Message from the Attorney General
[To be inserted]

Message from the President of West Virginia University

At West Virginia University, we are proud of our Forensic Identification Program's involvement with the Technical Working Group on Forensic Science Education and Training. Faculty and staff from WVU's Forensic Identification Program and its Forensic Science Initiative, in conjunction with the National Institute of Justice, have worked hard to produce this *Guide to Forensic Science Education and Training.*

West Virginia University is West Virginia's land-grant, flagship university and one of 148 institutions nationally that the Carnegie Foundation for the Advancement of Teaching classifies as Doctoral/Research University-Extensive. Developing excellent teaching, research, and service programs is WVU's mission, and helping to create this much needed educational guide is an important service effort.

Recent high-profile cases have highlighted the need for technical and educational training of forensic scientists. As professional requirements evolve, future forensic scientists need to know which scientific areas they should study. This guide will direct students toward the appropriate educational preparation and inform the public about forensic scientists' qualifications.

WVU and the Forensic Identification Program's Forensic Science Initiative commend the work members of the Technical Working Group on Forensic Science Education and Training have done. This guide will be a valuable tool for students interested in forensic science and for the career counselors who advise them. The guide's recommendations will also help institutions develop in-depth science-oriented curricula that provide the forensic community with the most competent forensic scientists.

David C. Hardesty, Jr.
President
West Virginia University

Technical Working Group on Education and Training in Forensic Science

The Technical Working Group on Education and Training in Forensic Science (TWGED) is a multidisciplinary group of content area experts from across the United States and Canada, from both urban and rural jurisdictions, each representing his or her respective agency or practice. Each of these individuals is involved in the education and/or training of forensic scientists (as students or professionals). They represent academia, operational forensic science laboratories, professional forensic science organizations, and the legal system.

At the outset of the TWGED effort, the National Institute of Justice (NIJ) created a planning panel—composed of forensic science educators, crime laboratory directors, and trainers – to define needs, develop initial strategies, and steer the larger group. This planning panel first determined that an NIJ Technical Working Group (TWG) would provide the best approach for addressing the demonstrated needs. Additional members of the technical working group were then selected from recommendations solicited from the planning panel, national organizations including the American

Academy of Forensic Sciences, American Society of Crime Laboratory Directors, American Society of Crime Laboratory Directors/Laboratory Accreditation Board, International Association for Identification, Drug Enforcement Administration, Federal Bureau of Investigation, George Washington University, West Virginia University, Marshall University, and the National Forensic Science Technology Center.

Collectively, over a 1 year period, the 52 members of the TWGED listed below worked together to develop this guide, *Education and Training in Forensic Science: A Guide for Forensic Science Laboratories, Educational Institutions and the Interested Student*.

Education and Training in Forensic Science Planning Panel

Dr. Jack Ballantyne, Associate Professor, Department of Chemistry, University of Central Florida

Inspector Mark Dale, Laboratory Director, New York State Police

Dr. Allison Eastman, Supervisor of DNA Services, New York State Police

Linda Errichetto, Laboratory Director, Las Vegas Metropolitan Police Department Forensic Laboratory

Dr. Terry Fenger, Director, Marshall University Forensic Science Center

Barry Fisher, Director, Scientific Services Bureau, Los Angeles County Sheriff's Office

Dr. Jane Homeyer, Forensic Science Training Unit Chief, Laboratory Division, Federal Bureau of Investigation

Peter Marone, Central Lab Director, Division of Forensic Sciences, Commonwealth of Virginia

Dr. Carl Selavka, Director, Massachusetts State Police Crime Laboratory

Dr. Ian Tebbett, Education and Training Consultant, University of Florida

Dr. Michael Yura, Director, Forensic Identification Program, West Virginia University

Additional Technical Working Group Members

Dr. Jose Almirall, Director, Forensic Science Program, Florida International University

Kathleen Barch Deputy Director, Ohio Bureau of Criminal Identification and Investigation

Dr. Clifton Bishop, Curriculum Coordinator and Advisor, Forensic Identification Program, West Virginia University

Garry Bombard, Director of Training, Illinois State Police Department: Forensic Sciences Command

Dr. Robert Briner, Director, Southeast Missouri Regional Crime Laboratory

Dr. Michael Bourke, DNA Manager, Connecticut Department of Public Safety*

Dr. Yale Caplan, Director, National Scientific Services,

Elizabeth Carpenter, Laboratory Director, Oregon State Police Crime Laboratory

Alan Clark, Associate Deputy Assistant Administrator, Office of Forensic Sciences, Drug Enforcement Agency Headquarters

Dr. Peter DeForest, Professor of Criminalistics, John Jay College/CUNY

Dr. Christopher D'Elia, Vice President for Research, State University of New York, Albany

Dr. Jamie Downs, Director/Chief Medical Examiner, Alabama Department of Forensic Sciences

Dr. David Foran, Assistant Professor, George Washington University, Department of Forensic Sciences

Dr. James Fox, Lipman Family Professor of Criminal Justice, College of Criminal Justice, Northeastern University

Dr. Robert Fraas, Director, Forensic Science Program, Eastern Kentucky University

Dr. Robert Gaensslen, Director of Graduate Studies, Forensic Science Program, University of Illinois at Chicago

Dr. Howard Harris, Director, Forensic Science Program, University of New Haven

Dr. Neal Haskell, Forensic entomologist, St. Joseph's College, Rennsselaer, Indiana

Carol Henderson, J.D., Professor of Law, Shepard Broad Law Center, Nova Southeastern University

Dwane Hilderbrand, Scottsdale Crime Laboratory, Arizona

Karen Irish, Director of Forensic Sciences, Baltimore County Police Department

Susan Johns, Bureau Chief, Illinois State Police

Dr. Graham Jones, President, Forensic Specialties Accreditation Board, Medical Examiner's Office, Edmonton, Alberta

Dr. Karen Kershenstein, President, KWK Enterprises

Dr. Michael Bourke, Connecticut Department of Public Safety

* Designee of TWGED member, attended one meeting as proxy.

Kevin Lothridge, Deputy Director, National Forensic Science and Technology Center

Joseph Polski, Chief Operations Officer, International Association for Identification

Lawrence Presley, Director of Criminalistics, National Medical Services

Victor Reeve, Laboratory Director, California Criminalistics Institute

Gerald Richards, Richards Forensic Services

Dr. Kathy Roberts, Assistant Professor, California State University, Los Angeles

Linda Rourke, John Jay College/City University of New York*

Dr. George Sensabaugh, Professor of Biomedical and Forensic Sciences, University of California, Berkely

Dr. Charles Tindall, Director of Forensic Science, Metropolitan State College of Denver

Dr. Victor Weedn, Principal Research Scientist and Director of Biotechnology and Health Initiatives, Carnegie Mellon University

Dr. Jeffrey Wells, Associate Professor, Department of Justice Sciences, University of Alabama at Birmingham

Wayne Williams, J.D., Electronic Consultant/Attorney-at-Law

Amy Wong, Laboratory Director, Virginia Division of Forensic Science

Kenneth Zercie, Assistant Director, Connecticut State Police Forensic Laboratory

Acknowledgements

West Virginia University (WVU) and the National Institute of Justice (NIJ) wish to thank the members of the Technical Working Group on Education and Training in Forensic Science (TWGED) for their extensive efforts and dedication to the enhancement of education and training in forensic science. The 52 members of the TWGED, who are national experts representing academia, operational forensic science laboratories, professional organizations, and the legal system, gave generously of their time to draft and review this document. In addition, thanks are extended to the agencies and organizations that TWGED members represent for their flexibility and support, which enabled the participants to see this project to completion.

NIJ also wishes to thank Attorney General John Ashcroft whose support and commitment to the advancement of forensic science education and training and to the overall improvement of the criminal justice system made this work possible.

* Designee of TWGED member, attended one meeting as proxy.

Appreciation is also extended to Sarah V. Hart, NIJ Director, for her support and guidance, Dr. David G. Boyd, Director of NIJ's Office of Science and Technology (OS&T) and Dr. Lisa Forman, Director of the Investigative and Forensic Sciences Division (IFSD of OS&T) for their vigorous commitment, support, and vision, to Dr. Lois Ann Tully, NIJ Program Manager, for her dedication and technical and substantive support, and to Christopher Turner, NIJ Project Monitor, for bringing this project to fruition.

NIJ and WVU would like to thank all the individuals from various national organizations who responded to the request for nominations of experts with a wide expanse of knowledge and experience from different areas of forensic science, both in practice and education. It was from their recommendations that the members were selected. In particular, thanks to Mary Fran Ernst from the American Academy of Forensic Sciences, Keith K. Coonrod from the American Society of Crime Laboratory Directors, Robert S. Conley from the American Society of Crime Laboratory Directors – Laboratory Accreditation Board, Thomas C. Smith from the American Bar Association, Criminal Justice Section, Jennifer S. Mihalovich from the American Board of Criminalistics, Thomas Janovsky from the Drug Enforcement Agency, Dick Johnson from the National White Collar Crime Center, Dr. Michael Baer from the American Council on Education, Dr. Jay Siegel from Michigan State University, Dr. Ray H. Liu from the University of Alabama-Birmingham, Dr. David A. Rowley from the George Washington University, and Dr. Philip H. Yeagle from the University of New Haven, CT. NIJ, WVU and the TWGED would also like to thank the more than [*number to be filled in later*] individuals and organizations who were sent a copy of the draft guide for review and comment.

WVU would like to thank President David Hardesty, Provost Gerry Lang, and Vice President for Research John Weete for their commitment and dedication to the forensic sciences and this project.

NIJ and WVU thank Aspen Systems, Inc. for their technical support in the form of editors Maggie Pettersen, Ryan Kuhn, Mark Eckert, Janel Edwards, and Michele Coppola, who assisted with the drafting of this document.

Special thanks go to Lori Britton, Forensic Identification Program Administrative Assistant, West Virginia University, for her organization and support of the various TWGED meetings.

