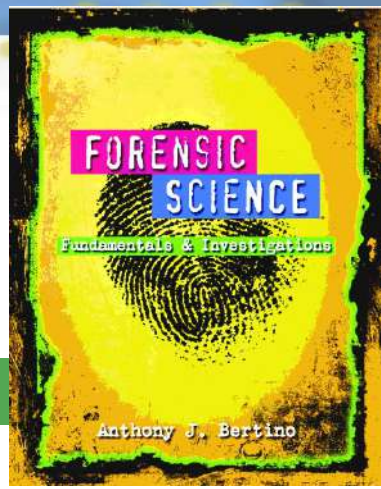
Chapter 3 *The Study of Hair*

By the end of this chapter you will be able to:



- Identify the various parts of a hair
- Describe variations in the structure of the medulla, cortex, and cuticle
- Distinguish between human and nonhuman hair

Chapter 3 *The Study of Hair*

By the end of this chapter you will be able to:

- Determine if two examples of hair are from the same person
- Explain how hair can be used in a forensic investigation
- Calculate the medullary index for a hair

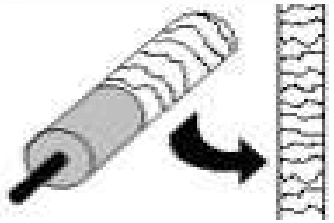
History of Hair Analysis

1. 1883: Alfred Swaine Taylor and Thomas Stevenson covered hair in a forensic science text
2. 1910: Victor Balthazard and Marcelle Lambert published a comprehensive study of hair
3. 1934: Dr. Sydney Smith, analyzed hairs side by side
4. Today: chemical tests, neutron activation analysis, and DNA analysis

The Function of Hair

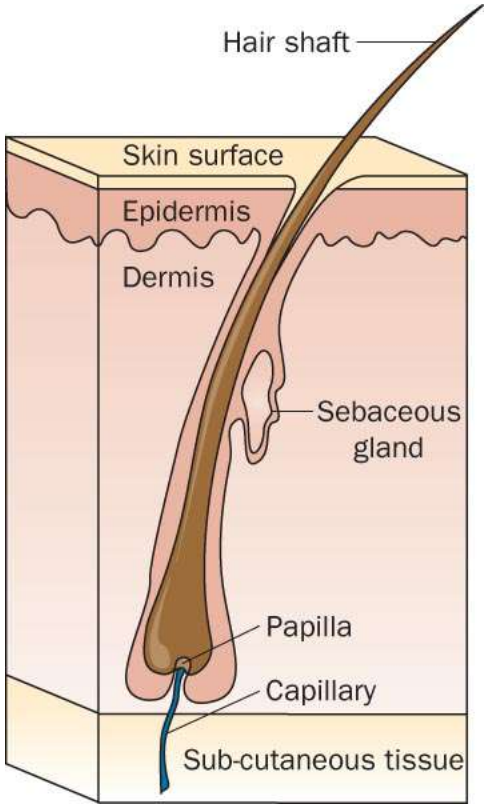
- Regulates body temperature
- Decreases friction
- Protects against sunlight

