Open source approaches to Intellectual Property for faster and more equitable innovation in biotechnology

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OPEN BIOECONOMY LAB

SHUTTLEWORTH FELLOW

UKRI Biotechnology and Biological Sciences Research Council

UKRI Engineering and Physical Sciences Research Council

Isaac Newton Trust

VolkswagenStiftung

GCRF Global Challenges Research Fund

EDCTP

Building a globally inclusive biomanufacturing value chain

Circular economies of resources

Shortening supply chains

Agile, just-in-time production

Using Open Source Enabling Technologies

Open toolkits for distributed biomanufacturing of reagents

Featured Project: Open Enzyme Collection

>60 enzymes and DNA parts for manufacturing essential research reagents.

Applying open source tools to address Sustainable Development Goals

Featured Project: CRISPR TyphoidDx

Novel partnerships for diagnostic development and manufacturing in Cameroon.

Policy towards an open, sustainable and equitable global bioeconomy

Featured Project: Advancing Open Science Hardware

Policy for open science hardware in research, technology transfer and sustainable development

Aish Venkatramani

Ana Pascual Garrigos

Yan Kay Ho

Minette Shalo

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OPEN BIOECONOMY LAB

What does “Open” mean?

universal access

e.g. availability of specific molecular tools unencumbered by intellectual property;

universal participation

e.g. greater involvement of stakeholders in shaping projects using those tools;

collaborative production

e.g. multiple partners working together for a common goal

Smith, M., Engler, N. J., Christian, G., Diga, K., Rashid, A., & Flynn-Dapaah, K. (2008). Open ICT4D. International Development Research Centre http://openict4d.wikidot.com/open-ness-to-open-ict4d.

How
do we make technology
“Open”

creative commons

MOST OPEN

LEAST OPEN

Licenses

- CC 0 ZERO
- CC BY
- CC BY SA
- CC BY NC
- CC BY ND
- CC BY NC SA
- CC BY NC ND

Icons

Terms of the Licenses

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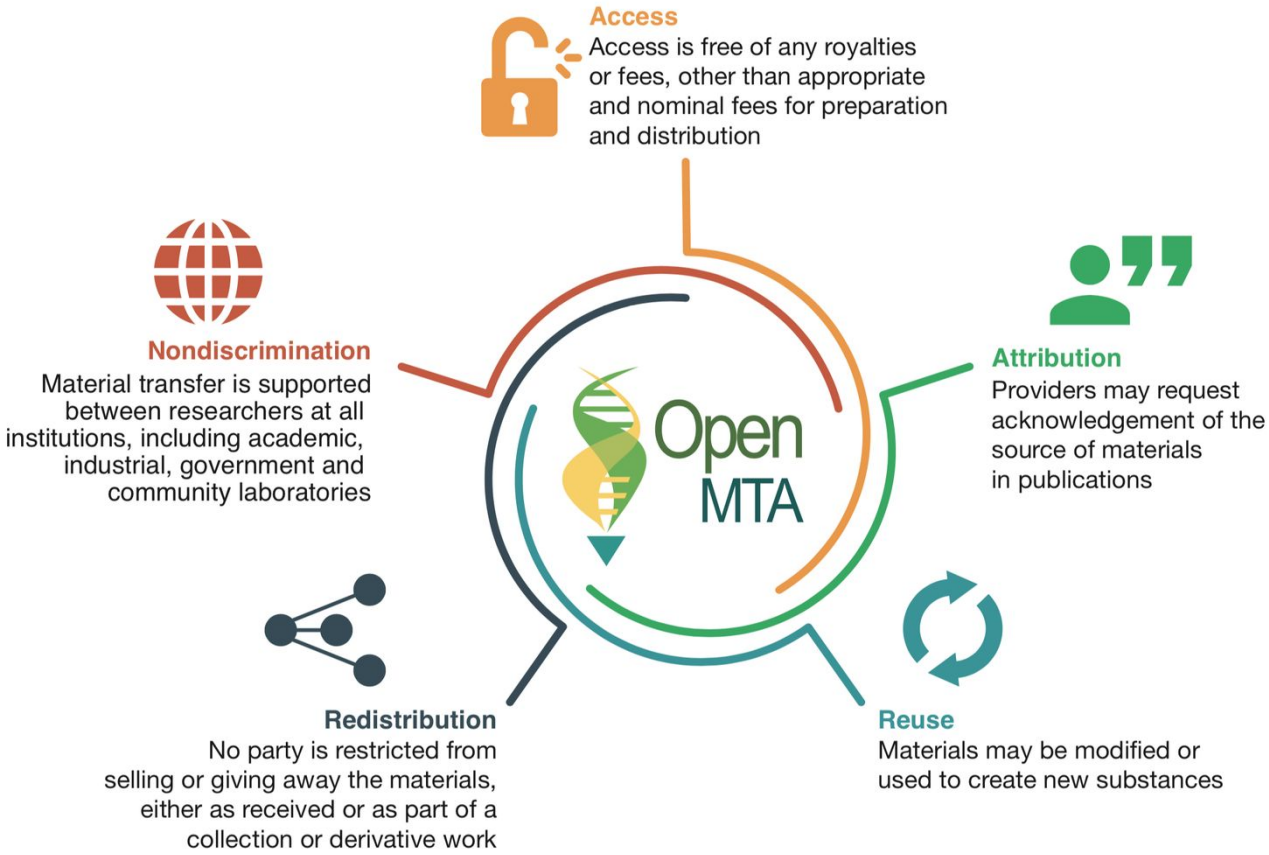
open source hardware

A simple, standardized legal tool that enables individuals and organizations to share their materials on an open basis.

http://openmta.org



OpenMTA Commentary. "Opening options for material transfer". Linda Kahl, Jennifer Molloy, Nicola Patron, Colette Matthewman, Jim Haseloff, David Grewal, Richard Johnson & Drew Endy. **Nature Biotechnology** 36:923–927 (2018). **https://doi.org/10.1038/nbt.4263**

In what context and by what mechanisms can open source sharing help generate impact?

Why open source approaches?

accelerating R&D

reducing friction in access to knowledge and materials

user innovation

more diverse ideas, expanding pool of developers

focusing on value-add

know-how, collaborations and community, using the technologies, building trust and buy-in

Why not open source approaches?

need for capital

open source can be a route to profit but it is often not a route to maximising profits - monopoly is quite effective at this

need to defend or control

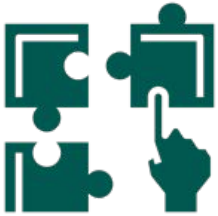
some projects use patents to maintain values of quality and equitable distribution under certain conditions.

it won’t be used

if it is a distraction or no one will adapt or use it, the effort needed to document an open hardware project is wasted.

What are effective collaborative engineering approaches?

