

Form	Deviation Request Form
Title	Technical Procedure for Microscopic Hair Analysis
Laboratory Location	Raleigh Lab
Discipline/Section	Trace Evidence
A. Requested deviation applies to:	Technical Procedure for Microscopic Hair Analysis - Version 3
B. Requested deviation:	<p>Add definition – <b>Probative hair standard</b> – the hair standard required to provide the necessary macroscopic and/or microscopic hair characteristics intended to focus the assessment of questioned hair evidence. (e.g., suspect pubic hair standard for comparison to victim's pubic hair combings; victim's head hair standard for comparison to suspect's vehicle tapings)</p> <p>Clarify 5.1.2.1 – If necessary, contact the submitting agency to obtain additional evidence, case information, and/or to request known hair standards following the Laboratory Procedure for Obtaining Evidentiary Standards. A known hair standard is required from any probative individuals in order for a hair comparison to be conducted. If the probative hair standards are not submitted, the examination may be limited or the evidence may be returned.</p> <p>Clarify 5.1.3.5.1 – The following is a list of macroscopic characteristics that may be used for classification and comparison of any questioned hairs that may be suitable for further analysis against any probative known hair standards.</p> <p>Clarify 5.1.4 – All questioned hairs that are found to be macroscopically similar to the probative known hair standard and may be suitable for further analysis are mounted on microscope slide(s). If mounting a representative sample of hair from the known standard(s), use the same mounting medium that was chosen for the questioned hairs. See <b>Sample Preparation</b>.</p> <p>Add 5.1.4.1 – If the probative and non-probative known hair standards can be distinguished macroscopically, no further hair comparison analysis may be performed on hairs that are found to be</p>

macroscopically similar to the non-probative known hair standard (e.g., victim on victim; suspect on suspect).

Add 5.4.1.1.1 – Unless otherwise indicated in the Forensic Scientist's notes, Permout is the semi-permanent mounting medium used in casework.

This deviation is intended to clarify the known standards that are required to perform a hair comparison.

This deviation also clarifies that Permout is the semi-permanent mounting medium used during casework.

This deviation only clarifies the Analytical Approach to hair comparisons in regards to which hair standards are needed to perform the analysis. This deviation does not affect how hair comparisons are performed.

This deviation also clarifies that currently only Permout is used for mounting hairs for comparison purposes.

C. Necessity for the deviation:

D: Technical Review and Authorization

Technical Authorization

Yes - Authorized

Technical Authorizer

Admire, Lindsey

Duration

1 year / next procedure revision

E: Quality Assurance Authorization

Acceptable within general QA guidelines and good laboratory practice? Yes

Significant negative impact to Crime Laboratory Quality System?

No

QA Authorization

Yes - Authorized

QA Authorizer

Freehling, David

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## Technical Procedure for Microscopic Hair Analysis

**1.0 Purpose** – This technical procedure shall be followed for the microscopic examination of hair evidence.

**2.0 Scope** – This procedure applies to microscopic hair analysis cases in the Trace Evidence Section. Microscopic hair analysis is a general term that encompasses many different methods of examination including, but not limited to, the microscopic analysis of questioned human hairs compared to known standards, animal classification, and force determination. The method(s) of examination used in a microscopic hair analysis is dependent upon the case information and evidence available.

### 3.0 Definitions

- **Classification** – the systematic arrangement of hairs into categories (e.g., human, animal, somatic, ancestry) based on shared traits or characteristics.
  - **Ancestral group classification** – Populations differentiated by the morphological and microscopic characteristics representative of individuals originating from geographically separated regions of the world such as Asia, Africa, and Europe.
  - **Animal hair classification** – Differentiation of hairs based upon morphological and microscopic characteristics representative of human or animals.
  - **Somatic origin classification** – Differentiation of hairs based upon morphological and microscopic characteristics representative of varying areas of the human body.
- **Environment, closed** – An area questioned hair evidence can be collected from that typically has restricted and/or controlled access limited to a relatively small number of individuals. (e.g., pubic hair combings)
- **Environment, open** – An area questioned hair evidence can be collected from that typically has unrestricted access from individuals or external transfers from their environment. (e.g., outer clothing, vehicles)
- **Primary transfer** – when trace evidence, such as hair, is deposited directly onto another surface.
- **Secondary transfer** – when previously transferred trace evidence is transferred to yet another surface.
- **Tertiary transfer** – when evidence is transferred three times: an initial transfer and then twice more.
- **Force determination** – Examination of the characteristics of a hair root to assist in determining the manner in which a hair was removed from the hair follicle, i.e., forcibly vs. naturally shed.
- **Hair characteristics** – A feature or quality of the hair that serves to classify it.
- **Hair comparison** – A term that describes the macroscopic and microscopic examination of characteristics exhibited by questioned human hairs to determine if those characteristics are represented in the submitted known hair standards. A hair comparison can only be performed on head hairs and pubic hairs and is not a means of personal identification.
- **Macroscopic** – A term that describes characteristics large enough to be perceived without magnification.
- **Microscopic** – A term that describes characteristics too small to be resolved by the unaided eye, but large enough to be resolved with a microscope.