Special thanks also go to Anjali R. Swienton, Senior Forensic Analyst, ACS Defense, Inc., Contractor to NIJ, and Max M. Houck, Projects Director, West Virginia University Forensic Science Initiative, for their diligent efforts at the TWGED meetings and in the production of this guide.

Table of Contents

Introduction

Forensic science plays a crucial role in the justice system by providing scientific and foundational information for investigations and the courts. TWGED focused primarily on education and training in those disciplines traditionally and generally associated with the work of forensic science laboratories, commonly referred to as "**criminalistics**[1]" (see Appendix A). Criminalistics is the profession and scientific discipline which is directed toward the recognition, identification, individualization, and evaluation of physical evidence in legal proceedings by the application of the natural sciences. There are many other forensic science specialty areas whose educational and training requirements are distinctly different from the traditional areas, such as forensic computer science, forensic entomology, forensic psychology, etc., and these are more fully described in Appendix B.

How to Use This Guide

This guide is intended for use by forensic science laboratories in hiring and training forensic scientists, educational institutions offering or seeking to establish forensic science programs, and individuals beginning or continuing careers in forensic science.

Forensic Science Laboratories can make use of this guide in a variety of ways. It offers suggested qualifications for prospective employees' academic background and may assist laboratories in posting and filling forensic science positions. The guide also provides structure for the continuing education of practicing forensic scientists and ways to enhance a current employee's knowledge, skills, and abilities.

Educational institutions can use this guide to gauge the curriculum and structure of their forensic science academic programs. As a reflection of the forensic science community's needs and requirements, this guide may provide direction and ideas for the design or expansion of forensic science academic programs.

The prospective forensic science student can use this guide as assistance in the evaluation of forensic science academic programs. It will also provide guidance regarding the requirements, career paths, and expectations for a career in forensic science.

Background

As stated in the 1999 NIJ publication *Forensic Science: Review of Status and Needs*, the educational and training needs "of the forensic community are immense. Training of newcomers to the field, as well as providing continuing education for seasoned professionals, is vital to ensuring that crime laboratories deliver the best possible service to the criminal justice system. Forensic scientists must stay up to date as new technology, equipment, methods, and techniques are developed. While training programs exist in a variety of forms, there is need to broaden their scope and build on existing resources." (*Forensic Science: Review of Status and Needs*, executive summary, page 4).

Forensic Science: Review of Status and Needs made a number of recommendations, including seeking mechanisms for:

- Accreditation/certification of forensic academic training programs/institutions,

[1] Words defined in the Glossary are in **bold type** on first use.

- Setting national consensus standards of education in the forensic sciences,
- Establishing independent, community wide, consensus standard-setting bodies, such as Technical Working Groups (TWGs),
- Funding by NIJ of forensic academic research and development programs, and
- Ensuring that all forensic scientists have professional orientations to the field, formal quality-assurance training, and expert witness training.

In recent years, the demand for forensic scientists has increased for many reasons, including population demographics, increased awareness by law enforcement of forensic science, increased numbers of law enforcement officers, automation of databasing in several categories of physical evidence, jury expectations, legal requirements, accreditation and certification requirements of laboratories and personnel, impending retirement of a large number of current practicing forensic scientists, and increased public awareness of forensic science through the popular media. The increased demand places a greater responsibility on educational institutions and the forensic science community to meet this challenge. The Technical Working Group on Education and Training in Forensic Science (TWGED) was created in response to the needs expressed by the justice system, including the forensic science and law enforcement communities, to establish models for training and education in forensic science.

Origin of the Education and Training in Forensic Science Planning Panel and the Technical Working Group on Education and Training in Forensic Science

In the summer of 2001, the American Academy of Forensic Sciences (AAFS), the American Society of Crime Laboratory Directors/Laboratory Accreditation Board (ASCLD/LAB), and the American Society of Crime Laboratory Directors (ASCLD) encouraged NIJ and WVU to establish TWGED. NIJ and WVU selected a 10 member planning panel, the members of which represented forensic science laboratory directors, educators, and trainers. The rationale for their involvement was two-fold: They represent the diversity of the professional disciplines and each organization is a key stakeholder in the future of education and training in forensic science.

The planning panel was charged with the development of the outline for a guide for education and training in forensic science. The planning panel also was charged with identifying experts to serve as members of TWGED, a task the panel completed at a meeting in Morgantown, West Virginia, in the summer of 2001.

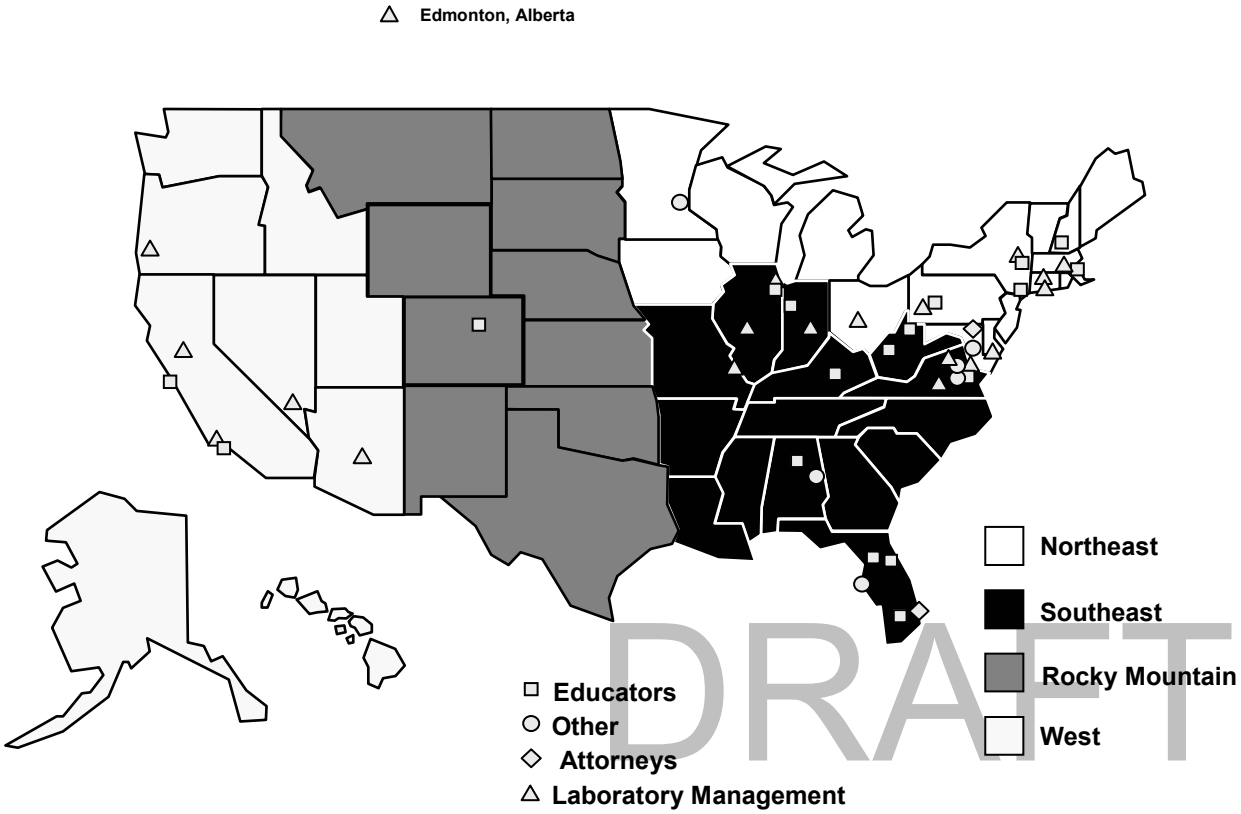
Candidates for TWGED were recommended by organizations representing law enforcement, forensic science, and educational programs that educate and train forensic scientists, prosecutors, and defense attorneys. The following criteria were used to select TWGED members:

- Each member was nominated/selected for the position by the planning panel and/or national organizations
- Each member had specific knowledge in education and/or training in forensic science.
- Each member could commit to the project for at least a 12-month period.

The experts invited to TWGED consisted of 52 individuals from 21 states. Their expertise was distributed among 20 forensic educators and trainers, 22 forensic science laboratory managers, 2

attorneys, and 6 experts from other organizations. This distribution of expertise, detailed below, brought together all of the necessary resources to produce this guide.

Technical Working Group on Education and Training in Forensic Science Membership Distribution



Region	Number of Participants	Percentage
Northeast	19	38
Southeast	22	44
Rocky Mountain	1	2
West	7	14
Canada	1	2
Total	50	100

Chronology

The Planning Panel meeting. In the summer of 2001, the Planning Panel met in Morgantown, West Virginia to prepare the project objectives and begin the guide development process. The Planning Panel's objective was to develop an outline for a guide based on existing programs in forensic science education and current models for forensic science training and present it for review to the assembled TWGED at a later date. During this initial session, the Planning Panel identified five distinct topics for inclusion in the guide which were distilled into four final sections.

The guide's content has the following format:

- A statement of *introduction*.
- A statement of *model criteria*, which set forth minimum recommendations.
- A statement of *implementation*, which describes how to execute the recommendations.
- A *summary* statement citing justification for performing the procedures.

TWGED Meetings

In November of 2001, TWGED met in Morgantown, West Virginia and in January of 2002 in San Diego, California. The group was separated into four committees to draft the sections of the guide: Qualifications for a Career in Forensic Science, Undergraduate Education in Forensic Science, Graduate Education in Forensic Science, and Training/Continuing Education in Forensic Science. An editor from Aspen Systems Corporation attended each of the breakout sections to facilitate the drafting process. Once all breakout sections completed their work, the full TWG assembled to evaluate their work.

The Planning Panel reassembled in March, 2002 in San Antonio, Texas to review and incorporate comments from the full TWG into the document.

In April, 2002, TWGED met once again in Crystal City, Virginia to make revisions and complete the initial document review as a group. The draft was edited and TWGED members were asked to recommend persons, organizations, or agencies they felt should comment on the draft. This draft was then sent to these stakeholder organizations and to all TWG members.

