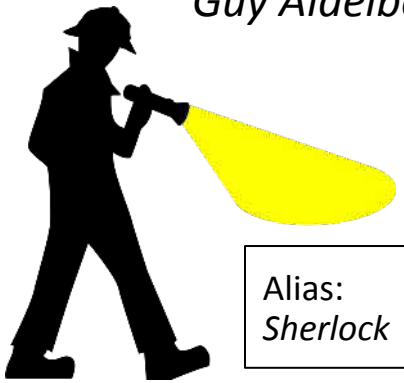
GMO Detective

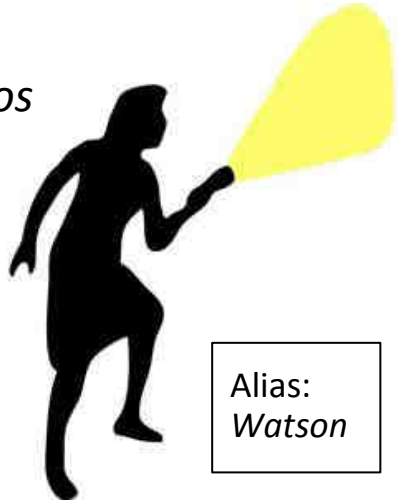
Workshop

Detective:
Guy Aidelberg



Alias:
Sherlock

Detective:
Naiane R. Rios



Alias:
Watson

Who are we

Guy Aidelberg

Centre de Recherches Interdisciplinaires

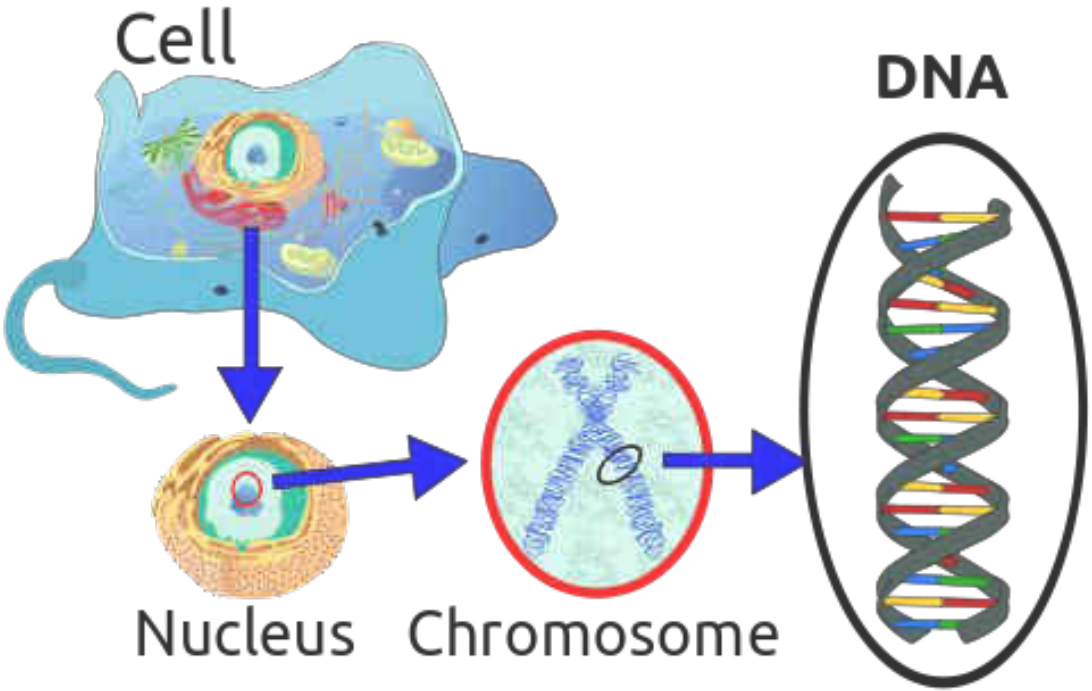
Naiane R. Rios

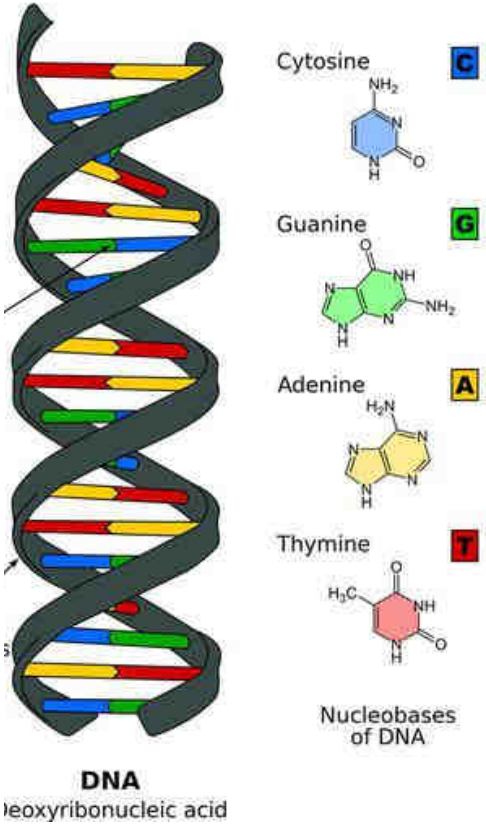
ÉCOLE DOCTORALE FdV PhD DOCTORAL SCHOOL

MASTER AIV

The aim of my project is to allow anybody anywhere to do genetic detection, simply rapidly and affordably.

