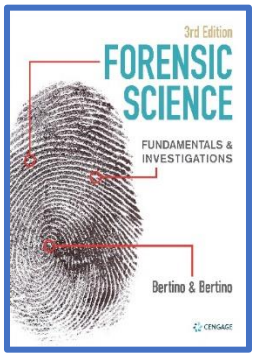

Chapter 6: Fingerprints Lesson Plans

Preparation:

These lesson plans are designed to help guide you in preparing your lessons for your forensic science course, including classroom and lab time. Each topic and corresponding learning objective are broken down for you with specific time estimates. A correlating PowerPoint presentation is also available to help engage students in the classroom. In addition to these Lesson Plans, we encourage you to refer to the Wraparound Teacher's Edition which contains additional information intended to assist you in teaching the topics introduced in this chapter. It includes background information, ways to engage students and enrich the learning experience, and explains how to differentiate learning for a heterogenous class. Review this additional information, found in the margins of the Wraparound Teacher Edition, when preparing to present your lesson.

Learning Objectives:

Covered in Lesson Plan

1. Summarize the history of fingerprinting including the development of new systems used in fingerprint analysis and identification.
2. Describe fingerprints and how they are formed.
3. Describe different characteristics and types of fingerprint patterns.
4. Describe the proper procedures involved in collecting and documenting fingerprint evidence.
5. Explain how fingerprints are analyzed and the reliability of fingerprint identification.
6. Discuss advances in fingerprinting that have enhanced the analysis and reliability of fingerprints in identifications.

Covered in Activities

7. Lift a latent print using different methods to analyze the print's ridge and minutiae patterns. (Activities 6-1, 6-2, and 6-7)
8. Distinguish among latent, plastic, and patent fingerprints. (Activity 6-3)
9. Prepare a ten card and analyze the ridge patterns of the prints. (Activity 6-4)
10. Analyze a fingerprint to determine if it is consistent with a fingerprint on record. (Activities 6-5 and 6-6)

Key Terms Introduced:

- **arch** a fingerprint pattern in which the ridge pattern originates from one side of the print and continues to the other side
- **biometrics** uses measurements and statistical analyses of someone's physical characteristics to aid in their identification
- **core** a center of a loop

- **delta** a triangular ridge pattern created when ridge patterns diverge
- **fingerprint** an impression left on any surface that consists of patterns made by the ridges on a finger
- **Integrated Automated Fingerprint Identification System (IAFIS)** FBI-developed national database of more than 76 million criminal fingerprints and criminal histories
- **latent fingerprint** a concealed fingerprint that is made visible through the use of powders or forensic techniques
- **loop** a fingerprint pattern in which the ridge pattern flows inward and returns in the direction of the origin
- **minutiae** the combination of details in the shapes and positions of ridges in fingerprints that makes each unique; also called ridge characteristics
- **patent fingerprint** a visible fingerprint produced when fingers coated with blood, ink, or some other substance touch a surface and transfer their print to that surface
- **plastic fingerprint** a three-dimensional fingerprint made in soft material such as clay, soap, or putty
- **ridge count** the number of ridges between the center of a delta and the core of a loop
- **ridge pattern** the recognizable pattern of the ridges found in the end pads of fingers that form lines on the surfaces of objects in a fingerprint. They fall into three categories: arches, loops, and whorls. They are also visible on the soles of feet and bottoms of toes
- **ten print card** a form used to record and preserve a person's fingerprints
- **whorl** (plain whorl) a fingerprint pattern that resembles a bull's-eye

References:

Forensic Science, 3e

Search the Internet for "FBI-Latent Print of the Year 2012" and read how a cold case was solved using IAFIS.

Introduction

A. Analyzing fingerprint evidence today involves far more than looking at the fingerprints left at a crime scene.
B. As technology has advanced, so has the world of fingerprint analysis.
C. Today, law-enforcement officers can quickly and easily submit fingerprints to a national database and obtain the identity of a suspect if their prints were entered into the database.
D. Although fingerprints are mostly considered individual evidence, biometrics have improved the ability to establish one's identity.

