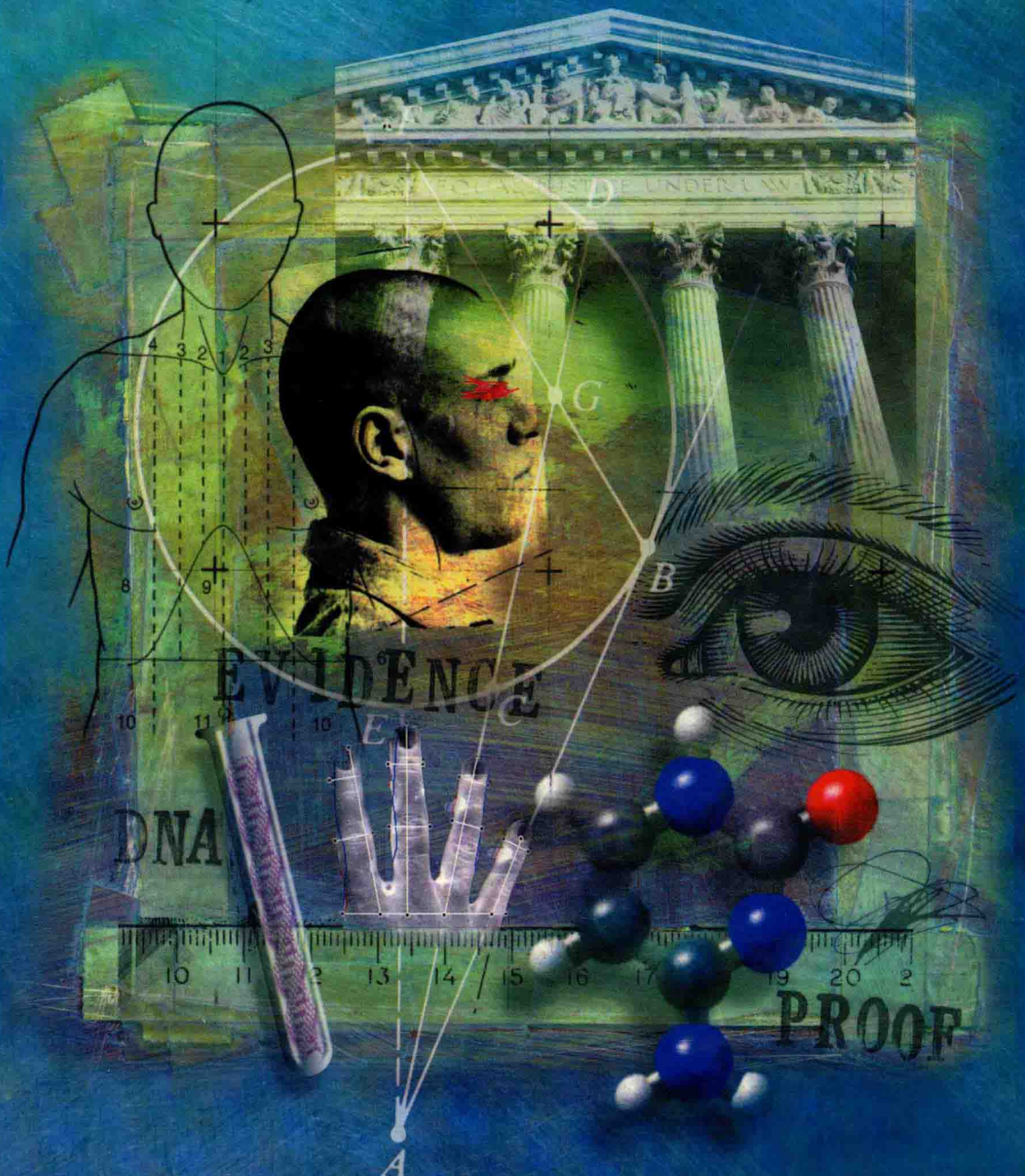
Seventh Edition

CRIMINALISTICS

AN INTRODUCTION TO FORENSIC SCIENCE



Richard Saferstein

CRIMINALISTICS

An Introduction to Forensic Science

Seventh Edition

RICHARD SAFERSTEIN, Ph.D.
Forensic Science Consultant, Mt. Laurel, N.J.
Lecturer, Widener University School of Law