Finally, in August of 2002, the Planning Panel met in Las Vegas, Nevada, to review the latest draft, make revisions, and approve changes. In addition, the Planning Panel reviewed the Glossary, Title, Introduction, and Appendices for the document.

At the end of the document are Appendices containing a list of forensic science careers outside of the traditional forensic science laboratory, a glossary, a list of the scientific and technical working groups and any published educational requirements from them, a reference list, and a list of organizations to which a draft copy of the document was sent.

Section I: Qualifications for a Career in Forensic Science

Introduction

Forensic science plays a crucial role in the criminal justice system. As an applied science, it requires a strong foundation in the natural sciences and the development of practical skills in the application of these sciences to a particular discipline. A forensic scientist must be capable of integrating knowledge and skills in the examination, analysis, interpretation, reporting, and testimonial support of physical evidence. A properly designed forensic science program should address these needs and strengthen the student's **knowledge, skills, and abilities (KSAs)** in these areas. A combination of education and practical training can prepare an individual for a career in forensic science.

Most of the nation's practicing forensic scientists are employed in crime laboratories associated with law enforcement or other governmental agencies. Forensic scientists come to the profession with diverse undergraduate science degrees. They may also have to go on to earn graduate degrees. This document contains suggestions for model programs in forensic science at both the undergraduate and graduate (M.S.) levels. Prospective forensic science examiners must be aware that a number of factors will influence their suitability for employment including a combination of personal, professional, and academic criteria.

Government entities have personnel or hiring processes which are driven by civil service regulations or collective bargaining agreements specific to the branch of government, state or locality. Private laboratories have their own hiring practices. The hiring process may include written and practical tests, phone interviews, and one-on-one personal interviews or interviews conducted by a panel. New employees may be hired provisionally or go through a probationary period. Applicants should be aware that provisional employment offers may be revoked either before or after reporting for duty.

Model Candidate

A model candidate for all forensic science practices should have personal integrity, hold at a minimum a baccalaureate degree in the natural sciences, and have additional KSAs which fulfill the recommendations contained throughout this Guide.

Personal Characteristics

Because forensic science is part of the criminal justice system, personal honesty, integrity, and scientific objectivity are paramount. Those seeking careers in this field should be aware that background checks similar to those required for law enforcement officers are likely to be a condition of employment. The following may be conducted and/or reviewed before an offer of employment is made and remain as ongoing conditions of employment (this list is not all-inclusive):

- Drug tests
- History of drug use

- Criminal history
- **Personal associations**
- Polygraph examination
- Driving record
- Past work performance
- Credit history
- Medical or physical examination

Personal candor in these areas is critical. In addition, an individual's history of community service or outside activities may also be considered.

Academic Qualifications

Forensic scientists need to have a strong fundamental background in the **natural sciences**. For example, new hires in forensic science laboratories performing analyses of drugs, DNA, trace, and toxicological evidence typically will have a degree in **chemistry**, biochemistry, **biology**, or forensic science from an accredited institution. Although forensic scientists involved in the recognition and comparison of patterns, such as latent prints, firearms, and questioned documents, historically may not have been required to have a degree, the trend in the field is to strengthen the academic requirements for these disciplines and require a baccalaureate degree, preferably in a science. The academic qualifications required for some of the emerging disciplines, such as digital evidence, are currently being defined and will be published by the appropriate groups. Achieving the appropriate academic qualifications is discussed in greater detail later in this Guide.

Copies of diplomas and formal academic transcripts are generally required as proof of academic qualification. Awards, publications, internships, and student activities may be used to differentiate one applicant from another. Claims in this regard are therefore subject to verification through the background investigation process.

Professional Skills

A variety of skills are essential to an individual's effectiveness as a forensic science professional, including:

- Critical thinking (quantitative reasoning and problem-solving)
- Decision-making
- Good laboratory practices
- Awareness of laboratory safety
- Observation and attention to detail
- Computer proficiency
- Interpersonal skills
- Public speaking
- Oral and written communication
- Time management
- Prioritization of tasks

For some of these skills, there are systematic tools available which may be used to measure skill or proficiency at or after the time of hire.

Model Career Path for Forensic Scientists

A model career path for a forensic scientist begins with formal education, and continues with training, post-graduate education, certification, and professional membership. In Chart 1 below, a model career path is provided to guide the reader in better understanding the stages and role of credentialing in the forensic science career. The career path contains elements which address most of the components of this flow chart to guide students, laboratory managers, agency personnel and the public in understanding how credentialing can positively impact the overall effectiveness of forensic science practice.

Credentials
A forensic scientist's career path should demonstrate continued professional development that is documented by credentials. A credential is a formal recognition of a professional's knowledge, skills, and/or abilities. Indicators of professional standing include academic credentials, professional credentials, training credentials, and competency tests.

Implementation

Pre-Employment Preparation
Competitive candidates will be prepared to demonstrate the knowledge, skills, and abilities that establish their readiness for a forensic science position. These KSAs could include areas important to all potential forensic science practitioners, including but not limited to Quality Assurance (QA), ethics, professional standards of behavior, evidence control, report writing, scientific method, inductive and deductive reasoning, statistics, and safety. Documentation of coursework or practical experiences involving these KSAs would significantly enhance the objective information available to an agency evaluating potential new hires.

On-the Job Training

After hire, on-the-job training by the hiring agency is common. This initial training is generally completed within 6-months to 3-years of the date of hire, depending on the trainee, agency, and forensic science specialty. Some specialties have established peer-based objective standards adopted throughout the field, while others vary from agency to agency.

Certification

Within forensic science, accreditation applies to *laboratories* whereas certification applies to *individuals*. Certification of an individual's competency by an independent, peer-based organization should be pursued, if available, from an appropriately-credentialed certifying body. These independent credentials must be governed by the quality assurance program for certifying organizations of the Forensic Specialties Accreditation Board (FSAB), or an organization that has constructed an equivalent program which meets ISO Guide 17024 for the accreditation of certifying bodies (see Appendix C).

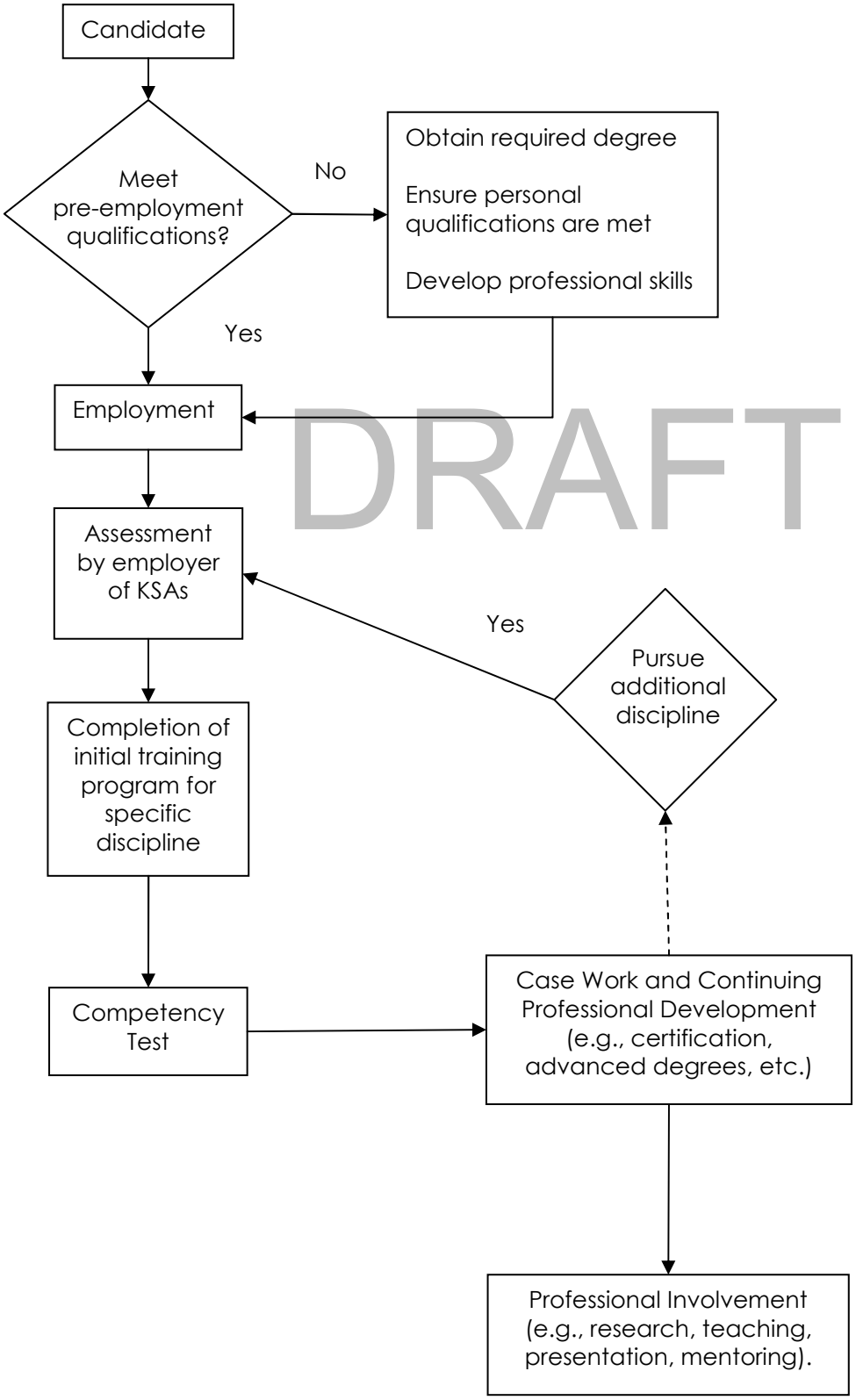


Chart 1: A Model Career Path in Forensic Science

Certification should be sought from an organization that is accredited by the Forensic Specialties Accreditation Board (FSAB) or other program that is based on nationally or internationally recognized standards. A credible certification program must require a meaningful evaluation of credentials, examination, and an ethics component, in addition to periodic re-certification. Re-certification should require a person to undergo a minimum amount of continuing education and may require demonstration of continued competency. Certification has been used by some employers as a pre-requisite for employment and/or advancement; in addition, it may enhance an individual's credibility as an expert witness.