Reference: *Forensic Science*, p. 192
Slide: 6-2 and 6-3

I. The History of Fingerprinting

Learning Objective 6-1: Summarize the history of fingerprinting including the development of new systems used in fingerprint analysis and identification.

A. Ancient interest in fingerprints
   1. Chinese use fingerprints and palm prints pressed into clay for official seals and legal documents in the third century BC
   2. Fingerprints pressed into clay tablet contracts date to Babylon 1792–1750 BC
   3. In ancient China, inked fingerprints on all official documents were common practice
B. Western Culture
   1. 1684
      a. Earliest record of the study of the patterns on human hands
   2. 1788
      a. Johann Christoph Andreas Mayer described "the arrangement of skin ridges is never duplicated in two persons"
   3. 1800s
      a. 1823: Jan Evangelist Purkinje described nine distinct fingerprint patterns
      b. 1856: Sir William Herschel noted that fingerprint patterns were unique to each person and not altered by age
      c. 1896: New system created with all 10 fingerprints of a person on a card; now called ten print card
   4. 20th century
      a. 1902: Fingerprints replaced the Bertillon measurements for identification
      b. 1980: AFIS used by individual states

   c. 1999: IAFS replaced manual fingerprint searching
5. 21st century
   a. 2011: NGI launched matching algorithmic patterns in its AFIT; launch of RISC
   b. 2013: NGI implemented palm and hand edge prints
   c. 2014: NGI added facial recognition and added Rap Back
   d. 2015: NGI included iris and identification examination in addition to scars, marks, and tattoos
   e. 2018: EBTS implementation; will ultimately contain complete biometric and biographical profiles

Reference: *Forensic Science*, pp. 192-194
Slides: 6-4 and 6-5

II. The Science of Fingerprints

Learning Objective 6-2: Describe fingerprints and how they are formed.

[Time Allocation: 5 min.]

A. Ridges on fingers
   1. Raised portions of skin
   2. Arranged in connected units
      a. Dermal, or friction, ridges
   3. Leave marks when pressed against things
      a. Impression is called a fingerprint
      b. Consist of secretions from skin and dirt
      c. Considered individual evidence
B. Formation of fingerprints
   1. Patterns are formed during the 10^{th} week of gestation
      a. Similar ridges form on palms and sides of hands, soles of feet and toes
   2. Ridge patterns
      a. Found on end pads of fingers
      b. Form lines on the surfaces of objects
      c. Grow in the basal layer
      d. May be altered by scars with damage to the dermal layer

Reference: *Forensic Science*, p. 195
Slides: 6-6 and 6-7

III. Characteristics of Fingerprints

Learning Objective 6-3: Describe different characteristics and types of fingerprint patterns.

[Time Allocation: 10 min.]

A. Types of fingerprints
   1. Patent fingerprints
      a. Visible prints
   2. Plastic fingerprints
      a. Actual indentations left in a soft material
   3. Latent fingerprints
      a. Not visible to the unaided eye
      b. Can be made visible (developed)
         i. Dusting with powders
         ii. Lifting by using tape or adhesive lifter

B. Basic ridge patterns
   1. Named for their general visual appearance
      a. Loops (about 65 percent of population)
      b. Whorls (about 30 percent of the population)
         i. Plain whorl (24 percent)
         ii. Central pocket loop whorl (2 percent)
         iii. Double loop whorl (4 percent)
         iv. Accidental whorl (0.01 percent)
      c. Arches (about 5 percent of the population)
         i. Plain arch (4 percent)
         ii. Tented arch (1 percent)
   2. Ridge count is the number of ridges between the core and center of the delta
      a. The core is the center of a loop or whorl
      b. A delta is a triangular ridge pattern

C. Minutiae and fingerprint identification
   1. Unique ridge characteristics details
      a. Number and location of minutiae create a unique signature
      b. About 150 individual characteristics are on a full print
   2. Minutiae patterns
      a. Ridge ending (including broken ridge)
      b. Fork (or bifurcation)
      c. Island ridge (or short edge)
      d. Bridge
      e. Spur (or hook)
      f. Eye (enclosure or island)
      g. Double bifurcation

h. Delta
i. Trifurcation

Reference: *Forensic Science*, pp. 195-198
Supplements: Activity 6-1, Activity 6-2, and Activity 6-5
Slides: 6-8 through 6-10

IV. Collection and Documentation of Fingerprints

Learning Objective 6-4: Describe the proper procedures involved in collecting and documenting fingerprint evidence.

