Forensic Science: An Essential STEM Component

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STEM School Leadership Forum

Expanding and Enhancing STEM in Schools

October 2, 2019

NJIT
New Jersey Institute of Technology

FIRST Forensic Science Degree in New Jersey

ONLY at NJIT

Bachelor of Science in Forensic Science: Curriculum Overview

MASTER THE BASICS

Complete coursework in biology, chemistry, physics, & mathematics. Become skilled in forensic evidence collection, technical analysis, data interpretation, and professional regulatory practices.

HONE YOUR EXPERTISE

Choose from one of two tracks in which to focus your forensic science studies: **Forensic Biology** or **Forensic Chemistry**. Each track is 120 credit hours and requires advanced coursework in analytical chemistry in addition to further specialized courses in either biology or chemistry.

BASIC SCIENCES COURSEWORK	
Biology (4)	Physics (8)
Chemistry (8)	Calculus (3-8)
Organic Chemistry (8)	Statistics (3)

ADVANCED CHEMISTRY COURSEWORK	
CHEM 221	Analytical Chemical Methods (2)
CHEM 222	Analytical Chemistry (3)
CHEM 473	Biochemistry (3)
CHEM 475	Biochemistry Lab I (2)
CHEM 480	Instrumental Analysis (2)

Bachelor of Science in Forensic Science: Curriculum Overview

- NJIT's forensic science program is designed to equip students with a strong background in forensic science core concepts, evidence collection, technical analysis, data interpretation, and professional regulatory practices.
- Students participate in a unique "Forensic Science Capstone" experience that entails a co-op position in a forensic science laboratory, professional workshops, or extensive forensic science research.
- NJIT's forensic science courses are taught by distinguished faculty and practicing professionals to ensure students gain working knowledge of the forensic science field and establish a professional network before graduation.

FORENSIC SCIENCE CORE COURSEWORK	
FRSC 201	Introduction to Forensic Science (3)
FRSC 307	Crime Scene Investigation & Lab (4)
HIST 320	Law & Evidence (3)
FRSC 359	Physical Methods of Forensic Analysis (4)
FRSC 475	Forensic Chemistry (4)
FRSC 480	Forensic Microscopy (4)
FRSC 49x	Forensic Science Capstone (3)

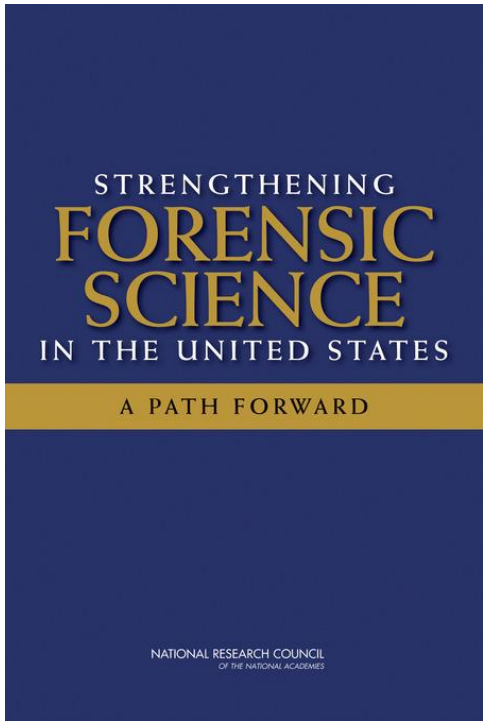
What is Forensic Science?

- In its broadest definition, forensic science is the application of science to criminal and civil laws.

- Do Science and the Law/Courts seek the same thing?

- The Prosecution and Defense in a criminal prosecution will each offer forensic expert witnesses attempting to discredit the other side.

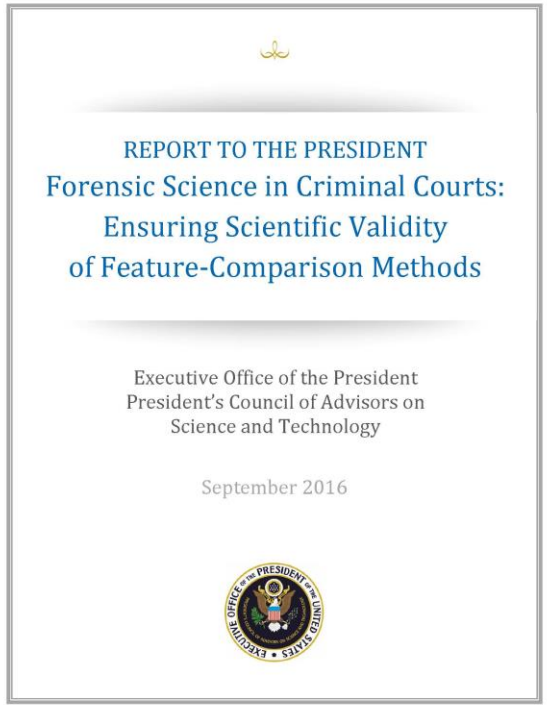
Recent High Profile National Reports



Committee on Identifying the Needs of the Forensic Sciences Community, National Research Council, 2009

Some recommendations:

- Expand research on the accuracy, reliability, and validity of the forensic sciences
- Develop tools for advancing measurement, validation, reliability, information sharing, and proficiency testing and to establish protocols for examinations, methods, and practices
- Improve the medico-legal death investigation system
- Support the use of forensic science in homeland security


