

## Development of Paper Based Cell Free Biosensors for the Detection of Controlled Substances

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Opioids are a class of drug highly valued for their potent analgesic properties; however, they are also highly addictive and cause severe side effects, including death as a result of respiratory depression. The Centers for Disease Control and Prevention estimates that 130 Americans die daily from opioid overdoses and that the number of opioid overdose deaths in 2017 represents a six-fold increase compared to 1999. These overdoses include the misuse of both legal and illicit drugs, such as heroin. Thus, simple, rapid and affordable methods for the detection of illicit and legal drugs in patient samples are required. Toward this need, in this project, we will develop paper-based biosensors for the detection of heroin in patient blood samples using cell free protein expression technology. In particular, heroin (and its degradation products) will be detected by a luminescence sensor motif consisting of three coupled enzymes which transform heroin (or its degradation products) into a chemiluminescent signal [1-3]. This sensor motif will be expressed on demand on a paper based sensor. Detection will be based upon the difference between sample and control spots using an iPhone/iOS13 application under development in the lab. The performance of the sensor will be optimized using a combination of mathematical modeling and quantitative physiology techniques.

Taken together, this project offers students training in synthetic biology and quantitative physiology techniques in combination with computational modeling and analysis.

1. Rathbone et al. (1996) "The use of a novel recombinant heroin esterase in the development of an illicit drugs biosensor." *Ann NY Acad Sci.* 12;799:90-6.
2. Gandhi, Sonu et al. (2015) "Recent advances in immunosensor for narcotic drug detection." *BioImpacts : BI* vol. 5,4 (2015): 207-13. doi:10.15171/bi.2015.30
3. Singh, Smritee et al. (2018) "Chemiluminescence based immunoassay for the detection of heroin and its metabolites." *BioImpacts : BI* vol. 8,1 (2018): 53-58. doi: 10.15171/bi.2018.07