‘The Century of Biology:
How Life Sciences has transformed into an Engineering discipline’

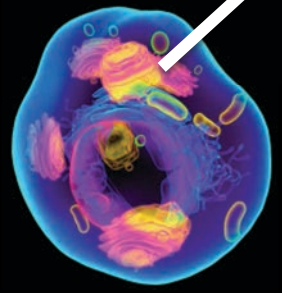
Faisal Khan

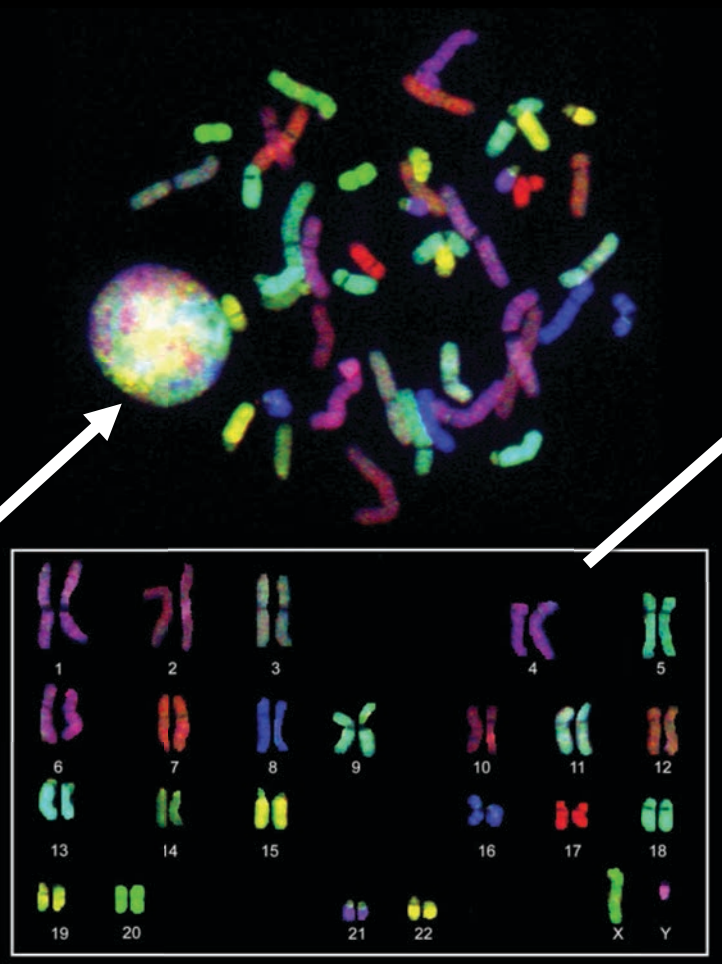
PPMA Pharma Summit 2020

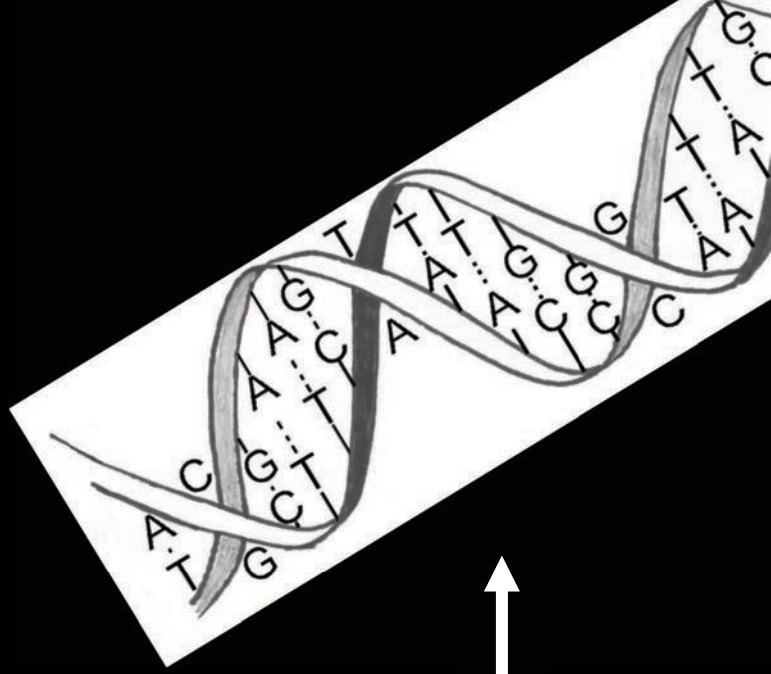
Islamabad

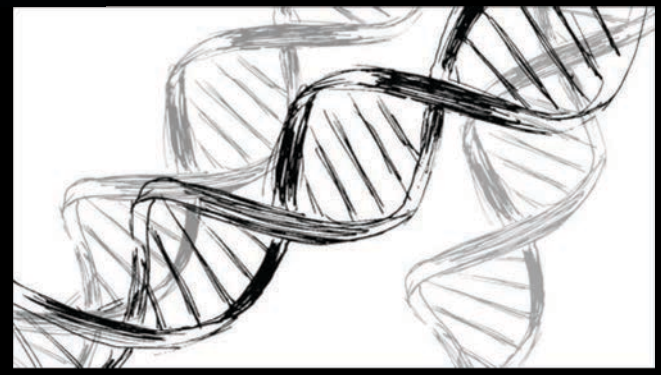
February 19, 2019

Molecular Biology 101









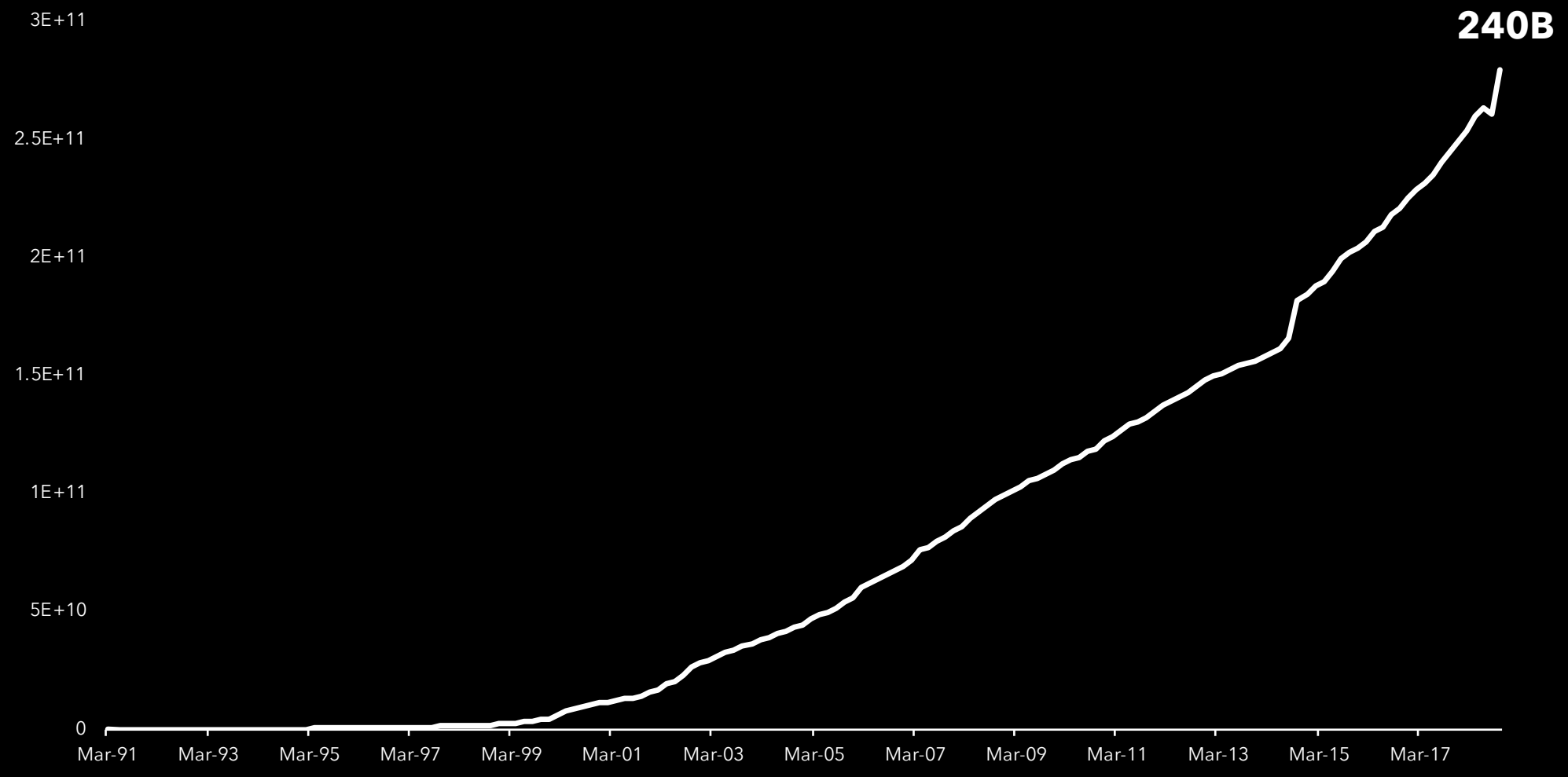
The Human Genome

‘If I read to you the whole genome at the rate of one word per second, eight hours a day, it would take me a century’

