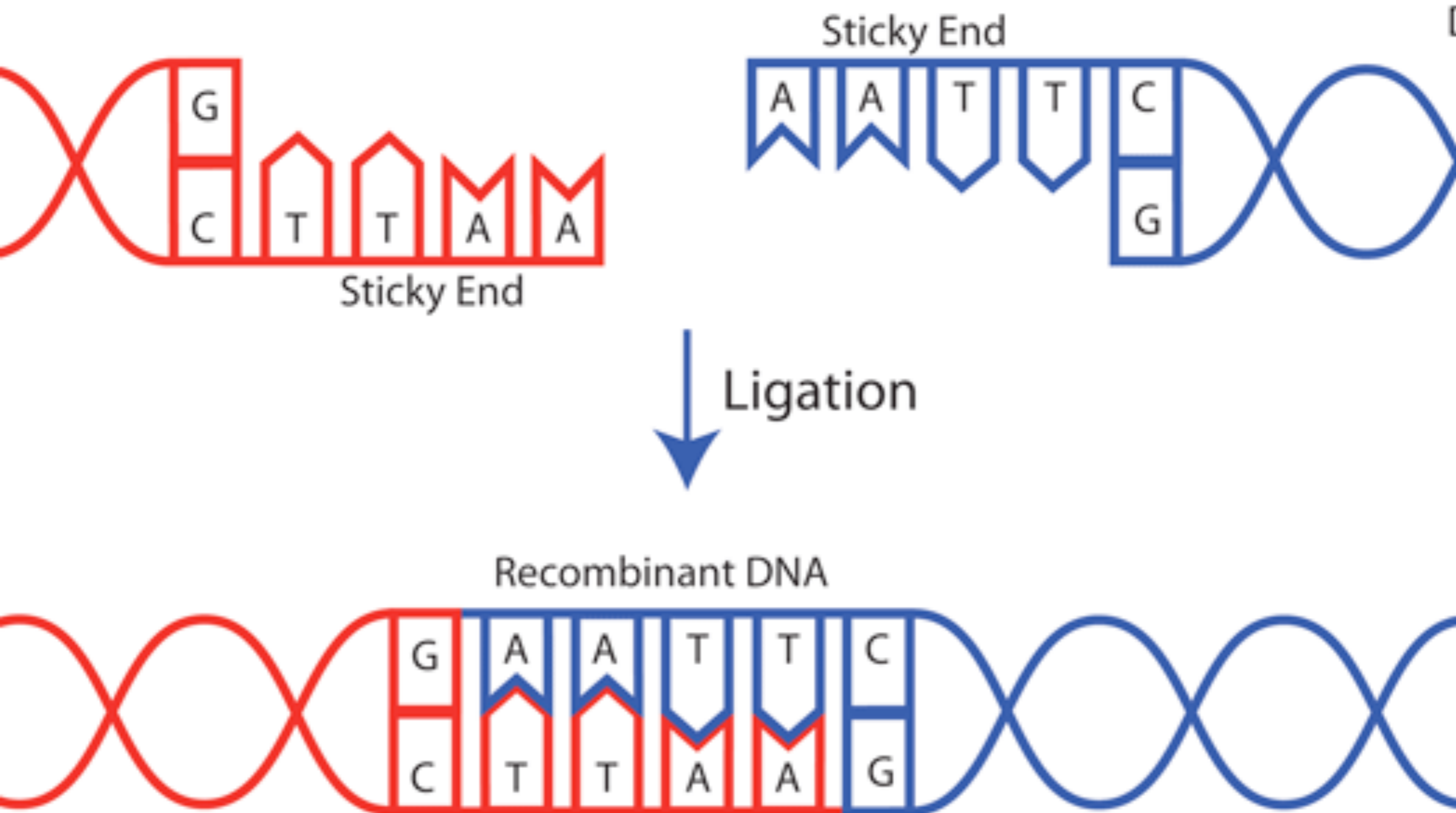


# Restriction Enzyme 1970





# DNA ligase, 1967





# Reading DNA 1977



Courtesy of Dr. F. Sanger, MRC, Cambridge.  
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**Different-length strands can be lined up by size to determine DNA sequence.**

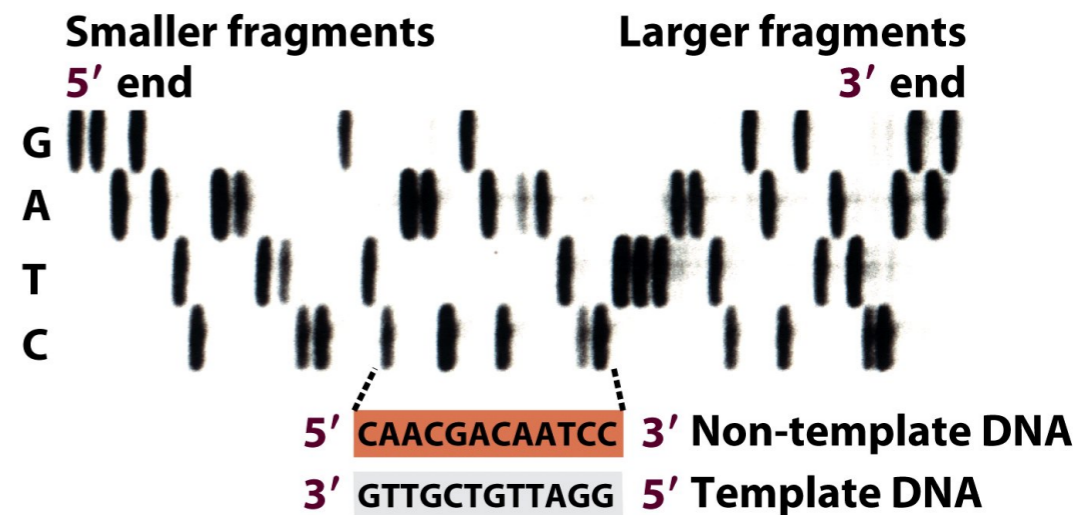
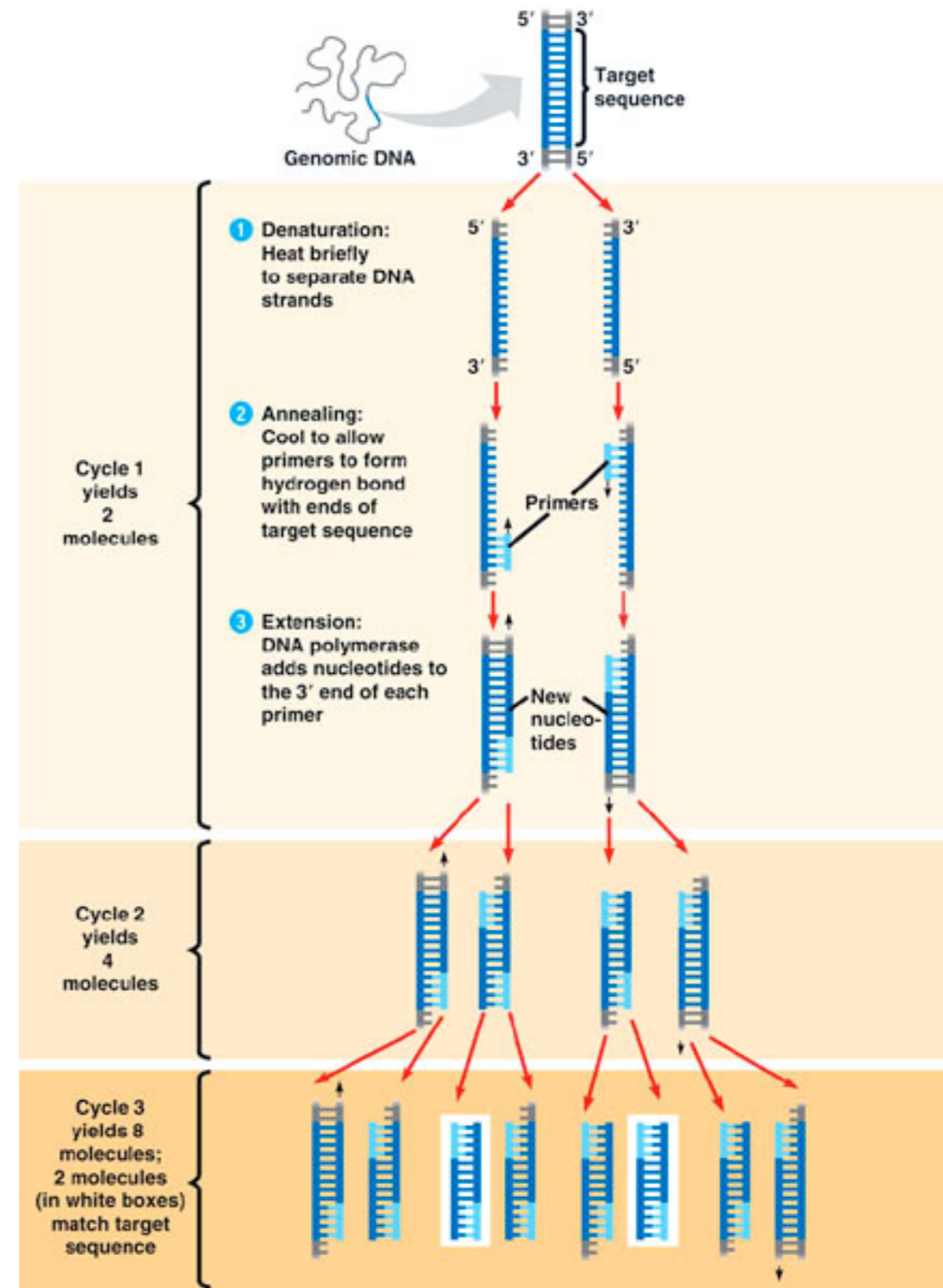


