A55 Rapid and Direct CODIS STR Screening Using Short Microchip Capillary Electrophoresis

Maurice J. Aboud, MS, FL International University, 11200 Southwest 8th Street, Chemistry & Biochemistry CP304, Miami, FL 33199*

After attending this presentation, attendees will understand the development of a fast and portable DNA screening method that uses microchip electrophoresis for the rapid detection of a set of seven CODIS STR markers. They will gain an understanding of how this system works, the limitations of the system, and how these limitations were surmounted to achieve the desired resolution and capability to genotype on the microfluidic chip.

This presentation will impact the forensic science community by addressing the problems and limitations encountered with the current commercial microfluidic systems for DNA separation, such as poor resolution, and provide a useful tool for quick CODIS screening of DNA samples.

There are situations in which it is very important to quickly and positively identify an individual. Examples include suspects detained in the neighborhood of a bombing or terrorist incident, individuals detained attempting to enter or leave the country, and victims of mass disasters. Systems utilized for these purposes must be fast, portable, and easy to maintain. Current DNA typing methods provide the best biometric information yielding identity, kinship and geographical origin, but they are not portable. Currently DNA typing is performed by large-scale sequencers using multichannel fluorescent capillary array electrophoresis. Complex robotic extraction and PCR processing creates economies of scale and time, permitting large numbers of samples to be efficiently processed. Unfortunately this process is not flexible enough for many applications in the field and is not quick on a per sample basis.

The proposed alternative, microfluidic DNA typing, holds great promise but constraints on resolution and problems with coupling inline extraction, inline PCR, and multicapillary analysis make these systems highly complex. These systems require complicated integration of engineered components making them highly vulnerable to clogging, misalignment, and voltage leakage. The issues with large-scale integration of extraction, amplification, and DNA electrophoresis also make these systems less than portable. While there is no doubt that the technological issues may someday be solved, there are alternative modular approaches to perform this task that do not require extensive engineering and do not require complete system integration. Such modular systems are easily repaired in the field and can be quickly switched if problems occur. Furthermore, new advances in the field of DNA typing involving direct PCR make it possible to eliminate complex extraction steps and simply amplify DNA directly from a paper punch. This has the potential to greatly simplify analysis. Other advances such as commercially available high speed PCR and disposable short channel microchips provide off the shelf solutions to the problem of portable high-speed DNA detection. This approach is simple and does not require major engineering or retooling of equipment.

This project was designed to optimize and combine off the shelf components (direct PCR, high speed thermal cycling, and short channel microfluidics) to produce a high-speed genotyping system. In this project, we are utilizing known biological principles to accelerate the amplification rate of direct PCR and couple this fast amplification to a beta version of an Agilent 2100 Bioanalyzer that has been upgraded to permit ssDNA typing. The microfluidic chip separation channel is 1.5cm, placing unique restraints on resolution and sizing that have been solved using a specialized polymer matrix and multichannel fluorescence detection. Per sample run times are 80 seconds and fast and direct PCR was utilized to minimize sample-processing times. The efforts of this study demonstrate a simple, highly portable DNA typing procedure that should prove valuable for applications involving a need for a robust and rapid analysis.

Microchip, DNA Screening, CODIS Markers

 ** Presenting Author*