Collaboration & co-creation



coordination challenge

people and things

navigating resources, power

different levels of resources, power and collaborative approaches

documentation

months can get lost to poor documentation, documenting know-how is hard

Reducing dependencies

production of the means of production

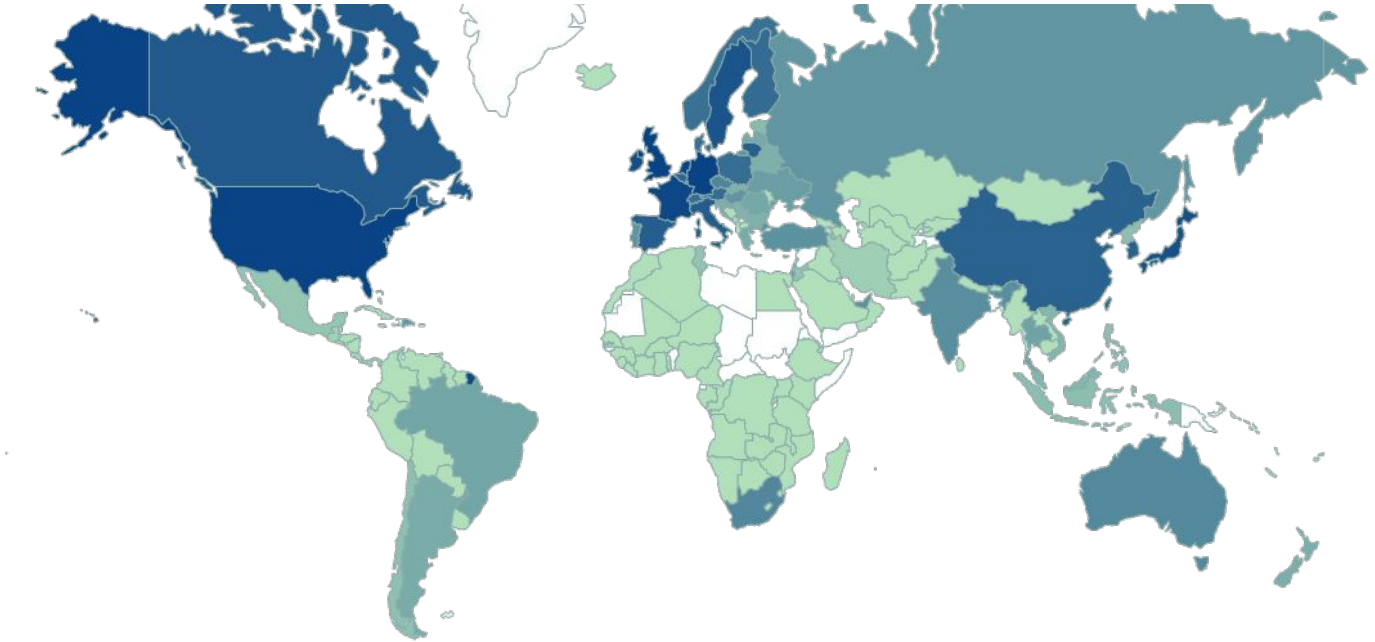
considering succession and endgame

balancing local autonomy and globalisation

CASE STUDY **1**

Access to reagents through **local production** in Cameroon

Supply chain for laboratory reagents



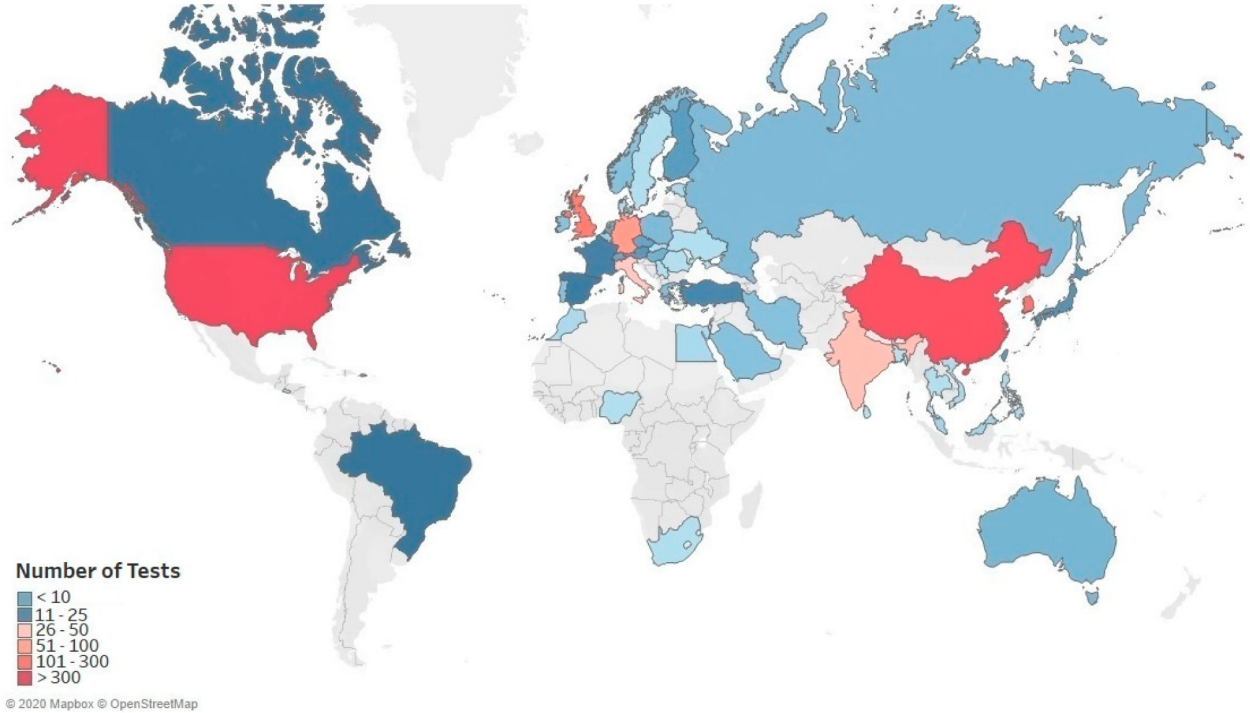
Export of laboratory reagents (HS 3822) in 2018

Image: Atlas of Economic Complexity https://atlas.cid.harvard.edu/

Geographies of synthetic biology innovation

Data: lens.org
Low and middle income countries were defined by the OECD DAC list.
Breakdown by region: Asia [exc China]: 653; Latin America: 357; Africa: 118

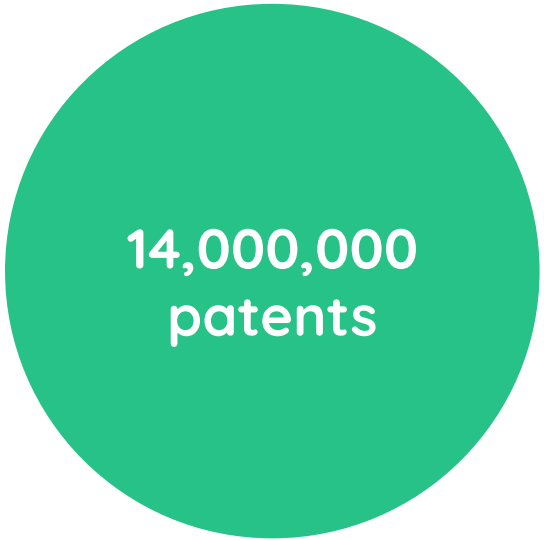
COVID Diagnostic Innovations



Oyewole, Anne O., et al. "COVID-19 Impact on Diagnostic Innovations: Emerging Trends and Implications." Diagnostics 11.2 (2021): 182.