Figure 19-6c Biological Science, 2/e





# Polymerase Chain Reaction, 1983



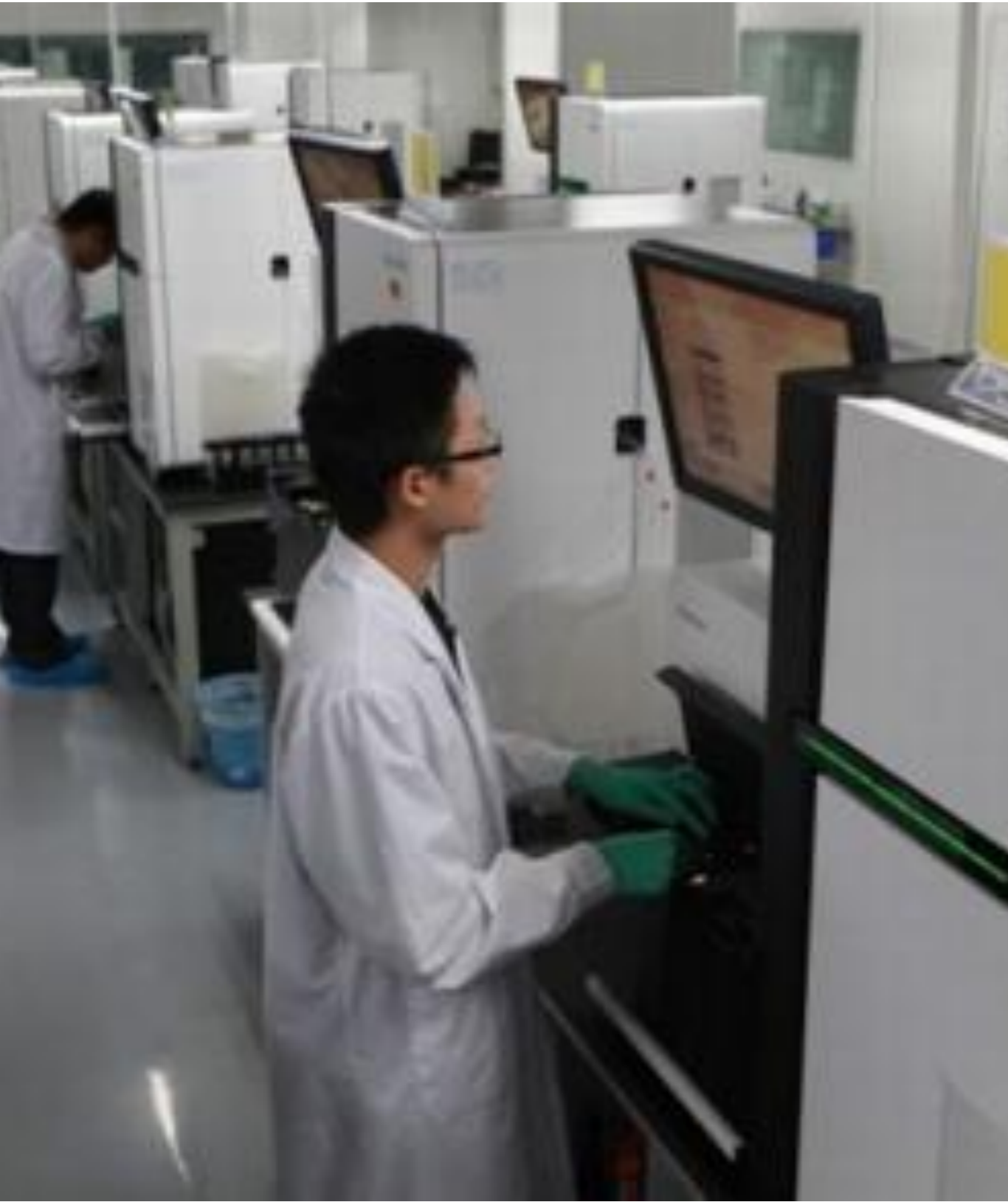


# Reading DNA 2014



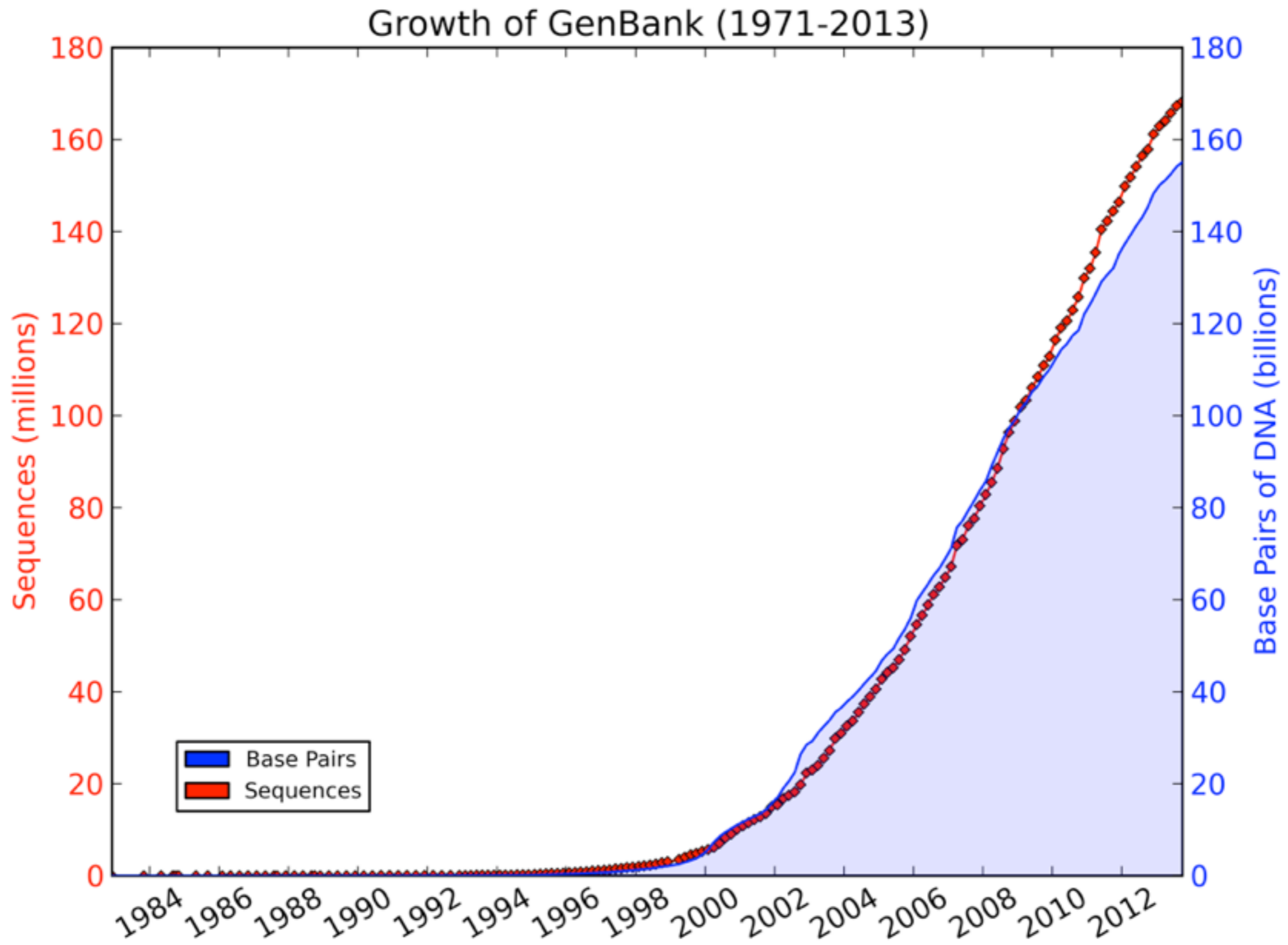


# Beijing Genomics Institute



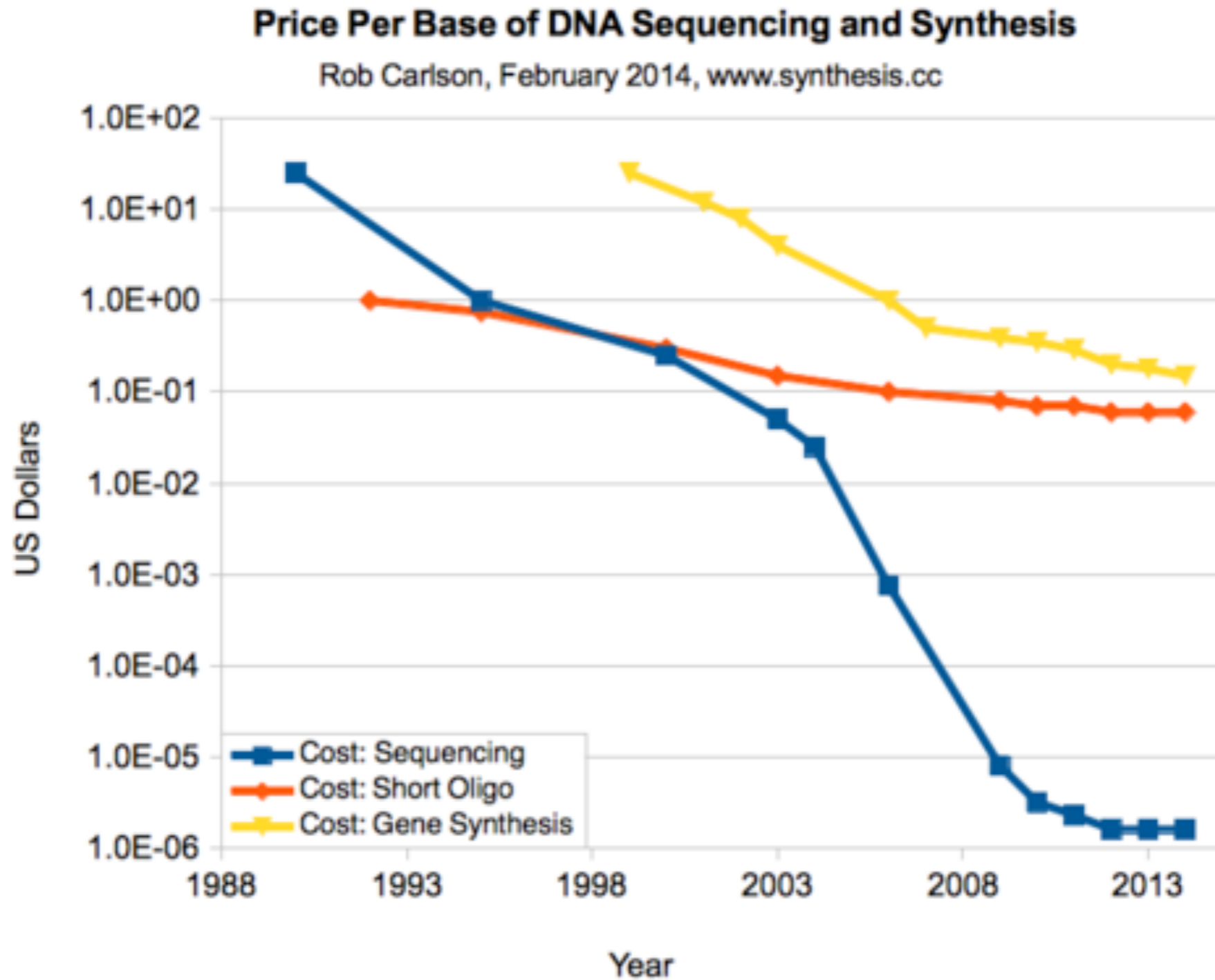


