Integrated Forensic Genetics Using Next Generation Sequencing By Synthesis (SBS)

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With the advent of next-generation sequencing (NGS), the spectrum of known human genomic variation has expanded at an unprecedented rate and is resetting the amount and type of information available to investigative genetics. To-date, the vast majority of sequence data generated globally has been done utilizing Illumina sequencing by synthesis (SBS) technology. In application to forensic biology, SBS has the potential to deliver a “universal" forensic DNA panel that addresses multiple disciplines simultaneously, including criminal casework and databank, parentage testing (mass disaster, missing persons), ancestry studies, phenotyping, death investigation and metagenomics. Practical implementation of SBS in a forensic setting is enabled by the MiSeq system, which simplifies and automates the NGS process in a single system.

Results have demonstrated the potential of NGS to be used as a multipurpose genotyping platform. Studies of saliva samples have shown that autosomal STR genotypes plus their internal SNPs, Y and mtDNA haplotypes (SNPs and STRs), ancestry information, predictive visible traits as well as metagenomic data, which may serve as investigative leads, can be done in a single sequencing run. Additional markers under development include a denser set of forensically relevant SNPs and STRs on autosomes, X and Y chromosomes, and in the mitochondrial genome as well as those that are useful in molecular autopsy.

Increased discrimination power from dense, high value forensic sequencing data allows interpretation of more unknown samples that contain partially degraded and/or mixed DNA. Because NGS performs a molecule-by-molecule analysis of the contents of the original sample it is possible to view the number of observations of a given allele, and measure mixture ratios based on a count (digital) vs. a peak height (analog) result. This is expected to dramatically extend capabilities in the analysis of complex samples.

The application of these technologies to forensic analysis will be presented along with data from Illumina internal labs and forensic collaborations.