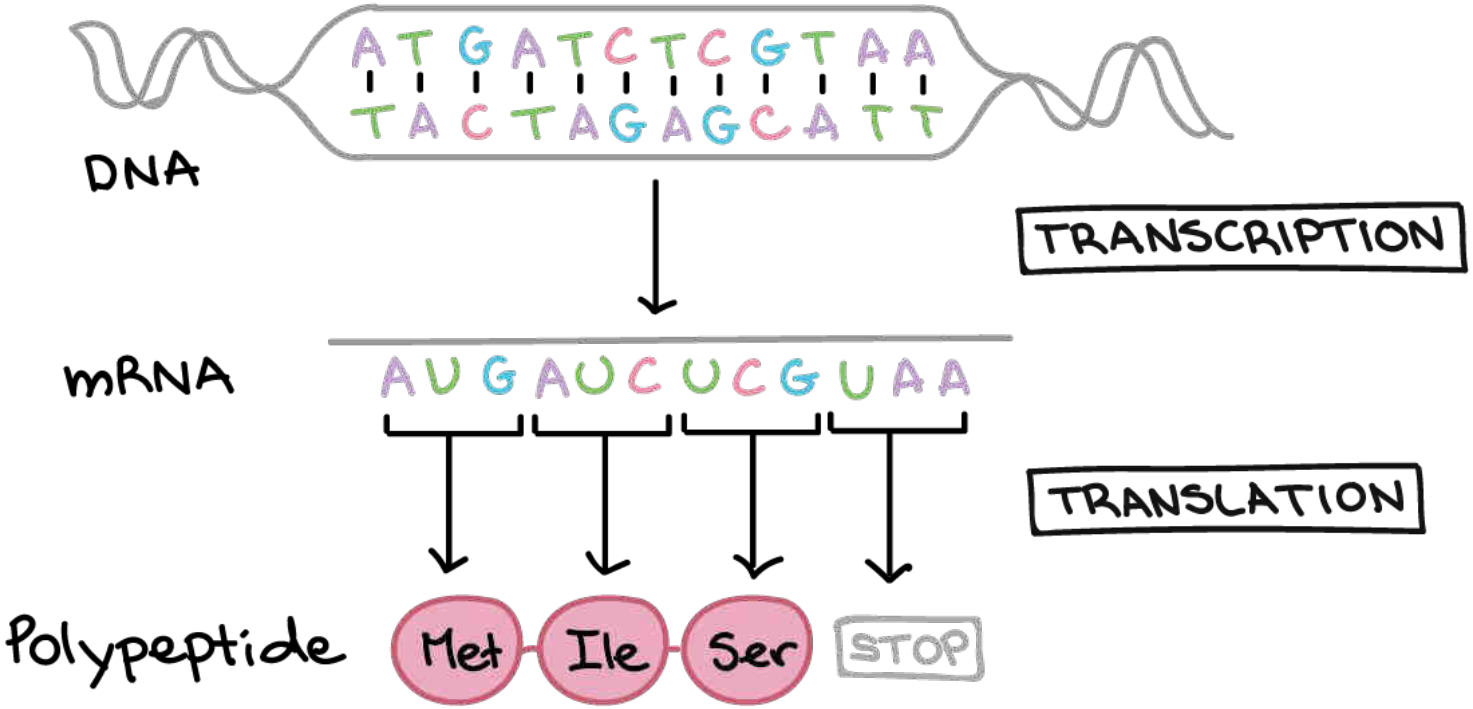
What is DNA





Source: Wikipedia

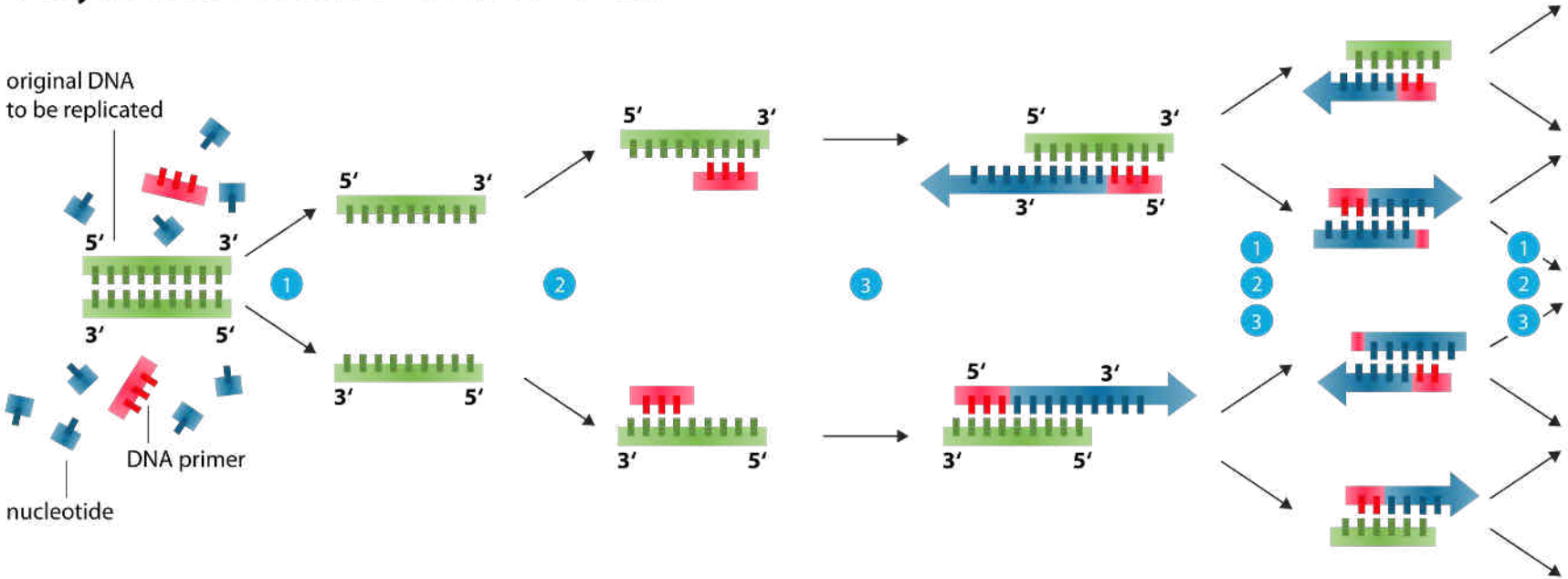
THE CENTRAL DOGMA



Source: Khan Academy

Source: Carl Zimmer - TED-ed

Polymerase chain reaction - PCR



1. **Denaturation** at 94-96°C
2. **Annealing** at ~68°C
3. **Elongation** at ca. 72 °C

