Cell-free Synthetic Biology for Pharmaceutical Applications

Over the past two decades applying engineering principles to biological systems has shaped the field of synthetic biology and led to breakthroughs that have improved our society in areas such as human health, agriculture, and industry. One key technology in the field is use of cell-free protein synthesis (CFPS) that has opened up new opportunities for point of care diagnostics[1–3], on-site therapeutic[4] and vaccine manufacturing[5]. Cell-free systems are biosafe, cost effective and shelf stable which makes them an ideal technology for portable "bio-makers" in the field. During the course of my PhD, I used bacterial CFPS to improve the accessibility of molecular diagnostics at the point of care[6–8]. I developed direct material interfaces with cell-free systems (e.g. electrodes[6] and nanoparticles) to enhance field deployable molecular detection of antibiotic resistance genes[4] and infectious disease (data to be published). Now during my postdoc, I am using CFPS as a platform to enhance discovery throughput and de-novo engineering of protein therapeutics as well as manufacturing the biological tools (enzymes) required for producing mRNA vaccines in remote areas. Moving forward, I am excited about cell-free systems and the potential it holds to make significant impact on human health and modern medicine.

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References

1. Pardee, K. *et al.* Paper-based synthetic gene networks. *Cell* **159**, 940–954 (2014).
2. Pardee, Pardee, Keith, Alexander A Green, Melissa K Takahashi, David H O Connor, Lee Gehrke, James J Collins, Keith Pardee, et al. Rapid , Low-Cost Detection of Zika Virus Using Programmable Biomolecular Components. *Cell* **165**, 1255–1266 (2016).
3. Karlikow, M. *et al.* Field validation of the performance of paper-based tests for the detection of the Zika and chikungunya viruses in serum samples. *Nat. Biomed. Eng.* **6**, 246–256 (2022).
4. Pardee, K. *et al.* Portable, On-Demand Biomolecular Manufacturing. *Cell* **167**, 248-259.e12 (2016).
5. Stark, J. C. *et al.* On-demand biomanufacturing of protective conjugate vaccines. *Sci. Adv.* **7**, (2021).
6. Sadat Mousavi, P. *et al.* A multiplexed, electrochemical interface for gene-circuit-based sensors. *Nat. Chem.* (2019). doi:10.1038/s41557-019-0366-y
7. Carr, A. R. *et al.* Toward Mail-in-Sensors for SARS-CoV-2 Detection: Interfacing Gel Switch Resonators with Cell-Free Toehold Switches. *ACS Sensors* **7**, 806–815 (2022).
8. Amalfitano, E. *et al.* A glucose meter interface for point-of-care gene circuit-based diagnostics. *Nat. Commun.* **12**, 1–10 (2021).