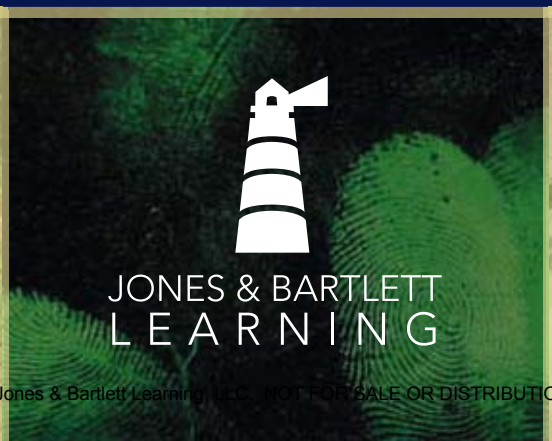
SECOND EDITION

Criminalistics

Forensic Science, Crime, and Terrorism

James E. Girard
American University



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Dedicated to all my children and grandchildren.

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Brief Contents

SECTION 1

Introduction to Criminalistics 3

CHAPTER 1 Investigating the Crime Scene 5

CHAPTER 2 Investigating and Processing Physical Evidence 31

SECTION 2

Trace Evidence 57

CHAPTER 3 Physical Properties: Forensic Characterization of Soil 59

CHAPTER 4 The Microscope and Forensic Identification of Hair, Fibers, and Paint 79

CHAPTER 5 Forensic Analysis of Glass 111

SECTION 3

Pattern Evidence 131

CHAPTER 6 Fingerprints 133

CHAPTER 7 Questioned Documents 161

CHAPTER 8 Firearms 187

SECTION 4

Chemical Evidence 211

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CHAPTER 9 Inorganic Analysis: Forensic Determination of Metals and Gunshot Residue 213

CHAPTER 10 Arson 245

CHAPTER 11 Drugs of Abuse 269

SECTION 5

Biological Evidence 303

CHAPTER 12 Forensic Toxicology 305

CHAPTER 13 Biological Fluids: Blood, Semen, Saliva, and an Introduction to DNA 329

CHAPTER 14 Forensic DNA Typing 357

SECTION 6

Terrorism 389

CHAPTER 15 Computer Forensics, Cybercrime, and Cyberterrorism 391

CHAPTER 16 Explosives 415

CHAPTER 17 Detecting Weapons of Mass Destruction 443

APPENDIX A

Forensic Science Resources 467

APPENDIX B

Measurement and the International System of Units (SI) 471

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Contents

Resource Review *00*
Preface *00*
Organization . . . . . **xiii**
Course Use . . . . . **xiv**
Acknowledgments *00*

SECTION 1

Introduction to Criminalistics **3**

CHAPTER 1

Investigating the Crime Scene **5**

Introduction **6**
Securing the Crime Scene **6**
Identifying, Establishing, Protecting, and Securing the Boundaries 6
Documenting the Scene and the Evidence . . . **8**
Note Taking 8
Photography 9
Sketching 10
Videography 12
Systematic Search for Evidence **13**
Recognition of Physical Evidence **14**
Collection, Preservation, Inventory, and Transportation of Physical Evidence **15**
Types of Evidence 15
Packaging Evidence **17**
Submitting Evidence to the Crime Laboratory **18**
Chain of Custody **19**
Criminal Evidence and the Fourth Amendment **19**
Exceptions to the Fourth Amendment 20
The Supreme Court and the Fourth Amendment . 21
Conclusion 23

CHAPTER 2

Investigating and Processing Physical Evidence **31**

Introduction **32**
Types of Evidence **32**
The Modern Crime Lab **33**
National Laboratories 34
State and Municipal Laboratories 35
Divisions of the Crime Lab 35
Functions of a Forensic Scientist **36**
Additional Information 36
State of the Evidence **37**
Why Examine Physical Evidence? **38**
Characteristics of Physical Evidence **38**
Identification 38
Associative Evidence 39
Crime Scene Reconstruction **43**
Pattern Evidence 44
Explosion Patterns 44
Firearm Ballistics 44
Entry and Exit Hole Geometry 44
Bullet Trajectory 44
Bullet Ricochet 45
Shell Casings 45
Bloodstain Patterns 45

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Point of Convergence 47
Physical Evidence in Court 49
Expert Testimony 50

SECTION 2
Trace Evidence 57

CHAPTER 3
Physical Properties: Forensic Characterization of Soil 59
Introduction 60
Physical and Chemical Properties 60
The Metric System 61
The International System of Units. 62
SI Base Units 62
Conversion from the SI to the English System (and Vice Versa) 63
Mass and Weight 64
Temperature. 64
Density. 66
Soils 67
Forensic Characteristics of Soils 68
Gradient Tube Separation of Soil: Separation by Density 70
Collection and Preservation of Soil Evidence 71

CHAPTER 4
The Microscope and Forensic Identification of Hair, Fibers, and Paint. 79
Introduction 80
Magnifying Small Details 80
Refraction 80
Types of Microscopes 81
Compound Microscopes 83
Comparison Microscopes 85
Stereoscopic Microscopes 85
Polarizing Microscopes 86
Microspectrophotometers 88
Scanning Electron Microscopes. 89
Forensic Applications of Microscopy: Hair 90
Hair Morphology 90
Hair Growth. 92
Comparison of Hair by Microscopy 93
Collecting Hair Evidence. 93
Information Obtained by Microscopic Comparison of Hair. 93
Forensic Applications of Microscopy: Fibers 94
Natural Fibers 94
Synthetic Fibers 97
Paint 101
Automobile Paint. 101
Collection of Paint Evidence 102
Forensic Analysis of Paint 102