The Structure of Hair

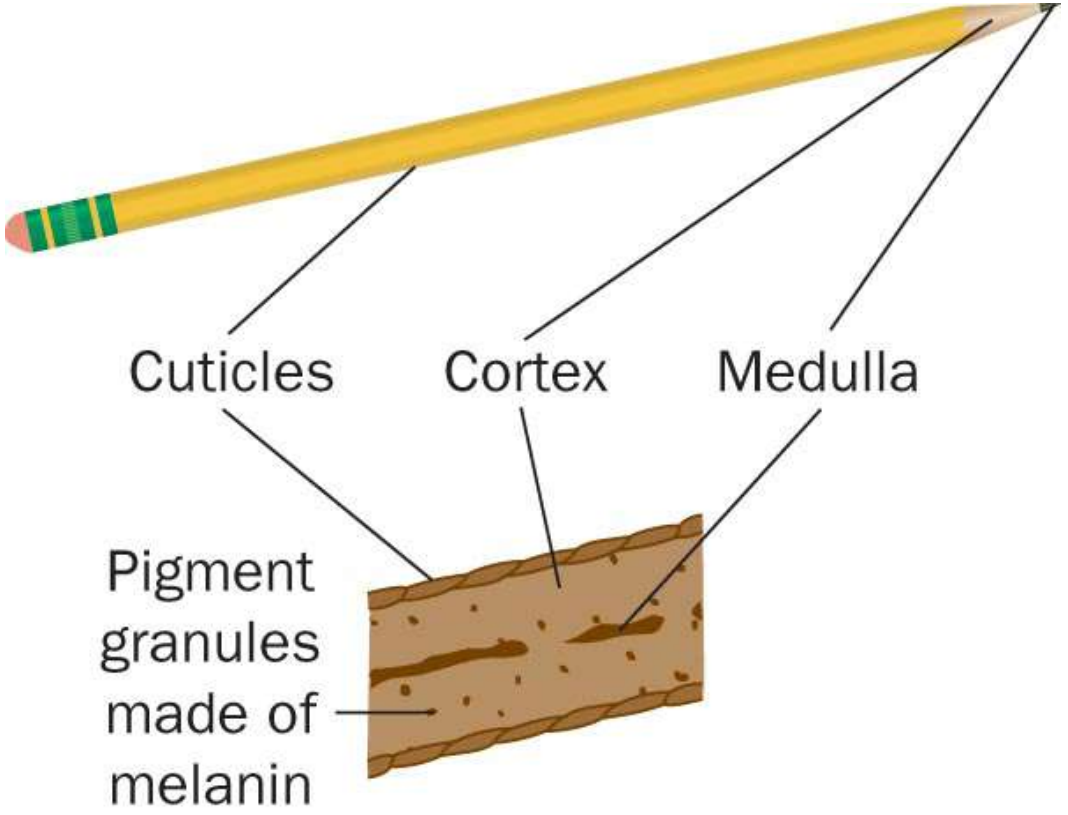


- A **follicle** embedded in the skin produces the **hair shaft**
- Three layers (illustrated above):
  - the inner medulla
  - the cortex
  - the outer cuticle

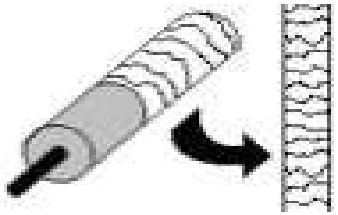
The Structure of Hair



Cuticles, Cortex, and Medulla



Types of Cuticle and Cortex



- **Cuticle:**
  - the outermost layer
  - over-lapping scales that protect the inner layers
- **Cortex:**
  - Thickest layer
  - Contains most of the pigment
  - Distribution of pigment varies
  - Usually denser nearer the cuticle

Types of Medulla

Medulla Pattern	Description	Diagram
Continuous	One unbroken line of color	
Interrupted (Intermittent)	Pigmented line broken at regular intervals	
Fragmented or Segmented	Pigmented line unevenly spaced	
Solid	Pigmented area filling both the medulla and the cortex	
None	No separate pigmentation in the medulla	

Types of Hair

Buckled **Blunt** **Double Medulla**

- A cross section: circular, triangular, irregular, or flattened
- Shape: influences the curl of the hair
- Texture: coarse or fine

Types of Hair

Human hair varies on the body

- Head
- Eyebrows
- Lashes
- Mustache
- Beard
- Underarms
- Body hair
- Pubic

The Life Cycle of Hair

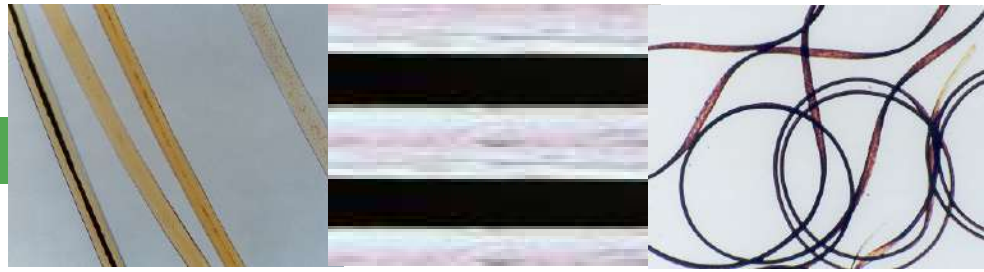
Hair proceeds through 3 stages as it develops:

