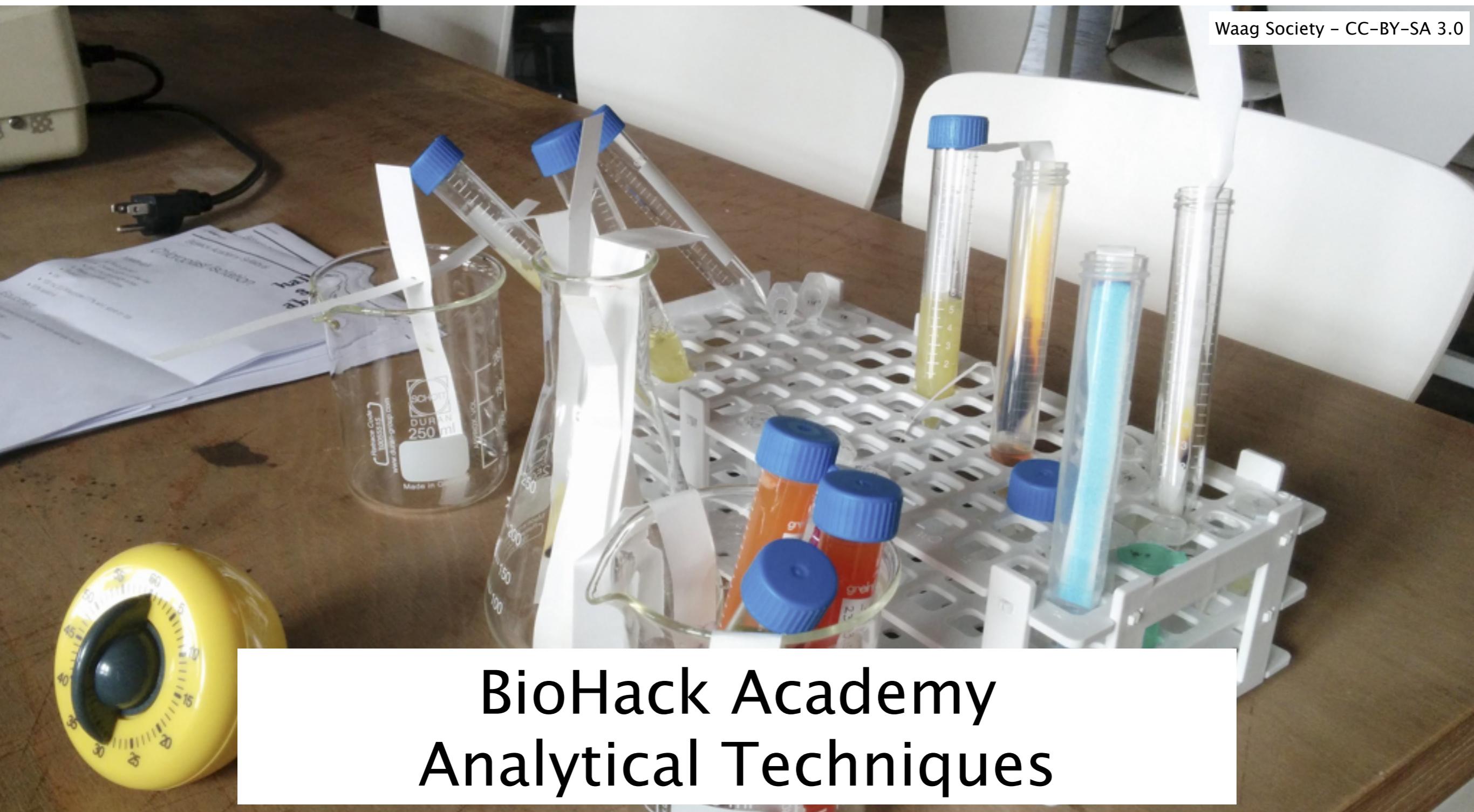




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Biological Analytical Techniques

- Spectrometry
 - Photo
 - Raman
 - Mass
- Chromatography
 - HPLC
- Electrophoresis
- Nuclear magnetic resonance
- DNA analytics
 - Sequencing
 - CHIP
 - DNA array
- DNA editing
 - Restriction ligation
 - Gateway
 - Gibson
 - CRISPR



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Spectrometry

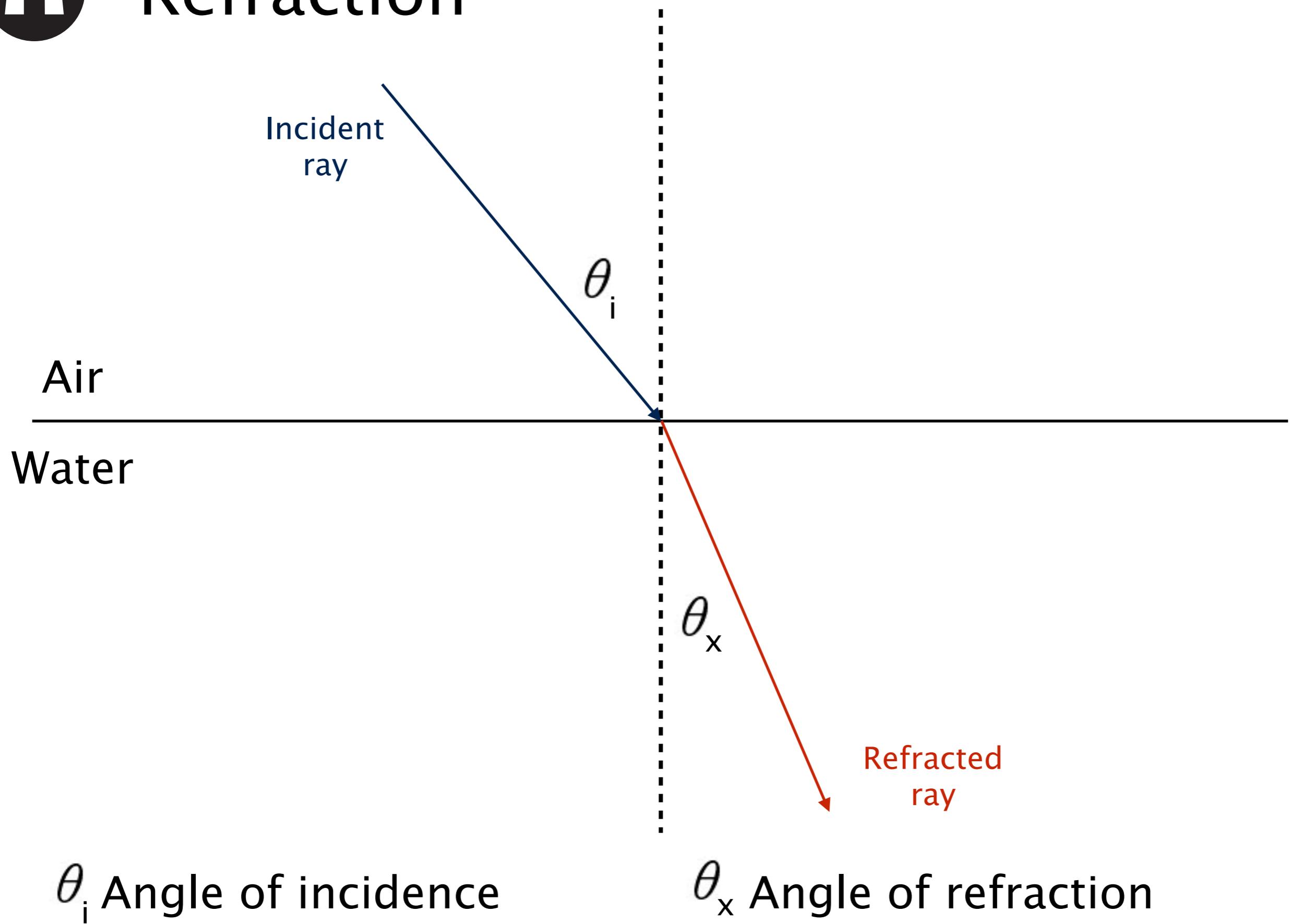


Tibicos – kefir





Refraction



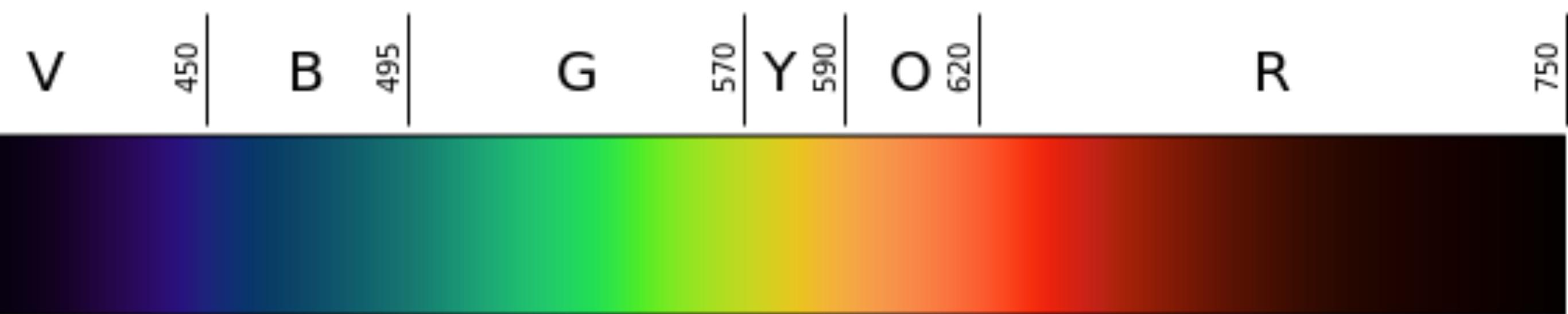


Snell's Law

$$\sin(\theta_i) = n_{material} \times \sin(\theta_x)$$

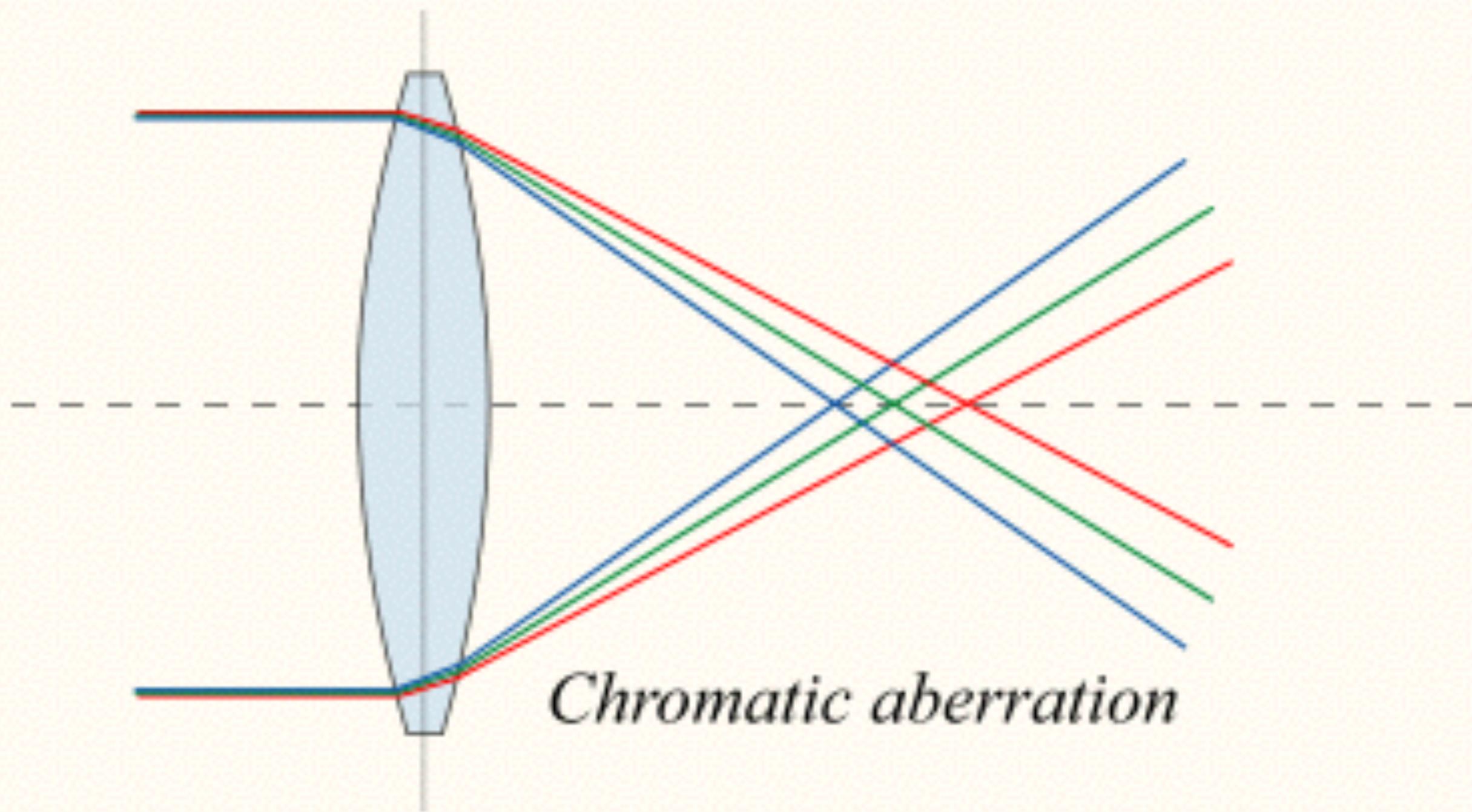


Visible light spectrum





Chromatic aberration



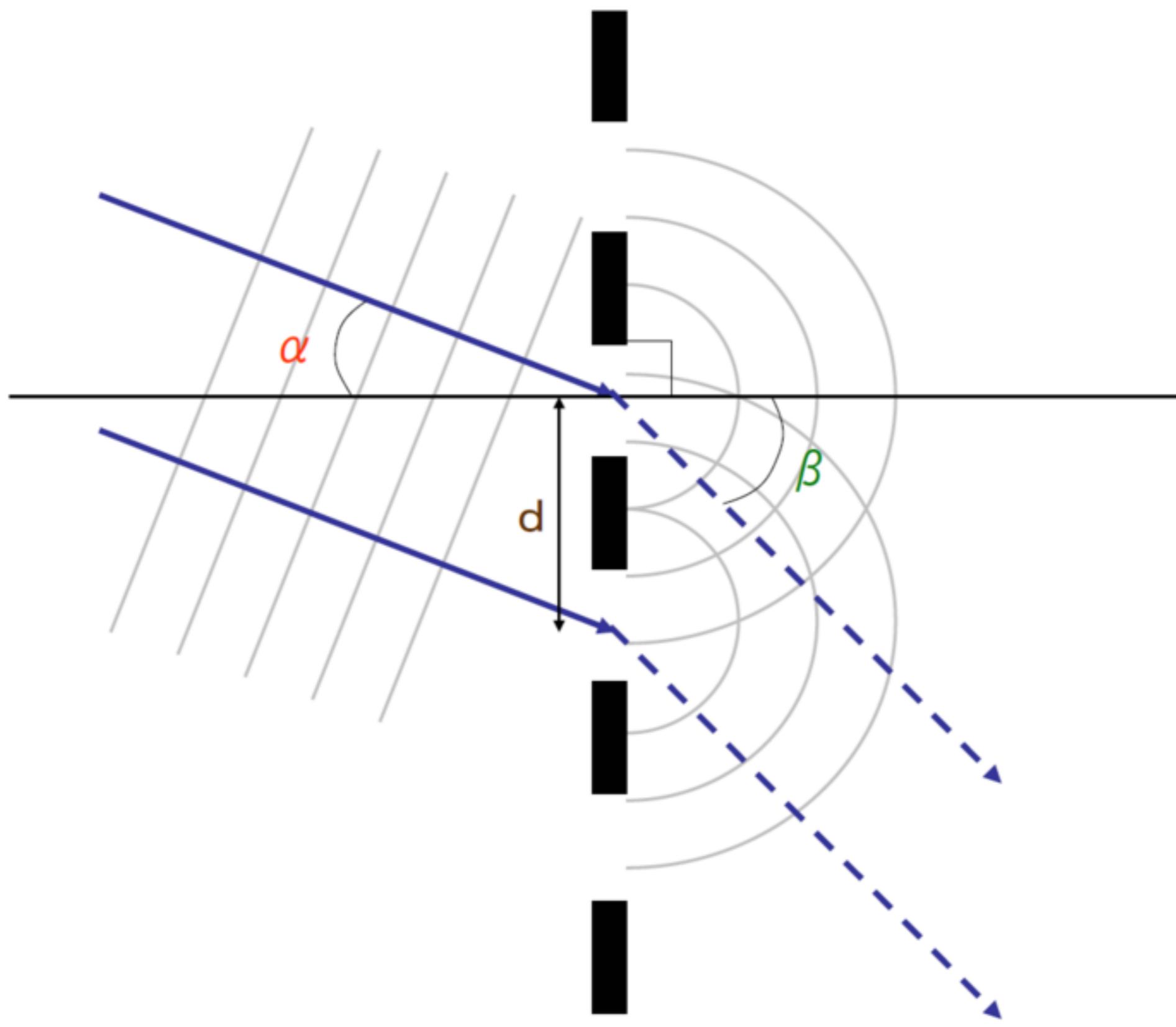


Grating diffraction



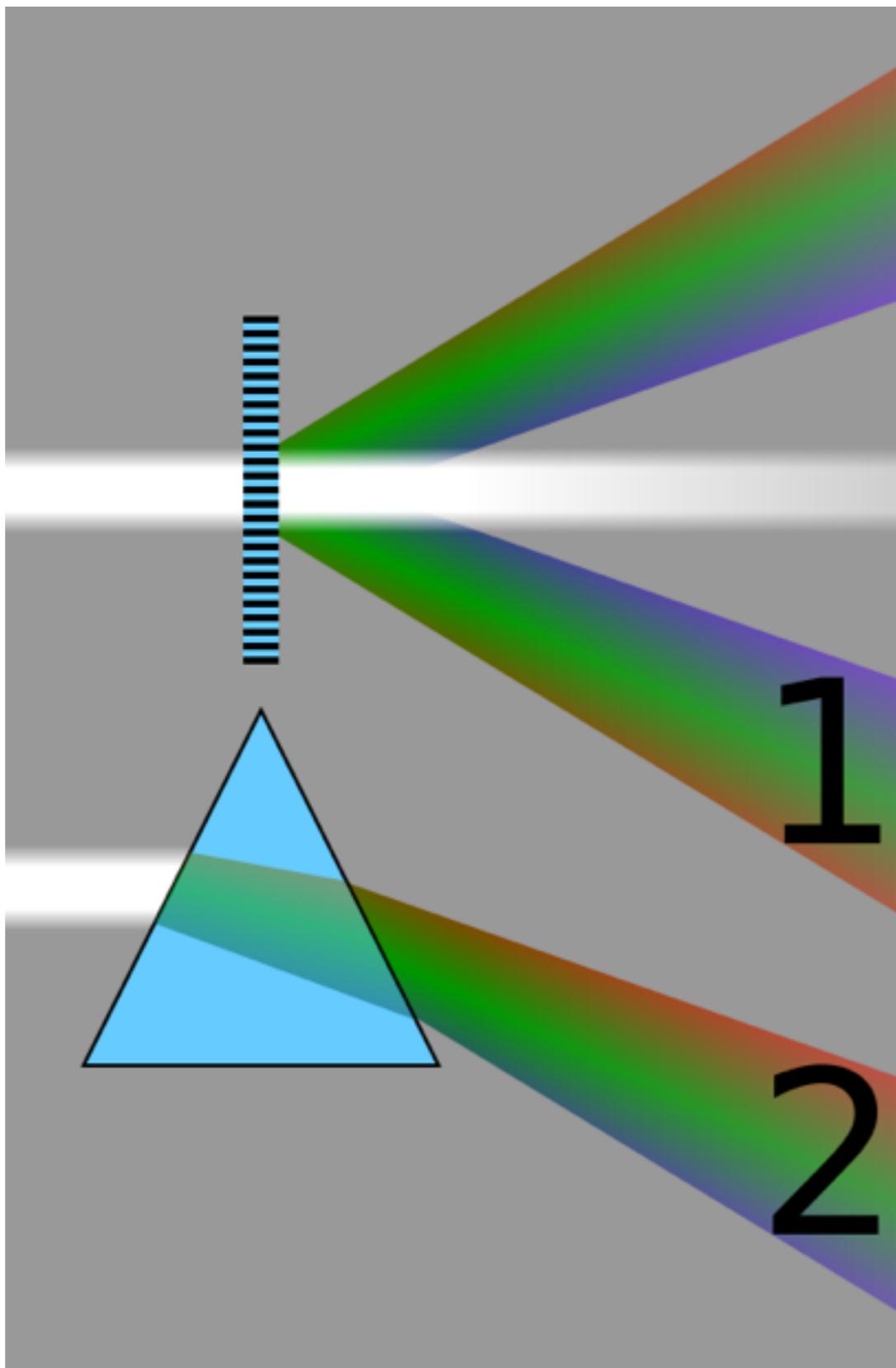


Diffraction grating principle





Just like a prism



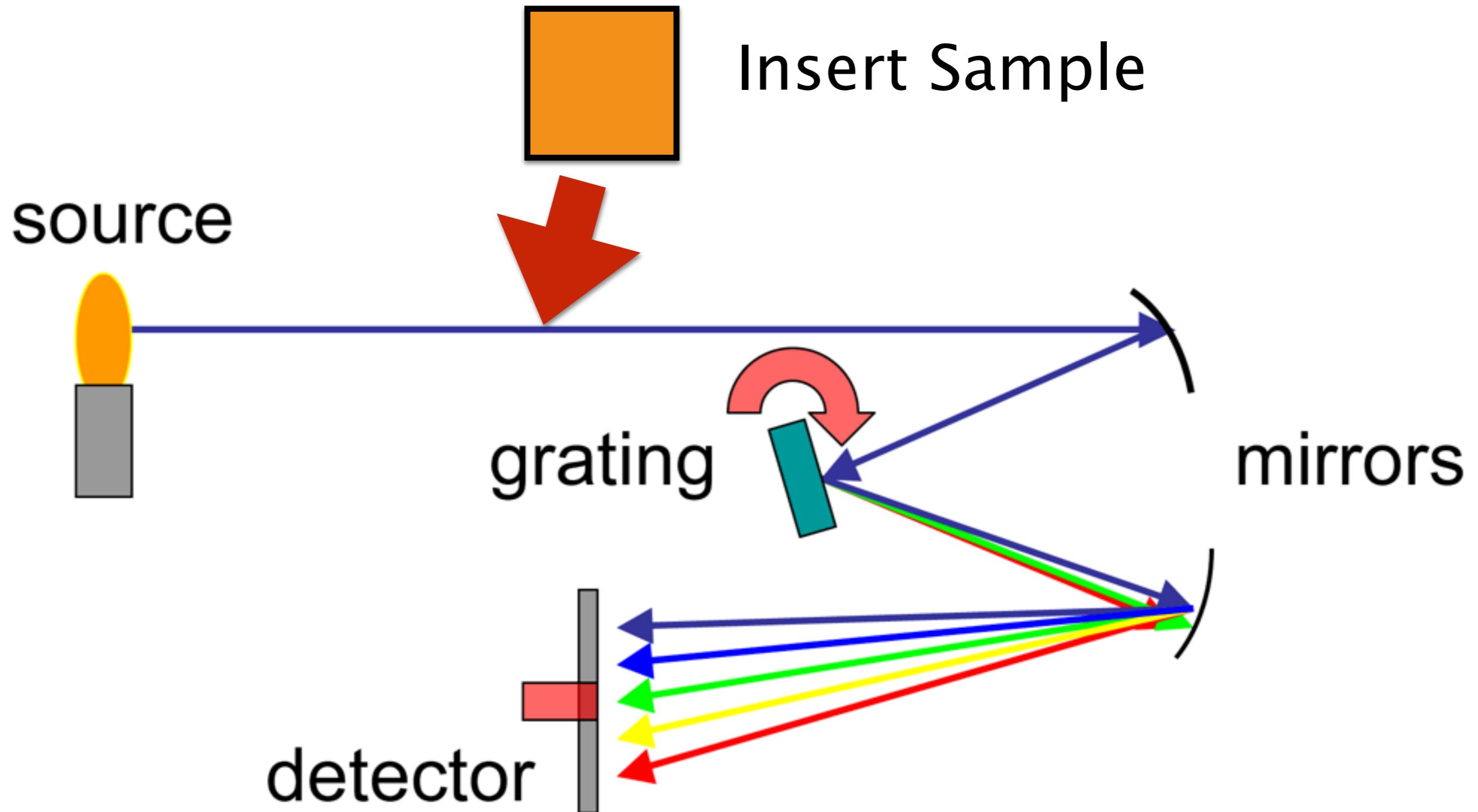


Industry standard



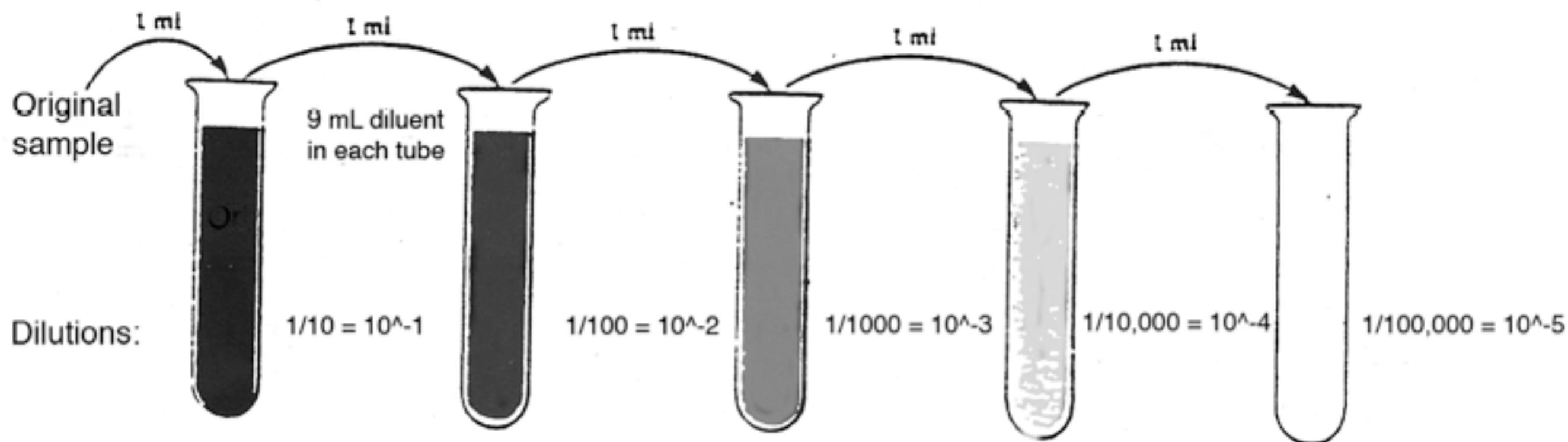
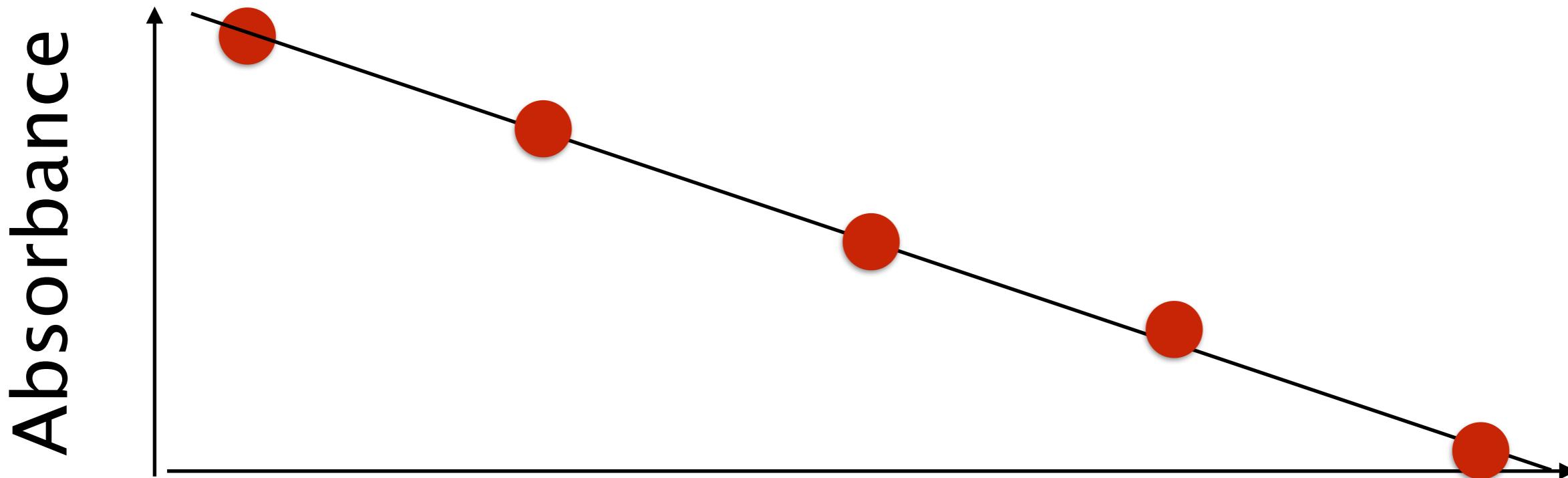