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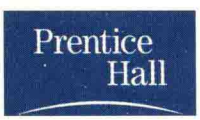

To the Memory of Fran and Michael

PREFACE

As we enter a new century, the science of DNA profiling has altered the complexion of criminal investigation. Just a few years ago, few could have envisioned the impact DNA technology would have at linking a crime with its perpetrator. DNA collected from saliva on a cup or from dandruff or sweat on a hat exemplifies the emergence of nontraditional forms of evidence collection at crime scenes. Currently, the criminal justice system is gearing up to create vast DNA data banks designed to snare the criminal who is unaware of the consequence of leaving behind the minutest quantity of biological material at a crime scene.

During the highly publicized O. J. Simpson criminal and civil trials, forensic scientists systematically placed Simpson at the crime scene through DNA analyses, hair and fiber comparisons, and footwear impressions. As millions of Americans watched the O. J. Simpson case unfold, they, in a sense, became students of forensic science. Intense media coverage of the crime-scene search and investigation, as well as the ramifications of findings of physical evidence at the crime scene, all became the subject of study, commentary, and conjecture. For those of us who have taught forensic science in the classroom, it comes as no surprise that forensic science can grip and hold the attention of those who otherwise would have no interest in any science subject. The O. J. Simpson case amply demonstrates how intertwined criminal investigation has become with forensic science. Through seven editions, *Criminalistics* has striven to depict the role of the forensic scientist in the criminal justice system. The current edition builds on the contents of its predecessors and seeks to update the reader with the latest technologies available to crime laboratory personnel. Like all facets of modern life, forensic science has been touched by the Internet. This new edition introduces the reader to basic concepts of Internet use and encourages exploration of Web sites particularly relevant to forensic science and criminal investigation.

Making science relevant and pertinent to the interests and goals of the student is a desirable but often elusive goal pursued by educators. *Criminalistics* is written with such lofty objectives in mind. The seventh edition of *Criminalistics* retains the purpose and intent of the previous editions. First and foremost is a presentation of the techniques, skills, and limitations of the modern crime laboratory for a reader who has no background in the forensic sciences. The nature of physical evidence is emphasized along with the limitations that technology and knowledge impose on its individualization and characterization.

A major portion of the text centers on discussions of the common items of physical evidence encountered at crime scenes. These chapters include

updated techniques describing forensic analysis as well as procedures and practices relating to the proper collection and preservation of evidence at crime scenes. Particular attention is paid to the meaning and role of probability in interpreting the evidential significance of scientifically evaluated evidence.

The implications of DNA profiling are important enough to warrant their inclusion in a chapter in *Criminalistics*. In keeping with the style and content of the book's previous editions, the topic of DNA is described in a manner that will make it comprehensible and relevant to readers who lack a scientific background. The discussion focuses on giving the reader insight into what DNA is and explains its central role in controlling the body's chemistry. Finally, the chapter describes the process of DNA typing and illustrates its application to criminal investigations through examples of actual case histories.

In selecting the subject matter for the book, I have drawn on my experience both as an active forensic scientist and as an instructor of forensic science at the college level. No prior knowledge about scientific principles or techniques is assumed of the reader. He or she is introduced to those areas of chemistry and biology relating to the analysis of physical evidence with a minimum of scientific terminology and equations. It is not the intent of this book to make scientists or forensic experts of the reader. For this reason, the chemistry and biology discussed are limited to a minimum core of facts and principles that will make the subject matter comprehensible and meaningful to the nonscientist. Nevertheless, it will certainly be gratifying if this effort motivates some students to seek further scientific knowledge and perhaps direct their education toward a career in forensic science.