- **Anagen** stage: (lasts 1,000 days) (80-90%)
  - hair actively grows
  - cells around the follicle rapidly divide and deposit materials in the hair
- **Catagen** stage: (2%)
  - hair grows and changes
- **Telogen** stage: (10-18%)
  - follicle becomes dormant, hairs easily lost

Treated Hair

- Bleaching
  - disturbs the scales on the cuticle and
  - removes pigment
  - leaves hair brittle and yellowish
- Dyeing colors the cuticle and the cortex
- Hair grows at about 1.3 cm per month
  - A forensic scientist can tell when the hair was last treated or colored

Racial Differences

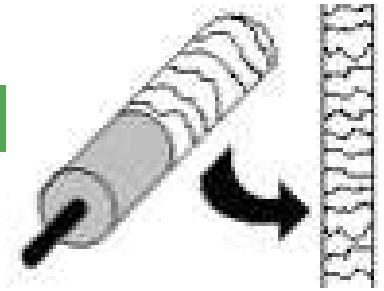


- Broad, racial groups do exhibit some shared physical characteristics
- But NOT applicable to all individuals in these groups

Therefore,

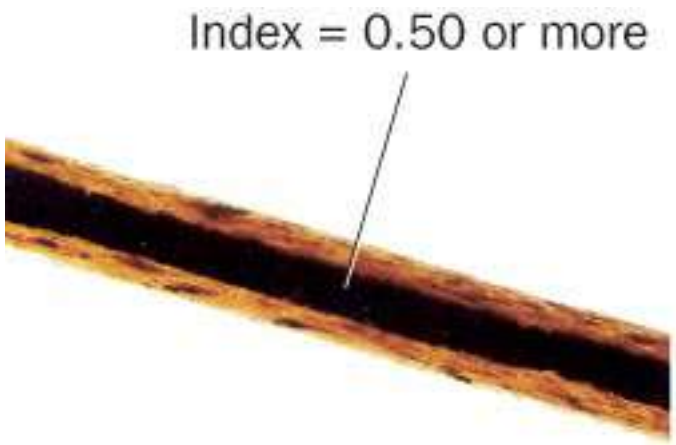
- Individual hairs CANNOT be assigned to any of these groups

Animal Hair and Human Hair



- Pigmentation:
  - animal hair is denser toward the medulla
  - human hair tends to be denser toward the cuticle
- Banded Color Patterns:
  - possible in animals
  - not in humans
- Medulla: much thicker in animals

Medulla Index—Animals vs. Humans



Cattle hair

Human hair

Animal Hair and Human Hair

Spinous **Coronal** **Imbricate**

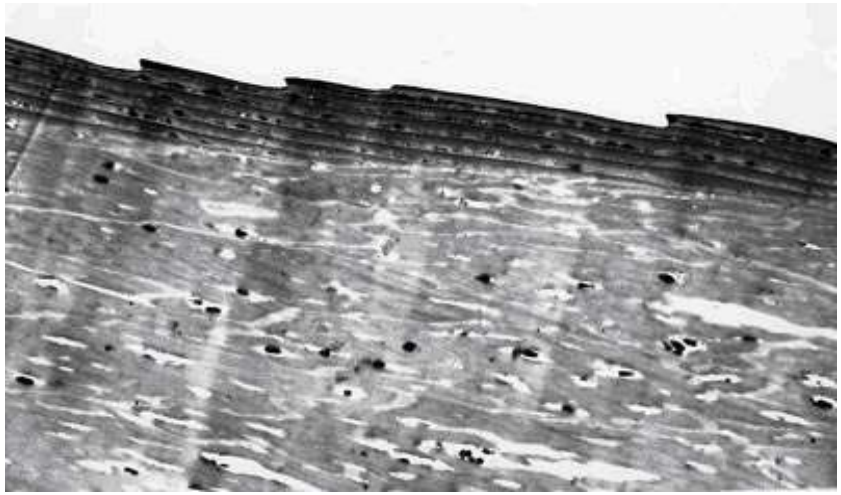
- Animals: cuticle scales resemble petals (spinous) or a stack of crowns (coronal)
- Humans: commonly flattened and narrow (imbricate)

