

ENCYCLOPEDIA OF FORENSIC SCIENCES

EDITED BY

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VOLUME ONE



ENCYCLOPEDIA OF FORENSIC SCIENCES

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FOREWORD

FORENSIC SCIENCE has evolved immeasurably in just a few decades – and continues to develop at a rapid pace. The changes are a result of both the developments in the work we scientists are carrying out and the changing face of society and of crime.

The *Encyclopedia of Forensic Sciences* reflects this; it boasts not only a very impressive editorial advisory board, but a comprehensive list of eminent forensic scientists – including a number from my own organization. We all have one thing in common – the desire to see forensic science and new technology put to maximum use in detecting, investigating and ultimately reducing crime.

We face a challenge. We not only have to keep coming up with scientific breakthroughs, but we also have to harness this scientific power for the fight against crime and then prove to the outside world that it is effective and efficient. We have risen to this challenge in the past, and we can do so going into the new Millennium.

We are proud that the criminal justice community is just that – a community which is willing to share its knowledge and thinking in a publication such as this; and it is right that we celebrate the ability of science in helping the law enforcement agencies beat crime. Our partnership across the world is getting stronger all the time. This is borne out by the work of the Forensic Science Service. We provide help to a number of countries in terms of the establishment of their own DNA databases and other forensic services, and we now have working links with over 60 countries. We cannot afford to forget that the work we do – in casework and in research – has a direct influence on the quality of life for citizens across the globe. This is the simple incentive we all need to keep the field of forensic science fresh, innovative and effective.

A handwritten signature in black ink, appearing to read 'Janet Thompson', with a stylized, flowing script.

Dr Janet Thompson
Chief Executive
The Forensic Science Service

FOREWORD

FORENSIC SCIENCE always is a diverse field, built on principles of chemistry, biology and physics, and incorporating countless other specialties. Today, the service offered under the guise of 'forensic science' include specialties from virtually all aspects of modern science, medicine, engineering, mathematics and technology. For those working within some area of forensic science, those in need of forensic services, or the simply fascinated, it is nearly impossible to maintain even a cursory level of knowledge regarding all available subcomponents within forensic science. At long last, there is a single comprehensive reference work to address over 200 of the most common areas and applications of forensic science.

The *Encyclopedia of Forensic Sciences* contains a broad range of topics including Medicolegal Causes of Death, Crime Scene Investigation, DNA Databanks and Analysis, Alcohol and Drug Analysis, Fire Investigation, Psychological Autopsies and Ethics. It is, however, a valuable resource not only for the quantity of subject matter, but also for the quality; this is mainly attributed to its distinguished Editors, Editorial Advisory Board and list of contributing authors.

Readily available information and a format to exchange ideas and review research will be critical elements to any future growth within the forensic sciences. Today, it is not uncommon to successfully resolve a criminal investigation by the comprehensive analysis of numerous articles of physical evidence. Physical evidence often comes in a wide variety of formats, requiring significantly different laboratory approaches to effectively analyze each item. A reference such as the *Encyclopedia of Forensic Sciences* can help a forensic scientist or laboratory to become aware of other potential procedures or methodologies, thus getting the most out of the available physical evidence.

Students, practitioners, police officers, members of the legal profession and the general public can successfully learn forensic science through the contributions of many world-renowned experts who participated in this project, as authors, Editorial Advisory Board members or Editors.



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PREFACE

FORENSIC SCIENCE is essentially the application of scientific methods and techniques to matters involving the public: that covers a lot of ground. Every science from chemistry to medicine, from biology to statistics, from dentistry to anthropology, can be a forensic science if it has some application to the law or public matter. Gathering even a representative sample of the techniques and methods of forensic science has been a monumental task.

In recent years there has been a proliferation of fiction and nonfiction books that cover some aspect of forensic science. This has paralleled, or perhaps fueled, the meteoric rise in public interest in forensic science. Most existing nonfiction or reference books attempt to cover one aspect of forensic science in detail, such as forensic entomology. The few textbooks and handbooks cover several areas; however they usually sacrifice depth and rigor for breadth. The *Encyclopedia of Forensic Sciences* is the first major work to cover the disparate scientific disciplines that make up this field in a manner that ensures both breadth and depth. The medical, chemical, biological, physical and mathematical sciences are covered as well as forensic jurisprudence.

