B151 Microscopical Discrimination of Human Head Hairs Sharing a Mitochondrial Haplogroup

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After attending this presentation, attendees will better understand the current state of forensic hair analysis and the benefits a combined microscopic and genetic approach can offer for discrimination of human hair samples. Attendees will appreciate the different forms of information available from microscopy and mitochondrial DNA (mtDNA) analysis and how these can complement each other in a forensic analysis.

This presentation will impact the forensic science community by introducing data from a current inter-laboratory study on the level of discrimination possible by microscopic hair analysis, adding to understanding of the strengths and limitations of microscopic comparisons of hairs and demonstrating the importance of combining microscopic and genetic analyses when evaluating evidential hairs. Previous studies have looked at the degree to which mtDNA can be used to differentiate microscopically similar hairs. This study focuses on hair samples that may not otherwise be discriminated by mtDNA to assess how well microscopy can differentiate hairs that share a mitochondrial haplogroup. This analysis illustrates that microscopy can provide distinguishing information not contained in forensic mtDNA DNA examinations.

Interpreting microscopic assessments of hair necessitates an understanding of the human factors that are involved in these examinations, such as visual perception, experience, and training. The accuracy and reliability of microscopic hair analysis was tested using 20 sets of hair samples from participants who share mtDNA haplogroups. The test sets were created using participants who had been genotyped and the hair samples for each test were then selected based on shared mtDNA haplogroup, ancestry, macroscopic similarity, and length. The tests were assigned random alphanumeric designators and mailed to hair examiners in forensic laboratories across the United States. Additional data was collected regarding the amount of training a forensic hair examiner had, how often hair proficiency tests were taken, years of experience, the types of casework typically received, degree of specialization in trace evidence subfields, and how the examiner characterized ancestry from the hair samples. The level of consensus was assessed between examiners for each test and how "rare" or "common" it was to not be able to differentiate hairs of mtDNA-defined groups by microscopic comparison. This study addresses some of the criticisms by the President's Council of Advisors on Science and Technology (PCAST) of forensic hair analysis and provides data regarding the strengths and limitations of microscopic hair analysis.

It is generally accepted that microscopic analysis of hairs will not provide a level of individualization that allows for identification of a hair to a single person to the exclusion of all others. By choosing sets of hairs from people who share the same mtDNA haplogroup, this study sought to determine how microscopically similar hair samples from these individuals may be and the degree to which microscopy can provide reliable differentiation of these hairs. While nuclear DNA analysis can lead to an individual identification, most evidential hairs are shed without sufficient follicular tissue for such testing, therefore limiting genetic testing of the majority of the hairs found in casework to mtDNA. Furthermore, identification through a destructive DNA analysis without first assessing a hair microscopically can hinder an investigation through the loss of valuable information. This study summarizes the current understanding of the utility of microscopic hair analysis in forensic casework, demonstrates the strengths and limitations of microscopic hair comparisons, and highlights the importance of combining non-destructive and destructive tests, such as microscopy and genetic analyses, to obtain the most information from a piece of evidence.

This study rigorously tested the accuracy and reliability of microscopic hair analysis with the conclusion that microscopy can discriminate greater than 85% of the hairs that mtDNA cannot. Accordingly, microscopic analysis of hairs should be maintained in forensic laboratories because it offers a cost-effective and non-destructive test that serves as the first level of sample discrimination and provides complementary information not available from mtDNA analysis.

Hair, Microscopy, Mitochondrial DNA