### 4.0 Equipment, Materials, and Reagents

#### 4.1 Equipment

- Stereomicroscope

- Compound or Polarized Light Microscope
- Comparison microscope

#### **4.2 Materials**

- Glass microscope slides and cover slips
- Forceps
- Scalpel and blades
- Scribe
- Fingerprint lifting tape
- Pasteur Pipettes
- Probes

#### **4.3 Reagents**

- Cytoseal 280
- Permount
- Xylene
- Xylene substitute
- Ethanol (anhydrous) 200 proof
- Deionized water
- Norland Optical Adhesive
- Clear nail polish
- 10 % bleach solution

### **5.0 Procedure**

#### **5.1 Analytical Approach**

**5.1.1** Review the request for analysis and determine the type(s) of examination required based on the request made by the agency. Examination(s) that may be performed are animal hair classification, force determination, and hair comparison.

**5.1.1.1** There may be times when an agency requests a variation on the above listed types of analyses (e.g., somatic origin classification request, ancestral group classification request). If the request falls within the scope of the technical procedures, the analysis may be permitted.

**5.1.2** Evaluate the case information and evidence submitted.

**5.1.2.1.** If necessary, contact the submitting agency to obtain additional evidence, case information, and/or to request known hair standards following the [Laboratory Procedure for Obtaining Evidentiary Standards](#). If standards are not submitted, the examination may be limited or the evidence may be returned.

**5.1.3** Open the questioned hair evidence container and describe the evidence present. Temporary mounting of any questioned hairs present may be used. If necessary, process the item to remove any hair evidence adhering to the item following the Trace Evidence Section [Technical Procedure for the Collection and Preservation of Evidence](#).

**5.1.3.1** Most hair cases involve some degree of evidence screening, either visually/macrospectically or in combination with microscopic techniques.

**5.1.3.1.1** In cases in which the questioned hair evidence is collected from a closed environment, the questioned hair evidence will be assessed prior to opening the known standards. Beginning with the questioned items is required in closed environments unless case constraints dictate otherwise.

**5.1.3.1.2** In cases in which the questioned hair evidence is collected from an open environment (e.g., tapings collected from an undergarment in a Sexual Assault Evidence Collection Kit, tapings collected from outer clothing), the known standards may be opened prior to the questioned hair evidence for an initial visual evaluation and macroscopic examination in order that those questioned hairs suitable for further comparison can be selected.

**5.1.3.2** If no questioned hair is present, the examination shall conclude.

**5.1.3.3** If the evidence is a fiber or vegetable material the hair analysis examination is concluded. The evidence may be retained for further trace examination.

**5.1.3.4** No further analysis shall be performed on hairs determined to be of animal origin, without prior approval from the Technical Leader, Forensic Scientist Supervisor, or the Forensic Scientist Manager. See **Animal Hair Classification**.

**5.1.3.5** If the questioned hair evidence is human hair the macroscopic characteristics will be assessed and compared to those of the known standard, depending upon somatic origin. See **Appendix 3, Sample Selection Guidelines** and **Evaluation of Known Standards**.

**5.1.3.5.1** The following is a list of macroscopic characteristics that may be used for classification and comparison of any questioned hairs that may be suitable for further analysis against any known hair standards. The characteristics listed below are not all-inclusive and may or may not be present in every hair.

- Color
- Form
- Ancestral group classification characteristics (see **Appendix 2**)
- Somatic origin classification characteristics (see **Appendix 3**)
- Other characteristics (e.g., shaft length, cosmetic treatment, root growth phase)

**5.1.3.5.2** No further hair comparison analysis may be performed on hairs that are found to be body hairs, macroscopically different from the known hair standards, or gray hairs. However, based on the case details and evidence, hairs these hairs may be screened for DNA. See the **Trace Evidence Section Technical Procedure for Screen for DNA Analysis**.

**5.1.3.5.3** If processing evidence in a Sexual Assault Evidence Collection Kit (SAECK), see the SAK Processing Guidance Form for additional evaluation criteria.

**5.1.4** All questioned hairs that are found to be macroscopically similar to the known standard and may be suitable for further analysis are mounted on microscope slides(s). If mounting a representative sample of hair from the known standard(s), use the same mounting medium that was chosen for the questioned hairs. See **Sample Preparation**.

**5.1.5** The hair examination shall continue following the applicable **Examination Procedures**.

**5.1.6** Once all visual and microscopic examinations have been completed, the Forensic Scientist shall issue a report stating his or her findings using the **Guidelines for Hair Examination Results Statements**.

**5.1.6.1** All results shall be based on the Forensic Scientist's knowledge and expertise and the case being examined. Results shall be in agreement with the technical review.

## **5.2 Examination Procedures**

### **5.2.1 Animal Classification**

**5.2.1.1** If specifically requested and approved, additional characterization of the hair as to family/genus/species may be done.

**5.2.1.1.1** The type of hair shall be determined (guard or fur).

**5.2.1.1.1.1** Guard hairs with the root and tip intact provide the most information during analysis. No further analysis can be performed on fur hairs.

**5.2.1.1.2** The scale pattern can be determined either by using the microscope or by scale casting.

**5.2.1.1.2.1** When making scale casts, the Forensic Scientist shall note the root end and tip end of the hair.

**5.2.1.1.2.2** There are numerous ways to make scale casts, some of which are listed below. This list is not all inclusive and the Forensic Scientist may employ other techniques if

they are not destructive, the hair can be retrieved from the casting medium, and a successful scale cast has been achieved on positive controls.