REPORT TO THE PRESIDENT

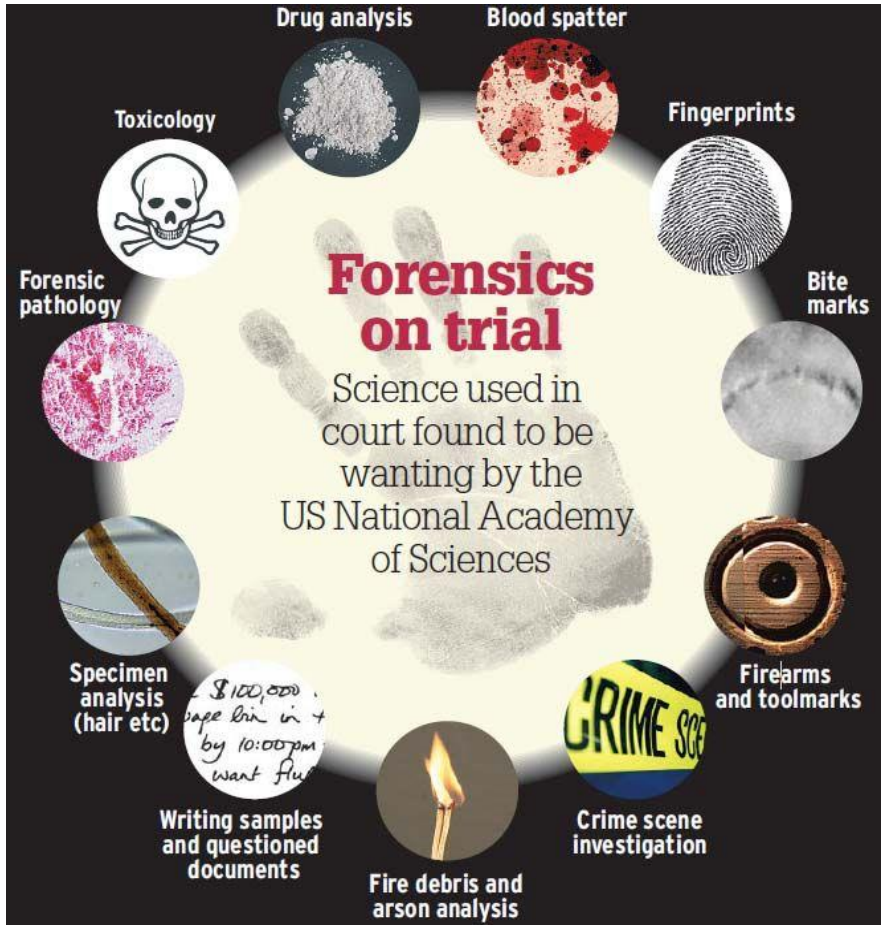
Forensic Science in Criminal Courts:
Ensuring Scientific Validity
of Feature-Comparison Methods

Executive Office of the President
President's Council of Advisors on
Science and Technology

September 2016

Stronger ties between the academic research community and the forensic science community.