# Growth of Genbank



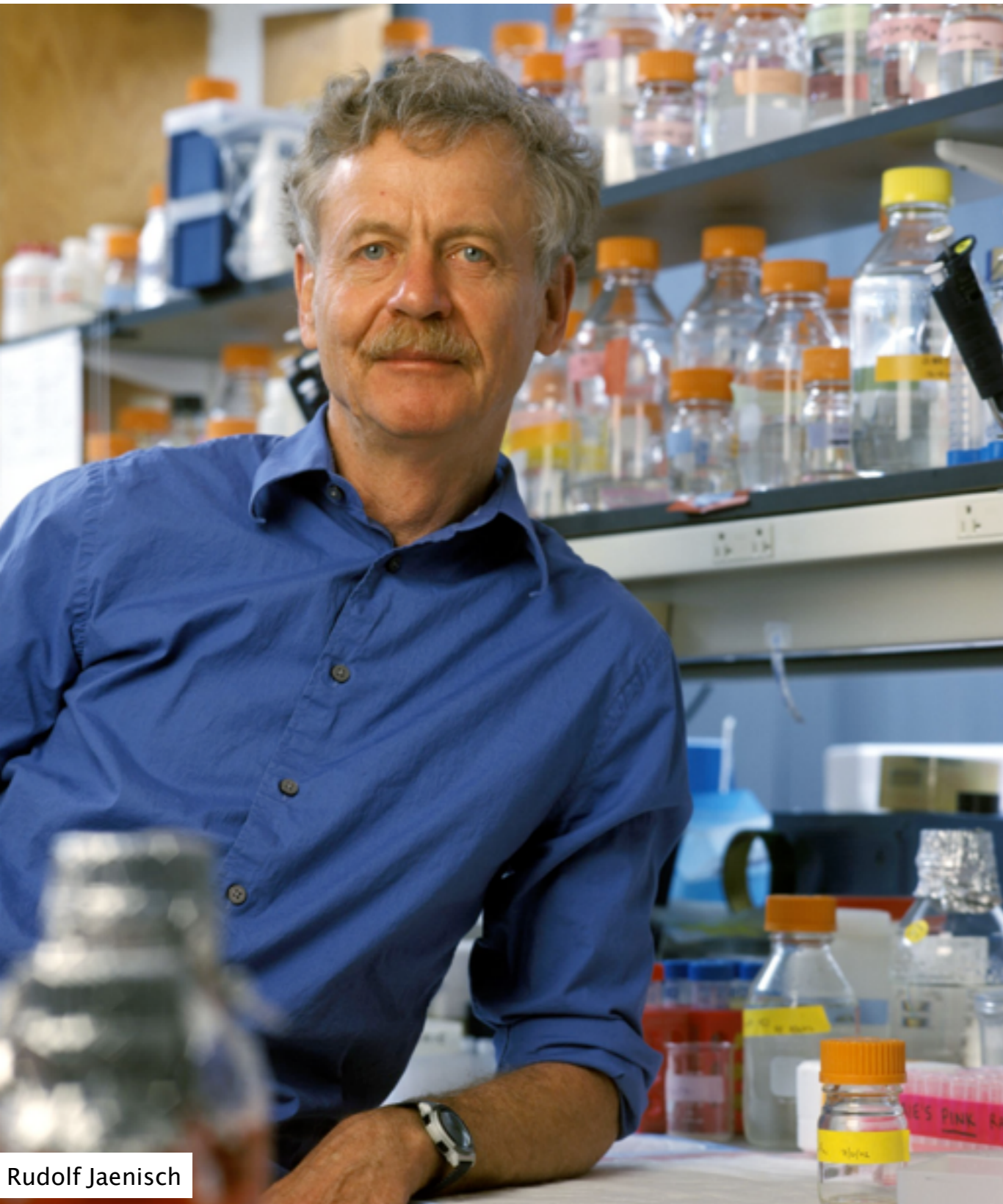


# Cost of DNA

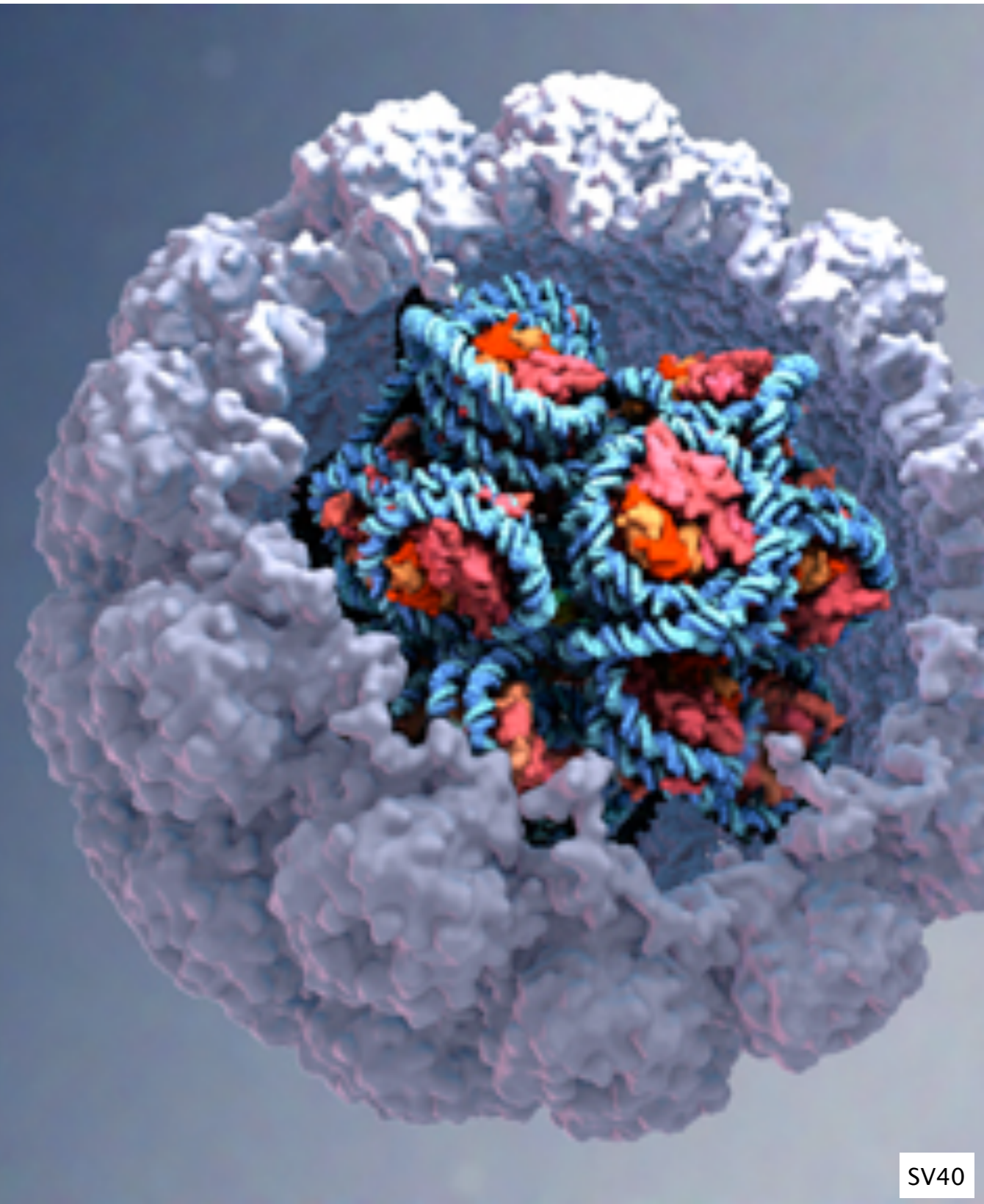




# Transgenic Mouse, 1973



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<sup>\*</sup>, RICHARD B. FLAVELL<sup>\*</sup> & MARY-DELL CHILTON<sup>†</sup>