Although *Criminalistics* is an outgrowth of a one-semester course offered as part of a criminal justice program at many New Jersey colleges, its subject matter is not limited to the college student. Optimum utilization of crime laboratory services requires that criminal investigators have a knowledge of the techniques and capabilities of the laboratory that extends beyond any summary that may be gleaned from departmental brochures dealing with the collection and packaging of physical evidence. Only by combining a knowledge of the principles and techniques of forensic science with logic and common sense will the investigator gain a comprehensive insight into the meaning and significance of physical evidence and its role in criminal investigations. Forensic science begins at the crime scene. If the investigator cannot recognize, collect, and package evidence properly, no amount of equipment or expertise will salvage the situation.

Likewise, there is a dire need to bridge the "communication gap" that currently exist among lawyers, judges, and the forensic scientist. An intelligent evaluation of the scientist's data and any subsequent testimony that may follow will again depend on the familiarity of the underlying principles of forensic science. Too many practitioners of the law profess ignorance of the subject or at best attempt to gain a superficial understanding of its meaning and significance only minutes before meeting the expert witness. To this end, it is hoped that the book will provide a painless route to comprehending the nature of the science.

In order to merge theory with practice, a number of actual forensic case histories are included in the text. It is intended that these illustra-

tions will remove forensic science from the domain of the abstract and make its applications relevant to the real world of criminal investigation.

I am indebted to many people for their assistance and advice in the preparation of this book. Many faculty members, colleagues, and friends have read and commented on various portions of the text. Particular thanks go to the following people for their critical reading and discussions of the manuscript: Norman Demeter, John Lintott, Charles Midkiff, Raymond Murray, Jay Siegel, and Richard Tidey.

In addition, I would like to acknowledge the contributions of Jeffrey C. Kercheval, Robert Thompson, Roger Ely, Jose R. Almirall, Darlene Brezinski, Michael Malone, and Ray Feldherr.

I want to credit the assistance of Pamela Cook and Gonul Turhan, whose research efforts are an integral part of this revision. I am also appreciative of the time and talent given by Peggy Cole and my production editor, Linda Pawelchak.

I would like to give credit to those law enforcement agencies, governmental agencies, private individuals, and equipment manufacturers cited in the text for contributing their photographs and illustrations. Finally, I particularly wish to express my appreciation to Major E. R. Leibe (retired) and Major V. P. O'Donoghue (retired) for their encouragement and support.

Anyone who expects to write a textbook must be prepared to contribute countless hours to the task, often at the expense of family obligations. This effort was no exception. My efforts would have fallen well short of completion without the patience and encouragement of my wife Gail. Her typing and critical readings of the manuscript, as well as her strength of character under circumstances that were less than ideal, will always be remembered.

Richard Saferstein, Ph.D.

About the Author

Richard Saferstein, Ph.D., retired in 1991 after serving 21 years as the Chief Forensic Scientist of the New Jersey State Police Laboratory, one of the largest crime laboratories in the United States. He currently acts as a consultant for attorneys and the media in the area of forensic science. During the O. J. Simpson criminal trial, Dr. Saferstein provided extensive commentary on forensic aspects of the case for the *Rivera Live* show, the *E!* television network, ABC radio, and various radio talk shows. Dr. Saferstein holds degrees from the City College of New York and earned his doctorate degree in chemistry in 1970 from the City University of New York. From 1972 to 1991, he taught an introductory forensic science course in the criminal justice programs at the College of New Jersey and Ocean County College. These teaching experiences played an influential role in Dr. Saferstein's authorship in 1977 of the widely used introductory textbook *Criminalistics: An Introduction to Forensic Science,* currently in this seventh edition. Saferstein's basic philosophy in writing *Criminalistics* is to make forensic science understandable and meaningful to the nonscience reader, while giving the reader an appreciation for the scientific principles that underlie the subject.