- Norland Optical Adhesive method
- Nail Polish method

**5.2.1.1.3** By examining the guard hair, the animal's family and sometimes genus can be determined. The following factors are used to determine the family and possible genus with the aid of the microscope:

- Form
- Root shape
- Color
- Medulla
- Banding patterns
- Scale pattern

## **5.2.2 Force Determination**

**5.2.2.1** If a hair root is present, the growth phase and structure of the hair root is examined. The Forensic Scientist determines if the hair could have been forcibly removed.

**5.2.2.2** If there is no root present, a force determination cannot be performed.

**5.2.2.3** If the hair has a root that may be suitable for DNA analysis, the hair root or the entire hair may be sent to the Forensic Biology Section for further testing. See the Trace Evidence Section [Technical Procedure for Screen for DNA Analysis](#).

## **5.2.3 Hair Comparison**

**5.2.3.1** Using a comparison microscope, the Forensic Scientist fully characterizes and documents the microscopic properties of the questioned hairs, followed by the known standards. See **Appendix 2** and **Appendix 3**.

**5.2.3.1.1** The comparison process involves a direct comparison of the questioned hair and the known standard along the entire length of the hair, utilizing any available microscopic characteristics that are present in the hair.

**5.2.3.1.2** The following is a list of the characteristics that may be used for classification and comparison of human hairs. The characteristics listed below are not all-inclusive and may or may not be present in every hair.

- Color
- Ancestral group classification characteristics (see **Appendix 2**)
- Somatic origin classification characteristics (see **Appendix 3**)
- Other characteristics (e.g., cosmetic treatment, root growth phase)

**5.2.3.1.3** No further analysis may be performed on hairs found unsuitable for a microscopic hair comparison (e.g., bland hairs, opaque hairs, body hairs, animal hairs, fibers).

**5.2.3.2** If the Forensic Scientist finds questioned and known hairs to be microscopically consistent, or to have similarities with slight differences:

**5.2.3.2.1** In cases in which the questioned hairs may establish an association (e.g., victim to suspect; victim to scene), then:

**5.2.3.2.1.1** A second Forensic Scientist, who is qualified in hair comparisons, shall confirm these microscopic comparisons. Additional verifications may be completed by other available Forensic Scientists who are qualified in hair comparisons. A verification review shall be completed in Forensic Advantage (FA) and the microscope slides shall be initialed and dated by the verifying Forensic Scientist(s). The verifying Forensic Scientist(s) will also note in FA the contents of all slides verified.

**5.2.3.2.1.2** If roots suitable for DNA analysis, at the North Carolina State Crime Laboratory, are present, a representative sample of the associative hairs shall be sent for DNA analysis. See the Trace Evidence Section [Technical Procedure for Screen for DNA Analysis](#). Additional hairs may be recommended for DNA analysis.

**5.2.3.2.2** In cases that do not establish an association (e.g., victim on victim; suspect on suspect), no additional analysis or verification is required.

**5.2.3.3** No further analysis may be performed on hairs found to be microscopically not consistent with the applicable known standard.

### **5.3 Evaluation of Known Standards**

**5.3.1** It is requested that a known head and/or pubic hair standard be submitted from all individuals involved in each case.

**5.3.1.1** A known head and/or pubic hair standard consists of approximately 50 full-length (plucked, if possible) hairs from all around the region of interest and should include a sample of any weave/wig fibers (e.g., false hair, extensions) that may be present.

**5.3.1.2** A standard may consist of fewer than 50 hairs if the analyst documents enough properties to perform a hair analysis. These properties may include macroscopic

and/or microscopic characteristics.

**5.3.2** In addition, the submitted standards may be deemed inadequate for comparison. Some of these factors may include:

**5.3.2.1** An insufficient quantity and/or variety of hairs submitted.

**5.3.2.1.1** Reach out to the agency to request more standards be submitted, if needed.

**5.3.2.2** Standards that are comprised solely of bland and/or gray hairs.

**5.3.2.3** Hairs where too much time has elapsed such that the standard does not adequately represent the hair at the time of incident.

**5.3.2.3.1** The growth cycle for scalp hairs ranges from 2 to 7 years. It is recommended that a head hair standard be collected within 5 years of the date of offense.

**5.3.2.3.2** The growth cycle for pubic hairs ranges from 4 months to 1.5 years. It is recommended that a pubic hair standard be collected within 1 year of the date of offense.

**5.3.3** If no standard, an improper standard, or no additional standard is available the questioned hairs may be screened for DNA suitability based on case details (e.g., Sexual Assault Evidence Collection Kit, cold cases).

## **5.4 Sample Preparation**

**5.4.1** Place the hair on a clean microscope slide and apply a thin film of an appropriate mounting medium, such that the hair is totally covered. Place a glass cover slip on top of the hair and mounting medium.

**5.4.1.1** It is permissible to mount hairs in a temporary mounting medium, such as water or xylene, or a semi-permanent mounting medium, such as Cytoseal or Permount. A non-temporary mounting medium shall be used for hairs mounted for a microscopic comparison.

**5.4.1.2** If a temporary mounting medium is used, the hairs shall be retrieved and placed into the original packaging after the examination is complete.