<sup>\*</sup>Plant Breeding Institute, Maris Lane, Trumpington, Cambridge CB2 2LQ, UK

<sup>†</sup>Department of Biology, Washington University, St Louis, Missouri 63130, USA

**The T-DNA region of *Agrobacterium tumefaciens* tumour-inducing plasmids of the nopaline type<sup>1</sup> 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<sup>2</sup>. 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<sup>4</sup>. 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<sup>5</sup>. 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. *Plant Cell* 1, 149-164 (1989). | [Open Peer Review on Nature Portfolio](#)



# Oncogene mouse, Phil Leder, Tim Stewart 1984







# Joe Davis, 1987

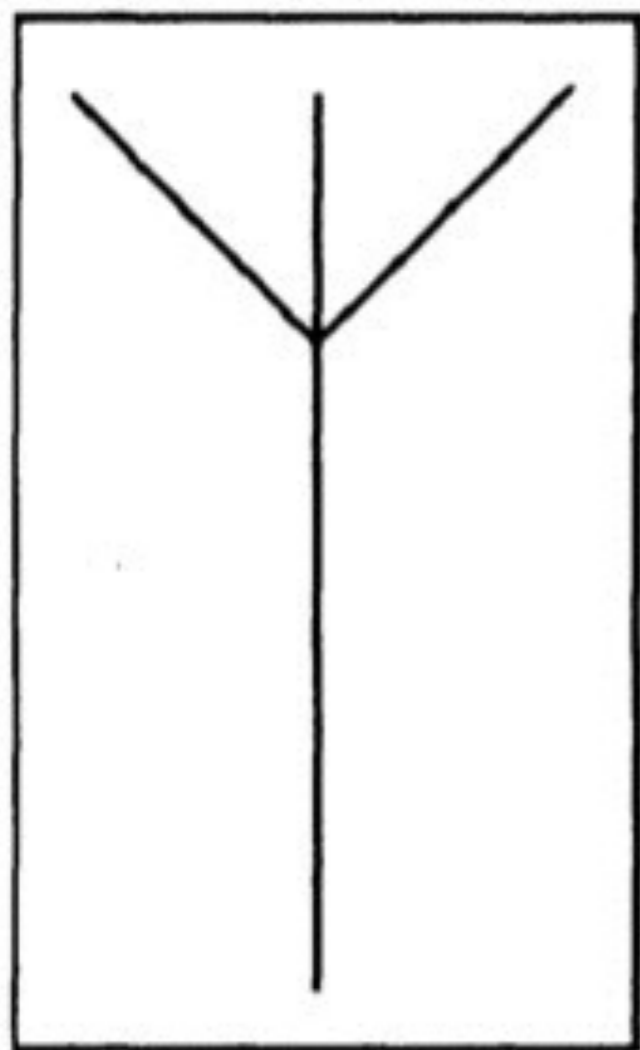


FIG. 1 *Microvenus* icon.



```
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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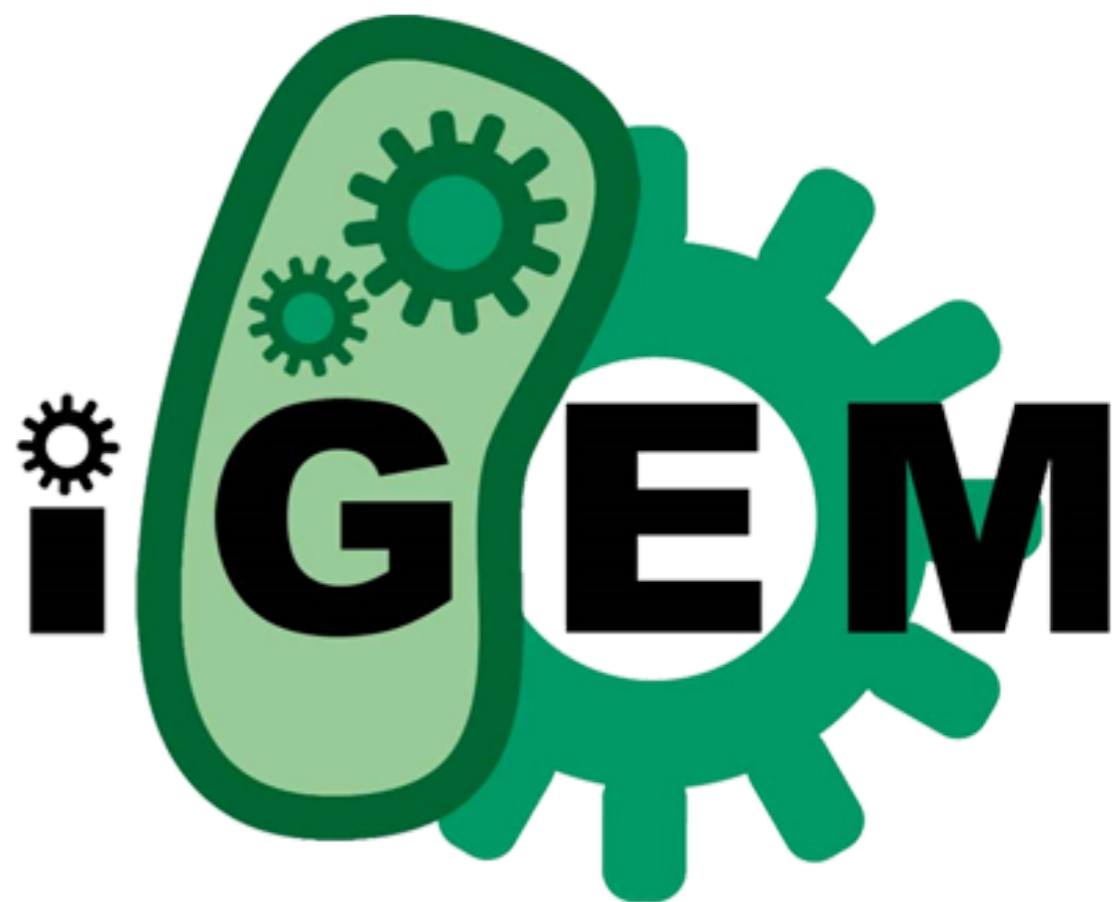
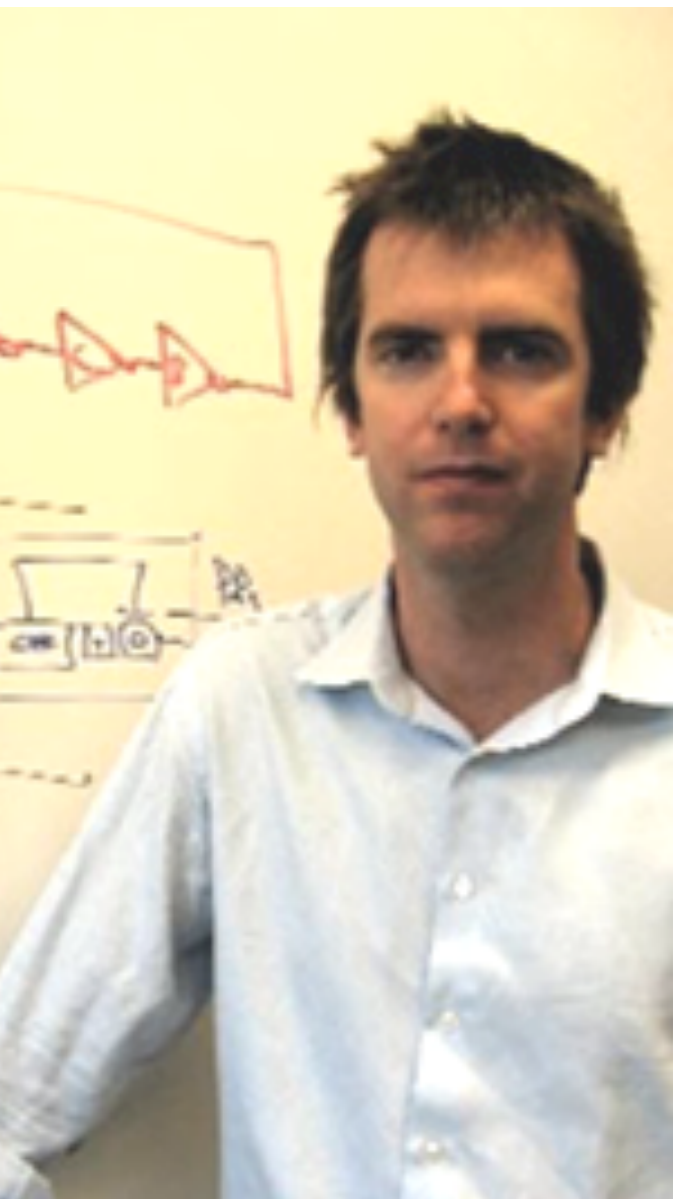
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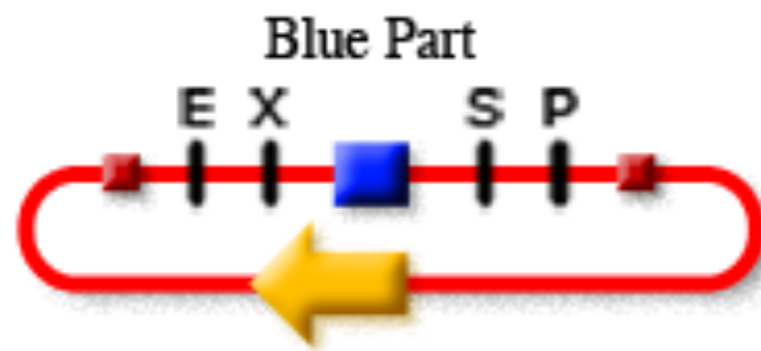


# Drew Andy, Tom Knight

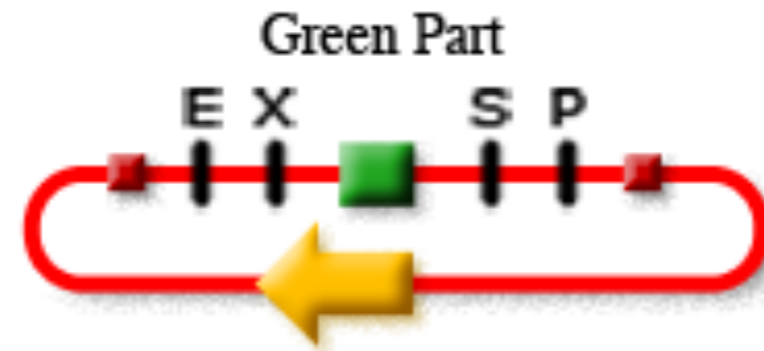
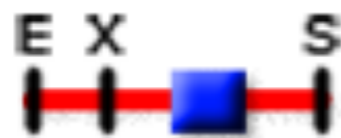