CHAPTER 5
Forensic Analysis of Glass 111
Introduction 112
Types of Glass 112
Tempered Glass 113
Windshield Glass. 113
Forensic Examination of Glass Evidence: An Overview 114
Non-Optical Physical Properties of Glass 115
Surface Striations and Markings 115
Surface Contaminants 115
Thickness. 115
Hardness 115
Glass Fractures 116
Characteristics of Glass Fractures 116
Forensic Examination of Glass Fractures 117
Glass Density Tests 118
Optical Physical Properties of Glass 119
Color 119
Refractive Index. 119
Refractive Index of Tempered versus Nontempered Glass. 122
Variations in Density and Refractive Index. 123
Elemental Analysis of Glass. 124

SECTION 3
Pattern Evidence 131

CHAPTER 6
Fingerprints 133
Introduction 134
History of Fingerprinting 134
Characteristics of Fingerprints 137
Uniqueness of Fingerprints. 137
Permanence of Fingerprints 138
Fingerprint Patterns. 139
Fingerprint Identification Points. 140
Methods for DevelopingFingerprints 140
Recovering Fingerprints from Hard and Nonabsorbent Surfaces 142

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Recovering Fingerprints from Soft and Porous Surfaces . . . 143
Preservation of Fingerprints . . . 145
Photography of Fingerprints: An Overview . . . 145
Digital Imaging of Fingerprints . . . 148
Classification of Fingerprints . . . 149
Primary Classification . . . 149
Automated Fingerprint Identification System . . . 150
Fingerprints for Biometric Identification . . . 151
Finger Scanning . . . 151
Biometrics-Related Issues . . . 153

CHAPTER 7

Questioned Documents . . . 161

Introduction . . . 162
Handwriting . . . 163
Development of Handwriting . . . 164
Comparison of Handwriting . . . 164
Collection of Handwriting Exemplars . . . 166
Signatures . . . 166
Erasures, Obliterations, and Alterations . . . 168
Optical Analysis of Ink . . . 169
Optical Analysis of Concealed Information . . . 169
Chemical Analysis of Ink . . . 170
Indented Writing . . . 170
Typed and Word-Processed Documents . . . 171
Photocopied Documents . . . 173
Paper . . . 174
Nondestructive Tests for Paper . . . 174
Destructive Tests for Paper . . . 174
Security Printing . . . 175
Currency . . . 175
Canadian Currency . . . 176
Identity Documents . . . 177
Use of Biometrics for Identity Authentication . . . 178
US-VISIT . . . 178
Testimony of Document Examiners . . . 179

CHAPTER 8

Firearms . . . 187

Introduction . . . 188
Firearm Accuracy . . . 188
Increasing the Force of the Bullet . . . 191
Improving the Rate of Firing and Firing Reliability . . . 191
Handguns . . . 192
Revolvers . . . 192
Semiautomatic Pistols . . . 192
Silencers . . . 194
Submachine Guns . . . 194
Rifles . . . 194
Shotguns . . . 195
Ammunition . . . 195
Cartridges . . . 196
Shotgun Ammunition . . . 198
Ballistics . . . 198
Collection and Preservation of Firearm Evidence . . . 199
Collection and Preservation of Firearms . . . 199
Serial Number Restoration . . . 200
Collection and Preservation of Ammunition . . . 201
Laboratory Examination of Firearm Evidence . . . 201
Laboratory Examination of Fired Bullets . . . 202
Automated Ballistics Comparisons . . . 203
Laboratory Examination of Expended Cartridges . . . 204

SECTION 4

Chemical Evidence . . . 211

CHAPTER 9

Inorganic Analysis: Forensic Determination of Metals and Gunshot Residue . . . 213

Introduction . . . 214
Elements and Compounds . . . 214
Elements and Molecules . . . 216
Physical Properties of Inorganic Substances . . . 217
Elements and Subatomic Particles . . . 218
Atomic Number . . . 219
Periodic Table . . . 219
Periods and Groups . . . 219
Metals and Nonmetals . . . 221
Techniques for the Analysis of Inorganic Materials . . . 221
Electromagnetic Radiation and Spectra . . . 222
Electron Configuration and the Periodic Table . . . 226
Forensic Determination of Metals . . . 229
Atomic Spectroscopy . . . 229
Inductively Coupled Plasma Optical Emission Spectroscopy . . . 229
Determining the Elemental Composition of Glass by ICP-OES . . . 231
X-Ray Fluorescence Spectrometry . . . 232

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Gunpowder Residue 233
Composition of Gunshot Residue 233
Detection of Gunshot Residue. 233
Gunpowder Residue: Greiss Test. 237