Like many other aspects of life today, forensic science has become global in scope. The editors have been determined from the start that the *Encyclopedia of Forensic Sciences* would have a strong international perspective. To that end, we have assembled an international group of expert authors from 22 countries, and feel that this rich repository of viewpoints and excellence has added immensely to the value of this work.

Although we have tried to cover as many subjects as possible in the *Encyclopedia of Forensic Sciences*, we are aware that some areas have been missed or perhaps not covered in sufficient depth. It is difficult to appreciate the difficulties in commissioning more than 200 articles and hoping that all will be received on time. Still, we have endeavored to cover as much ground as possible and we are confident that we have delivered enough material that should satisfy most readers.

We would like to take this opportunity to thank all of the authors who worked so hard to deliver high quality manuscripts on time. We would also like to thank our Editorial Advisory Board who labored mightily to suggest topics and authors, and review manuscripts in a thorough and timely manner. Thanks also go to Carey Chapman and Nick Fallon of the Major Reference Works Group at Academic Press for their guidance, and especially to our Developmental Editor within that group, Sara Gorman, without whose tireless efforts, this Encyclopedia simply could not have been written.

Jay A Siegel, Pekka J Saukko, Geoffrey C Knupfer
Editors
July 2000

INTRODUCTION

THERE ARE those who say that there really is no such thing as ‘forensic science’; that instead, it is a collection of scientific techniques and principles that are begged and borrowed from ‘real’ sciences such as chemistry, biology, physics, medicine and mathematics. Others have suggested that the ‘sciences’ of fingerprints, firearms and toolmarks and questioned documents are the only real forensic sciences, and all the rest of it is on loan from the classical hard sciences. There is some truth to both of these definitions. Few would doubt that much of the process of forensic DNA typing consists of classical laboratory methods of DNA characterization, applied to real world evidentiary material, much of which has been degraded or contaminated. Or that in the case of controlled substance analysis, the methods of analytical chemistry are applied to the characterization and comparison of so-called ‘street’ drugs.

However, although many of the techniques used in modern forensic science have been borrowed from other sciences, it is also true that in recent years, it has matured into a scientific discipline in its own right. Many scientific techniques used in the analysis of physical evidence have been developed and perfected principally for forensic purposes. Also, forensic science does not just involve analysis of chemical, physical and biological materials. There are important considerations of collection and preservation of evidence, interpretation of findings from analysis, and presentation of expert, scientific testimony in criminal and civil courts. These processes are not isolated, but in fact must be carefully integrated, if forensic science is to have any meaningful effect on the criminal and civil justice systems in the world. This is what makes forensic science a unique and fascinating field of study and work.

The *Encyclopedia of Forensic Sciences* was conceived and developed with these principles in mind. It brings together, for the first time in such breadth and depth, a collection of articles that cover the whole panoply of activities which make up forensic science. Although the main focus of the Encyclopedia is the analysis of evidence, considerable space is devoted to investigative aspects including collection and preservation of evidence, and the interpretation of analytical findings and their presentation in court. The editors want the reader to be mindful of the interconnections between the various disciplines and factors that comprise the forensic science enterprise, all of which are necessary to make it work. We also want the reader to appreciate that, although there are differences in how various agencies worldwide handle and analyze evidence – and how expert testimony is offered in court, there is the same basic framework and interdependence at work everywhere.

We hope and trust that the reader will see the Encyclopedia as a valuable resource in navigating the interesting and ever-evolving world of forensic science.

GUIDE TO USE OF THE ENCYCLOPEDIA

Structure of the Encyclopedia

The material in the Encyclopedia is arranged as a series of entries in alphabetical order. Some entries comprise a single article, whilst entries on more diverse subjects consist of several articles that deal with various aspects of the topic. In the latter case the articles are arranged in a logical sequence within an entry.