# Biobrick standard 2003



Cut with  
EcoRI and SpeI



Cut with  
EcoRI and XbaI



Mix and Ligate  
(Blue-Green Part)







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# Bioart & Design

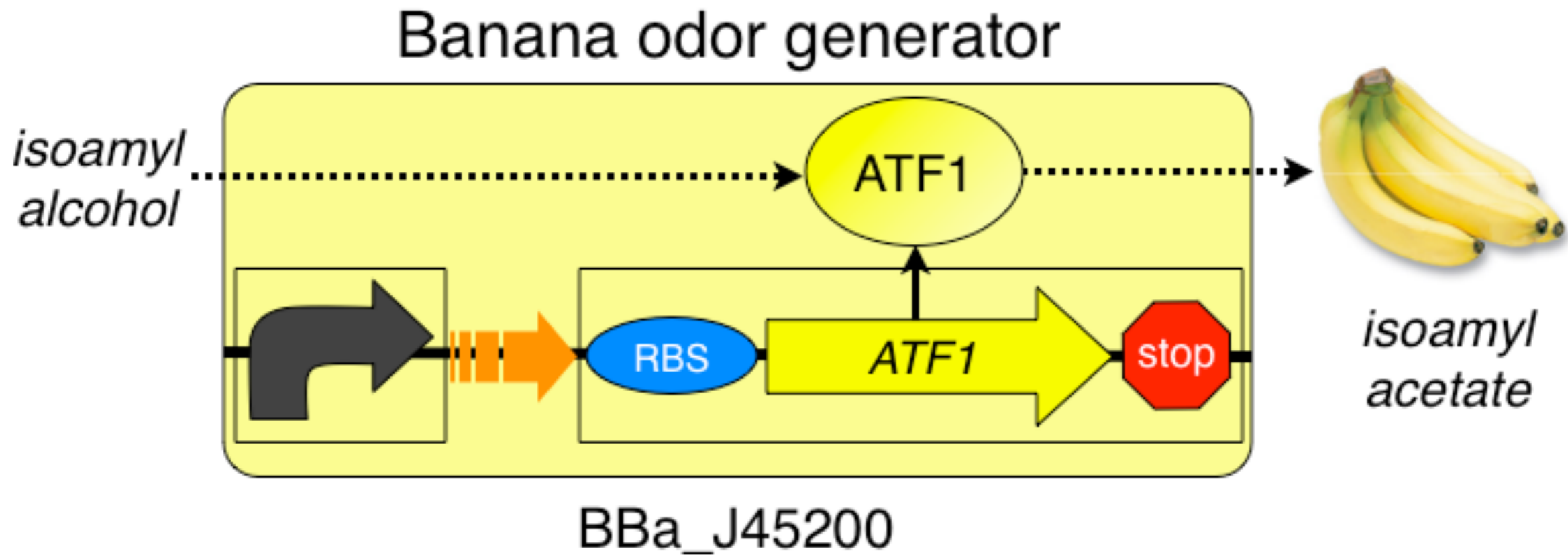


# UT Austin/UCSF team 2004





# Banana Odor generator MIT, 2006





E Chromi, Cambridge UK 2009





# Bio art and design: E-chromi

Scatalog

## 1. Drink

Drink a bottle of *E.chromi* Scatalog probiotic once weekly. Anhydrobiotic granules contain synthetic bacteria.



## 2. Colonise

The gut is colonised by *E.chromi* bacteria that secrete colours in presence of chemical signals.



Colitis

Rotavirus

Colorectal Cancer

OK!

Salmonella

Worms

Stomach Ulcer

## 4. Personalise

Genetic susceptibility can be managed easily.

## 3. Monitor

If change is detected, bacteria produce a colour signal visible in faeces.



*E.chromi*

Cheap, Personalised Disease Monitoring using synthetic bacterial technology



# Center for Postnatural History – Rich Pell





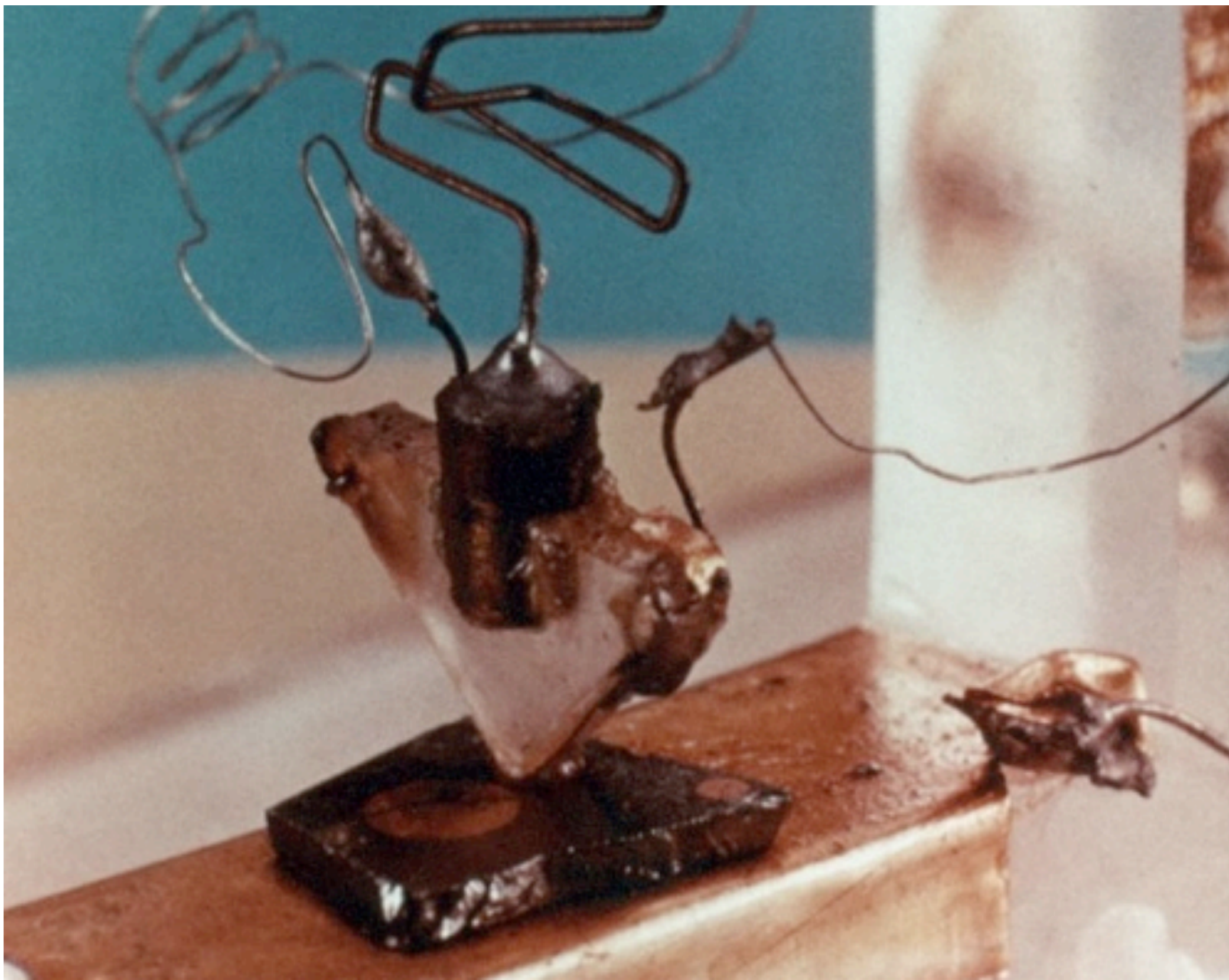
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# Biology & hacking



# Inspiration & justification







Joe Davis