– Matt Ridley

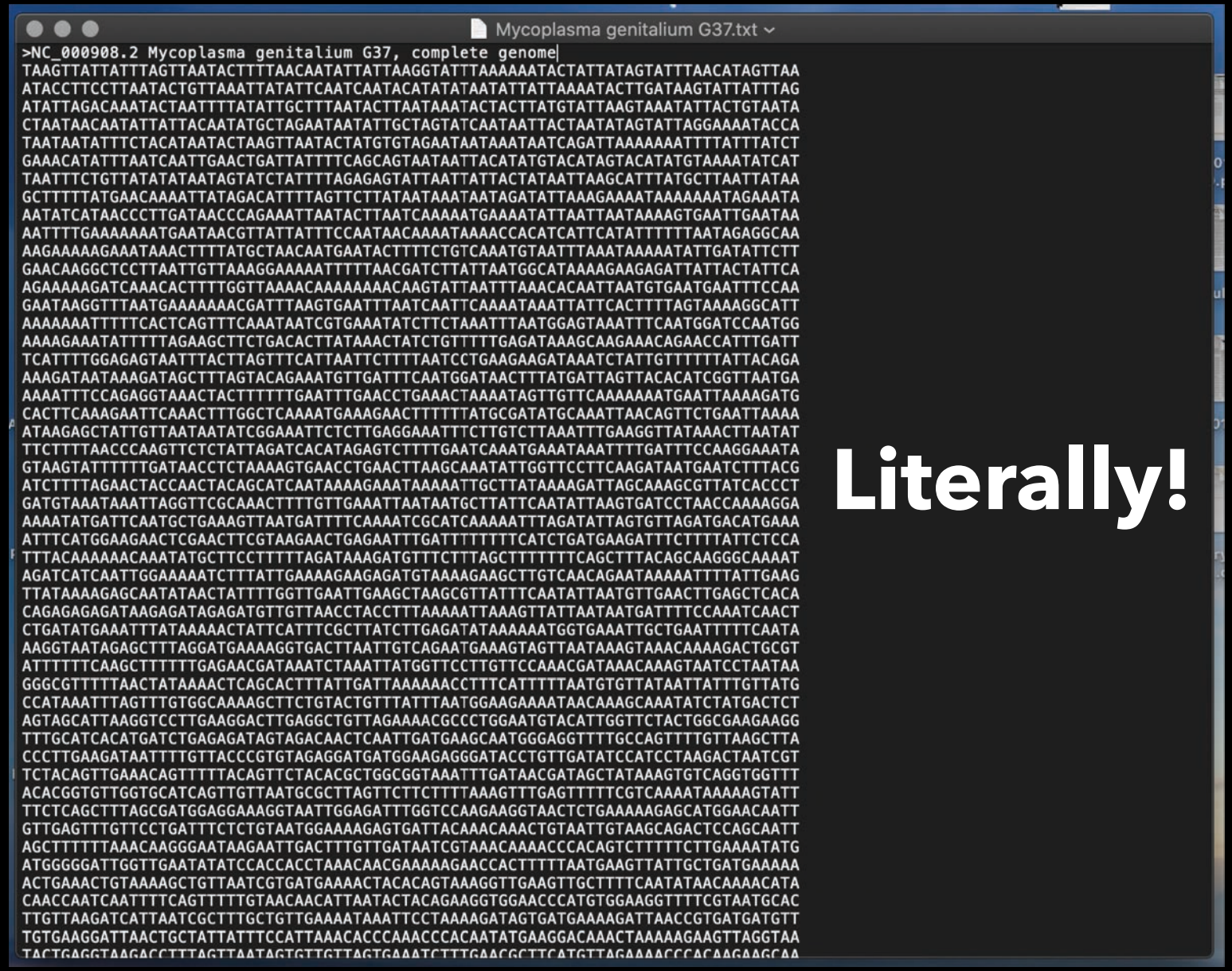
= 3.2 billion bases (letter); ~240GB Hard Drive

DNA sequence data



NCBI, 2018

A living organism is now a txt file!


Mycoplasma genitalium G37.txt
>NC_000908.2 Mycoplasma genitalium G37, complete genome
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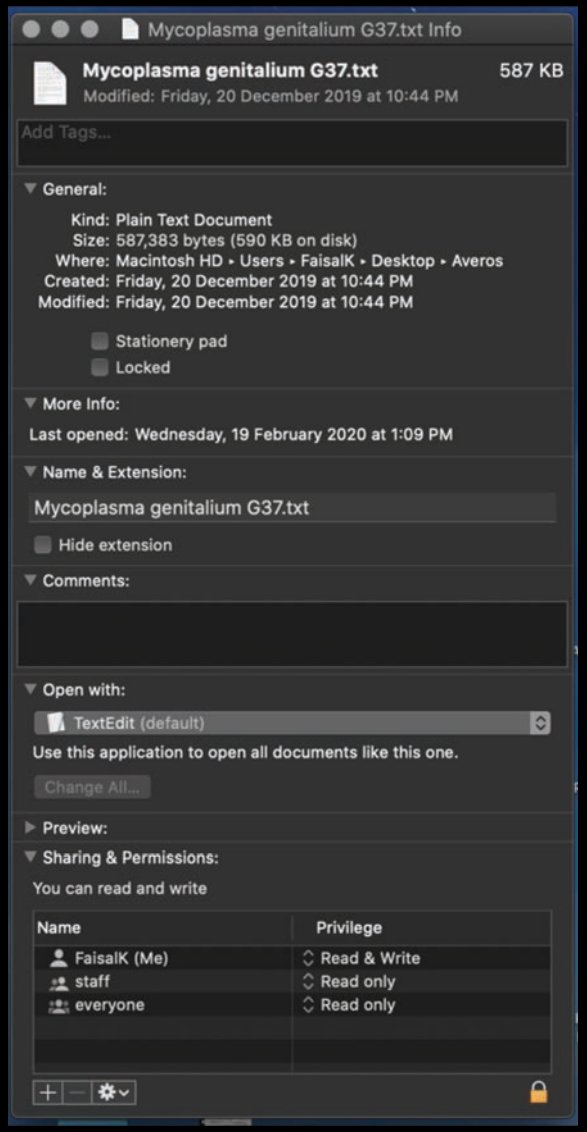
Literally!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Mycoplasma genitalium G37.txt
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Stationery pad
Locked
More Info:
Last opened: Wednesday, 19 February 2020 at 1:09 PM
Name & Extension:
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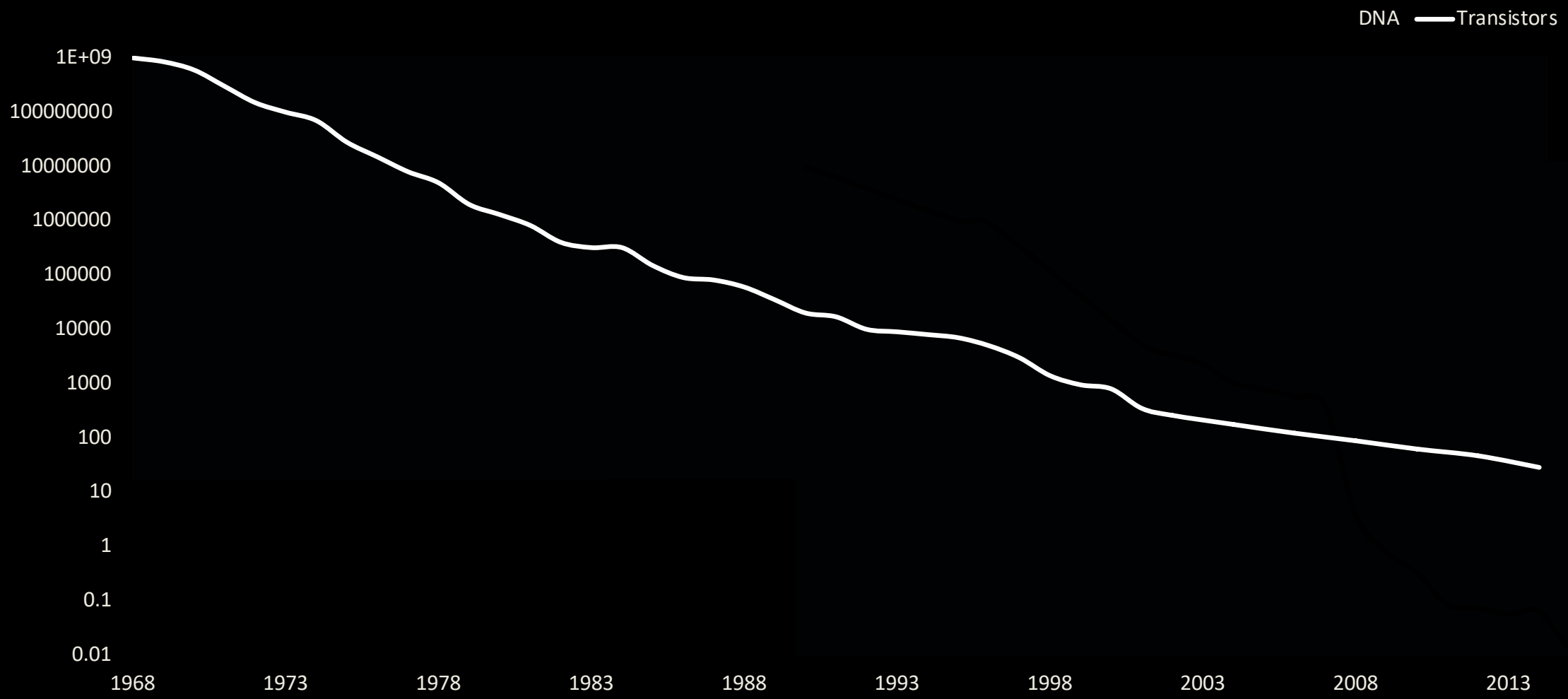
Hide extension
Comments:
Open with:
TextEdit (default)
Use this application to open all documents like this one.
Change All...
Preview:
Sharing & Permissions:
You can read and write
Name
Privilege
FaisalK (Me)
Read & Write
staff
Read only
everyone
Read only