To help you realize the full potential of the material in the Encyclopedia we have provided three features to help you find the topic of your choice.

I. Contents Lists

Your first point of reference will probably be the contents list. The complete contents list appearing in each volume will provide you with both the volume number and the page number of the entry. On the opening page of an entry a contents list is provided so that the full details of the articles within the entry are immediately available.

Alternatively you may choose to browse through a volume using the alphabetical order of the entries as your guide. To assist you in identifying your location within the Encyclopedia a running headline indicates the current entry and the current article within that entry.

You will find 'dummy entries' where obvious synonyms exist for entries or where we have grouped together related topics. Dummy entries appear in both the contents list and the body of the text. For example, a dummy entry appears for Lip Print which directs you to Cheiloscropy, where the material is located.

Example

If you were attempting to locate material on Friction Ridge Impressions via the contents list.

FRICTION RIDGE IMPRESSIONS *see* CHEILOSCOPY; CRIME-SCENE INVESTIGATION AND EXAMINATION:

Fingerprints; EAR PRINTS; FINGERPRINTS (DACTYLOSCOPY): Automated Methods, including Criminal Record Administration; Chemistry of Print Residue; Identification and Classification; Sequential Treatment and Enhancement; Standards of Proof; Visualization; PATTERN EVIDENCE: Bare Footprint Marks.

At the appropriate location in the contents list, the page numbers for articles under Fingerprints are given.

If you were trying to locate the material by browsing through the text and you looked up Friction Ridge Impressions then the following information would be provided.

Friction Ridge Impressions *see* **Cheiloscropy. Crime-scene Investigation and Examinations:** Fingerprints. **Ear Prints. Fingerprints (Dactyloscopy):** Automated Methods, including Criminal Record Administration; Chemistry of Print Residue; Identification and Classification; Sequential Treatment and Enhancement; Standards of Proof; Visualization. **Pattern Evidence:** Bare Footprint Marks.

Alternatively, if you were looking up Fingerprints the following information would be provided.

FINGERPRINTS (DACTYLOSCOPY)

Contents

Automated Methods, including Criminal Record Administration

Chemistry of Print Residue

An International Perspective

Identification and Classification

Sequential Treatment and Enhancement

Standards of Proof

Visualization

2. Cross References

All of the articles in the Encyclopedia have been extensively cross referenced.

The cross references, which appear at the end of an article, have been provided at three levels:

- i. To indicate if a topic is discussed in greater detail elsewhere.

FIRE INVESTIGATION/Evidence Recovery at the Fire-scene.

See also: **Crime-scene Investigation and Examination:** Recording; Collection and Chain of Evidence; Recovery of Human Remains; Packaging; Preservation; Contamination. **Evidence:** Classification. **Fire Investigation:** Types of Fire; Physics/Thermodynamics; Chemistry of Fire; Fire-scene.

- ii. To draw the reader's attention to parallel discussions in other articles.

FIRE INVESTIGATION/Evidence Recovery at the Fire-scene.

See also: **Crime-scene Investigation and Examination:** Recording; Collection and Chain of Evidence; Recovery of Human Remains; Packaging; Preservation; Contamination. **Evidence:** Classification. **Fire Investigation:** Types of Fire; Physics/Thermodynamics; Chemistry of Fire; Fire-scene.

- iii. To indicate material that broadens the discussion.

FIRE INVESTIGATION/Evidence Recovery at the Fire-scene.

See also: **Crime-scene Investigation and Examination:** Recording; Collection and Chain of Evidence; Recovery of Human Remains; Packaging; Preservation; Contamination. **Evidence:** Classification. **Fire Investigation:** Types of Fire; Physics/Thermodynamics; Chemistry of Fire; Fire-scene.

3. Index

The index will provide you with the volume number and page number of where the material is to be located, and the index entries differentiate between material that is a whole article, is part of an article or is data presented in a table. On the opening page of the index detailed notes are provided.

4. Color Plates

The color figures for each volume have been grouped together in a plate section. The location of this section is cited both in the contents list and before the *See also* list of the pertinent articles.

5. Contributors

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