# Critical Art Ensemble – Free Range Grain 2003



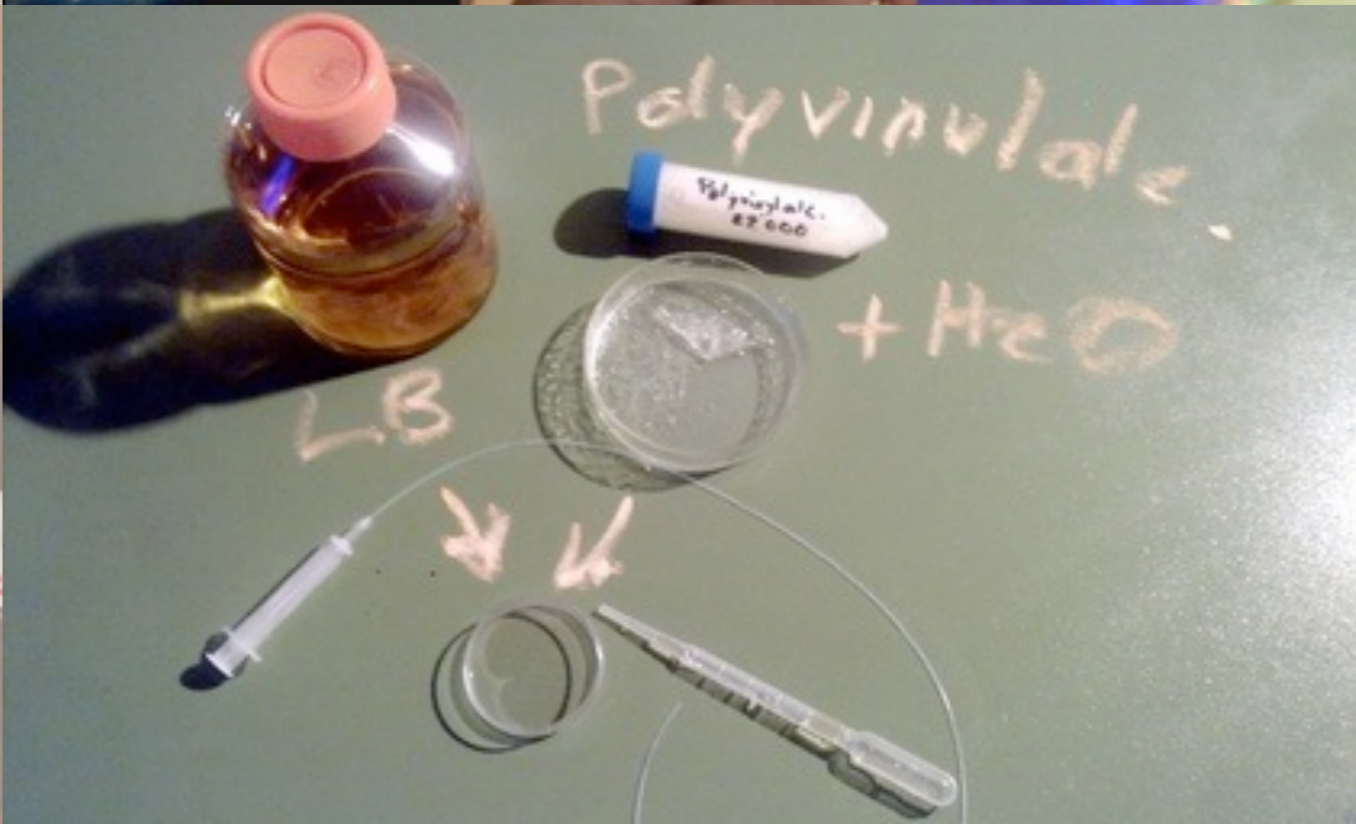
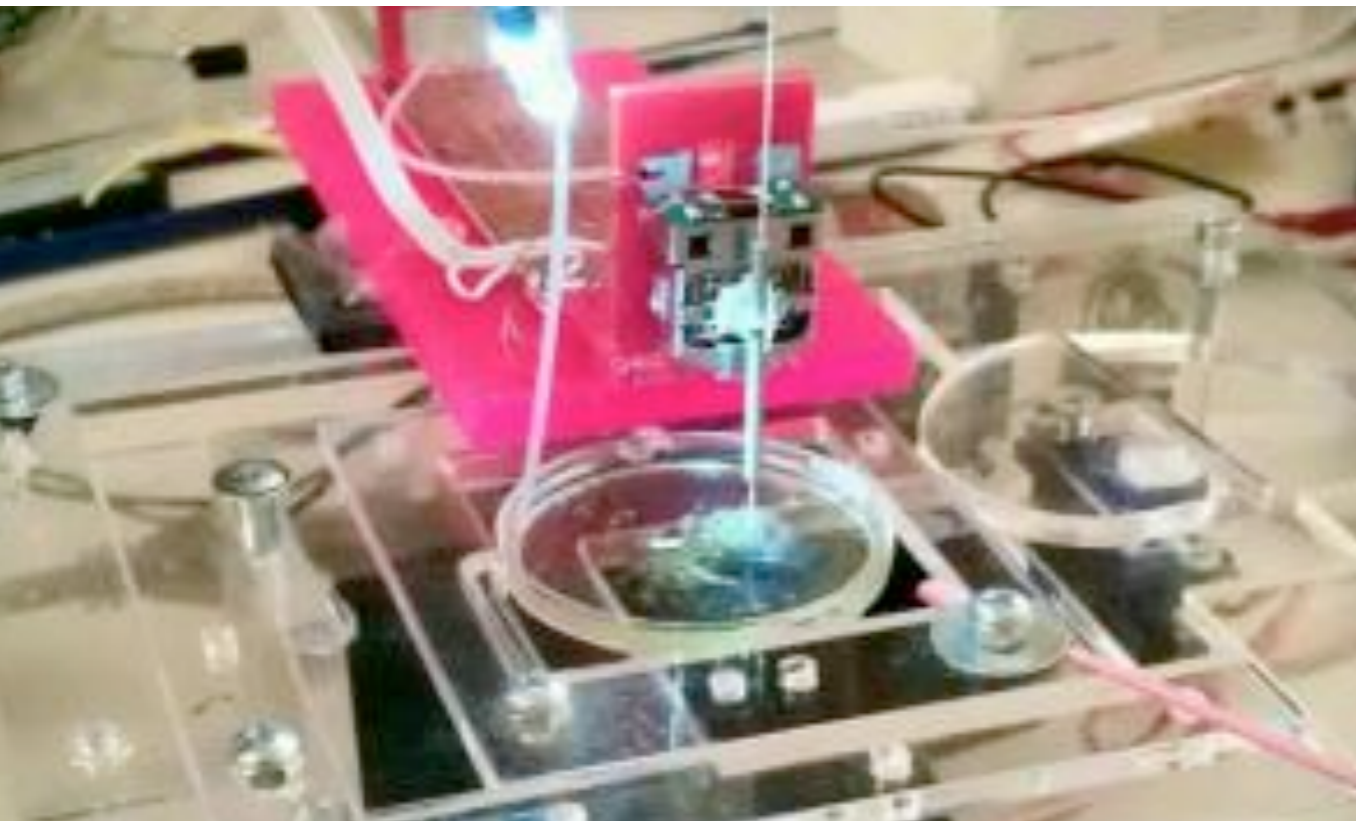


# DIYBio 2008





# Hackteria, 2009



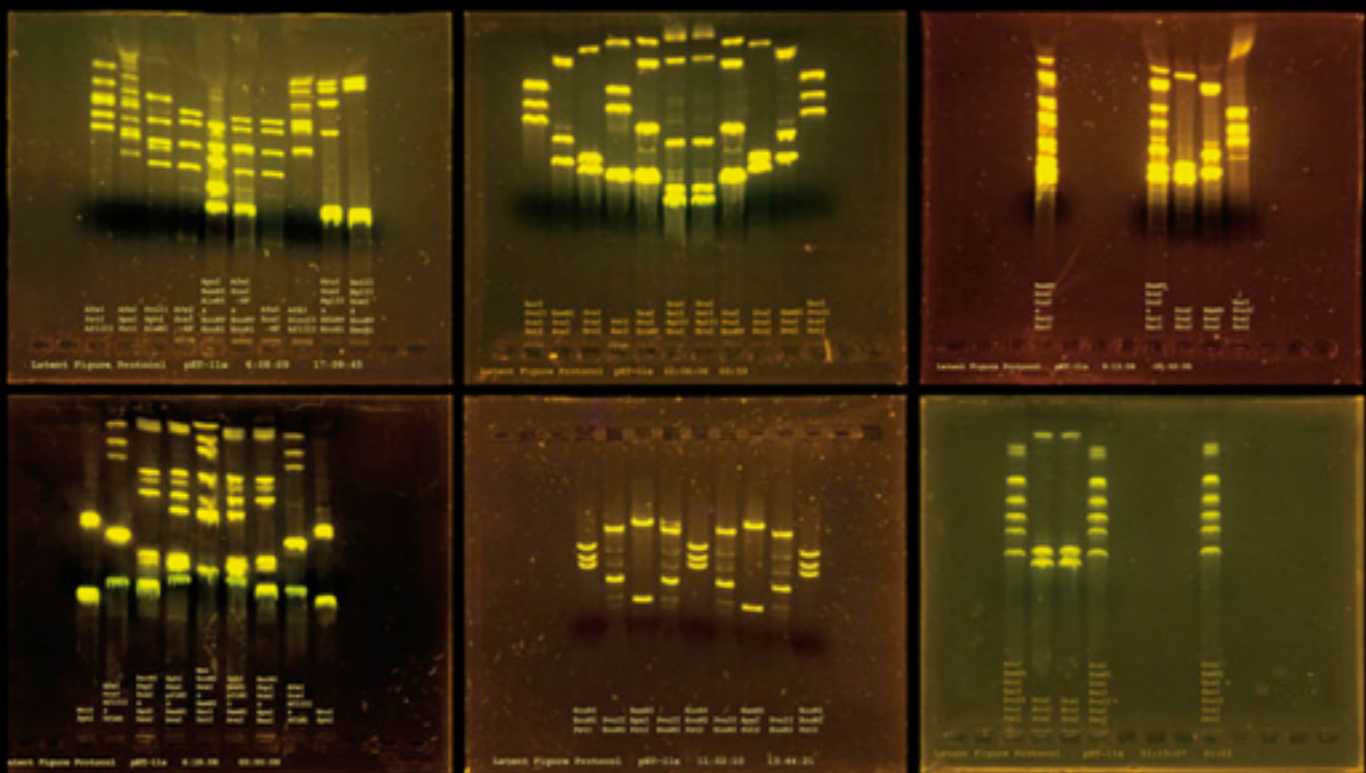
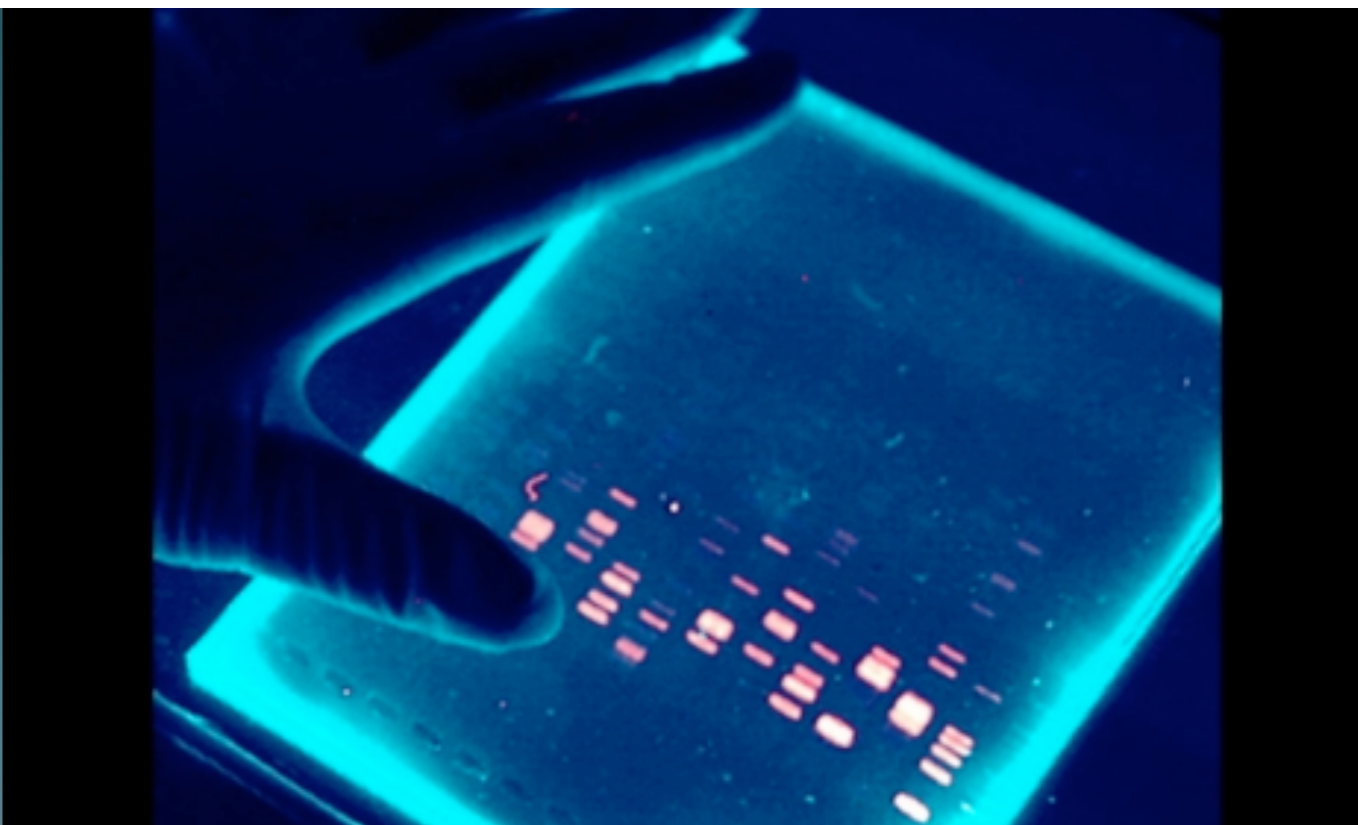


“We thought that a lot of the art and science stuff was too academic and not accessible to the geek artists and, at the same time, the DIYbio was too geeky and not critical or artistic enough,”

- 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](#) ➔

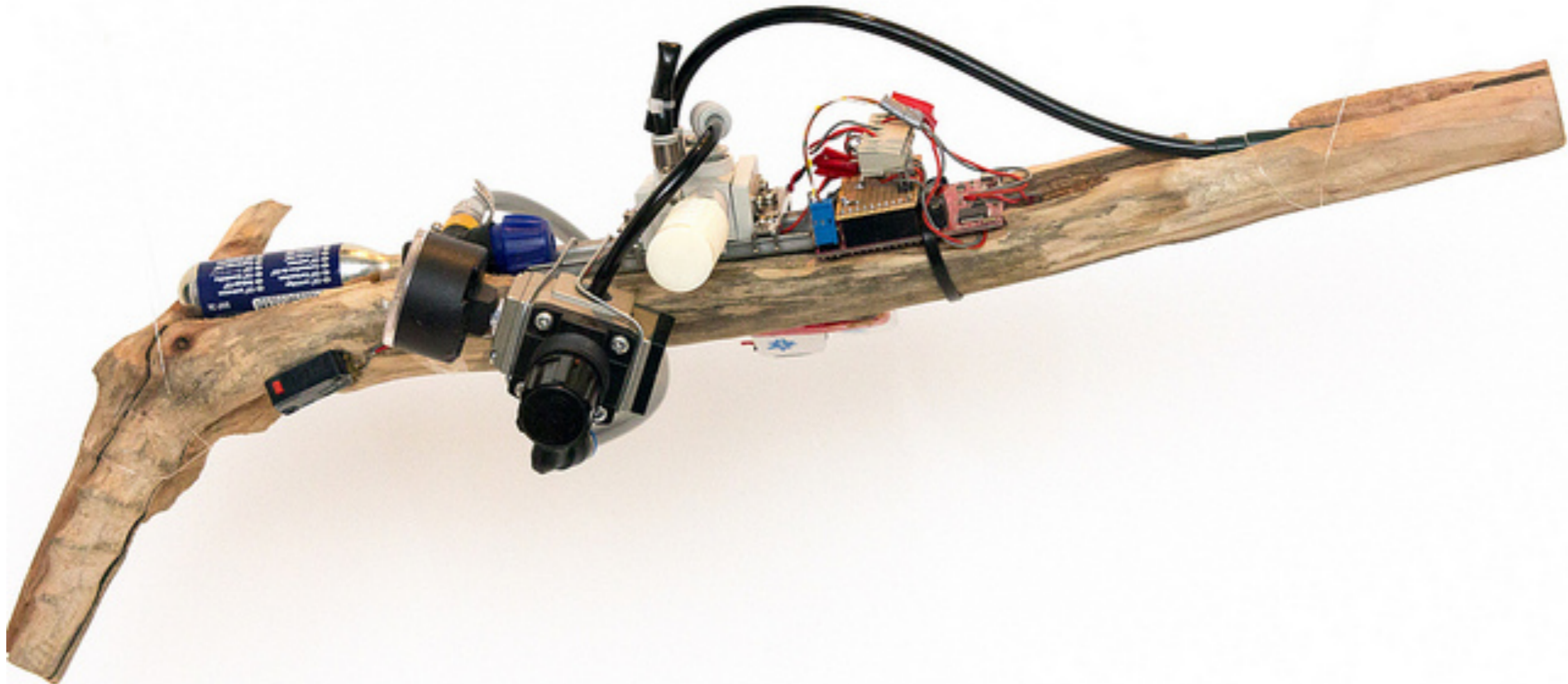
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[Purchase a print copy](#) ➔





# DIY GeneGun 2012





# Ontology

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



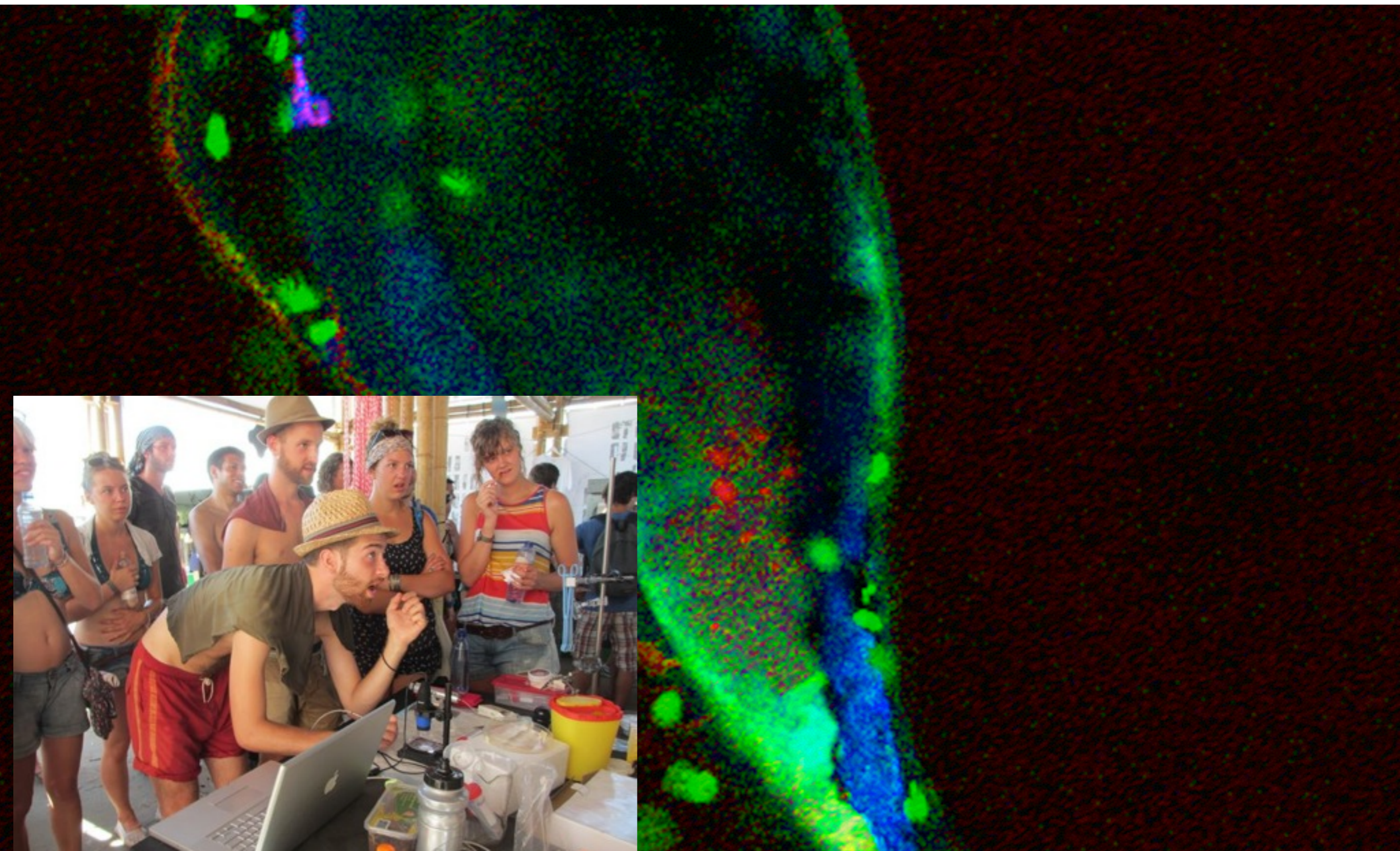
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# Biohacking at the Waag



# Bio art and performance art – Bio Solar Ensemble





# Making competent cells – Clab







# Hack the Brain





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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

**IndieBB: Your First GMO**  
IndieBB: a DNA system designed to help you and your friends to explore genetic engineering and synthetic biology by making fluorescent bacteria at home.  
