

FOURTH EDITION

CRIMINALISTICS

An Introduction to FORENSIC SCIENCE

Richard Saferstein

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Criminalistics

An Introduction to Forensic Science

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PRENTICE HALL, Englewood Cliffs, New Jersey 07632

Library of Congress Cataloging-in-Publication Data

Saferstein, Richard,
Criminalistics : an introduction to forensic science / Richard
Saferstein. — 4th ed.

p. cm.

Includes bibliographical references.

ISBN 0-13-193525-9

1. Criminal investigation. 2. Forensic ballistics. 3. Chemistry,
Forensic. 4. Medical jurisprudence. I. Title.

HV8073.S2 1990

363.2'5—dc20

89-22787

CIP

Editorial/production supervision and interior design: David Ershun

Cover design: Photo Plus Art

Manufacturing buyer: David Dickey



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A Division of Simon & Schuster

Englewood Cliffs, New Jersey 07632

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Printed in the United States of America

10 9 8 7 6 5 4

ISBN 0-13-193525-9

Prentice-Hall International (UK) Limited, *London*

Prentice-Hall of Australia Pty. Limited, *Sydney*

Prentice-Hall Canada Inc., *Toronto*

Prentice-Hall Hispanoamericana, S.A., *Mexico*

Prentice-Hall of India Private Limited, *New Delhi*

Prentice-Hall of Japan, Inc., *Tokyo*

Simon & Schuster Asia Pte. Ltd., *Singapore*

Editora Prentice-Hall do Brasil, Ltda., *Rio de Janeiro*

Preface

The fourth edition of *Criminalistics* brings with its publication news of a new breakthrough in the practice of forensic science. The technology of DNA typing for the first time gives forensic scientists the capability of narrowing the origin of blood, semen, and hair to a single individual. The implications of DNA typing are important enough to warrant its inclusion in a new chapter in *Criminalistics*. In keeping with the style and content of the book's previous editions, the DNA subject is described in a manner that will make it comprehensible and relevant to readers who lack a scientific background. The discussion will focus on giving the reader insight into what DNA is and will explain its central role in controlling the body's chemistry. Lastly, the chapter will describe the process of DNA typing and illustrate its application to criminal investigations through examples of actual case histories. Recent progress in forensic science has not been limited to DNA typing, however. The fourth edition will also update the reader with the latest advances in such areas as drug testing, computerized fingerprint search systems, and arson 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 fourth edition of

Criminalistics retains the purpose and intent of its 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.

In selecting the subject matter for the book, I have drawn upon 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/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.

Though *Criminalistics* is an outgrowth of a one-semester course offered as a 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 presently exists between 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 illustrations 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. I want to particularly thank the following people for their critical reading and discussions of the manuscript:

Michael Camp, Jew-Ming Chao, James Chickos, Frank Creveling, Peter De Forest, Norman Demeter, Wayne Dunning, Robert Epstein, David Garin, Steve Klug, John Lintott, Raymond Murray, Jay Siegel, Richard Tidey, and Charles Tindall.

I'm appreciative of the time and talent given by Peggy Cole and my production editor, David Ershun.

I would also like to give credit to John Bartek, Linda Jankowski, and the New Jersey State Police Photography Laboratory for the special photographic skills that they so generously gave to this book. In addition, I am indebted to the New Jersey State Police, as well as those law enforcement agencies, governmental agencies, private individuals, and equipment manufacturers cited in the text for contributing their photographs and illustrations. I particularly wish to express my appreciation to Major E.R. Leibe (retired) and Major V.P. O'Donoghue (retired) for their encouragement and their 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.

The views and opinions expressed in this book are those of the author and do not necessarily represent those of the New Jersey State Police or any other governmental agency.

Richard Saferstein, Ph.D.



Foreword

It is impossible to overstate the importance of the forensic support provided the law enforcement community by the scientists we have available in laboratories across this nation. Although some may assume that forensic technologies are new to law enforcement, history will show that the sworn officer has always relied on criminalistic support in one form or another. It is only the technology that changes, not the partnership.

The text of this fourth edition of *Criminalistics* by Richard Saferstein exemplifies the continuing change in technology, and the research done by our scientists illustrates the continuing need for a fresh new look at established procedures. Although technology may change, the importance of the relationship between the criminal investigator and the forensic scientist remains constant. The impact of the drug problem on our forensic facilities sometimes creates a factory-like perspective, which disappears when the investigator becomes aware of new developments and the application of changes in the sciences. New procedures such as DNA and Automated Fingerprint Identification Systems lend a new excitement to our investigative capacity, and we rely on books like this to convey these new developments to every member of the criminal justice fraternity.

The works of Dr. Saferstein to date have done more to attract competent scientists to the field of forensics than can be imagined and, without question, have placed the criminalistic investigator at a higher level of professionalism than ever before. As you review this book, you will come to appreciate more than ever the role of the forensic scientist and the importance of new technology in the never-ending effort to preserve the safety and welfare of the public.

Clinton L. Pagano
Colonel
Superintendent
New Jersey State Police

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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 offers 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 sup-

port of their efforts. Can the technology that put man on the moon, split the atom, and eradicated man's 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 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, 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.

¹Two excellent references are: André A. Moenssens, Fred E. Inbau, and James Starrs, *Scientific Evidence in Criminal Cases*, 3rd ed. (Mineola, N.Y.: The Foundation Press, Inc., 1986); and Werner U. Spitz and Russell S. Fisher, eds., *Medicolegal Investigation of Death*, 2nd ed. (Springfield, Ill.: Charles C Thomas, Publisher, 1980).

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, 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:

"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