Professional Involvement

While casework is the primary focus of a forensic scientist, he or she should also strive to advance the profession. This may be accomplished through research, mentoring, teaching, participation in professional organizations, community outreach, publishing, and other professional activities.

Summary

A strong educational background in the natural sciences, personal attributes such as honesty and integrity, and additional professional skills are necessary to prepare the candidate for a career in forensic science. In addition to formal academic education and employer-provided training, a level of self-motivated professional development, including certification and involvement in the field – in activities such as research, mentoring, and participation in professional organizations – provides a tremendous opportunity for growth for both the experienced professional and those entering the field.

Section II: Undergraduate Curriculum in Forensic Science

Introduction

Forensic science is an applied science that covers a broad array of disciplines. Regardless of what area of forensic science the student may subsequently choose to pursue, an undergraduate degree in forensic science should be interdisciplinary, combining a strong foundation in the natural sciences with extensive laboratory experience. What will be presented here are the elements of a model undergraduate forensic science degree program grounded in a strong science foundation.

The undergraduate forensic science major offered at an academic institution should provide a strong and credible science foundation emphasizing the scientific method and problem-solving skills for use in both classroom and laboratory settings. Graduates of an undergraduate forensic science program should also have acquired knowledge, skills, and abilities including scientific writing, public speaking, laboratory safety practices, computer software application skills, and laboratory skills.

The strengths of a model undergraduate forensic science degree include:

- Preparation for becoming a forensic science professional
- Opportunity to establish a network of forensic science contacts
- An educational background directly linked to the work in a forensic science laboratory
- Exposure to the breadth of forensic science disciplines
- Acculturation into the forensic science and justice communities
- Provision of a foundation for professional certification
- Emphasis on a wide range of courses (e.g., public speaking, ethics, and statistics) that may not be required in the curricula of other natural science majors

Most employment in the field is within a forensic science laboratory setting. Results of these analyses are typically used by law enforcement in the investigation of crimes, identification or elimination of suspects, and to assist the courts in reaching fair and just determinations. Professionals working in forensic science laboratories typically perform examinations on the following types of evidence (see Appendix A):

- Controlled substances (drugs)
- Toxicological specimens, including body tissues, body fluids, and breath
- Trace evidence, including hairs, fibers, paint, glass, and explosives and fire debris
- Biological, including DNA
- Firearms
- Fingerprints
- Impression evidence, including tool marks, tire marks, and shoe prints
- Questioned documents
- Crime scene

This list is not exhaustive. If a career goal is specifically to be a crime scene specialist, this science curriculum is not generally required, however, it is highly recommended. Students seeking to work

in alternative areas of forensic science, such as forensic computer sciences, will require other curricula or further specialized training (see Appendix B).

This section of the guide provides minimum recommendations for a model undergraduate degree in forensic science. Such a degree provides an educational foundation that meets current hiring requirements of forensic science laboratories. These programs are not designed to produce case-ready forensic scientists. Laboratory managers, educators, and students should recognize that prior to beginning casework, additional on-the-job training and possible post-graduate studies may be necessary to meet the specific needs of the individual employer.

Model Curriculum

The following constitutes a recommended model for an undergraduate forensic science program. These curricula emphasize the strong natural science foundation that is essential for preparing a student for a successful career in forensic science. Refer to Table 1 for an overview of the model curricula.

There are peer-based working groups which have promulgated specific education requirements (see Appendices D and E). Forensic science laboratories and graduate programs may require more than the recommended credit hours of specific course work.

University General Education

Courses required by the university, which may include language, humanities, social sciences, technical writing, computer science, and public speaking. The actual number of credit hours required will vary with the university and some of the courses may count toward fulfilling this requirement. Some care should be taken to select these university general education courses to compliment the student's program of study.

Natural Science Core

Certain natural science courses are required for any student in forensic science. Unlike other criminal justice professionals, a forensic scientist requires a foundation in chemistry, biology, physics, and mathematics.

Minimum general core requirements for all undergraduate forensic science programs (34-38 total credit hours):

- General chemistry I & II and lab for science majors (8 credit hours)
- Organic chemistry I & II and lab (8 credit hours)
- Biology I & II for science majors (4-8 credit hours)[2]
- Physics I & II for science majors and lab (8 credit hours)
- Calculus (3 credit hours)
- Statistics for science majors (3 credit hours)

Specialized Science Courses

[2] Classes with laboratory components are preferable, if available.

An undergraduate degree in forensic science should be an interdisciplinary degree that includes substantial laboratory work and an emphasis on advanced (upper level) coursework in either chemistry or biology. Students can use these additional courses to begin to specialize along a forensic science discipline track, such as forensic biology or forensic chemistry.

Specialized science courses from any of the following (minimum 12 credit hours; includes minimum of 2 laboratory courses):

- Biochemistry
- Molecular biology
- Genetics
- Population genetics
- Inorganic chemistry
- Analytical/quantitative chemistry
- Physical chemistry
- Instrumental analysis
- Cell biology
- Pharmacology
- Calculus II
- Microbiology

Forensic Science Laboratory Courses

In addition to a strong foundation in the natural sciences, forensic science professionals must be aware of certain concepts central to forensic science. Concepts such as individualization, reconstruction, association, and chain of custody of evidence are integral to the field of forensic science. Because the work product of a forensic scientist is used by the justice system, it must meet legal as well as scientific standards. The following courses are designed to give the student an understanding of the application of scientific analysis to the legal system. These concerns should be addressed by a minimum of 15 credit hours, including laboratory science courses and other related forensic science courses.

Forensic science laboratory courses (minimum 9 credit hours)

- Forensic Chemistry **and** lab (3)
- Forensic Biology **and** lab (3)
- Physical methods in forensic science **and** lab (3)
- Internship (up to 6) or Independent study/research (up to 6)
- Microscopy **and** lab (3)

Forensic Science Core

Certain forensic science topics must be covered in specific courses or as portions of other courses which may combine several of the topics mentioned below. *The following topics must be included within the forensic science curriculum:*

- Introduction to law/justice system
- Ethics/professional practice
- Forensic science specialty overview (survey course)
- Evidence identification, collection and processing
- Quality assurance
- Courtroom testimony
- Technical or scientific writing

Additional Courses

Students should be advised to select additional courses which would give them greater depth in their specific area of concentration. Additional courses may be necessary to satisfy admission requirements into some graduate programs. Table 1 provides examples of appropriate coursework for various areas of concentration indicated by the headings.

Summary of credit hour breakdown:

- 36-40 hours for general university requirements
- 46-50 hours natural science
- 15 hours forensic science (including 9 hours of courses that include a laboratory)
- 19 hours for additional courses

Total: 120 credit hours

Table 1: Sample Curricula for Forensic Science Undergraduate Degrees

	Biology	Chemistry/Trace/Controlled Substances	Toxicology	Firearms/QD/Prints
University General Education (36-40 hrs)	Courses required by the university, which may include language, humanities, social sciences, technical writing, computer science, and public speaking. The actual number of credit hours required will vary with the university and some of the courses below may count toward fulfilling this requirement.			
Natural Science Core (34-38 hrs)	Biology I, II* Calculus General Chemistry* I,II Organic Chemistry* I,II Physics* I,II Statistics	Biology I* Calculus General Chemistry* I,II Organic Chemistry* I,II Physics* I,II Statistics	Biology I* Calculus General Chemistry* I,II Organic Chemistry* I,II Physics* I,II Statistics	Biology I* Calculus General Chemistry* I,II Organic Chemistry* I,II Physics* I,II Statistics
Specialty Core (12 hrs)	Biochemistry Genetics Instrumental Analysis Molecular Biology	Analytic Chemistry Quantitative* Inorganic Chemistry Instrumental Analysis Physical Chemistry	Analytic Chemistry Quantitative* Biochemistry Instrumental Analysis Physical Chemistry	Inorganic Chemistry Instrumental Analysis Optics/Lasers Physical Chemistry
Forensic Science Core (6 hrs)	Forensic Science Survey Forensic Professional Practice♣	Forensic Science Survey Forensic Professional Practice	Forensic Science Survey Forensic Professional Practice	Forensic Science Survey Forensic Professional Practice
Forensic Laboratory Science (9 hrs)	Forensic Biology* Internship Microscopy* Physical Methods*	Forensic Chemistry* Internship Microscopy* Physical Methods*	Forensic Chemistry* Internship Microscopy* Physical Methods*	Internship Microscopy* Physical Methods*
Additional Courses • (19 hrs)	Cell Biology Introduction to Criminal Justice Legal Evidence Microbiology Population Genetics Public Speaking Immunology	Advanced Instrumental Analysis Drugs Introduction to Criminal Justice Legal Evidence Analytical Toxicology Materials Science Pharmacology Public Speaking	Advanced Instrumental Analysis Drugs Introduction to Criminal Justice Legal Evidence Analytical Toxicology Pharmacology Public Speaking	Crime Scene Introduction to Criminal Justice Legal Evidence Materials Science Public Speaking

* Laboratory courses.

• Electives listed here are not exhaustive and students may wish to tailor courses according to their areas of concentration.

♣ This course includes ethics, testimony, evidence, chain of custody, etc.

Note: These examples are based on a minimum of 120 semester hours to obtain a degree. Credit hours as described above are meant to indicate semester credit hours.

Implementation

Significant additional funding is necessary to bolster existing forensic science undergraduate programs and to create new programs. Funding will act as an incentive for those programs to provide the highest quality forensic science education necessary for future students' success in the field. The following are needed for the proper implementation of a successful undergraduate academic program:

Objectives and assessments of institutional effectiveness

The program should provide documented, measurable objectives, including expected outcomes for graduates. The program should regularly assess its progress against its objectives and use the results of the assessments to identify areas for program improvement and to modify the program's objectives.