Technology - Cork, Ireland

€6,927 EUR  
Raised of €16,000 Goal  
14 days left

**CONTRIBUTE NOW**

**Fixed Funding**  
This campaign will only receive funds if at least €16,000 EUR is raised by its deadline. Funding duration: January 22, 2014 - March 13, 2014 (11:00am PT).

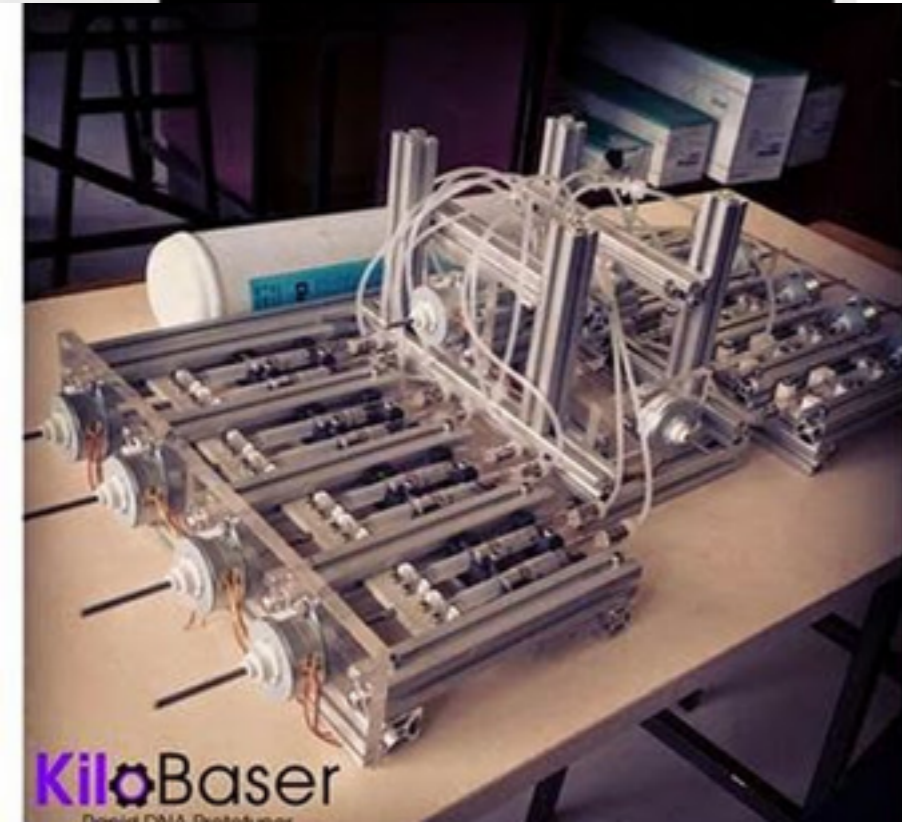
**real vegan cheese**

Science Ethics Contribute Community Team Press Ask a Biohacker Wiki

## 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: Open-Source Rapid Prototyping for Biology

by OpenTrons

Home Updates 2 Backers 135 Comments 6 Brooklyn, NY Robots

**KICKSTARTER STAFF PICK**

**135** Backers  
**\$50,375** pledged of \$100,000 goal  
**17** days to go

**Back This Project**  
\$1 minimum pledge

This project will only be funded if at least \$100,000 is pledged by Sun, Nov 30 2014



# Immunity project 2014

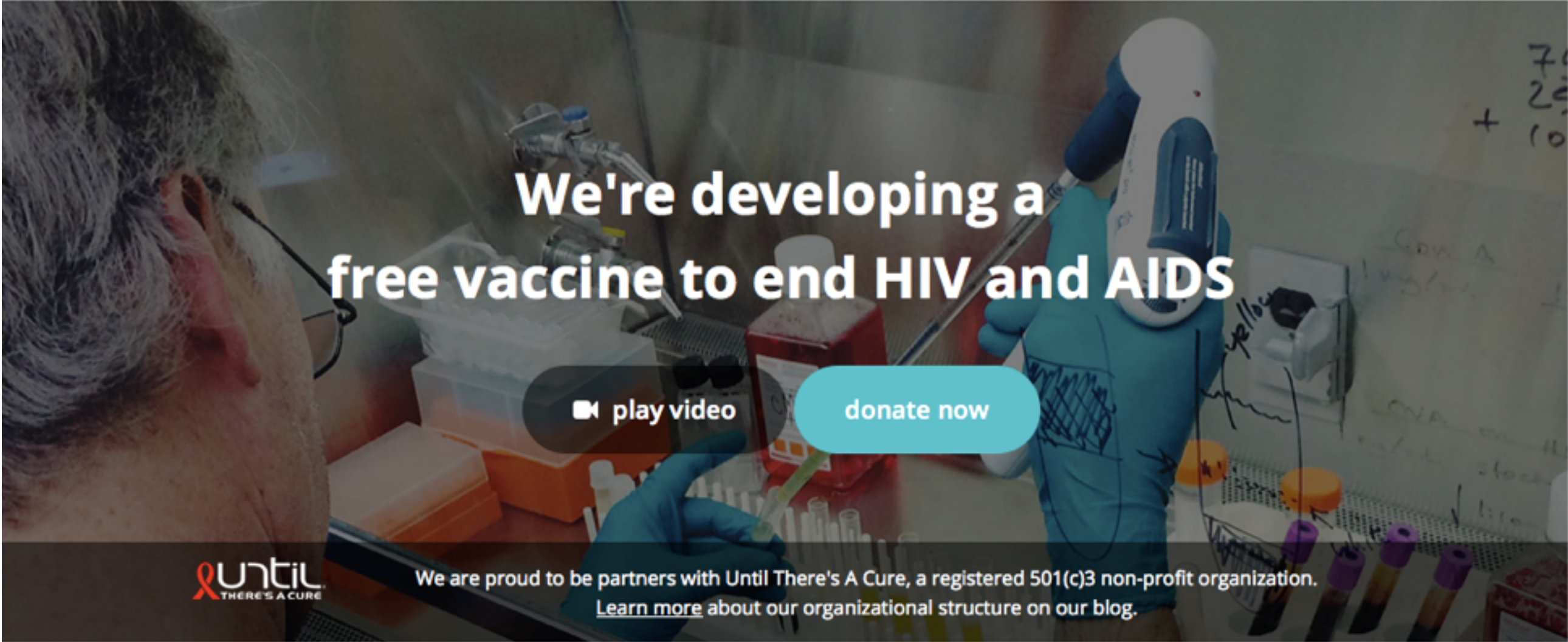


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[official blog](#)

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**We're developing a  
free vaccine to end HIV and AIDS**

[play video](#)

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We are proud to be partners with Until There's A Cure, a registered 501(c)3 non-profit organization.  
[Learn more](#) about our organizational structure on our blog.

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.



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# Online communities



# Networks

- [hackteria.org](http://hackteria.org)  
kitchen mailing list:
  - <http://lists.hackteria.org/cgi-bin/mailman/listinfo>
- [biohacklabs.org](http://biohacklabs.org)  
European biohacker list:
  - <http://www.biohacklabs.org/Europe>  
List of labs:
    - <http://www.biohacklabs.org/List>
- [diybio.org](http://diybio.org)  
International mailing list:
  - <https://groups.google.com/d/forum/diybio>





# Events

- Announced on the mailing lists
  - Hackteria Lab
  - CCC Hamburg
  - OuiShare Paris
  - Pixelache Helsinki





# Assignment

1. Search for previous projects within the Biohack community similar to your biofactory and set up a small reference library on your Github Page.
2. Start growing your organism in a liquid culture.



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