Bento Lab

~1300$

Source: www.bento.bio

miniPCR

~1000$

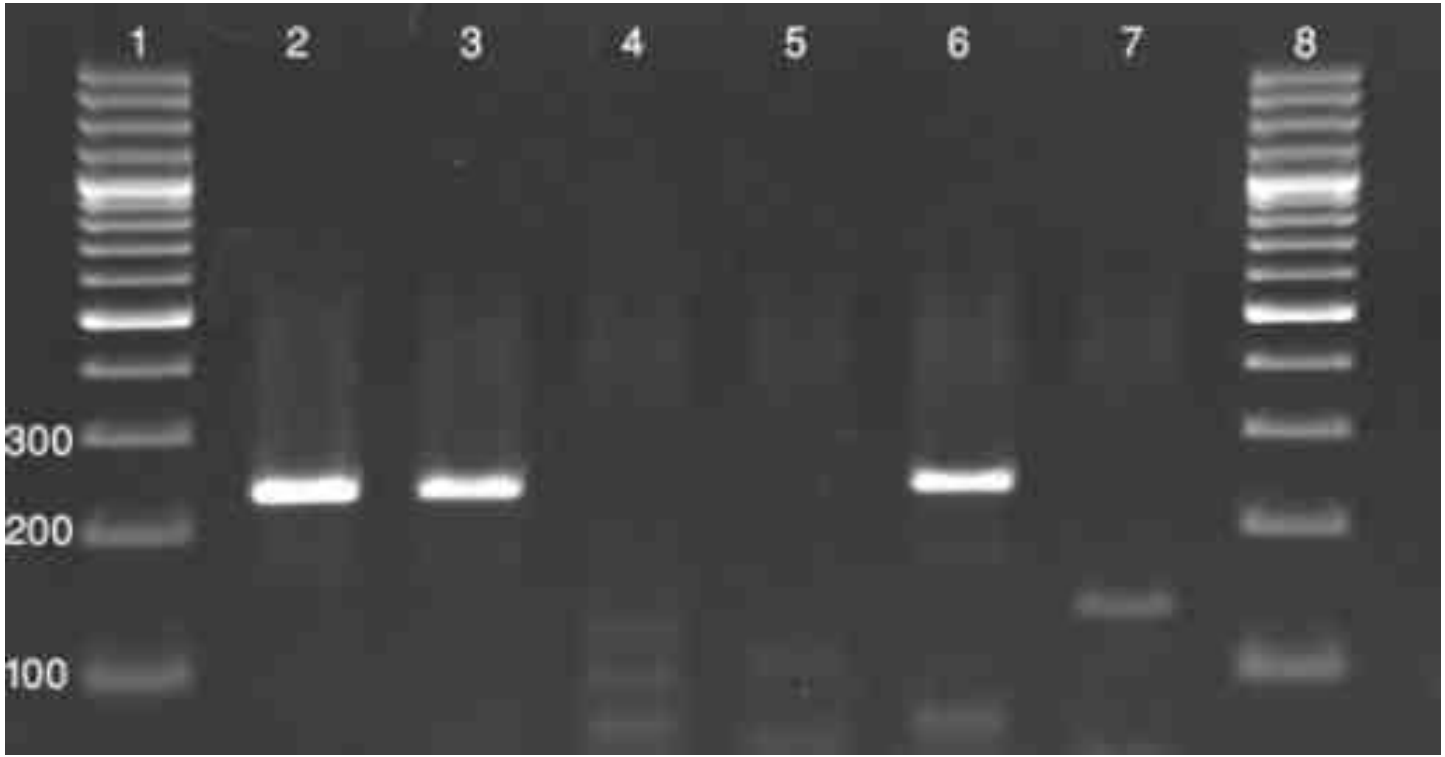
Source: www.minipcr.com

Open Source PCR

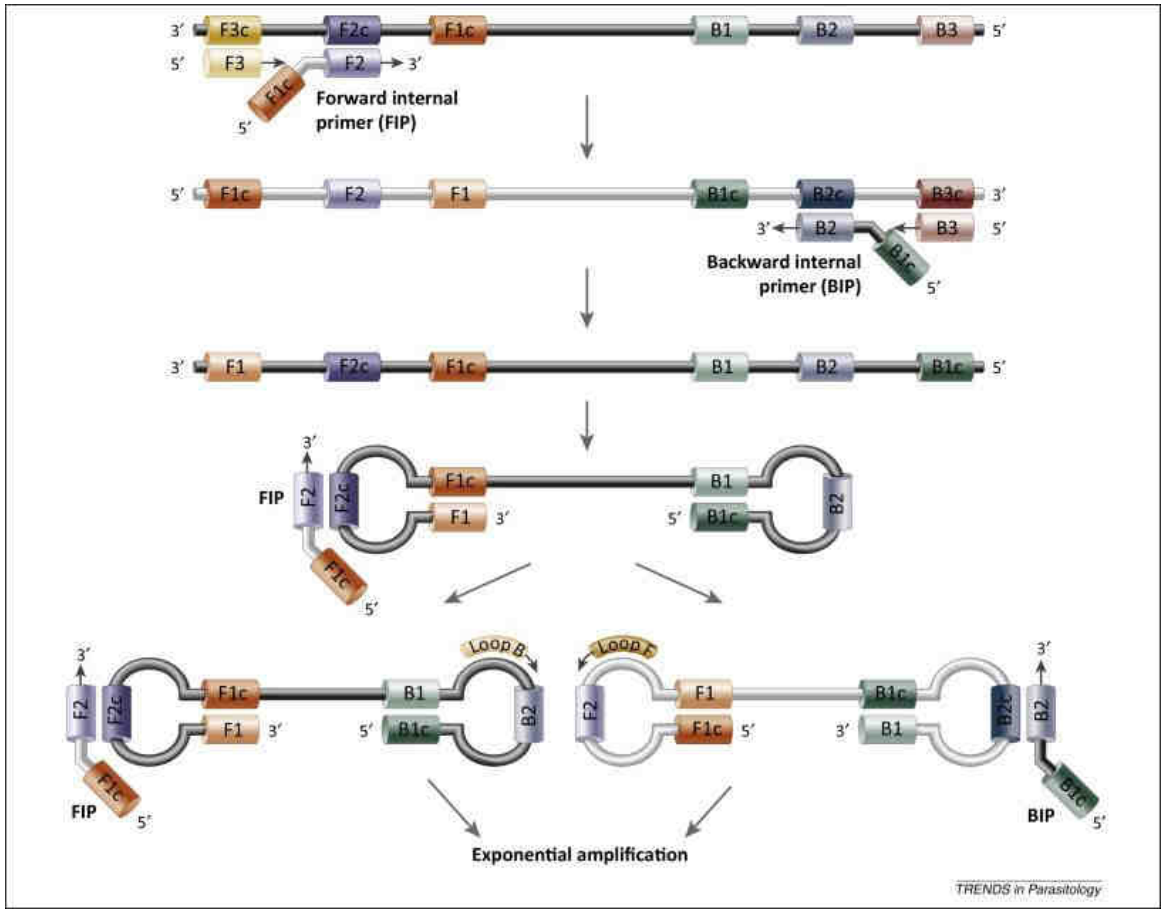
~500$

Source: http://openpcr.org/

PCR results



We use LAMP-Loop -mediated isothermal AMPlification



LAMP has many advantages over PCR

Specificity

Easy to visualize

Sensitivity

Equipment simplicity

Time

Cost

Something simple to show the people can do genetic testing themselves

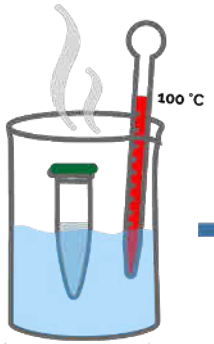
- DNA not RNA
- No Biosecurity
- No need for clinical trials
- Interesting
- Fun
- Will allow people to engage and learn Biology

Let’s test if your food has GMOs!