Inside



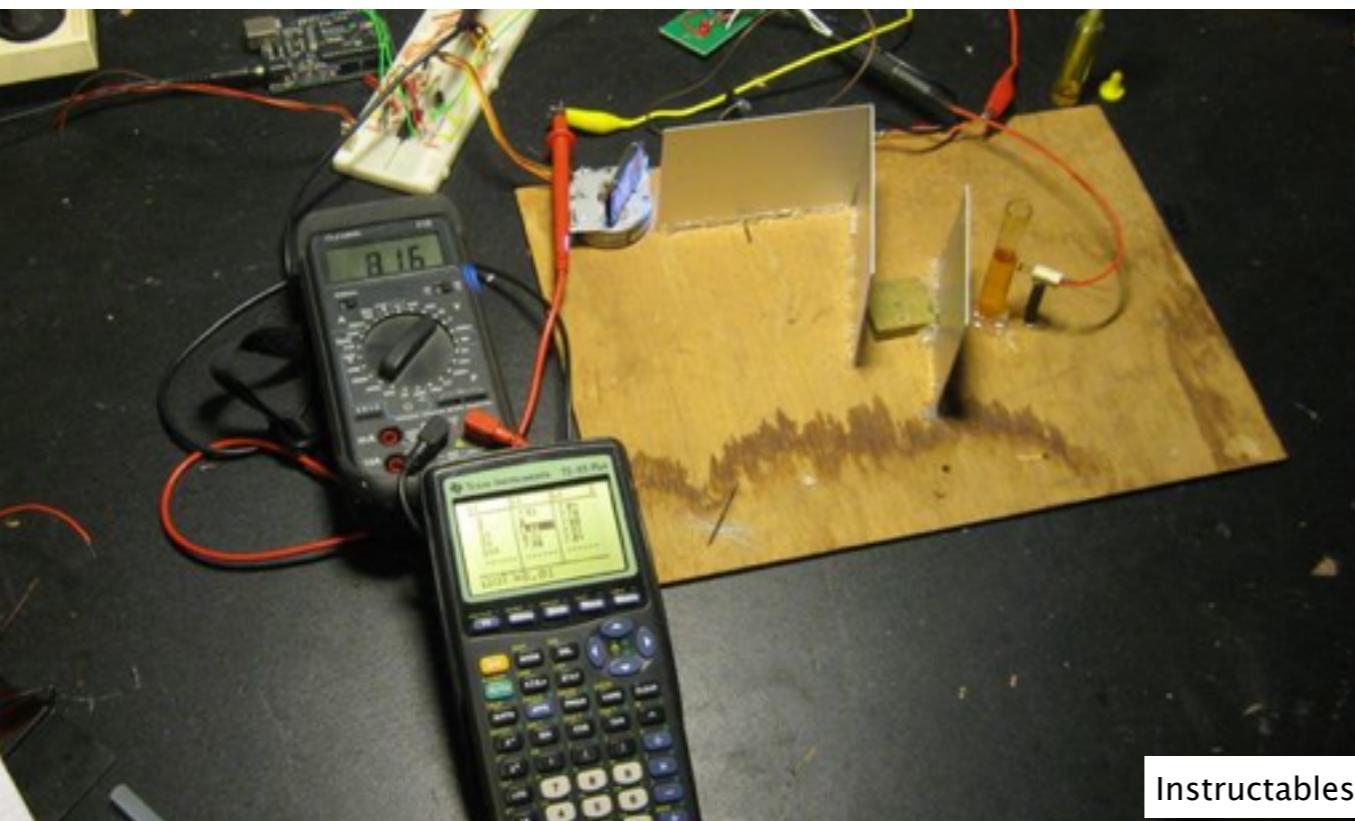


Dilution series





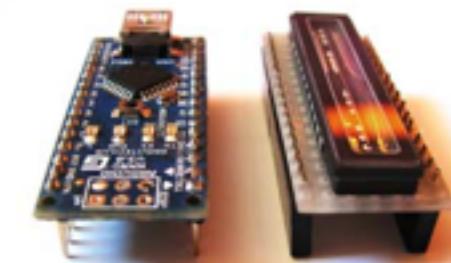
Previous hacks



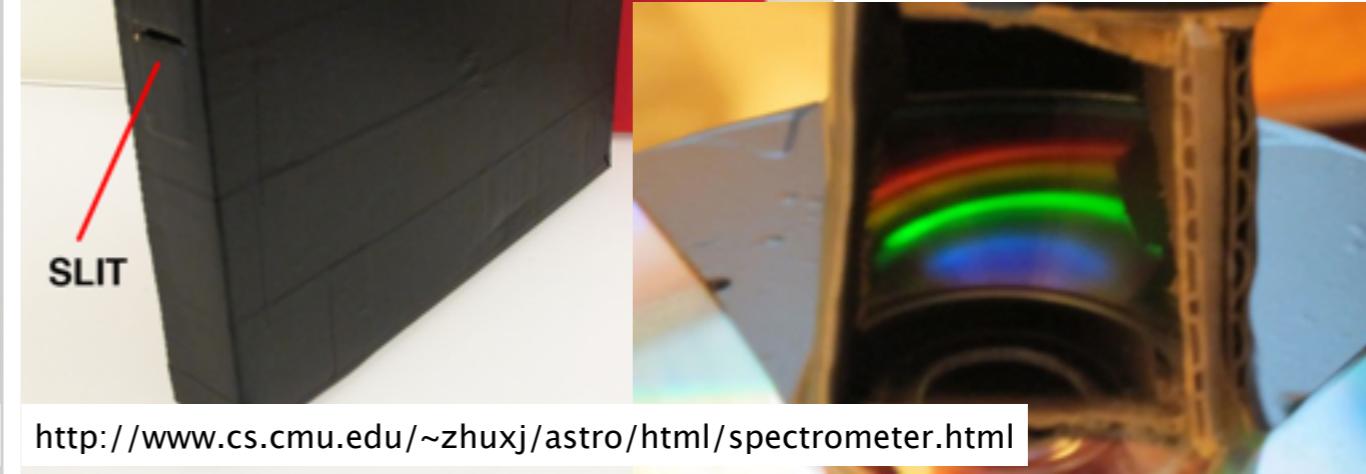
Instructables



myspectral



PublicLab



<http://www.cs.cmu.edu/~zhuxj/astro/html/spectrometer.html>



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Raman Spectrometry



Border security





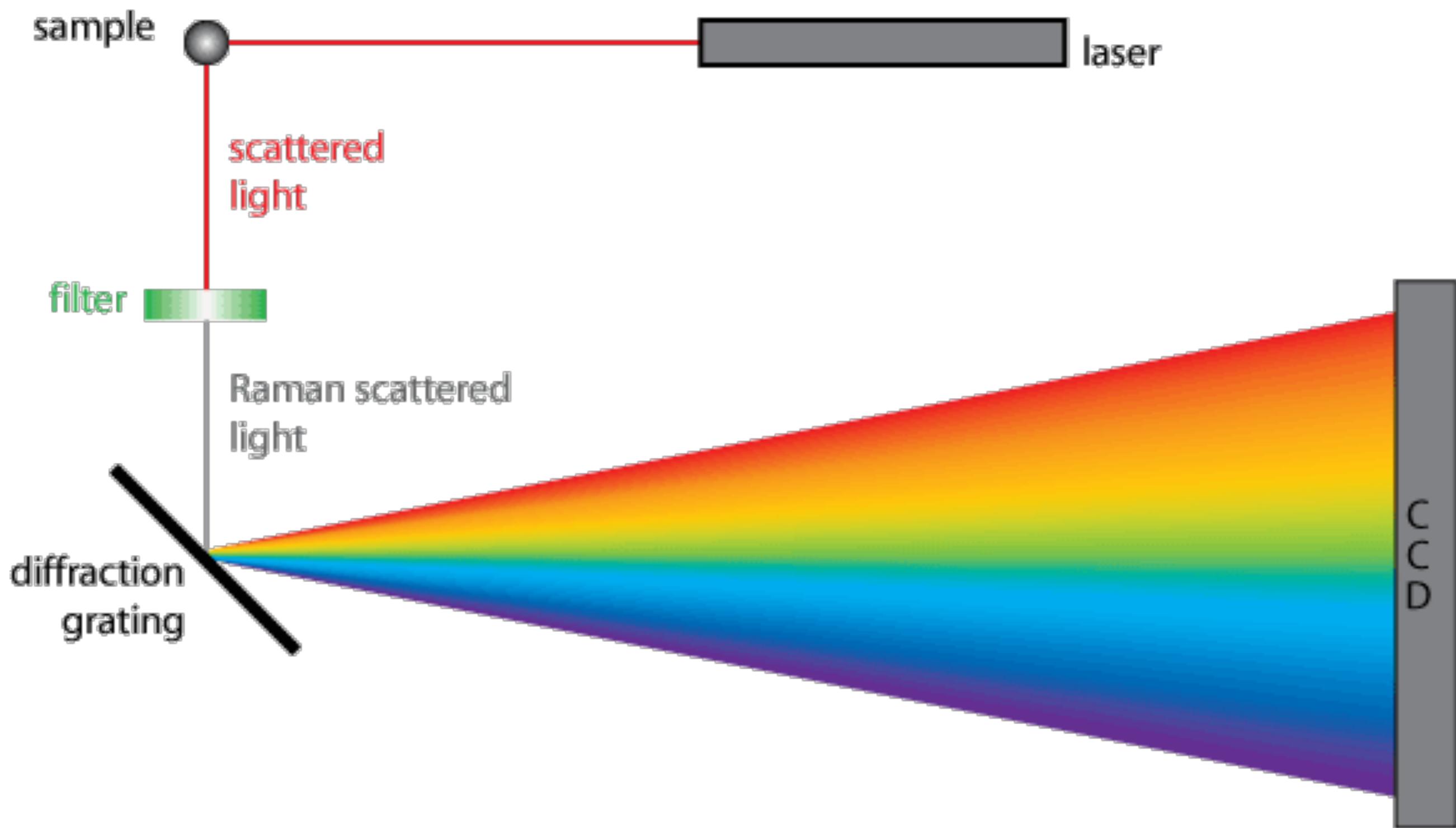
C.V. Raman

- Nobel Prize 1930
- „Raman Scattering“





Principle





DIY versions

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Start



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SCiO: Your Sixth Sense. A Pocket Molecular Sensor For All !



Scan materials or physical objects. Get instant relevant information to your smartphone. Food, medicine, plants, and more.

Created by

Consumer Physics, Inc.



12,958 backers pledged \$2,762,571 to help bring this project to life.



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Chromatography

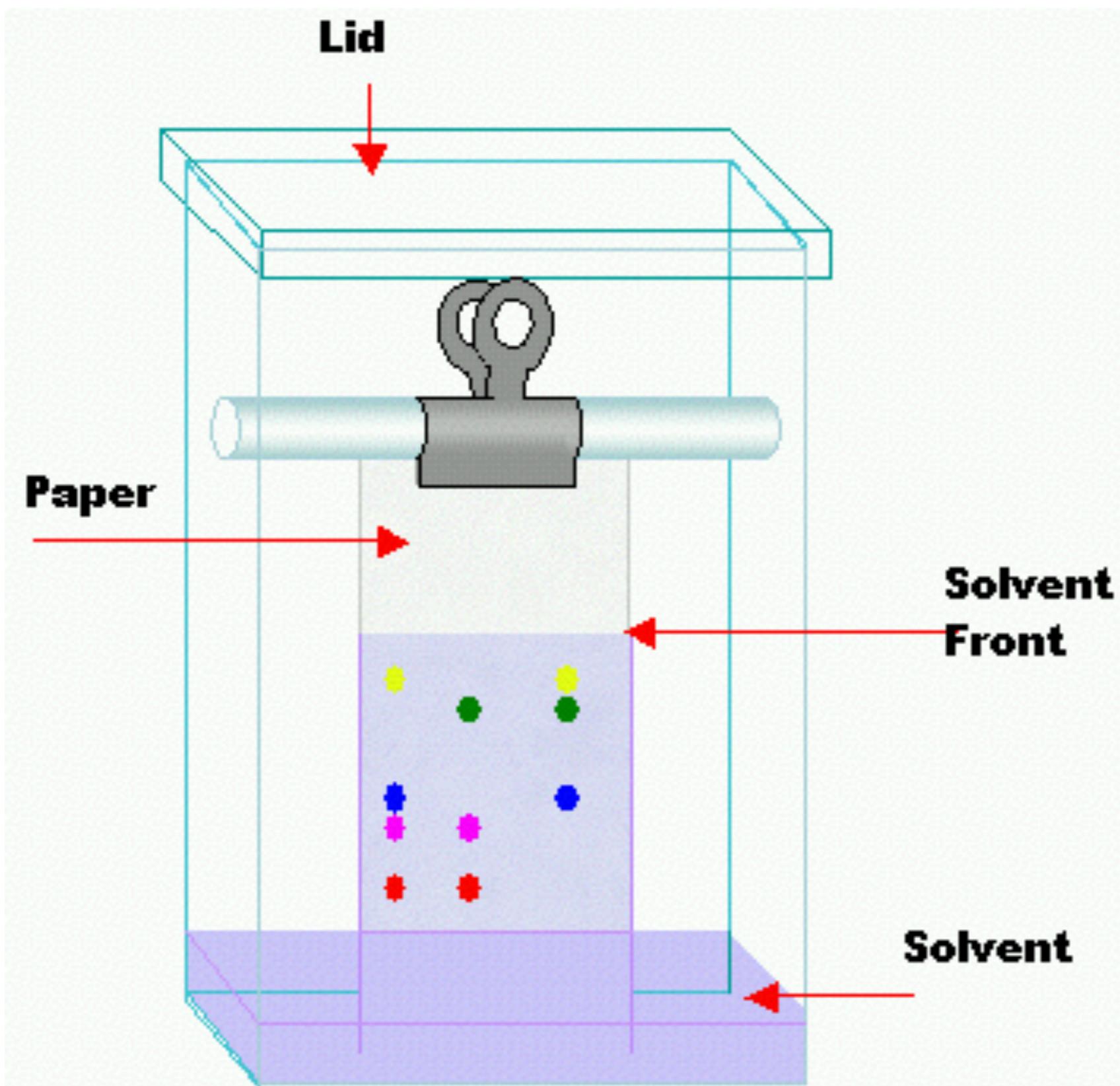


What's in here?





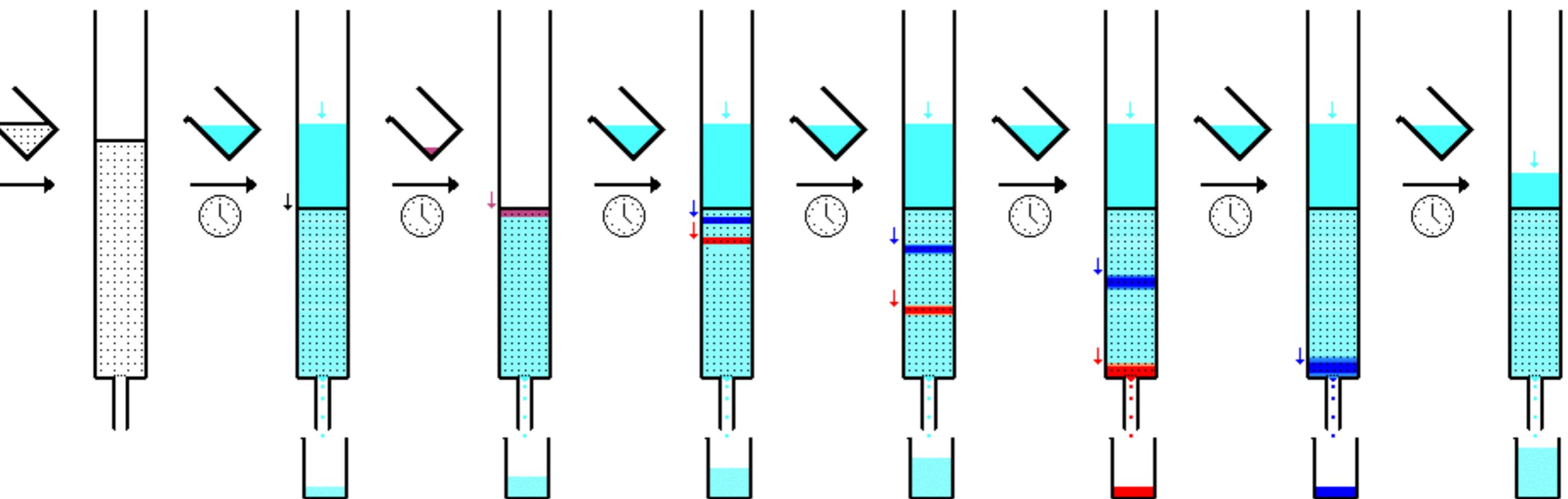
Paper





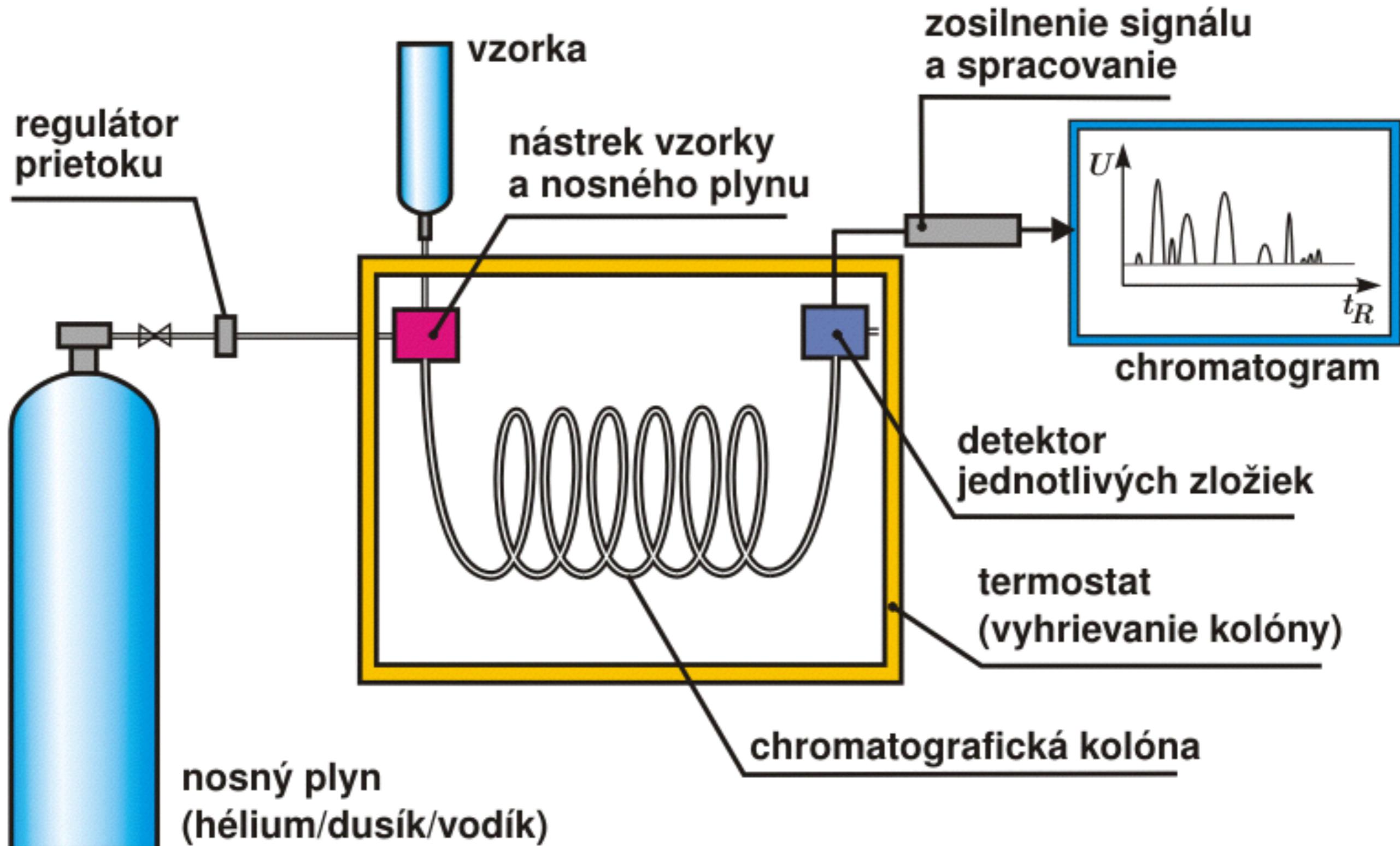
Liquid

Public Domain





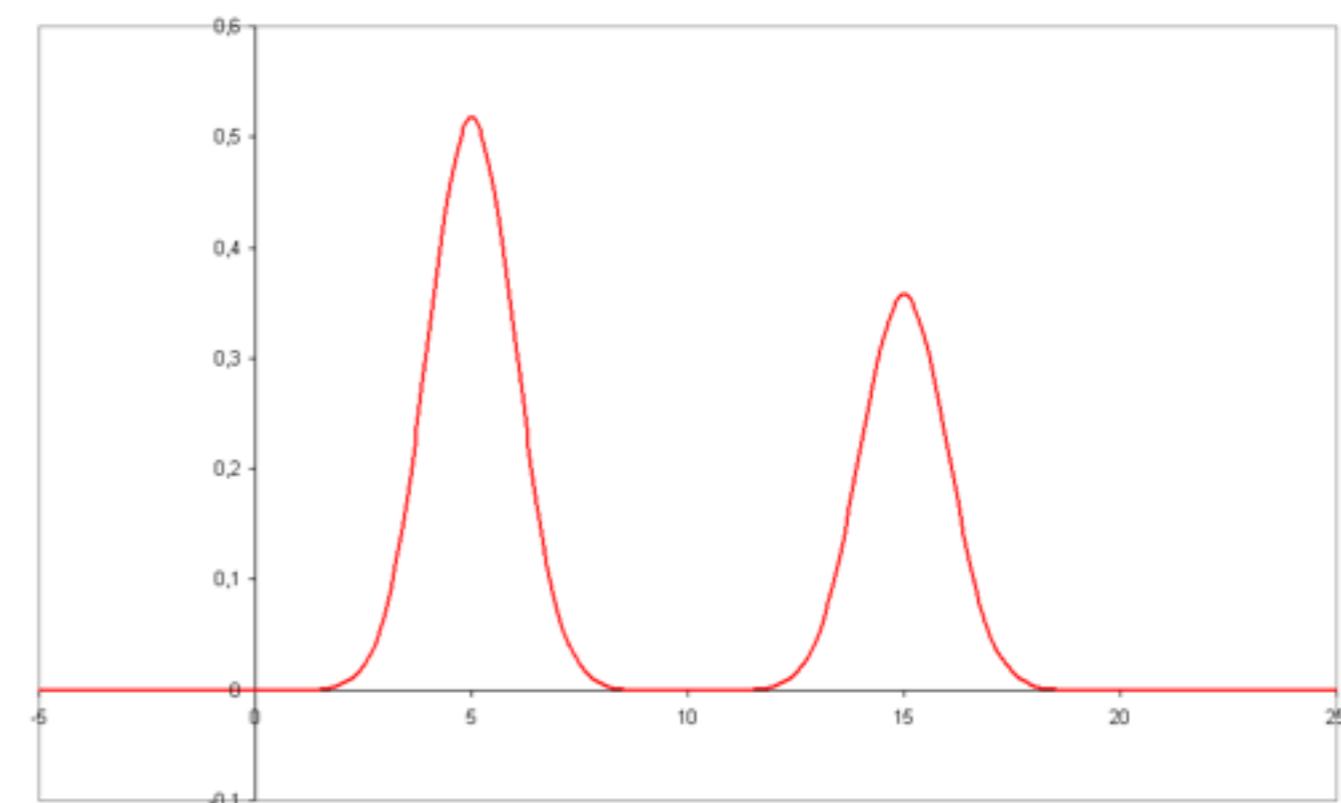
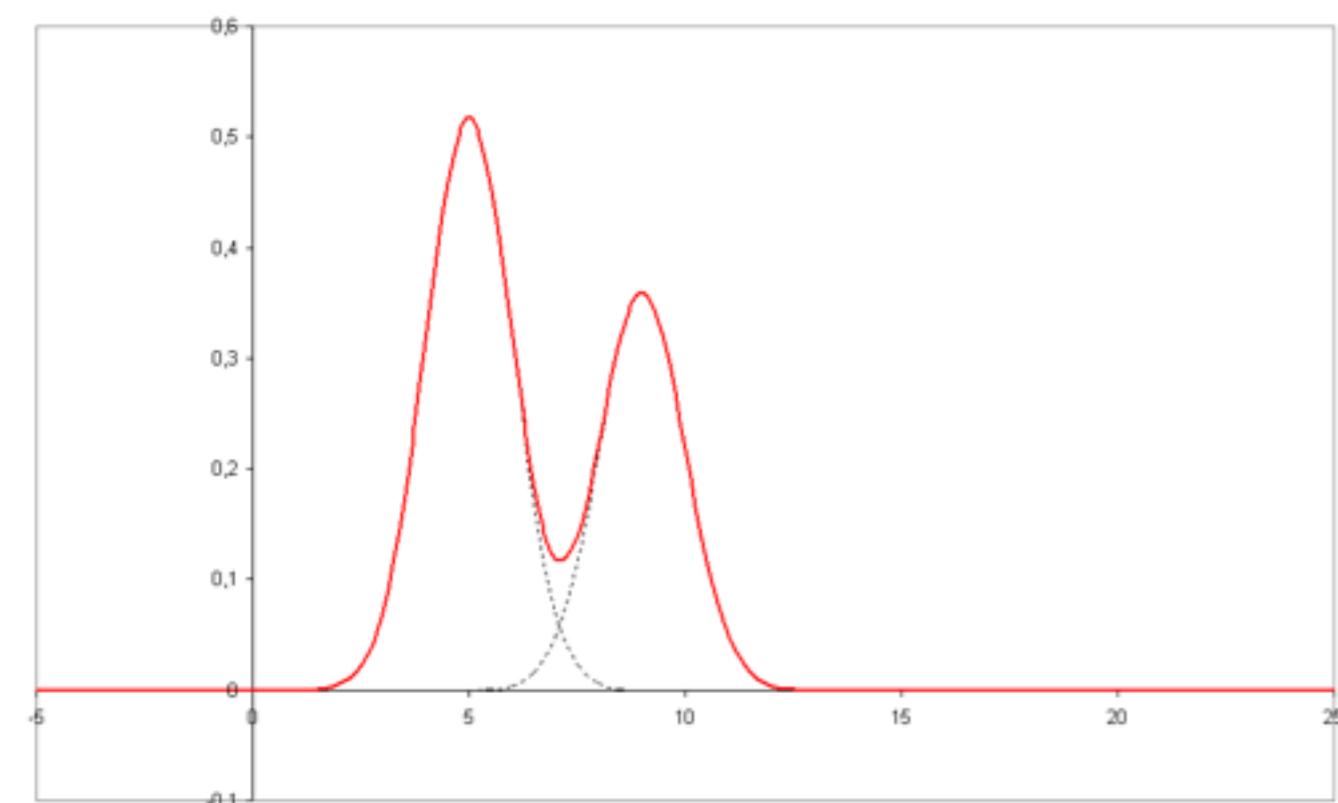
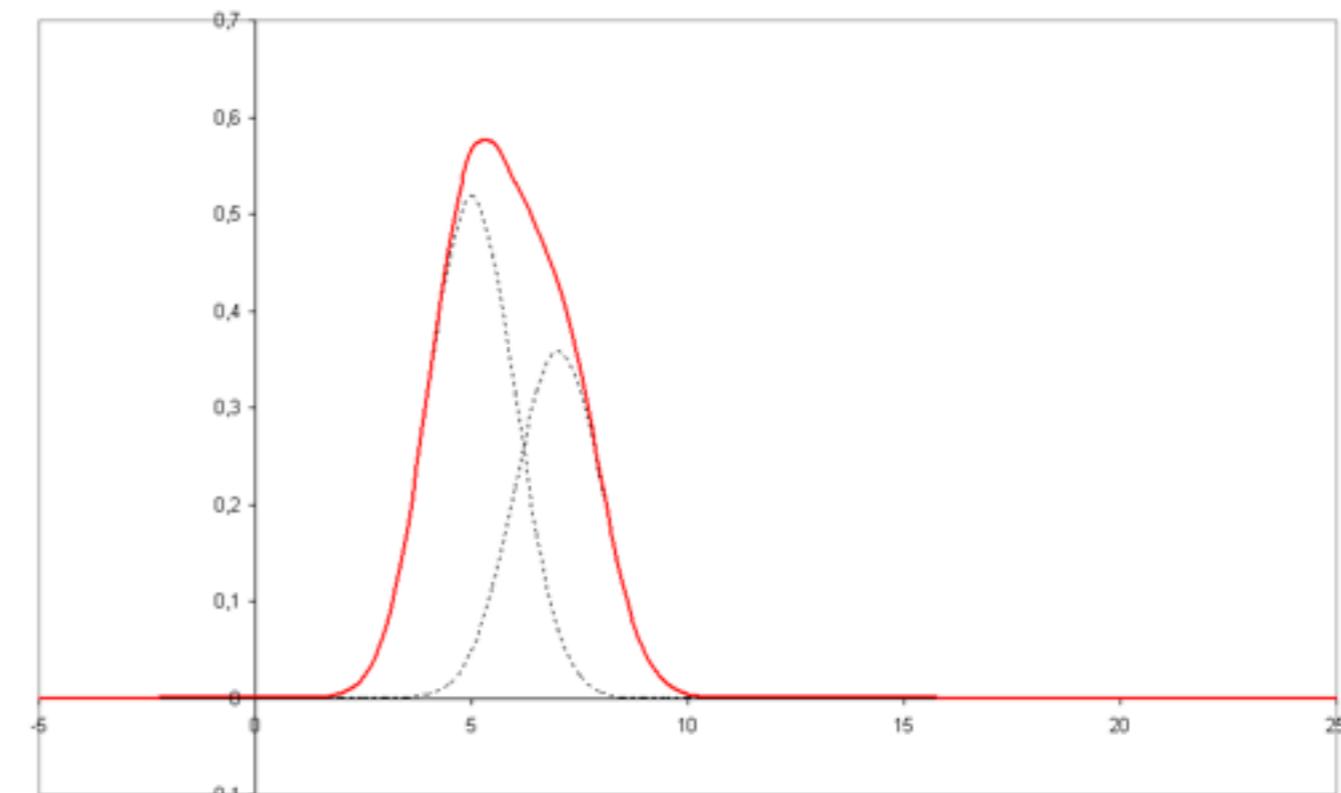
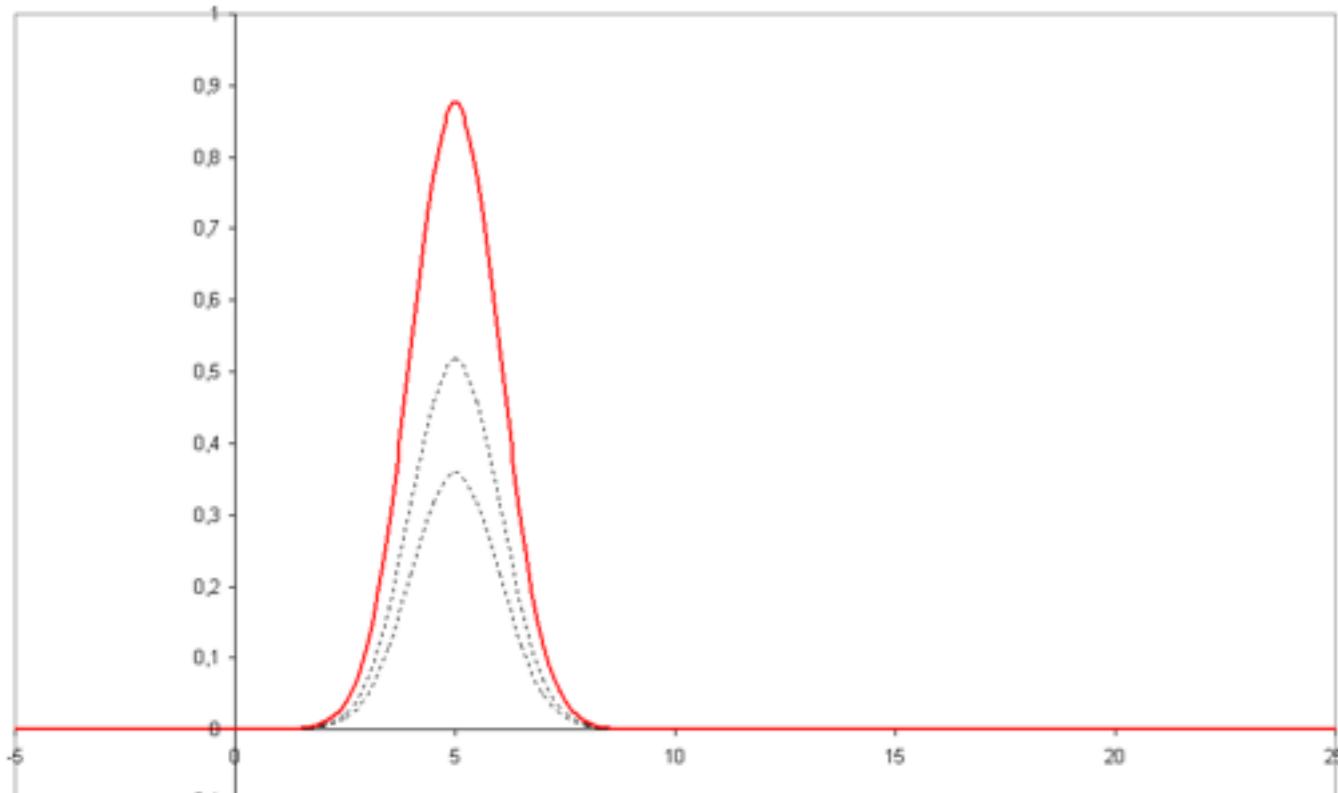
Gas