CHAPTER 10

Arson 245

Introduction 246
Oxidation: The Heart of Fire 246
Chemical Reactions: What Makes Them Happen? 247
Spontaneous Reactions 247
Getting a Reaction Started. 247
Factors That Influence the Intensity of a Fire 248
The Effect of Temperature 248
The Effect of Concentration 249
The Sequence of Events During a Fire 249
Incipient Stage 249
Free-Burning Stage 250
Smoldering Stage 250
Hydrocarbon Accelerants 250
Hydrocarbons. 250
The Composition of Petroleum 252
Refining Petroleum 253
Determining the Origin and Cause of a Fire 254
Burn Patterns 255
Burn Pattern Geometry 257
Melting of Materials. 258
Discolored Metals 258
Indicators of Arson 258
Charring of Floor Surfaces 258
Containers 259
Odors 259
Collection and Preservation of Arson Evidence 260
Analysis of Flammable Residue 260
Heated Headspace Sampling 260
Passive Headspace Diffusion (Charcoal Sampling) 260
Solid-Phase Microextraction 261
Gas Chromatography. 261

CHAPTER 11

Drugs of Abuse 269

Introduction 270
History of Drug Regulation 270
Drug Control Laws 271
The Comprehensive Drug Abuse Prevention and Control Act of 1970 272
Drug Dependence 274
Commonly Abused Drugs 274
Narcotics 274
Why Opiates Work 275
Morphine and Codeine 277
Heroin 277
Methadone 278
OxyContin 279
Hallucinogens 279
Marijuana. 279
Mescaline 282
Lysergic Acid Diethylamide 282
Phencyclidine. 283
Methylenedioxymethamphetamine (Ecstasy) . . . 283
Depressants 284
Ethyl Alcohol. 284
Barbiturates 284
Stimulants 285
Amphetamines. 285
Cocaine 287
Inhalants 287
Club Drugs 288
Anabolic Steroids 288
Identifying Compounds in Evidence Samples Suspected of Containing Controlled Substances 289
Principles of Drug Analysis 289
Presumptive Tests 290
Confirmatory Tests 293
Tracking Drug Distribution: CISPA 295
Personal Testing for Drugs of Abuse 296

SECTION 5

Biological Evidence 303

CHAPTER 12

Forensic Toxicology 305

Introduction 306
Postmortem Toxicology 306
Collection of Postmortem Specimens 306
Analysis of Toxicology Specimens. 308
Interpretation of Toxicological Information 309
Human Performance Testing 310
Field Sobriety Testing 310
BAC Levels. 311
Alcohol and the Law 311
Alcohol Metabolism 313
Absorption of Alcohol into the Body 313

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Elimination of Alcohol by Oxidation–Reduction Reactions 314
Measurement of Blood Alcohol Concentration 315
Estimating the BAC from Absorption–Elimination Data 315
Estimating the Amount of Alcohol in the Circulatory System 316
Breath Tests for Alcohol 317
Breathalyzer 317
Intoxilyzer 318
Alcosensor 319
Blood Tests for Alcohol 320
Collection and Preservation of Blood 321
Gas Chromatography Analysis of BAC 321
Noninvasive Alcohol Testing 322

CHAPTER 13

Biological Fluids: Blood, Semen, Saliva, and an Introduction to DNA 329

Introduction 330
Blood 331
Tests for the Presence of Blood 332
Presumptive Tests for Blood 332
Serological Tests for Blood. 332
Serological Blood Typing 335
Forensic Characterization of Saliva 337
Forensic Characterization of Semen 337
Rape Evidence Collection 338
Principles of Paternity 340
Introduction to DNA 341
Functions of Nucleic Acids 341
Structure of Nucleic Acids. 342
The Double Helix 343
DNA, Genes, and Chromosomes. 343
Cell Replication 344
Protein Synthesis 345
The Genetic Code 347
Nuclear DNA and the Law 349
Mitochondrial DNA 350

CHAPTER 14

Forensic DNA Typing 357

Introduction 358
Restriction Fragment Length Polymorphisms 359
Polymerase Chain Reaction: A DNA Copy Machine 360
Short Tandem Repeats 363
DNA Sequence Variations Among Individuals 364
Inheritance of Alleles 365
Analyzing the STR by Electrophoresis 365
Gel Electrophoresis 365
Capillary Electrophoresis. 368
Multiplex DNA Analysis 371
Multiplexing by Size 371
Multiplexing by Dye Color 371
Multiplexing with Multiple Capillaries 372
Forensic STRs 372
CODIS 374
Interpretation of DNA Profiles 376
Simple Population Genetics 376
Interpreting Multiplex DNA Profiles. 378
Paternity Testing 378
Mitochondrial DNA Analysis 380
The Y Chromosome: STRs and SNPs 383
Low-Copy-Number DNA Typing 383

SECTION 6

Terrorism 389

CHAPTER 15

Computer Forensics, Cybercrime, and Cyberterrorism 391

Introduction 392
Personal Computer 394
Central Processing Unit (CPU) 394
Read-Only Memory (ROM). 394
Random-Access Memory (RAM). 395
How Data Is Stored: The Hard Disk Drive (HDD) 396
The Electronic Crime Scene 397
Electronic Equipment and the Fourth Amendment 397
Cybercrime 397
Cyberspace and Cyberterrorism 398
Electric Power Grid 398
Other Cybercrimes. 399
How Cybercrime Changes the Picture 400
Processing the Crime Scene 401
Processing the Physical Crime Scene 401
Processing the Electronic Crime Scene 403
Acquiring an Electronic Image of the Crime Scene: The Hard Drive 404
Forensic Examination of Computer Devices 404
Copying the Hard Disk Drive 404
Analyzing Digital Evidence 406