GMO Detective

Overview of the Workshop

Simple DNA extraction



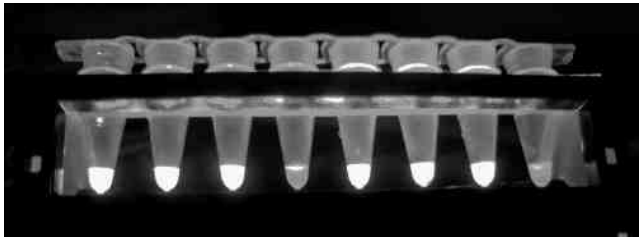
~100℃ 5 mins

Heating

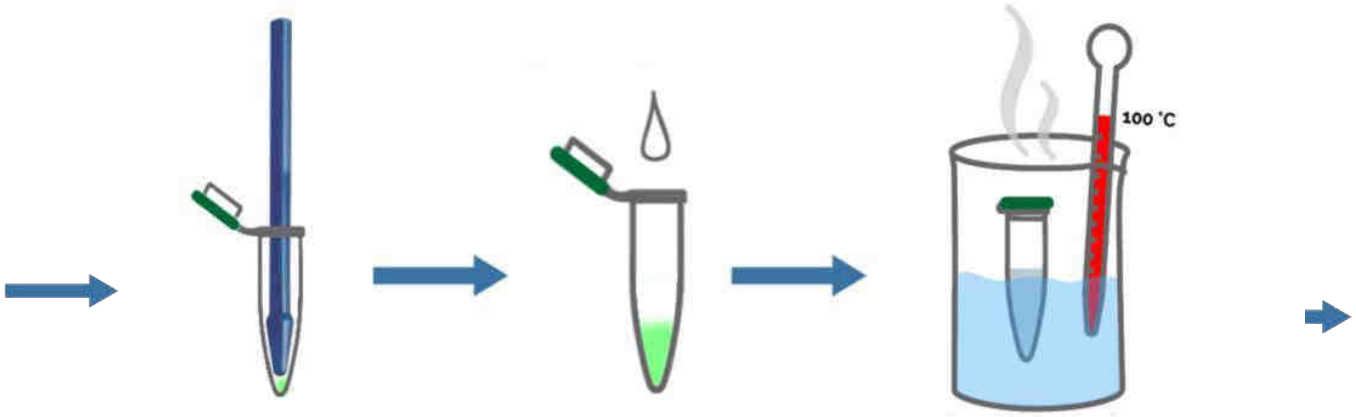
~63℃

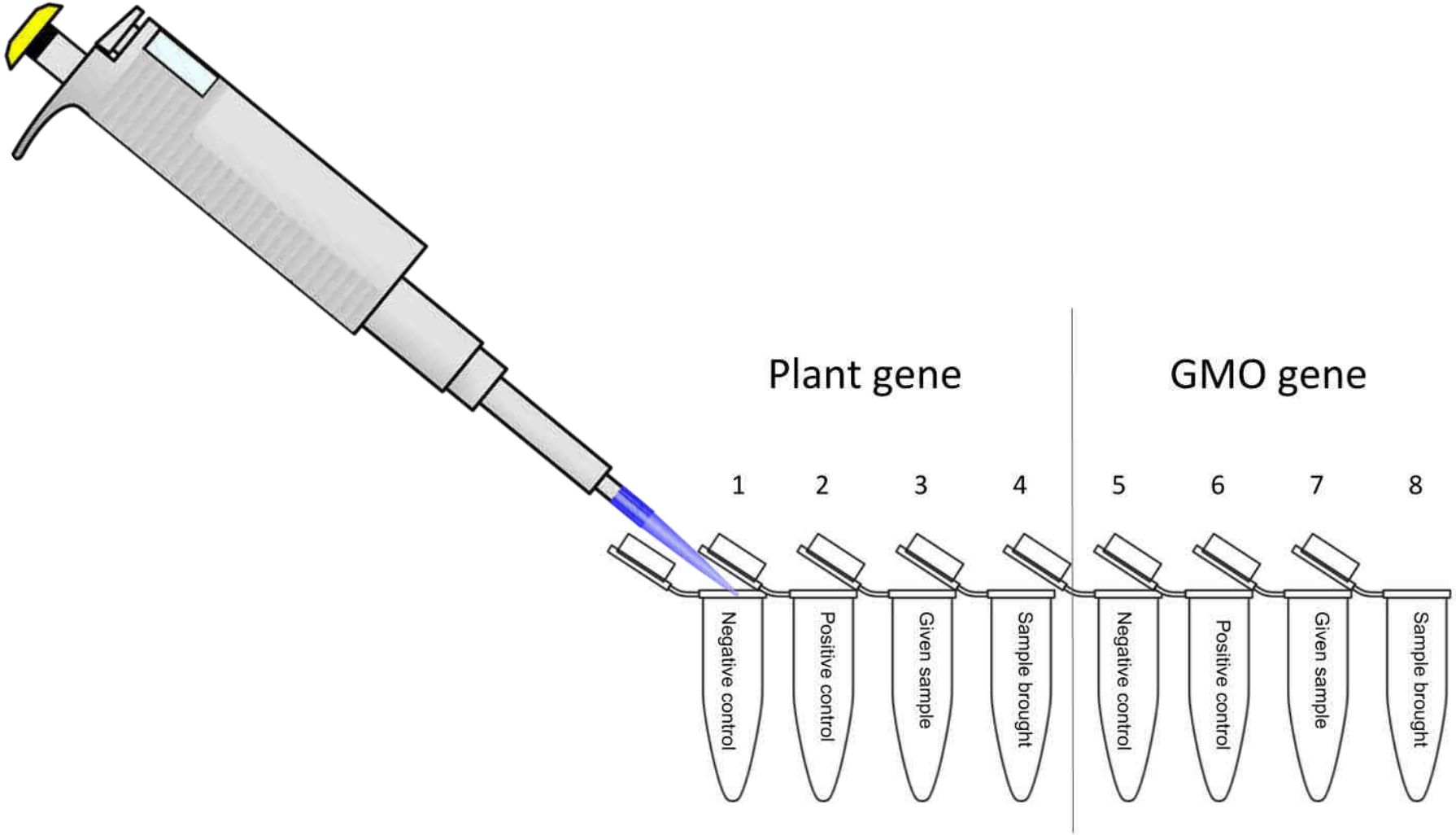
< 1 hour

Reading and sharing



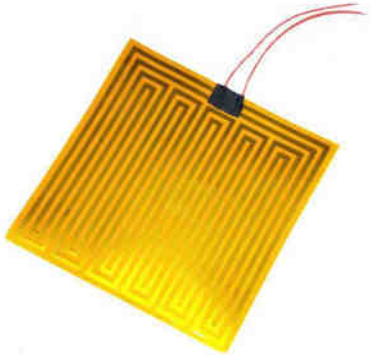
Extremely Simple DNA Extraction



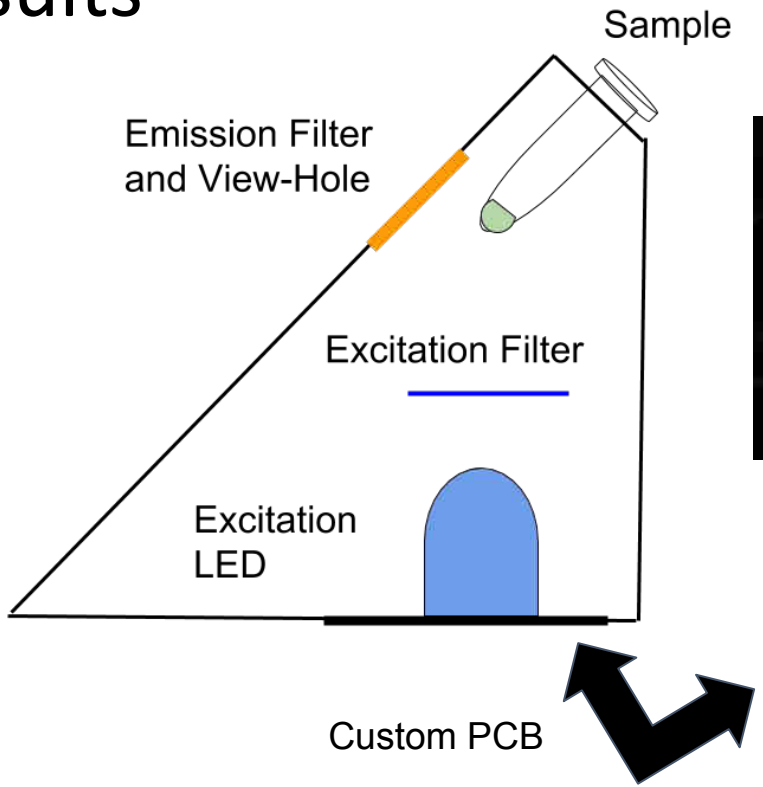

Plant gene
GMO gene
1
2
3
4
5
6
7
8
Negative control
Positive control
Given sample
Sample brought
Negative control
Positive control
Given sample
Sample brought

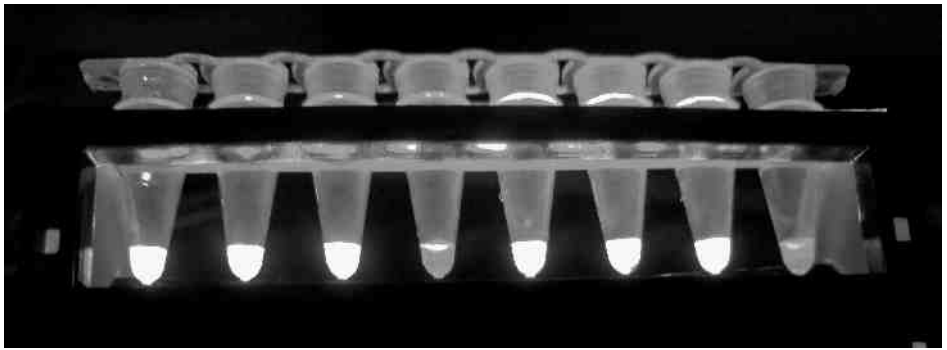

Plant gene
GMO gene
1
2
3
4
5
6
7
8
Negative control
Positive control
Given sample
Sample brought
Negative control
Positive control
Given sample
Sample brought

Heating < 1h at ~63°C



Incredibly affordable and easy to build Open hardware detector, allows to easily read the results





Start of the experiment

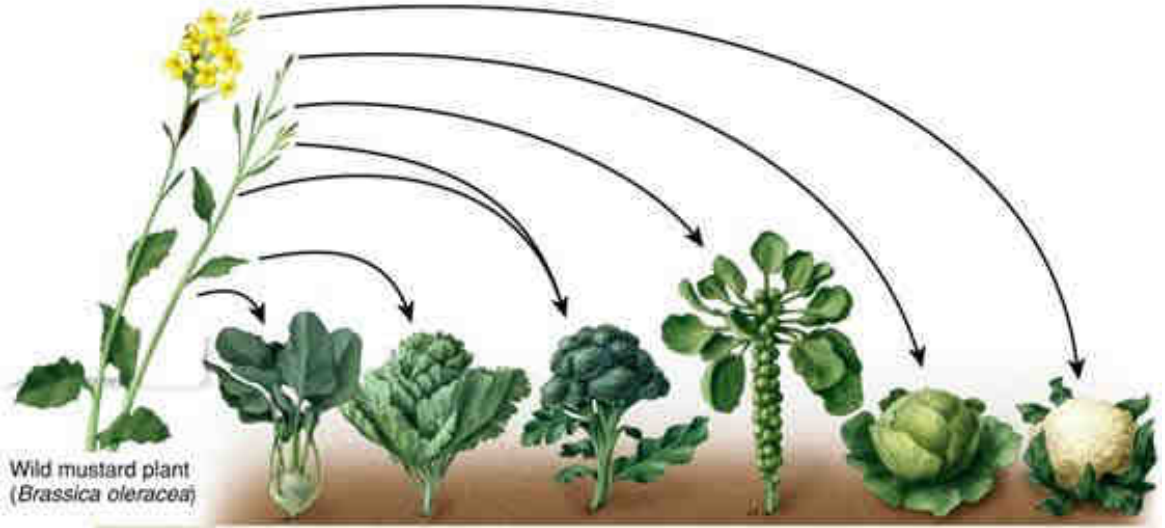
The things we eat today have greatly divergered from thier ancestors

Over last 4,000 years all major crop species have been domesticated: e.g., rice, wheat, and maize

Classical genetics: selective breeding for plants with desired traits

Early biotechnology: cross-breeding and hybrid plants. Mutagenesis

Genetic engineering: ability to confer very specific traits rapidly by introducing particular genes directly into plants



Strain	Kohlrabi	Kale	Broccoli	Brussels sprouts	Cabbage	Cauliflower
Modified trait	Stem	Leaves	Flower buds and stem	Lateral leaf buds	Terminal leaf bud	Flower buds

How Crops Are Genetically Modified

Traditional Breeding

Crossing plants and selecting offspring

Almost All Crops

Desired gene(s) inserted with other genetic material. No safety testing requirements.