Chromatogram

public domain





HPLC

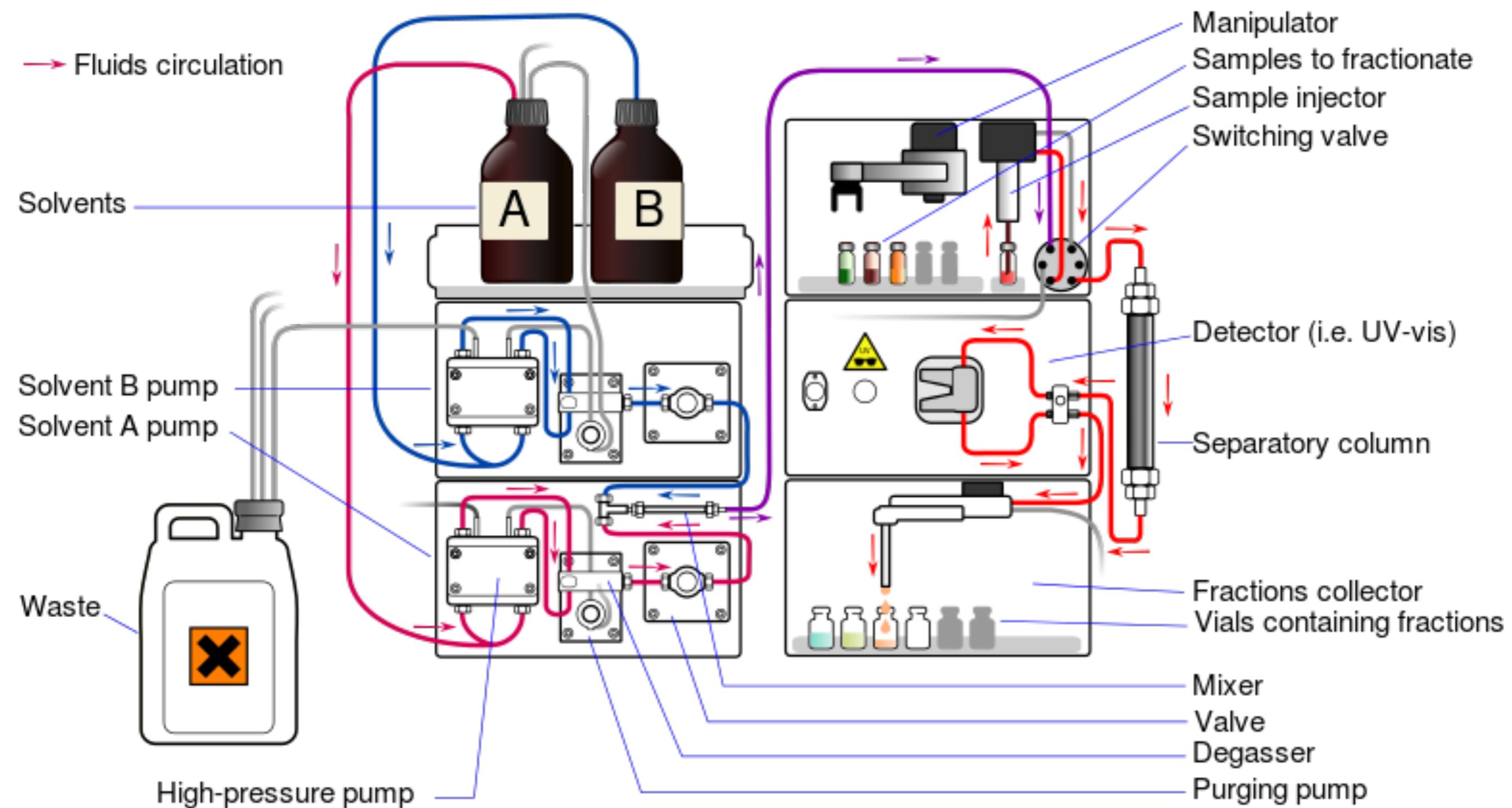


Superchilem - CC-BY-SA 3.0



HPLC

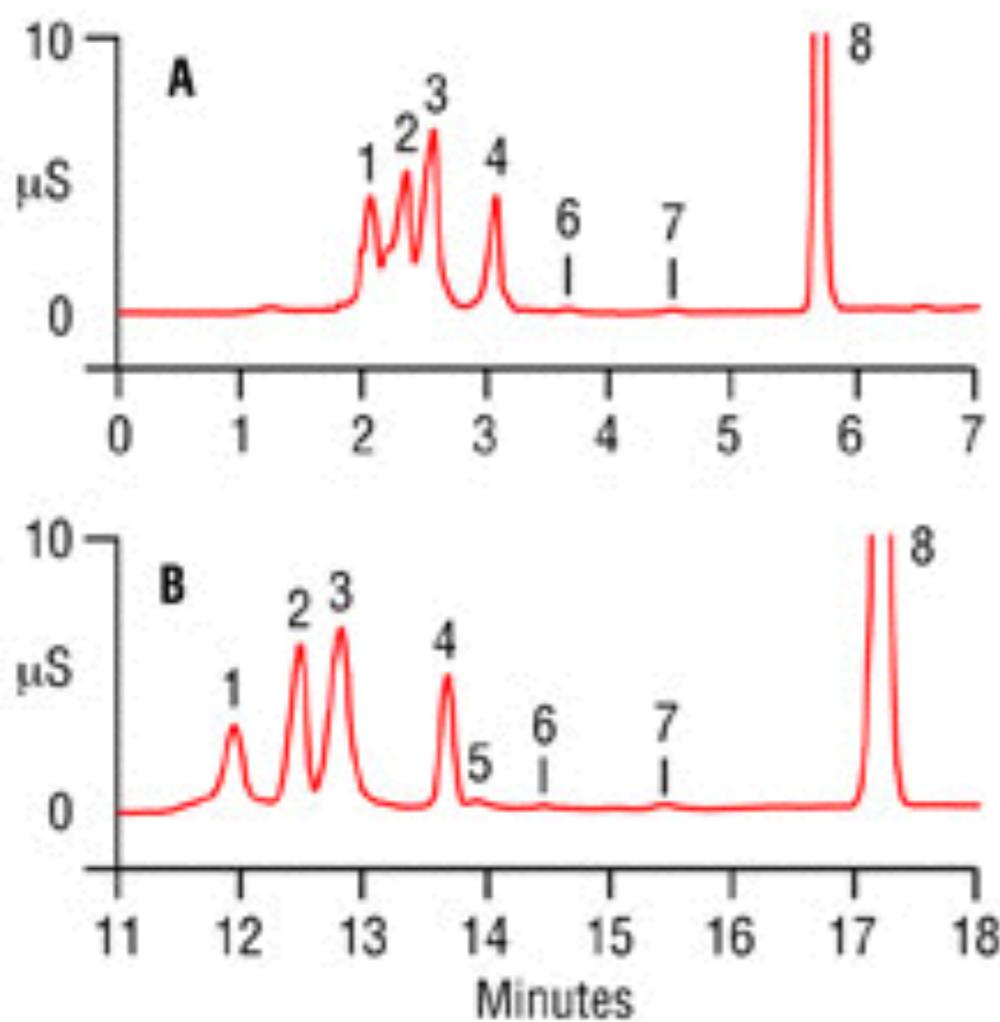
YassinMbarat - CC-BY-SA 3.0





Typical HPLC graph

Yeast Fermentation Broth Culture (10-fold Dilution) Using the IonPac® AS11 and AS11-HC



Column:
A. IonPac AS11, AG11 Guard
B. IonPac AS11-HC, AG11-HC Guard

Eluent:
A. 0.5 – 38 mM Sodium hydroxide
B. 0.5 – 90 mM Sodium hydroxide

Flow Rate:
A. 2.0 mL/min
B. 1.5 mL/min

Inj. Volume: 10 μL

Temperature:
A. Ambient
B. 30 °C

Detection: Suppressed conductivity, ASRS®, AutoSuppression® recycle mode

Peaks:
1. Unknown
2. Lactate
3. Acetate/Glycolate
4. Formate
5. Butyrate
6. Pyruvate/Isovalerate
7. Valerate
8. Chloride



DIY HPLC?



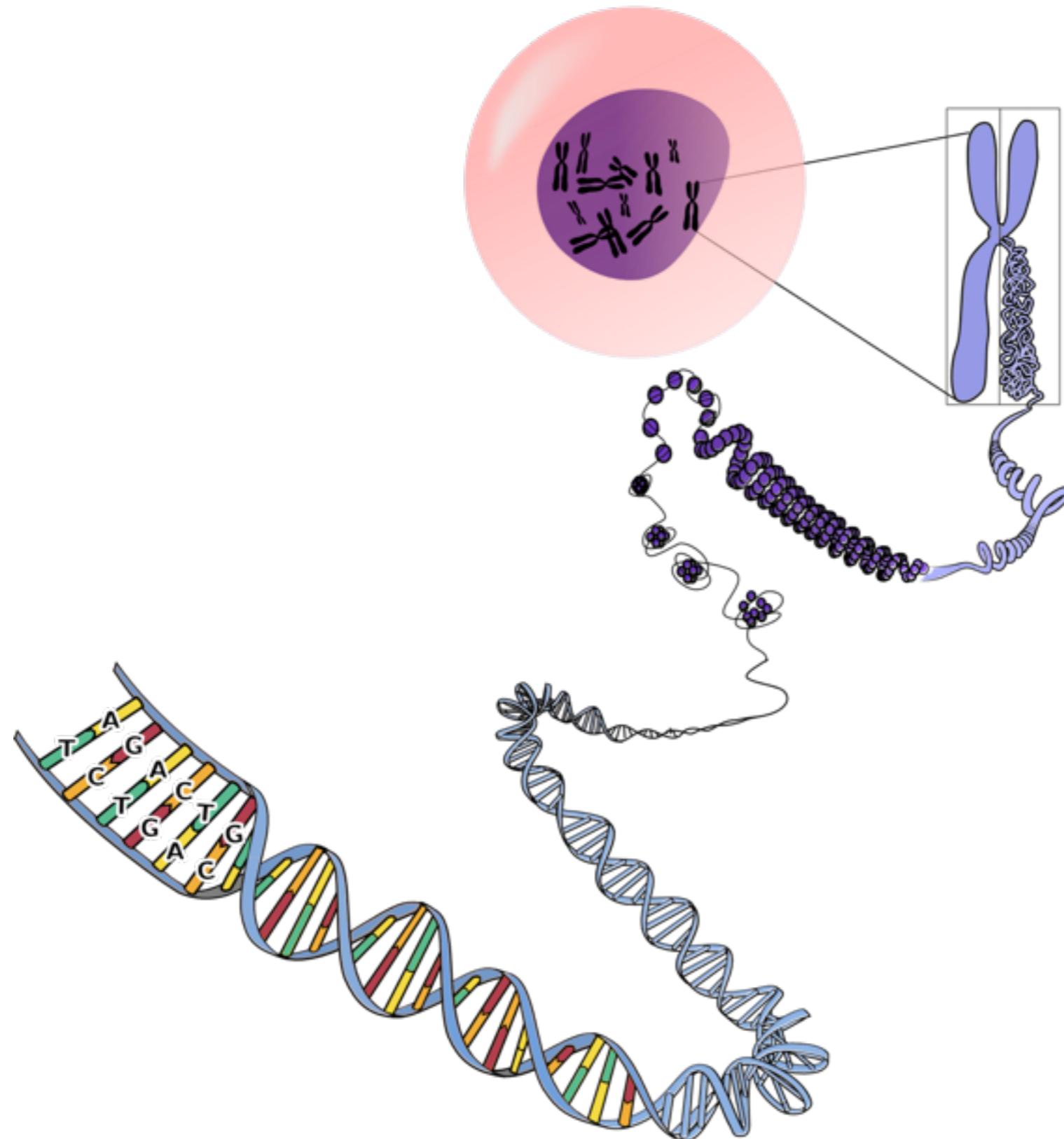
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Electrophoresis



How to analyse DNA





Sushi test





PooPrints

PooPrints™

Match The Mess Through DNA

D305-520

DNA Collection Kit

PET Identification Card

www.biopetvetlab.com
DNA PET ID
BioPet
Vet Lab
A DIVISION OF SECO BIOTECH CORPORATION
1-865-833-7389

DNA PET ID
DNA 011101Z
L-865-
833-7389

Affix barcode sticker OR write dog's name here

Affix barcode sticker OR write dog's name here

Customer Information Card

*Required Information

Account Information

*Country: _____
*Email: _____
*Your Name: _____
*Address: _____
*City, State, Zip: _____
Phone: _____

Pet Information

Pet's Name: _____
Pet's Species: _____ Dog _____ Cat _____
Where did you purchase your DNA Pet ID Kit?
Company: _____

Apply Barcode Sticker Here

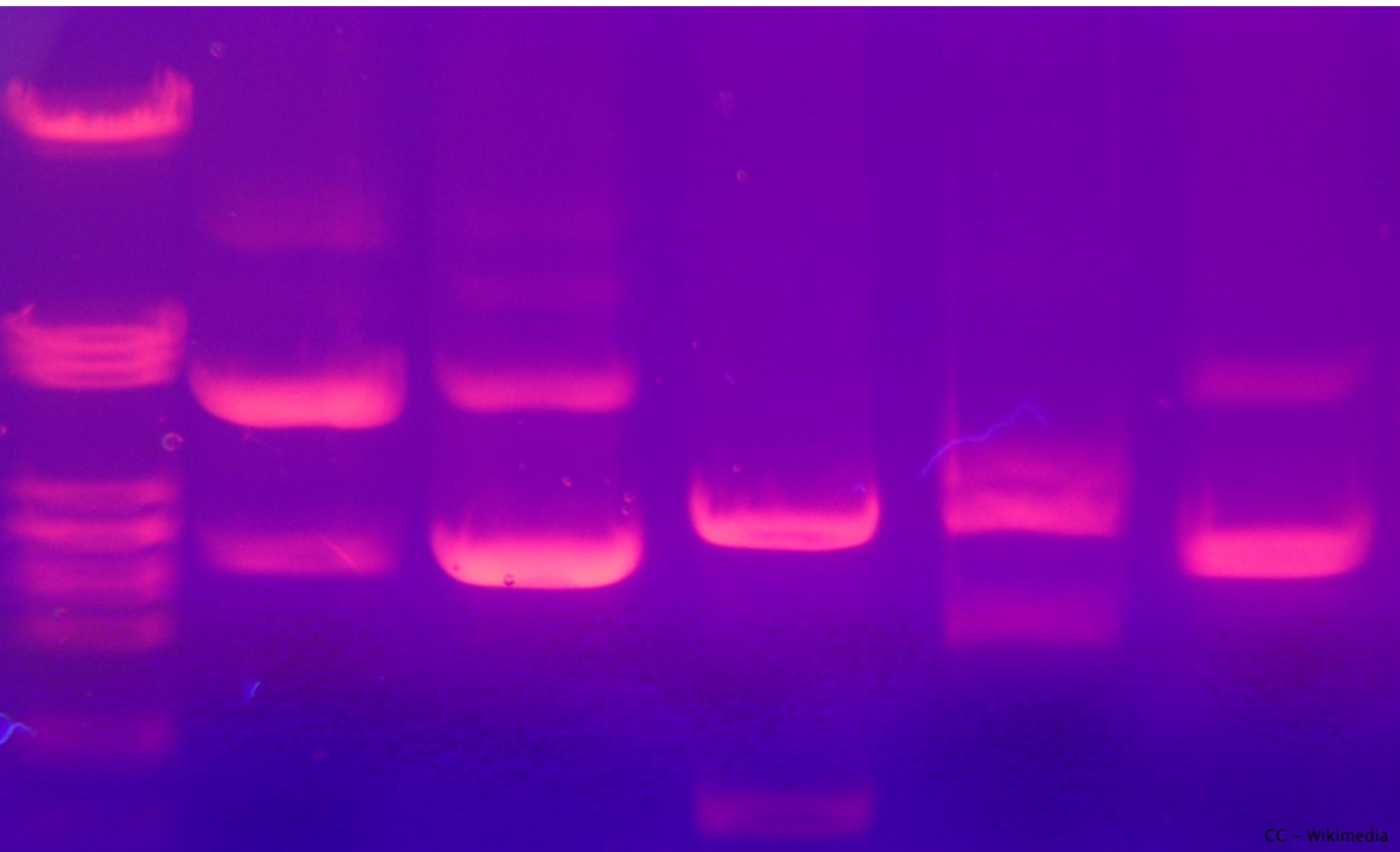
BioPet
Vet Lab
A DIVISION OF SECO BIOTECH CORPORATION

BioPet
Vet Lab
A DIVISION OF SECO BIOTECH CORPORATION

DNA World Pet Registry



DNA fingerprint



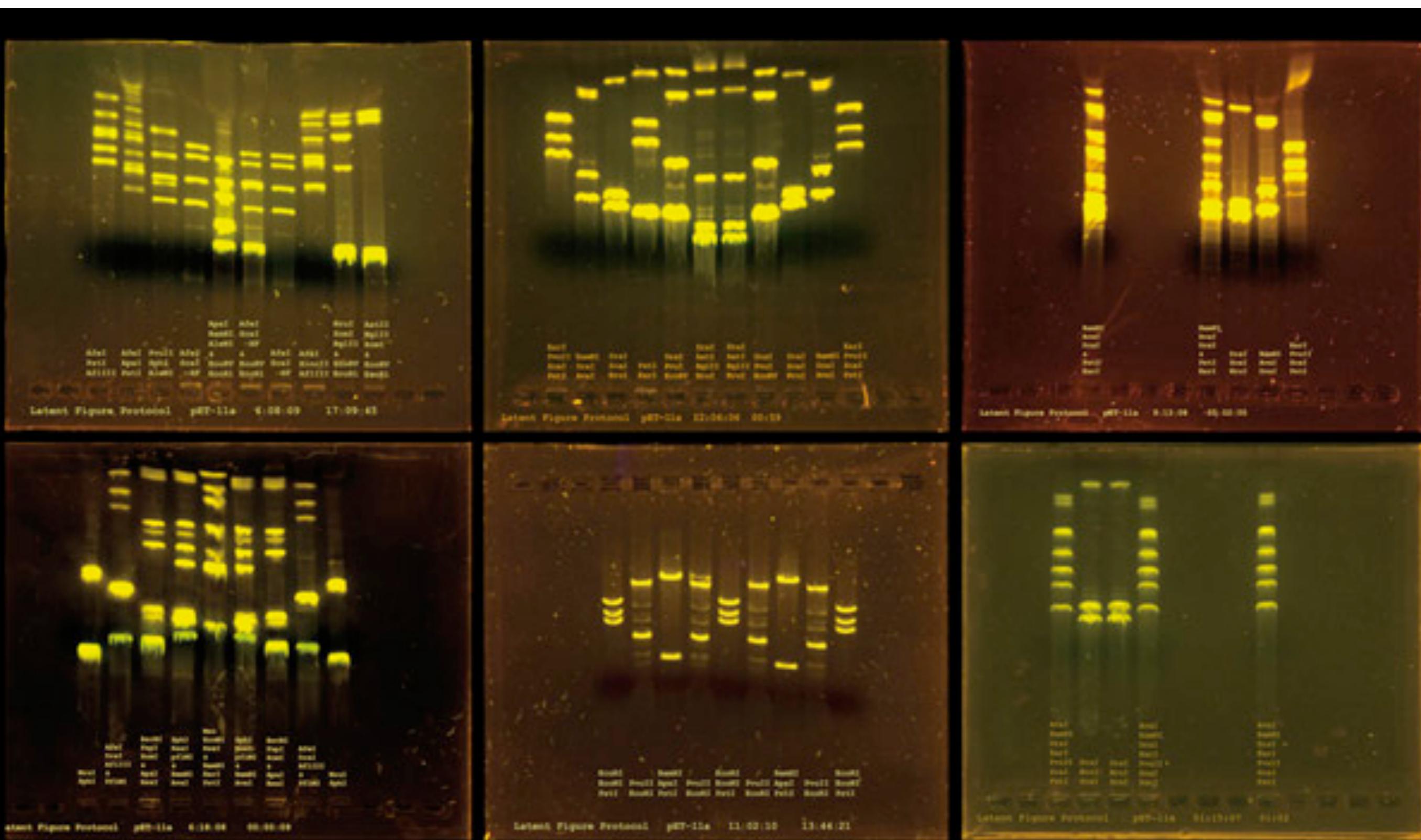


Barcode



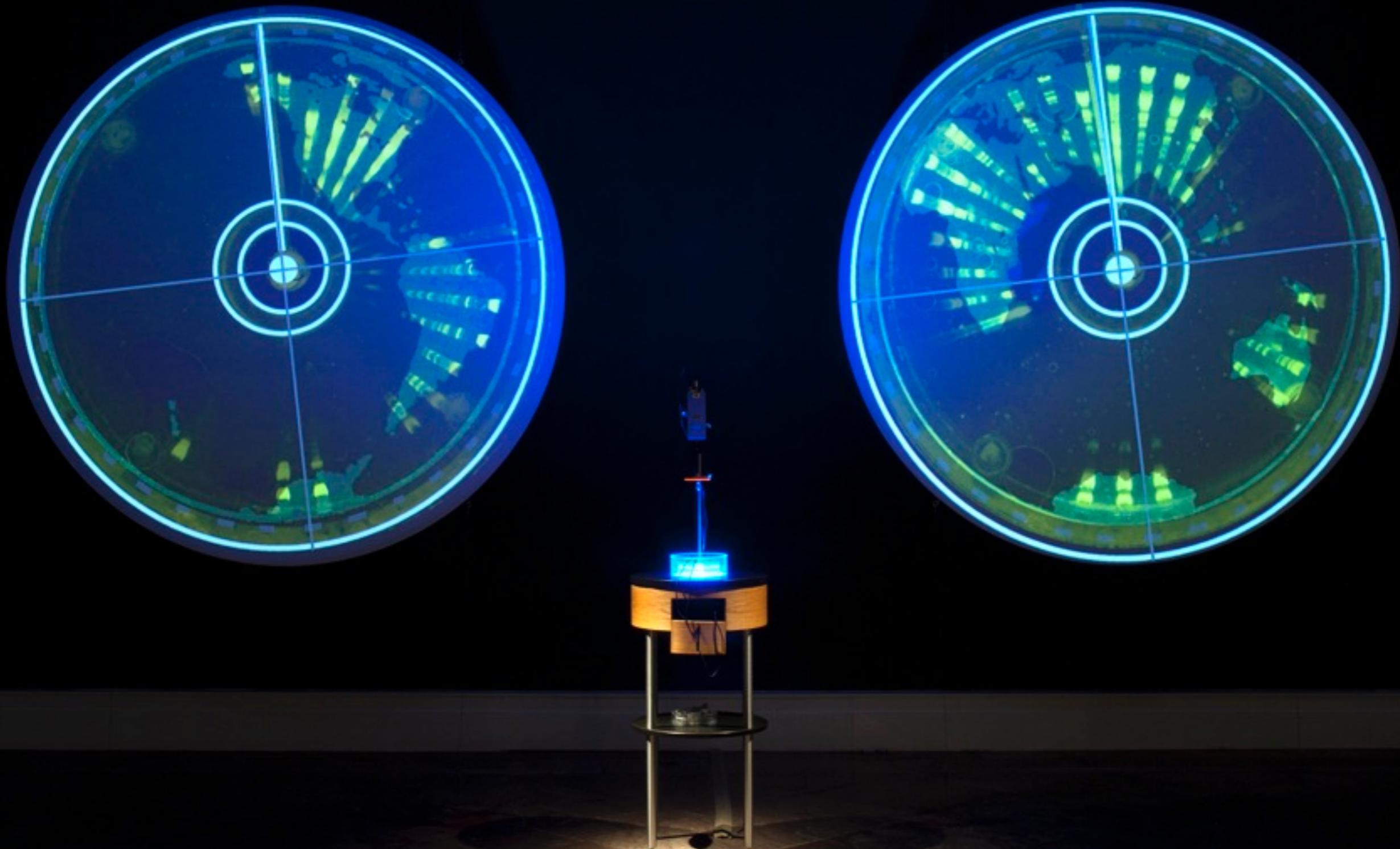


Paul Vanouse





Paul Vanouse





Sequence specific cuts

Restrictie site

Palindrome

The diagram shows a DNA sequence with a palindromic region highlighted by a blue dashed box. An orange box highlights the sequence GATTC. A pair of scissors icon is positioned above the blue box.

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

The diagram shows two rows of DNA sequence. The top row is G T A G A A T T C A T T C A C G C A and the bottom row is C A T C T T A A G T A A G T G C G T. A blue dashed box encloses the sequence from the third base of the first row to the second base of the second row. Above this box is a black icon of a pair of scissors.