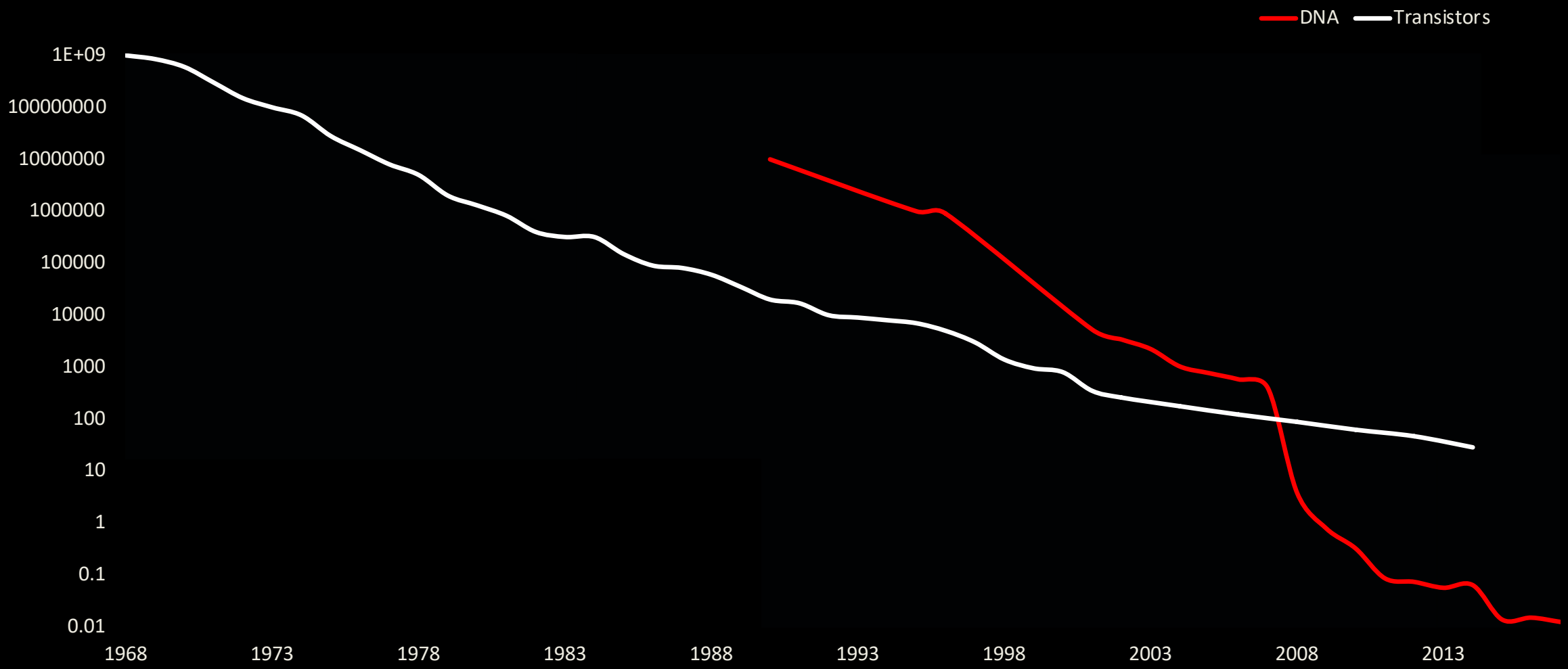
But we know this?

3 trends

Trend 1: DNA vs Transistors



Trend 1: DNA vs Transistors



Trend 1: DNA vs Transistors

Sequencing Costs
(HGP days; ~2000)

- First Draft in 2001
- 15 years
- 8 countries; 100s of scientists
- ~3 billion USD

Sequencing Costs (2018)