“The collapse of global cooperation [has] shoved Africa out of the diagnostics market. African countries have funds to pay for reagents but cannot buy them”
John Nkengasong
Director, Africa CDC

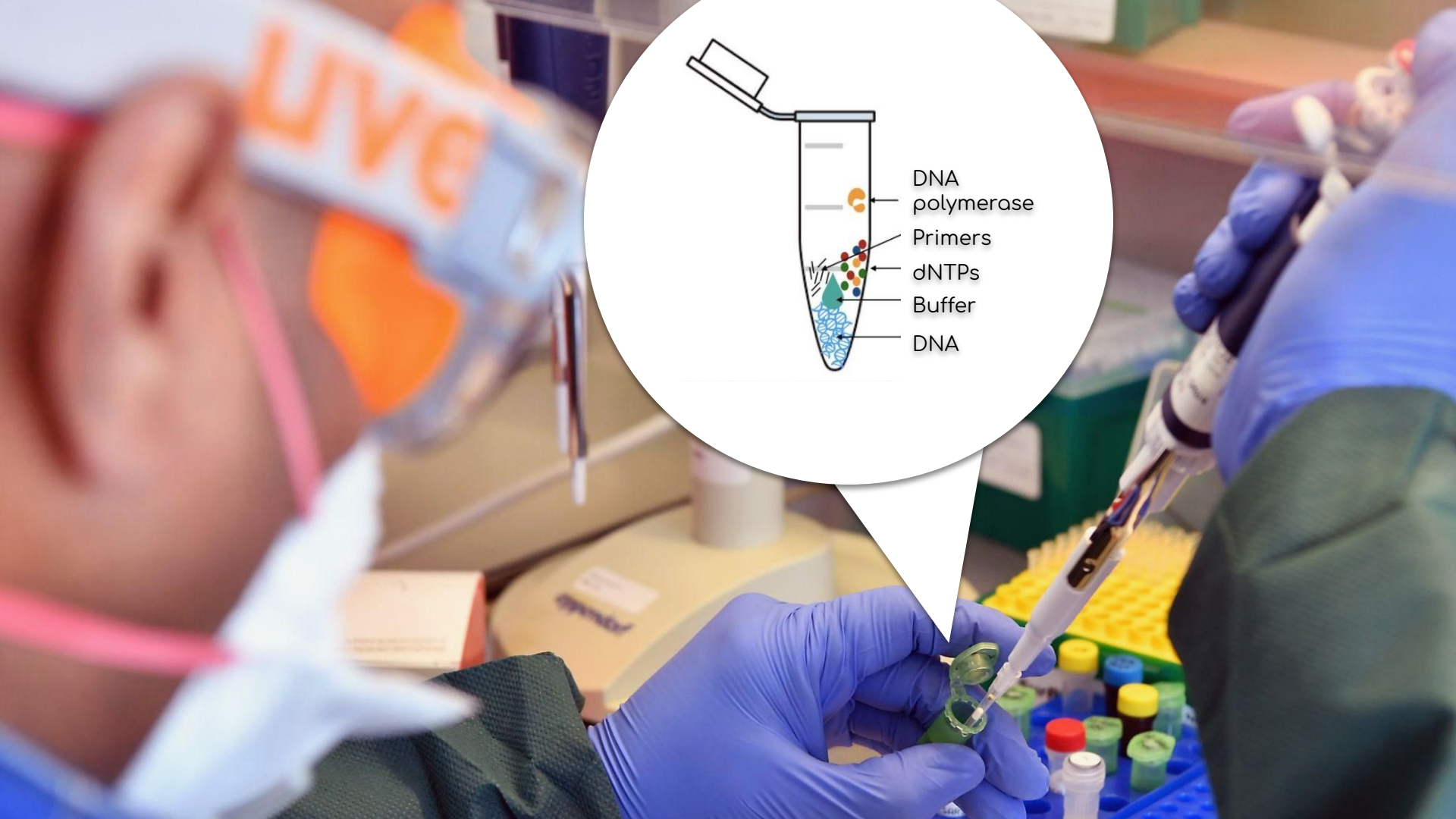
Freedom to operate landscape



1% registered in the global South

Data: lens.org
99% have rights in fewer than 20 countries

PCR


DNA
polymerase
Primers
dNTPs
Buffer
DNA

One problem to address: supply chain for reagents

Export of laboratory reagents (HS 3822) in 2018

Image: Atlas of Economic Complexity https://atlas.cid.harvard.edu/

One problem to address: supply chain for reagents

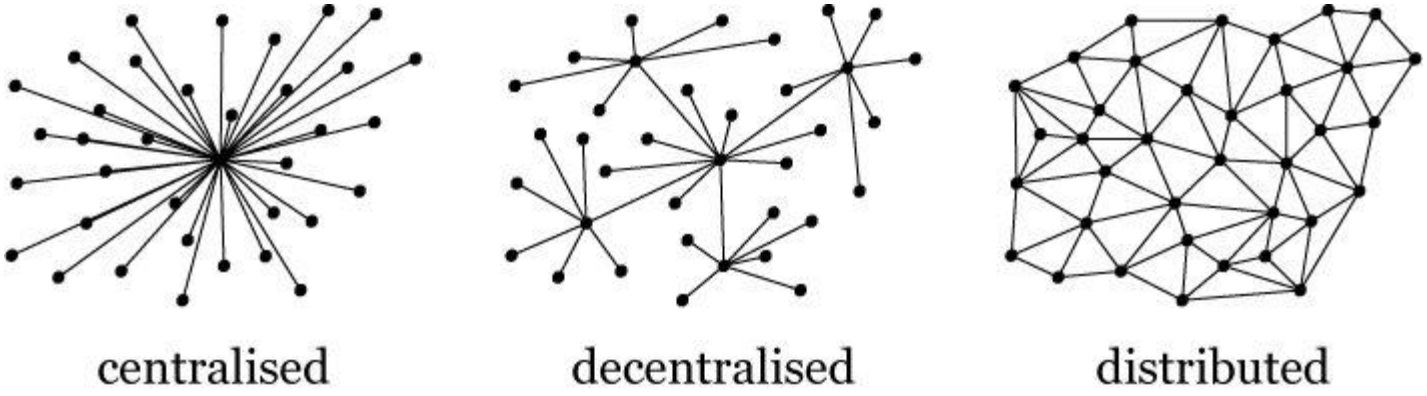
time to delivery

Export of laboratory reagents (HS 3822) in 2018

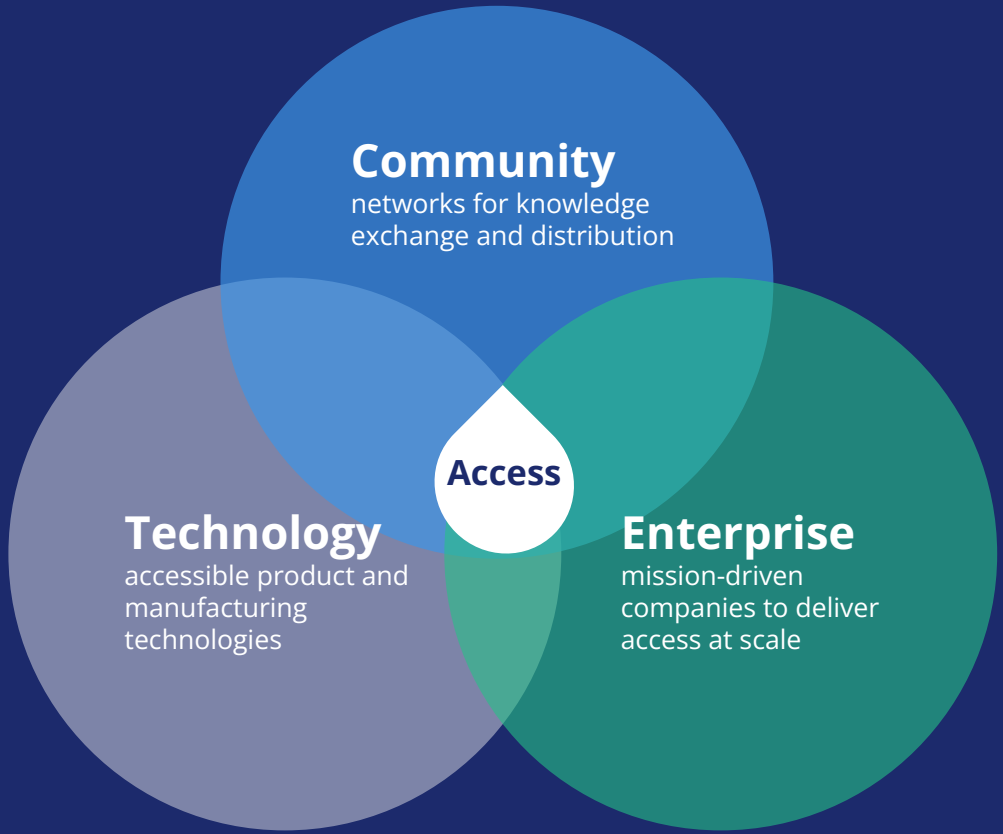
Image: Atlas of Economic Complexity https://atlas.cid.harvard.edu/

“The gap in terms of research, research output, access to tools like enzymes and equipment couldn’t be wider.”

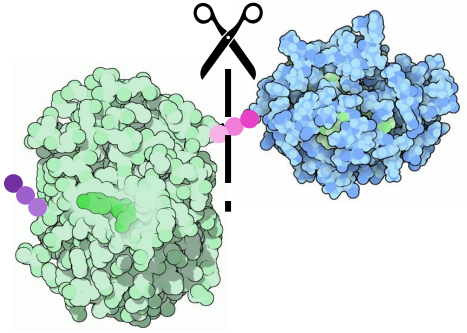
Lenshina Agbor
PhD Candidate
Newcastle University



Goal: increasing resilience and autonomy through a distributed supply chain


Community
networks for knowledge exchange and distribution
Access
Technology
accessible product and manufacturing technologies
Enterprise
mission-driven companies to deliver access at scale

Open Enzyme Collection



Promoter	Tag	Reporter	Cleave	CDS	Terminator
	His Silica Cellulose	Chromoproteins Fluorescent proteins Enzymatic	Inteins TEV SUMO	Polymerases Ligases Reverse Transcriptases	
	10	**31**	**5**	**>60**	