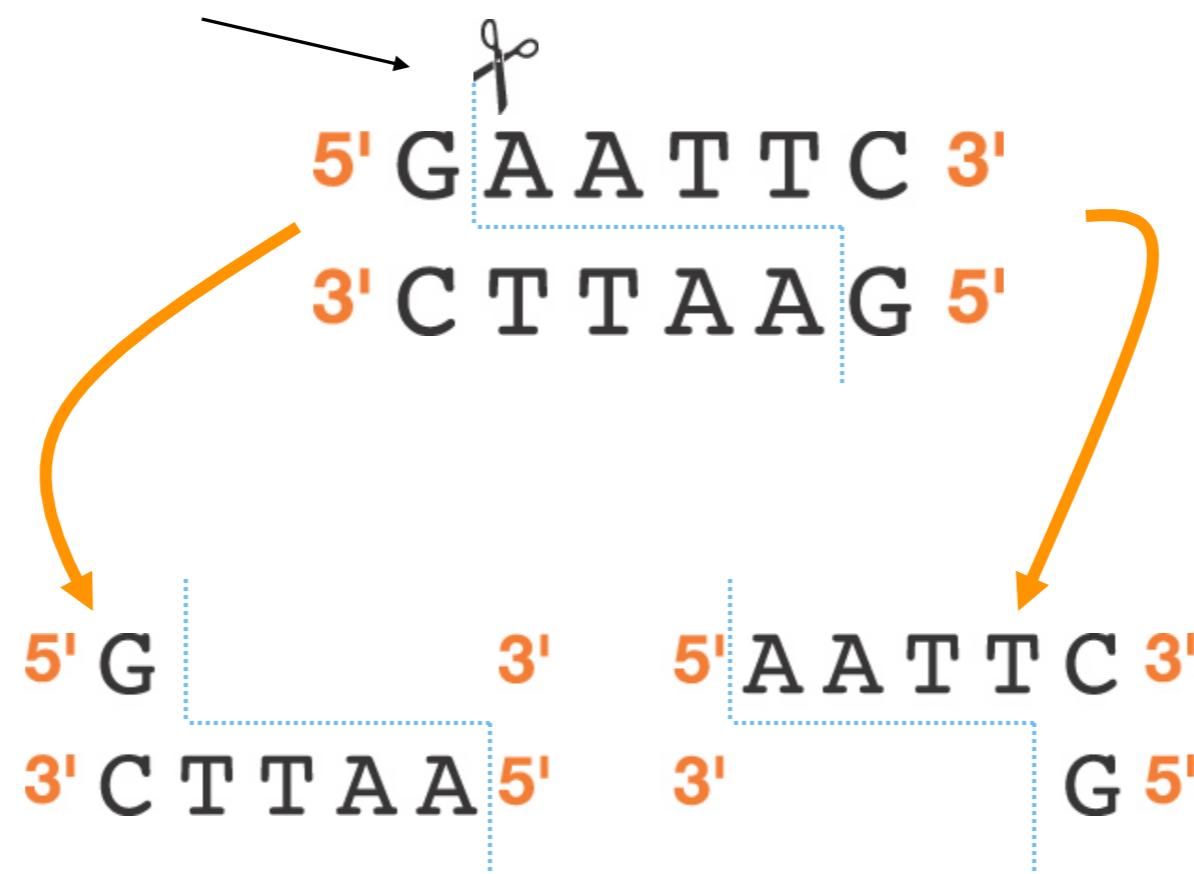
Fragment 1

Fragment 2



5 vs 3 accent overlap

cut site





EcoRI en PstI



EcoRI

- Escherichia coli
- 5 prime overlap



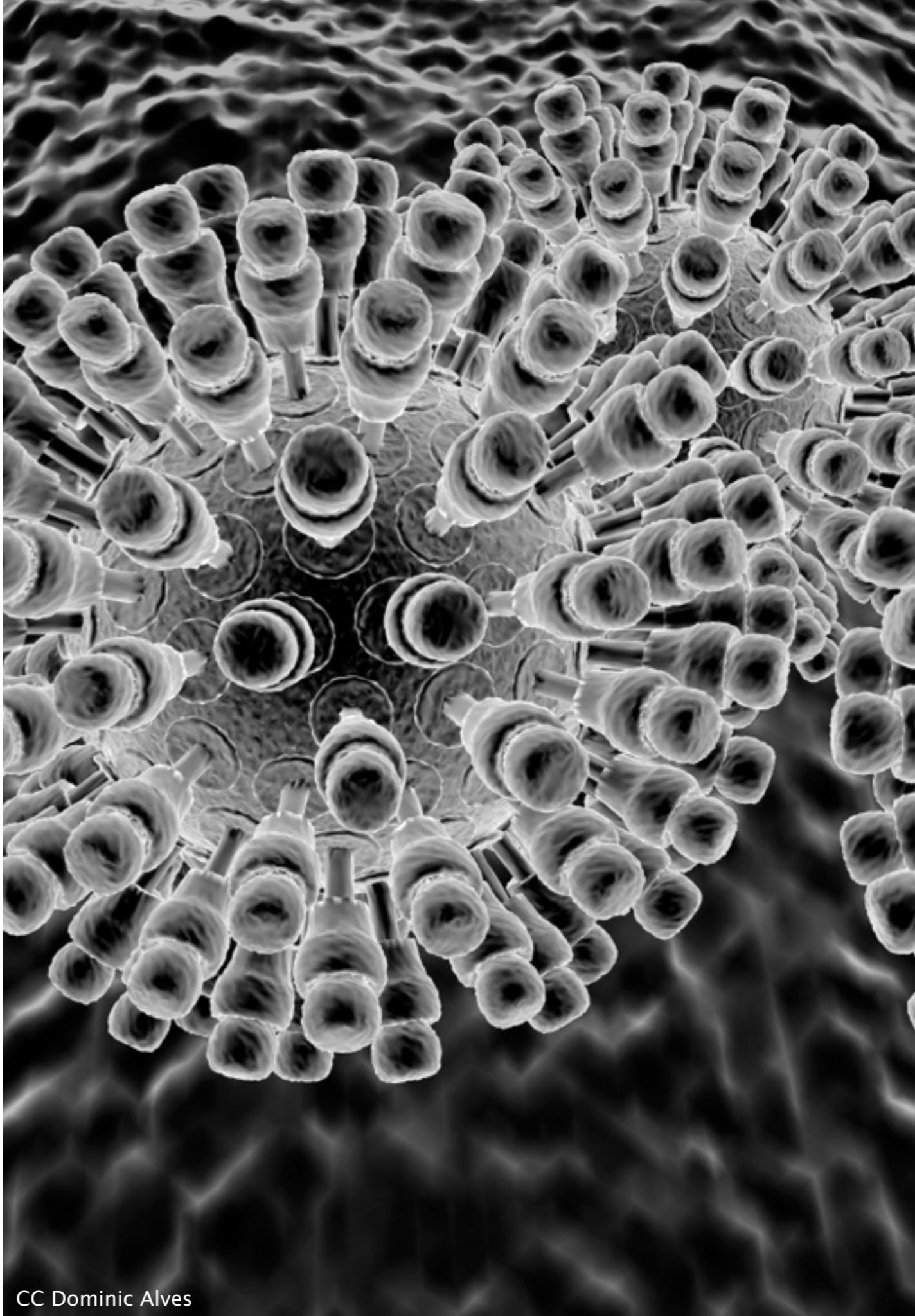
PstI

- Providencia stuartii
- 3 prime overlap



DNA restriction enzymes

- Protect against viral infections
- Over 3000 types known





Step 1: samples and enzymes

Get DNA and enzymes

Crime Scene → Suspects → DNA reference



Take the 5 samples



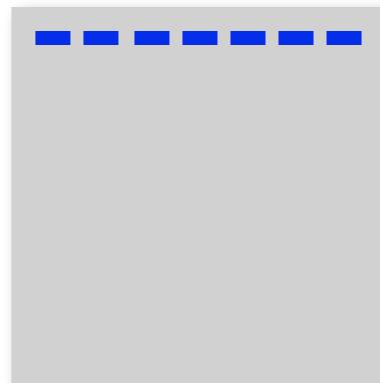
Cut it using a EcoRI/
PstI restriction-
enzymmix

Incubate 45 minutes at 37 degrees

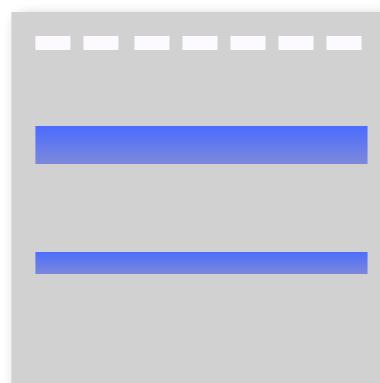


Step 2: Gel electrophoreses

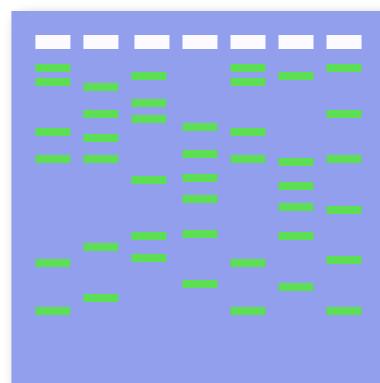
Mix the samples with loading dye



Load the samples in a gel



Apply current

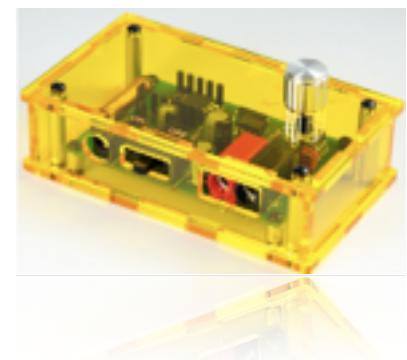
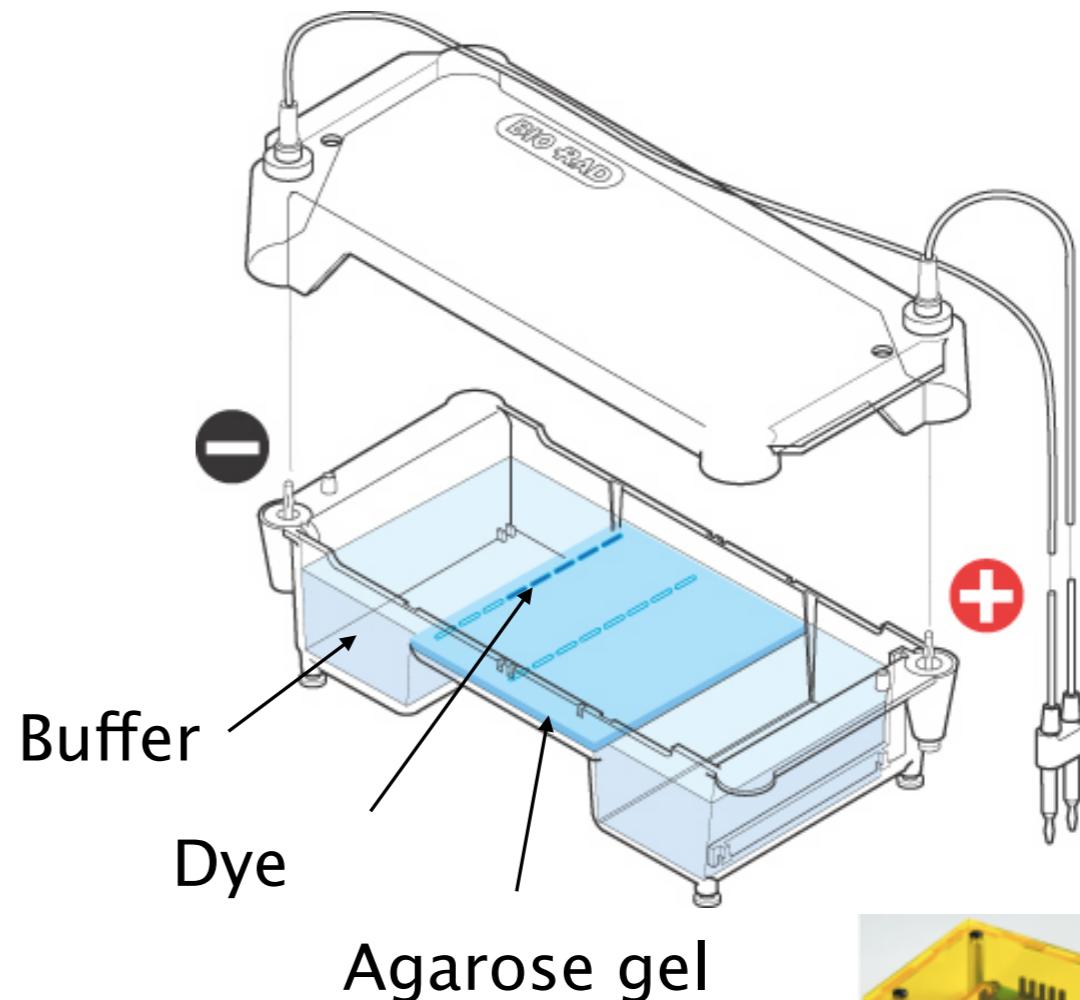


Read the pattern

Identify the killer

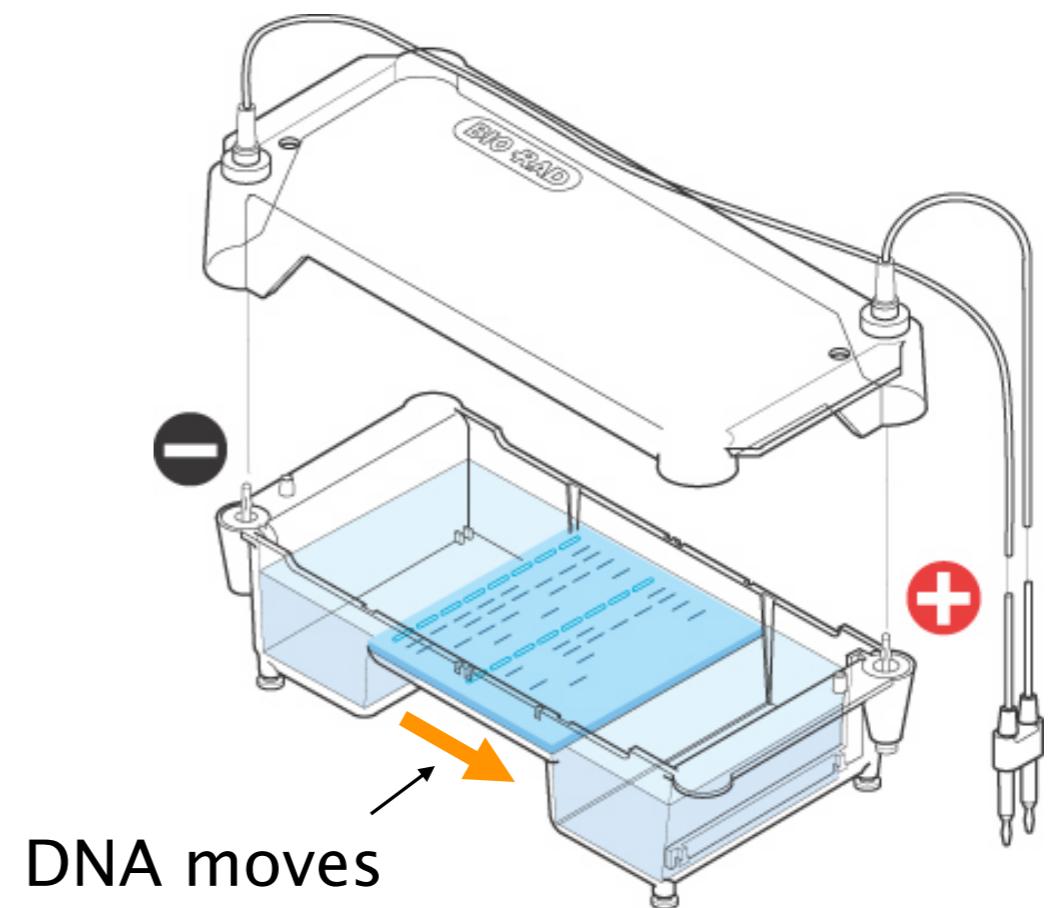
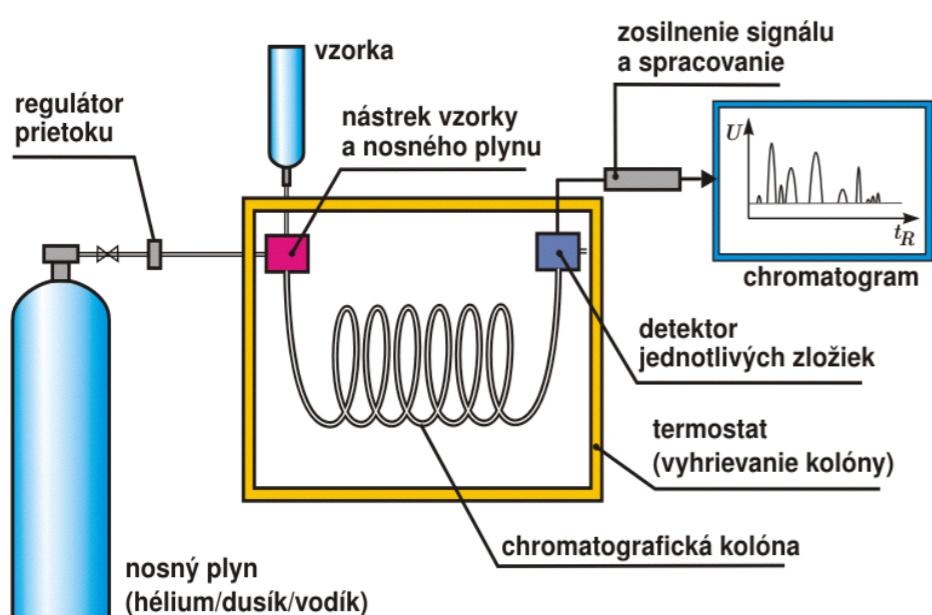


DNA is attracted by the anode





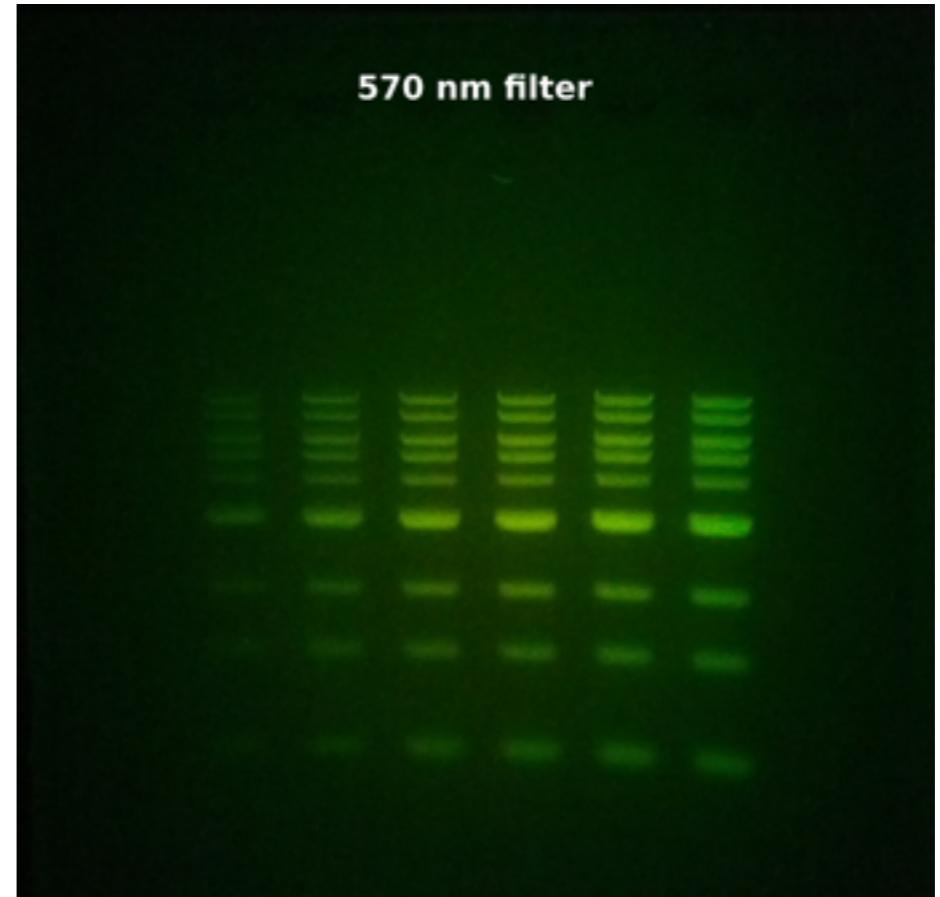
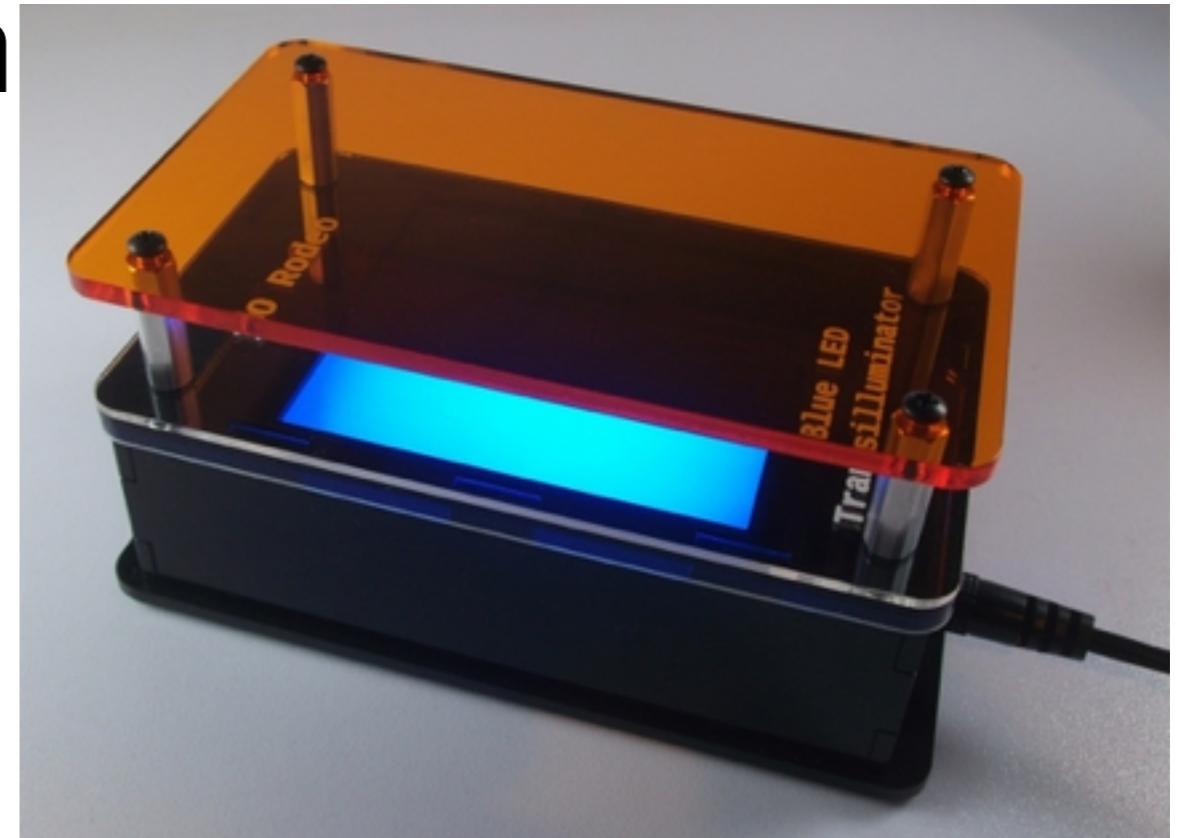
Short pieces move faster than long pieces





Transillumination

- Fluorescent DNA dye
- Sensitive to blue light
- Emits green light
- Orange filter blocks blue light

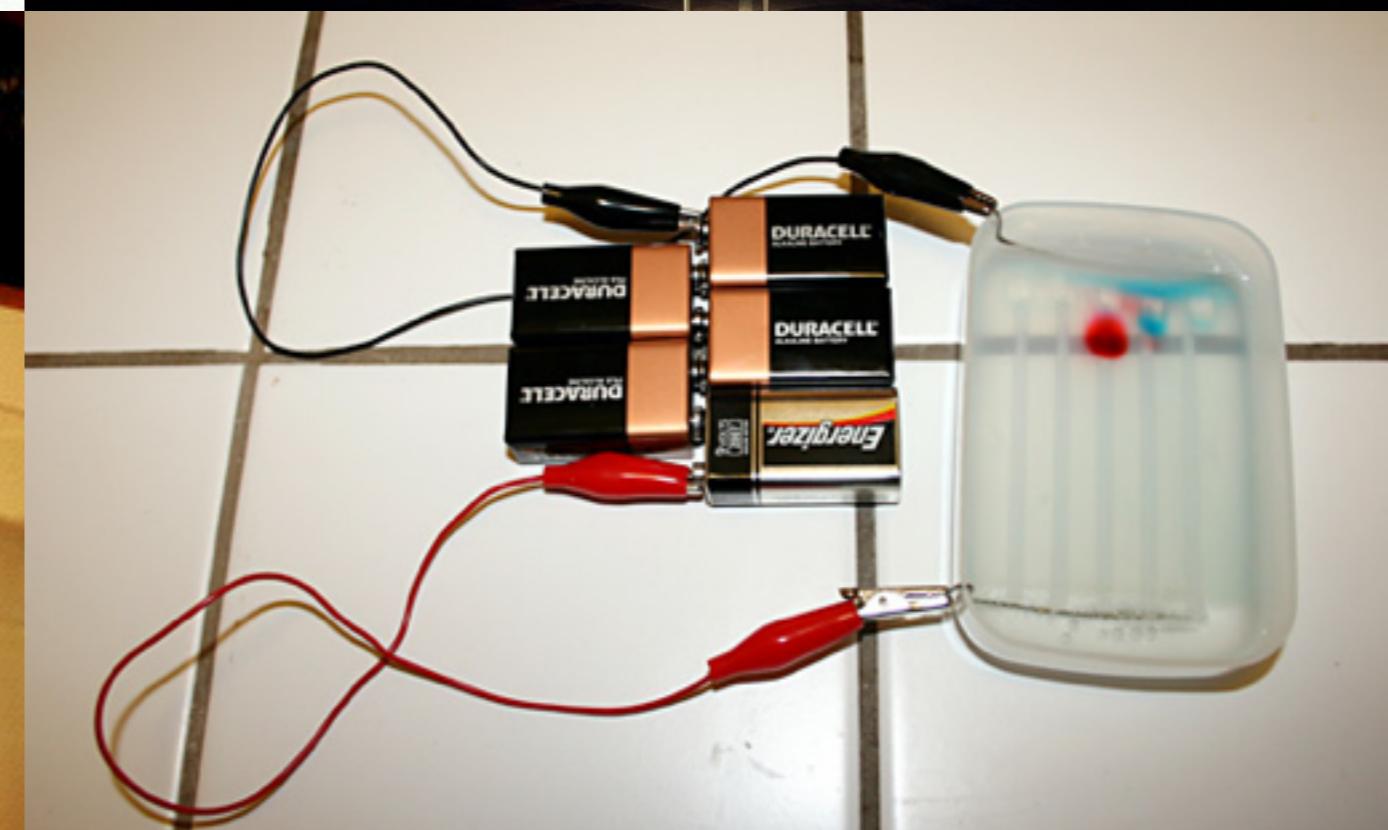
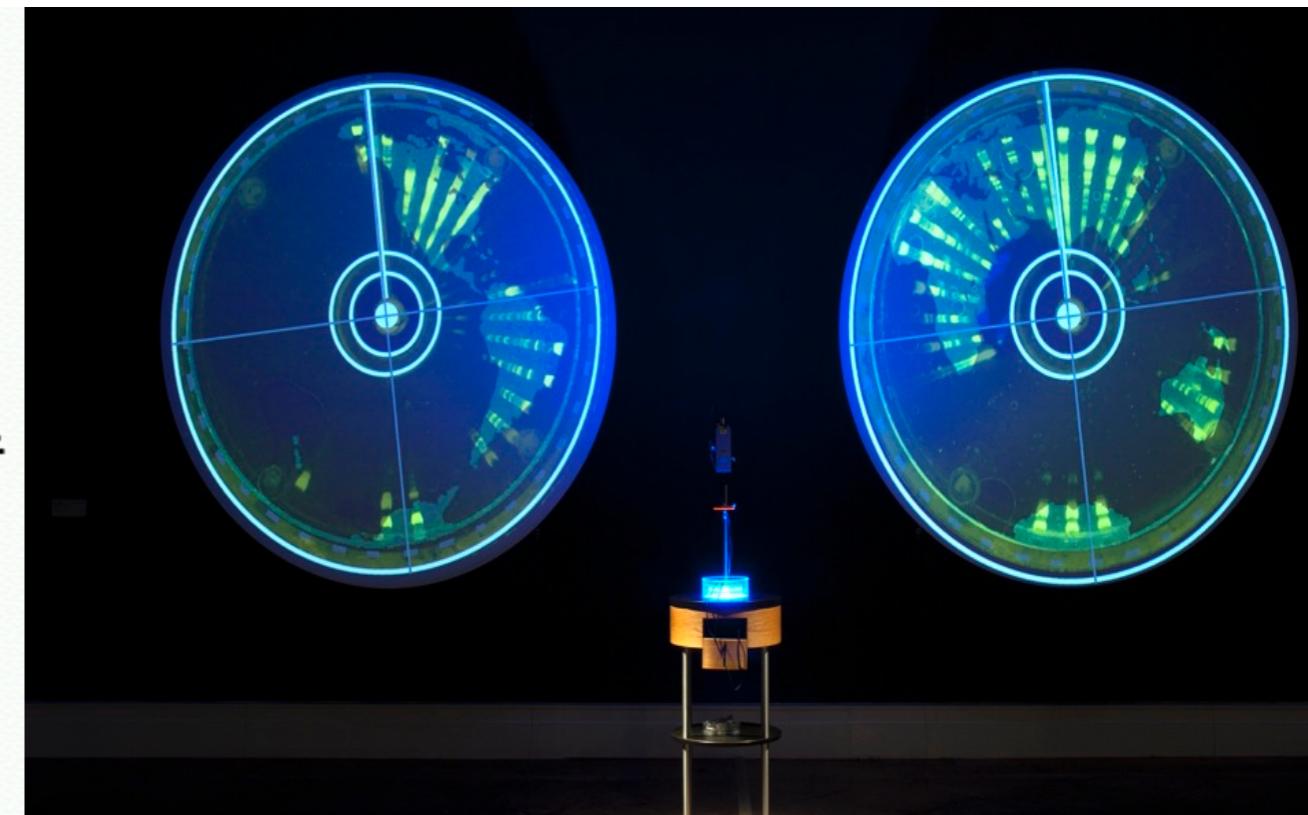
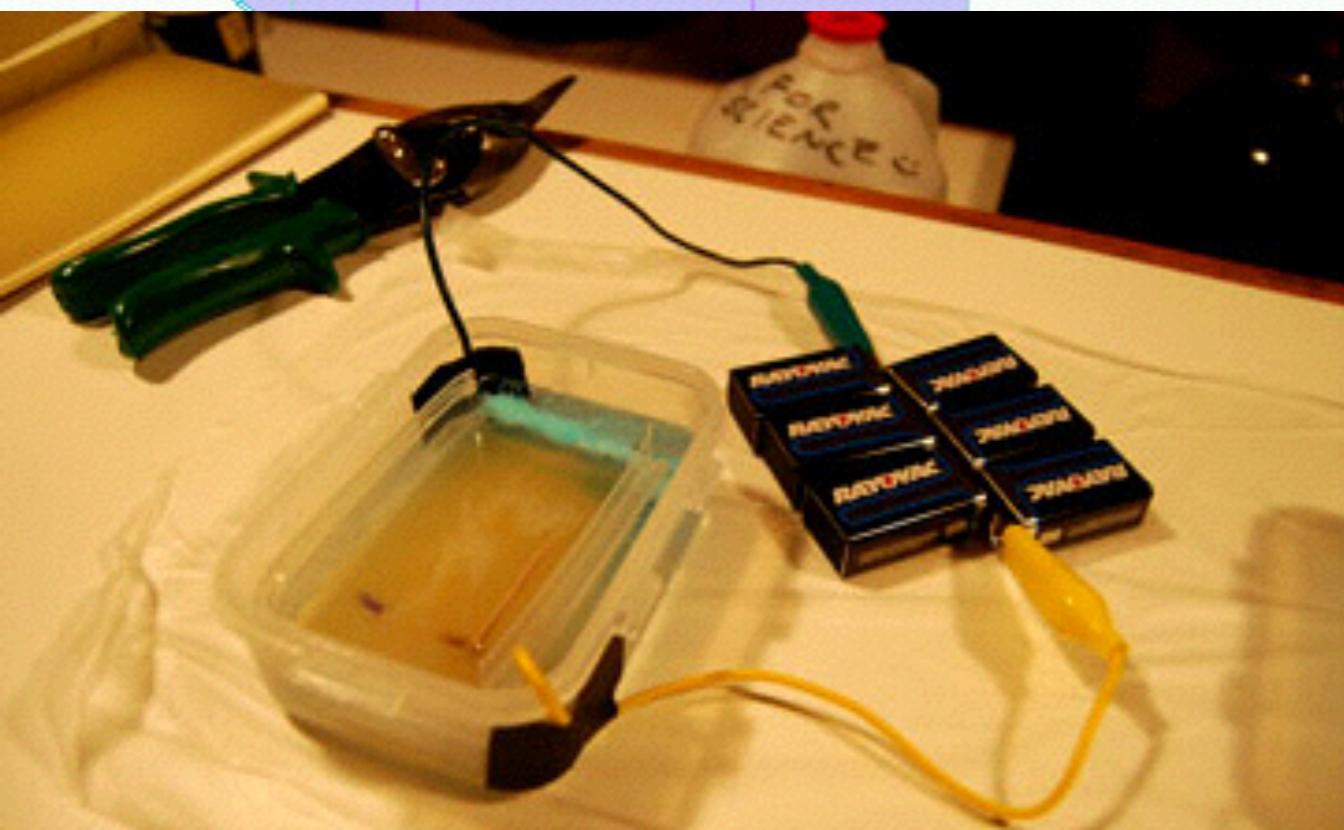
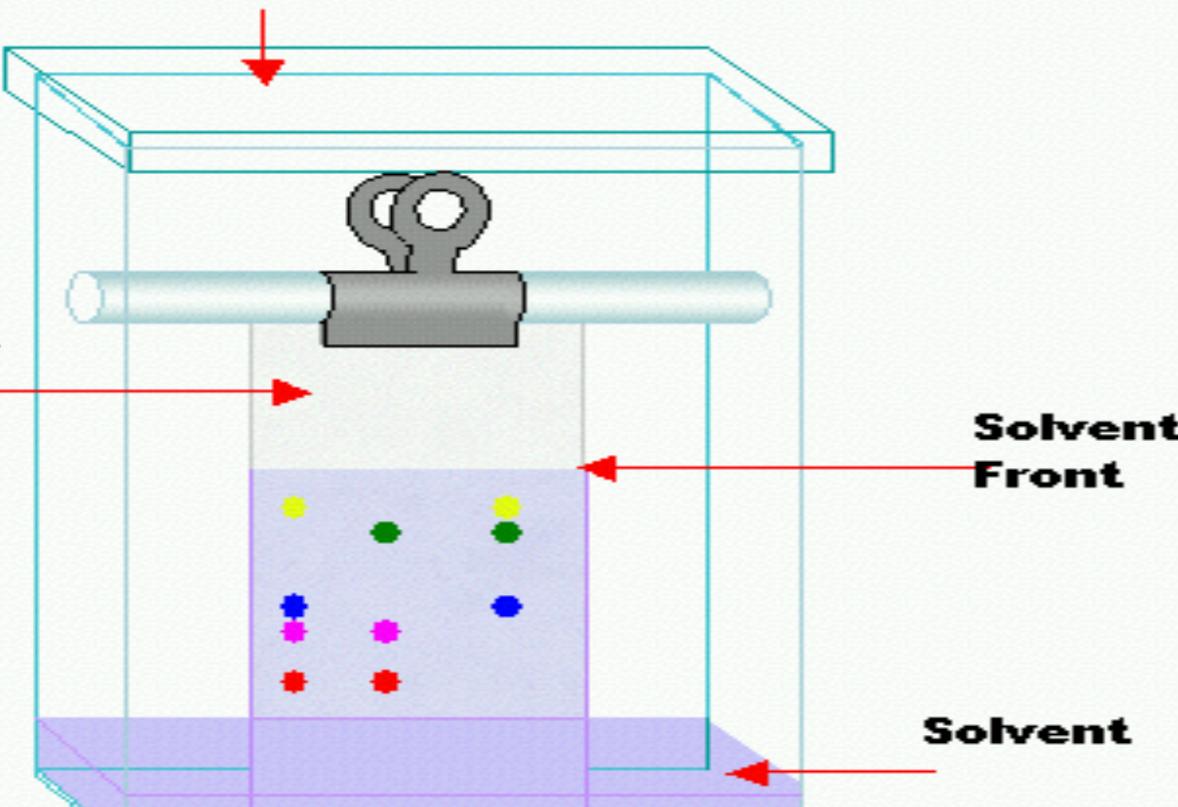