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Forensic Electronic Toolkits 407
E-Evidence Collection Process 407
File Slack 407
Deleted Files 409

CHAPTER 16

Explosives 415

Introduction 416
Explosions 416
Types of Explosives 418
Low Explosives 418
High Explosives 419
Commercial Explosives 419
Dynamite 419
Ammonium Nitrate/Fuel Oil 420
Military Explosives 420
TNT 420
RDX 421
HMX. 421
Improvised Explosives 421
Low-Explosive IEDs 422
High-Explosive IEDs 422
Initiators 422
Safety Fuses 422
Electric Matches 423
Detonators 423
Collection of Explosive-Related Evidence 423
Field Tests for Explosive Residue 425
Laboratory Analysis of Explosives and Explosive Residues 428
Thin-Layer Chromatography. 429
Gas Chromatography. 429
Infrared Tests 431
Analysis of Inorganic Explosive Residues 432
Ion Chromatography 433
Taggants 434

CHAPTER 17

Detecting Weapons of Mass Destruction. 443

Introduction 444
Chemical Warfare Agents 445
Choking Agents 445
Blister Agents. 445
Blood Agents 446
Irritating Agents. 446
Incapacitating Agents 446
Nerve Agents 446
Toxic Industrial Chemicals and Materials 448
Detection of Chemical Warfare Agents and Toxic Industrial Materials 448
Point Detection Technologies 448
Analytical Instruments 450
Standoff Detectors 451
Nuclear Weapons 452
Nuclear Radiation 452
Penetrating Power and Speed of Radiation 452
Nuclear Reactions 453
Radioisotope Half-life 453
The Harmful Effects of Radiation on Humans 454
Why Is Radiation Harmful?. 454
Factors Influencing Radiation Damage 454
Units of Radiation 455
Detection of Radiation 455
Biological Weapons 455
Government Efforts to Thwart Bioterrorism. . . . 457
Detection of Biological Agents 458

APPENDIX A

Forensic Science Resources 467

Professional Organizations 467
Federal Forensic Laboratories 468
Non-Government Forensic Testing Laboratories 468
DNA. 468
Fingerprints 469

APPENDIX B

Measurement and the International System of Units (SI) 471

The International System of Units (SI) 471
Base Units 472
Prefixes 472
Derived SI Units 472
Conversions Within the SI 473
Conversions from the SI to the English System and Vice Versa 473
Useful Approximations Between SI and English Units 474
Other Commonly Used Units of Measurement 474
Temperature. 474
Conversions Between °C and °F 475
Energy 475
The Difference Between Mass and Weight 475
Problems 475

Glossary 477

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Resource Preview

OBJECTIVES

In this chapter you should gain an understanding of:

- The characteristics that permit fingerprints to be used for personal identification
- Methods used to develop latent fingerprints
- Methods used to visualize fingerprints
- The classification of fingerprints
- The use of fingerprints for biometric identification

CHAPTER 6

Fingerprints

OBJECTIVES

In this chapter you should gain an understanding of:

- The characteristics that permit fingerprints to be used for personal identification
- Methods used to develop latent fingerprints
- Methods used to visualize fingerprints
- The classification of fingerprints
- The use of fingerprints for biometric identification

FEATURES

On the Crime Scene

Back at the Crime Lab

See You in Court

WRAP UP

Chapter Spotlight

Key Terms

Putting It All Together

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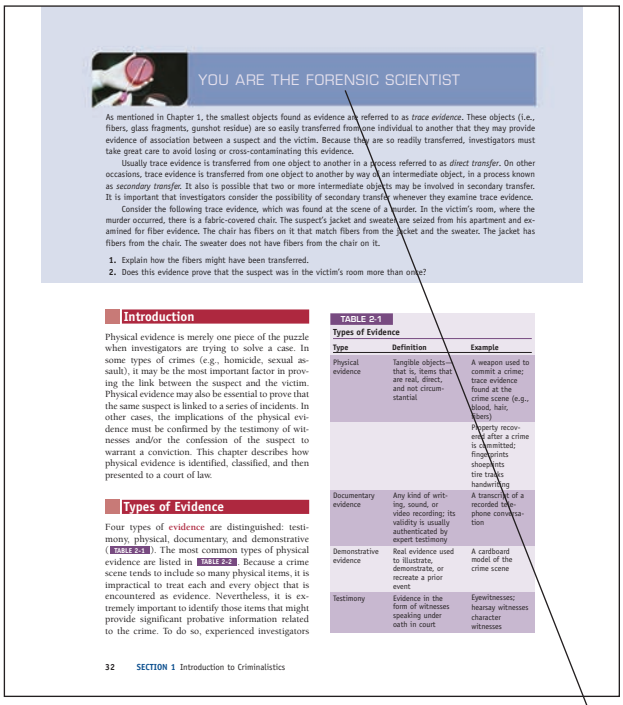


YOU ARE THE FORENSIC SCIENTIST

As mentioned in Chapter 1, the smallest objects found as evidence are referred to as *trace evidence*. These objects (i.e., fibers, glass fragments, gunshot residue) are so easily transferred from one individual to another that they may provide evidence of association between a suspect and the victim. Because they are so readily transferred, investigators must take great care to avoid losing or cross-contaminating this evidence.