Using Hair in an Investigation

- Macroscopic investigations indicate
  - length
  - color
  - curliness
- Phase contrast microscopy shows
  - presence of dye or other treatments
- Electron microscopes yield yet more detail

Using Hair in an Investigation

Note the overlapping scales and the pigment granules in the cortex



Testing for Substances in the Hair Shaft

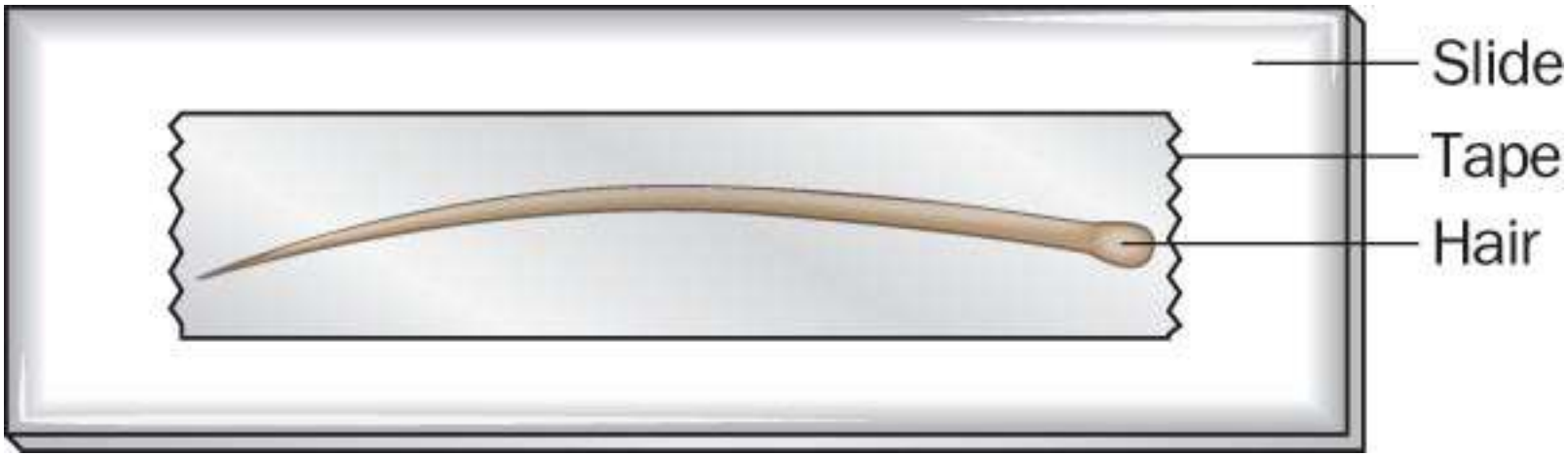
- Chemical tests
  - presence of various substances
- Examining a hair shaft
  - timeline for exposure to toxins
- Neutron Activation Analysis (NAA)
  - concentrations of substances (up to 14 different elements)

Testing the Hair Follicle

- Microscopic assessment
  - Cost effective and quick
- Blood test
  - Determine blood type
- DNA analysis
  - Identification with a high degree of confidence

Microscopic Assessment

- Preparation



. . . . . Summary . . . .

- Hair functions to regulate temperature, reduce friction, protect from light, and produce sensory data.
- Hair consists of a (a) hair shaft produced by a (b) follicle embedded in the skin.
- The shaft consists of an outer cuticle, a cortex, and an inner medulla.
- Hair characteristics vary depending on location on the body.

Summary

- Hair development has three stages: anagen, catagen, and telogen.
- Various hair treatments produce characteristic effects useful to forensic experts.
- Some characteristics can be grouped into general racial categories.
- Forensic experts examine hair using chemicals, light, electrons, neutrons, and DNA sequencing.