Dr. Saferstein presently teaches a course on the role of the expert witness in the courtroom at the law school of Widener University in Wilmington, Delaware. He has authored or co-authored more than 30 technical papers covering a variety of forensic topics. He has also edited the widely used professional reference books *Forensic Science Handbook,* Volumes I–III (Prentice Hall, 1982, 1988, 1993) dealing with important forensic science topics. Dr. Saferstein is a member of the American Chemical Society, the American Academy of Forensic Sciences, the Forensic Science Society of England, the Canadian Society of Forensic Scientists, the International Association for Identification, the Mid-Atlantic Association of Forensic Scientists, the Northeastern Association of Forensic Scientists, the Northwestern Association of Forensic Scientists, and the Society of Forensic Toxicologists.

CONTENTS

CHAPTER

INTRODUCTION

DEFINITION AND SCOPE OF FORENSIC SCIENCE

Forensic science in its broadest definition is the application of science to law. As our society has grown more complex, it has become more dependent on rules of law to regulate the activities of its members. Forensic science applies the knowledge and technology of science for the definition and enforcement of such laws.

Each year, as government finds it increasingly necessary to regulate those activities that most intimately influence our daily lives, science merges more closely with civil and criminal law. Consider, for example, the laws and agencies that regulate the quality of our food, the nature and potency of drugs, the extent of automobile emissions, the kind of fuel oil we burn, the purity of our drinking water, and the pesticides we use on our crops and plants. It would be difficult to conceive of any food and drug regulation or any environmental protection act that could be effectively monitored and enforced without the assistance of scientific technology and the skill of the scientific community.

In the arena of criminal justice, laws are continually being broadened and revised to counter the alarming increase in crime rates. In response to public concern, law enforcement agencies have expanded their patrol and investigative functions, hoping to stem the rising tide of crime. At the same time they are looking more and more to the scientific community for advice and technical support of their efforts. Can the technology that put astronauts on the moon, split the atom, and eradicated most dreaded diseases be enlisted in this critical battle? Unfortunately, science cannot offer final and authoritative solutions to problems that stem from a maze of social and psychological factors. However, as the contents of this book will attest, science does occupy an important and unique role in the criminal justice system—a role that relates to the scientist's ability to supply accurate and objective information that reflects the events that have occurred at a crime. It will also become apparent to the reader that a good deal of work remains to be done if the full potential of science as it is applied to criminal investigations is to be realized.

Considering the vast array of civil and criminal laws that regulate society, forensic science, in its broadest sense, has become so comprehensive a subject as to make a meaningful introductory textbook treatment of its role and techniques most difficult, if not overwhelming. For this reason, we must find practical limits that narrow the scope of the subject. Fortunately, common usage provides us with such a limited definition: **Forensic science is the application of science to those criminal and civil laws that are enforced by police agencies in a criminal justice system.**

Even within this limited definition, we will restrict our discussion in this book to only those areas of chemistry, biology, physics, and geology that are useful for determining the evidential value of crime-scene and

KEY TERMS

algor mortis
autopsy
expert witness
livor mortis
rigor mortis

related evidence, omitting any references to the subject of medicine and the law. Forensic pathology, psychology, and odontology certainly encompass important and relevant areas of knowledge and practice in law enforcement, each being an integral part of the total forensic science service that is provided to any up-to-date criminal justice system. However, except for a brief discussion at the end of this chapter, these subjects go beyond the intended range of the book, and the reader is referred elsewhere for discussions of their applications and techniques.[1] Instead, we will attempt to focus on the services of what has popularly become known as the crime laboratory. It is here that the principles and techniques of the physical and natural sciences are practiced and applied to the analysis of crime-scene evidence.

For many, the term *criminalistics* seems more descriptive for describing the services of a crime laboratory. However, it will serve no useful purpose to rationalize whether the subject matter included in this book can best be classified as criminalistics or forensic science, if indeed this distinction can be made at all. For all intents and purposes, the two terms are taken to be one and the same and will be used interchangeably in the text. Regardless of title, criminalist or forensic scientist, the trend of events has made the scientist in the crime laboratory an active participant in the criminal justice system.

