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Pathogen Molecular Detection Platform

Accurate detection and diagnosis of infectious diseases is paramount to appropriate treatment and better outcomes. Despite tremendous efforts to advance new diagnostic techniques, there are still critical gaps in the healthcare system in quickly diagnosing and responding to infectious diseases. Current diagnostic technologies identify pathogens by detecting nucleic acids or antibody proteins produced by the immune system. However, these technologies require healthcare settings with basic equipment, electricity and a skilled technician, which are difficult to achieve in remote settings. Additionally, the temperature needs of nucleic acid interactions, costs associated with synthesizing modified nucleic acids, and the limited number of reliable low-cost readout methods further hampers quick and low-cost point-of-care (POC) diagnostics.

Researchers at the Biodesign Institute of Arizona State University have developed a novel suite of technologies for rapid and efficient pathogen detection. These paper-based tests use embedded and programmable biomolecular computing components to eliminate the need for outside intervention or additional information processing for use in a variety of low-instrument settings such as homes and non-hospital clinics. These biomolecular components are instrumental to reducing false negatives, increasing assay specificity and sensitivity and more importantly allowing this platform to transition to use in broader and more diverse care settings. These technologies have also been adapted for detecting mutations in circulating cell-free DNA in blood for assessing cancer risk.

This suite of technologies comprises novel riboregulators, artificial translational repressors, riboswitches, upstream enhancement RNAs, and aptamer-based sensors that come together to create a powerful POC platform for detection of pathogen analytes in a simple, low-cost and rapid manner.

Potential Applications

- Pathogen detection

o Viral, bacterial, parasitic organism diagnostics (Zika, Ebola, Dengue, Chikungunya, Coronaviruses, etc.)

o Detecting antibiotic resistance

o Pathogen surveillance

- Cancer detection, surveillance and management

Benefits and Advantages

- Low-cost paper-based diagnostics
- Test results require reduced outside intervention or additional information processing
- Single-nucleotide polymorphism (SNP) sensitivity
- Ultralow leakage/off state signal levels
- Activation of gene expression well over 100-fold
- Repression of gene expression by well over 50-fold (98% repression)
- Can detect nearly arbitrary RNA sequences
- Upstream enhancement RNAs can modulate transcript stability with minimal influence on translation initiation
- Riboregulators can turn off gene expression in response to a target RNA

o Preserves energy bandwidth of cell-free reactions

o Provides wide dynamic range in diagnostic tests

- Cell-free reactions can be at room temperature - ideal for at-home coronavirus testing
- SARS-CoV-2 is detectable at a concentration as low as 0.5 attoMolar in as little as 2.5 hours with either colorimetric or fluorometric detection
- The tests can be stably stored at room temperature with simple reactivation in water

For more information about this opportunity, please see

Pardee et al - Cell 2016

Green et al - Nature 2017

Kim et al - bioRxiv 2018

For more information about the inventor(s) and their research, please see

Dr. Green's departmental webpage

Dr. Yan's departmental webpage