DIY Electrophoresis

<http://fablab.waag.org/project/ow-dna-gel-electrophoresis-box>

Paper





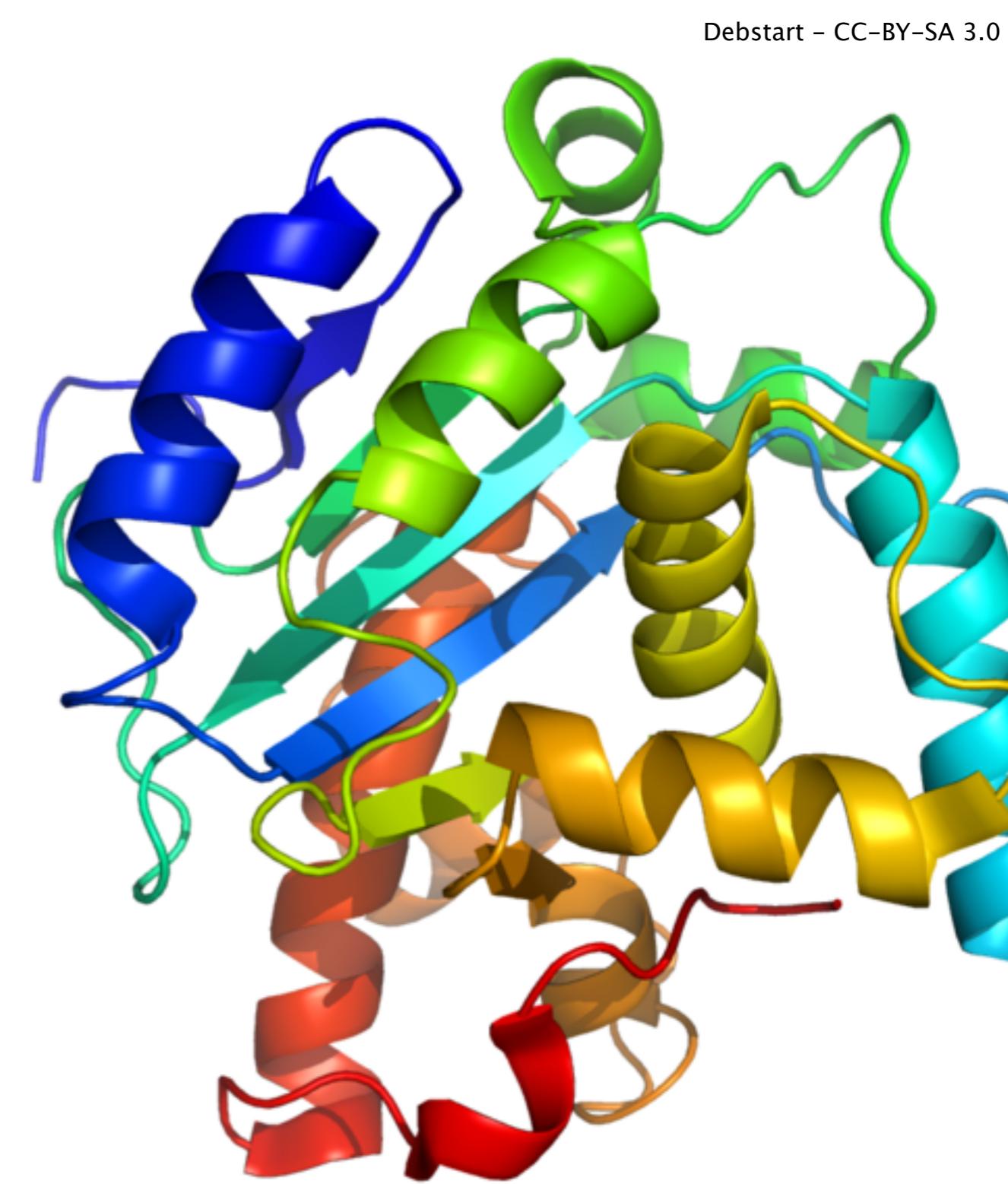
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Nuclear Magnetic Resonance



What is this?





NMR Machines

MartinSaunders

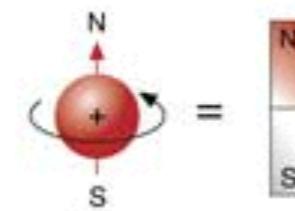
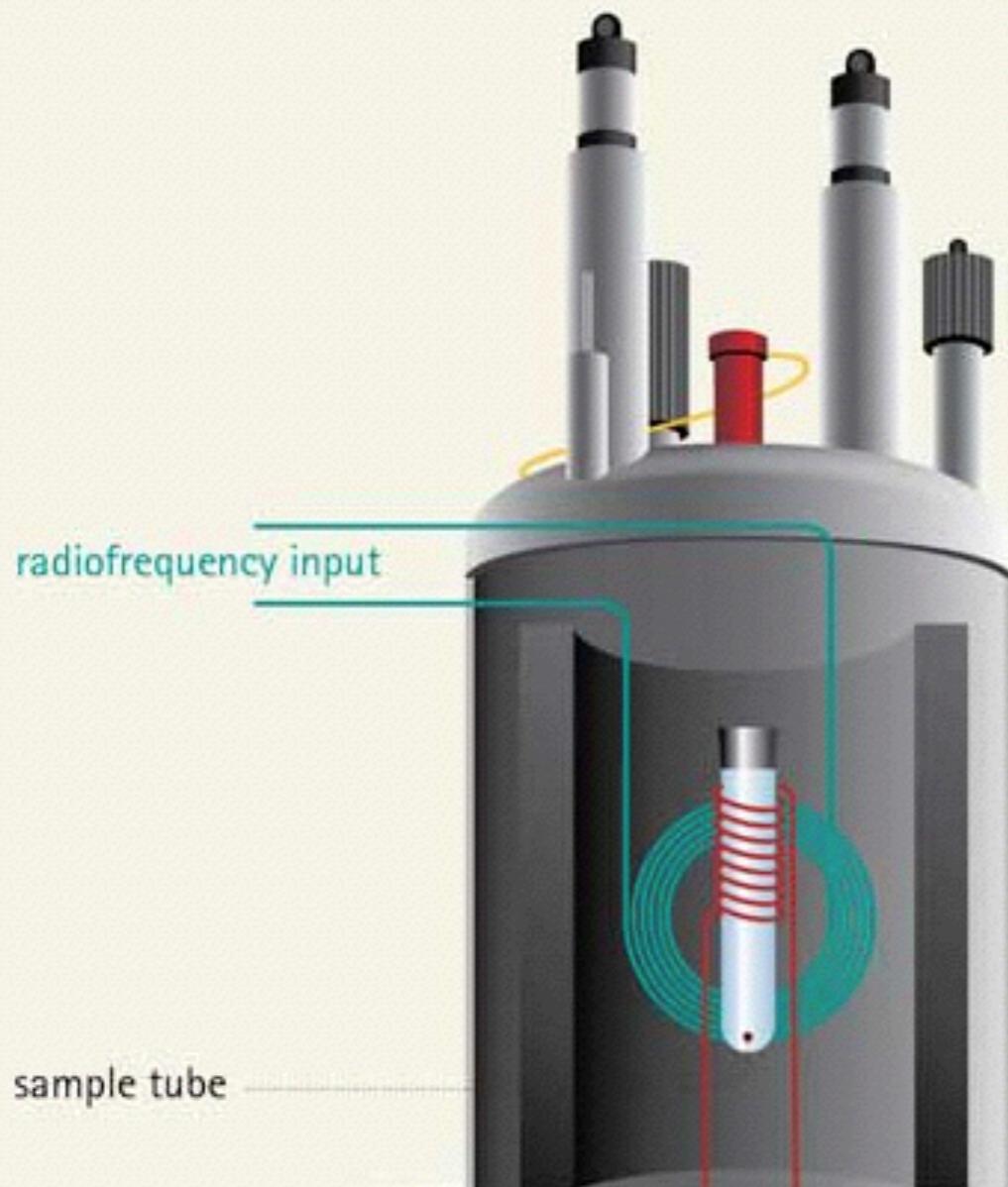


Public Domain

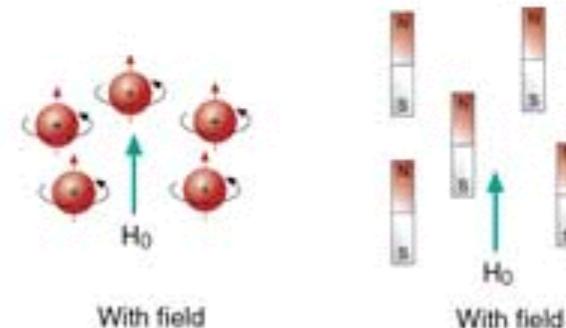




NMR principles



No field No field



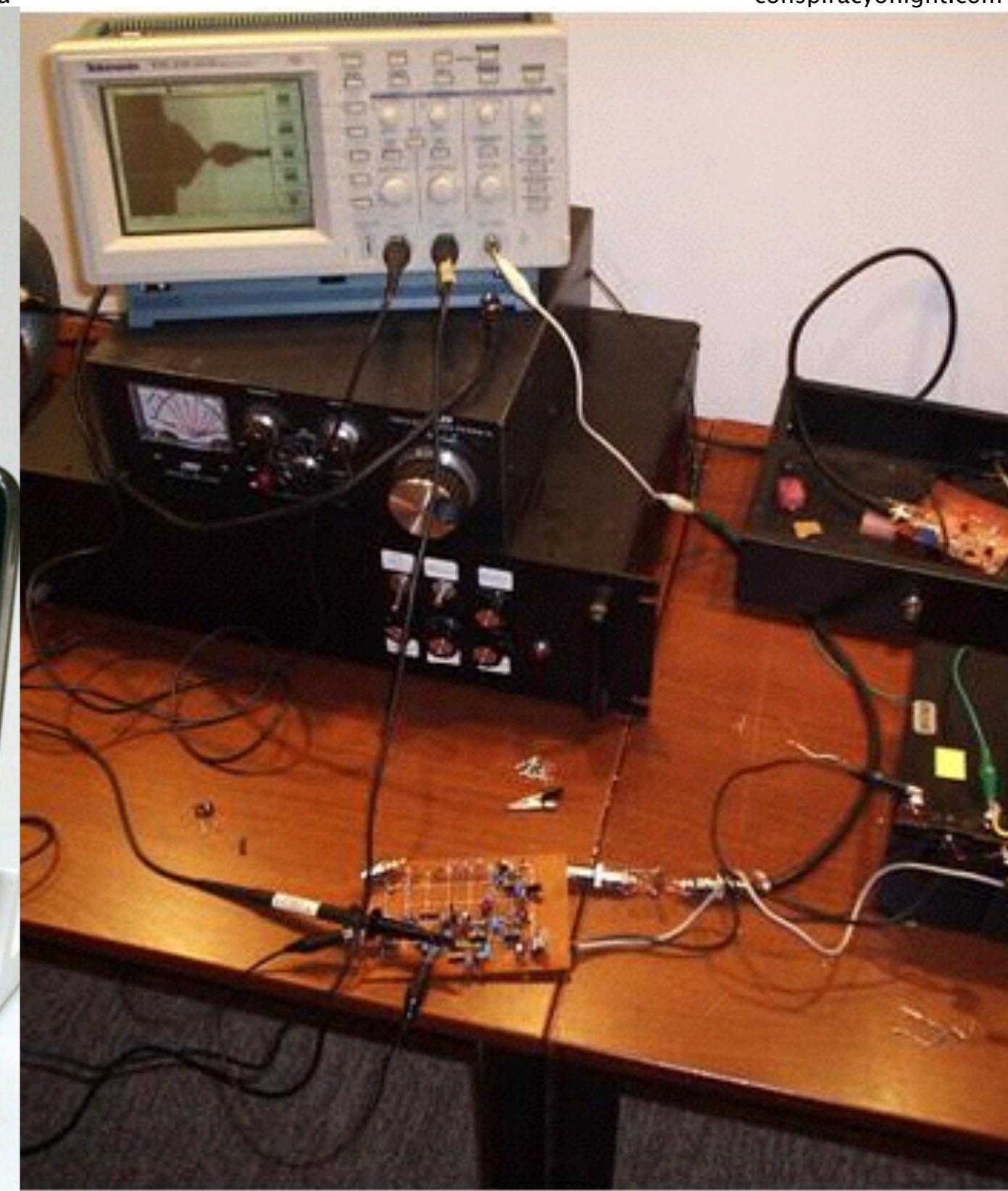
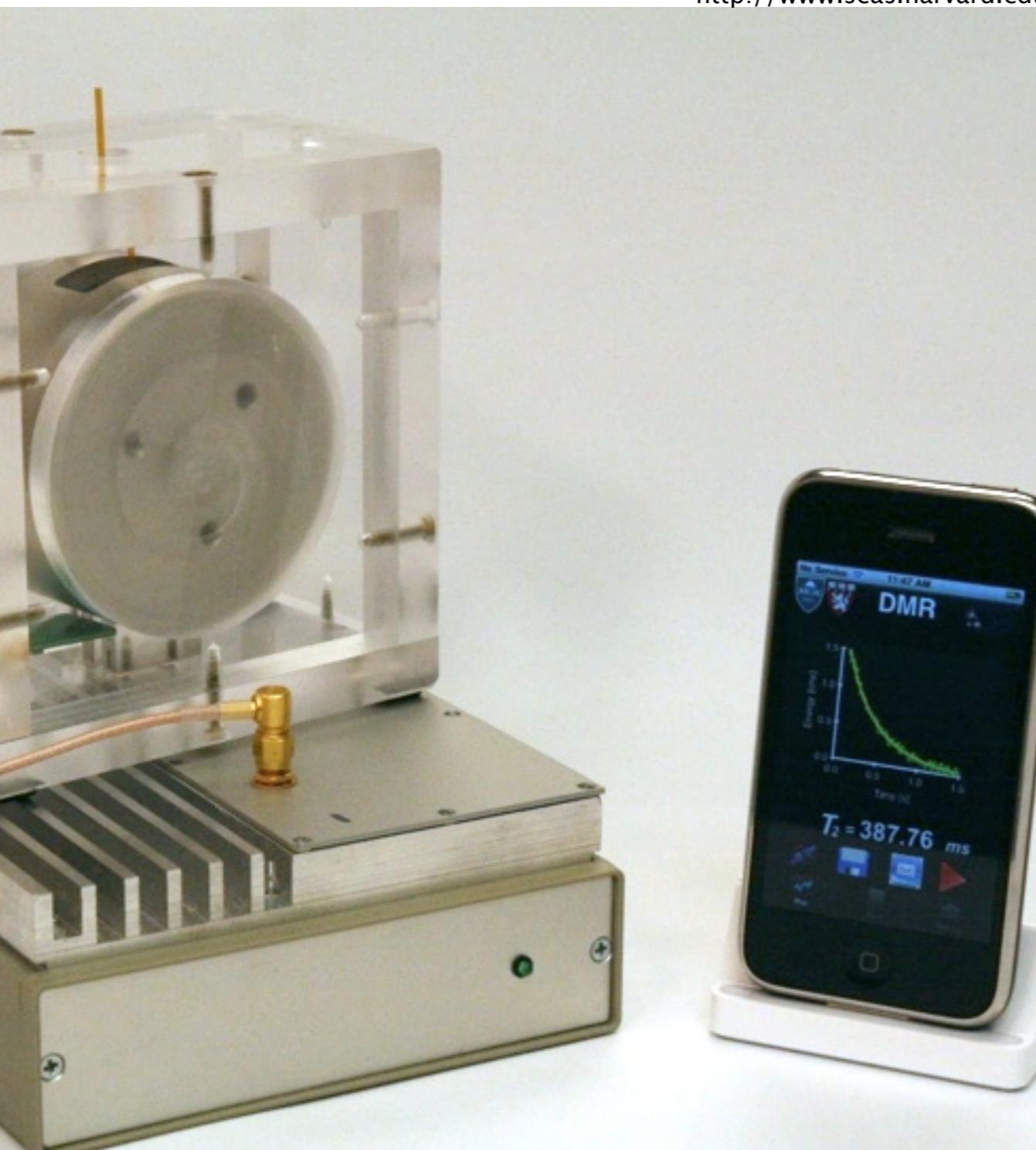
With field With field



DIY NMR?

<http://www.seas.harvard.edu>

conspiracyoflight.com





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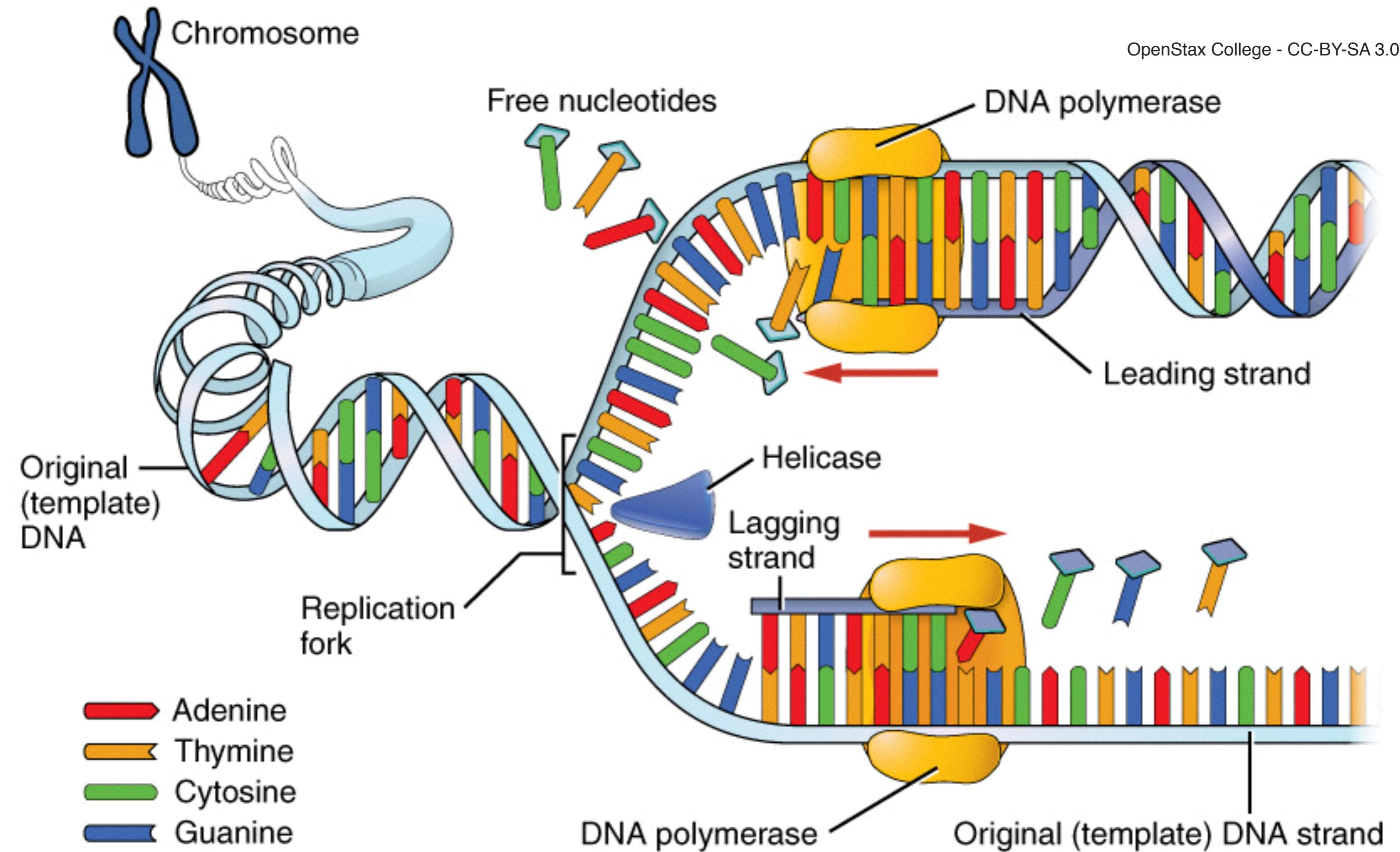
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DNA analytics



DNA Replication

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DNA Transcription

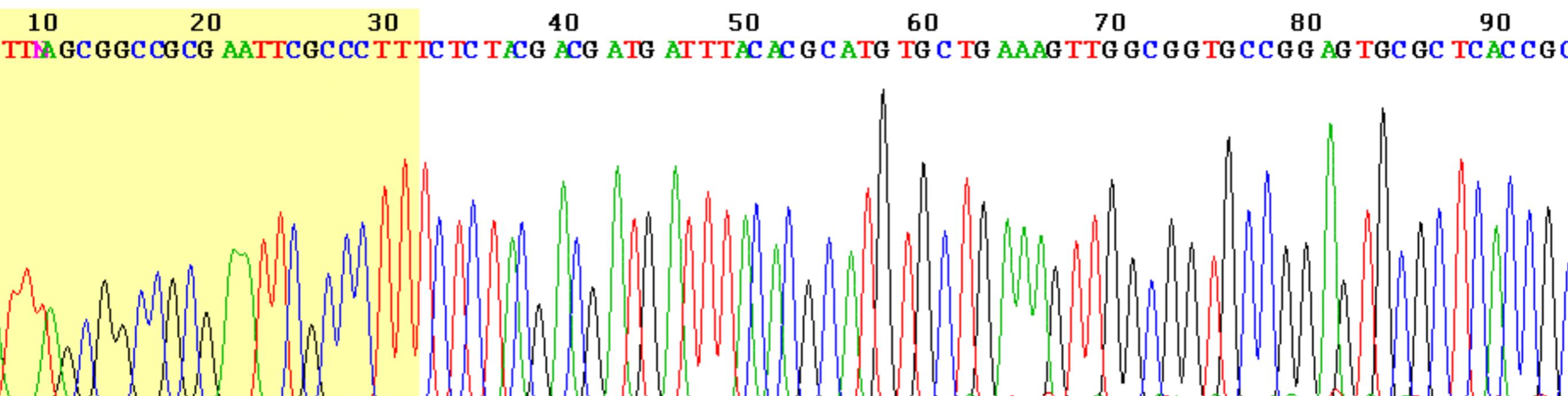
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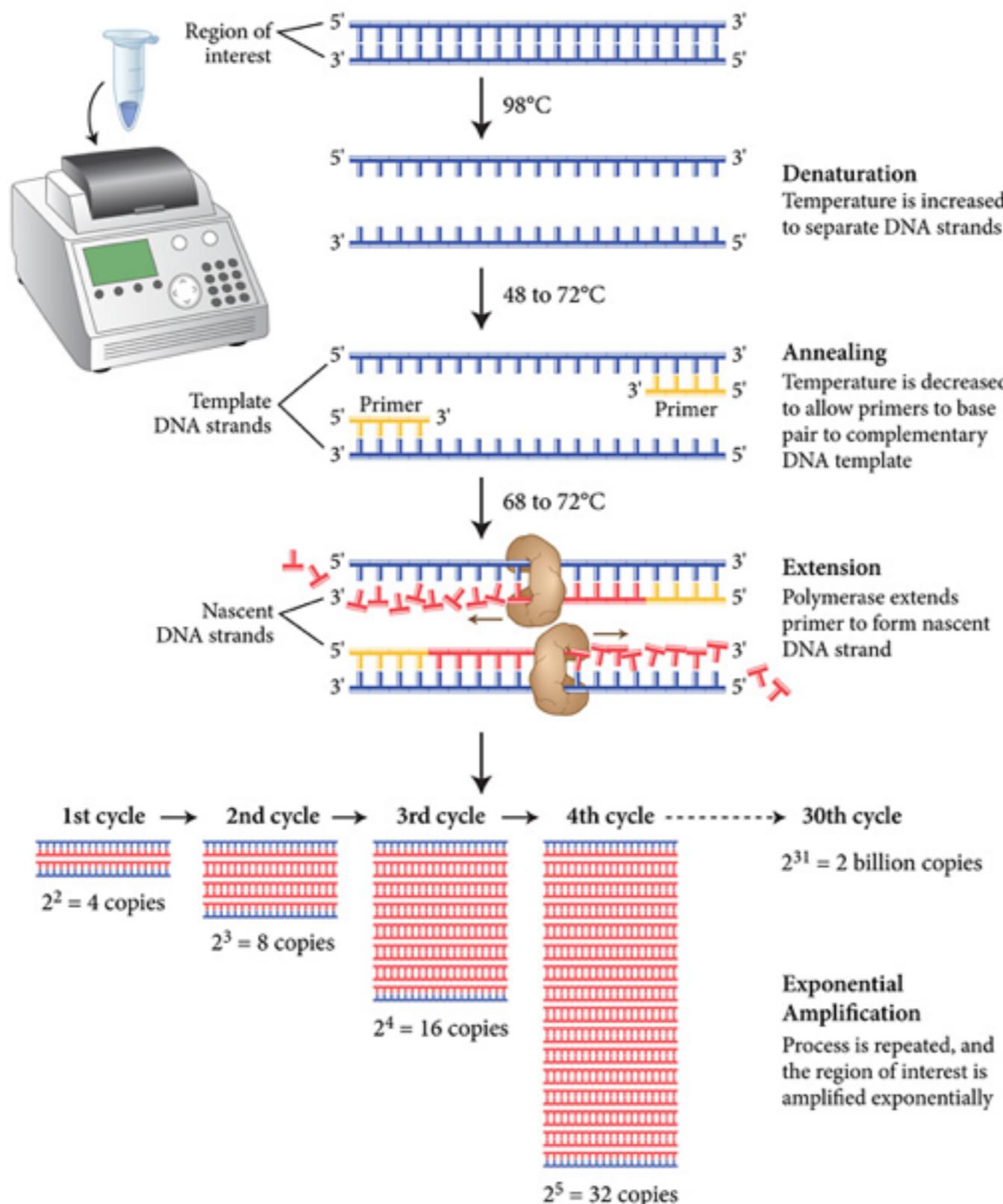
Sequencing