Institutional support

A forensic science curriculum should enjoy a level of institutional support equal to any other natural science program such as biology or chemistry. Existing forensic science undergraduate programs that are under-supported according to these recommendations must be upgraded. New programs should not be created if the proper facilities and operational budget are not available. Sources for funding could include: competitive federal funding, funding from other public and private sources, and funding from the host university or college. Institutions must provide the appropriate variety of courses with sufficient frequency to allow students to complete the program in a reasonable amount of time.

Full-Time faculty

There should be adequate full-time faculty members to provide continuity and stability to cover the curriculum and to allow an appropriate mix of instruction and scholarly activity. The interests and qualifications of the faculty members must be sufficient to teach the courses and plan and modify the courses and curriculum. Faculty members must have knowledge and experience appropriate to the course being taught. Advising duties must be a recognized and valued part of faculty workload.

Adjunct faculty

It is the nature of forensic science education that practicing forensic scientists are often required as adjunct faculty. Adjunct faculty members must have knowledge and experience appropriate to the course being taught. However, full-time faculty must oversee the curriculum for all coursework and maintain institutional standards.

Facilities

Laboratories and computing facilities should be available, accessible, and adequately equipped and supported to enable students to complete their coursework and to support faculty teaching needs and scholarly activities. Institutional facilities including the library, classrooms, and offices must be adequate to support the objectives of the program. A library where faculty and students have access to books, periodicals, and electronic resources where adequate support for database searching is available is essential to a program. The institution should subscribe to several refereed journals in the forensic sciences.

Student support
Each student must have adequate and reasonable access to equipment of the type currently used in forensic science laboratories appropriate to the course of instruction. This equipment may be in the forensic science department, natural science department, or nearby cooperating operational forensic science laboratories. Students should have ample opportunity to interact with their instructors. Students should be offered timely and informed guidance about the program's requirements, course options, and career opportunities.

Faculty support
Support for faculty must be sufficient to enable the program to attract and retain high-quality faculty capable of supporting the program's objectives. This support should include opportunities to attend professional meetings, recognition of scholarly activities, adequate time for administrative duties, and clerical support.

Collaboration with forensic science laboratories
Academic forensic science programs should establish a working relationship with forensic science laboratories, if possible. Collaboration can provide meaningful internships, employment opportunities, guest lecturers, adjunct faculty, direct interaction with forensic scientists, and cooperative research.

Accreditation
The institution granting the degree must be accredited by an accrediting body that is recognized by the U.S. Department of Education.

At the time of this writing, there is no mechanism for the accreditation of forensic science undergraduate programs. When such a process is implemented, it is strongly recommended that all such programs seek accreditation. Benefits of accreditation include:

- An external means of validation of the program
- A valuable tool to help students select a program
- A means for forensic scientists and potential employers to judge the credentials of graduates
- Improvement of program quality
- A high level of competency for the graduates

Summary

Forensic science is an applied multidisciplinary profession based on the natural sciences. Therefore, it is essential that students studying forensic science have education and training consistent with this scientific foundation. The strengths of an undergraduate forensic science education include professional preparation, networking, and links to laboratories, work-related knowledge, and preparation for professional certification. Recommendations regarding this scientific foundation have been described within this document in the form of minimum guidelines for proposed forensic science undergraduate curricula. These recommendations include core natural science courses, extensive laboratory experience in both the natural and forensic sciences, special topics in forensic science, and other supportive coursework. The forensic science undergraduate degree is designed to

prepare students for entry into traditional forensic science laboratory employment and additional graduate-level education and training in many other disciplines.

In addition, this section provides implementation recommendations for a forensic science program including the following issues: program objectives and assessments, institutional support, faculty qualifications, the role of adjunct faculty, facility requirements, support of students and faculty, collaborations with forensic science laboratories, and program accreditation.

Section III: Graduate Education in Forensic Science
Introduction

The minimum pre-requisite for entry into a graduate-level forensic science program is either a baccalaureate degree in forensic science or a natural science; this is in addition to any college or university requirements, such as grade point average and Graduate Record Examination scores, among others.

A fundamental background in the natural sciences is central to the education of a forensic scientist who conducts examinations of physical evidence in the laboratory setting. A program of forensic science education at the graduate level must do more than educate students in theoretical concepts. A graduate education for forensic scientists is expected to provide the student with critical thinking ability, problem-solving skills and advanced, discipline-specific knowledge. It is likely that an increased number of forensic scientists will seek graduate level education in the forensic or natural sciences and this may facilitate career advancement.

Most graduate programs in forensic science will lead to the Master of Science (M.S.) degree. The graduate curricula recommendations in this document refer to programs that award a M.S. in forensic science. It is expected that students earning this degree will be prepared for employment in operational forensic science laboratories.

There is also a need for doctoral programs in the natural sciences with emphasis on forensic science research. Advanced education is necessary to prepare forensic scientists, academicians, and researchers for leadership roles in public and private laboratories and academic institutions. A full treatment of forensic science doctoral programs is beyond the scope of this document.

The forensic sciences encompass many disciplines, but this section will focus on the following:

- Controlled substances (drugs)
- Toxicological specimens, including body tissues, body fluids, and breath
- Trace evidence, including hairs, fibers, paint, glass, and explosives and fire debris
- Biological, including DNA
- Firearms
- Fingerprints
- Impression evidence, including tool marks, tire marks, and shoe prints
- Questioned documents
- Crime scene

The overall educational objectives and resources of an institution will govern the nature of any particular graduate program, and these will vary considerably. For programs intended to prepare students for a career in forensic science in accordance with these guidelines, there must be strong institutional commitment.

Model Curricula

Existing graduate programs in North America include the Master of Science in Forensic Science/Criminalistics and Master of Science in a natural science (e.g. chemistry, biology) with a track or emphasis in forensic science. Programmatic and other considerations have led to a wide variation in the content and structure of these programs.

A desirable program should contain the following elements (discussed in detail below):

- Forensic science topics
- Rigorous academic coursework in specialized area(s)
- Research component
- Laboratory component
- Interaction with operational forensic science laboratories and professional societies
- Qualified faculty with appropriate forensic science experience
- Sufficient faculty to student ratio and support personnel
- Adequate academic resources (library, journal subscriptions, laboratory space, equipment, etc.)
- Student support in the form of assistantships and/or fellowships

Curriculum Recommendations

A bachelor's degree in a forensic or natural science (or its equivalent coursework in a relevant field) is preferable for entrance into a forensic science graduate program. Prerequisite courses for entrance into a graduate forensic science program are, at a minimum, those courses described in Table 1 in Section II. Other degrees may contain sufficient prerequisite courses for consideration.

Master's programs in forensic science can be organized in many ways to reflect the institution's mission, the available facilities, and the interests and capabilities of the students and faculty. Regardless of how the program is organized, that part of the program specified as the core curriculum must be taken by all graduates. The program must include a minimum of 30 semester credit-hours. Students with undergraduate coursework or degrees that emphasized forensic science who enter a graduate forensic science program may have their specific coursework adjusted to reflect this background.

Syllabi must be current and describe the content of the course and required textbook(s).

The following topics must be included in the graduate forensic science curriculum:

- Crime scenes
- Physical evidence concepts
- Law/science interface
- Ethics and professional responsibilities
- **Quality assurance**
- Specific course(s) covering the following topic areas:
    - Analytical chemistry and instrumental methods of analysis
    - Drug chemistry/toxicology

- Microscopy and materials analysis
- Forensic biology
- Pattern evidence

Forensic science programs may offer specializations, tracks, or concentrations in a number of different areas such as analytical chemistry or molecular genetics. It is expected, however, that all forensic science programs will offer rigorous, graduate level academic coursework in appropriate subjects. The syllabi should present evidence that the courses are advanced, comprehensive, and current. Advanced courses should be offered on a regular basis to permit students to schedule the courses in proper sequence and with reasonable flexibility. In addition, it is expected that a number of advanced (graduate level) courses in specialized areas would be required to suit the interests of the students and enhance the research experience. A graduate seminar is recommended that includes regular attendance at presentations by experts on original research and other relevant topics.

Research Component

The student will conduct a research project, prepare a written report, and present the results of the research in a public forum prior to graduation. The research component of the program may include preparatory coursework in research methods and statistics. The ideal research project is well-defined, stands a reasonable chance of completion in the time available, and requires the student to use advanced concepts as well as a variety of experimental techniques and instruments. Research in forensic science contributes to the advancement of the body of knowledge and elevates the status of the profession.

Communication Skills

Effective written and oral communication skills are essential to the well-trained scientist. Forensic scientists should be proficient in written and oral communication skills. Frequent exercises in writing and oral presentation skills should be a part of the forensic science curriculum and should be critically evaluated by the forensic science faculty.

Institutional Accreditation

The institution granting the degree must be accredited by an accrediting body that is recognized by the U.S. Department of Education.

Faculty Requirements

At least 75 percent of the full time science faculty teaching in the forensic science graduate program should have an appropriate doctoral degree; faculty who have had experience working in a forensic science laboratory are preferred. The scientific and educational capabilities of the faculty should be distributed over the major areas of the program courses that are taught by persons qualified in each specialty. The number of faculty and their competence must be adequate to allow the teaching on a regular basis of the full range of courses needed for graduate education in forensic science.

Library Requirements and Information Retrieval

A library where faculty and students have access to books, periodicals, and electronic resources where adequate support for database searching is available is essential to a program. An institution

with a broad spectrum of research activity will require extensive holdings. The institution should subscribe to several refereed journals in the forensic sciences. Further, students must learn how to retrieve specific information from the enormous and rapidly expanding literature.

Classroom and Laboratory Requirements

Classroom and laboratories should meet the appropriate academic and safety requirements for the number of students in the program. In addition to the instructional laboratories, provisions should be made for faculty and students to have access to laboratories with facilities, equipment, and instrumentation appropriate for research.