Designed by

OPEN BIOECONOMY LAB

& many collaborators!

Synthesised by

FREE GENES

Distributed under

Open MTA

Funded by

SHUTTLEWORTH FOUNDATION

EPSRC Engineering and Physical Sciences Research Council

BBSRC

Reclone.org

a global collaboration for
equitable access to biotechnology

Type	Examples
6 Promoters	pDawn: light inducible
	cI857_PL/PR: heat inducible
8 Affinity Tags	R5: silica binding
	CipA: cellulose binding
2 Reporters	fuGFP: green fluorescence
	AmilCP: blue chromoprotein
4 Cleavage	TEV site: TEV protease
	HutMCM2aa: salt-cleaved intein
3 Terminators	TZ: Strong triple terminator
	T7term: late T7 terminator
20 Coding Seq	OpenVent, Bst-LF, HIV-RT, MMLV-RT, RNaseH, TEV Protease, HRP, T7 RNA Polymerase, Bsu, gp32, UvsX, UvsY, PBCV-1ligase.

Impact

The Research in Diagnostics Collection is made available under an Open Material Transfer Agreement (which allows commerical use) and via Free Genes at no cost. It is now in **185 labs in 41 countries**, enabling research in diagnostics despite supply chain disruptions. Examples include:

Joint research into LAMP and RPA for SARS-CoV-2 diagnostics in Chile and Peru.

Lowering the cost of ViralALERT, an assay that was a finalist in the X Prize for Rapid COVID Testing.

Underpinning development of BioENGINE, a UK-Africa synthetic biology and diagnostics course

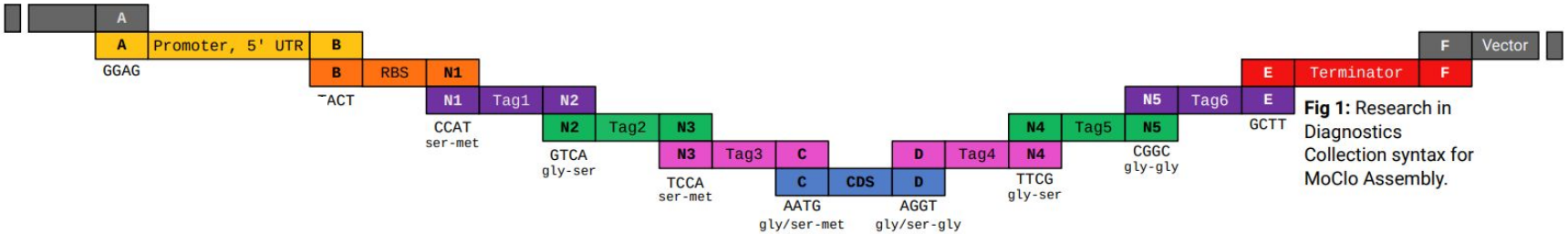
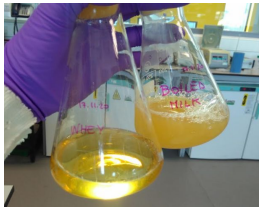
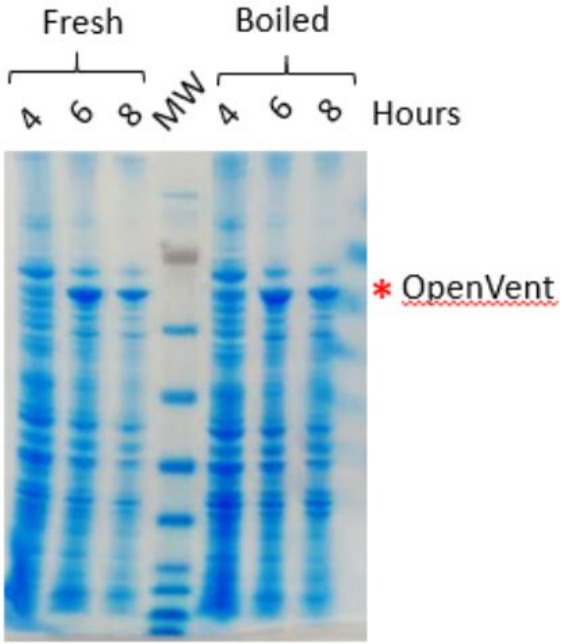


Fig 1: Research in Diagnostics Collection syntax for MoClo Assembly.

