



Standard Guide for Forensic Examination of Hair by Microscopy¹

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1. Scope

1.1 This guide covers procedures used by forensic laboratory personnel in the forensic examination of hair by microscopy, including microscopical comparisons and classification of hair samples.

1.2 This guide addresses instrument setup, hair collection, sample handling techniques, and the use of various microscopes in the examination and comparison of hair.

1.3 This guide addresses the benefit of following microscopical examinations with DNA analysis.

1.4 This standard is intended for use by competent forensic science practitioners with the requisite formal education, discipline-specific training (see Practice E2917), and demonstrated proficiency to perform forensic casework.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

E620 Practice for Reporting Opinions of Scientific or Technical Experts

E1459 Practice for Physical Evidence Labeling and Related Documentation

E1492 Practice for Receiving, Documenting, Storing, and Retrieving Evidence in a Forensic Science Laboratory

E1732 Terminology Relating to Forensic Science

E2917 Practice for Forensic Science Practitioner Training, Continuing Education, and Professional Development Programs

2.2 Other Standards:

ISO 17025 Testing and calibration laboratories³

3. Terminology

3.1 *Definitions*—For definitions of terms used in this guide, refer to Terminology E1732.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *anagen, n*—the active growth phase of a hair follicle in the hair growth cycle.

3.2.1.1 *Discussion*—The root from a pulled anagen hair is elongated and is usually fully pigmented (1).⁴

3.2.2 *ancestral group, n*—a biogeographic designation of human populations (for example, Asian, African, European) whose hair can share similar morphological and microscopic traits.

3.2.2.1 *Discussion*—The racial terms Caucasoid, Mongoloid, and Negroid should not be used as these terms are no longer acceptable in the field of anthropology (the field from which these designations originated) (2).

3.2.3 *association, inclusion, n*—the result of a comparison between two hair samples in which the characteristics of the questioned hair are present in the known sample without any exclusionary differences, and therefore the donor of the known hair sample can be included as a possible source of the questioned hair.

3.2.3.1 *Discussion*—A microscopical association of hair cannot identify the definitive source of a questioned hair to the exclusion of all others, and the number of individuals who could be included as a possible donor of a specific hair is unknown and cannot be reliably estimated.

3.2.4 *buckling, n*—an abrupt change in the shape and orientation of a hair shaft with or without a slight twist.

¹ This test method is under the jurisdiction of ASTM Committee E30 on Forensic Sciences and is the direct responsibility of Subcommittee E30.15 on Trace.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁴ The boldface numbers in parentheses refer to the list of references at the end of this standard.

3.2.5 *catagen, n*—the transitional phase of the hair follicle between the active growth phase (anagen) and the resting phase (telogen) in the hair growth cycle (1).

3.2.6 *classification, n*—the systematic arrangement of hairs into categories (for example, human, animal, somatic origin, ancestry) based on shared traits.

3.2.7 *cortex, n*—the primary anatomical region of a hair between the cuticle region and the medullary region composed of elongated and fusiform cells.

3.2.8 *cortical fusi, n*—small air spaces that form between the cortical cells in the hair shaft and under transmitted light appear as tiny, dark structures.

3.2.9 *cortical texture, n*—the relief or definition of the margins of the cortical cells when viewed using transmitted light microscopy.

3.2.10 *cross-sectional shape, n*—the shape of a hair shaft when cut at a right angle to its longitudinal axis.

3.2.10.1 *Discussion*—When viewed longitudinally with transparent light, the apparent cross-sectional shape is determined by slowly focusing through the hair (optical cross-sectioning). When viewed longitudinally between crossed polars, the cross-sectional shape can be determined by observing the interference colors.

3.2.11 *cuticle, n*—the outermost region of a hair composed of layers of overlapping scales.

3.2.11.1 *Discussion*—The dimension of the cuticle as measured from its outer margin to the cortex is often described in relative terms (for example, thin, medium, thick).