Laboratory Experience

The laboratory component should include the use of appropriate instrumentation. It should give students hands-on knowledge of forensic science and competence to:

- Anticipate, recognize, and respond properly to chemical and biological hazards
- Keep legible and complete laboratory records
- Conduct qualitative and quantitative analyses
- Use and understand instrumentation and fundamental techniques
- Analyze data and evaluate experimental results
- Assess reliability of results and draw reasonable conclusions
- Communicate effectively through oral and written reports

Interaction with operational laboratories

Academic programs should interact with the operational forensic science laboratories. Cooperative efforts may take the form of internships, adjunct faculty interaction, staying current in the discipline, collaborative research, visiting scientist programs, and seminars.

An option within a graduate program may be a residency or fellowship program based on the medical model that combines formal, structured specialty training with an academic program. These programs can serve as a valuable component of a comprehensive and experiential training program. Such a program would provide hands-on training and experience in a forensic specialty so that the student would be essentially casework ready after completion of the program. This program option would include discipline-specific simulated casework analysis, oral boards, moot courts, data review and interpretation, and reports writing. This option will extend the normal time for completion of a graduate degree.

Implementation

The following necessary resources and actions are required for the proper implementation of successful graduate programs:

Funding

Increased funding is essential for graduate forensic science education to meet the demonstrated needs of the profession. At present there is no sustainable source of funding at the state or federal level to support graduate education or research in forensic science. The National Institute of Justice has traditionally provided virtually all research funding for the forensic sciences but additional funding from alternative sources is essential.

In additional to state and private sources, funding may be available from the following federal agencies: Department of Justice, National Science Foundation, National Institutes of Health, Department of Energy, National Security Agency, Department of Education, and Department of Commerce. In light of homeland security and terrorism concerns, funding may also be sought from the Centers for Disease Control and Prevention, Federal Aviation Administration, Department of Defense, Food and Drug Administration, Federal Emergency Management Agency, and the Department of Homeland Security.

Support for graduate student education is essential to the future successful operations of the graduate programs in forensic science. Ideally, this support should be provided in the form of competitive training grants to educational institutions. In addition, individual graduate research fellowships should be available. Programs should also take advantage of existing institutional graduate support mechanisms.

A program to forgive student loans for those graduates who obtain full-time employment in public forensic science institutions should be considered by appropriate legislative bodies.

In addition to research and student support, funding is also needed for the acquisition and maintenance of equipment and major research instrumentation and laboratory renovation. Institutions offering forensic science programs need to provide for ongoing costs associated with the laboratory component of the curriculum and program administration.

Accreditation

At the time of this writing, there is no mechanism for the accreditation of forensic science graduate programs. When such a process is implemented, it is strongly recommended that all such programs seek accreditation. Benefits of accreditation include:

- An external means of validation of the program
- A valuable tool to help students select a program
- A means for forensic scientists and potential employers to judge the credentials of graduates
- Improvement of program quality
- A high level of competency for the graduates

Section IV: Training and Continuing Education in Forensic Science

Introduction

The purpose of this section is to outline model criteria and implementation approaches for the training and **continuing professional development** of forensic scientists. Model criteria will be presented separately for training to attain competency and for post-competency continuing professional development.

Training is the formal, structured process through which an individual progresses from a current level of scientific knowledge and expertise to the level of competency required to conduct specific forensic analyses. Appropriate training must be provided before an individual is assigned case analysis responsibilities.

Continuing professional development is the mechanism through which an individual remains current or advances to a higher level of expertise, specialization, or responsibility. All forensic scientists have an ongoing obligation to remain current in their field through the process of continuing education and those other developmental activities noted in Chart 1 in Section I. Similarly, laboratory management and its parent agency have an ongoing responsibility to provide support and opportunities for this continuing professional development.

In order for any training or continuing professional development to be recognized, it must be properly documented. The agency or training entity must keep a permanent, official training record and provide the trainee with a copy. The trainee is encouraged to keep a personal copy of the training record. The training record must include:

- Documentation that entry requirements have been satisfied
- Detailed description of program structure, content, and assessment
- Trainee performance documentation
- Certificate or statement of successful completion of the training program

Model Criteria

Model criteria are intended to be utilized as a guide for the formulation of training and continuing professional development programs. These model criteria can provide a common framework across forensic disciplines and thereby help ensure that programs are consistent and contain essential elements.

Training

The model criteria for training consist of entry requirements, program structure and content, assessment mechanisms, and documentation.

Entry requirements should include:

- Specified minimum academic and experiential requirements consistent with recognized, peer-defined standards (e.g., SWGs, ASCLD/LAB, ABC) (See Appendices C and D)

- Applicant awareness that ongoing background security clearances and random drug testing may be required. Factors such as drug use, credit and criminal history, and personal references may affect career opportunities

Program structure should include the following written components:

- Learning objectives
- Instructor qualifications
- Student requirements
- Detailed syllabus
- Performance goals
- Periodic assessments
- **Competency testing**

Program content should be designed to include both discipline-specific and **core elements.** Core elements are essential topics that lay the foundation for entry into professional practice regardless of the specialty area and include the following:

- Standards of conduct—includes professional ethics training
- Safety—includes biological, chemical, and physical hazards
- Policy—includes administrative and laboratory policies such as Standard Operating Procedures (SOPs), Quality Assurance (QA), accreditation, and security
- Legal—includes expert testimony, depositions, rules of evidence, criminal and civil law and procedures, and evidence authentication
- Evidence handling—includes interdisciplinary issues, recognition, collection, and preservation of evidence, and chain-of-custody
- Communication—includes written, verbal, and nonverbal communication skills, report writing, exhibit and pretrial preparation, and trial presentation

Discipline-specific elements guided by recognized peer-defined standards should be incorporated, as appropriate. Topics include:

- History of the discipline
- Relevant literature
- Methodologies and validation studies
- Instrumentation
- Statistics
- Knowledge of related fields
- Testimony

The trainee's progress should be assessed at appropriate intervals. Assessment mechanisms may include:

- Oral exams
- Written exams
- **Laboratory practicals** and **exercises**
- Mock trials
- Assessment of technical performance by appropriate senior staff

Continuing professional development

Continuing professional development encompasses competency maintenance, skill enhancement, and other aspects of professional activities. It is important that continuing professional development be structured, measurable, and documented.

Structure
Courses taken for continuing professional development should include the following predefined components:

- Learning objectives
- Instructor qualifications
- Detailed syllabus or program description
- Assessment
- Documentation

Measurement
Assessment mechanisms include:

- Oral exams or reports
- Written exams or reports
- Peer-reviewed publications
- Instructor or presenter evaluation
- Laboratory practicals and exercises
- Observation of technical performance

Documentation
The agency must keep a permanent, official record of employee continuing professional development activities. The employee is encouraged to keep a personal copy of his/her record. The agency record must include a description of the activity, its format, and performance documentation (when available), such as academic credit, continuing education credit, certificates, and/or proceedings' abstracts.

Implementation

Training and continuing professional development based on the model criteria can be implemented in a variety of ways to maximize opportunities, minimize costs, and ensure high standards of professional practice. The examples below offer guidance for implementation.

Approaches for Training and Continuing Professional Development

Different disciplines require varying levels and combinations of approaches. The approach depends on the relative degree of academic and experiential learning required to attain and maintain competency. For example, the questioned document discipline may require more experiential-based skill, whereas the forensic biology discipline may require more academic knowledge.

Some peer groups (e.g., SWGs, TWGs, ASCLD/LAB, ABC, IAI, AFTE) provide guidance regarding training and frequency of continuing professional development. It is recommended that this guidance be considered when choosing any approach. Some approaches include:

- Instructor-led
- Professional conference/seminars
- **Distributed learning**
- **Apprenticeships**
- **Residencies**
- **Internships**
- Teaching and presentations by trainee/employee
- Independent learning.

Administration of Training and Continuing Professional Development Programs

It is recommended that the forensic laboratory establish a process to oversee, coordinate, and document all training and continuing professional development. Training and continuing professional development programs should be externally audited on a periodic basis.

It is recommended that continuing education and training courses include:

- Qualified instructor
- Written course syllabus/outline
- Written course objectives
- Instructor/course evaluation
- Mechanism for student assessment
- Documentation of student performance
- Quantifiable element such as continuing education units, academic credits, number of hours, or points

It is recognized that seminars, lectures, professional meetings, and in-service classes, while possibly less structured than a formal course, also add to the professional development of forensic scientists. Content and attendance should be documented and available for external audits.

Sources of Training and Continuing Professional Development

The sources of training and continuing professional development can be internal and/or external to a forensic science laboratory. Training partnerships are valuable because they provide broad perspectives and facilitate the consistency of professional practices. Sources include:

- Government agencies
- Academic institutions
- Training academies and institutions
- Private industries and organizations
- Professional societies
- Mentors

Funding for Training and Continuing Professional Development

Resources are needed to properly support training and continuing professional development. Qualified forensic scientists and supervisors should be afforded time in addition to their regular duties to mentor trainees and/or for their own continuing professional development. It should be recognized by agency management that case productivity will be affected by this reallocation of laboratory resources and this should be taken into account in agency planning.

Agencies can partner to develop and provide intensive formal discipline-specific programs for trainees. These programs can relieve an operational forensic science laboratory of the in-house mentoring needed for an individual to be able to conduct casework. This partnering model can also be extended to continuing professional development, with agencies working together to develop and provide standardized training curricula and materials for use across multiple agencies. Although these partnerships significantly reduce costs, funding for student attendance will be needed.

When considering the costs of continuing professional development, some scientific working groups recommend minimum mandatory "contact hours." For example, SWGDRUG recommends that a minimum of 20 contact hours per year be devoted to continuing professional development for each drug examiner. The FBI Quality Assurance Standards for Forensic DNA Testing Laboratories requires 1 day of continuing professional development per year, and this has been adopted as the requirement for DNA examiners for compliance with ASCLD/LAB standards

In the absence of external guidelines on contact time per year, some agencies designate contact time requirements of their own. Alternately, some agencies specify a budget for training and continuing professional development at, for example, $1,000 to $1,500 per year for each examiner. Such funds are used to support travel and fees for both externally-available opportunities and implementation of in-house programs. It is recommended that between 1% and 3% of the total forensic science laboratory budget be allocated for training and continuing professional development.