**5.4.1.3** A mounting medium, such as Cytoseal or Permount, may be used so long as, based on the Forensic Scientist's training and experience, it flows properly and has not discolored.

## **5.5 Guidelines for Hair Examination Result Statements**

- 5.5.1** A methodology statement shall be added to all reports where an examination was performed.
- 5.5.1.1** Example: The following methodologies were used in the examination of this case: visual examination and microscopy.
- 5.5.2** The wording of the results shall accurately describe the evidence at hand.
- 5.5.3** The report shall address all questioned hairs present in a case, whether microscopically compared or not.
- 5.5.3.1** Any unsecured hairs (e.g., loose hairs in a Sexual Assault Evidence Collection Kit box) noted in items of evidence will be preserved and included on the report but will not be analyzed without prior approval from the Technical Leader, Forensic Scientist Supervisor, or Forensic Scientist Manager.
- 5.5.3.2** In cases involving a SAECK, a statement shall be added to the lab report to indicate the suitability of any remaining questioned hair for microscopic hair comparison, based on the results of the pending DNA analysis.
- 5.5.4** In cases where there are multiple victims/suspects listed and standards are not provided for all of the individuals, a statement shall be added at the beginning of the report which informs the reader what comparisons were made.
- 5.5.4.1** Example: Items A, B, and C were examined for the presence of hairs that could be associated with the submitted standards from \_\_\_ only. A hair standard was not provided from \_\_\_\_\_.
- 5.5.5 Hair Comparison**
- 5.5.5.1 Consistent**
- 5.5.5.1.1** Only applicable to head and pubic hairs.
- 5.5.5.1.2** No exclusionary differences were observed between the questioned and known hairs (i.e., characteristics exhibited by the unknown hair fit within the range of characteristics present in the known standard).
- 5.5.5.1.2.1** Example: The hair in Item A was found to be microscopically consistent with the hair in Item B. Microscopically consistent means characteristics exhibited by the unknown hair fit within the range of characteristics present in the known standard. Therefore, the hair in Item A could have originated from the same source as the hair in Item B.
- 5.5.5.2 Inconclusive**

**5.5.5.2.1** Questioned and known hairs exhibit similarities in characteristics, but slight differences were noted.

**5.5.5.2.1.1** Example: The hair in Item A exhibited both similarities and slight differences to the hair in Item B. Similarities with slight differences means minor variations were noted between the characteristics exhibited by the unknown hair and the range of characteristics present in the submitted known standard. Accordingly, no conclusion could be reached as to whether or not the hair in Item A could have originated from the same source as Item B.

**5.5.5.2.2** Questioned and known hairs exhibit overlapping characteristics.

**5.5.5.2.2.1** Example: The hair in Item A exhibited overlapping characteristics with the hair in Items B and C. Overlapping characteristics means characteristics exhibited by the unknown hair fit within the range of characteristics present in more than one known standard. Accordingly, no conclusion could be reached as to whether or not the hair in Item A could have originated from the same source as Item B or C.

**5.5.5.2.3** Questioned and known hairs are bland in nature

**5.5.5.2.3.1** Example: Examination of Item A revealed the presence of one bland hair. Bland hairs lack many of the characteristics used in performing a hair comparison. Accordingly, no conclusion could be reached as to whether or not this hair could have originated from the same source as Item B. It should be noted that this type of bland hair was present in the victim/suspect's standard but not in the suspect/victim's standard.

### **5.5.5.3 Not Consistent**

**5.5.5.3.1** Numerous differences were found between the questioned and known sample (i.e., characteristics found in the questioned hair cannot be found in the known sample). These differences shall be the basis for exclusion.

**5.5.5.3.1.1** Example: The hair in Item A was found to be macroscopically/microscopically different from the hair in Item B. Macroscopically/Microscopically

different means distinct characteristics exhibited by the unknown hair were not noted within the range of characteristics present in the submitted known standard. Therefore, the hair in Item A could not be associated with the submitted standard from \_\_ (Item B).

#### **5.5.6 Ancestral Group Classification**

**5.5.6.1** Example: Examination of Item A revealed the presence of several hairs that exhibit macroscopic/microscopic European characteristics.

#### **5.5.7 Somatic Origin Classification**

**5.5.7.1** Example: Examination of Item A revealed the presence of one hair. This hair exhibited macroscopic/microscopic pubic/head hair characteristics and may be suitable for a microscopic hair comparison.

#### **5.5.8 Animal Classification**

**5.5.8.1** Example: Examination of Item A revealed the presence of one hair found to be of animal origin and exhibiting characteristics of the deer family.

#### **5.5.9 Force Determination**

**5.5.9.1** Example: The hair in Item A has characteristics that indicate it was forcibly removed. Hair roots may exhibit properties that indicate a hair has been forcibly removed. However, they type of force, amount of force, or when the force was applied cannot be determined.

**5.5.9.2** Example: It cannot be determined whether or not hairs with roots in the telogen growth phase were forcibly removed or naturally shed.

**5.5.9.3** Example: Because fragments do not contain a root, a force determination is not possible and it cannot be determined whether or not this hair was forcibly removed.

#### **5.5.10. Limited Nature**

**5.5.10.1.** Questioned hair or hair standard is of a limited nature.

**5.5.10.1.1.** Example: Due to the nature/condition of Item A, no conclusion could be reached as to whether or not Item A could have originated from the same source as Item B.