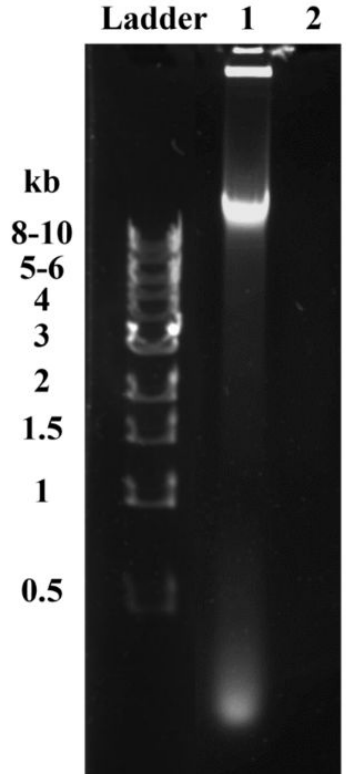
Autoinduction using milk



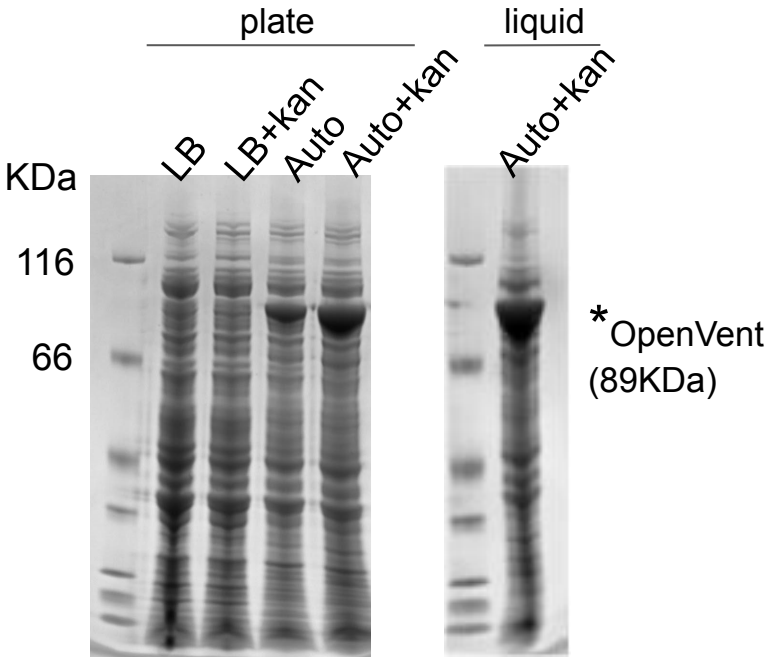


Autolysis

Autohydrolysis (light-inducible)

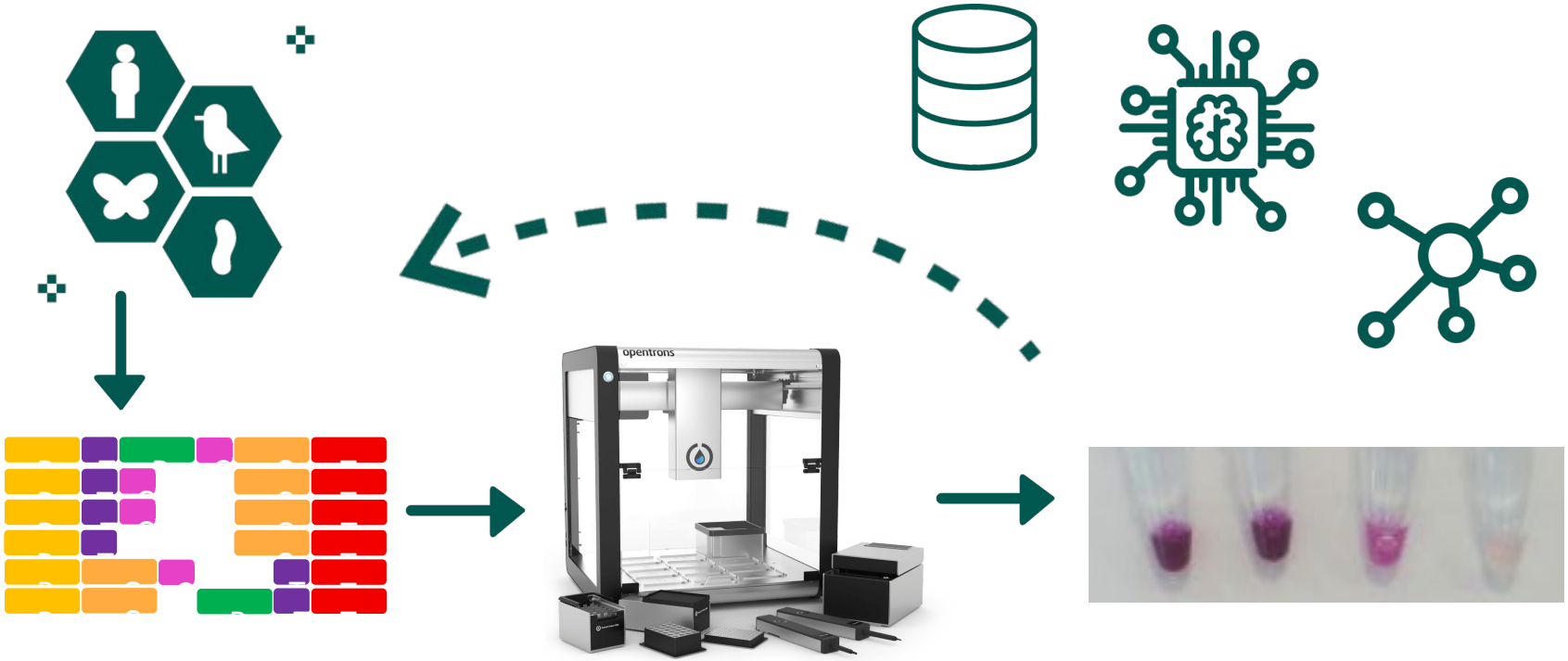


Protein expression analysis - SDS-PAGE



1 plate = 1000s PCR Reactions

Hyperlocal discovery, innovation, manufacturing
Bridging the digital-physical interface for bio-collaboration

