THE RESEARCH REVOLUTION

SCIENCE AND THE SHAPING OF MODERN LIFE

A VIEWING AND DISCUSSION PROGRAM IN AMERICA'S LIBRARIES

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Session 4 Forensics
Gene Sleuths

When Thomas Jennings reached the end of his rope at the gallows of the Cook County jail in 1912, he became the first murderer to be executed in the United States after a verdict based on fingerprint identification. Seventy-five years later, convicted rapist Daniel Washington became the first prisoner to be exonerated due to DNA matching. Both were milestones in forensics—the validation of biological evidence for legal proceedings.

Fingerprinting and DNA profiling have much in common for identifying individuals, but the former is confined to species with fingers, while the latter is applicable to all living things. Since the mid-1980's, when DNA profiling and matching became widely practicable, it has been used in an enormous range of legal situations—from establishing parentage of babies to authenticating official Super Bowl footballs. Identifying the remains of people killed in the World Trade Center atrocity is the largest DNA fingerprinting project to date.

DNA forensics obviously is a useful tool for establishing individuality. In criminal investigations, the FBI lab can create a genetic profile that has a very high level of accuracy. Every individual has up to several million adenine-thymine or guanine-cytosine base pairs of DNA that are different from all other individuals. These so-called "single nucleotide polymorphisms" or "SNPs" are not necessarily part of genes per se, but are involved in gene functions. This level of identification requires gene expression analysis and genetic sequencing.

An important implication of SNP's in medicine is that no two people ever have exactly the same disease. In multigenic illnesses like cancer, two patients may have the same array of mutated genes, but not the same point mutations that constitute the ultimate origin of the disease. Even in monogenic disorders like Cystic Fibrosis, where seventy percent of sufferers share an identical point mutation, the genomic variation will be unique in each case. This evidence comes from microarray analysis that is likely to become the next tool for forensic sleuthing.

Microarray technology, which enables scientists to compare tens of thousands of genes at once, promises to unlock the genetic roots of diseases and to enhance our ability to treat them. Microarrays rely upon single-stranded DNA sequences. When single-stranded RNA is extracted from cells and applied to a glass slide, the two nucleic acids attach to each other if they have complementary strands. A laser then determines which sequences have joined and the image is scanned to a computer screen. Because RNA tells what cells are doing rather than their inherited potential, the image shows a pattern of complex genetic activity. Microarrays are used, for example, to distinguish different kinds of leukemias and to predict the likelihood that certain malignant tumors will spread, and also targets therapies and predicts the efficacy of treatment and probability of adverse effects. Moreover, the ability to identify disease origins, instead of symptoms, and to address those origins in individuals rather than in the population as a whole, heralds a fundamental transformation of health care.

With fingerprinting, DNA matching, and gene expression analysis have come legal and ethical controversies which must be addressed, and that drag society into the future, ready or not.

Further Reading:

- Beavan, Colin. *Fingerprints: The Origins of Crime Detection and the Murder Case That Launched Forensic Science.* (Hyperion/Little, Brown, 2001)
- Fridell, Ron. *DNA Fingerprinting.* (Watts, 2001)
- Miller, Hugh. *What the Corpse Revealed: Murder and the Science of Forensic Detection.* (St. Martin's Press, 1999)

Online Reading:

Ann Meeker-O'Connell, "How DNA Evidence Works," in Marshall Brain's "How Stuff Works," http://www.howstuffworks.com/dna-evidence6.htm

Human Genome Project, "DNA Forensics," http:///www.ornl.gov/hgmis/elsi/forensics.html

Also search under "DNA Forensics News;" "Cellmark Labs;" "Cold Spring Harbor Laboratory;" and the "National Center for Biotechnology Information."

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