- 48h max
- 1 scientist
- >1000 USD

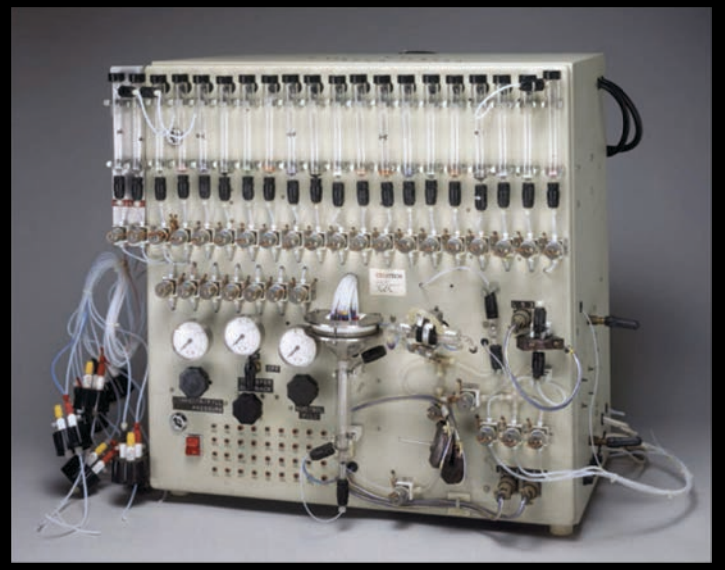
Trend 1: DNA sequencing costs

Oxford Nanopore, 2016

Trend 1: DNA sequencing costs

Oxford Nanopore, 2020

Trend 2: DNA synthesis costs



$1/letter

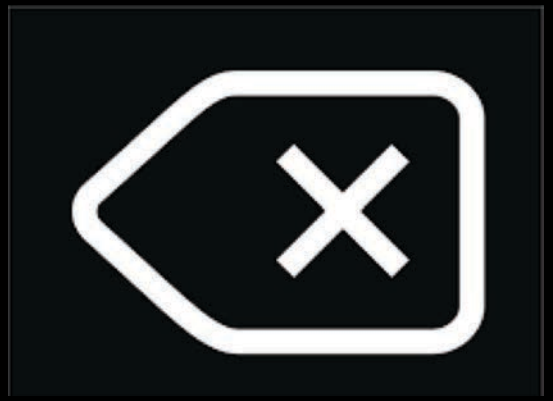
Now,

$0.01/letter

Trend 3: DNA engineering costs

COPY

PASTE



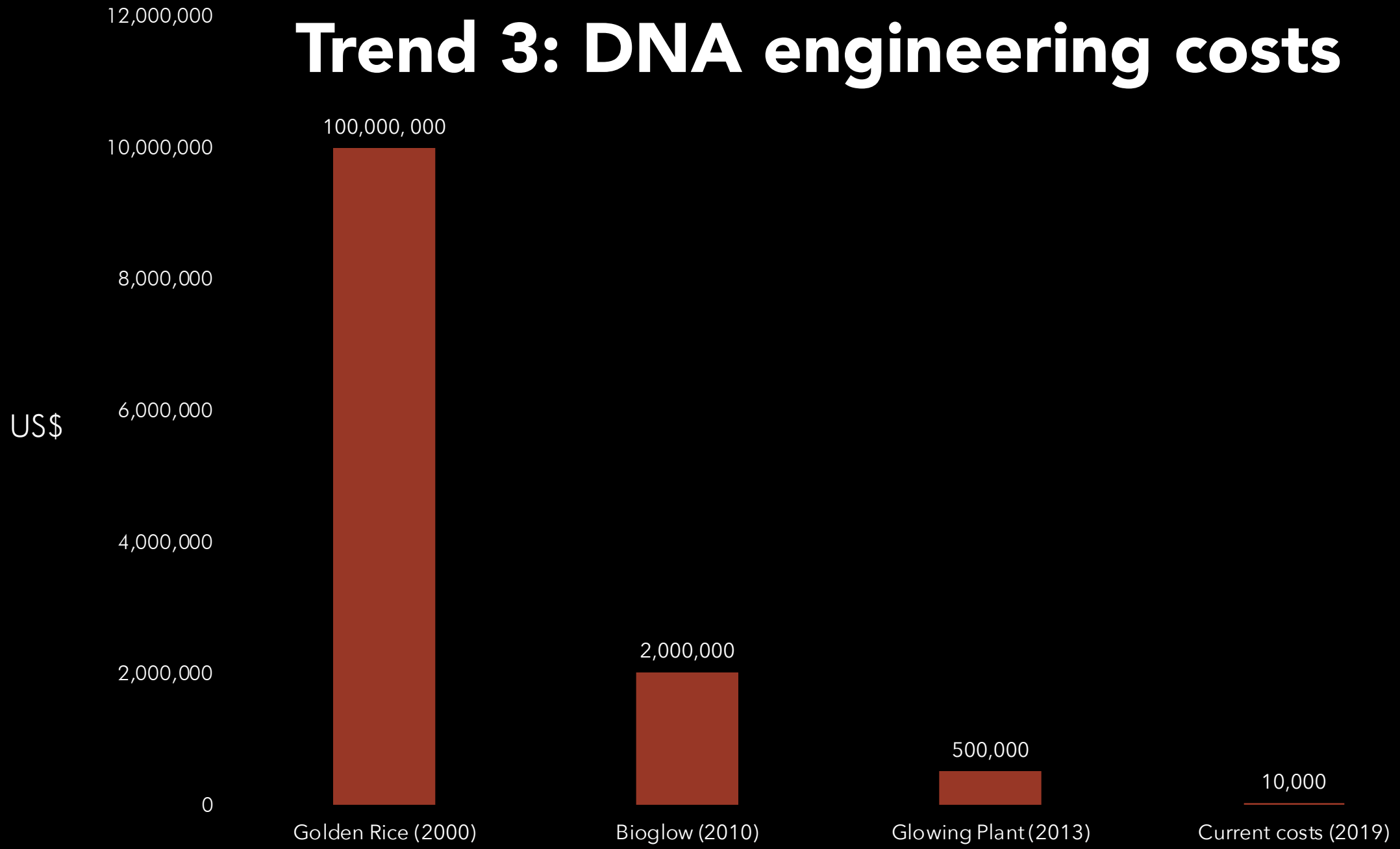
EDIT

Trend 3: DNA engineering costs

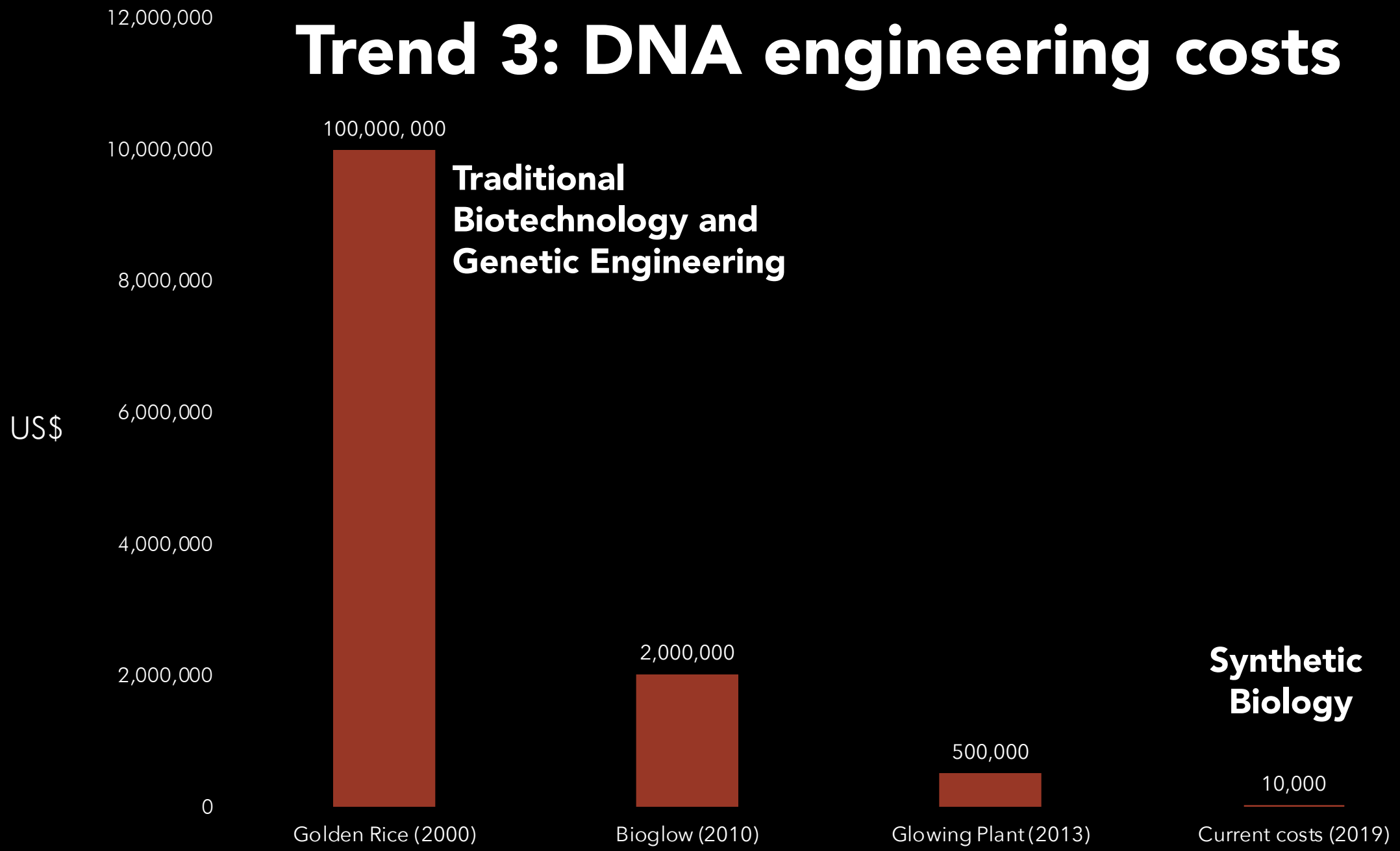
Trend 3: DNA engineering costs

GlowingPlant.com

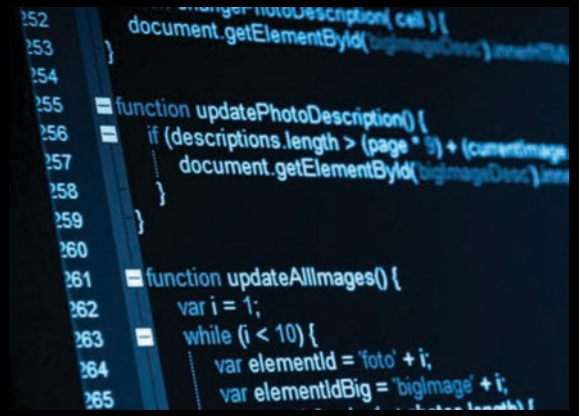
Trend 3: DNA engineering costs



Trend 3: DNA engineering costs

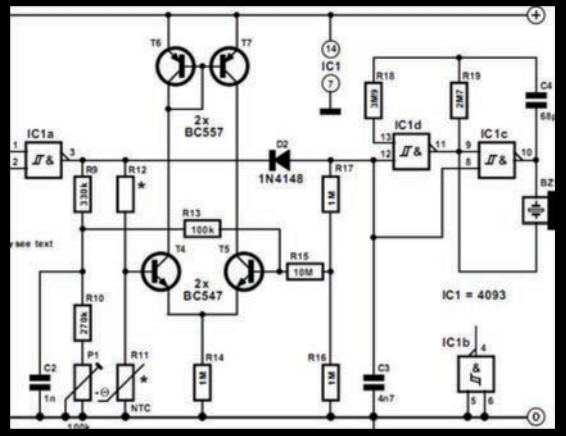


Computer Science



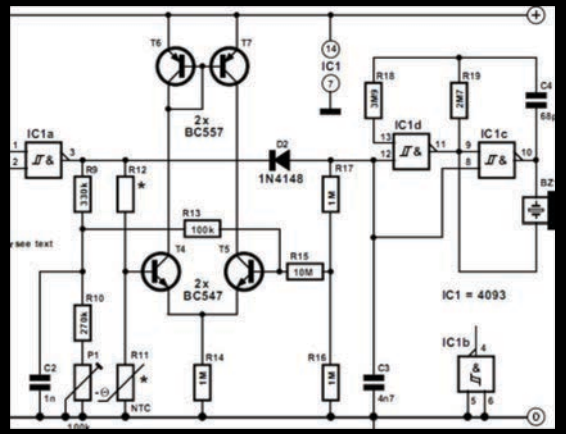
Computer Science

Engineering

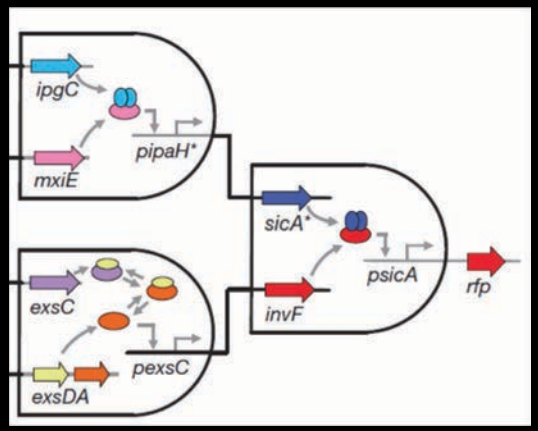


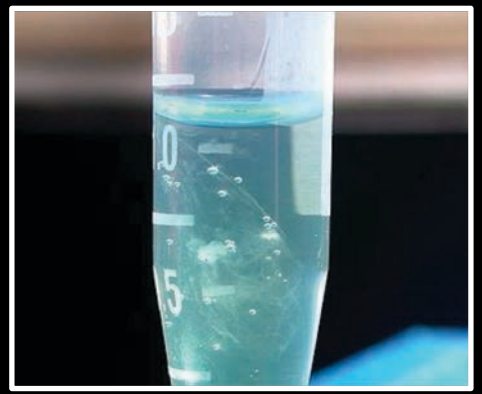
Computer Science

Engineering

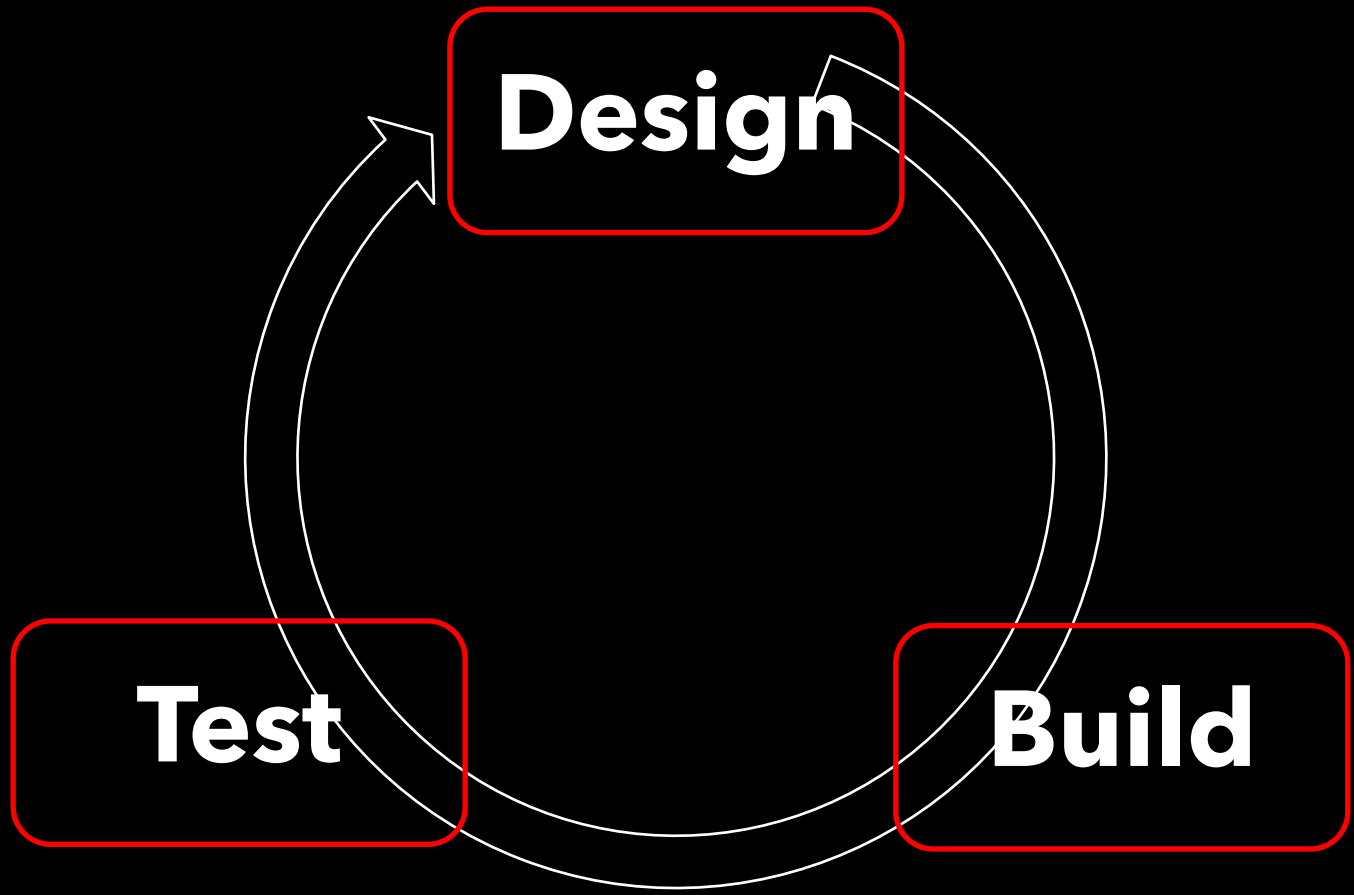


Synthetic Biology



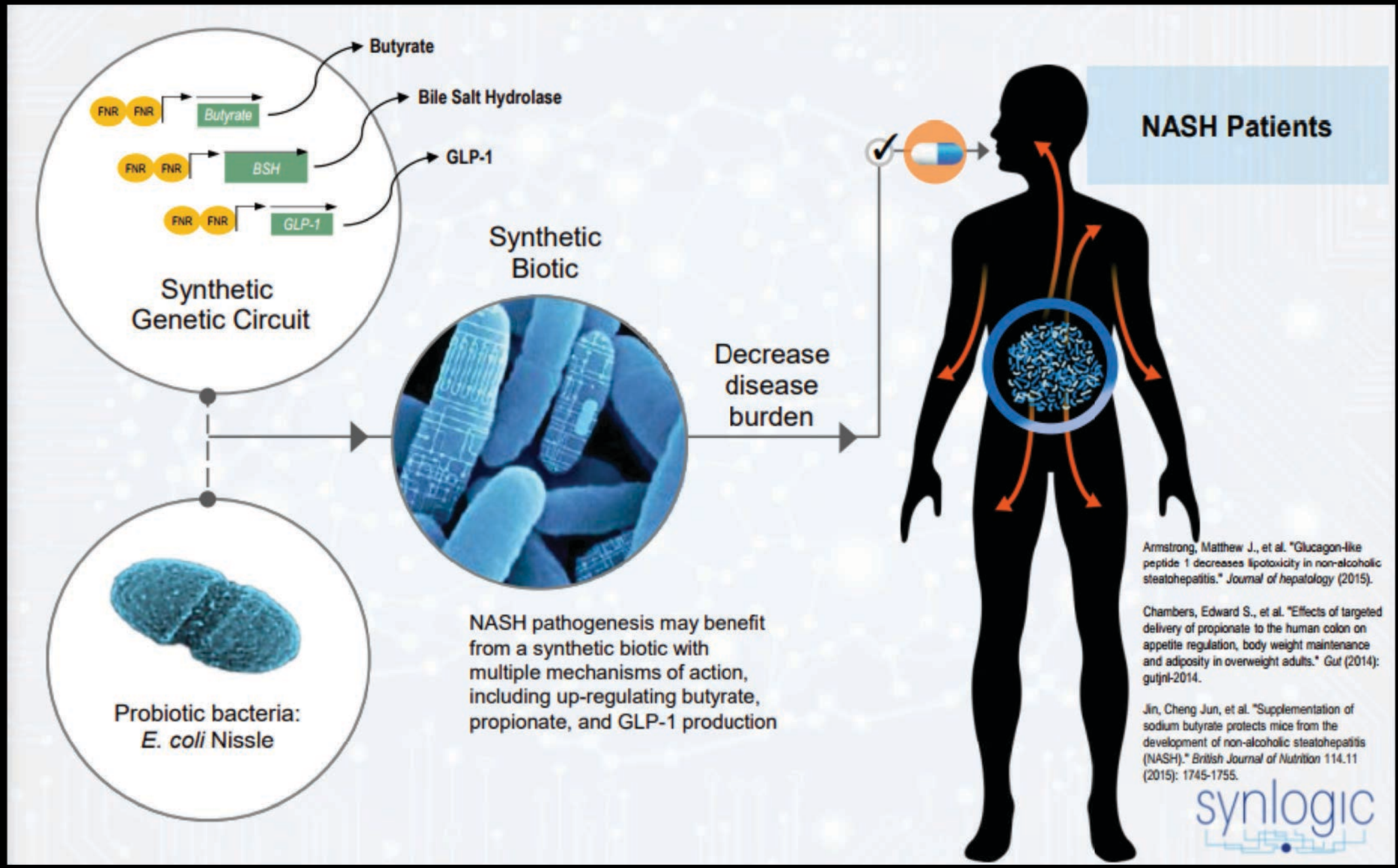


Engineering principles



Artemisinin production

Robbie Rogers
LA Galaxy Star
Bolt Threads


Butyrate
Bile Salt Hydrolase
GLP-1
FNR FNR Butyrate
FNR FNR BSH
FNR FNR GLP-1
Synthetic Genetic Circuit
Synthetic Biotic
Decrease disease burden