NJIT's Role

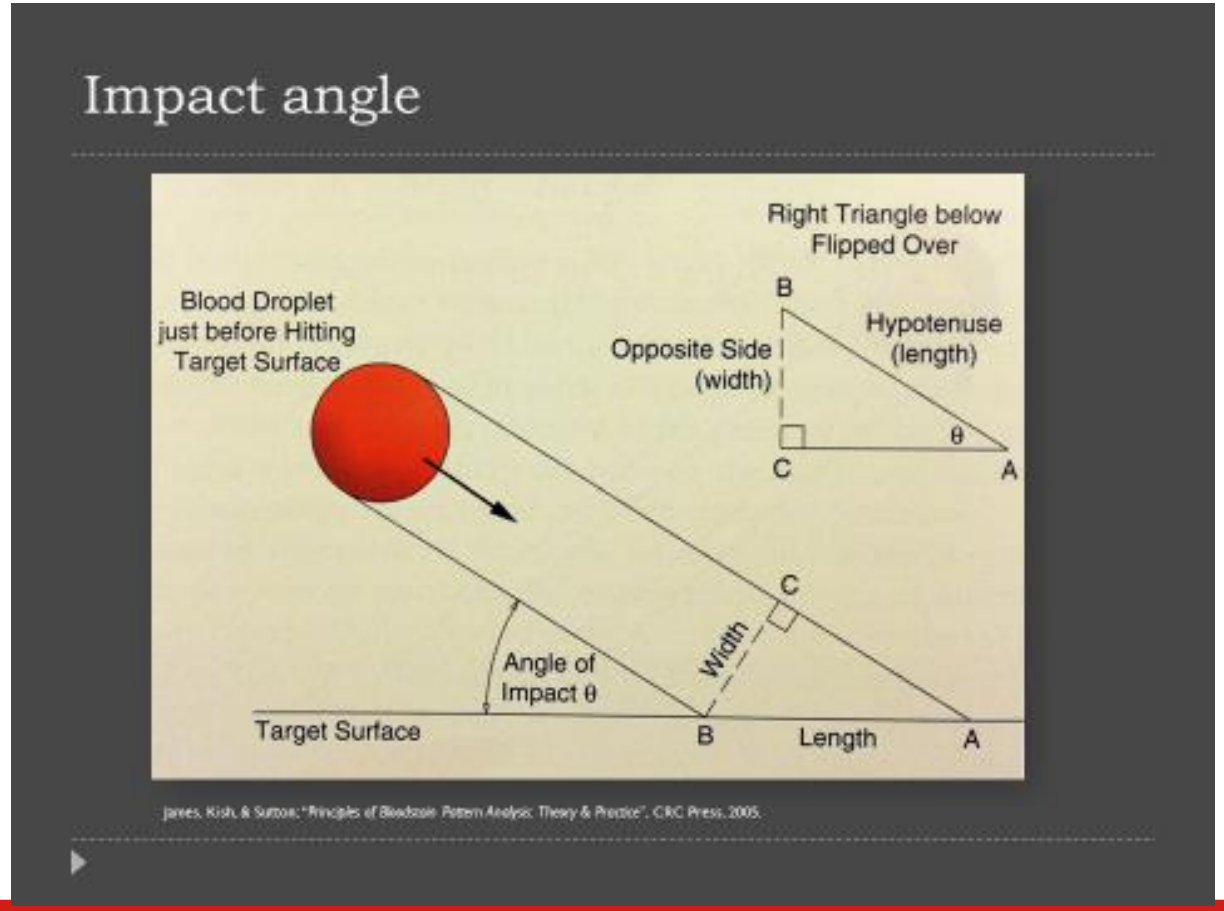


NJIT's program is a physical science-based curriculum designed to develop foundational science background, familiarity with professional standards & practices, critical thinking, & professional experience to prepare the next generation of highly qualified forensic scientists that will lead the profession.

Skills of a Forensic Scientist

- A forensic scientist must be skilled in applying the principles and techniques of the physical and natural sciences to the analysis of the many types of evidence that may be recovered during a criminal investigation.
- The expert witness is called on to evaluate evidence based on specialized training and experience that the court lacks the expertise to do.
- The expert will then express an opinion as to the significance of the findings.

