B181 Light It Up: Fluorescent Biosensors for the Detection of Biological Fluids and Fingerprints

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After attending this presentation, attendees will better understand biosensing technology and its potential for application toward the simultaneous detection and identification of biological fluids as a replacement for traditional serological testing. Attendees will also be aware of how this approach can be extended to other forensically relevant targets, including fingerprints.

This presentation will impact the forensic science community by introducing new techniques that are able to offer the rapid, non-destructive, and highly specific multiplex analysis of biological fluids at crime scenes. It is hoped that this presentation will also encourage researchers to utilize biosensor technology for the detection of other forensic analytes in their relative fields of expertise.

The search for body fluids often forms a crucial element of many forensic investigations. Confirming fluid presence at a scene can not only support or refute the circumstantial claims of a victim, suspect, or witness, but may additionally provide a valuable source of DNA for further identification purposes; however, current biological fluid testing techniques are impaired by a number of well-characterized limitations: (1) they often give false positives (between fluids and other non-fluid substances); (2) they cannot be used simultaneously; (3) they are sample destructive; and, (4) they lack the ability to visually locate fluid depositions.[1] These disadvantages can negatively affect the outcome of a case through missed or misinterpreted evidence.[2,3]

Recent improvements in fluid assay specificity have utilized immunological testing strips for the detection of fluid-endogenous protein biomarkers; however, these testing processes do not allow for the retention of fluids following application, potentially sacrificing the opportunity for genetic profiling.4,[5] The direct detection of these proteomic markers without the removal and possible destruction of fluids may be achieved through "biosensing," in which biological interactions are transduced into observable signal outputs within the same molecular unit. High specificities make both antibody- and enzymatic-sensing elements ideal candidates for fluid analysis, while changes in fluorescence intensity upon target interaction may allow the visualization of *in situ* fluid depositions. Furthermore, the simultaneous detection of multiple fluid analytes may potentially be achieved by exploiting fluorophores of differing wavelengths in a single multiplex assay.

This study utilized two biosensing mechanisms toward the detection of biological evidence. Two fluorogenic peptide substratesreagents specific to Prostate Specific Antigen (PSA) and Kalikrein 8 (KLK8) were first utilized for the detection of human semen and sweat, respectively. Both substrates were able to successfully detect targets across a range of surfaces typical to forensic investigation with additional visualization via a direct spraying application. Substrates exhibited ideal increases in fluorescence intensity upon target interaction, even at 1:1,000 fluid dilutions, providing an opportunity for their use in contaminated deposits or those washed in removal attempts. Furthermore, promising results were displayed in the design and development of a customized displacement immunosensor specific to human semen, which was able to identify nM amounts of PSA within solution. Importantly, both sensing mechanisms explored were found to have no effect on DNA profiling processes after application to biological fluids, allowing the source of depositions to be identified without potential destruction of genetic material.

Displaying immediate and specific response to analyte presence, biosensors have the potential to prevent month-long visual evidence searches by localizing fluid depositions within a matter of seconds. Successful sensor employment is likely to lead to a significant reduction in the labor expense associated with current manual stain search and identification strategies.

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