NASH Patients
Probiotic bacteria: E. coli Nissle
NASH pathogenesis may benefit from a synthetic biotic with multiple mechanisms of action, including up-regulating butyrate, propionate, and GLP-1 production
Armstrong, Matthew J., et al. "Glucagon-like peptide 1 decreases lipotoxicity in non-alcoholic steatohepatitis." Journal of hepatology (2015).
Chambers, Edward S., et al. "Effects of targeted delivery of propionate to the human colon on appetite regulation, body weight maintenance and adiposity in overweight adults." Gut (2014): gutjnl-2014.
Jin, Cheng Jun, et al. "Supplementation of sodium butyrate protects mice from the development of non-alcoholic steatohepatitis (NASH)." British Journal of Nutrition 114.11 (2015): 1745-1755.
synlogic

PRECISION MEDICINE LAB

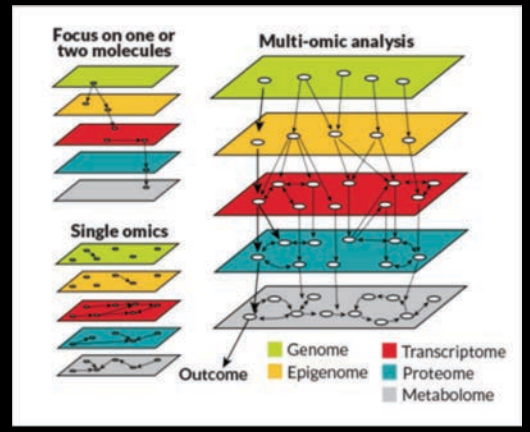
AN AFFILIATE OF THE
NATIONAL CENTRE FOR BIG DATA & CLOUD COMPUTING AT **CECOS & RMI**

PRECISION MEDICINE LAB

Recruit Patients, Collect Samples

Extract and 'read' the DNA

Multi-omic Analyses



Test in Cell Lines

Inform Oncologist

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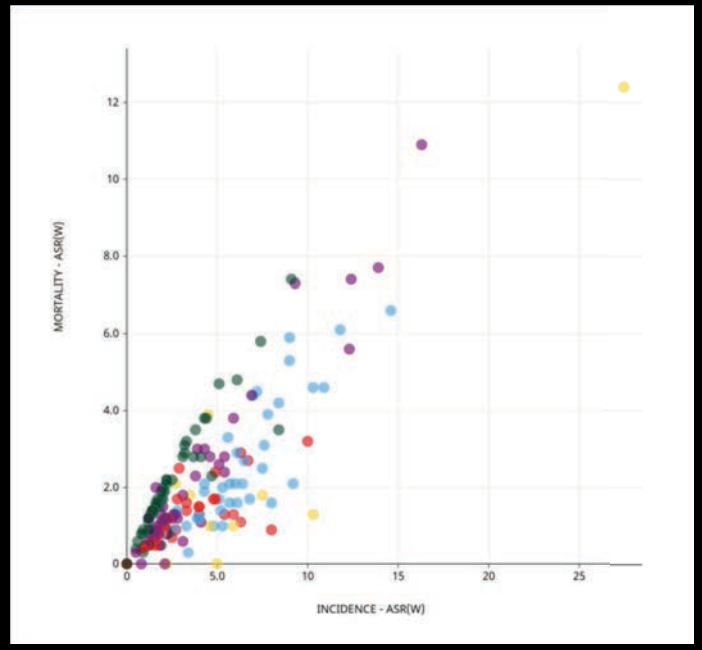
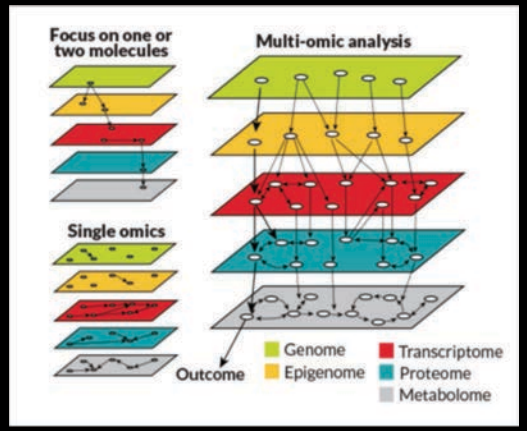