Public Domain



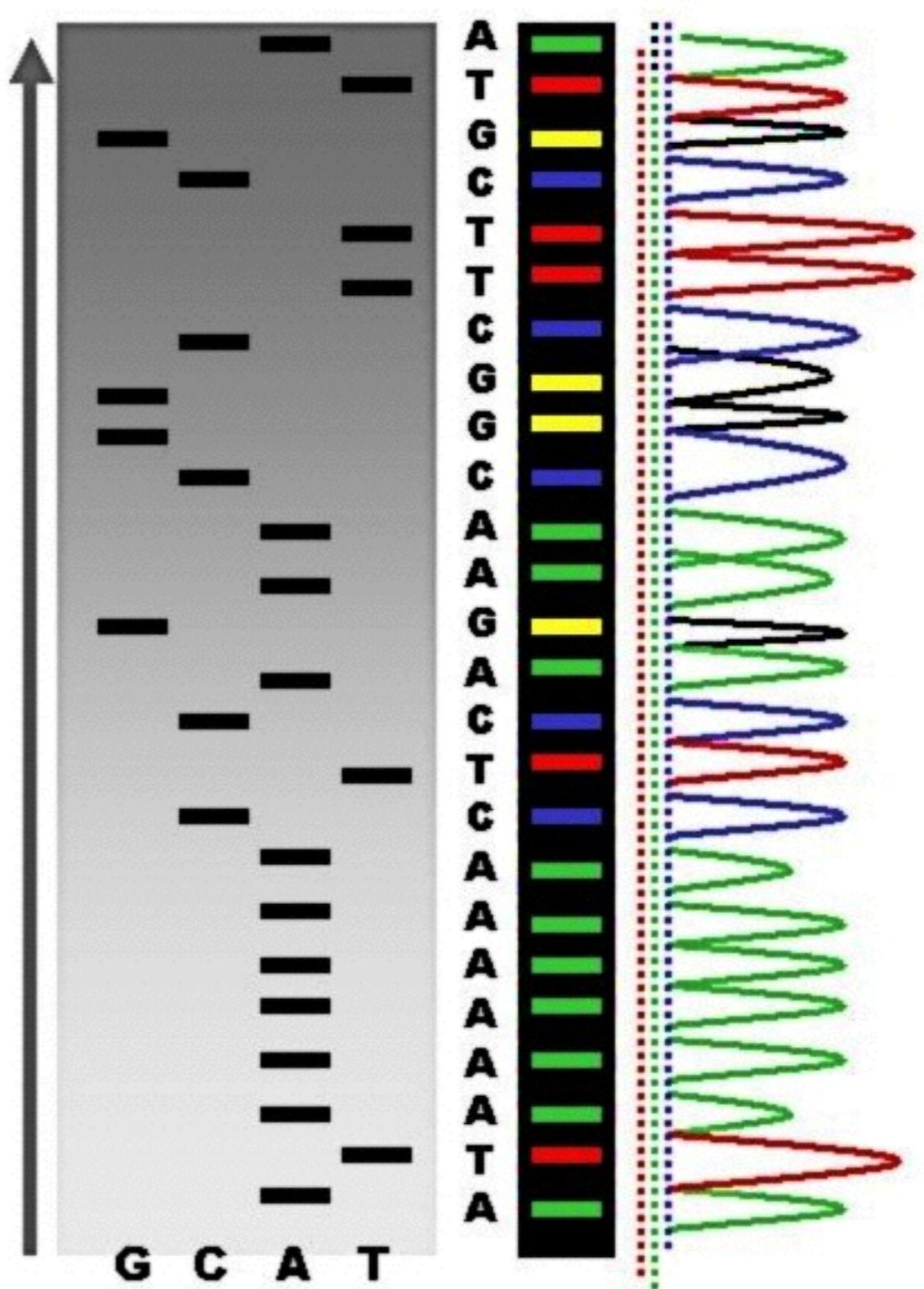


Polymerase Chain Reaction





Sanger Sequencing - chain termination





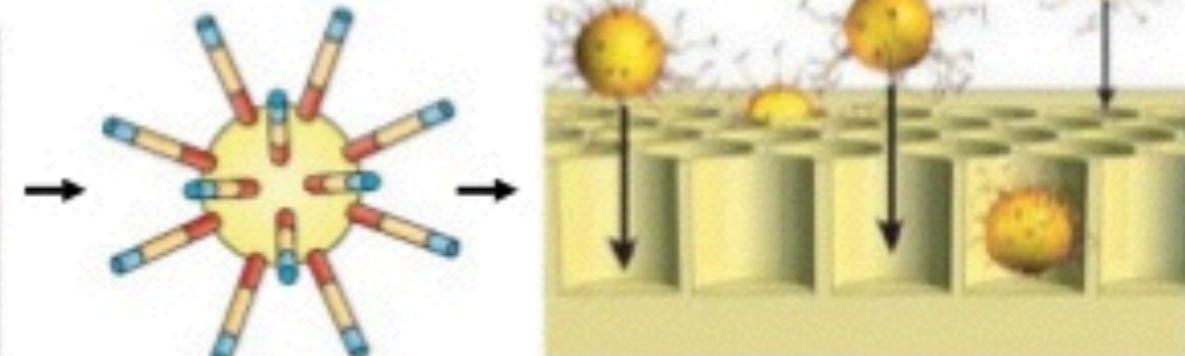
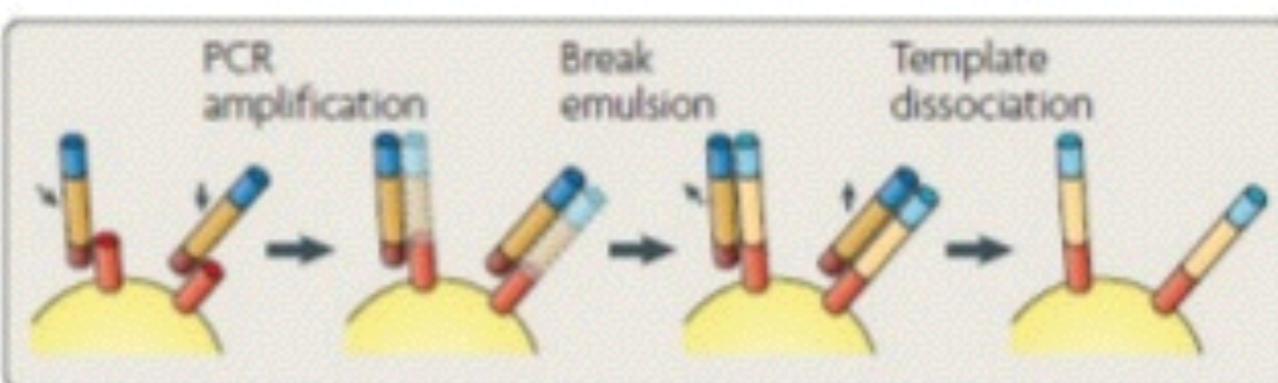
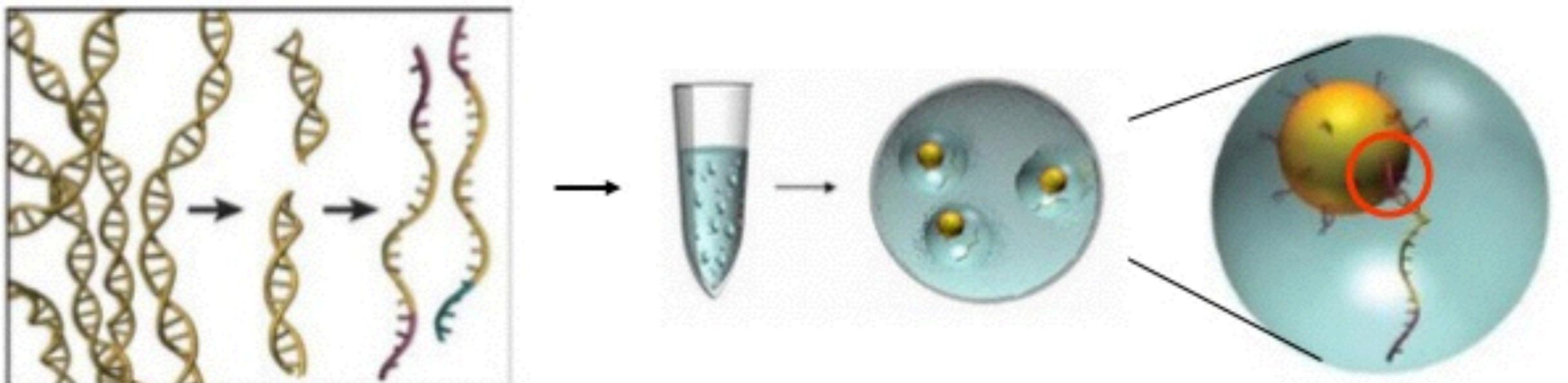
454 sequencer





