

## TES05 - Forensic Hair Examinations

### Scope

This document describes the techniques used as well as the conclusions that can be reached from the microscopic identification and comparison of hairs in the Trace Evidence Unit. In addition, this document outlines the steps taken to submit a hair for subsequent DNA. This procedure applies to hair samples that have been previously removed from evidentiary items and have been mounted on glass microscope slides.

### Safety Precautions

- While working with physical evidence, laboratory personnel will wear appropriate protective attire.
- Universal precautions will be followed.
- No specific hazards are associated with the microscopic examination techniques performed.
- Care should be exercised when using solvents such as xylene or xylene substitute.

### Materials Required

- Comparison microscope, magnification range from 40x to 600x
- Stereobinocular microscope, magnification range from 0.5x to at least 40x
- Permount mounting medium
- Xylene substitute, xyleless or reagent grade xylene
- Glass microscope slides and coverslips
- Kraft paper
- Pillboxes
- Forceps
- Spatula
- Scissors
- Probes

### Standards and Controls

Not applicable.

### Procedure

The microscopic examination of hairs requires the use of low power magnification as well as high power magnification. A stereobinocular microscope can be utilized to screen the glass microscope slides at low magnification and a high quality comparison microscope is necessary to compare the microscopic characteristics of hairs, typically using a magnification range from 35x to 600x. This examination determines if hairs are present, and if so, what type of hair is present.

## 1 Documentation of Hair Evidence

- a. Based on a microscopic examination of the glass microscope slides containing debris recovered from an item (or group of items) of evidence, the presence or absence of hairs can be determined. The absence of hairs may either be documented with a statement such as “no hairs were found”, or, the absence of any reference to hairs on an item implies that no hairs are present.
- b. If animal hairs are present, the species of animal can usually be determined from the hair based on an examination of the microscopic characteristics. This information will be documented in the case notes. If the species cannot be determined, simply the presence of animal hair will be documented in the case notes. A statement regarding the suitability for comparison purposes may be added at the discretion of the examiner.
- c. If human hairs are present, the race (Caucasian, Negroid, Mongoloid, mixed racial) and somatic origin (body area) of human hairs can usually be determined based on an examination of the microscopic characteristics. Refer to the Abbreviation List for approved abbreviations for human hairs in the *Laboratory Quality Assurance Manual* (current revision).
- d. The presence of human head hairs and pubic hairs and their racial designation will be documented in the case notes. These hairs may be identified individually or collectively for each evidentiary item or group of items, based on the discretion of the examiner and the facts of the case. A statement regarding the suitability for comparison purposes may be added at the discretion of the examiner.
- e. The presence of other body area hairs and their racial designation will be documented in the case notes. These hairs are typically not identified to the specific somatic origin. A statement regarding the unsuitability for comparison purposes may be added at the discretion of the examiner.

## 2 Hair Comparisons

- a. Animal guard (protective outer coat) hairs recovered from evidentiary items can be compared to known samples of animal hairs.
- b. With human hairs, the only hairs that are routinely compared to a known hair sample samples are head hairs and pubic hairs. Other body areas may be compared; however, a qualifying statement will be present in the report regarding the limited conclusions that can be reached from these comparisons.

- c. Comparison microscopy will be used to compare all of the characteristics present in the questioned hairs to the hairs in the known sample.
  - d. The following is a list of characteristics that may be used for classification and comparison of hairs. The characteristics listed below are not all-inclusive and each characteristic may or may not be present in every hair.
- Macroscopic
    - Color (in reflected light)
      - White
      - Blonde
      - Red
      - Brown
      - Black
    - Structure
      - Shaft form
      - Straight
      - Arched
      - Wavy
      - Curly
      - Twisted
      - Tightly coiled
      - Crimped
    - Shaft length range in centimeters or inches
    - Overall shaft thickness
      - Fine
      - Medium
      - Coarse
  - Microscopic
    - Color (in transmitted light)
      - Color
        - Colorless (white)
        - Blonde
        - Red
        - Brown
        - Black
      - Natural pigmentation
        - Pigment size
          - Coarse
          - Medium
          - Fine
        - Pigment aggregation