Trigonometry through Bloodspatter Analysis



Electromagnetic Spectrum through Alternate Light sources

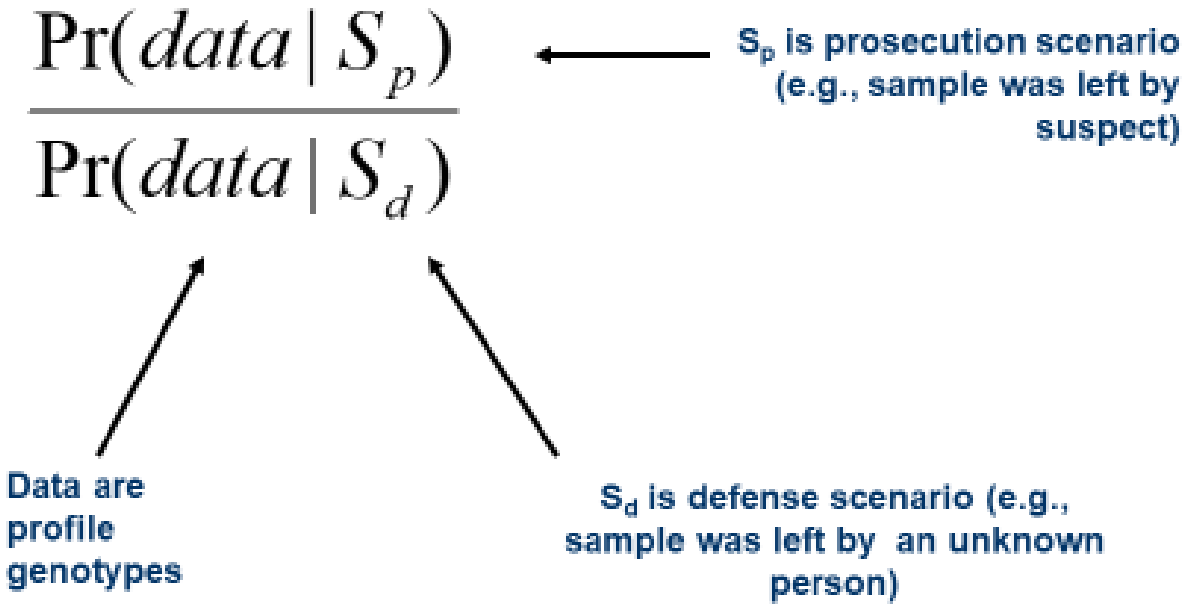
Check Forgery

Under white light

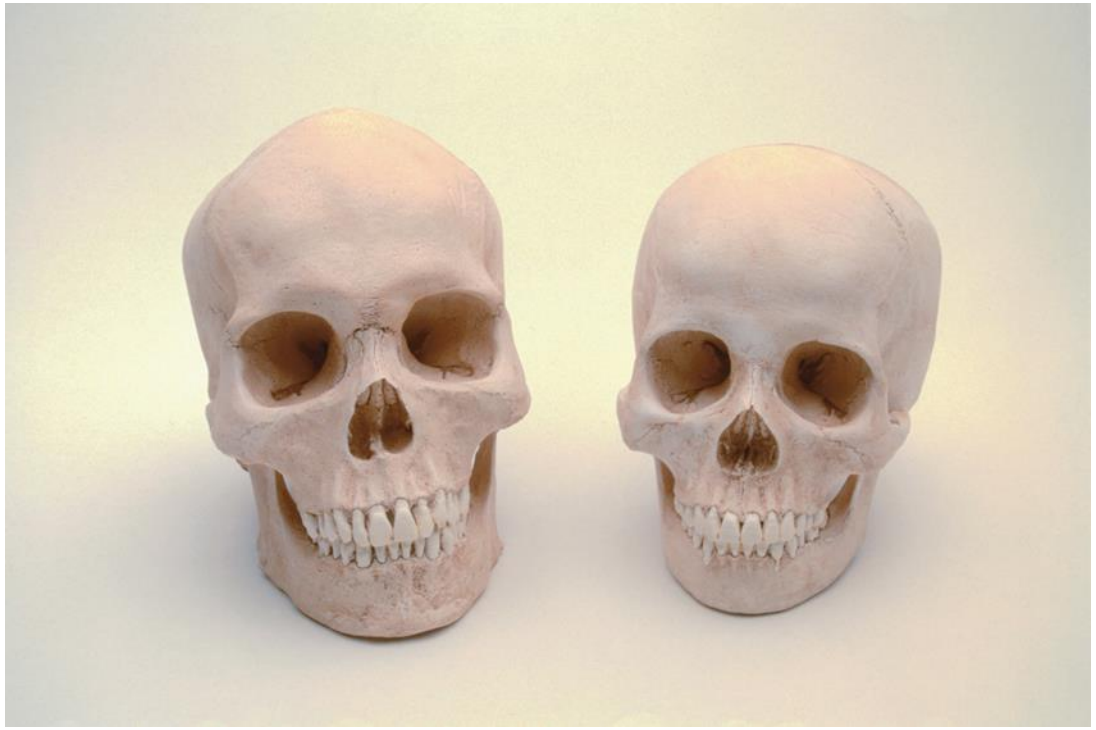
With IR

Statistics through Forensic DNA Analysis

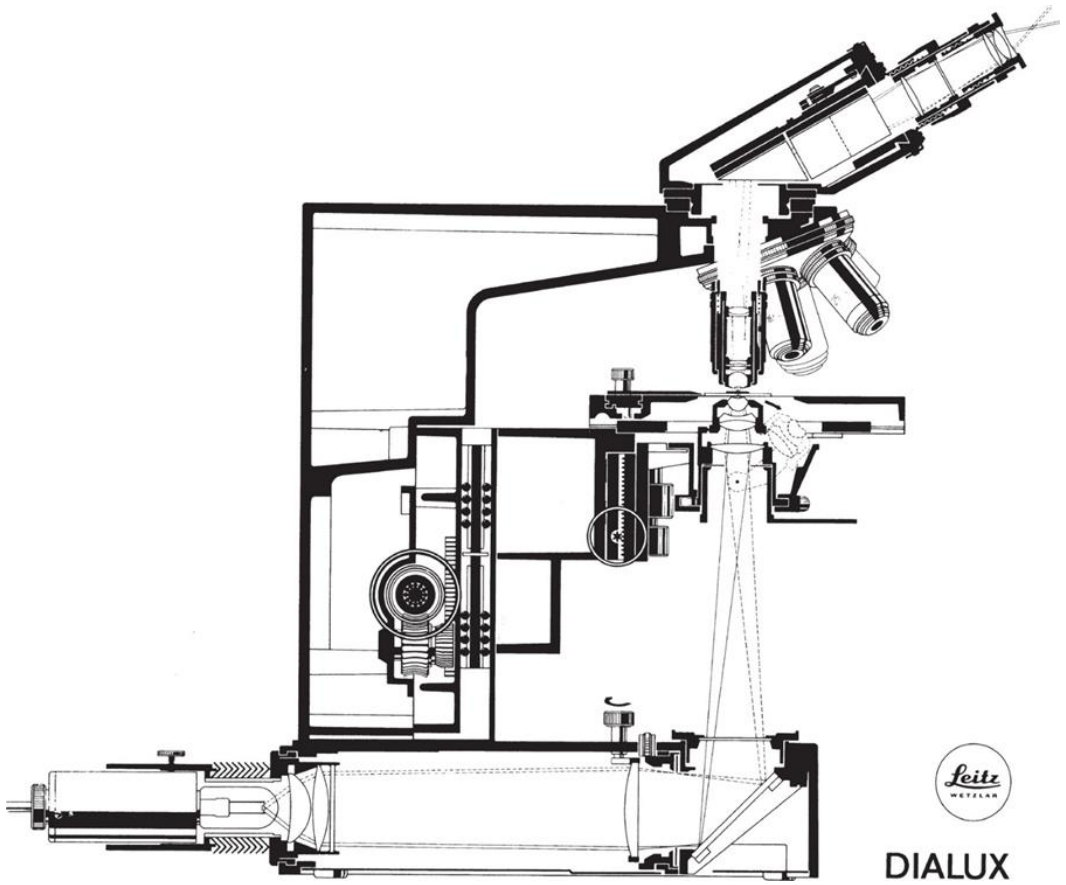