454 Pyrosequencing

1. Emulsion-based sample preparation (emPCR)

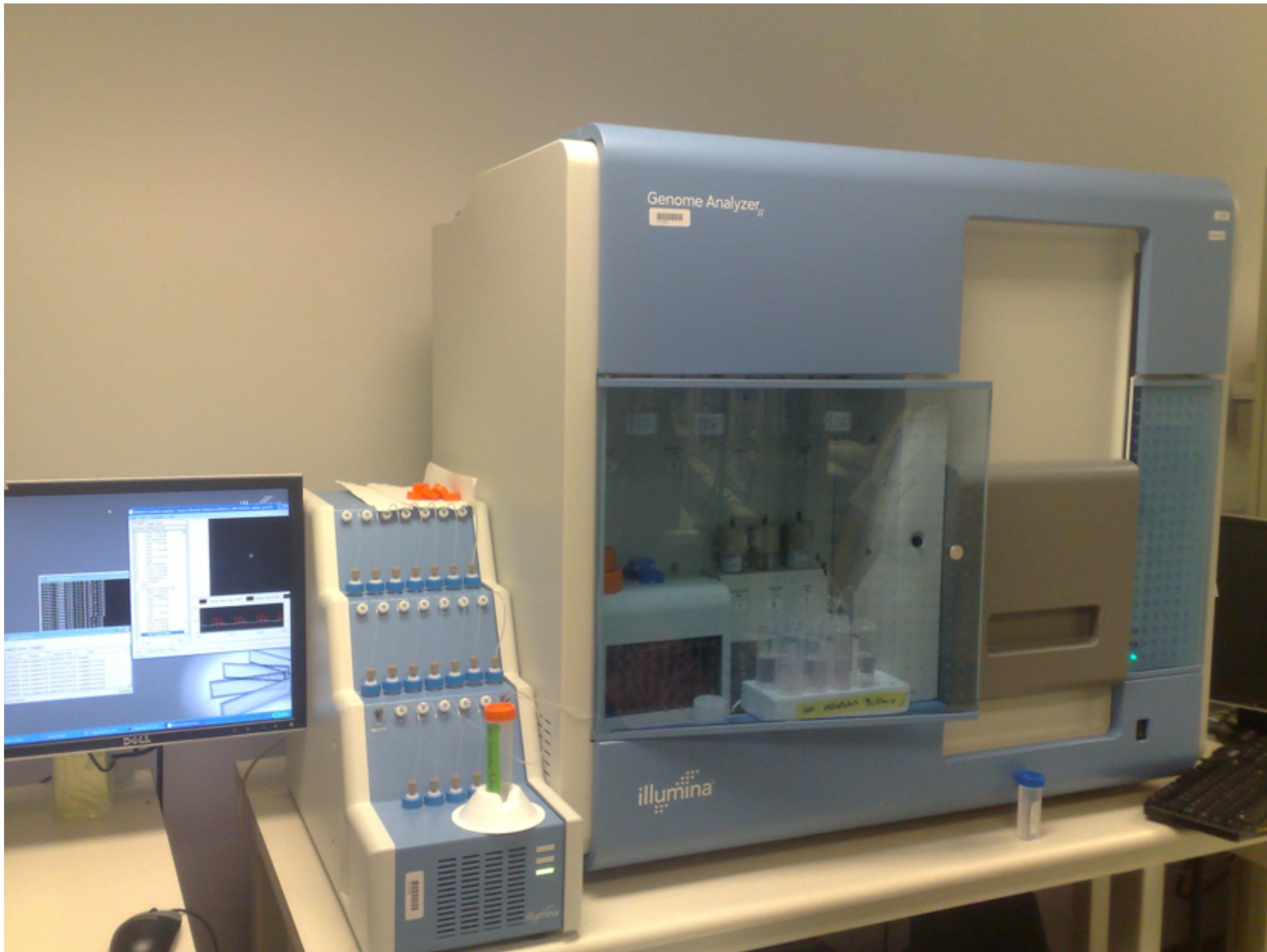


Several thousand
copies of the same
template sequence
on each bead

on average 1.6 million wells



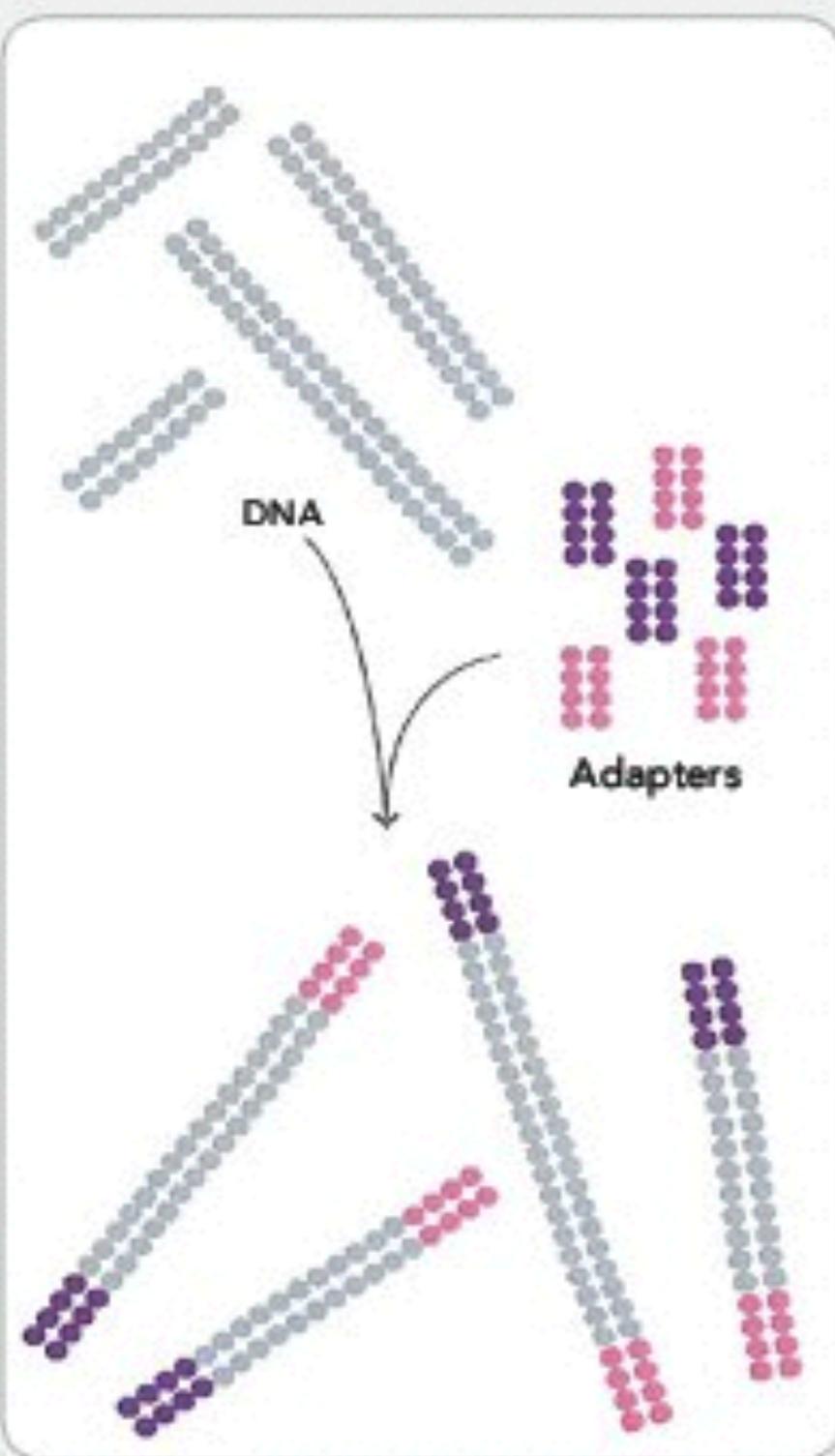
Illumina - Solexa



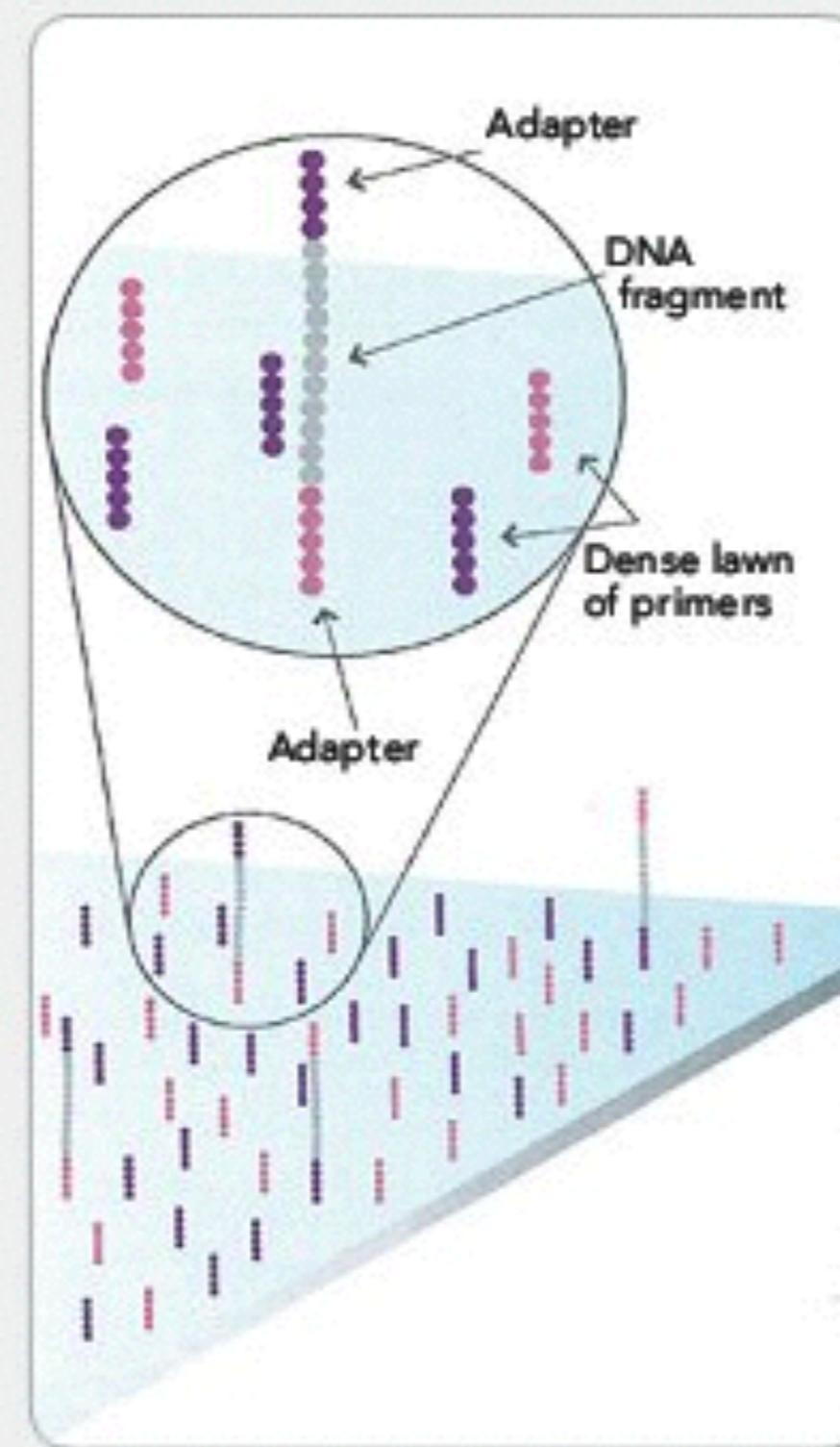


Solexa - Illumina sequencing

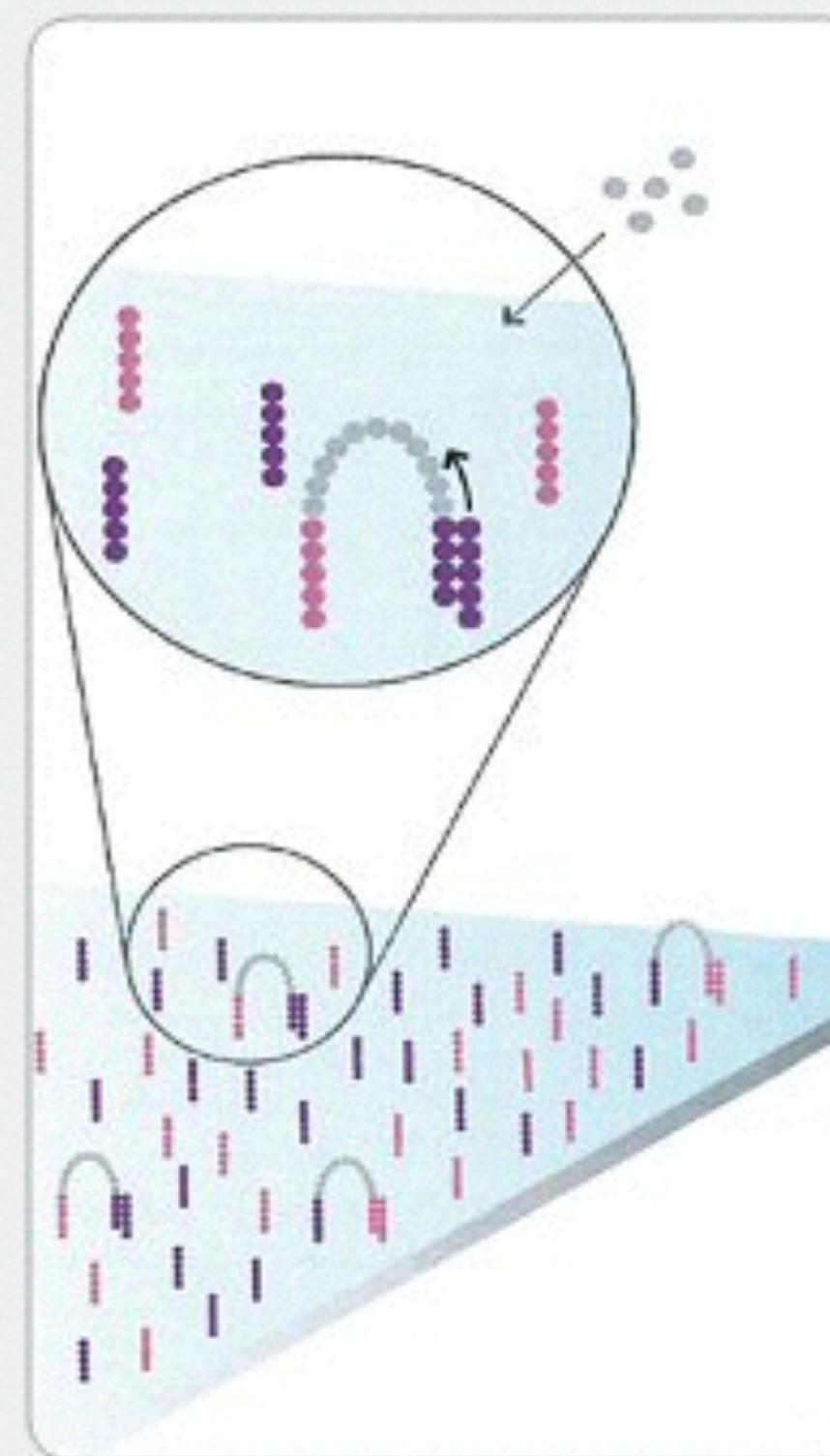
1. PREPARE GENOMIC DNA SAMPLE



2. ATTACH DNA TO SURFACE

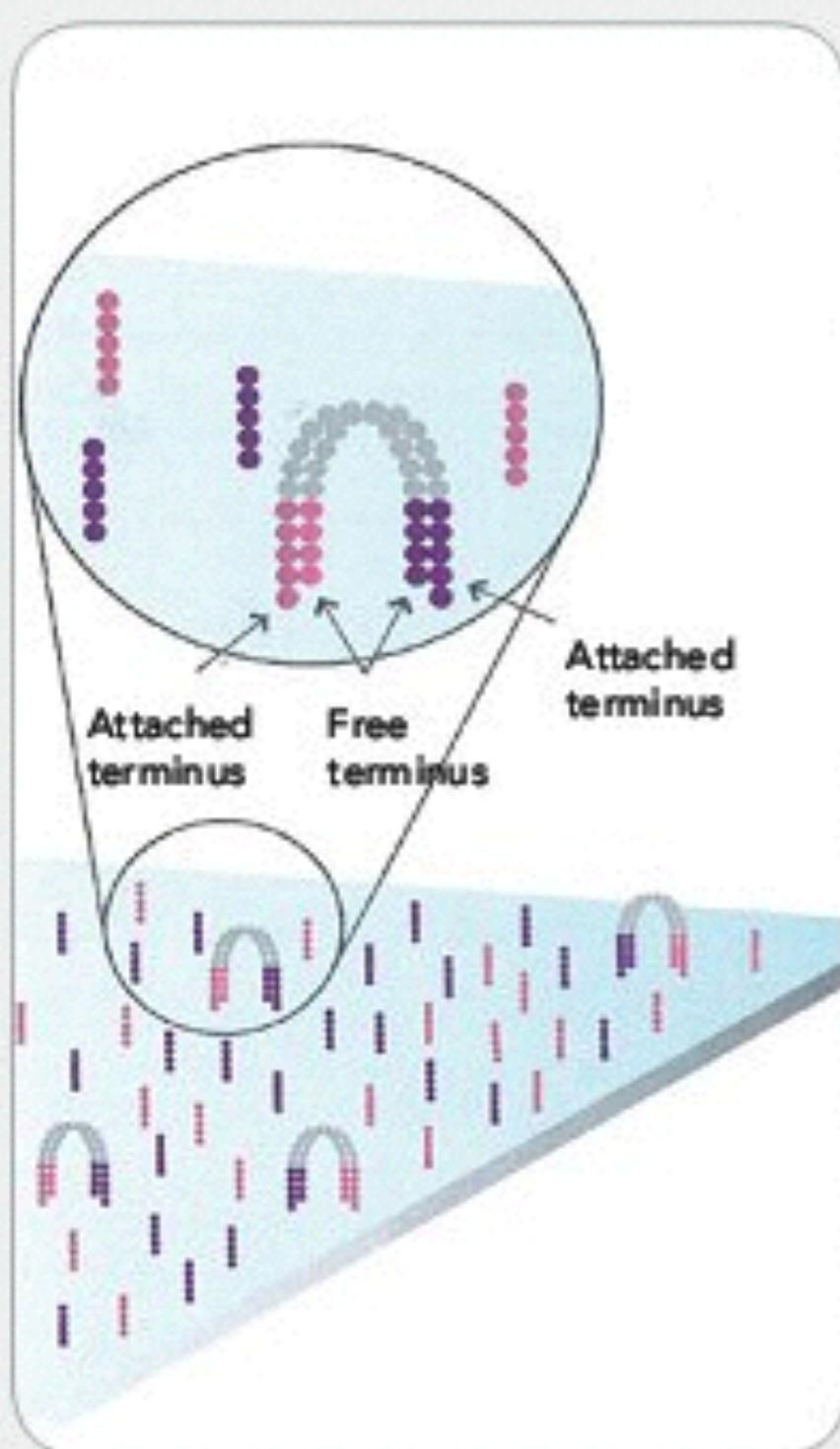


3. BRIDGE AMPLIFICATION

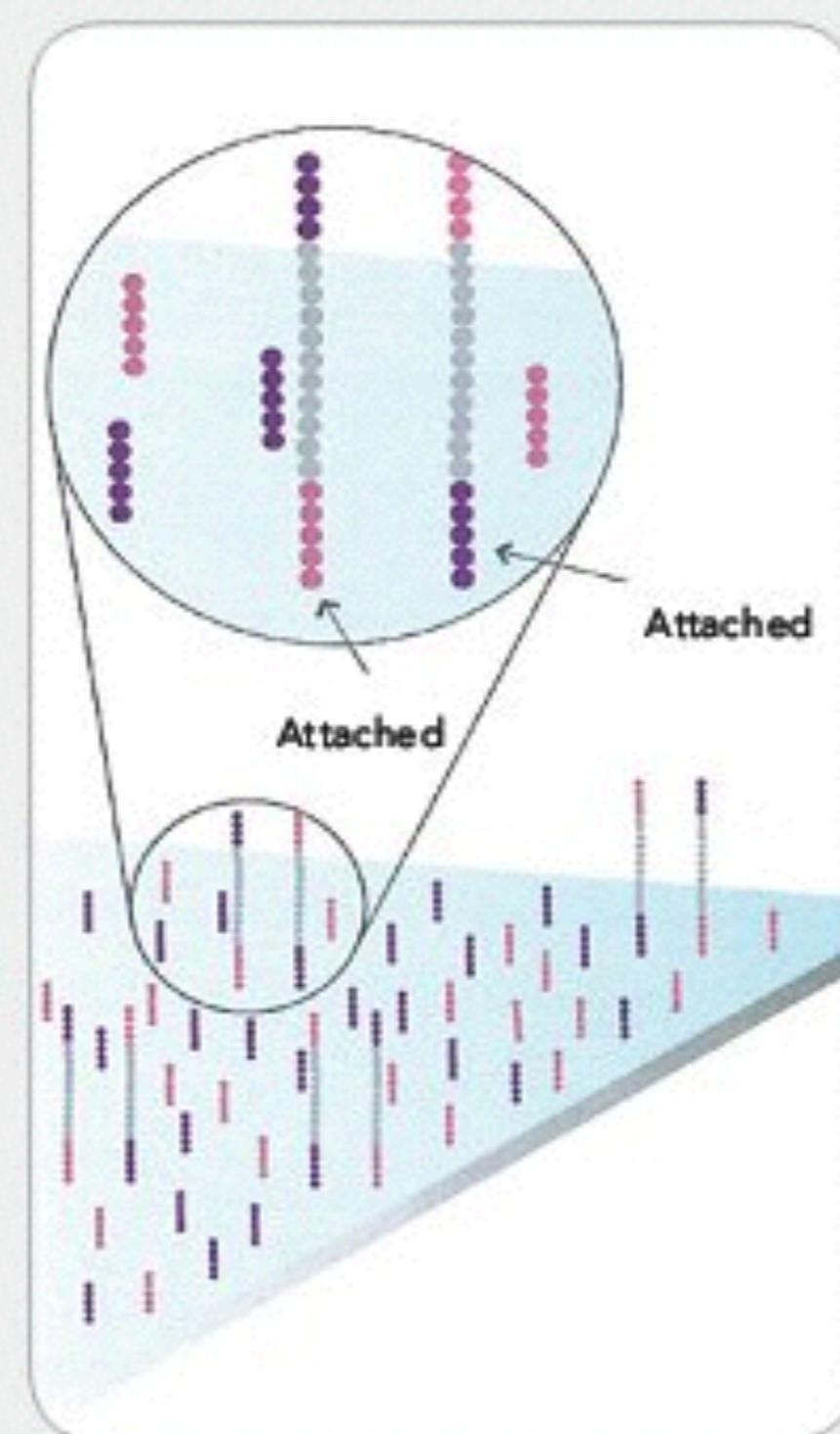




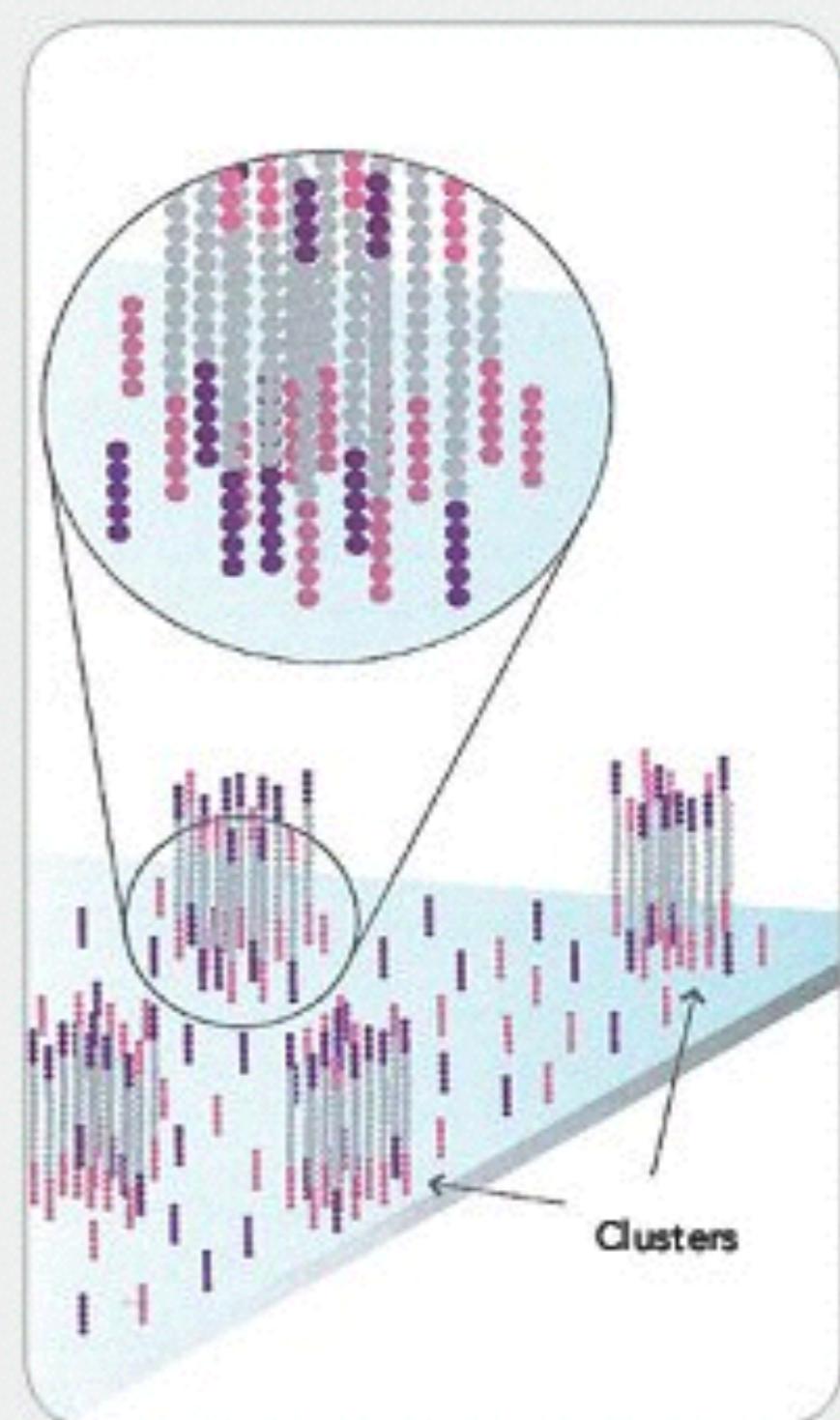
4. FRAGMENTS BECOME DOUBLE STRANDED



5. DENATURE THE DOUBLE-STRANDED MOLECULES

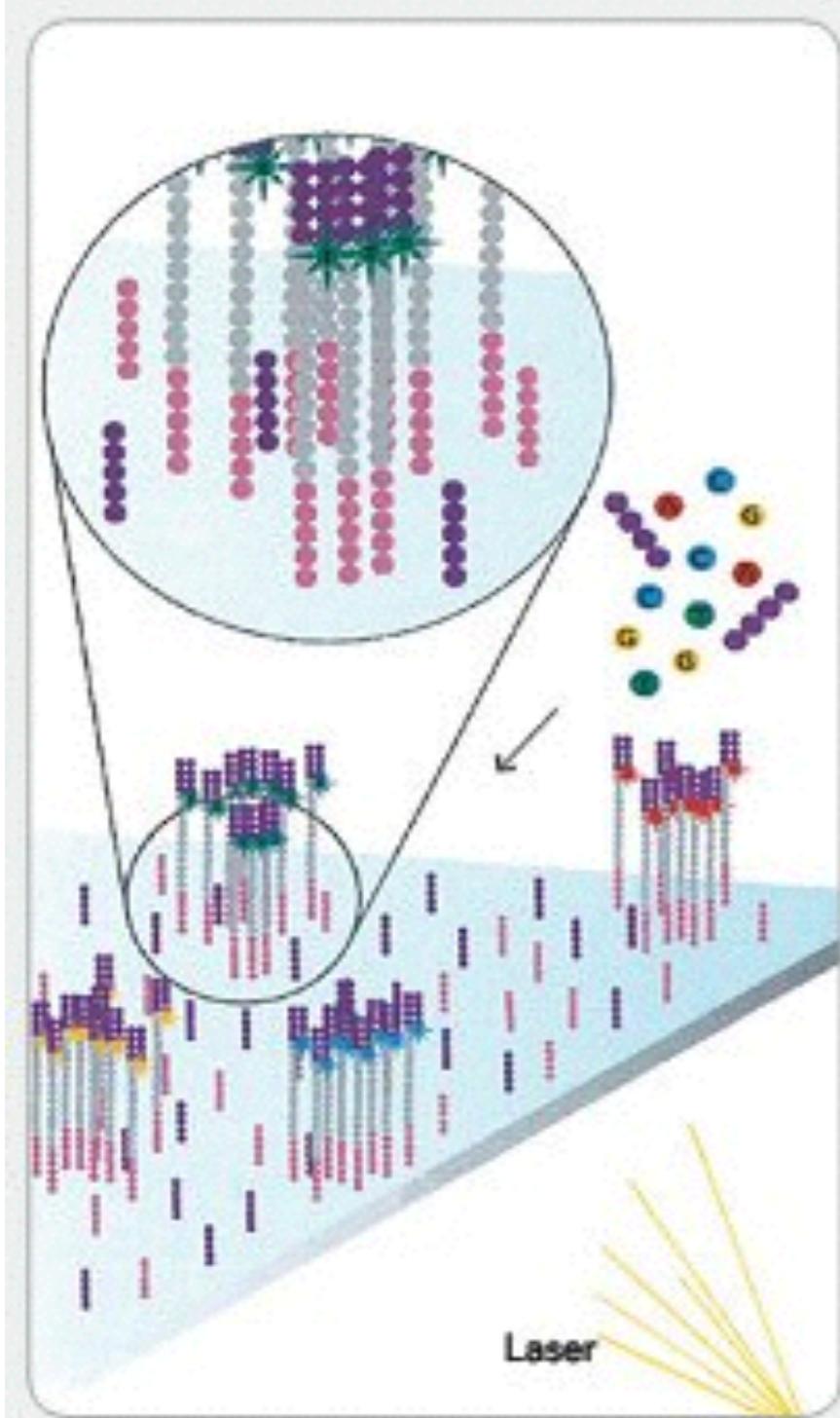


6. COMPLETE AMPLIFICATION

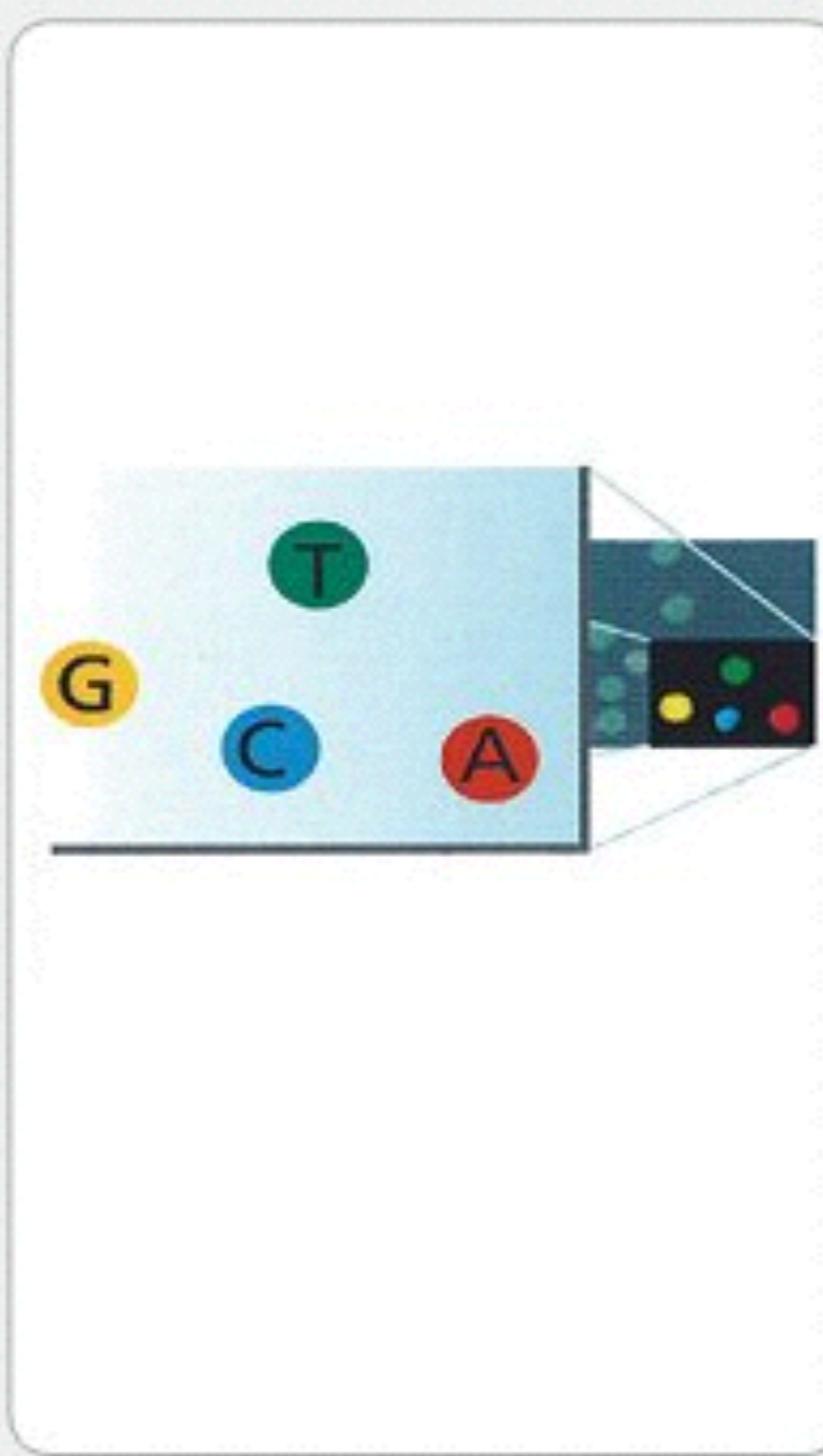




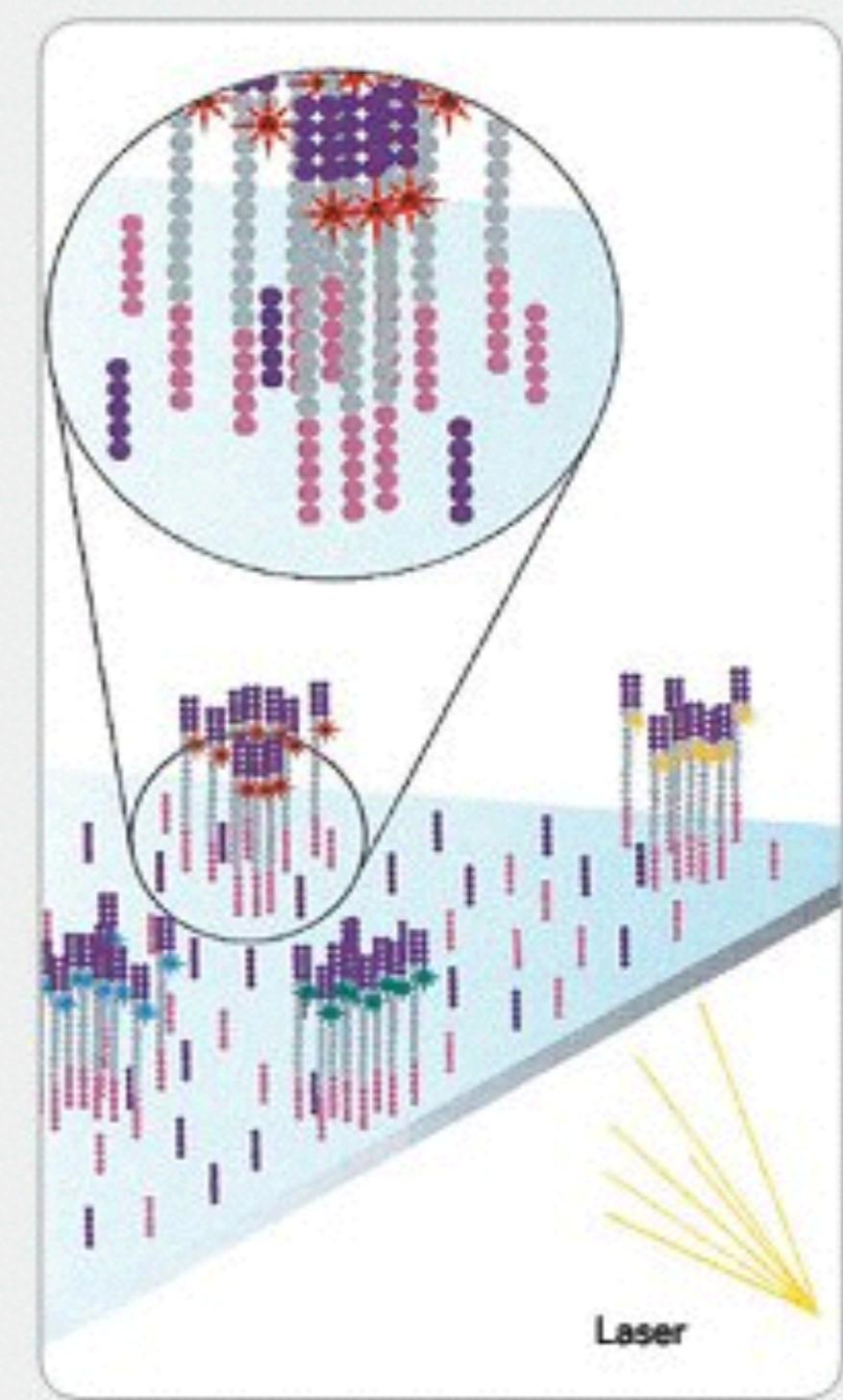
7. DETERMINE FIRST BASE



8. IMAGE FIRST BASE

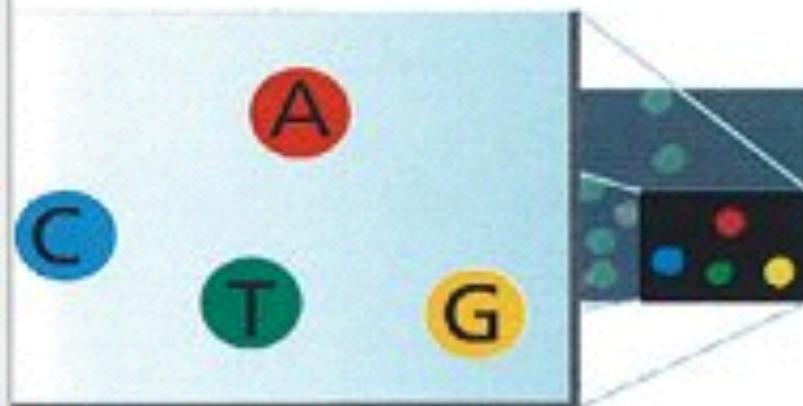


9. DETERMINE SECOND BASE

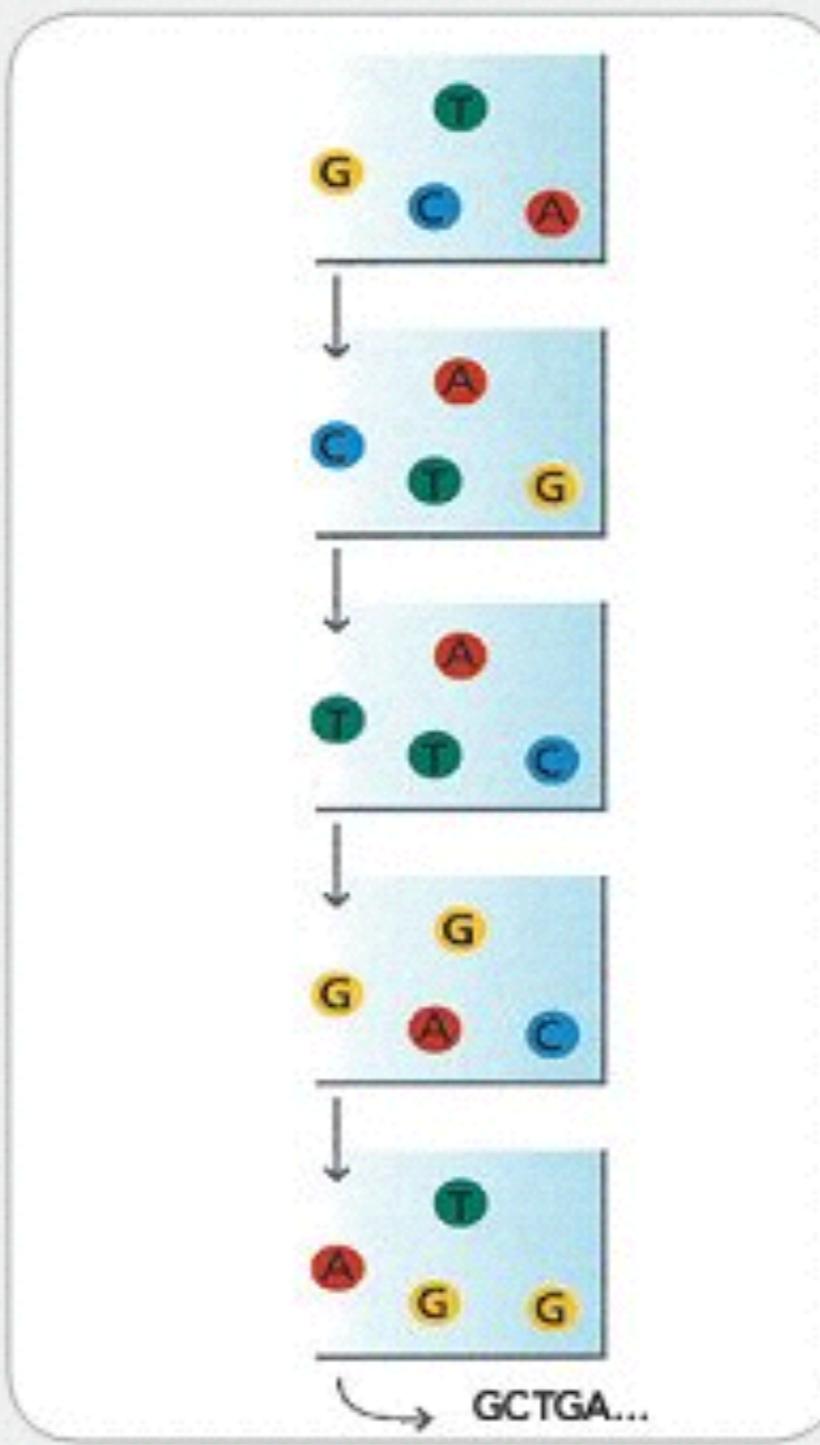




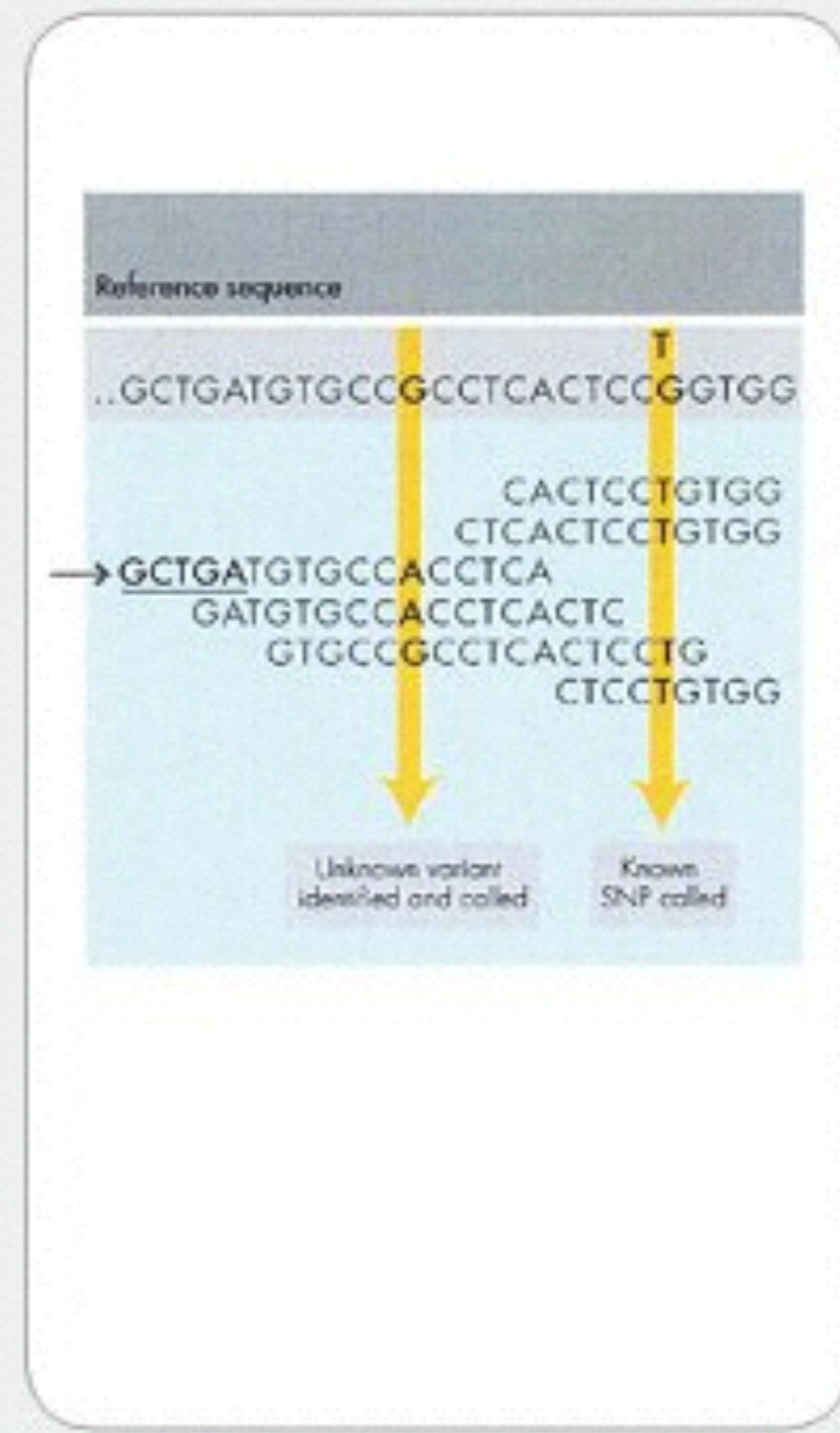
10. IMAGE SECOND CHEMISTRY CYCLE



11. SEQUENCE READS OVER MULTIPLE CHEMISTRY CYCLES

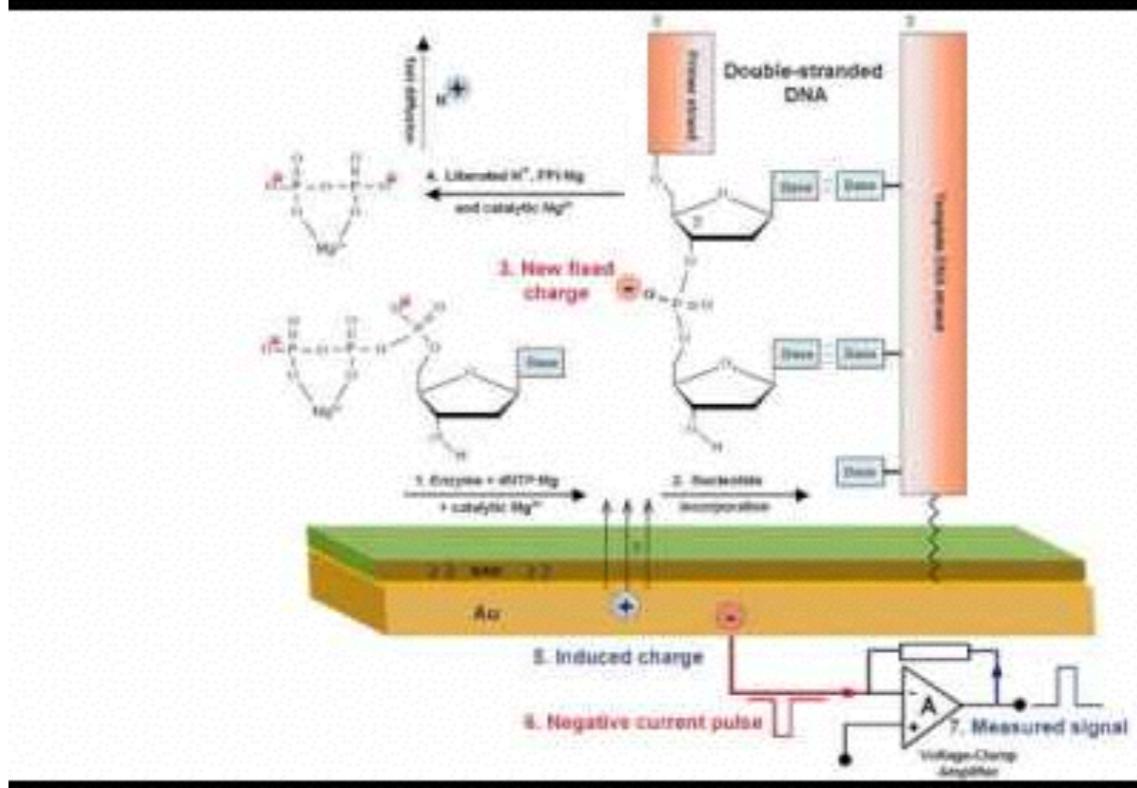
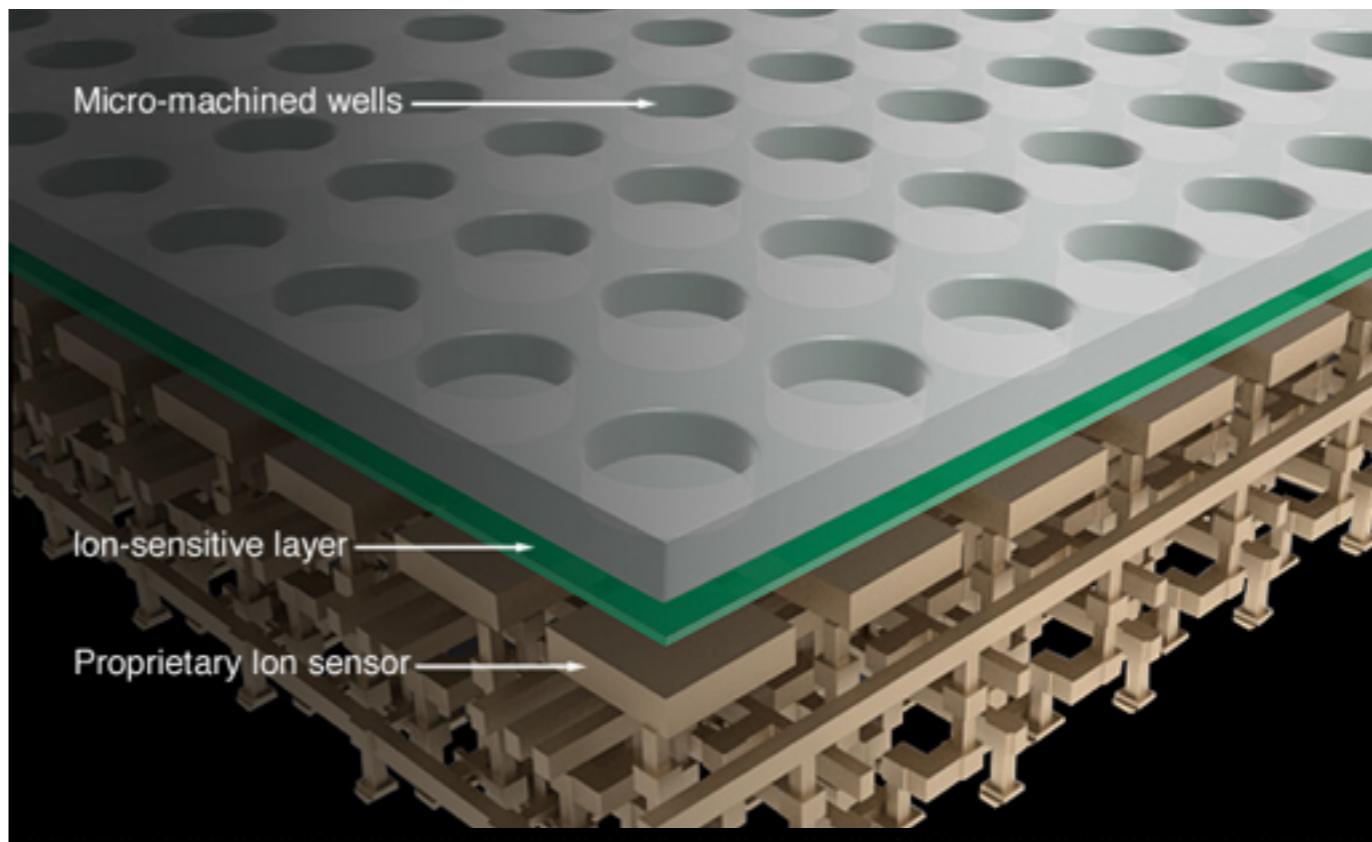