Mutagenesis

Exposing seeds to chemicals or radiation

Random changes in genome, usually unpredictable. No safety testing requirements.

RNA Interference

Switching off selected genes with RNA

Targeted gene(s) switched off or 'silenced'. Safety testing required.

Transgenics

Inserting selected genes using recombinant DNA methods

Desired gene(s) inserted only at known locations. Safety testing required.

Number of Genes Affected

10K - >300K	? No way to assess	1- 2	1 - 4

GENETIC LITERACY PROJECT

Sources: Biotechnology Provides New Tools for Plant Breeding, University of California Davis Publication 8043; Plant Breeding: Induced Mutation Technology for Crop Improvement, F.J. Novak, H. Brunner, International Atomic Energy Agency, 1992; Atomic Gardens: Public Perceptions and Public Policy, B. Dick, M. Jones, Life Sciences Foundation Magazine; RNAi for Crop Improvement, International Service for the Acquisition of Agri-Biotech Applications Pocket K No. 34. **Infographic by XiaoZhi Lim**

Common challenges in agriculture

GMO crops growing quickly worldwide

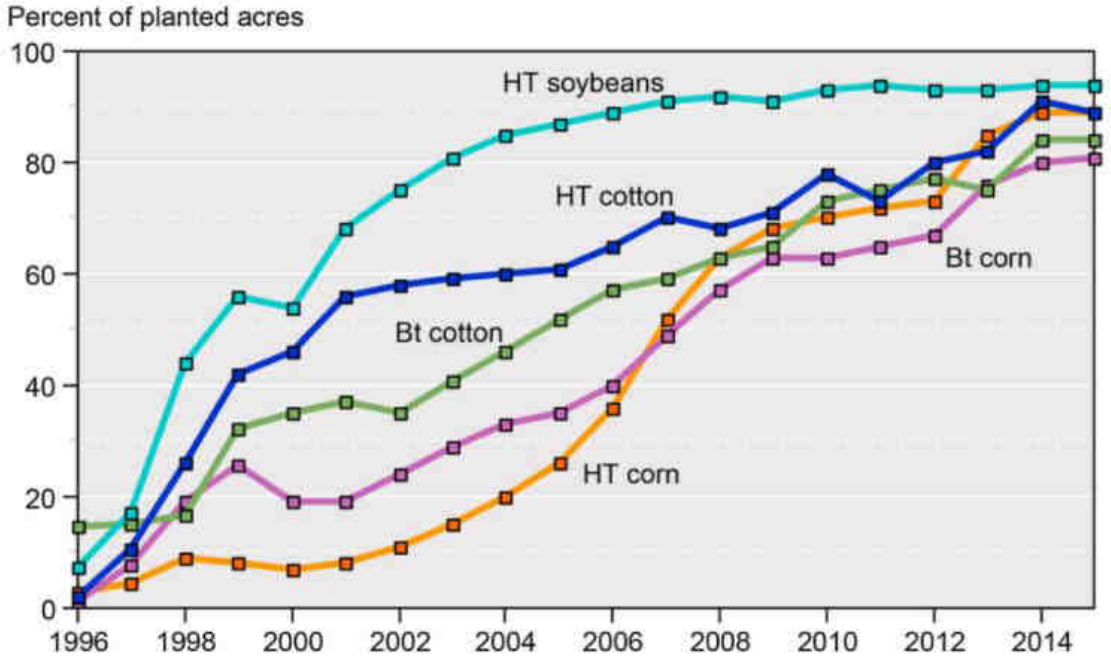


Fig. 3 US statistics of Adoption of GM crops from 1996–2015 (Source: USDA, Economic Research Service using data from Fernandez-Cornejo and McBride (2002) for the year 1996–99 and USDA, National Agricultural Statistics Service, June Agricultural Survey for the years 2000–15;

In 2015, 82% (90.7 of 111 million ha) of the soybean planted were GM soybean strains, whereas GM cotton accounted for 68% (25.1 of 37 million ha) of global cotton production (Figs. 3, 4; James 2015). Of the 184 million hectares of maize planted, global 55.2 million ha (30%) was GM maize

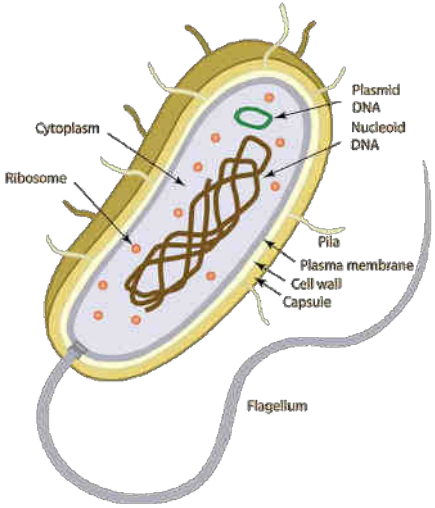
Kamle, M., Kumar, P., Patra, J.K. et al. 3 Biotech (2017) 7: 219.
https://doi.org/10.1007/s13205-017-0809-3

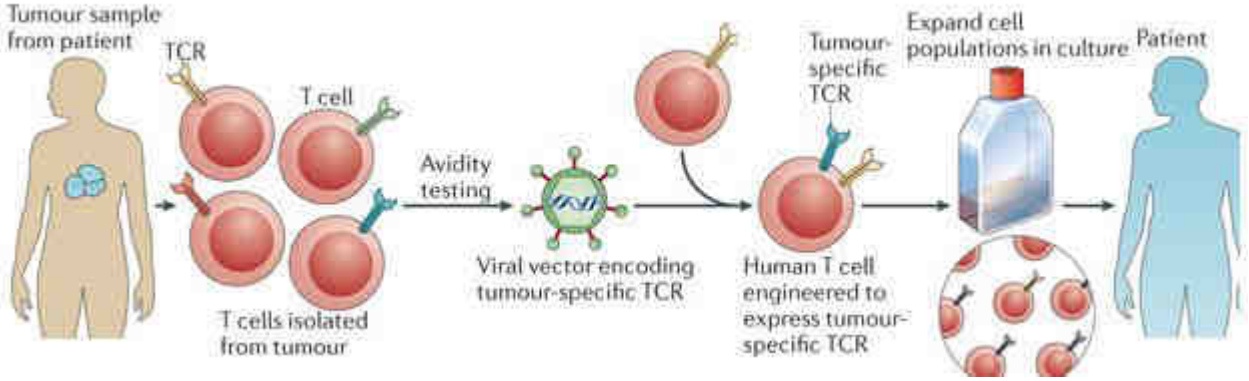
Transgenics

Insulin

Artemisinin

Chymosine





Discussion

GMOS: When? How? Why?

Do you think we should use Genetic Modification?