LIKELIHOOD RATIO: Traditionally



Anatonomy and Physiology through Forensic Anthropology

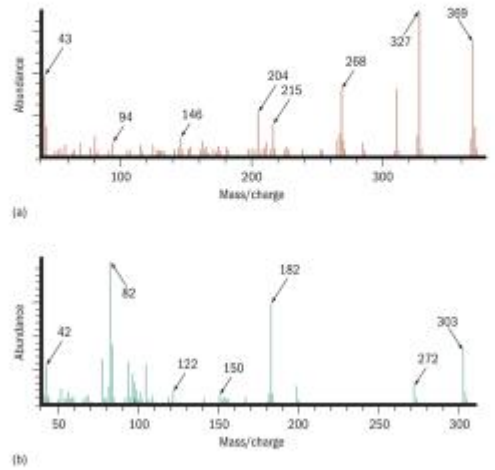


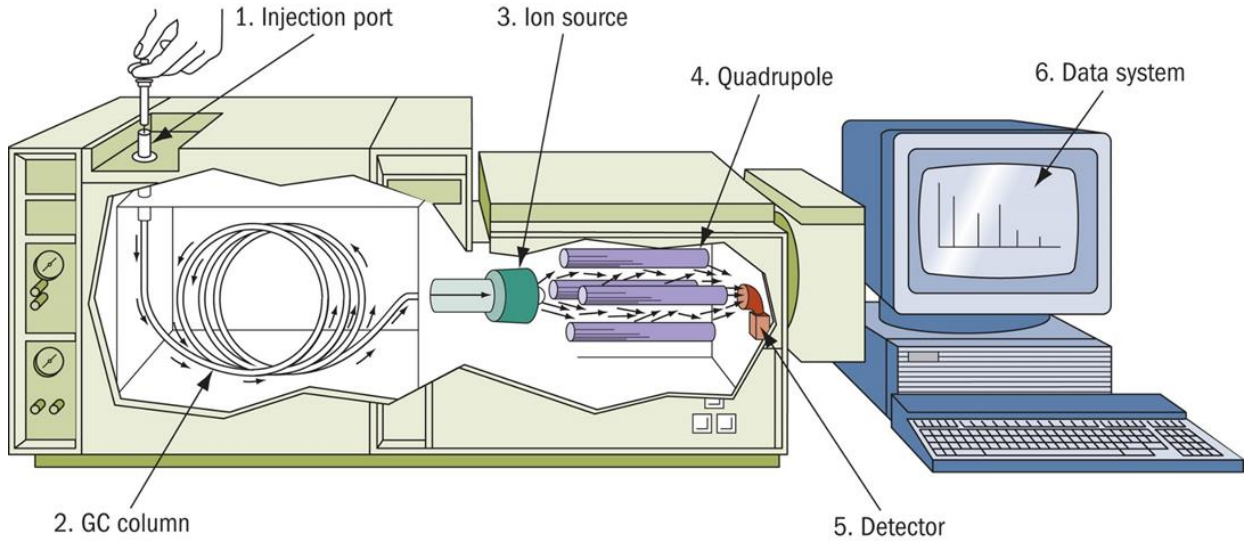
Light and Optics through Forensic Microscopy



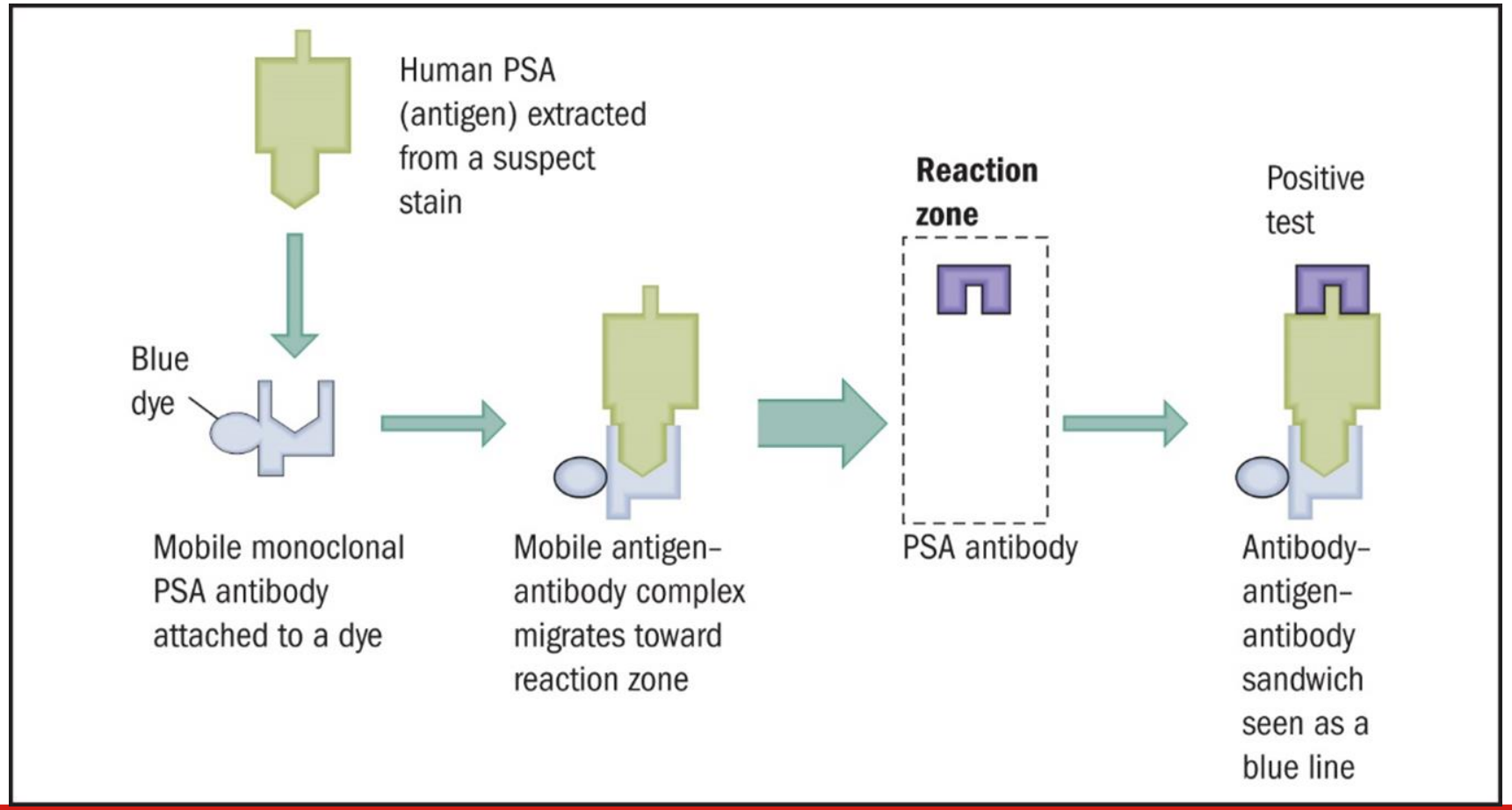
Chemistry through Forensic Drug Analysis