12. ALIGN DATA



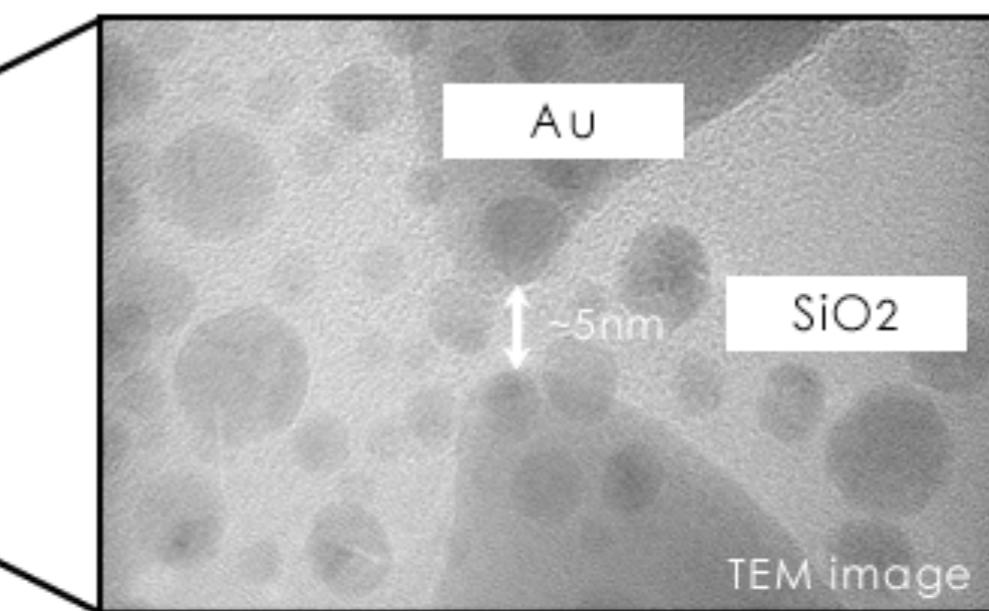
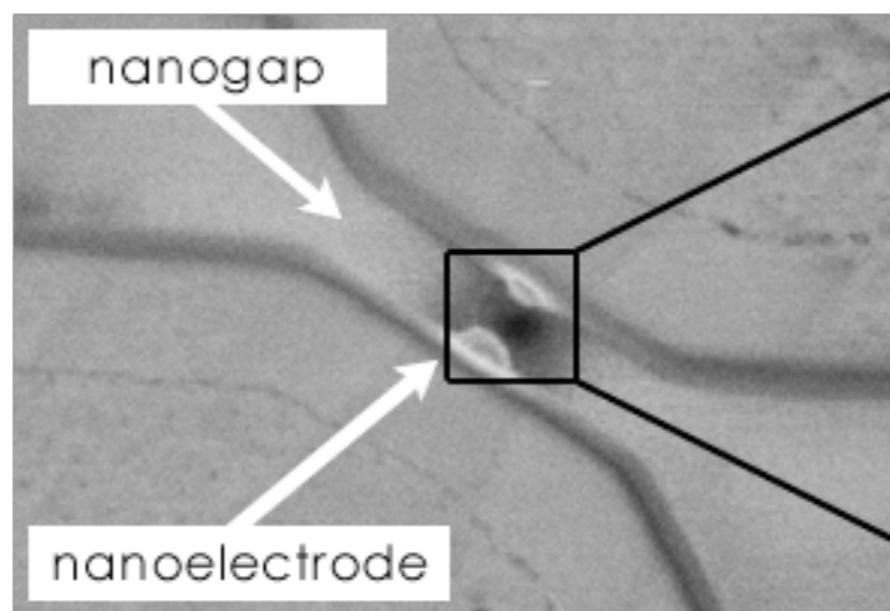
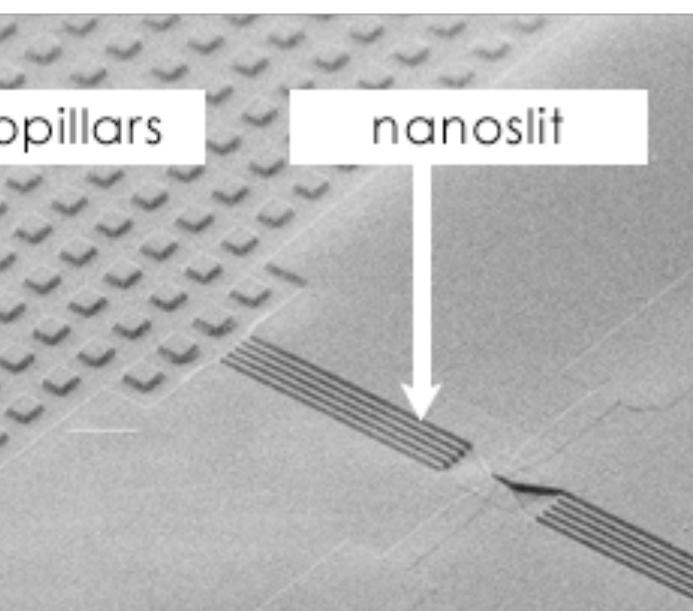
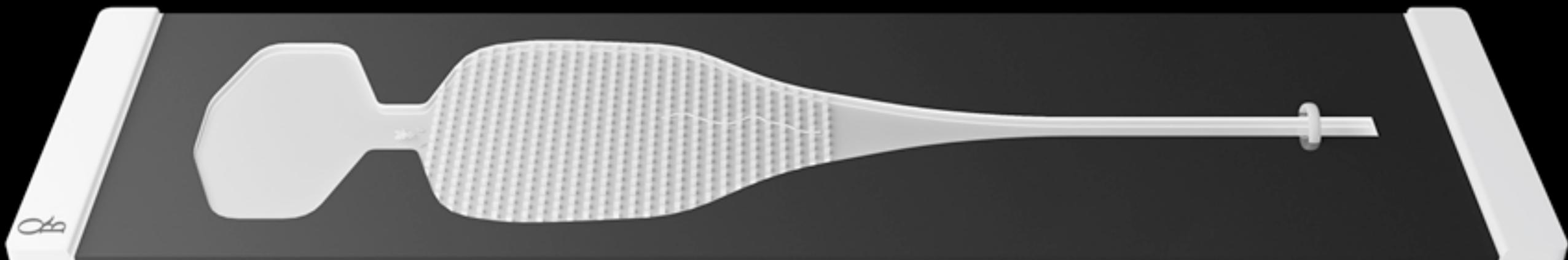


IonTorrent sequencing



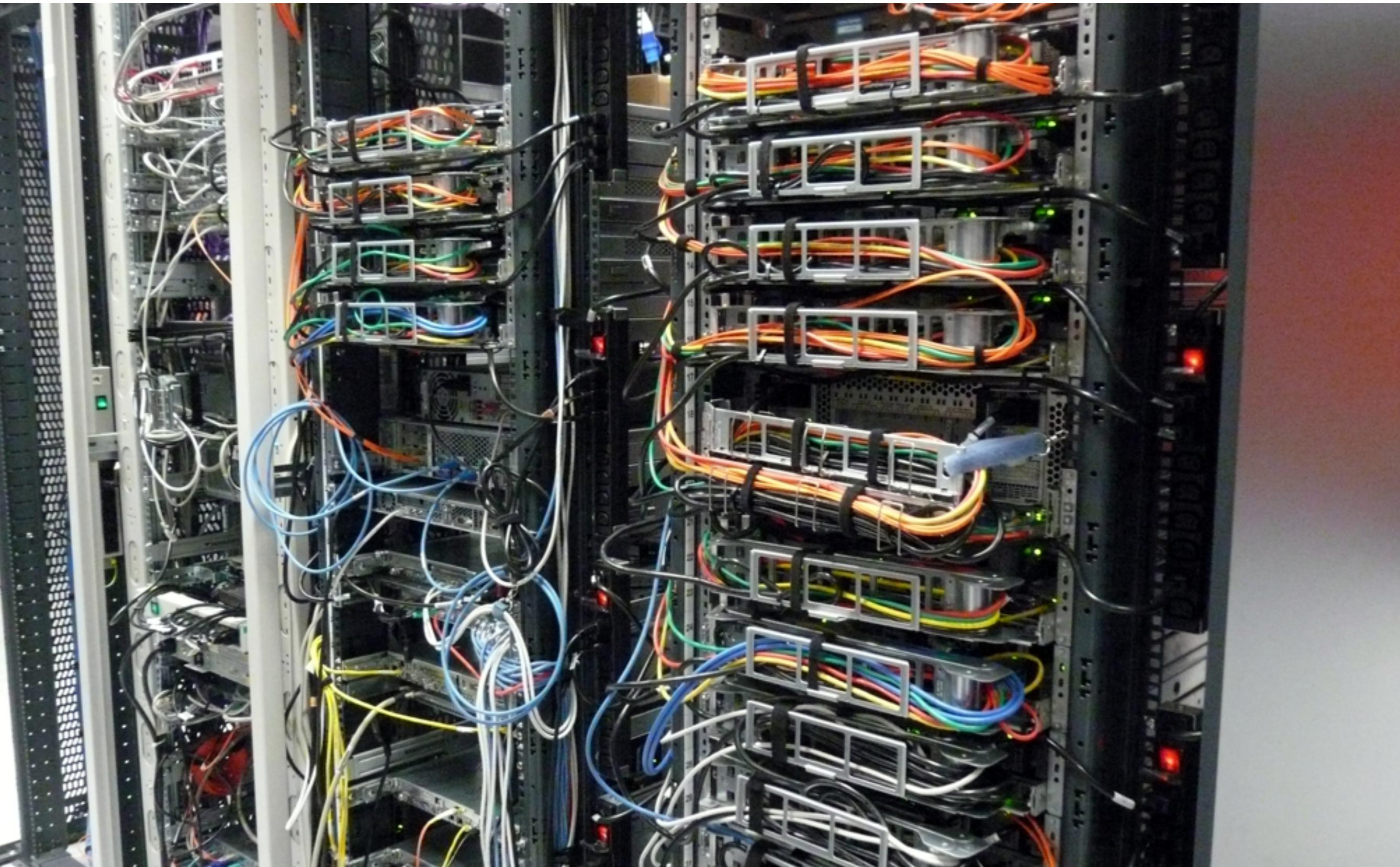


Nanopore sequencing





Bioinformatics





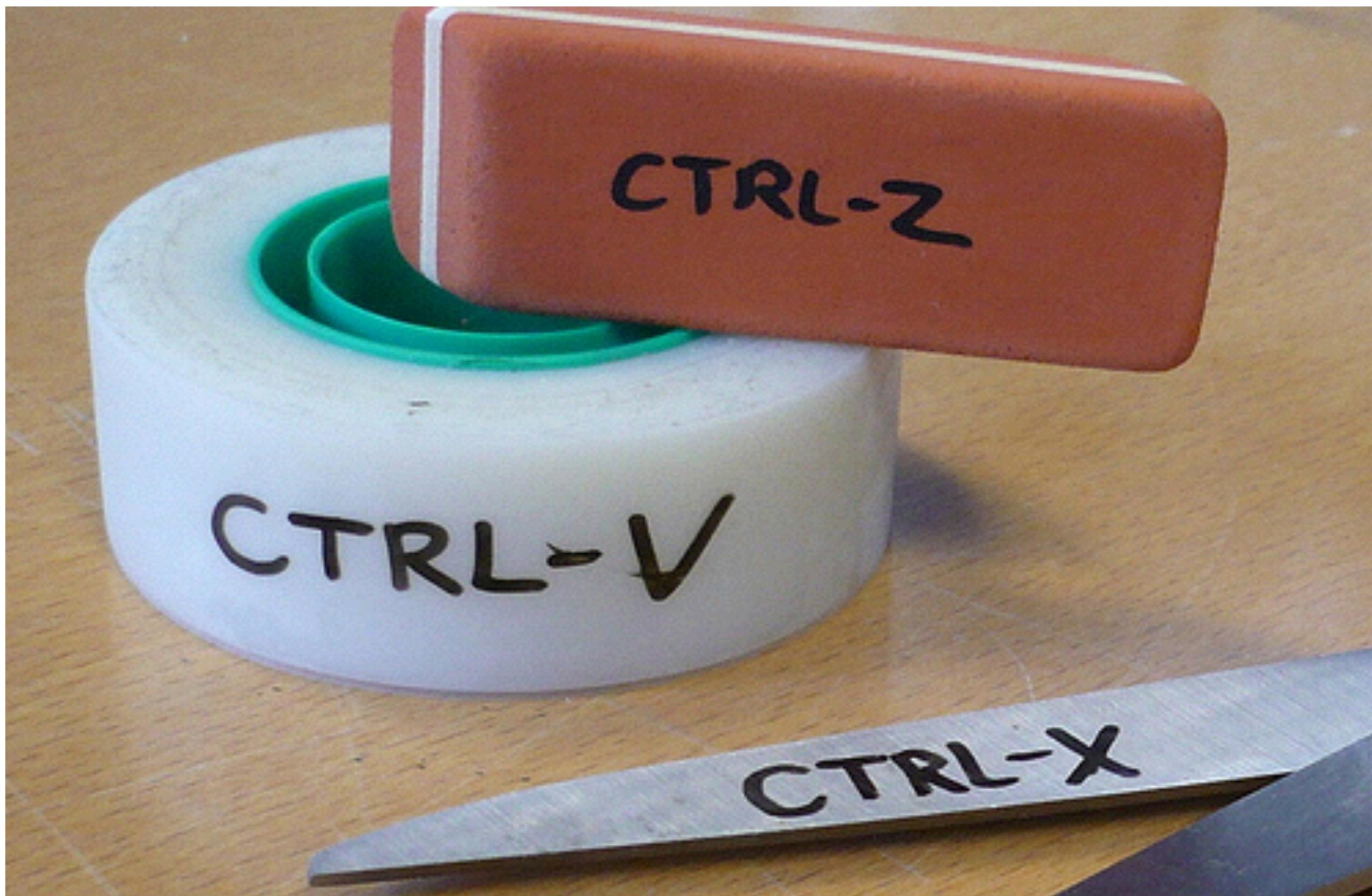
waag society

institute for art, science and technology

DNA editing

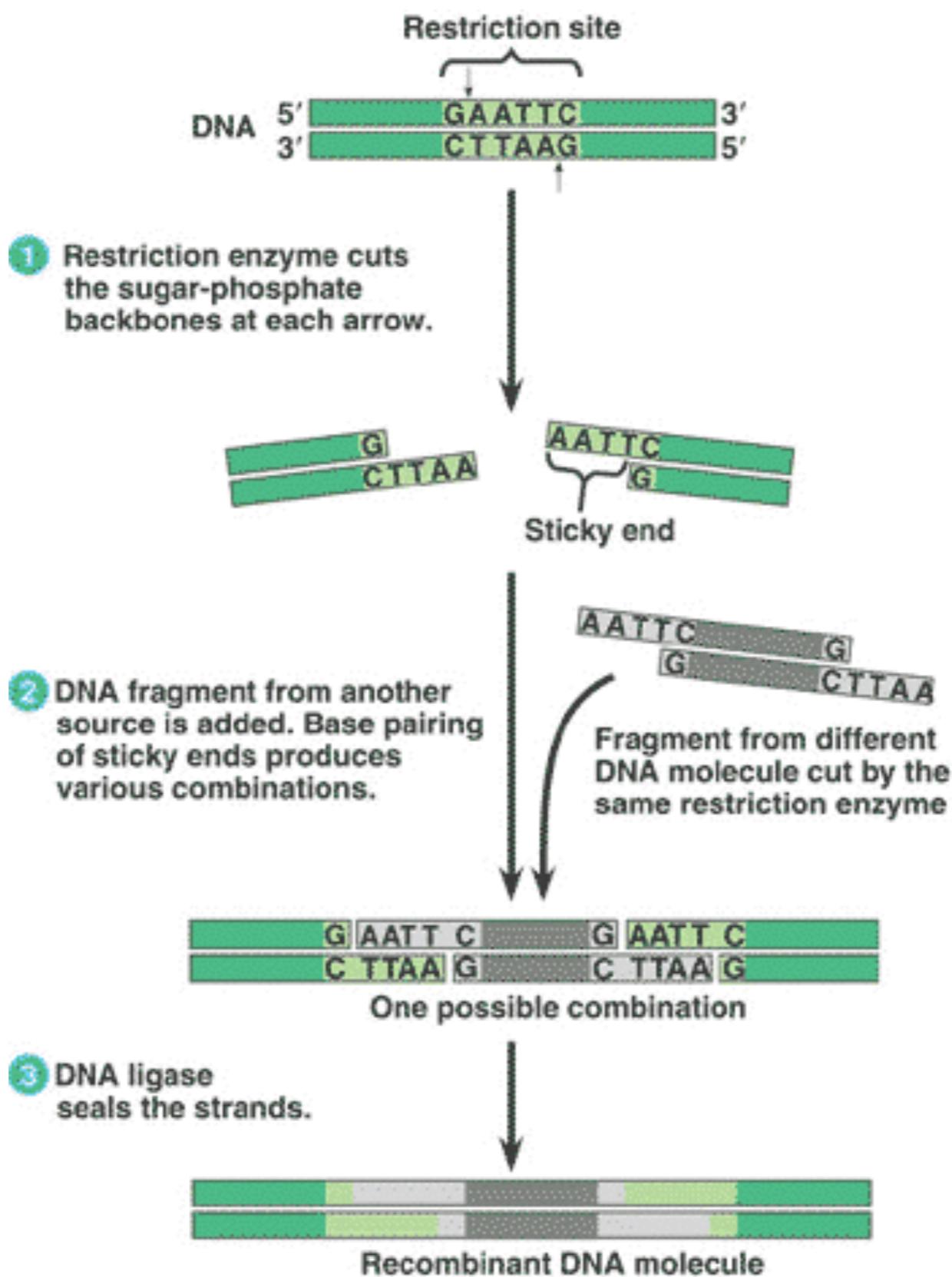


Cutting & Pasting



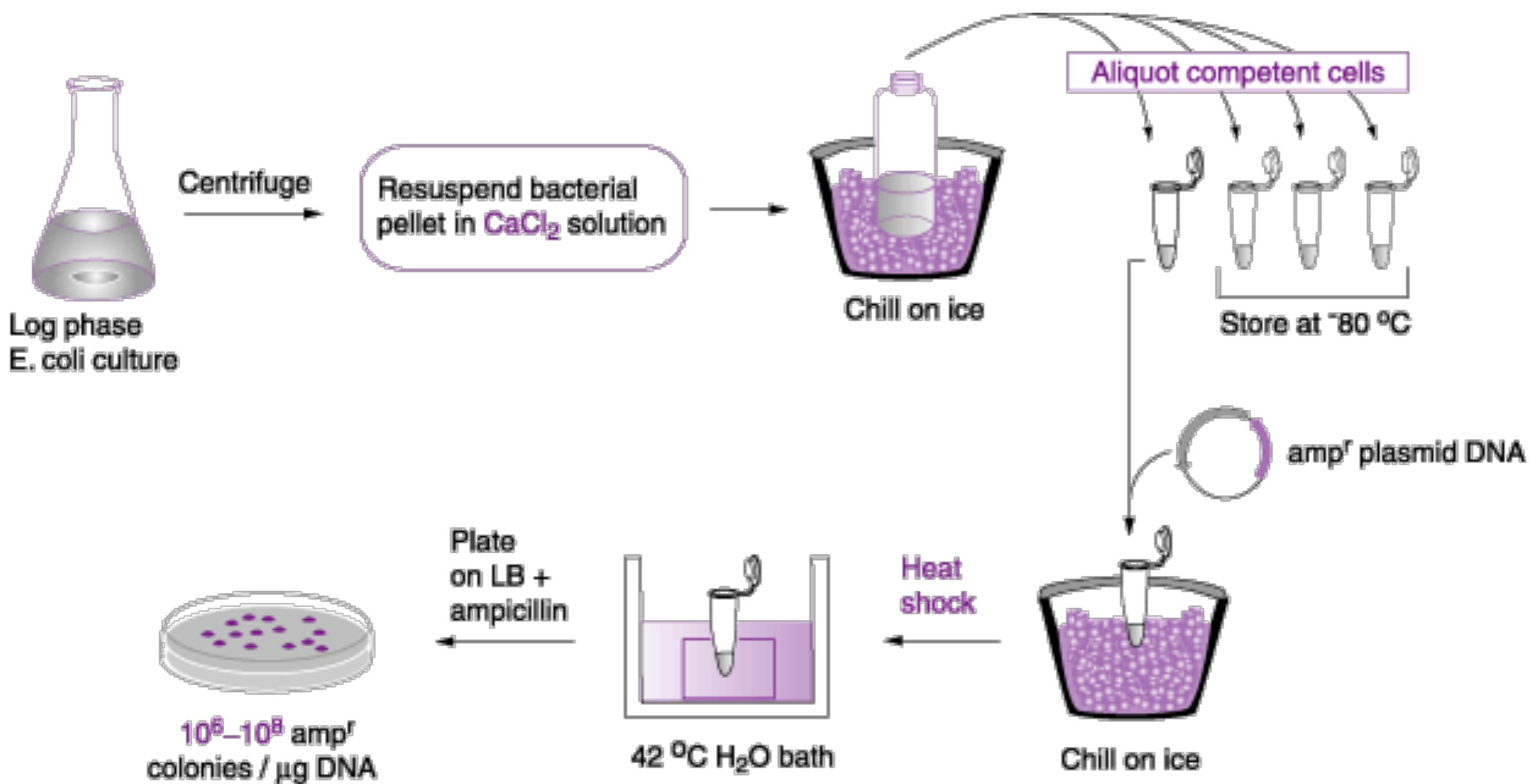


DNA Restriction Ligation



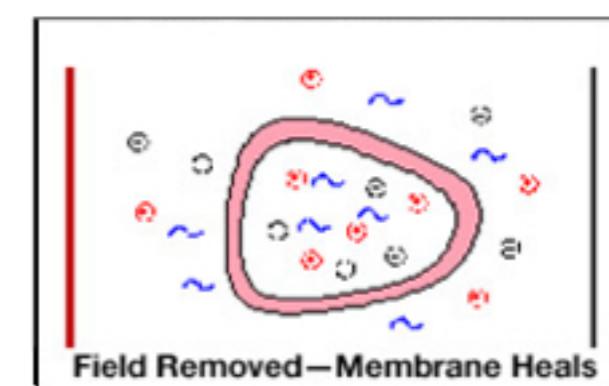
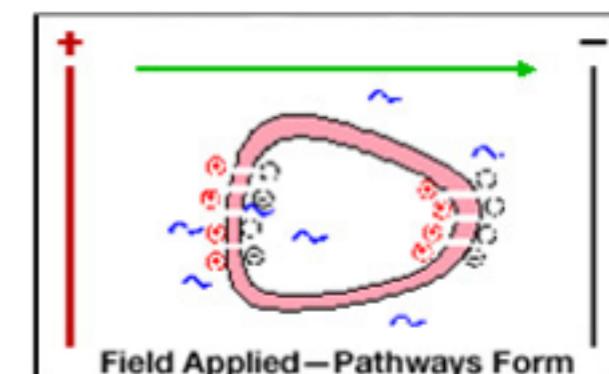
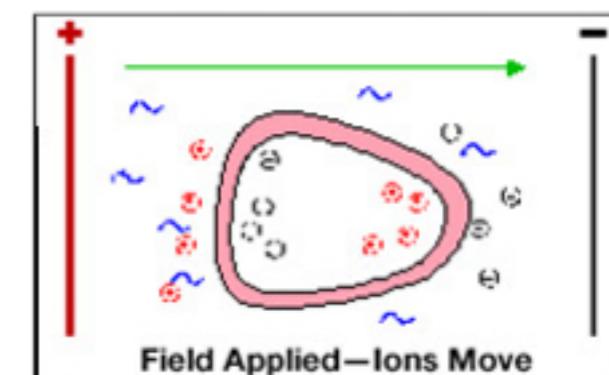
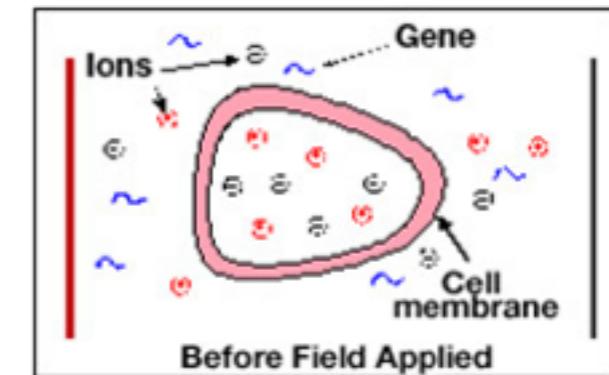


Heat Shock Transformation





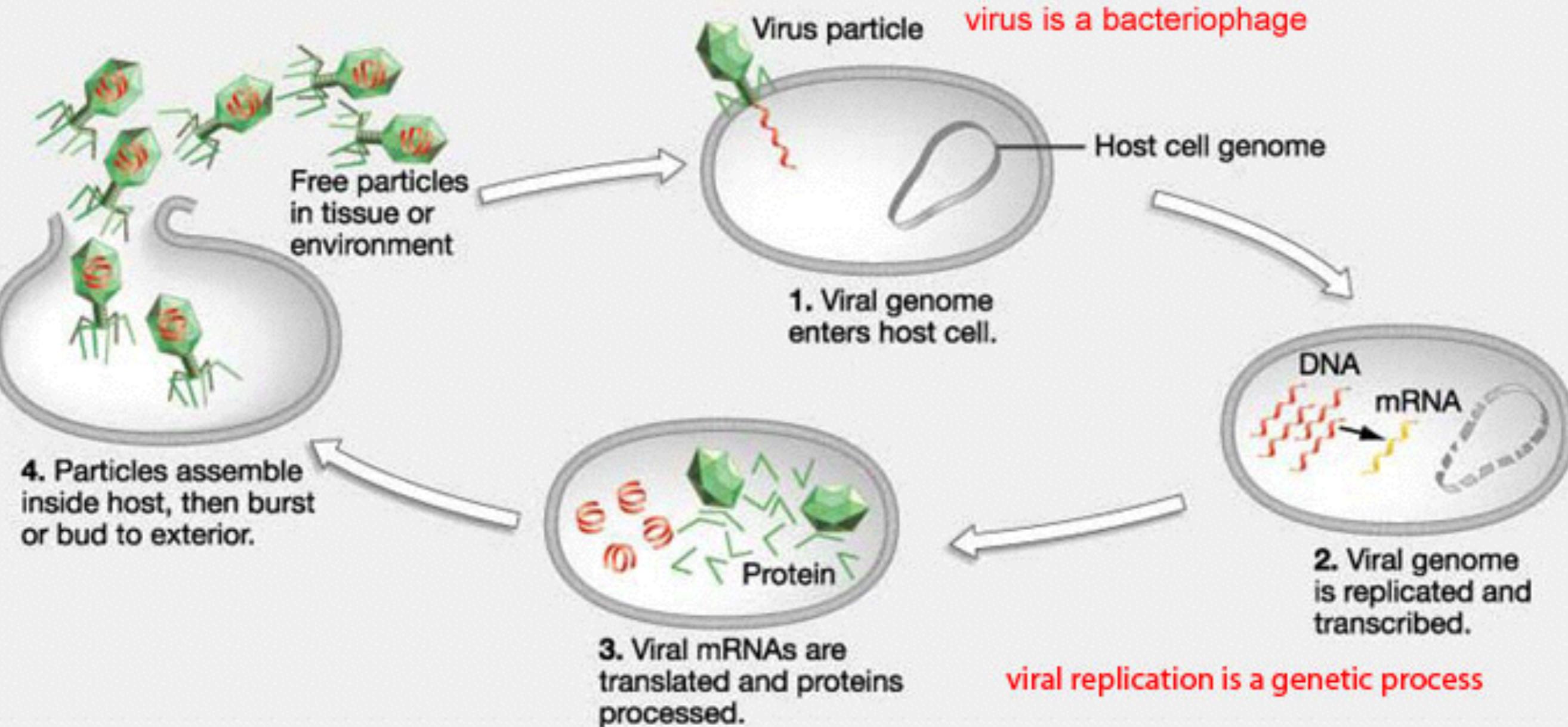
GeneGun – Electroporation





Viral Transformation

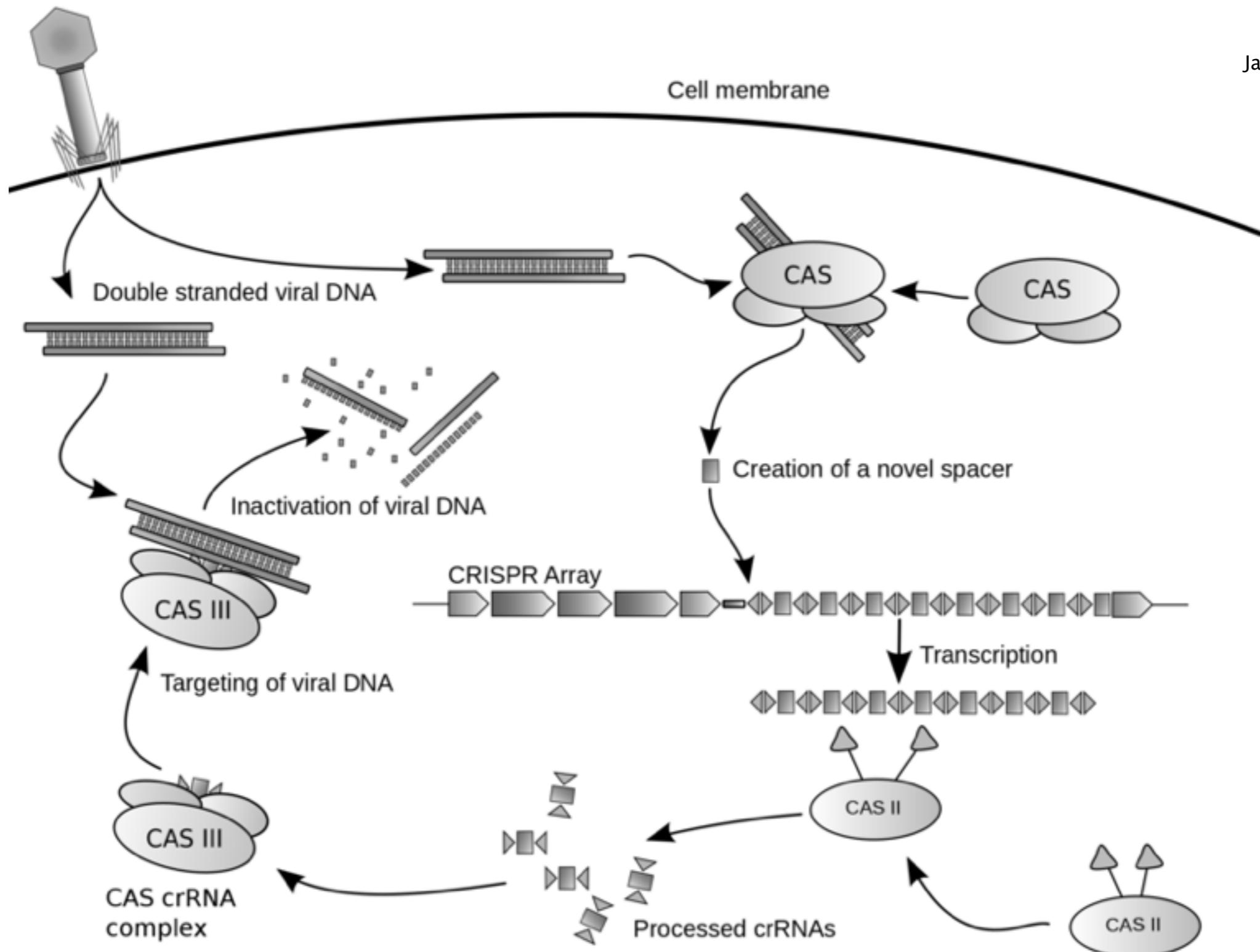
HOW DO VIRUSES WORK?





CRISPR – Cas9

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