Anal. Chem. **1999,** *71,* 235R−255R

Forensic Science

T. A. Brettell*

Forensic Science Bureau, New Jersey State Police, Box 7068, West Trenton, New Jersey 08625

K. Inman

California Department of Justice DNA Laboratory, 626 Bancroft Way, Berkeley, California 94710

N. Rudin[†]

1563 Solano Ave. #506, Berkeley, California 94707

R. Saferstein[‡]

Box 1334, Mount Laurel, New Jersey 08054

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It is the aim of this review to present a concise survey of articles appearing in publications that primarily appeal to forensic practitioners. To accomplish this objective, we have focused our attention on the following journals: *Journal of Forensic Sciences, Science & Justice, Forensic Science International, Journal of the Canadian Society of Forensic Science, Journal of Forensic Identification, Forensic Science Review, Analytical Toxicology, Electrophoresis,* and *BioTechniques*, as well as *Chemical Abstracts Selects: Forensic Chemistry*. Our survey encompasses the period from January 1997 through December 1998. Because of the normal delays in the abstraction of journal articles by Chemical Abstracts, some work covering this period will inadvertently be omitted. Hopefully these references will be included in the next biennial review.

The format selected for this survey divides coverage into three distinct areas: drug and poisons, forensic DNA analysis, and trace evidence. Within the scope of each of the areas, articles have been selected to describe current forensic science practices in analytical chemistry and to outline relevant forensic science research interests. To keep our discussion concise and meaningful, we have limited our survey to drugs regulated under the United States Controlled Substances Act, ethanol, and common poisons. Furthermore, to eliminate unnecessary duplication of effort, citations of articles appearing in *Clinical Chemistry, Journal of Pharmaceutical Sciences*, and other pharmaceutical journals have been minimized. We believe that ample coverage of these journals is provided within the pharmaceutical and clinical chemistry reviews planned for this journal. It is recommended that interested readers consult these sections in order to obtain a complete survey of the drug-abuse subject.

DRUGS AND POISONS

Ethanol and Volatiles. The ability of subjects with impaired respiratory function to provide a satisfactory breath sample for the Alcotest 7410 breath alcohol device (*1*) and the Breathalyzer 7410-CDN evidential breath alcohol analyzer has been evaluated (*2*). The recommended standards and procedures of the Canadian Society of Forensic Science Alcohol Test Committee have been published (*3*). Compressed-gas ethanol breath standards have been compared to wet simulators as calibration standards (*4*). The influence of hypersalivation on breath alcohol was investigated (*5*). Breath and blood ethanol concentrations were simultaneously measured with the Draeger 7110 Mk II from individuals who received 0.8 g of ethanol/kg of body weight combined with 1 g

[†] www.forensicdna.com. Forensic DNA consultant.
[‡] Forensic science consultant.

10.1021/a1990009c CCC: $18.00 © 1999 American Chemical Society
Published on Web 05/07/1999

of fructose/kg of weight or with 30 mg/kg (*6*). No differences in mouth alcohol elimination patterns were observed with oral jewelry when tested on a DataMaster breath test instrument (*7*). The effects of asthma inhalers and nasal decongestants on the DataMaster were evaluated (*8*). A study was conducted of potential vapor-phase interferences that could be present on human breath and also be capable of inducing a false-positive response for ethanol on the Intoxilyzer-5000 (*9*).

Estimation of blood alcohol concentrations after social drinking has been reported (*10*). The estimation of time between drinking and death from tissue distribution patterns of ethanol has been studied (*11*). Concentration−time profiles of ethanol in arterial and venous blood and end-expired breath during and after intravenous infusion have been reported (*12*). The influence of the ethanol metabolism was investigated on the concentration of ethanol in venous blood using a computer simulation model (*13*). The blood alcohol level was calculated in women while taking into consideration body weight, body height, blood water content, and body water content (*14*). The inhibition of ethanol production by *Saccharomyces cerevisiae* in human blood by sodium fluoride has been studied (*15*).

An accurate, automated, simultaneous gas chromatographic headspace measurement of whole blood ethanol and acetaldehyde has been reported (*16*). Automated headspace gas chromatography/flame ionization detection (GC/FID) was used to study the stability of ethanol in human whole blood controls (*17*). Static headspace sampling and automated solid-phase microextraction (SPME) were compared for the determination of blood alcohol (*18*). A new procedure has been proposed for the direct determination of ethanol in plasma and whole blood using vapor generation and Fourier transform infrared spectrometry (FT-IR) (*19*).