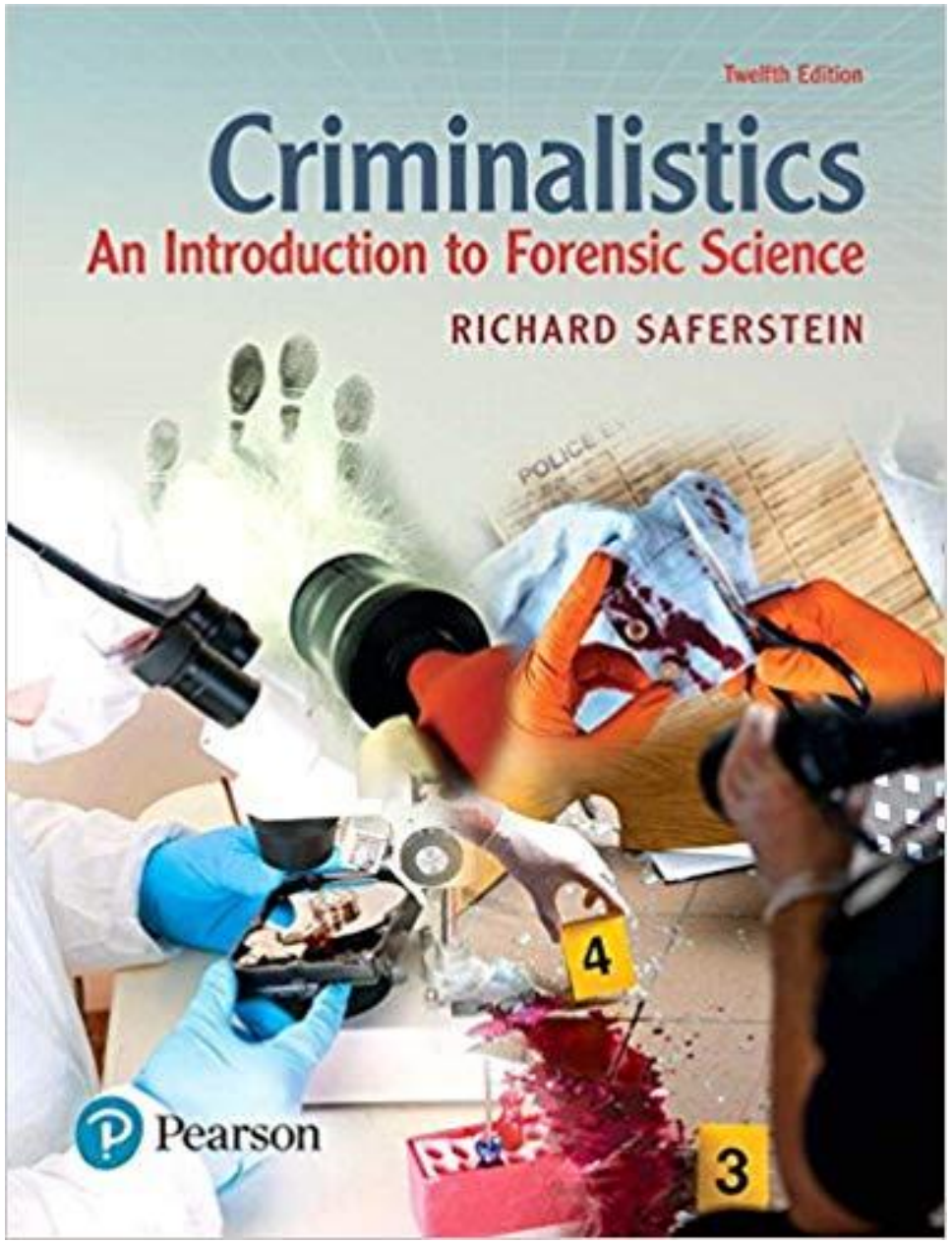
Figure 12–20 (a) Mass Spectrum of Heroin. (b) Mass Spectrum of Cocaine