**5.5.10.2.** Questioned hair is gray or opaque.

**5.5.10.2.1.** Example: Examination of Item A revealed the presence of one hair

that was gray and therefore not suitable for a microscopic hair comparison. It should be noted that gray hairs were present in the pubic/head hair standard collected from victim/suspect, while gray hairs were not present in the pubic/head hair standard collected from suspect/victim.

#### **5.5.11. No Analysis**

##### **5.5.11.1. No analysis is performed due to the outcome of DNA analysis.**

**5.5.11.1.1.** DNA results correlate two items of evidence (e.g., suspect's DNA profile is identified on the victim's vaginal swabs).

**5.5.11.1.1.1** Example: Based on the results of DNA analysis, the above listed evidence is being returned without analysis. If you have any questions, please contact the Forensic Scientist who issued this report.

**5.5.11.1.2** An unknown DNA profile was developed on an item of evidence (e.g., vaginal swabs).

**5.5.11.1.2.1** Example: Due to the fact that there is an unknown DNA profile noted in the Forensic Biology report dated *mm/dd/yy* by *analyst*, the above listed evidence is being returned without examination at this time. If you have any questions, please contact the Forensic Scientist that issued this report.

##### **5.5.11.2 Insufficient Standard**

**5.5.11.2.1** Example: Due to the fact that there was an insufficient pubic/head hair standard for the victim/suspect, no further analysis could be performed. If further analysis is needed, please resubmit the above listed evidence along with a proper victim/suspect pubic/head hair standard.

##### **5.5.11.3 Standards Not Submitted**

**5.5.11.3.1** No analysis is performed because all standards have not been submitted to the laboratory.

**5.5.11.3.1.1** Example: Due to the fact that no suspect/victim/elimination standards were submitted, the above listed evidence is being returned without examination. The evidence may be resubmitted for hair analysis accompanied by the suspect's/victim's/elimination's head/pubic hair

standards.

**5.5.11.3.2** Analysis has been discontinued because the requested standards have not been submitted.

**5.5.11.3.2.1** Example: The hair standards previously requested by the Trace Evidence Section have not been submitted; therefore, no further analysis could be performed.

**5.5.11.4 Pubic hair combings collected more than 48 hours after the incident occurred.**

**5.5.11.4.1** Example: Item A was not examined, as it was collected more than 48 hours after the incident occurred.

**5.5.11.5 No questioned hair evidence present.**

**5.5.11.5.1** Example: Because no questioned hair evidence was submitted for analysis, the above listed known standards are being returned without examination. If you have any questions, please contact the Forensic Scientist who issued this report.

**5.5.11.5.2** Example: Examination of Item A did not reveal the presence of any hairs.

**5.5.11.6 Improper Collection of Hair Evidence.**

**5.5.11.6.1** Example: Item A was improperly collected/packaged and will be returned without examination.

**5.5.11.6.2** Example: Because the evidence collection envelopes/victim kit paperwork indicates that the pubic hair combings were collected after the pubic hair standard, Item A was improperly collected. Therefore, Item A is being returned without examination.

## **5.5.12 Qualifying Statements**

**5.5.12.1** Qualifying statements shall be included in the formal report if their inclusion further explains the conclusion or provides necessary information to the reader regarding the interpretation of the conclusion.

**5.5.12.2 Qualifying Statement Regarding Passage of Time**

**5.5.12.2.1** Because hair is a biological material, it can change with the passage of time. A qualifying statement may be added to the report when, based on the Forensic Scientist's training and experience, a large

lapse of time has occurred between the date of the crime and the collection of the standard.

**5.5.12.2.1.1** Example: Hair characteristics can change with the passage of time and [amount of time] has passed between the above listed date of offense and the collection of these known hair standards.

### **5.5.12.3 Qualifying Statement Regarding Bland or Gray Hairs**

**5.5.12.3.1** A statement qualifying any comparison conclusions made regarding bland or gray hairs shall be included in the formal report. Because many characteristics are absent and less information is available to make these comparisons, the Forensic Scientist shall be cautious with his/her conclusions in these circumstances.

**5.5.12.3.2** Bland hairs lack many of the characteristics used in the evaluation, examination, and comparison of hairs.

**5.5.12.3.3** Gray hairs have no pigment, may have an absent medulla, and are not suitable for a microscopic hair comparison.

### **5.5.12.4 Qualifying Statement Regarding Ancestral Group Classification**

**5.5.12.4.1** A qualifying statement shall be added to state that the ancestral group determination of the hair may not be indicative of the individual's outward appearance or how they identify themselves.

### **5.5.12.5 Qualifying Statement Regarding Force Determinations**

**5.5.12.5.1** When determining if a hair has been forcibly removed, it is not possible for the Forensic Scientist to determine how, when or why the hair was forcibly removed. A qualifying statement shall be added to communicate this.

### **5.5.12.6 Qualifying Statement Regarding Hair Comparisons and DNA Analysis**

**5.5.12.6.1** A statement as to the non-individualizing nature of hair examinations shall be included on the report.

**5.5.12.6.1.1** Example: The conclusions rendered in this report apply only to comparisons with the submitted standards (Item A and Item B). Should future investigation develop additional information or individuals related to the case, please contact the Forensic Scientist that issued this report. The comparison of the microscopic characteristics in hairs

does not constitute a basis for absolute personal identification. The probative value of hair comparisons may be affected by the results of DNA analysis.