Mutagenesis vs Directed Modification

CRISPR

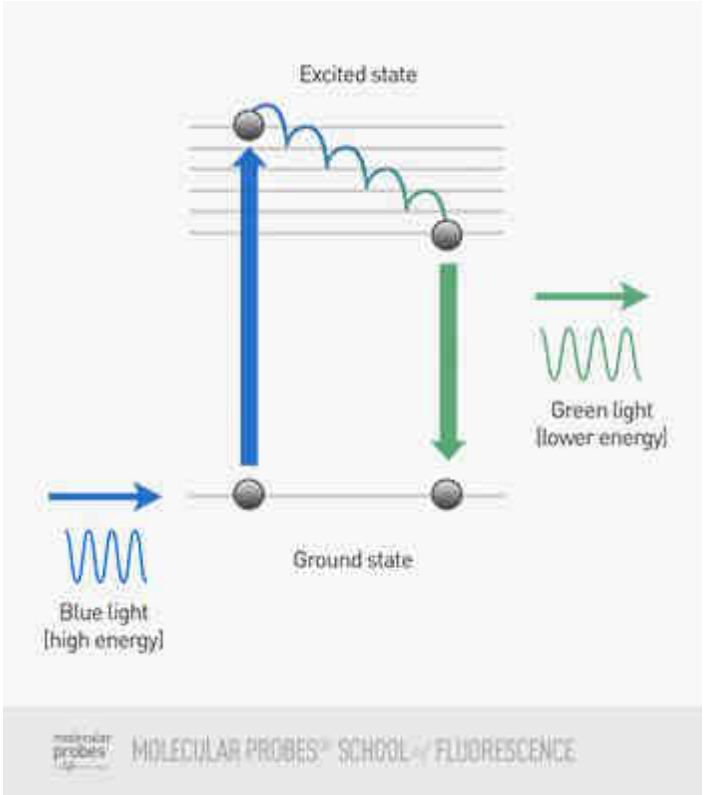
Using GMOs for more healthy food

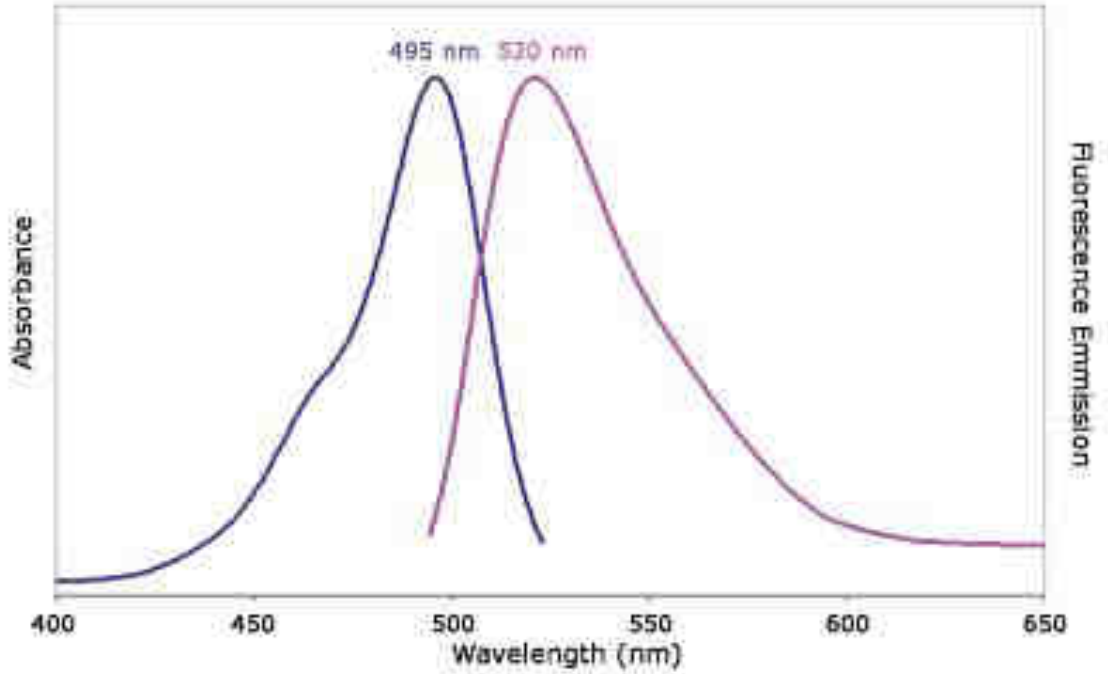
For communication with the crops?

The vast majority of commercial GMO crops until now, have this genetic element

Schematic representation of a transgenic cassette used to generate GMOs. The regulatory elements CaMV35S Promoter and NOS Terminator are commonly used to drive expression of the transgene (inserted gene) in every plant cell and were selected because of their ability to be recognized in most plant species.

Fluorescence





Fluorescent Proteins in Bio-Imaging

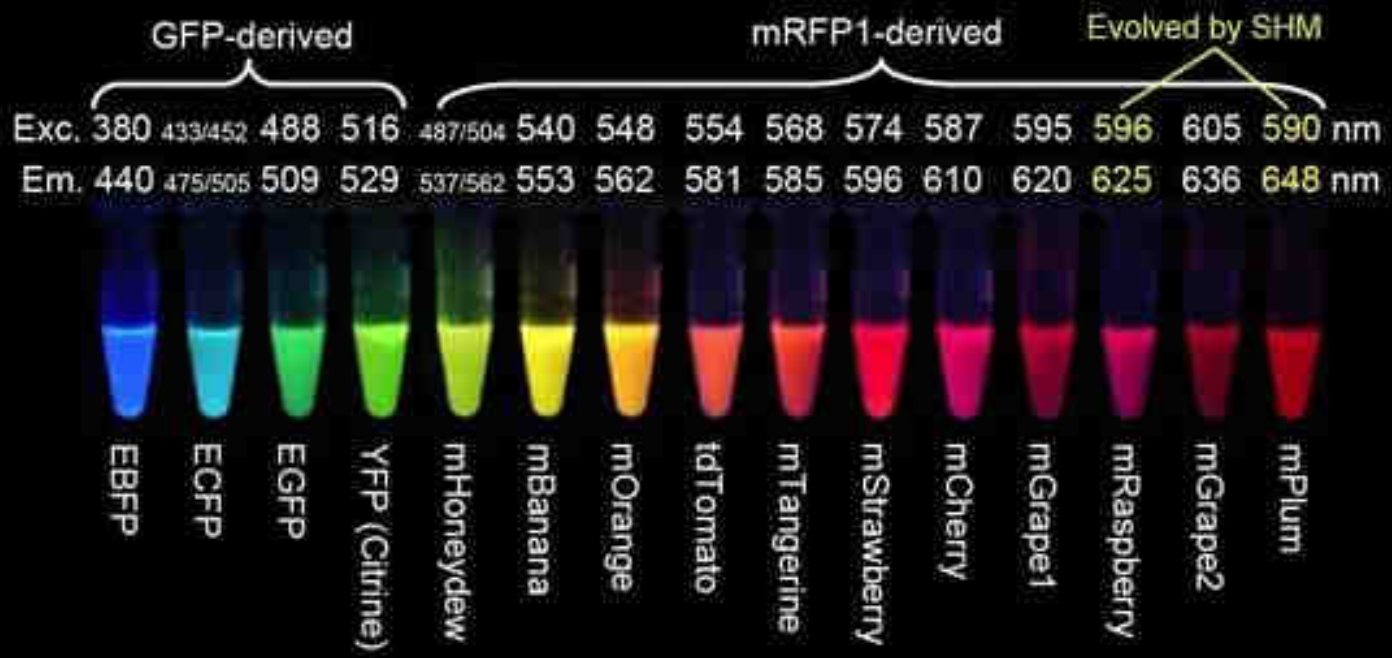
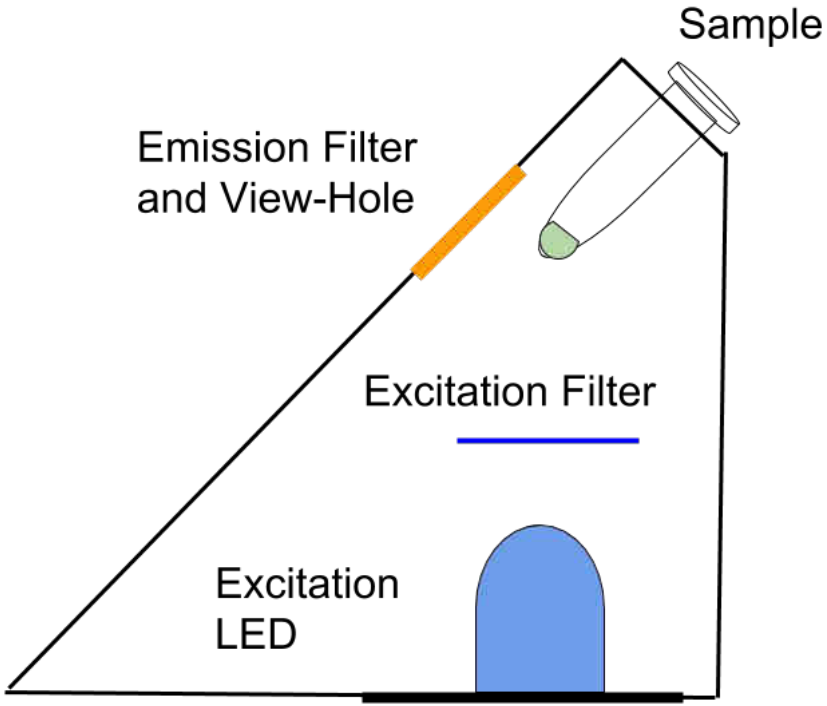
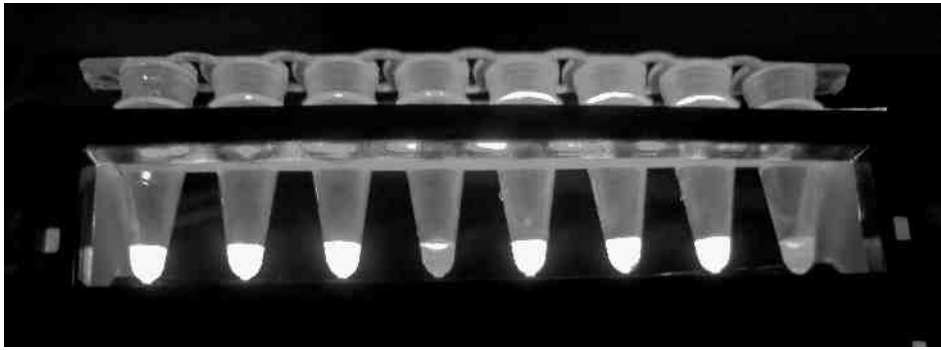