Usually trace evidence is transferred from one object to another in a process referred to as *direct transfer*. On other occasions, trace evidence is transferred from one object to another by way of an intermediate object, in a process known as *secondary transfer*. It also is possible that two or more intermediate objects may be involved in secondary transfer. It is important that investigators consider the possibility of secondary transfer whenever they examine trace evidence.

Consider the following trace evidence, which was found at the scene of a murder. In the victim's room, where the murder occurred, there is a fabric-covered chair. The suspect's jacket and sweater are seized from his apartment and examined for fiber evidence. The chair has fibers on it that match fibers from the jacket and the sweater. The jacket has fibers from the chair. The sweater does not have fibers from the chair on it.

1. Explain how the fibers might have been transferred.
2. Does this evidence prove that the suspect was in the victim's room more than once?

Introduction

Physical evidence is merely one piece of the puzzle when investigators are trying to solve a case. In some types of crimes (e.g., homicide, sexual assault), it may be the most important factor in proving the link between the suspect and the victim. Physical evidence may also be essential to prove that the same suspect is linked to a series of incidents. In other cases, the implications of the physical evidence must be confirmed by the testimony of witnesses and/or the confession of the suspect to warrant a conviction. This chapter describes how physical evidence is identified, classified, and then presented to a court of law.

Types of Evidence

Four types of evidence are distinguished: testimony, physical, documentary, and demonstrative (TABLE 2-1). The most common types of physical evidence are listed in TABLE 2-2. Because a crime scene tends to include so many physical items, it is impractical to treat each and every object that is encountered as evidence. Nevertheless, it is extremely important to identify those items that might provide significant probative information related to the crime. To do so, experienced investigators

TABLE 2-1 Types of Evidence

Type	Definition	Example
Physical evidence	Tangible objects—that is, items that are real, direct, and not circumstantial	A weapon used to commit a crime; trace evidence found at the crime scene (e.g., blood, hair, fibers)
		Property recovered after a crime is committed; fingerprints shoeprints tire tracks handwriting
Documentary evidence	Any kind of writing, sound, or video recording; its validity is usually authenticated by expert testimony	A transcript of a recorded telephone conversation
Demonstrative evidence	Real evidence used to illustrate, demonstrate, or recreate a prior event	A cardboard model of the crime scene
Testimony	Evidence in the form of witnesses speaking under oath in court	Eyewitnesses; hearsay witnesses character witnesses

32 SECTION 1 Introduction to Criminalistics

You are the Forensic Scientist: Realistic case studies and accompanying discussion questions challenge readers to think like a practicing forensic scientist.

scans recorded earlier at the embassy abroad. If the two finger scans match, the visitor is allowed to enter the country. In addition, US-VISIT uses a biometric digital photograph of the individuals face that is matched by a federal agent at the border crossing.

The index finger scanning system included in US-VISIT has been criticized because it is not linked to the Federal Bureau of Investigation (FBI) fingerprint files or the government terrorist watch list file. Both of these databases rely on state-of-the-art, 10-fingerprint systems, rather than just fingerprints taken from the two index fingers. In addition, the discrepancy in the number of fingerprints found in the IDENT and FBI databases are striking: The IDENT database contains fingerprints for 15,000 suspected terrorists and their alleged associates and about 1 million known criminals or deportees overall; the FBI fingerprint database contains data for 47 million people. According to the U.S. Justice Department, Homeland Security officials expected to check about 800 people out of the roughly 118,000 visitors a day who should be screened against the FBI database in 2006. The failure to check visitors' information against the much more extensive FBI database suggests that the US-VISIT program might inadvertently allow terrorists to slip into the United States.

Testimony of Document Examiners

Testimony from document examiners has been accepted by the courts for almost 100 years. In 1989, however, three law school professors—D. Michael Risinger, Mark P. Denbeaux, and Michael J. Saks—wrote an article challenging the use of expert handwriting testimony. These authors argued that documentation examination had an unacceptably high error rate and that no evidence had ever been presented proving that trained document examiners would make fewer errors when examining documents than would nonexperts. This article had an immediate effect, prompting courts to subject expert document testimony to more scrutiny and defense attorneys to more aggressively challenge expert document testimony. In a 1995 case, *United States v. Starzecpyzel*, the court ruled that the document examiner provides technical—rather than scientific—testimony. This decision marked a major turning point in how expert document testimony was viewed under the Federal Rules of Evidence.

A subsequent study of the proficiency of document examiners was published in 1997 (Kam, Fielding, & Conn, 1997). It revealed that when trained document examiners were compared with nonexperts in terms of their proficiency in handwriting identification, the experts erred only 6.5% of the time, whereas the error rate for nonexperts was 38.3%. The nonexperts mistakenly matched handwriting samples at a rate more than 5 times higher than the experts did. In 2001, another study by the same authors found that when examining false signatures, trained document examiners had an error rate of less than 1%, whereas nonexperts had an error rate greater than 6% (Kam, Fielding, & Conn, 2001). Thus, both studies demonstrated that trained document examiners possess skills that exceed those of nonexperts.