#### **5.5.12.7 Qualifying Statement Regarding DNA Analysis**

**5.5.12.7.1** A statement regarding the option for DNA testing shall be included on the report when the results of a hair comparison may establish an association (e.g., victim to suspect; victim to scene).

**5.5.12.7.1.1** Example: It is recommended that this hair be outsourced for additional DNA testing which is not performed at this laboratory.

**5.5.12.7.1.2** Example: Should DNA analysis of the hair root yield no profile, it is recommended that the remaining portion of the hair be outsourced for additional DNA testing, which is not performed at this laboratory.

**5.5.12.7.2** A statement regarding the option of additional DNA testing shall be included on the report when the hair analyst has exhausted the examination capabilities of the North Carolina State Crime Laboratory and questioned hairs remain that may be suitable for additional DNA testing.

#### **5.5.12.8 Qualifying Statement Regarding Common Environment**

**5.5.12.8.1** Example: Because it cannot be determined when or how a hair was deposited on an item from an environment common to both the victim and suspect, a hair analysis cannot be performed on Item A.

**5.6. Standards and Controls – N/A**

**5.7. Calibration – N/A**

**5.8. Maintenance –** No maintenance is required in this procedure. However, the procedure does utilize instruments that require maintenance. See the individual technical procedures for the operations of those instruments.

#### **5.9 Sampling and Sample Selection**

**5.9.1** No sampling is performed. When sample selection occurs, it shall be based on the Forensic Scientist's training and experience.

**5.9.2** In general, each questioned hair shall be compared separately to the range of characteristics in the known hair standard(s) provided .

### **5.9.3 Sample Selection Guidelines**

**5.9.3.1** If a number of questioned hairs are submitted from the same location and are believed to have been deposited at the same time during the same event (e.g., a clump of hairs, dreadlock, etc.), a representative sample of the questioned hairs shall be selected by the Forensic Scientist. The selection shall be based primarily on macroscopic characteristics. All hairs included in the representative questioned item shall be compared to a known standard.

**5.9.3.2** No further analysis may be performed on hairs excluded on the basis of ancestral group if the ancestral group of the subject is known (i.e., suitable root on a European hair from a European victim's clothing does not require submission for DNA analysis if the subject is African).

**5.10. Calculations – N/A**

**5.11 Uncertainty of Measurement – N/A**

## **6.0 Limitations**

**6.1** It is not possible to state that a hair originates from a particular person to the exclusion of all others based on a comparative hair examination.

**6.2** Hair examinations may be limited where a considerable length of time exists between the deposition of questioned hairs and the collection of known hair standards.

**6.3** Gray hairs typically have no color and lack the characteristics used to determine the ancestral group and somatic origin classification. Therefore, they will be identified only as gray hairs with no conclusion as to their ancestral group or somatic origin classification. In addition, these hairs are not suitable for microscopic comparison.

**6.4** When a human hair does not have a root suitable for the DNA testing options offered at this Laboratory, it will be recommended that samples be outsourced for additional DNA testing when the results of a hair comparison may establish an association (e.g., victim to suspect, victim to scene).

**6.5** This laboratory does not perform animal hair comparisons.

## **7.0 Safety**

**7.1** Items may have blood or other body fluids present. Use protective equipment when dealing with items that may contain biohazard material.

**7.2** Care shall be exercised when using solvents such as xylene and xylene substitute. Consult Safety Data Sheets for information on safe use for reagents listed in this procedure.

- 7.3** Care shall be exercised when using Cytosol 280. Consult Safety Data Sheet for information on safe use in this procedure. Refer to Appendix 1 for Chemical Hygiene and Safety Precautions.
- 7.4** Glass pipettes, razor blades, and probes are sharp and can be dangerous.

## **8.0 References**

### **8.1 ASTM and SWG Guidelines**

SWGMA. "Forensic Human Hair Examination Guidelines." *Forensic Science Communications* 7.2 (2005).

ASTM Standard E1732, "Standard Terminology Relating to Forensic Science." ASTM International, West Conshohocken, PA, 2000.

### **8.2 Books**

DeForest, P.R., R.E. Gaensslen and H.C. Lee. *Forensic Science: An Introduction to Criminalistics*. New York: McGraw-Hill, 1983.

F.B.I. *Proceedings of the International Symposium on Forensic Hair Comparisons*. Washington, D.C.: The Laboratory Division, 1985.

Gaudette, B.D. *The Forensic Aspects of Hair Examination*. RCMP, Central Forensic Laboratory, 1988.

Hepworth, W.G. *Identification of the Dorsal Guard Hairs of Some Mammals of Wyoming*. Wyoming: Wyoming Game and Fish Department, 1974.

Hicks, John. *Microscopy of Hairs: A Practical Guide and Manual*. Washington, D.C.: The Laboratory Division, 1977.

Robertson, J., ed. *Forensic Examination of Hair*. London: Taylor & Francis, 1999.

Saferstein, R., ed. *Forensic Science Handbook*. Volume I. Englewood Cliffs, NJ: Prentice Hall, 1983.

### **8.3 Journal Articles**

Deedrick, D.W. "Hairs, Fibers, Crime, and Evidence." *Forensic Science Communications* 2.3 (2000).