Multi-omic Analyses



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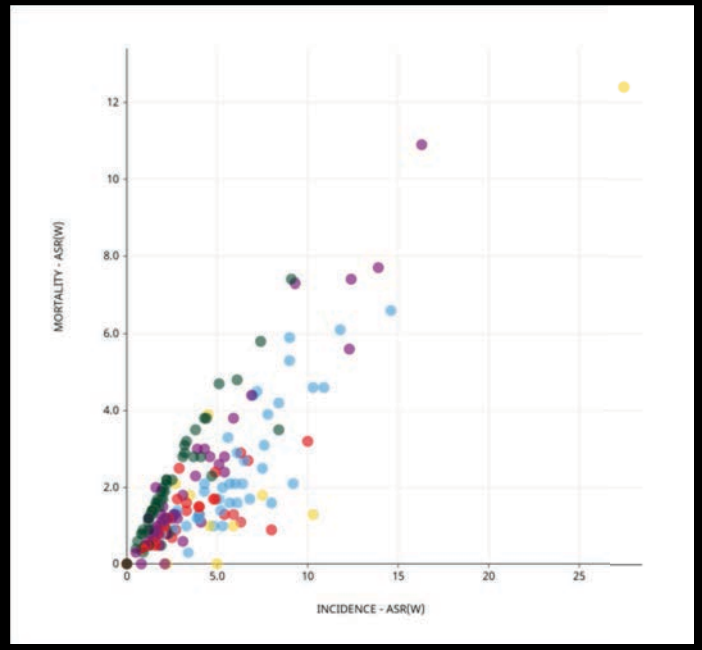

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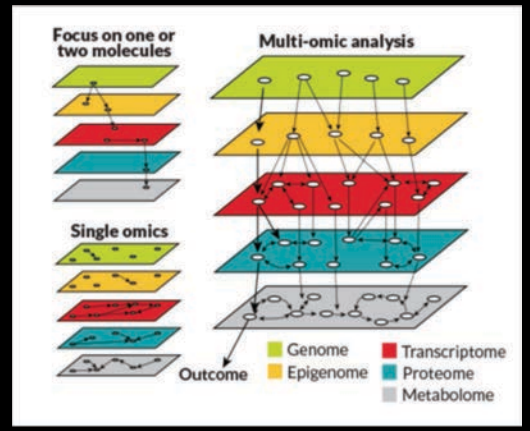

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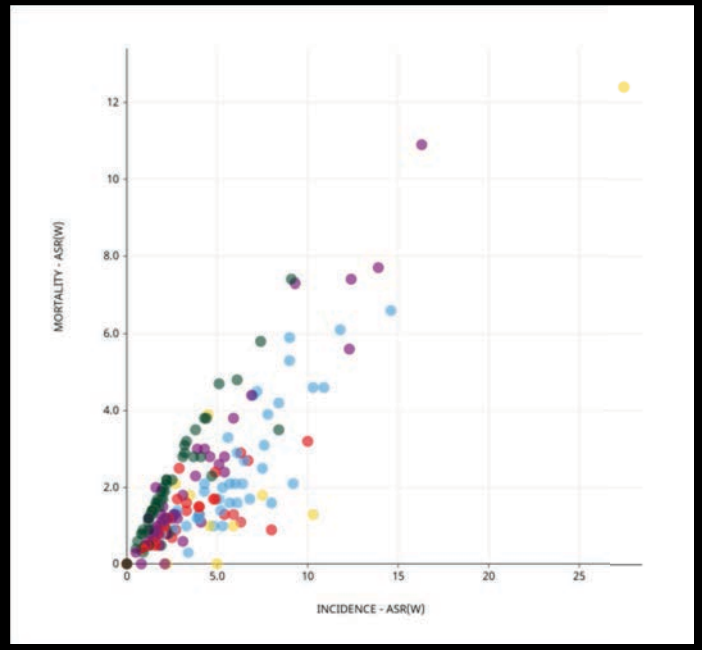
PRECISION MEDICINE LAB

Recruit Patients, Collect Samples

Extract and 'read' the DNA



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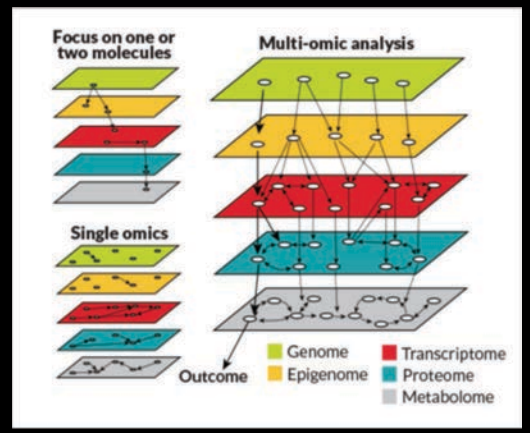

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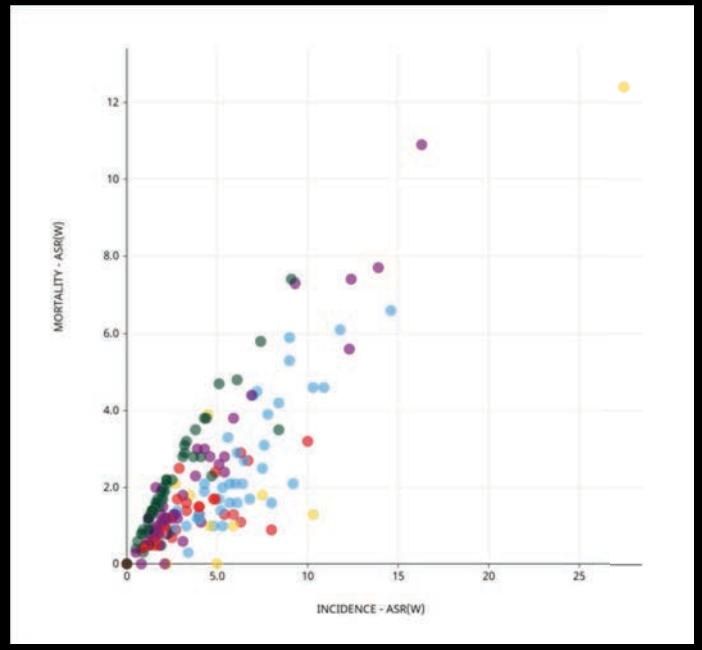
PRECISION MEDICINE LAB