In 1999, the U.S. Court of Appeals for the 11th Circuit upheld a ruling in *United States v. Paul* that had admitted expert handwriting testimony. In addition, it upheld the lower court's decision to exclude the testimony of Mark Denbeaux, who had attempted to be qualified as a document expert. The court ruled that Denbeaux's education and training as a lawyer did not qualify him to testify about the reliability of handwriting examination because he had no specific training or education in handwriting examination.

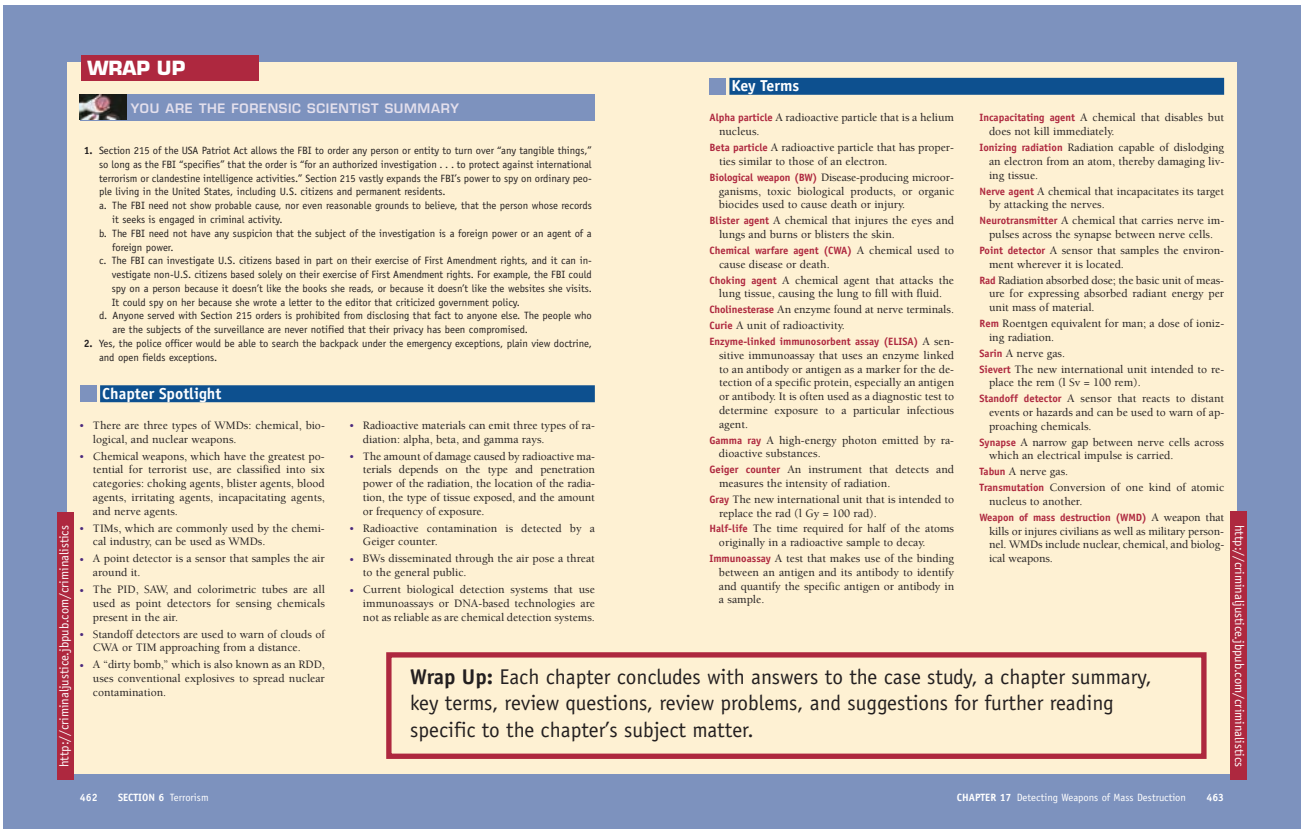
BACK AT THE CRIME LAB

Questioned document examination often involves studying obliterated writing. Examiners must take care with this type of evidence to ensure that the sample is not further altered or destroyed.

For example, organic solvents used to clean surfaces may destroy trace evidence that was invisible to the naked eye but might be readily viewed under ultraviolet or infrared light. Infrared photographs of questioned documents are commonly taken, even when writing is visible, to see whether the document has been altered. Looking at questioned documents under various types of light can help examiners identify writing imprints, altered writing, and writing that may have been covered by paint.

CHAPTER 7 Questioned Documents 179

Back at the Crime Lab: Summary of scientific principles and procedures.



WRAP UP

YOU ARE THE FORENSIC SCIENTIST SUMMARY

1. Section 215 of the USA Patriot Act allows the FBI to order any person or entity to turn over "any tangible things," so long as the FBI "specifies" that the order is "for an authorized investigation . . . to protect against international terrorism or clandestine intelligence activities." Section 215 vastly expands the FBI's power to spy on ordinary people living in the United States, including U.S. citizens and permanent residents.
   a. The FBI need not show probable cause, nor even reasonable grounds to believe, that the person whose records it seeks is engaged in criminal activity.
   b. The FBI need not have any suspicion that the subject of the investigation is a foreign power or an agent of a foreign power.
   c. The FBI can investigate U.S. citizens based in part on their exercise of First Amendment rights, and it can investigate non-U.S. citizens based solely on their exercise of First Amendment rights. For example, the FBI could spy on a person because it doesn't like the books she reads, or because it doesn't like the websites she visits. It could spy on her because she wrote a letter to the editor that criticized government policy.
   d. Anyone served with Section 215 orders is prohibited from disclosing that fact to anyone else. The people who are the subjects of the surveillance are never notified that their privacy has been compromised.
2. Yes, the police officer would be able to search the backpack under the emergency exceptions, plain view doctrine, and open fields exceptions.