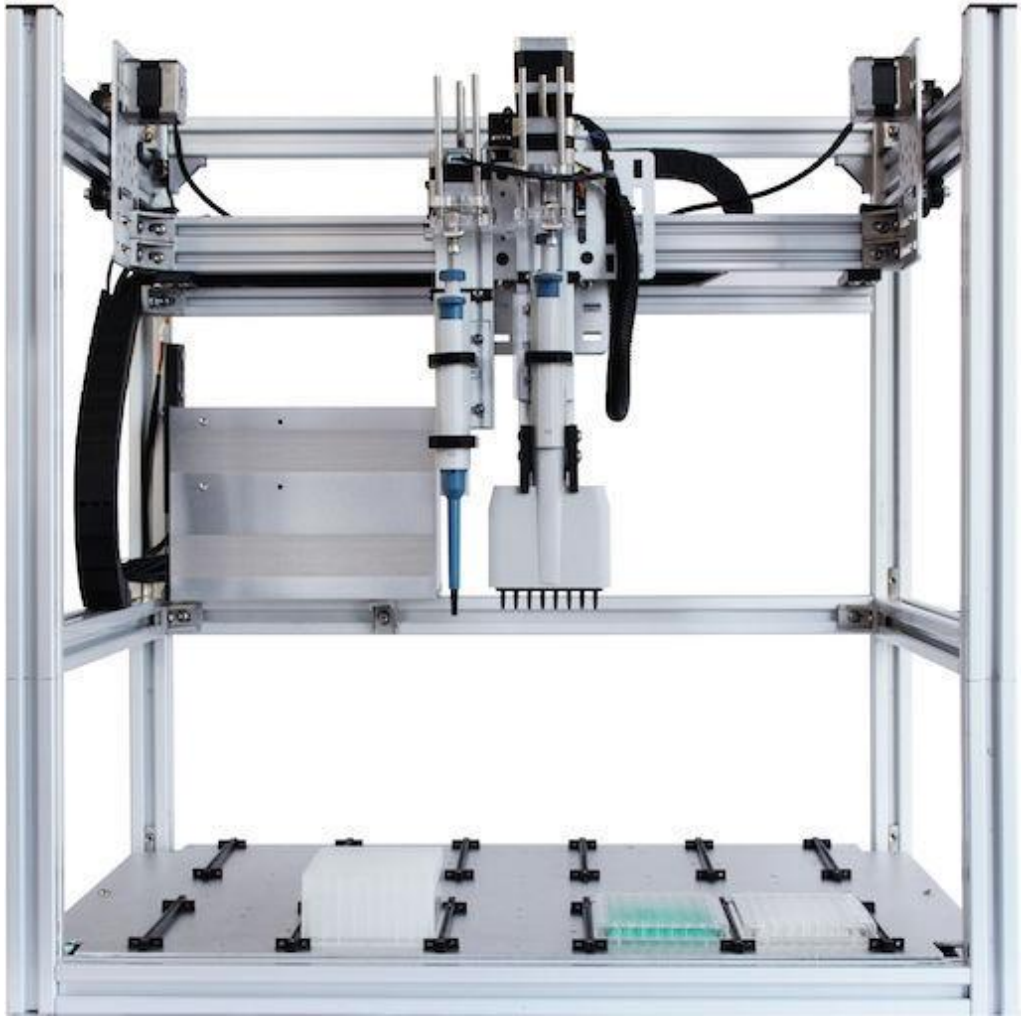


CASE STUDY **2**

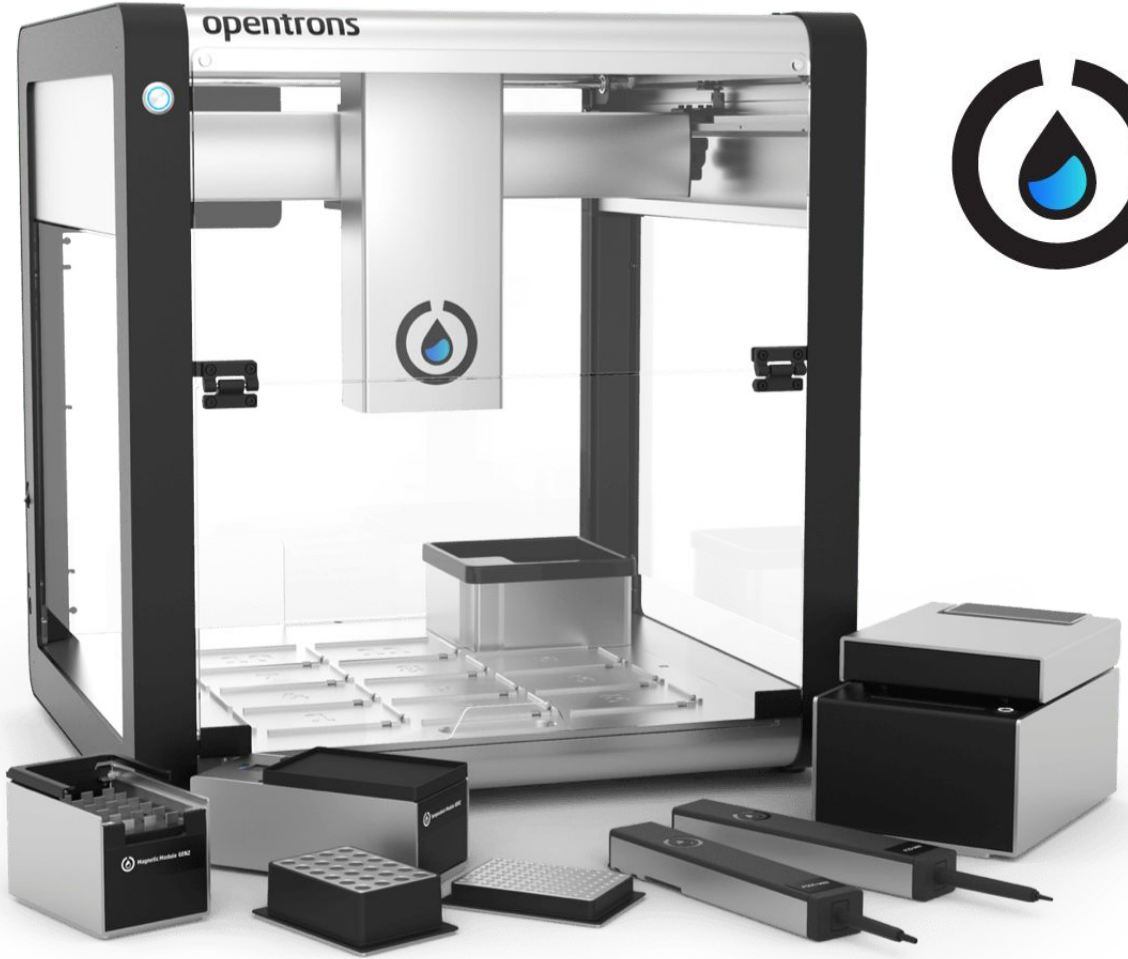
Automation with

OpenTrons

Increasing supply options



opentrons



opentrons

Opentrons

Lab robots for Biologists

Brooklyn, NYC https://opentrons.com info@opentrons.com Verified

Overview Repositories 62 Packages People 9 Projects

Pinned

opentrons Public

Software for writing protocols and running them on the Opentrons OT-2

TypeScript 235 121

ot2 Public

Open source hardware documentation for the OT-2 liquid handling robot

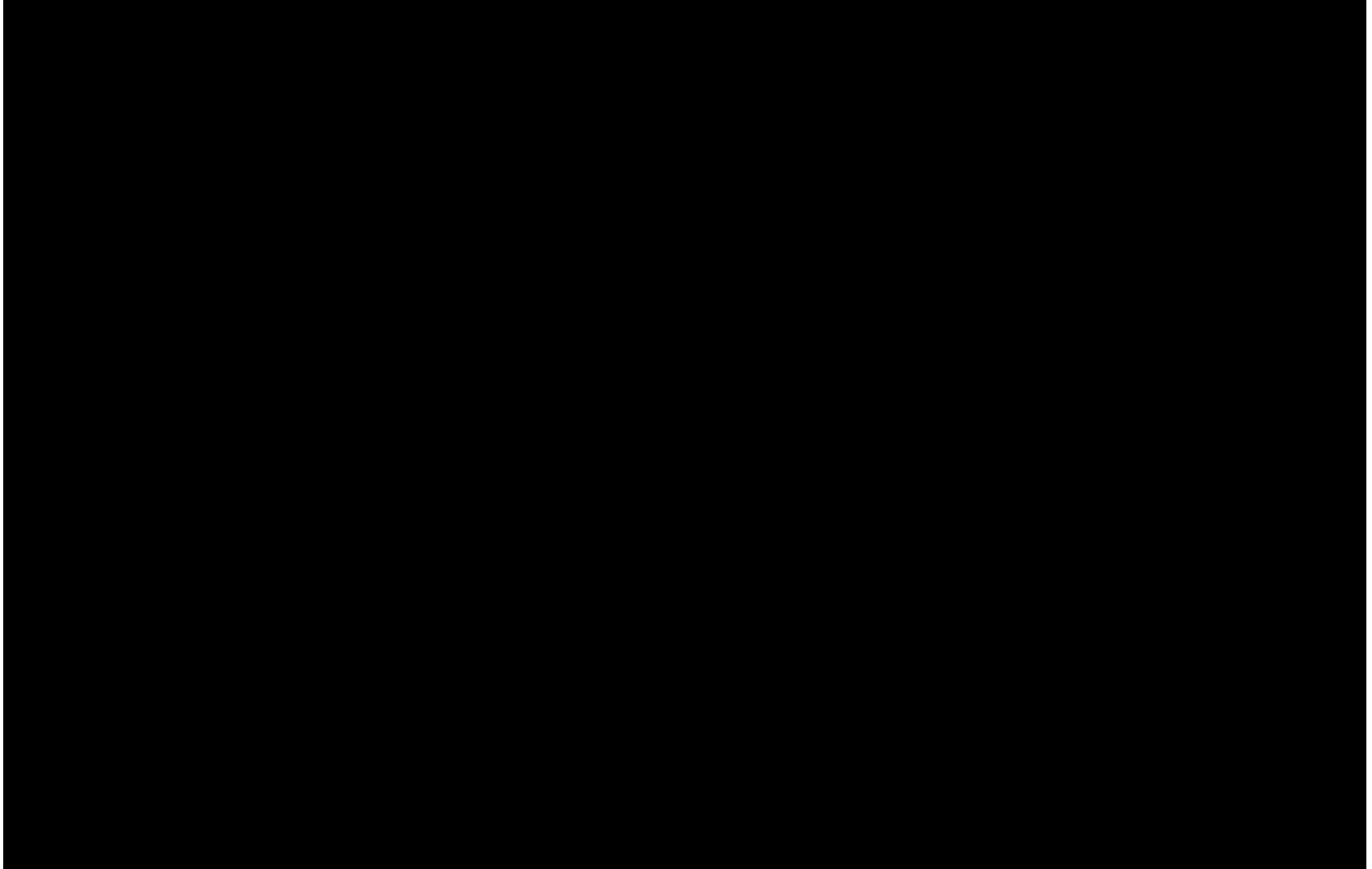