The professionalism expected of forensic science staff mandates that appropriate resources for training and development are provided by the parent agency. Forensic science is a labor-intensive undertaking, in which the quality, experience, and technical currency of personnel performing the work is paramount. Neglect of on-going training and professional development of staff leads to organizational failure to meet service goals and quality requirements of stakeholder agencies.

Regardless of the mechanism used, it is essential that a reasonable foundation be in place to offset the direct and indirect costs associated with having an adequate program of training and continuing professional development.

Summary

Model criteria are presented as a framework for achieving and maintaining professional competency in forensic sciences. Implementation of these criteria will extend learning opportunities and promote high standards of professional practice.

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Glossary

Apprenticeship: A relationship where an individual works for an entity while learning skills.

Biology: The science that is concerned with the growth, development, and functioning of living things.

Certification: A peer-based voluntary process of credentialing involving objective review of academic degrees, minimum mandatory experience in the discipline, and successful completion of a written examination. Certifying organizations should satisfy the requirements of ISO Guide 17024 for the accreditation of certifying bodies. See Appendix C for a list of certifying organizations.

Chemistry: the science that studies the structures, functions, transformations, and interactions of basic elements and matter.

Competency Testing: The evaluation of a person's ability to perform work in a functional area prior to the performance of independent casework.

Continued Professional Development: Continuing professional development is the mechanism through which an individual remains current or advances to a higher level of expertise, specialization, or responsibility.

Core Elements: Concepts, theories, and information that represent the foundation of a science or area of study.

Credentialing: Formal recognition of a professional's knowledge, skills and abilities in a particular field of expertise. This recognition is documented by means of academic degrees, certifications by professional organizations, and completion of specialty training programs.

Crime laboratory: A facility that receives, processes, and analyzes evidence (obtained through civil or criminal investigations) using scientific or technical methods and opinion testimony with respect to such physical evidence in a court of law; equivalent to **forensic science laboratory**.

Criminalistics: The profession and scientific discipline which is directed toward the recognition, identification, individualization, and evaluation of physical evidence in legal proceedings by the application of the natural sciences.

Distributed Learning: Educational methods that use models of distant, distributed, or remote education, such as video, the Internet, networked multimedia, and independent or proctored study models.

Forensic Science Laboratory: A facility that receives, processes, and analyzes evidence (obtained through civil or criminal investigations) using scientific or technical methods and opinion testimony with respect to such physical evidence in a court of law; equivalent to **crime laboratory**.

Forensic Science: The profession of assisting criminal and civil investigations and litigation through science.

Internship: An in-depth educational or training program offered in a forensic science setting providing a period of supervised practical experience.

Knowledge, Skills, and Abilities (KSA): The level of information, qualifications and experience needed by the employee in order to perform the assigned tasks. **K**nowledge refers to acquired principles and practices related to a particular job; **S**kills refer to acquired psychomotor behaviors; and **A**bilities are the talents, observable behaviors or acquired dexterity.

Laboratory Exercises: An educational activity where scientific concepts, principles, and methods that relate to laboratory procedures are demonstrated.

Laboratory Practical: An educational testing situation that emphasizes hands-on methods and procedures.

Materials analysis: The characterization of composition and structure (including defects) of a material that is significant for a particular product, study of properties, or use. In forensic science, this typically refers but is not limited to the analysis of **trace evidence**.

Natural Sciences: A science, such as biology, chemistry, or physics, that deals with the objects, phenomena, or laws of nature and the physical world.

Personal Associations: Social and professional relationships that may reflect on the morals, values, and citizenship of an individual.

Pre-qualification: The suggested milestones that should be obtained before seeking employment in a **crime laboratory** or a **forensic science laboratory**, including a required degree, personal character qualifications, and professional skills.

Provisional Employment: Introductory period of employment that allows the employee and agency to determine if the employee is suited for the job. During the provisional employment period, employees may be terminated at the discretion of the appointing authority, without access to a grievance procedure. A normal probationary period is 6 to 12 months; however, it can be extended as specified in the agency's policies.

Professional involvement: Activities that advance a profession, such as research, mentoring, teaching, participation in professional organizations, community outreach, publishing, and others.

Residency: The tenure of a professional in specialized training, usually occurring after an internship.

Trace evidence: Any evidence that, because of its size or texture, is easily transferred from one location to another and retained there. Forensic laboratories may categorize what constitutes 'trace evidence' differently.

Training: Training is the formal, structured process through which an individual progresses from a current level of scientific knowledge and expertise to the level of competency required to conduct specific forensic analyses.

Quality Assurance: Those planned and systematic actions necessary to provide sufficient confidence that a laboratory's product or service will satisfy given requirements for quality.

Appendix A: A note on the word 'criminalistics'

"Criminalistics is the science and profession dealing with the recognition, collection, identification, individualization, and interpretation of physical evidence, and the application of the natural sciences to law-science matters. The term originated from the book *Handbuch fur Untersuchungsrichter als System der Kriminalististik* (3 ed., 1898) by Hans Gross, an investigating magistrate and professor of criminology at the University of Prague. He described the need for a scientifically trained investigator who could undertake certain technical aspects of an investigation and could also serve as liaison between scientific specialists who might assist in the investigation of criminal activity. This concept was popular in Europe, where a number of forensic science institutes were developed to apply the tools and techniques of the natural sciences to the investigation of crime and, generally, in official governmental inquiries."[4]

The following specialized areas may be included under the criminalistics umbrella: biology (including biochemistry, molecular biology, and DNA analysis), chemistry, toxicology, microscopy, analysis of controlled substances, analysis of fire debris, explosive residues, analysis of hairs, fibers, glass, soil, paint and other materials, fingerprints and other impressions (such as footwear and tire tracks), questioned documents, tool marks and firearms identification, reconstruction, and reconstruction patterns.

Some terminology notes

Like other scientific and technical subjects, forensic science and criminalistics have specialized terminology that may not always be clear to non-specialists. In addition, people within the field may not always agree on the meaning of every term. To help make this document more accessible, we briefly discuss some of the terms used to describe specialized areas of criminalistics.

In the biological evidence analysis arena, the term "forensic serology" was common for a long time because blood groups were among the individual features of blood and physiological fluids. "Serology" is the study of blood groups (blood types). In the 1970s, a number of proteins, some of which were enzymes, came into use as additional individual characteristics of blood and physiological fluids, and the term "forensic biochemistry" came into use. With the introduction of DNA typing in the mid-1980s, forensic scientists no longer used blood types, enzymes or other proteins to characterize biological evidence. The term "forensic molecular biology" tries to capture forensic DNA analysis. "Forensic biology" usually now means the analysis of blood and physiological fluids, including DNA typing. There are some specialized areas, such as analysis of botanical evidence, that are really part of "forensic biology" as well.

"Forensic chemistry" sometimes means the use of analytical chemical methods for analysis of controlled substances (illegal drugs), and it also commonly encompasses the use of chemical methods to analyze fibers, glass, soil, paint and various other materials. These materials have often been called **trace evidence** in forensic science, but lately, some people have come to recognize that "trace" is not a very good term for this class of evidence. For one thing, it implies that there is a small quantity, and this is not necessarily true. Microscopy is commonly used to conduct these types of examinations.

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[4] Barnett, P. "Criminalistics", *The McGraw-Hill Encyclopedia of Science & Technology*, 9th Edition, Licker, M. (ed). New York: McGraw-Hall, Inc. 2002.

The "fingerprints" specialty includes automated fingerprint identification system (AFIS) technologies, methods for developing latent fingerprints, and fingerprint comparison and identification. The latter two areas are most often identified with criminalistics.

Tool mark and firearms identification refers to the use of class and individual markings made by tools or firearms to attribute markings to specific tools or bullets and/or cartridge cases to specific weapons.

Questioned documents, more recently called "forensic document examination" by some, includes several different types of examinations: comparing handwriting with known handwriting samples to determine whether or not a document was written by a specific individual, examining machine prepared documents (e.g., typewriting) to determine what type of machine or if a specific machine was used to prepare the document, analysis of forgeries, counterfeit money, or identification documents, and restoration of damaged or altered documents.

"Reconstruction" involves using physical evidence and its analysis to help put together past events in time and/or space. Reconstructions typically require the documentation and analysis of patterns (such as blood stain or glass fracture patterns). Reconstruction as a part of criminalistics usually implies not only studying patterns, but also incorporating laboratory-based physical evidence analysis (and at times, analysis of the crime scene) into the final hypothesis.

Appendix B: Forensic Science Careers Outside of the Traditional Forensic Science Crime Laboratory

The primary focus of this document is the education and training of individuals working in forensic science laboratories. Careers outside the traditional forensic science laboratory span a wide range of activities, including pathology, engineering, anthropology, and others. Interested students should realize that in some of these fields, the total number of practicing forensic scientists is quite small and career opportunities may be limited. In some cases, professionals function as part-time forensic science consultants. Most fields can be approached as a basic undergraduate natural science degree followed by a graduate program with a forensic course of study (e.g., entomology degree followed by a graduate forensic entomology program).

Students should discuss possible career paths with established professionals in the field. Some specific examples of forensic science careers outside of traditional forensic science laboratories are described below. This list is not all inclusive and the interested student may investigate other possible career areas in forensic science.

Forensic Pathology

Forensic pathologists are medical doctors who serve as medical examiners and sometimes as coroners. They determine the cause and manner of death through autopsies and death investigation. They are licensed physicians, who have completed medical school, five years of pathology internship and residency, and a year of forensic pathology fellowship. They have passed general medical certifying exams as well as pathology (anatomic pathology (AP) and/or clinical pathology (CP)) and forensic pathology (FP) board examinations administered by the American Board of Pathology. The principal professional organization is the National Association of Medical Examiners (www.thename.org).