- Streaked
  - Clumped
  - Patchy
  
- Pigment aggregate size
  - Large
  - Medium
  - Small
- Pigment density
  - Absent
  - Uniform
  - Peripheral
  - One-sided
  - Random or variable
  - Central or medial
  - Pigment in cuticle
  - Banded
- Color treatments
  - Dyes (permanent, semipermanent)
  - Temporary treatments (rinses, sprays, gels, mousses)
  - Bleaches or lighteners
- Structure
  - Shaft characteristics
    - Diameter range in  $\mu\text{m}$
    - Cross-sectional shape
      - Round
      - Oval
      - Triangular
      - Flattened
    - Shaft configurations
      - Buckling
      - Convoluting
      - Shouldering
      - Undulating
      - Splitting
      - Regular
  - Medulla
    - Absent
    - Continuous
    - Discontinuous
    - Fragmented

- Opaque
- Translucent
- Relative width
- Amorphous
- Other (i.e., doubled, tripled)
  
- Cuticle
  - Present
  - Absent
  - Cuticle thickness
    - Thin
    - Medium
    - Thick
  - Outer cuticle margin
    - Flattened
    - Smooth
    - Serrated
    - Cracked
    - Looped
    - Irregular or other
  - Inner cuticle margin
    - Distinct
    - Indistinct
  - Cuticle color and clarity
    - Natural
    - Pigment
    - Dye
  
- Cortex
  - Cellular texture
    - Coarse
    - Medium
    - Fine
  - Ovoid bodies
    - Size
    - Distribution
    - Abundance
  - Cortical fusi
    - Size
    - Shape
    - Distribution
    - Abundance
  
- Ends

- Proximal ends
  - Root present
    - Telogen
    - Catagen
    - Anagen
    - Sheathed
    - Follicular tag
    - Postmortem banding
    - Putrid
  - Root absent
    - Severed
    - Decomposed
    - Crushed
- Distal ends
  - Tapered tips (uncut)
  - Rounded or abraded
  - Square cut
  - Angular cut
  - Frayed
  - Split
  - Crushed
  - Broken
  - Singed
- Acquired characteristics
  - Artifacts
    - Nits or lice
    - Mold
    - Fungal tunnels
    - Insect bite marks
    - Debris
    - Blood
  - Abnormalities
    - Pili annulati
    - Trichoschisis
    - Monilethrix
    - Trichorrhexis nodosa
    - Trichorrhexis invaginati
    - Pili torti
    - Trichonodosis
    - Trichoptilosis
  - Artificial treatments (other than color)
    - Hair spray
    - Hair gel

- Permanents
  - Hair cosmetics
  - Damage
    - Environmental/chemical damage
    - Mechanical damage
    - Crushed
    - Burned
    - Glass cut
    - Broken
    - Frayed
    - Twisted
    - Tangled
- e. The comparison process will involve a direct comparison of the questioned hair and the known sample along the entire hair, utilizing all of the microscopic characteristics listed above that are present in the hair.
- f. There is no minimum number of microscopic characteristics necessary to reach a conclusion. All of the characteristics present in the hairs will be considered as part of the comparison process.
- g. The presence, absence and distribution of characteristics in the hairs being compared are important considerations. The variability of hair characteristics between individuals gives weight to a hair association.
- h. A significant difference between a questioned hair and a known sample is defined as a characteristic that is found in the questioned hair that cannot be found in the known hair sample. A significant difference may be the basis for an exclusion.
- i. A hair association is defined as a hair and a known hair sample that exhibit the same microscopic characteristics. Hair associations are confirmed by a second qualified examiner. Documentation of the confirmation is the signature of the confirming examiner and the date on the Confirmation Form.

### 3 Animal Hair Conclusions

- a. If no significant differences are found, it can be stated that the questioned hair and the known animal hair sample exhibit the same microscopic characteristics and, accordingly, are consistent with coming from the same source. However, it is noted that animal hairs do not always possess sufficient microscopic characteristics to distinguish between members of the same breed.

- b. The questioned hair exhibits both similarities and differences to the known animal hair sample and, accordingly, no conclusion can be reached as to whether or not the hair originated from the source of the known animal hairs.
- c. The questioned hair is microscopically dissimilar to the known animal hair sample and, accordingly the questioned hair could not have originated from the source of the known animal hair sample.