Image showing widely used Fluorescent Proteins and their peak emission / absorption wavelengths.
Image Courtesy: Roger Y Tsien Nobel Lecture, 2008

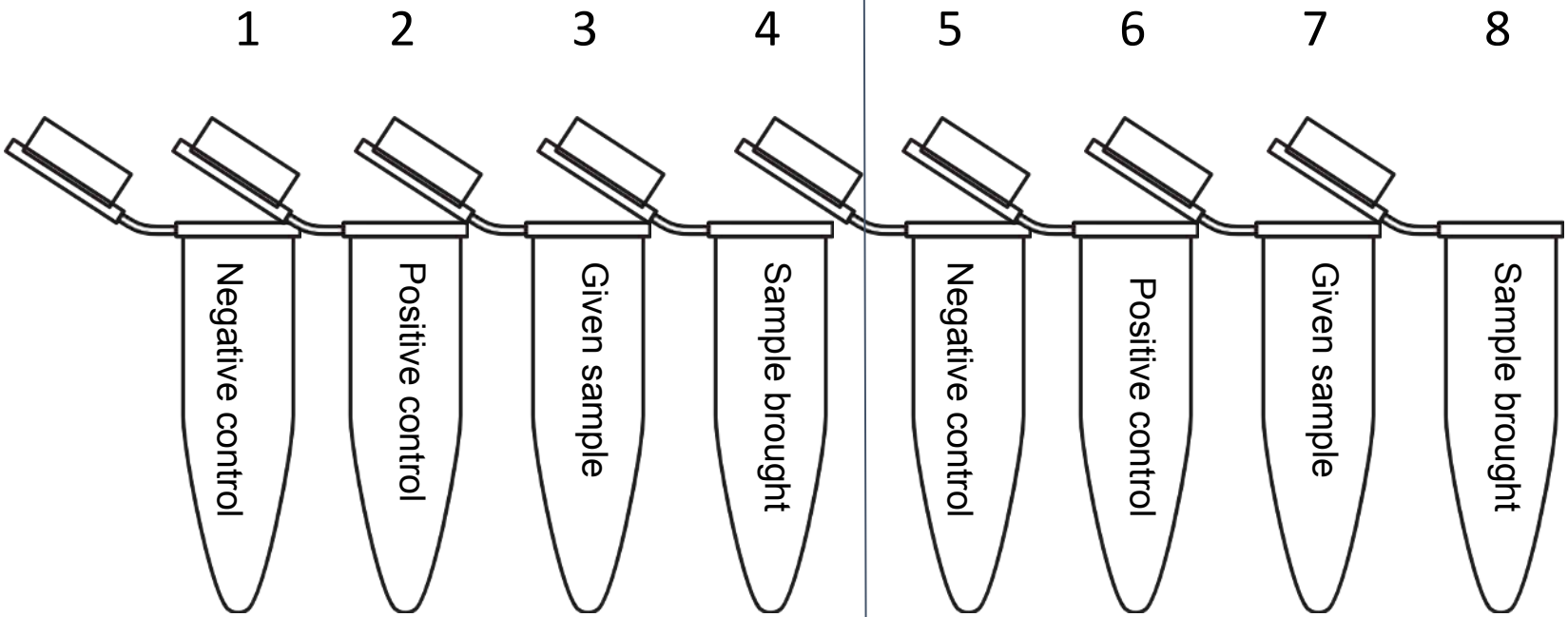
Reading the results



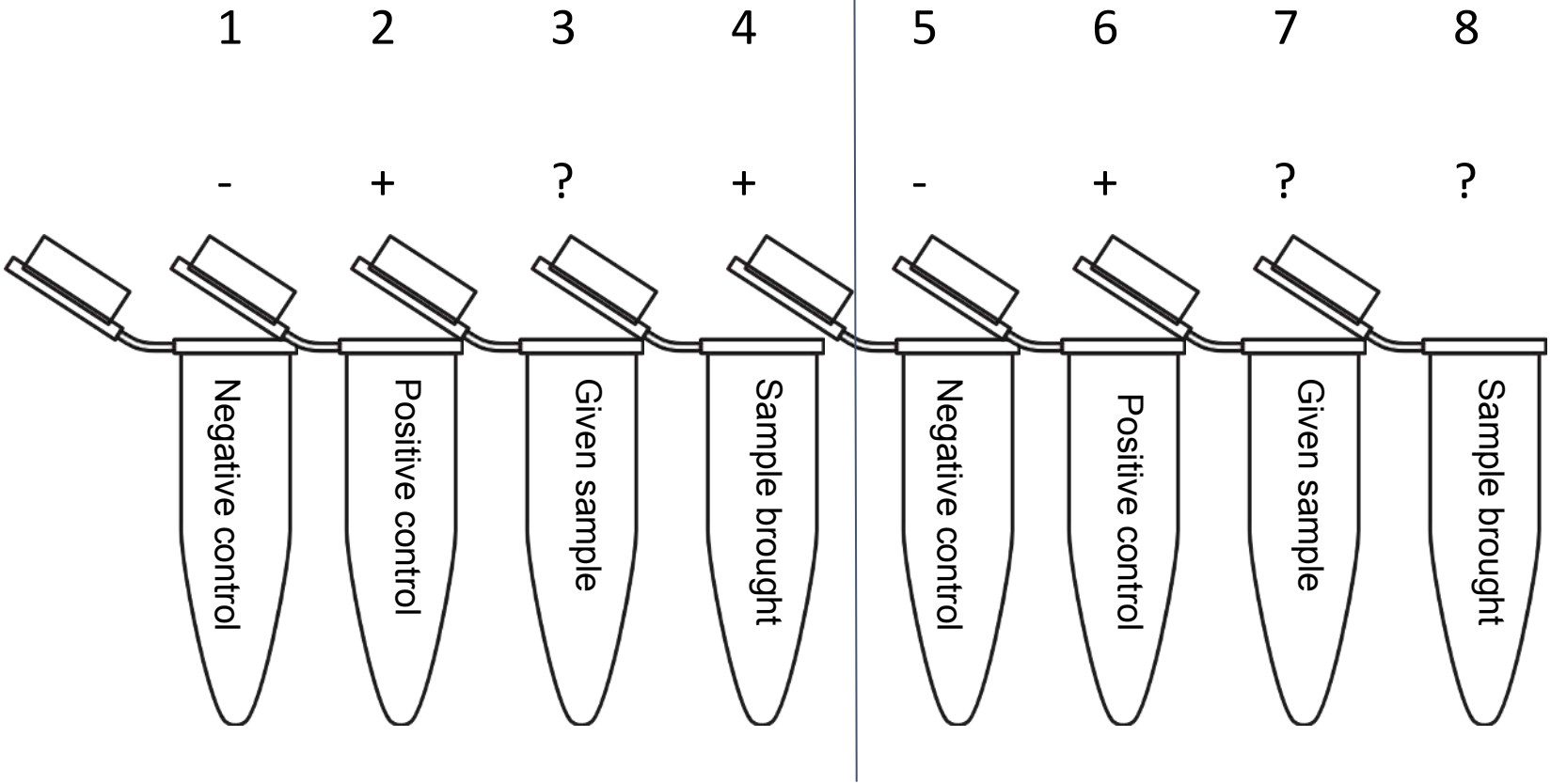


soy/corn control gene

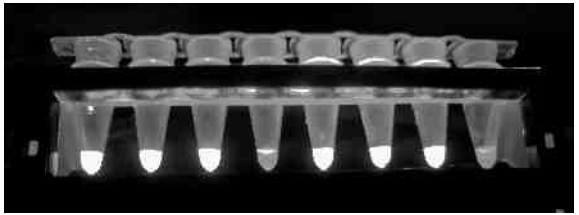
GMO

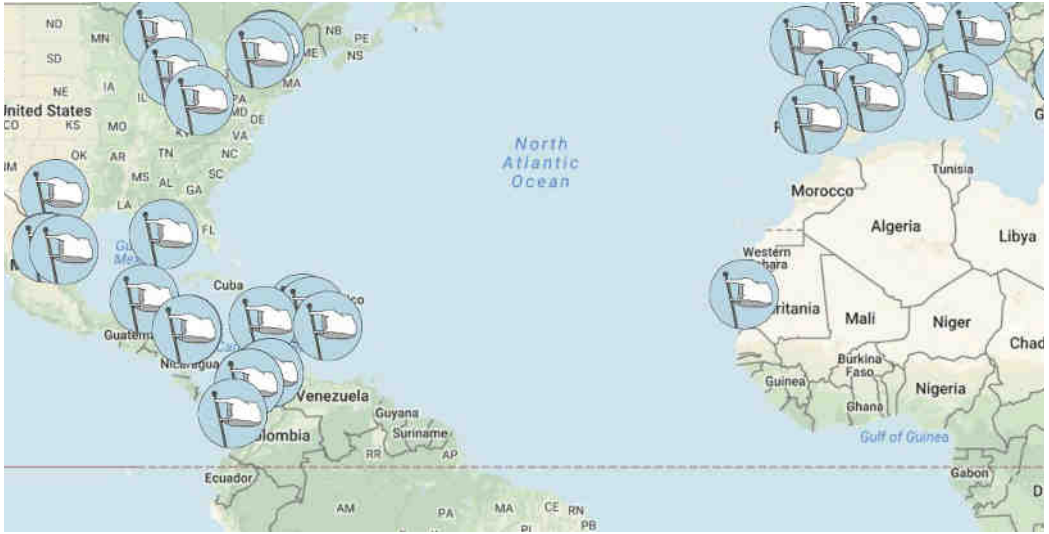


Reading the results



Uploading Sharing Discussing





Discourse

Collaborations

SYNTHETIC BIOLOGY - ONE -

LE GÉNIE DU GÉNOME

Tout ce que vous n'avez jamais voulu savoir sur la génétique parce que vous ne saviez pas que ça existait.

Les Savanturiers – L'école de la recherche

CRI

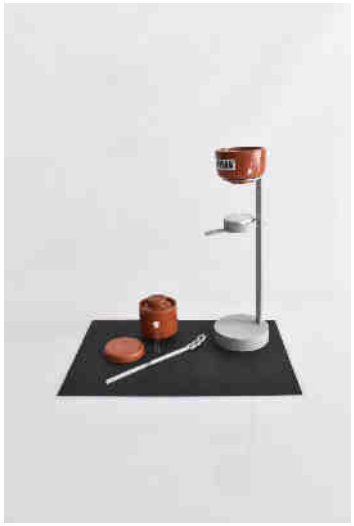
W X A

www.wax-science.org

CRI LABS SUMMER SCHOOL

HEALTH & ENVIRONMENT

OPEN SCIENCE SCHOOL



ÉCOLE BOULLE

MoMA

Workshop for High Schools

Learning Goals

- Basic understanding of DNA
- Introduction to GMOs