History and Development of Forensic Science

Forensic science owes its origins first to those individuals who developed the principles and techniques needed to identify or compare physical evidence, and second to those who recognized the necessity of merging these principles into a coherent discipline that could be practically applied to a criminal justice system.

Today, many believe that Sir Arthur Conan Doyle had a considerable influence on popularizing scientific crime-detection methods through his fictional character Sherlock Holmes. It was Holmes who first applied the newly developing principles of *serology* (see Chapter 12), fingerprinting, firearm identification, and questioned-document examination long before their value was first recognized and accepted by real-life criminal investigators. Holmes's feats excited the imagination of an emerging generation of forensic scientists and criminal investigators. Even in the first Sherlock Holmes novel, *A Study in Scarlet,* published in 1887, we find examples of Doyle's uncanny ability to describe scientific methods of detection years before they were actually discovered and implemented. For instance, here Holmes is probing and recognizing the potential usefulness of forensic serology to criminal investigation:

[1]Two excellent references are André A. Moenssens, Fred E. Inbau, James Starrs, and Carol E. Henderson, *Scientific Evidence in Civil and Criminal Cases,* 4th ed. (Mineola, N.Y.: The Foundation Press, Inc., 1995); and Werner U. Spitz, ed., *Medicolegal Investigation of Death,* 3rd ed. (Springfield, Ill.: Charles C Thomas, Publisher, 1993).

> "I've found it. I've found it," he shouted to my companion, running towards us with a test tube in his hand. "I have found a reagent which is precipitated by hemoglobin and by nothing else. . . . Why, man, it is the most practical medico-legal discovery for years. Don't you see that it gives us an infallible test for blood stains? . . . The old guaiacum test was very clumsy and uncertain. So is the microscopic examination for blood corpuscles. The latter is valueless if the stains are a few hours old. Now, this appears to act as well whether the blood is old or new. Had this test been invented, there are hundreds of men now walking the earth who would long ago have paid the penalty of their crimes. . . . Criminal cases are continually hinging upon that one point. A man is suspected of a crime months perhaps after it has been committed. His linen or clothes are examined and brownish stains discovered upon them. Are they blood stains, or rust stains, or fruit stains, or what are they? That is a question which has puzzled many an expert, and why? Because there was no reliable test. Now we have the Sherlock Holmes test, and there will no longer be any difficulty."

There are many who can be cited for their specific contributions to the field of forensic science. The following is just a brief list of those who made the earliest contributions to formulating the disciplines that now constitute forensic science.

Mathieu Orfila (1787–1853). Orfila is considered the father of forensic toxicology. A native of Spain, he ultimately became a renowned teacher of medicine in France. In 1814, Orfila published the first scientific treatise on the detection of poisons and their effects on animals. This treatise established forensic toxicology as a legitimate scientific endeavor.

Alphonse Bertillon (1853–1914). The first scientific system of personal identification was devised by Alphonse Bertillon. In 1879, Bertillon began to develop the science of *anthropometry* (see Chapter 14), a systematic procedure of taking a series of body measurements as a means of distinguishing one individual from another. For nearly two decades, this system was considered the most accurate method of personal identification. Although anthropometry was eventually replaced by fingerprinting in the early 1900s, Bertillon's early efforts have earned him the distinction of being known as the father of criminal identification.

Francis Galton (1822–1911). Galton undertook the first definitive study of fingerprints and developed a methodology of classifying them for filing. In 1892, he published a book titled *Finger Prints,* which contained the first statistical proof supporting the uniqueness of his method of personal identification. His work went on to describe the basic principles that form the present system of identification by fingerprints.

Leone Lattes (1887–1954). In 1901, Dr. Karl Landsteiner discovered that blood can be grouped into different categories. These blood groups or types are now recognized as A, B, AB, and O. The possibility that blood grouping could be a useful characteristic for the identification of an indi-