3.2.12 *cuticle, cracked, n*—a cuticle with linear breaks that are perpendicular to the length of the shaft.

3.2.13 *cuticle, looped, n*—a feature in which the distal edges of the cuticular scales are curved away from or cupped toward the hair shaft.

3.2.14 *cuticle, serrated, n*—a cuticle in which the outer margin has a notched appearance like a saw blade.

3.2.15 *decompositional changes, n*—alteration in the root or the proximal end of a hair that can include discoloration, postmortem root banding, or a tapered or brush-like appearance as well as fungal tunneling along the length of the shaft.

3.2.16 *exclusion/elimination, n*—the result of a comparison between two hair samples in which exclusionary differences are observed in the characteristics of the questioned hair that are not present in the known hair sample, and therefore the donor of the known sample can be excluded as a possible source of the questioned hair.

3.2.16.1 *Discussion*—This result is reached in a comparative hair examination when exclusionary differences (for example, color, characteristics indicative of ancestry) are noted in the macroscopic or microscopic characteristics between the questioned and known hairs. In these circumstances, the source of the known hairs, as represented by the known sample, is eliminated as a possible source of the questioned hair.

3.2.17 *exclusion with limitations, n*—the result of a comparison between two hair samples in which the characteristics of the questioned hair differ from those present in the known

hair sample, and therefore the donor of the known sample cannot be included as a possible source of the questioned hair.

3.2.17.1 *Discussion*—This result is reached in a comparative hair examination when differences are noted in the macroscopic or microscopic characteristics between the questioned and known hairs; however, the differences are insufficient for an absolute exclusion of a person as a possible source. This could be due to the natural variation that occurs in hairs as a biological specimen, the effect that time or environment can have upon a hair, or the reference sample does not capture the complete variation of the individual's hair.

3.2.18 *exclusionary difference, n*—a difference in a feature or property between compared items that is substantial enough to determine that they did not originate from the same source.

3.2.19 *follicular tag, n*—tissue from a hair follicle that is still attached to the root end of a hair which has been forcibly removed.

3.2.20 *fungal tunneling, n*—air pockets in a hair shaft caused by fungal growth.

3.2.21 *imbricate, n*—a term that describes a scale pattern in which the scales overlap and the edges have an irregular wavy pattern; this pattern is typical of human hair.

3.2.22 *inconclusive, n*—the result of a comparison between two hair samples in which similarities and differences were observed in the characteristics of the provided standard and the questioned hair to the extent that the known source of the standard could not be included or excluded as a possible source of the questioned hair.

3.2.23 *individualization, n*—a term indicating an individual can be discriminated to the exclusion of all other sources.

3.2.23.1 *Discussion*—Hairs cannot be individualized by means of microscopical hair comparison.

3.2.24 *inner cuticle margin, n*—the border between the cortex and the visible cuticle.

3.2.25 *keratin, n*—a class of sulfur-containing fibrous proteins that forms the foundation of outgrowth tissue from the epidermis, such as hair, nails, feathers, and horns (1).

3.2.26 *medulla, n*—the core of the hair shaft that is composed of vacuoles and cells that can be air- or fluid-filled.

3.2.26.1 *Discussion*—The medulla (if present) occurs in a continuous, discontinuous, or fragmented pattern along the length of a hair and appears translucent or opaque.

3.2.27 *monilethrix, n*—a hair disorder that results in periodic nodes or beading along the length of the hair with intervening, tapering constrictions that are not medullated.

3.2.28 *ovoid bodies, n*—oval-shaped, heavily-pigmented inclusions usually found in the hair cortex.

3.2.29 *pigment aggregation, n*—clusters of pigment granules.

3.2.30 *pigment density, n*—the relative abundance of pigment granules in the hair cortex as described along a continuum (for example, sparse, medium, heavy).

3.2.31 *pigment distribution, n*—the pattern or arrangement of the pigment granules in the hair shaft, such as uniform, peripheral, one-sided, variable, or central.