- DNA Amplification and detection techniques: PCR *vs.* LAMP
- DNA visualization (fluorescence)
- Genetically engineered crops and their impact
- Open Science Culture

Scientific Skills

- Micropipetting
- DNA extraction
- LAMP amplification technique
- DNA visualisation: fluorescence emission
- Electronics

Transversal Skills

- Communication
- Give & receive feedback
- Critical thinking
- Cooperation
- Digital Literacy

Different audiences

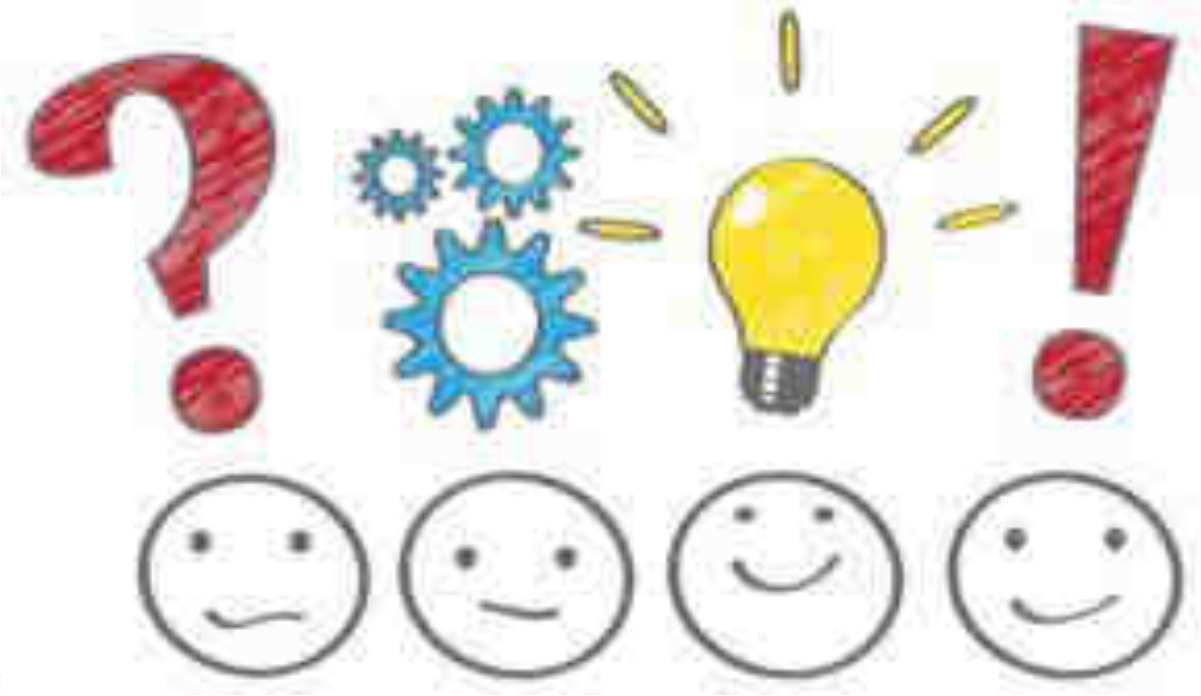
- Students
- Activists
- Foodies
- Parents
- BioHackers
- Everyone

Longer Term plans

- Scaling
- Partners
- Paper/Dry
- Other uses :
    - Animal Allergen detection
    - Pathogen
    - Invasive species
    - ANYTHING!

Thank you for you participation!

Thanks!!



Inserm
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Centre Recherches Interdisciplinaires
IIFR Institut Innovant de Formation par la Recherche
Investissements d'Avenir 11-IDFI-0023