Chapter Spotlight

- There are three types of WMDs: chemical, biological, and nuclear weapons.
- Chemical weapons, which have the greatest potential for terrorist use, are classified into six categories: choking agents, blister agents, blood agents, irritating agents, incapacitating agents, and nerve agents.
- TIMs, which are commonly used by the chemical industry, can be used as WMDs.
- A point detector is a sensor that samples the air around it.
- The PID, SAW, and colorimetric tubes are all used as point detectors for sensing chemicals present in the air.
- Standoff detectors are used to warn of clouds of CWA or TIM approaching from a distance.
- A "dirty bomb," which is also known as an RDD, uses conventional explosives to spread nuclear contamination.
- Radioactive materials can emit three types of radiation: alpha, beta, and gamma rays.
- The amount of damage caused by radioactive materials depends on the type and penetration power of the radiation, the location of the radiation, the type of tissue exposed, and the amount or frequency of exposure.
- Radioactive contamination is detected by a Geiger counter.
- BWs disseminated through the air pose a threat to the general public.
- Current biological detection systems that use immunoassays or DNA-based technologies are not as reliable as are chemical detection systems.

Key Terms

Alpha particle A radioactive particle that is a helium nucleus.
Beta particle A radioactive particle that has properties similar to those of an electron.
Biological weapon (BW) Disease-producing microorganisms, toxic biological products, or organic biocides used to cause death or injury.
Blister agent A chemical that injures the eyes and lungs and burns or blisters the skin.
Chemical warfare agent (CWA) A chemical used to cause disease or death.
Choking agent A chemical agent that attacks the lung tissue, causing the lung to fill with fluid.
Cholinesterase An enzyme found at nerve terminals.
Curie A unit of radioactivity.
Enzyme-linked immunosorbent assay (ELISA) A sensitive immunoassay that uses an enzyme linked to an antibody or antigen as a marker for the detection of a specific protein, especially an antigen or antibody. It is often used as a diagnostic test to determine exposure to a particular infectious agent.
Gamma ray A high-energy photon emitted by radioactive substances.
Geiger counter An instrument that detects and measures the intensity of radiation.
Gray The new international unit that is intended to replace the rad (1 Gy = 100 rad).
Half-life The time required for half of the atoms originally in a radioactive sample to decay.
Immunoassay A test that makes use of the binding between an antigen and its antibody to identify and quantify the specific antigen or antibody in a sample.
Incapacitating agent A chemical that disables but does not kill immediately.
Ionizing radiation Radiation capable of dislodging an electron from an atom, thereby damaging living tissue.
Nerve agent A chemical that incapacitates its target by attacking the nerves.
Neurotransmitter A chemical that carries nerve impulses across the synapse between nerve cells.
Point detector A sensor that samples the environment wherever it is located.
Rad Radiation absorbed dose; the basic unit of measure for expressing absorbed radiant energy per unit mass of material.
Rem Roentgen equivalent for man; a dose of ionizing radiation.
Sarin A nerve gas.
Sievert The new international unit intended to replace the rem (1 Sv = 100 rem).
Standoff detector A sensor that reacts to distant events or hazards and can be used to warn of approaching chemicals.
Synapse A narrow gap between nerve cells across which an electrical impulse is carried.
Tabun A nerve gas.
Transmutation Conversion of one kind of atomic nucleus to another.
Weapon of mass destruction (WMD) A weapon that kills or injures civilians as well as military personnel. WMDs include nuclear, chemical, and biological weapons.

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462 SECTION 6 Terrorism

CHAPTER 17 Detecting Weapons of Mass Destruction 463

Wrap Up: Each chapter concludes with answers to the case study, a chapter summary, key terms, review questions, review problems, and suggestions for further reading specific to the chapter's subject matter.

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Preface

The criminal justice system has learned to rely heavily on the analysis of physical evidence as scientific procedures and methods have become increasingly more reliable and telling than eyewitness testimony. The influence of television programs showing the use of highly sophisticated analytical equipment to solve crimes has caused juries to come to expect scientific evidence to be presented in all criminal cases. Greater stress is now placed on investigators to handle physical evidence in an appropriate scientific manner for later presentation in court. The introduction of DNA typing and database matching have revolutionized how physical evidence from the crime scene is processed. Forensic investigators must process both a sound understanding of the scientific principles that underlie the measurements they make and a keen knowledge of how to locate physical evidence without disrupting any trace elements at the scene.

In many ways, the attacks of September 11, 2001, expanded the role of criminalistics from traditional examination of crime scenes and physical evidence to assisting the Department of Homeland Security in deterring terrorism. Threats of terrorism from both within and outside of United States borders widen the scope of those working in the criminal justice system. I have included sections of this book that speak directly to these issues because of the changed nature and role of criminalistics.