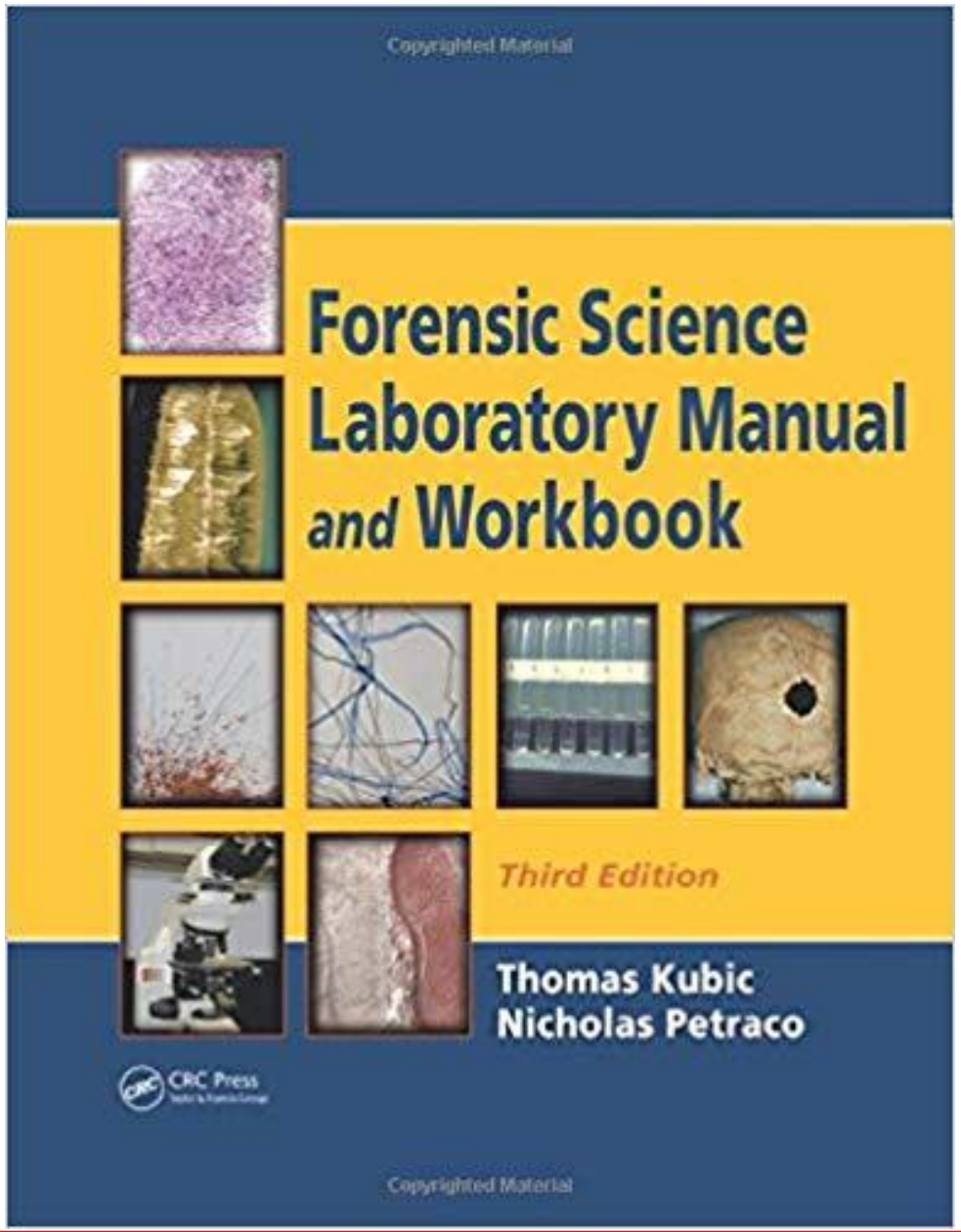




Immunology through Forensic Biology




Twelfth Edition
Criminalistics
An Introduction to Forensic Science
RICHARD SAFERSTEIN
Pearson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Forensic Science
Laboratory Manual
and Workbook
Third Edition
Thomas Kubic
Nicholas Petraco
CRC Press
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Analyzing Physical Evidence Requires Utilizing the Scientific Method

- The Scientific Method:
  - Formulate a question worthy of investigation.
  - Formulate a reasonable hypothesis to answer the question.
  - Test the hypothesis through experimentation.
  - Upon validation of the hypothesis, it becomes suitable as scientific evidence.

Step 1: Observation and Description

- The Forensic examiner must observe an incident or situation
  - (i.e. the crime scene or the evidence submitted to the crime lab)

- Alleged fraudulent check
- Alleged forged document

Step 2: Formulation of Hypothesis to explain the Phenomena

- Framing of the question or theory around the crime/incident.

- Is the check/document authentic?
- Could the suspect be the source of the questioned document?

Step 3: Use of the Hypothesis to Predict the Existence of other Phenomena, or to Predict Quantitatively the Results of New Observations

- The hypothesis is the tentative answer to the question: a testable explanation for what was observed.

- The forensic scientist attempts to explain what has been observed.
  - Hypothesis = the possible cause
  - Observation = the effect

- Built on the work of previous researchers. (i.e. literature review)

Step 4: Performance of Experimental Tests of the Predictions by Several Independent Experimenters

- Is the hypothesis supported by the results?
  - If yes, then the hypothesis is plausible
- Testing needs to be repeatable, reproducible, run against controls, and peer reviewed
  - To make sure results are accurate and not simply coincidental
- What constitutes a match?

Demo

- Each person will write a fraudulent check.
- Each person will also submit known writing samples.
- Examine the evidence (i.e. the check) for unique handwriting characteristics.
- Study the known handwriting samples to locate those exemplars with the same features as the check.
- Report your findings.

12 Handwriting Characteristics

Line quality is the thickness, strength, and flow of the letters. Some factors are if the letters are flowing, shaky, or very thick.

Letter spacing is the amount of space put between letters. The letters could all be connected or spaced drastically.

Height, width, and size of the Letters is very self-explanatory; this simply analyzes the proportions of the handwriting. Is one letter unusually tall or short?