Deedrick, D.W. and S.L. Koch. "Microscopy of Hair Part I: A Practical Guide and Manual for Human Hairs." *Forensic Science Communications* 6.1 (2004).

Deedrick, D.W. and S.L. Koch. "Microscopy of Hair Part II: A Practical Guide and Manual for Animal Hairs." *Forensic Science Communications* 6.3 (2004).

McCrone, W.C. "Characterization of Human Hair by Light Microscopy." *The Microscope* 25.1 (1977): 15-30.

Oien, C.T. "Forensic Hair Comparisons: Background Information for Interpretation." *Forensic Science Communications* 11.2 (2009).

## **9.0 Records**

Laboratory Safety Manual- Chemical Hygiene Plan and Hazardous Communication Program

Laboratory Safety Manual: Bloodborne Pathogen Compliance Program

## **10.0 Attachments**


Appendix 1: Chemical Hygiene and Safety Precautions

Appendix 2: Ancestral Group Classification

Appendix 3: Somatic Origin Classification

Revision History		
Effective Date	Version Number	Reason
05/10/2024	3	2.0 – replace somatic origin classification with force determination 3.0 – remove “undergarment in a Sexual Assault Evidence Collection Kit” from Environment, closed definition 5.1.3 (and subheadings) – moved to 5.1.4.1 (and subheadings) 5.1.3.1 – removed and combined with 5.1.3.3 5.1.3.2 – replaced i.e. with e.g. 5.1.4 – add temporary mounting of any questioned hairs present may be used 5.1.4.1 – Now 5.1.4.5.3 5.1.4.5.1 – replace will with may Reorganized 5.1.4.5.1 and 5.1.4.5.2 5.1.5.1 – Now 5.1.5 5.1.5.2 – combined with 5.1.5.1 5.1.5.3 – Now 5.2.3.1.2 5.1.5.4 – Now 5.2.3.1.3 5.2.3.1.3 – Removed microscopically not consistent with statement and made it 5.2.3.3. 5.2.3.2.1.2 – Clarified if roots suitable for DNA analysis are present. 5.2.3.2.2 – Add or verification 5.5 and 5.5.1 (including all subheadings) – Moved to SAK Processing Guidance Form 5.5.3 – Now 5.5.3.2 5.9.3.2 – changed will to may 5.5.11.7 (and subheading) – now 5.5.10.2 (and subheading)

**Appendix 1: Chemical Hygiene and Safety Precautions**

<b>Cytoseal 280</b>	
<b>DANGER: PARTICULARLY HAZARDOUS SUBSTANCE *</b>	
	<b>HEALTH</b> <span style="float: right;"><b>3</b></span>
	<b>FLAMMABILITY</b> <span style="float: right;"><b>3</b></span>
	<b>REACTIVITY</b> <span style="float: right;"><b>0</b></span>
<b>Detection of Release</b>	Colorless liquid; Aromatic Odor
<b>Signs/Symptoms of Exposure</b>	Skin, eye irritation; drowsiness or dizziness; Breathing difficulties. Inhalation of high vapor concentrations may cause symptoms like headache, dizziness, tiredness, nausea and vomiting.
<b>PEL</b>	ACGIH TLV 20 ppm; OSHA PEL 100 ppm (TWA); NIOSH IDLH 500 ppm
<b>Associated Hazards</b>	<b>May be fatal if swallowed and enters airways;</b> Highly flammable liquid and vapor. Causes skin irritation. <b>Suspected of damaging fertility or the unborn child. May cause damage to organs (Central nervous system) through prolonged or repeated exposure.</b>
<b>Controls</b>	Use only under a chemical fume hood. Use explosion-proof electrical/ventilating/lighting/equipment. Ensure that eyewash stations and safety showers are close to the workstation location. Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product. Use eye protection. Handle with impervious gloves.
<b>Safe handling, storage, disposal</b>	Avoid contact with skin and eyes. Avoid inhalation of vapor or mist; Use explosion-proof equipment; Keep away from heat and sources of ignition; take measures to prevent the build-up of electrostatic charge. Dispose in Hazardous Chemical Waste.
<b>Emergency Procedures</b>	<p><b><u>Eye Contact:</u></b> Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Obtain medical attention. Immediately flush with plenty of water. After initial flushing, remove any contact lenses and continue flushing for at least 15 minutes. Keep eye wide open while rinsing. If symptoms persist, call a physician.</p> <p><b><u>Inhalation Exposure:</u></b> Move to fresh air. If breathing is difficult, give oxygen. Do not use mouth-to-mouth resuscitation if victim ingested or inhaled the substance; induce artificial respiration with a respiratory medical device. Immediate medical attention is required. Move to fresh air in case of accidental inhalation of vapors. If symptoms persist, call a physician.</p> <p><b><u>Ingestion:</u></b> Do not induce vomiting. Call a physician or Poison Control Center immediately. Clean mouth with water and drink afterwards plenty of water. Do not induce vomiting without medical advice. Never give anything by mouth to an unconscious person. Consult a physician.</p> <p><b><u>Skin Contact:</u></b> Wash off immediately with plenty of water for at least 15 minutes. Obtain medical attention. Call a physician immediately. <b>SPEEDY ACTION IS</b></p>

CRITICAL, GET MEDICAL AID IMMEDIATELY.. If symptoms persist, call a physician. If skin irritation persists, call a physician.  
Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes.  
**Spills:** Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapors accumulating to form explosive concentrations. Vapors can accumulate in low areas. Small contained spill: wearing appropriate PPE, collect with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and place in container. Dispose in Hazardous Chemical Waste. Large spills: Evacuate area and call 911 (Haz Mat).