#### **4 Human Hair Conclusions**

- a. If no significant differences are found, it can be stated that the questioned hair and the known hair sample exhibit the same microscopic characteristics and, accordingly, are consistent with originating from the same source.
- b. The questioned hair exhibits both similarities and differences to the known hair sample and, accordingly, no conclusion can be reached as to whether or not the hair originated from the source of the known hair sample.
- c. The questioned hair is microscopically dissimilar to the known hair sample and, accordingly the questioned hair could not have originated from the source of the known hair sample.
- d. In some situations, the questioned hair will be microscopically dissimilar to the known hair sample but the examiner cannot reach the conclusion that the questioned hairs could not have originated from the source of the known hair sample. In these instances it will be reported that the questioned hair cannot be associated with the source of the known hair sample.

#### **5 Hair Confirmation**

Hair associations are confirmed by a second qualified examiner. Documentation of the confirmation is the signature of the confirming examiner and the date on the Confirmation Form.

#### **6 Hair Comparison significance**

- a. There are a number of factors that must be considered in assessing the significance or evidential value of a hair association based on comparison microscopy. As pointed out earlier the variability of hair characteristics, especially in most head and pubic hairs, between individuals gives weight to a hair association. Generally the significance is assessed by considering the probability that the matching hair evidence is due to chance or that the hairs of unknown origin are present in a particular location by coincidence. This probability is directly related to the relative frequency of the microscopic characteristics of the hair or hairs involved in the association. Any information

that reduces the relative frequency of the hair characteristics of hairs involved in the association increases the evidential value of matching hair evidence. Most human head and pubic hairs microscopically consistent with hairs from a particular person would be the basis of a strong association. If a hair contains uncommon characteristics, then that association can very strong. Hairs with uncommon characteristics would include hairs that are long and show considerable variation in microscopic characteristics along the hair shaft, hairs that have been treated and hairs that have been damaged. Other factors that must be considered in assessing the evidential value of the hair evidence in a particular case are the number of hairs involved in the association, the location of the hairs involved in the association, whether there is evidence of a cross transfer of hairs between two persons, the potential for contamination in a case and the relationship between the individuals associated with the hair evidence.

## 7 Submitting Hairs for DNA Analysis

- a. A DNA comparison is conducted, when possible, on head hairs and/or pubic hairs associated microscopically to a known hair sample. Other hairs, especially forcibly removed hairs, may be submitted for DNA analysis at the discretion of the examiner.
- b. Nuclear DNA analysis may be conducted on hairs that have been forcibly removed especially those that have adhering tissue. If the hair does not give the appearance of having been forcibly removed, then the hairs are generally submitted for mitochondrial DNA testing.
- c. Removal of the hair from the glass microscope slide is critical for DNA testing. Precautions should be taken so that the questioned hair is not contaminated with foreign debris and/or fluids. The procedure for removal of hair from the glass microscope slide for DNA analysis is as follows:
  - d. Prior to removing the hair, a photograph may be taken of the root end of the questioned hair at an appropriate magnification.
  - e. Carefully punch a hole in the coverslip around the root of the questioned hair using a probe or other similar instrument.
  - f. Place a drop of xylene or suitable solvent on the exposed root area.
  - g. Carefully remove the questioned hair or a portion of the hair from the slide.
  - h. Rinse the hair or hair fragment that has been removed in xylene or xylene substitute to remove any adhering mounting media.

- i. Cut off a portion of the hair (when necessary) for DNA testing. For nuclear DNA analysis of forcibly removed hairs, cut off the root. For mitochondrial DNA (mtDNA) analysis, cut off approximately two (2) centimeters of hair.
- j. Dry mount the questioned hair fragment on a glass microscope slide with a cover slip held down with pieces of tape. The hair is now designated by the next available derivative of the item number from which it came ( e.g. Item 2.1).
- k. The remaining portion of hair (if applicable) may either be maintained in a microfuge tube, or dry mounted on a glass microscope slide.
- l. In some cases, it may be necessary to soak a Permount slide in xylene or xylene substitute for an extended period of time to dissolve the Permount. The coverslip and the hair can then be carefully removed and the hair washed with xylene or xylene substitute. A section of the hair can then be obtained depending on whether nuclear or mitochondrial DNA testing is to be conducted.

### Limitations

Hair examinations may have limited value where a considerable length of time exists between the deposition of questioned hairs and the collection of known hair sample.

### Comments

Not applicable.

### Documentation

The following worksheet(s) shall be generated and managed:

<b>Casework Documentation</b>
<i>Hair Association Form</i>

### References

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