33 12

SmoothiewareOT Public

Forked from Smoothieware/Smoothieware

Opentrons' fork of the modular, opensource, high performance G-code interpreter and CNC controller written in Object-Oriented C++

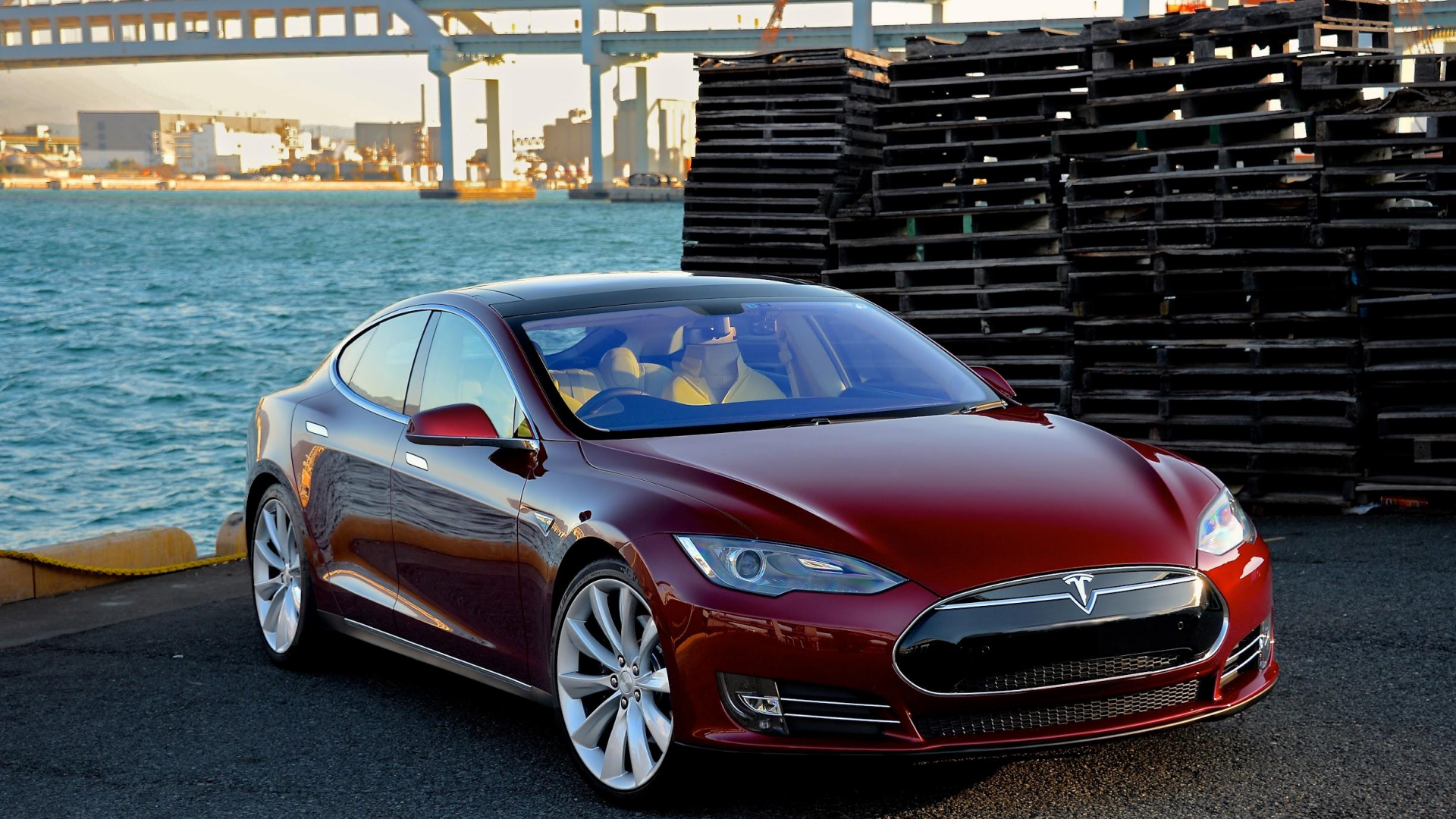
C++ 5 5



MedTech

Lab platform Opentrons closes $200M series C to build out robotics, diagnostics, cell engineering services

by Andrea Park | Sep 23, 2021 10:10am



Since 2004 the SGC has operated an Open Science approach to research for the purposes of furthering research into human disease and drug development