Forensic Psychiatry

Forensic psychiatrists are medical doctors who serve as researchers and clinical practioners in the many areas in which psychiatry is applied to legal issues. They conduct psychiatric evaluations to determine civil and criminal competence, psychological trauma, criminal responsibility, etc. Forensic psychiatrists may serve prison systems and mental hospitals, as well as act as consultants to prosecutors and criminal defense attorneys. They are licensed physicians that have completed medical school, four years in psychiatry internship and residency and who have spent time training in forensic psychiatry. They have passed general medical certifying exams as well as psychiatry board examinations administered by the American Board of Psychiatry and Neurology. The principal professional organization is the American Academy of Psychiatry and the Law (www.cc.emory.edu/AAPL/org.htm).

Forensic Psychology

Forensic psychology is the application of the science and profession of psychology to questions and issues relating to law and the legal system. The practice of forensic psychology includes psychological evaluation and expert testimony regarding criminal forensic issues such as trial competency, forensic behavioral analysis, civil commitment and guardianship, and others. Forensic psychologists must obtain a graduate degree, be licensed by a state board, and may be board certified

by the American Board of Professional Psychology (ABPP). The *American Academy of Forensic Psychology* (AAFP) is the education and training arm of the *American Board of Forensic Psychology* (ABFP), which is responsible for board certifications in forensic psychology. Both AAFP and ABFP are part of the American Board of Professional Psychology (www.WEBSITE?.com).

Forensic Nursing

Forensic nurses perform a wide range of functions, including as sexual assault nurse examiners (SANE) and case reviewers for medical malpractice attorneys. Forensic nurses are typically registered nurses (RN), and some have bachelor of science degrees in nursing (BSN) or graduate degrees. Many nursing educational programs now have specific forensic nursing curricula. The principal professional organization is the International Association of Forensic Nurses (www.forensicnurse.org).

Forensic Engineering

The engineering sciences include, in addition to the usual categories of engineering, include physics, chemistry, geophysics, etc. The forensic work of individuals in these fields is most often related to civil litigation, though there is also occasionally a need for their skills in criminal casework. Forensic engineers usually have engineering degrees and, in the U.S., are often Registered Professional Engineers (PE). Alternatively, scientists engaged in this work often have Ph.D.s in their respective fields. The range of forensic activity in the engineering sciences includes accident reconstructions, product failure investigations, structural failure analysis, and related investigations. The American Academy of Forensic Sciences (www.aafs.org), also has an Engineering Sciences Section. Certification in the forensic engineering sciences is available from the International Institute of Forensic Engineering Sciences.

Forensic Anthropology

Forensic anthropologists are physical anthropologists involved in the generation of a biological profile (sex, age, height, etc.) for unidentified human skeletal remains, identification of unknown individuals, and evaluation of skeletal trauma. Forensic anthropologists are often university-based and consult for medical examiner offices while some are employed directly by medical examiner offices. They have graduate degrees in physical or forensic anthropology and may be board certified in forensic anthropology by the American Board of Forensic Anthropology. The largest group of forensic anthropologists work for the military in the Central Identification Laboratory—Hawaii (CILHI). The principal professional organizations are the American Academy of Forensic Sciences (www.aafs.org), Forensic Anthropology Section, and the American Association of Physical Anthropology (www.physanth.org).

Forensic Entomology

Forensic entomologists are often university-based and consult for medical examiners and coroners, law enforcement agencies, and attorneys across the country. They use insect evidence to assist in the reconstruction of the circumstances surrounding human death (time of death, movement of the body, etc.). Most are Ph.D. entomologists who have become board certified in forensic entomology by the American Board of Forensic Entomology (INSERT URL HERE). The principal professional organizations are the American Academy of Forensic Sciences (www.aafs.org) and the

Entomological Society of America (www.entsoc.org); information about forensic entomology can be found at: www.missouri.edu/~agwww/entomology/.

Forensic Odontology

Forensic odontologists are dentists and oral pathologists who most often consult for medical examiner offices; few are employed full-time by medical examiner offices. They provide identification of people from dental structures and analysis and comparison of bite marks. They have completed dental school and have received a D.D.S., D.M.D., or equivalent degree, and have become board certified in forensic odontology by the American Board of Forensic Odontology. The principal professional organization is the American Academy of Forensic Sciences (www.aafs.org), Forensic Odontology Section.

Forensic Computer Science/Digital Evidence

Forensic computer specialists are computer and information scientists/technicians who may be involved in the recovery and examination of probative information from digital evidence in a court admissible manner. The types of evidence include both hardware (desktop computers, laptop computers, network servers, and other digital equipment (cameras, personal digital assistants, pagers, etc.)) as well as software (programs, databases, electronic mail, etc). The discipline of forensic computer science is, by comparison with the other forensic disciplines listed in this Appendix, relatively new and many areas of the field are not yet defined. Useful sources for information about forensic computer science are the National White Collar Crime Center (www.nw3c.org) and the Scientific Working Group for Digital Evidence (SWGDE).

Forensic Toxicology

Forensic toxicologists are scientists who provide services in postmortem cases (support death investigations), human performance cases (driving under the influence of alcohol and / or drugs) and workplace testing (job related mandated alcohol/drug testing). Although some toxicologists may work within the criminalistics/ crime laboratory structure, most work in other government and private laboratories. B.S., M.S. and Ph.D. degrees are common and the work, encompassing the determination and interpretation of drugs and their metabolites in biological fluids, requires significant training in chemistry and biology, as well as physiology and pharmacology. The principal membership organizations are the Society of Forensic Toxicologists (www.soft-tox.org) and the Toxicology Section of the American Academy of Forensic Sciences (www.aafs.org). Many toxicologists are board certified by the American Board of Forensic Toxicology as Diplomates or Forensic Toxicology Certification Board Specialists.

Appendix C: Forensic Science Professional and Certifying Organizations

Professional Organizations

American Academy of Forensic Sciences (AAFS), www.aafs.org

American Society of Crime Laboratory Directors (ASCLD), www.ascld.org

American Society of Questioned Document Examiners (ASQDE)

Association of Firearms and Toolmarks Examiners (AFTE)

Association of Forensic Quality Assurance Managers (AFQAM)

California Association of Criminalists (CAC)

California Association of Toxicologists (CAT)

Clandestine Laboratory Investigating Chemists Association (CLIC)

International Association for Identification (IAI), www.theiai.org

Mid-Atlantic Association of Forensic Scientists (MAAFS),
http://gwis.circ.gwu.edu/~fors/maafs/links.htm

Mid-Western Association of Forensic Scientists (MAFS), www.mafs.net

National White Collar Crime Center (NW3C)

Northeastern Association of Forensic Scientists (NEAFS),
www.geocities.com/CapeCanaveral/Lab/5122/

Northwestern Association of Forensic Scientists (NWAFS),
http://users.aol.com/lctox/nwafshome.htm

Society of Forensic Toxicologists (SOFT)

Southern Association of Forensic Scientists (SAFS), www.southernforensic.org/

Southwestern Association of Forensic Scientists (SAFS)

Certifying Organizations

American Board of Criminalists (ABC)*
American Board of Forensic Anthropology (ABFA)***
American Board of Forensic Document Examiners (ABFDE)*
American Board of Forensic Entomology (ABFE)***
American Board of Forensic Odontology (ABFO)*
American Board of Forensic Toxicology (ABFT)*

American Board of Medicolegal Death Investigators (ABMDI)*
American Board of Pathology - Forensic Pathology (ABP-FP)**
American Board of Psychiatry and Neurology - Forensic Pathology (ABPN-FP)**
Association of Firearm and Toolmark Examiners (AFTE)***
Association of Forensic Document Examiners (AFDE)*
Forensic Toxicologist Certification Board (FTCB)*
International Association for Identification (IAI)*
International Institute of Forensic Engineering Sciences (IIFES)*

*Represented on the FSAB (Forensic Specialties Accreditation Board)
**Accredited by ABMS (American Board of Medical Specialties)
***Recognized as a certifying board representing that discipline, but yet not formally represented on FSAB

Appendix D: Technical and Scientific Working Groups

NIJ Sponsored Working Groups
Technical Working Group on **Bombing Scene Investigation** (TWGBSI)
Technical Working Group on **Crime Scene Investigation** (TWGCSI)
Technical Working Group on **Death Investigation**
Technical Working Group on **Digital Evidence** (TWGDE)
Technical Working Group on **Eye Witness Evidence** (TWGEYEE)
Technical Working Group on **Fire/Arson Scene Investigation** (TWGFASI)
Technical Working Group on **Mass Fatality Incidents** (TWGMFI)

FBI Sponsored Working Groups
Scientific Working Group on **Bloodstain Pattern Analysis** (SWGSTAIN)
Scientific Working Group on **Digital Evidence** (SWGDE)
Scientific Working Group on **DNA Analysis Methods** (SWGDAM)
Scientific Working Group on **Firearms and Toolmarks** (SWGGUN)
Scientific Working Group on **Friction Ridge Analysis, Study, and Technology** (SWGFAST)
Scientific Working Group on **Imaging Technologies** (SWGIT)
Scientific Working Group on **Materials Analysis** (SWGMAT)
Scientific Working Group on **Microbial Genetic Forensics** (SWGMGF)
Scientific Working Group on **Questioned Documents** (SWGDOC)

DEA Sponsored Working Groups
Scientific Working Group on **Drug Analysis** (SWGDRUG)

National Center for Forensic Science Sponsored Working Groups
Technical Working Group on **Fire and Explosive Investigations** (TWGFEX)

Appendix E: Technical and Scientific Working Group's Educational Criteria

Scientific Working Group on Materials Analysis (SWGMAT), "Trace Evidence Quality Assurance Guidelines," *Forensic Science Communications*, 2 (1), 2000, on-line at: www.fbi.gov.

Scientific Working Group on DNA Analysis Methods (SWGDAM), "Training Guidelines," *Forensic Science Communications* 3(4) 2001, on-line at: www.fbi.gov.

Scientific Working Group on Imaging Technology (SWGIT), *Forensic Science Communications* 4(2) 2002, on-line at: www.fbi.gov.