Pen Lifts and Separations is the way the person writes. Do they stop before writing a new letter, or do they connect the letters? People usually use the same pen lifts, and so a forgery may stand out if all the letters are separated when the real signature connects them.

Connecting Strokes is similar to pen lifts and separations. This analyzes whether or not the capital letters are connected to lowercase letters and if words are connected.

Beginning and Ending Strokes looks at how the writer begins and ends their words. Do they end with a curl, and on an upstroke or a downstroke?

Unusual Letter Formation takes note of any peculiar, unique capital or lowercase letters. Does the writer add any extra curls or loops where the average author would not?

Shading (Pen Pressure) analyzes where the writer presses their writing utensil down the most, either on the upstroke or the downstroke. Where the most pressure is applied is where the script is thickest.

Slant looks at which way the letters tend to slant, either to the left, right, or no slant at all. The most average slant is to the right.

Baseline Habits is where the writer tends to write. It could be above the line, below the line, or on the line.

Flourishments and Embellishments are large loops and swirls in handwriting. The most common flourishment is on letters such as lowercase "G", "J", and "F" - anything that involves a loop!

Diacritic Placement is the way the author crosses their t's and dots their j's and i's

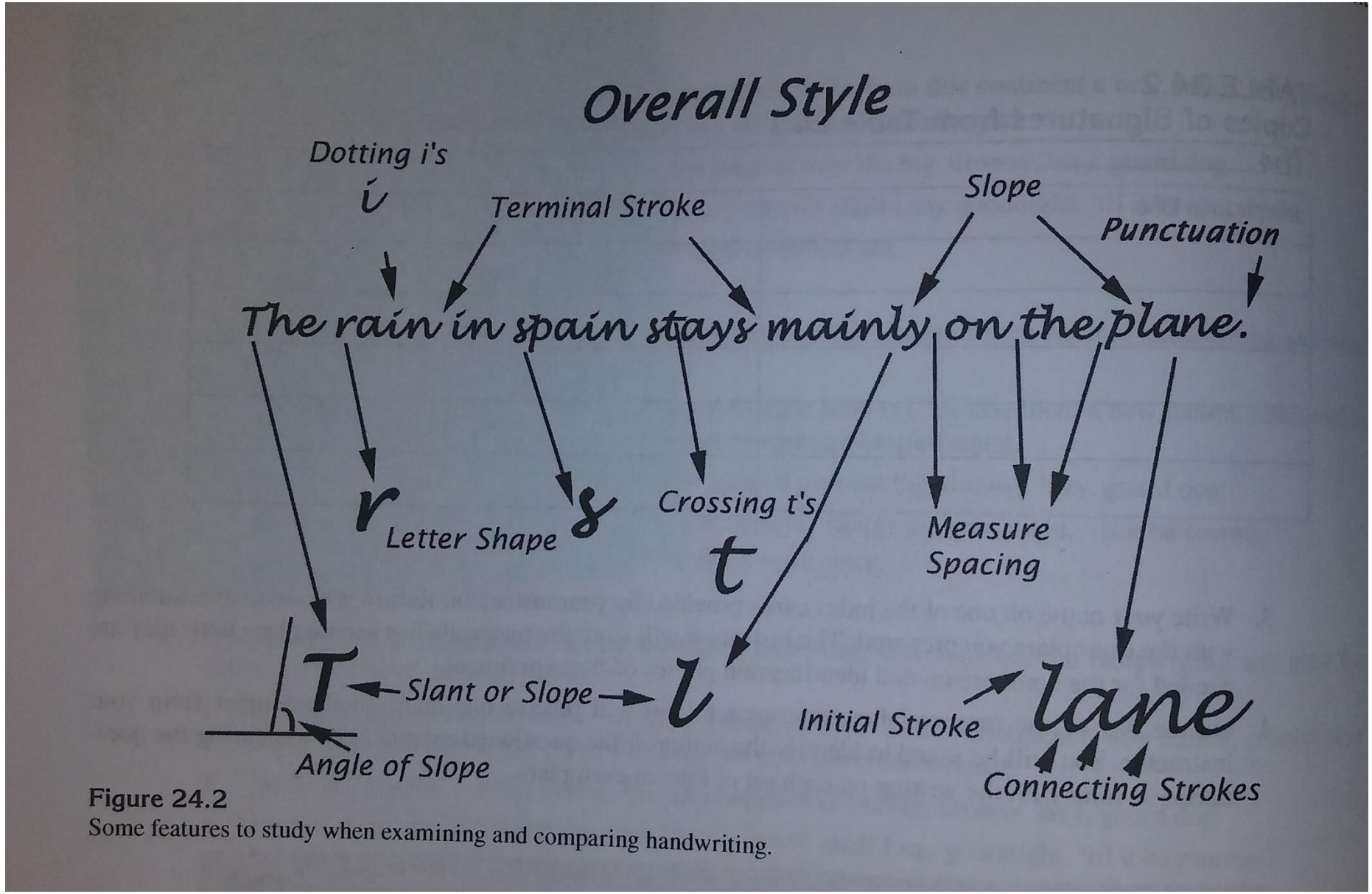

Figure 24.2
Some features to study when examining and comparing handwriting.

References

- Saferstein, R., *Criminalistics: An Introduction to Forensic Science*, Pearson, 2018.
- Kubic, T., and Petraco, N., *Forensic Science Laboratory Manual and Workbook*, CRC Press, 2009.

Questions?

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