## Appendix 2: Ancestral Group Classification

The ancestral group terms Caucasian, Mongoloid, and Negroid have been used in cases completed at this laboratory. However, these terms are no longer acceptable in the field of anthropology (the field from which these designations originated).

The following outline is adapted from *Handbook of Trace Evidence Analysis* and sets forth certain key characteristics which serve as indicators of ancestral group classification (European, African, and Asian). It should be understood that these indicators are generalities and apply primarily to head hairs.

### Ancestral Group Classification:

#### European

- Contour varies from relatively straight to moderately curly (*macroscopic characteristic*).
- Wide variety of natural macroscopic color (light blonde to dark brown/black) (*macroscopic characteristic*). Typically, oval cross-sectional shape (*microscopic characteristic*).
- Moderate to fine shaft diameter (*macroscopic and microscopic characteristic*).
- Moderate cuticle thickness (*microscopic characteristic*).
- Relatively low to moderate pigment density (*microscopic characteristic*).

#### African

- Generally curly or kinked contour (sometimes tightly curled) (*macroscopic characteristic*).
- Macroscopically dark in color (*macroscopic characteristic*).
- Relatively fine to coarse shaft diameter (*macroscopic and microscopic characteristic*).
- Typically flattened cross-sectional shape (*microscopic characteristic*).
- Relatively high pigment density often with clumps of pigment (*microscopic characteristic*).

#### Asian

- Generally straight contour (*macroscopic characteristic*).
- Macroscopically dark in color (*macroscopic characteristic*).
- Moderate to thick shaft diameter (*macroscopic and microscopic characteristic*).
- Typically, circular cross-sectional shape (*microscopic characteristic*).
- Relatively thick cuticle (*microscopic characteristic*).
- Relatively high pigment density, often with a reddish cast (*microscopic characteristic*).

### Appendix 3: Somatic Origin Classification

The following outline is adapted from *Handbook of Trace Evidence Analysis* and lists features of individual hairs which serve to identify the region of the body from which they come. Again, the features listed are generalities and one must consider ancestral group origin of the specimen when analyzing features such as the degree of diameter variation or the medullary structure.

Somatic Origin:

#### Head Hairs

- Diameter varies greatly between hairs (typical range ~25-125µm) but it is relatively uniform for a given hair (*macroscopic and microscopic characteristic*).
- Length varies greatly from a few millimeters to over a meter (*macroscopic characteristic*).
- The medulla, if present, is relatively narrow (*microscopic characteristic*).
- Typically possess cut or frayed tips, except in young children which have naturally tapered tips until their hair is cut (*microscopic characteristic*).

#### Pubic Hairs

- Generally coarse and wiry (*macroscopic characteristic*).
- Irregular cross-sectional shapes and contours with twists and constrictions (*microscopic characteristic*).
- Distinct “buckles” often visible using microscopy (*microscopic characteristic*).
- Moderate in length (less than ~90mm) (*macroscopic characteristic*).
- Medullae often relatively thick (*microscopic characteristic*).
- Telogen roots often possess follicular material (*microscopic characteristic*).

#### Axillary

- Resembling pubic hairs but generally shorter (less than ~70mm) and thinner, with less pronounced contour irregularities (i.e. straighter without distinct buckles) (*macroscopic characteristic*).
- Distal tips may be abraded or frayed and appear lighter or yellowish in color (*microscopic characteristic*).

#### Beard/mustache

- Coarse with varying lengths (less than 1 mm to lengths more typical of head hairs) (*macroscopic characteristic*).
- Many are somewhat triangular in cross-sectional shape, although there can be significant variability (*microscopic characteristic*).
- Medullae are often relatively thick with complex structure (a double medulla may be present) (*microscopic characteristic*).
- Often exhibit razor or clipper cuts (*microscopic characteristic*).
- Typically have a thick cuticle compared to head hairs (*microscopic characteristic*).

#### Eyelash/eyebrow

- Short (less than ~ 1 cm) and curved but some eyebrow hairs may be longer and curled/twisted (*macroscopic characteristic*).
- Relatively thick for length (*macroscopic characteristic*).
- Generally tapered tip but eyebrows may be cut (*microscopic characteristic*).

#### Body/limb

- Typically, relatively thin and short but thickness and length are highly variable depending on body area (*macroscopic characteristic*).

- Generally, possess tapered tips that may be abraded (*microscopic characteristic*).
- Chest hairs may resemble some less distinct pubic and axillary hairs (*macroscopic and microscopic characteristic*).

Due to the inherent complexities and limitations described above, it is not always possible to determine the somatic origin of an unknown hair. Variations may occur with hairs that may make somatic origin determination difficult or impossible to determine. These particular hair specimens may be nonclassifiable due to immaturity or changes caused by artificial treatment or damage. The hairs may be transitional hairs (fringe hairs); i.e., from an areas of the body between two identifiable regions, or they may be fragmentary and not of sufficient size for an adequate examination.