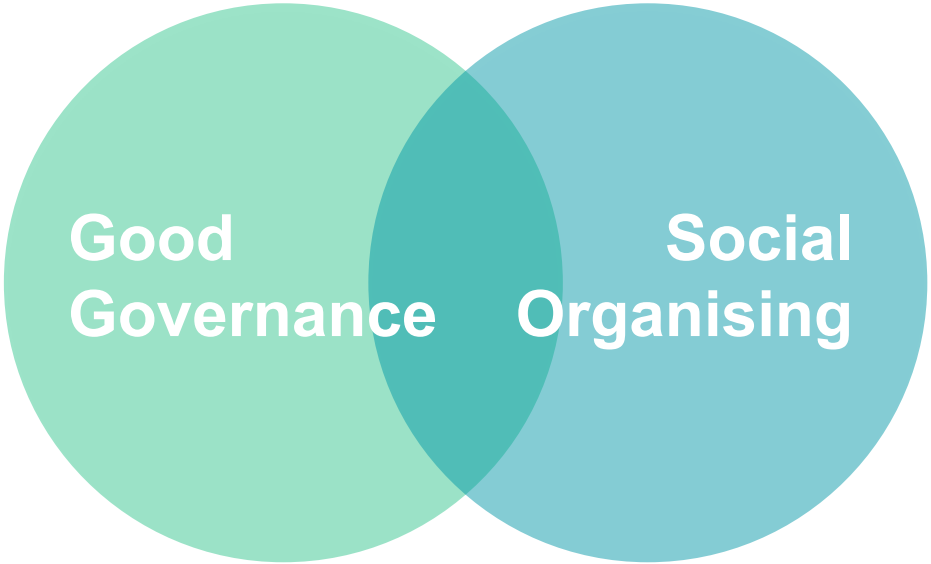
We work globally with academics and industry on early stage drug discovery with a zero patent policy allowing swift collaborations to be established.

How can we as researchers increase opportunities for technologies to generate positive impacts within health systems?

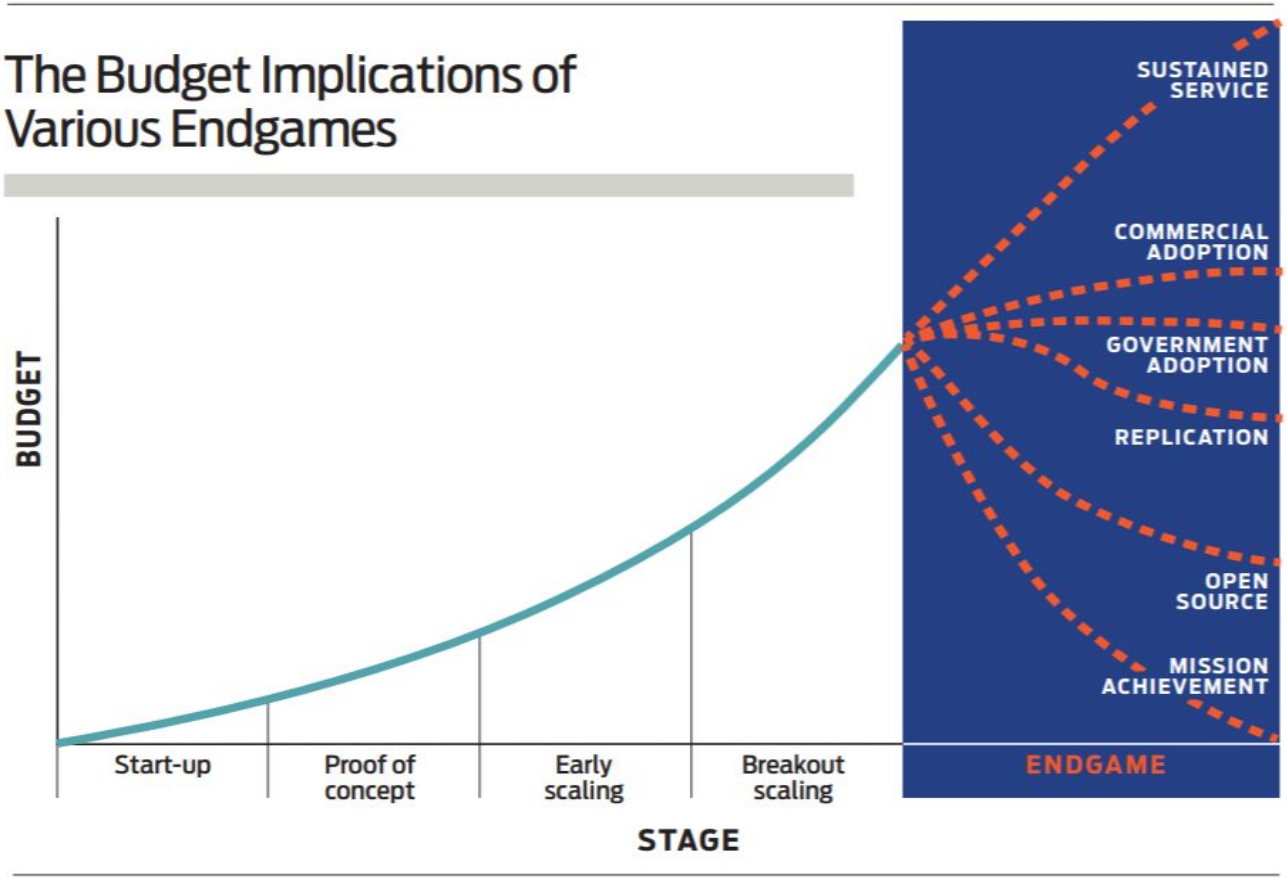
Taking Pragmatic Action

Technology

- Co-creation with end users - we have heard a lot about this today
- Think about quality and regulations early (early) on in your tech development
- The technology probably won’t be the hardest part.



Impact in the world



Gugelev, Alice, and Andrew Stern. "What's your Endgame." *Stanford Social Innovation Review* 13.1 (2015): 40-47.

Exciting experiments are underway

MOLOGIC
BIG IN TINY SCIENCE

global access diagnostics

SEDF
Soros Economic Development Fund

BILL & MELINDA GATES foundation

Global Access Health (GAH) is a social enterprise that will seek to expand access to affordable state-of-the-art medical technology through decentralized research, development, and manufacturing in and for the Global South.

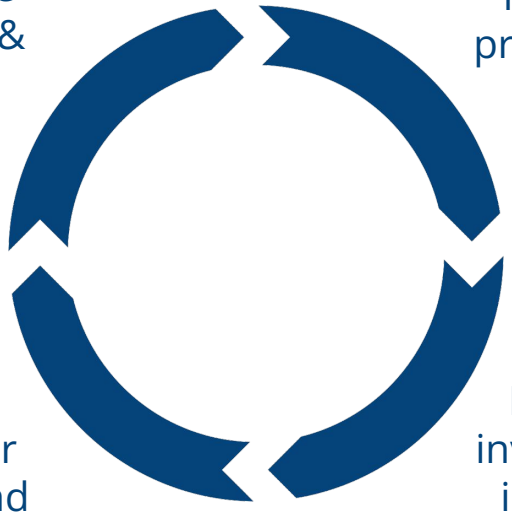
Replication

Use our distributed manufacturing platform to catalyse a ***virtuous cycle***

BENEFICIAL.BIO

initial catalyst

Affordable, Accessible Reagents & Support



catalyses

Increased research productivity

catalyses

Increased investment & innovation activity

catalyses

Increased demand for reagents and support

enables further investment

Policy Engagement

World Health Organization

COVID Technology Access Pool

TECH ACCESS PARTNERSHIP

medicines patent pool

OPEN COVID PLEDGE

ACTaccelerator
ACCESS TO COVID-19 TOOLS

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Shuttleworth Fellow, University of Cambridge

Beneficial Bio | Gathering for Open Science Hardware | WEF Global Future Council on Synthetic Biology

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