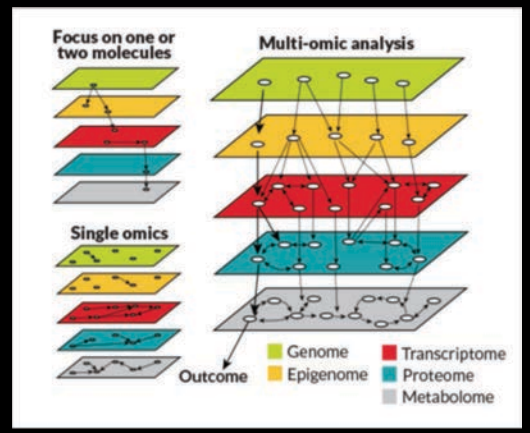
Recruit Patients, Collect Samples

Clinical Trials

Extract and 'read' the DNA



Multi-omic Analyses



Test in Cell Lines

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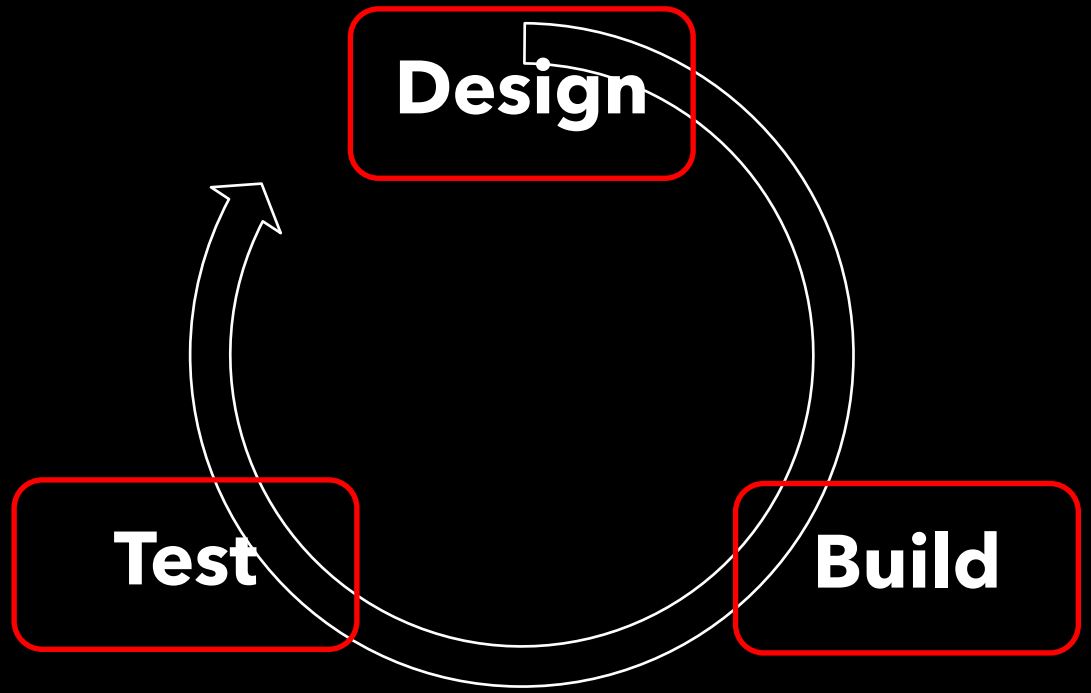
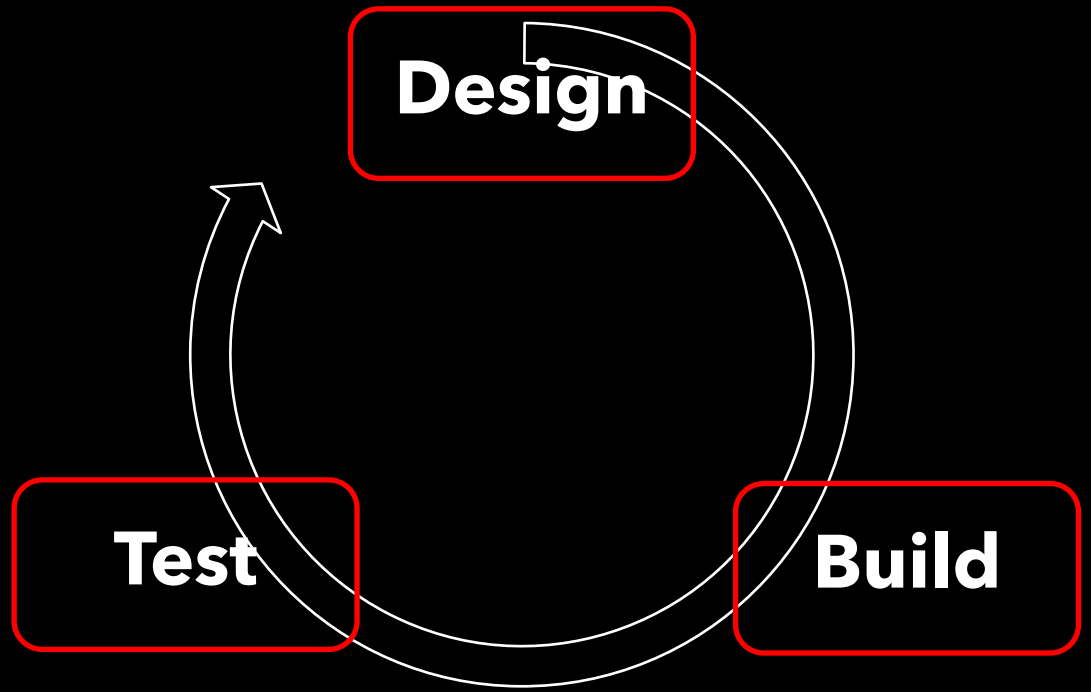
AVEROS

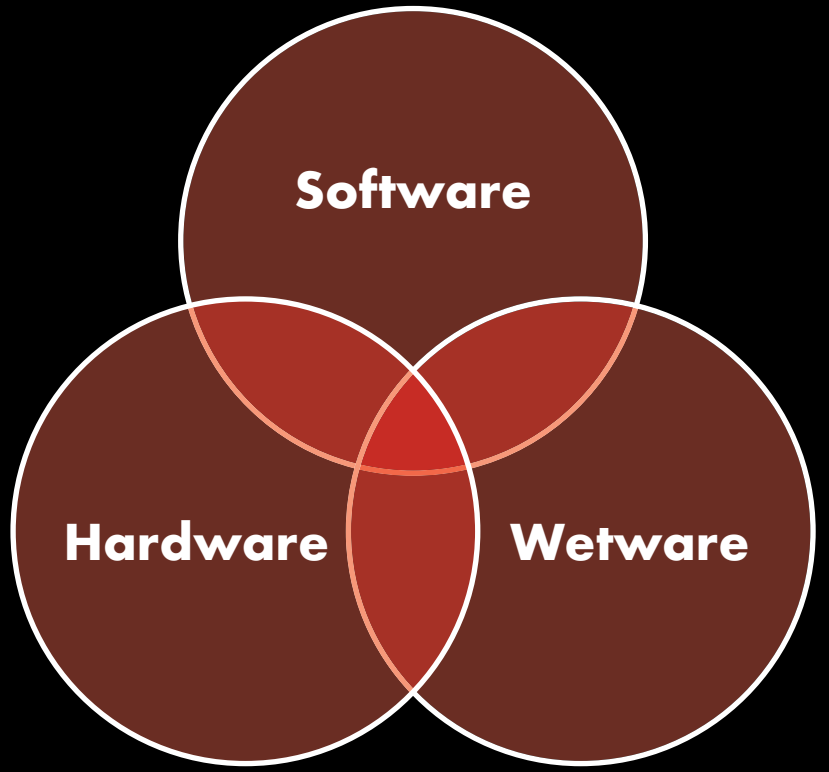
We programme living cells.

