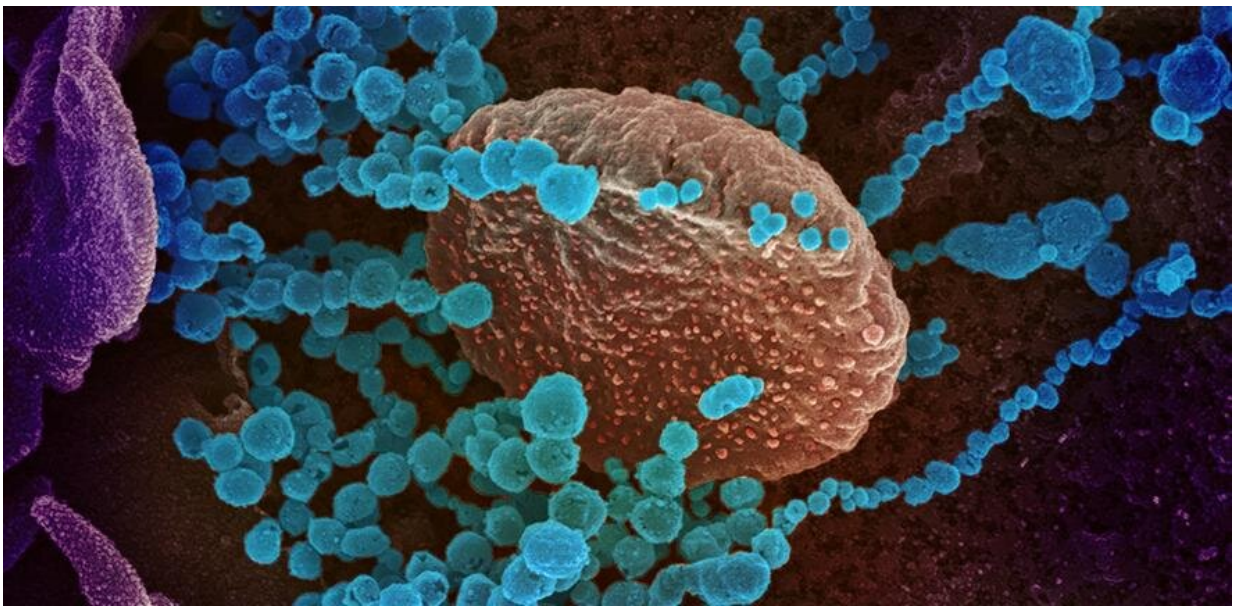
Open-source toolkit helps developing countries meet demand for COVID-19 research and diagnostics

December 8 2020, by Eleanor Hall



Novel Coronavirus SARS-CoV-2. Credit: NIAID

Researchers have developed a free, open-source toolkit that allows laboratories in developing countries to produce their own tools for COVID-19 research and diagnosis, without relying on an increasingly fractured global supply chain.

High demand for millions of COVID-19 tests per day combined with a

disrupted global supply chain has left many countries facing diagnostic shortages. In a recent *Nature* commentary, John Nkengasong, Director of the Africa Centres for Disease Control and Prevention, said, "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."

Scientists across the world are therefore developing new tests that are faster, cheaper, adapted to needs of local health systems and easy to manufacture in order to overcome this challenge.

To enable scientists to access the research tools they need for their work, researchers from the Open Bioeconomy Lab at the University of Cambridge, the Lab de Tecnología Libre at iBio/PUC Chile and the FreeGenes Project at Stanford University teamed up with synthetic biology company Ginkgo Bioworks to design an open source toolkit that enables researchers to produce 16 of the most useful enzymes for a number of diagnostic techniques used to detect SARS-CoV-2, the virus which causes COVID-19.

"Designing the collections was a great collaborative effort between researchers with diverse expertise and different local needs for fighting the pandemic," said Dr. Chiara Gandini from Cambridge's Department of Chemical Engineering and Biotechnology. "We designed it with other biologists in mind, making it as easy as possible for them to reconfigure the toolkit for their requirements."

The 'Molecular Diagnostic Toolkit' comprises ready-to-use DNA to produce enzymes including DNA polymerases and reverse transcriptases—the enzymes used in gold standard RT-qPCR tests. These enzymes are also useful for tests like LAMP, which is faster and simpler than RT-qPCR and is rapidly being adopted by more labs. Control DNA is also included in the toolkit to validate that tests will specifically detect

SARS-CoV-2 but not closely related viruses.

The Molecular Diagnostic Toolkit uses standard laboratory techniques to produce and purify the enzymes, but many researchers in the Global South work under challenging resource constraints and may need to adapt their work to the local availability of materials. They can therefore make use of the 'E. coli Protein Expression Toolkit': a collection of over 100 DNA parts that can be assembled in thousands of combinations to tailor the whole production process. For example, modules are included to bind enzymes to cellulose to develop paper-based tests or to activate enzyme production in cells using light from LEDs instead of expensive chemicals.

The toolkit has been pre-ordered by over 34 labs from 16 countries, including Brazil, Chile, Peru, Colombia, Costa Rica, Mexico, Cameroon, Ethiopia, India and Vietnam.

"Having access to this palette of molecular tools is crucial for our region to fight any reagent supply shortages in the short-term, and to leverage technological autonomy in diagnostics and viral monitoring in the long term," said Tamara Matute from the Pontificia Universidad Católica de Chile and iBio, who participated in the design of the collection. Matute's colleague Isaac Núñez added that mechanisms like the open online community, Reclone Network, are also needed to enhance the usefulness of the collection through peer support including fostering "a collaborative community, crowd-sourced protocols and openly-shared resources."

While the initial focus of the toolkit is to support research and development, the same DNA could be used to manufacture diagnostic kits with the correct processes and regulatory approvals in place. As it is open source, any company or institution is able to produce and commercialize enzymes from the toolkit. For example, LAMP enzymes

will be manufactured at the Ethiopian Biotechnology Institute in a collaboration with the University of Cambridge supported by the Cambridge-Africa Alborada Fund.

Dr. Brook Esseye of the EBTi LAMP Initiative said, "this initiative will enhance local capacity for bio-manufacturing and strengthen partnerships among researchers in various countries so we can join hands to fight this global pandemic."

Looking beyond COVID-19, local bio-manufacturing capacity could underpin other advances in biotechnology research, education and innovation.

"A resilient local supply chain for diagnostics is vital to future health security and pandemic preparedness," said Dr. Jenny Molloy, Shuttleworth Fellow at Cambridge's Department of Chemical Engineering and Biotechnology. "The same enzymes used to detect COVID-19 can also detect malaria, typhoid and many other diseases. They can be applied in lots of other ways to make positive social and economic impact, including research to breed better crops, measuring the effect of conservation initiatives on biodiversity and tracking antibiotic resistance. This flexibility is why it is so important that key tools for biotechnology are accessible, used and useful for all researchers around the world."

The toolkit has been made freely available under the Open Material Transfer Agreement (OpenMTA), which gives explicit permission for recipients to distribute to other labs and to use the toolkit for commercial purposes, and can be ordered online via Stanford University's Free Genes project.

Researchers and users of the toolkit are invited to share protocols, resources and advice via the Reclone Forum.

More information: John Nkengasong. Let Africa into the market for COVID-19 diagnostics, *Nature* (2020). DOI: 10.1038/d41586-020-01265-0