[Time Allocation: 10 min.]

A. Training for CSIs
   1. Where to look for fingerprint evidence
   2. Identifying different types of fingerprints
   3. Type of lighting, powders, or chemicals should be used to enhance the fingerprint
   4. How to photograph and document each fingerprint
B. Photographing fingerprints
   1. Using alternative light sources
      a. Lasers
      b. LED devices
   2. Photographing *in situ* before lifting
C. Methods of collection
   1. Collecting latent fingerprints
      a. Enhancing the print
         i. Dusting with carbon or magnetic powder
         ii. Using fluorescent dye stains or powders
      b. Lifting the print
         i. Using tape
   2. Collecting patent prints
      a. Patent or visible prints found in blood or ink
      b. Immediately photographed
      c. Source is dried and bagged
   3. Collecting plastic prints
      a. Appear as indentations on soft items
      b. First photographed
      c. Source collected and cast if necessary
   4. Collecting suspect prints
      a. Rolling each of the 10 fingers in ink
      b. Rolling them onto a ten print card

Reference: *Forensic Science*, pp. 199-200

Supplements: Activity 6-3, Activity 6-4, and Activity 6-7
Slides: 6-11 through 6-13

V. Forensic Analysis of Fingerprinting

Learning Objective 6-5: Explain how fingerprints are analyzed and the reliability of fingerprint identification.

[Time Allocation: 10 min.]

A. Initial assessment
   1. Made by fingerprint expert
   2. Determines if fingerprint has adequate quality and quantity of features
B. Automated fingerprint searches
   1. 1999: IAFIS
      a. Digital fingerprint searches
      b. Latent print searches
      c. Electronic storage of fingerprint photo files
      d. Electronic exchange of fingerprints
      e. Operates 24 hours a day, 365 days a year
   2. 2011: FBI's NGI
      a. Enhanced and will ultimately replace IAFIS
      b. Improved automated fingerprint, latent capabilities, mobile fingerprint identification, and electronic storage
      c. Incorporated biometrics, facial recognition, iris scans, and palm and hand edge prints
   3. 2019: RISC
      a. NGI contained Repository for Individuals of Special Concern with 5 million sets of fingerprints
      b. Over 24,000 law-enforcement agencies submit fingerprints and other identify information to NGI
   4. Today
      a. Most fingerprints are compared using technology first
         i. Image enhancement algorithms
         ii. Scanners used to identify and mark minutiae points
         iii. Software to calculates distances and angles between key minutiae points
      b. Final comparisons are made by an expert
         i. Today, there has been a 90 percent reduction in the number of manual fingerprint reviews
C. Fingerprint reliability and validity
   1. Subjectivity of the examiner
      a. Problem of fingerprint evidence analysis in the past
      b. Led to creation of SWGs

i. Ensure high standards of evidence evaluation
ii. Became OSAC in 2014

2. Recommendations made by SWG and OSAC
   a. Results need to be double-checked
   b. Language for trials needs to be standardized
      ii. Conclusions can be: exclusive, inclusive, or inconclusive

D. Altering or disguising fingerprints
   1. John Dillinger
      a. Put acid on his fingertips to change their appearance
      b. Based on Cuban pineapple field workers
         i. Did not have readily visible fingerprints
         ii. Effects of working with pineapple plants was temporary
   2. Fingerprints from Dillinger's body
      a. Had grown back even after putting acid on them
      b. Allowed him to be identified

Reference: *Forensic Science*, pp. 201-203
Supplements: Activity 6-6 and Capstone Project 3
Slides: 6-14 through 6-17

VI. Advances in Fingerprinting

Learning Objective 6-6: Discuss advances in fingerprinting that have enhanced the analysis and reliability of fingerprints in identifications.