Our Value Prop



Our Value Prop



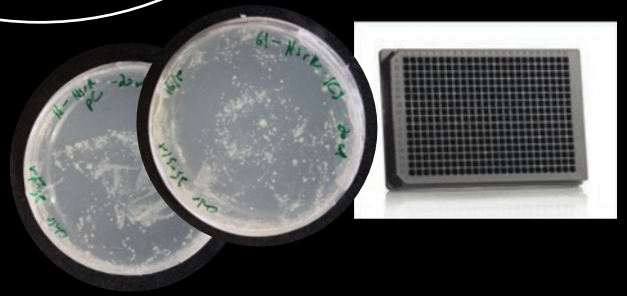


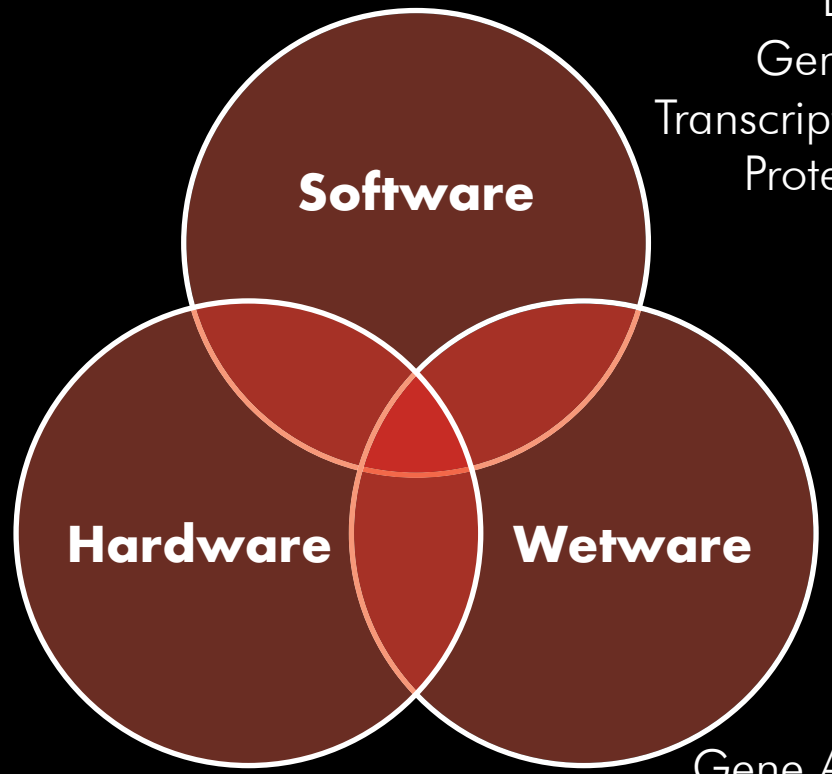
Our Value Prop

Design

Test

Build





Design
Genomics
Transcriptomics
Proteomics
ML/AI

High-throughput
Automation
IO(L)T

Gene Assembly
Transformation
CRISPR
Scaleup Fermentation

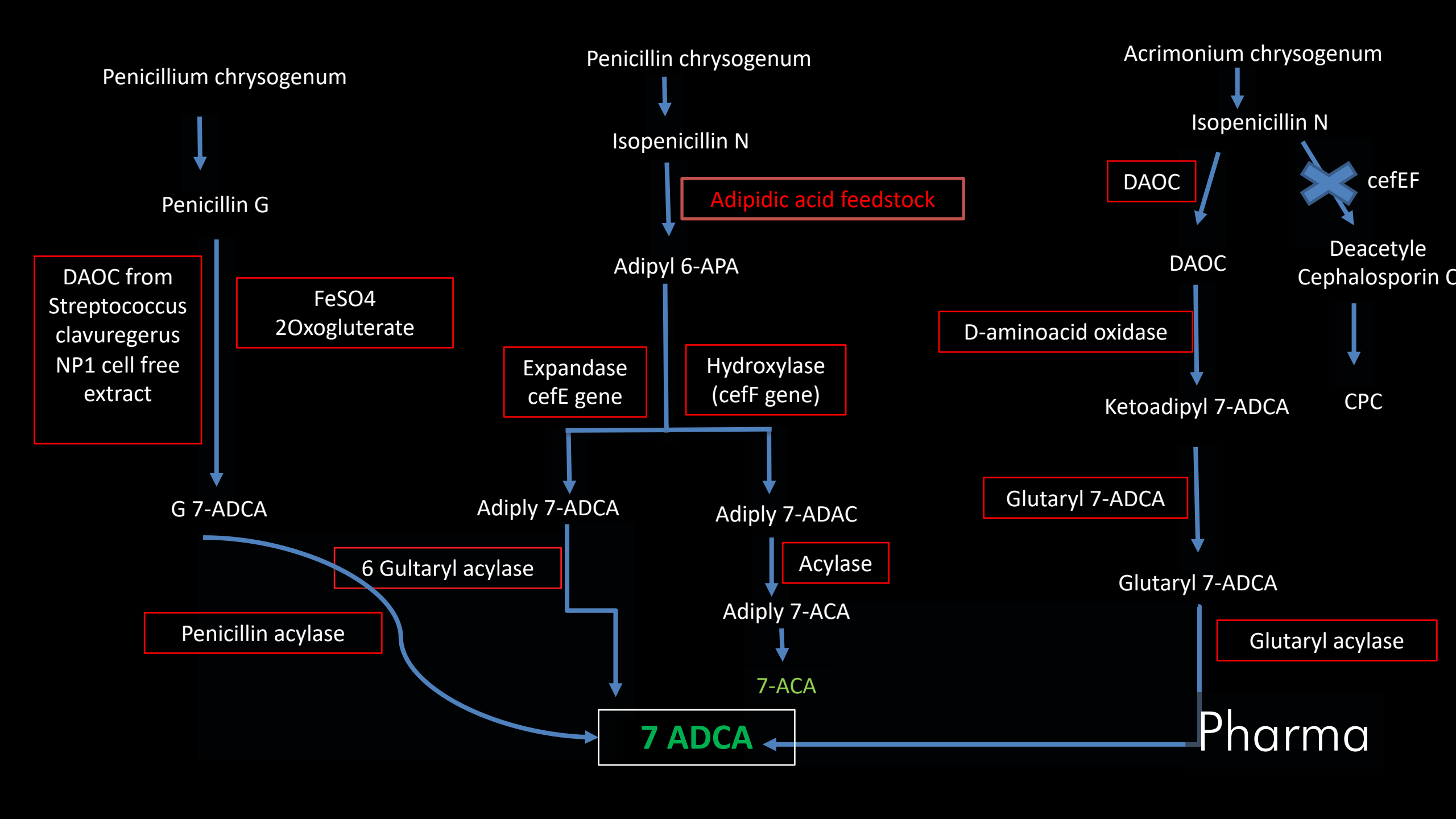
Fragrances

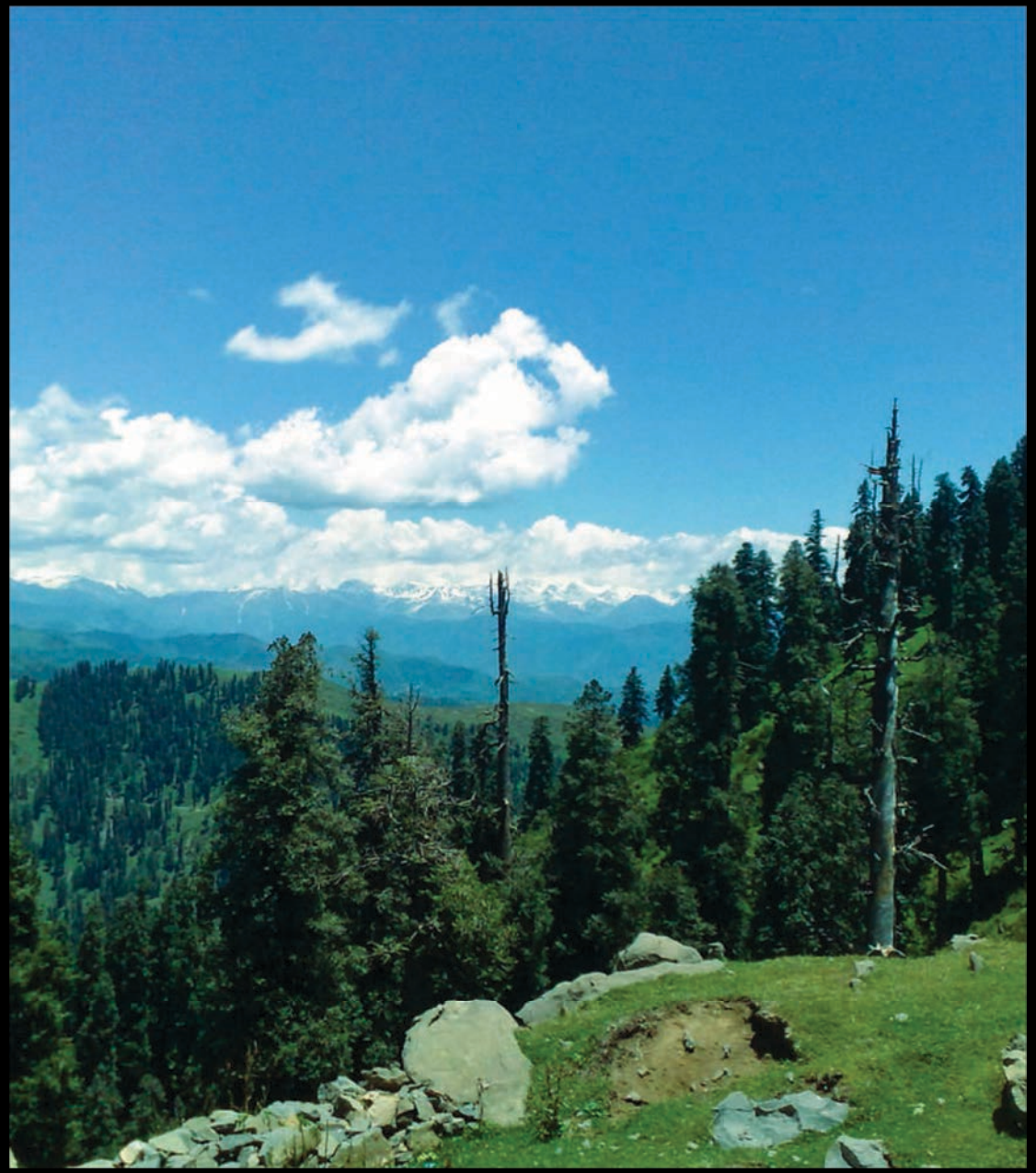
Input = CO
Output = Red Color

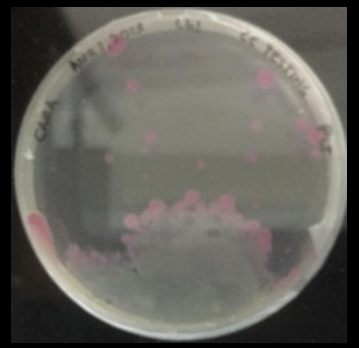
Living Sensors

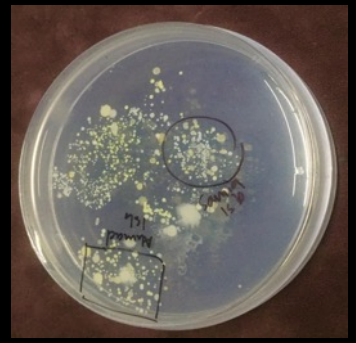
Agriculture

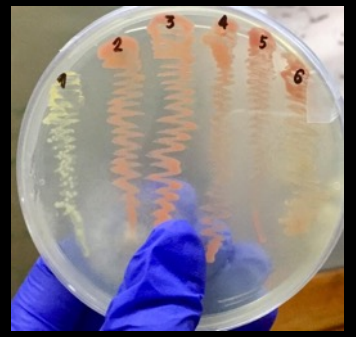
Pigments


Penicillium chrysogenum
Penicillin G
DAOC from Streptococcus clavuregerus NP1 cell free extract
FeSO4
2Oxogluterate
G 7-ADCA
Penicillin acylase
Penicillin chrysogenum
Isopenicillin N
Adipidic acid feedstock
Adipyl 6-APA
Expandase cefE gene
Hydroxylase (cefF gene)
Adiply 7-ADCA
Adiply 7-ADAC
6 Gultaryl acylase
Acylase
Adiply 7-ACA
7-ACA
Acrimonium chrysogenum
Isopenicillin N
DAOC
cefEF
DAOC
Deacetyle Cephalosporin C
D-aminoacid oxidase
Ketoadipyl 7-ADCA
CPC
Glutaryl 7-ADCA
Glutaryl 7-ADCA
Glutaryl acylase
7 ADCA
Pharma









Pharma

Design Questions

1) Different enzymes for different steps of the pathway.
2) Different sources (fungal and bacterial sources) of these enzymes.
3) Each enzyme can be engineered, at the DNA level.
4) Can we have a single-step reaction: molasses to end product with no intermediate steps.

B2B

Enzymes

Fragrances

Pigments

Fibres

Flavours

APIs

B2C

Living Sensors

Agriprobiotics

Probiotics

Bioremediation

Key Points

1) Biology has transformed; its molecular, its data driven.
2) Costs are like software now: A big big opportunity to reset our R&D agenda
3) Can we manufacture the APIs we import? Can we have our own clinical trials?
4) Its all happening here in Pakistan, in Peshawar.
5) This century belongs to Biology. Is Pakistan ready?

We are looking for visionary partners in the pharma space!

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@esepzai

Thank you!