

## QUIZ – Questions & Answers – Hair Forensics

- 1) How can you **identify species** through hair samples?
- 2) Describe the **hair root** shape & characteristics in detail.
- 3) Explain the **structure** of human hair.
- 4) What are the characteristics of the hair **medulla**?
- 5) Describe the **three phases** of hair growth.
- 6) What is the role of hair evidence in **forensic toxicology**?

## **1) How can you identify species through hair samples?**

Identifying species through hair samples is primarily done through microscopic analysis and DNA profiling. Under a microscope, hair from different species can be distinguished by the unique characteristics of the cuticle (outer layer), medulla (inner core), and cortex (middle layer). For example, the scale patterns of the cuticle can differ between species, providing key identifiers. In addition, medullary patterns, such as the presence or absence of a continuous or fragmented medulla, offer further clues. These structural differences are species-specific, allowing forensic scientists to compare unknown samples to a database of known hair types.

DNA analysis, specifically mitochondrial DNA extracted from the hair shaft or nuclear DNA from the hair root, can definitively determine the species. Mitochondrial DNA (mtDNA) is especially useful when the hair lacks a root, as it is more abundant in hair shafts. By comparing mtDNA sequences to genetic databases, scientists can identify the species of the hair sample. This technique is vital in forensic science, wildlife poaching investigations, and ecological studies.

## **2) Describe the hair root shape & characteristics in detail.**

The shape and characteristics of the hair root provide important clues about the hair's growth phase and its origin. In a healthy anagen (growth) phase, the hair root typically has a rounded, club-like shape with a soft tissue surrounding it, known as the root sheath. This bulbous appearance signifies that the hair is actively growing, anchored deeply within the follicle. Conversely, during the telogen (resting) phase, the root becomes shrunken and hard, resembling a small "club" with no surrounding tissue, which indicates the hair is no longer growing and is ready to be shed.

Microscopic examination of the hair root can also reveal whether the hair was forcibly removed or naturally shed. A forcibly removed hair root often appears jagged or torn, and may contain follicular tissue. In contrast, a naturally shed hair root is smooth and rounded, indicating it fell out during the telogen phase. These characteristics are important in forensic investigations, as they can indicate how the hair was obtained and whether it was connected to a violent event.

### **3) Explain the structure of human hair.**

Human hair consists of three primary layers: the cuticle, cortex, and medulla. The cuticle is the outermost layer, made up of overlapping, flattened cells that form a protective barrier for the inner components. The cuticle's scale pattern can vary and is often used in forensic hair comparisons. Beneath the cuticle is the cortex, the thickest layer, composed of keratinized protein fibers that give hair its strength, elasticity, and color. The pigments found in the cortex are responsible for the hair's natural color.

The innermost layer is the medulla, which can be present in various forms (continuous, fragmented, or absent) depending on the individual. While the medulla does not significantly affect the hair's strength, it can play a role in distinguishing between different types of hair, including human versus animal hair. The structure of human hair, with its distinct layers and characteristics, provides essential information for forensic analysis, allowing investigators to identify potential matches in criminal cases.

#### **4) What are the characteristics of the hair medulla?**

The hair medulla is the central core of the hair shaft, but its presence and characteristics vary widely among individuals and across species. In humans, the medulla may be continuous, fragmented, or completely absent, and these patterns can provide significant forensic information. A continuous medulla runs unbroken through the length of the hair, whereas a fragmented medulla appears in separate sections. The medulla is often more pronounced in animal hair, and its structure can help differentiate between species.

The medulla's cellular structure and composition also differ. In some individuals, it may appear as a hollow tube, while in others, it can contain cells or be filled with air pockets. The medulla's width relative to the hair shaft is another key characteristic used in forensic comparisons. These patterns and features of the medulla are critical in identifying hair samples, as they provide distinct markers that can help distinguish between individuals or species.

## **5) Describe the three phases of hair growth.**

Human hair grows in three distinct phases: anagen, catagen, and telogen. The anagen phase is the active growth phase, during which the hair follicle is deeply rooted in the scalp, and the hair grows approximately 1 centimeter per month. This phase can last anywhere from 2 to 7 years, depending on genetic factors, and it determines the maximum length of the hair.

The catagen phase is a brief transitional phase lasting about 2 to 3 weeks. During this phase, hair growth stops, and the follicle begins to shrink. The hair separates from the blood supply but remains anchored in place. Finally, the telogen phase is the resting phase, which lasts for about 3 months. In this stage, the hair is fully detached from the follicle and will eventually shed. After the telogen phase, the cycle repeats, and new hair starts to grow in the anagen phase.

## 6) What is the role of hair evidence in forensic toxicology?

Hair evidence plays a crucial role in forensic toxicology because it can retain traces of drugs, poisons, and other chemicals for extended periods. Unlike blood or urine samples, which reflect recent drug use, hair can provide a long-term record of substance exposure, often up to several months or even years. This is because substances enter the hair shaft through the bloodstream during its growth phase, becoming incorporated into the hair structure. Analyzing segments of the hair can give a timeline of drug use, helping to establish patterns of chronic use or a single exposure.

Hair analysis is particularly valuable in cases where other biological samples are unavailable or compromised. In forensic investigations, hair samples can be tested for a variety of substances, including illegal drugs, alcohol, heavy metals, and environmental toxins. This makes hair evidence an essential tool for proving drug use in criminal cases, workplace drug testing, and post-mortem toxicology studies.