[Time Allocation: 5 min.]

A. New technology
   1. Significantly improved fingerprint analysis
      a. Speed, accuracy, and reliability
   2. Scanning technology and digital systems of identifying patterns
      a. Algorithm that automates and standardizes the key first step
      b. Assesses a fingerprint's quality and quantity for usability
   3. Analysis of trace amounts of DNA found in fingerprints
      a. Fingerprints contain sweat that can be chemically analyzed
      b. Can determine if explosive or chemicals were handled
   4. Molecular fingerprint
      a. Technology under development
      b. May be able to tell us much more about the lives of the fingerprint donor than just identity

Reference: *Forensic Science*, pp. 203-204
Slide: 6-18

VII. Summary

[Time Allocation: 10 min.]

- Humans have noticed the patterns on their hands for thousands of years, but it was not until 1684 that these patterns were described in detail. In the mid-1800s, the idea of a fingerprint's uniqueness was studied, and the application of fingerprints to an identification system began. By the late 1800s, two effective systems were being used to identify criminals, and fingerprints were being collected as evidence in crimes. In the past 20 years, improvements in technology have improved fingerprint analysis and reliability.
- The elevated regions in the skin of the finger are called friction ridges formed early in development between two layers of skin. Unique to individuals, their shape does not change during their lifetime.
- Fingerprints left on an object are created by the naturally occurring ridges in the skin of fingertips and secretions from sweat glands that leave small amounts of oils and salts when the ridges are pressed against an object. The residues leave a reproduction of the ridges found on the finger of the donor.
- Fingerprints found at a crime scene are latent, not easily seen without the addition of powders or chemical; plastic prints are found embedded in soft materials; patent prints are formed when fingers come in contact with a material and are transferred to a surface.
- Fingerprint patterns are classified as loops, whorls, and arches. A core is the center of a loop or whorl. A delta is a triangular region where the ridges diverge. Ridge counts, measured from the center of the delta to the center of a core, provide distinguishing characteristics of fingerprints. The three basic patterns of fingerprints can be further subdivided into more specific subcategories.
- Minutiae patterns are small distinguishing features used to analyze fingerprints.
- Prior to advancements in scanners, fingerprint analysis was a very slow process undertaken by a fingerprint expert that was not always reliable.
- Criminals have sought to alter their fingerprints with chemicals, surgery, and superficial destruction. Some fingerprints can temporarily be altered by long-term contact with rough surfaces. Attempts at permanent fingerprint alteration have been painful, leaving mutilated, deformed, and even more recognizable fingerprints than the original fingerprints.
- Fingerprints must be properly collected and documented to be an acceptable evidence. Both the SWG and OSAC have developed

standards and protocols to improve fingerprint evidence reliability and validity.

- Fingerprint collection and documentation may involve dusting with specialized powders or chemicals, casting of plastic prints, and photographing the print.
- Today, much of fingerprint analysis is automated. Fingerprints of suspects can be quickly scanned and compared to a national FBI database of over 149 million fingerprints.
- Mobile handheld scanners obtain fingerprints of suspects, forward them to the national database. Within minutes, the police officer knows if the suspect has an open warrant for arrest, is on a terrorist or sex offender list, or has previously committed crimes.
- New technology continues to improve fingerprint analysis through machine learning to access usability of prints and improved scanning technologies using nanoparticles for pore analysis.
- New uses of fingerprints include DNA analysis and chemical analysis of the sweat found in prints using infrared spectromicroscopy to detect evidence of what donor touched or consumed.
- Fingerprint analysis has become less subjective, faster, and more reliable with advances in technology. AFIT's use of algorithms and NGI's inclusion of palm prints, rapid ID in the field, and biometrics have improved both reliability and validity of fingerprint analysis.

Reference: *Forensic Science*, pp. 204-205
Slides: 6-19 through 6-22

VIII. Assignment – Review Chapter 7 and reference accompanying teacher notes in the Wraparound Teacher's Edition of *Forensic Science, 3e*.