New laws passed since 9/11 have placed a precarious balance between the rights and freedoms of individuals and the protection of society as a whole. This tension is evident when we are asked by politicians how much personal freedom we are willing to sacrifice in the name of national security. We now stand in long lines to pass through extensive security monitoring to board airplanes. We are limited in what we can carry with us on these flights. We face the potential of having out telephone conversations recorded. We can even be questioned about the material we check out of public and academic libraries. While these issues are of great importance to the individual, they are of even greater importance to understand for those working in the criminal justice field.

There are no easy answers to these issues, but it is the goal of this textbook to present information to students to help them understand how forensic measurements are made and to find a balance that protects the individual and benefits society as a whole.

Organization

The organization and approach of this text differ in several ways from other criminalistics books intended solely for criminal justice students. It places

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forensic science with the framework of the basic principles of chemistry, biology, and physics and assumes the reader has little or no scientific background.

The first two chapters introduce the student to the crime scene and physical evidence. In Chapter 1, we learn to secure and document the crime scene. Next, to collect, preserve, package, inventory, and then submit evident to the crime lab. In Chapter 2, common types of physical evidence are described, and basic scientific principles familiarize students with crime scene reconstruction. This early description of the many types of physical evidence found at crime scenes not only establishes the importance of a careful methodical approach to the crime scene but also gives students a firm foundation for how this evidence will be used to reconstruct the events that transpired during the commission of the crime.

Chapters 3, 4, and 5 offer a solid introduction to the core physical properties that are normally used to examine trace evidence. Chapter 3 shows how the physical properties can be used to characterize evidence. Chapter 4 describes the many types of microscopes used to examine fiber, hair, and paint evidence. The addition of paint evidence is new to the second edition and a response to requests from users of the first edition. Chapter 5 describes optical physical properties, such as color and refractive index, and how they can be used to characterize glass evidence. Wherever possible in these chapters, physical properties are discussed in the context of characterizing physical evidence, building a bridge to understanding how patterns and chemical and biological properties will be used to characterize evidence in the chapters that follow.

Next, students are introduced to pattern evidence. Chapters 6 covers fingerprints—their classification and the methods used to visualize latent fingerprints. A new box in Chapter 6 describes the new hand-held fingerprint scanners that search fingerprint databases while wirelessly connected to the Internet. The focus of Chapter 7 turns to questioned documents, with discussion of handwriting, typed and word processed documents, ink, indented writing, and security printing. Chapter 8 is devoted to firearms and describes handguns, rifles, shotguns, and submachine guns. Techniques used to compare fired bullets and shell casings are described, as well as the methods used to restore obliterated serial numbers.

We then focus on chemical evidence. Chapter 9, which introduces readers to the periodic table and inorganic chemistry, provides a useful introduction to the examination of bullets and gunshot residue. In addition, it provides a foundation for more advanced chemical principles that will be presented in later chapters. Chapter 10 describes the chemistry of fire and introduces the student to organic chemistry through a discussion of hydrocarbon accelerants that are used by arsonists. In Chapter 11, drugs of abuse are arranged by category and the techniques used to detect them in bulk or in person samples are described.

Chapters 12, 13, and 14 deal with biological evidence. Chapter 12 describes how toxicological measurements are made. Even if the measurements are made after a person has died, they can often be used to reconstruct events that transpired days before. Biological fluids, such as blood, semen, and saliva are the focus of Chapter 13. Techniques used to locate and characterize biological evidence are presented, along with an introduction to DNA. Chapter 14 presents the separation and characterization of short tandem repeats (STRs) by capillary electrophoresis and how this information is used to establish paternity and match offender profiles.

The final section of the text focuses on terrorism. Chapter 15, a new chapter added for the second edition, describes computer forensics, cybercrime, and cyberterrorism. Chapter 16 describes the construction of explosive devices such as improvised explosive devices and the methods used to test for explosive residue. Chapter 17 presents the three major types of weapons of mass destruction—chemical, nuclear, and biological—and the techniques being developed to detect these threats, both point and standoff detectors.

Course Use

Criminalistics: Forensic Science, Crime, and Terrorism, Second Edition, offers the flexibility to tailor a course to suit both instructors' preferences and the needs of particular audiences. The full text may be used for a comprehensive two-semester course, or the book may be broken down in several ways for a one-

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semester course. The text is arranged in a traditional format, beginning with the crime scene and physical evidence, followed by sections on trace evidence, pattern evidence, and terrorism. Those who have been teaching a one-semester criminalistics course with a different text can use the first 12 chapters of this text in sequence. Other options for a one-semester course are to use the first five chapters, followed by choices for the remaining chapter depending on the teacher's preferences. Those instructors who stress chemical and biological evidence may choose to skip Chapters 6, 7, and 8. Those wanting to stress terrorism may chose to skip the first three chapters.

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In preparing the second edition of this book I have added topics that weren't covered in the first edition. A section on the composition and analysis of paint has been added to Chapter 4. Most importantly, a whole new chapter (15) on computer forensics and cybercrime has been added as a response to instructor requests. Since the publication of the first edition in 2007, there have been many advances in the field of forensic science, and the book has been updated throughout to incorporate these changes.

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