A comparison of ethanol concentrations in the occipital lobe and cerebellum has been reported (*20*). Ethanol and putrefactive alcohols were determined in fluids from putrefactive blisters by GC (*21*). Ethanol concentrations in the mixed left and right heart blood, urine, and stomach contents of 186 cadavers were analyzed by GC in order to find the influence of postmortem diffusion of alcohol from the stomach contents to the heart blood (*22*). Ethanol analyses using the synovial fluid of the knee joint as well as blood and urine were performed by the pulse heating-gas chromatographic method in 12 medio-legal autopsy cases (*23*). A prospective and comprehensive investigation was done on 73 medicolegal autopsies of alcoholics (*24*). The concentration of ethanol in blood and plasma was determined by headspace GC and the water content of whole blood was determined from the change in weight after desiccation (*25*). The effect of omeprazole, ranitidine, and cimetidine on peak blood ethanol concentrations has been studied (*26*). The relationship between urinary ethanol concentrations, urine/blood ratio of ethanol, and urinary creatinine content was investigated by the analysis of two successive voids from 40 individuals apprehended for driving under the influence of alcohol in Sweden (*27*). The urine concentrations of ethanol, methanol, and the ratio of serotonin metabolites were determined from apprehended drunk drivers (*28*). The ethanol content of various foods and soft drinks, and their potential for interference with the DataMaster, have been studied (*29*). The inter- and intraindividual variation of methanol elimination in nonalcoholics has been studied (*30*). The kinetics of methanol elimination in alcoholics has been studied (*31*). A study of rearrests for drunken driving in Norway has been reported (*32*). Drugs and alcohol among suspected impaired drivers in Switzerland has been studied (*33*).

Benzyl alcohol was identified and quantified by GC/mass spectrometry (GC/MS) in human serum and postmortem blood after derivatization with 4-carbethoxyhexafluorobutyryl chloride (*34*). Commercial products containing diethyl ether were detected in the blood of three homicide victims by GC and GC/MS (*35*). Headspace GC was used to detect and quantify difluoroethane in two traffic fatality victims (*36*). Trichloroethylene was determined in the blood of victims in forensic cases by GC/ECD (*37*) and GC/ECD and GC/FT-IR (*38*). The distribution of toluene in glue sniffers' biological fluids has been studied by GC and GC/MS (*39*). Headspace GC/FID was used to determine benzene in biological fluids of a victim of fatal poisoning (*40*). Volatiles that are used and abused as anesthetics have been reviewed (*41*). Enflurane has been determined in human tissues by GC/MS (*42*). The chemical, toxicity, and pharmacological properties of the current fluorinated inhalation anesthetics have been surveyed (*43*). An analytical method for the identification of volatile organic compounds in blood has been developed using purge-and-trap extraction coupled with GC/FT-IR (*44*). SPME and GC/MS were used to confirm volatiles in the investigation of two traffic fatalities (*45*). Literature reports concerning the analysis of occluded solvent as a basis for determining whether cocaine and heroin samples have a common origin have been reviewed (*46*). Headspace analysis of solvents in cocaine and heroin samples was determined by GC/FID and confirmed by GC/MS (*47*).

Carboxyhemoglobin levels were determined in two victims of open air carbon monoxide poisoning (*48*). The interpretation of postmortem carboxyhemoglobin concentrations has been discussed (*49*). The performance of the Instrumentation Laboratory Inc. IL-682 for the analysis of postmortem blood specimens for carboxyhemoglobin was evaluated (*50*).

Cannabinoids. A preliminary study of the analysis of cannabis by supercritical fluid chromatography (SFC) with atmospheric pressure chemical ionization mass spectroscopy (APCI-MS) has been reported (*51*). GC/MS was used to identify butyl cannabinoids in marijuana (*52*). Unsmoked handrolled cigarettes were analyzed for cannabis resin/cannabis content by thin-layer chromatography (TLC) (*53*). Capillary electrochromatography was used to analyze the cannabinoid content in marijuana and hashish (*54*). The cannabinoid content was determined by GC/MS of marijuana samples seized in Greece and its forensic application has been reported (*55*). Tetrahydrocannabinol (THC) was detected in foodstuff containing hemp and the forensic significance was discussed (*56*). The inorganic element pattern of marijauna was evaluated as a tool for comparing different seizures (*57*). The filtering effects of various household fabrics on the pollen content of hash oil has been studied (*58*).

A method for the identification of cannabis using DNA-specific primers has been developed (*59*). Methods have been reported for the identification of *Cannabis sativa* L., comparing the sequence of the nuclear ribosomal DNA internal transcribed spacer II (ITS2) of an unknown sample with a known predetermined consensus sequence of cannabis (*60*, *61*). Western blotting

and development of an enzyme-linked immunosorbent assay was utilized for the detection of cannabis pollen allergens (*62*).

Δ^9-Tetrahydrocannabinol has been confirmed in blood by GC/MS (*63*, *64*) and GC/MS/MS (*65*). The CEDIA DAU (EIA) and the Abbott AsSym system (FPIA) cannabinoids assays were evaluated for their combined effectiveness in the analysis of cannabinoids in whole blood (*66*). A noncannabinoid immunogen has been used to elicit antibodies with broad cross-reactivity to cannabinoid metabolites (*67*). 11-Nor-9-carboxy-Δ^8-tetrahydrocannabinol was determined in urine of cannabis users by GC/MS (*68*). 11-nor-Δ^9-tetrahydrocannabinol-9-carboxylic acid (THC-COOH) was determined in urine by high-performance thin-layer chromatography (HPTLC)/ultraviolet (UV) spectrophotometry/FT-IR on-line coupling (*69*). A sensitive and reliable method has been developed for the identification and quantification of THC-COOH in urine using a microbed solid-phase extraction (SPE) column (*70*). Cannabinoids were detected in urine by an enzyme multiplied immunoassay technique (EMIT) and confirmed by GC/MS (*71*). Immunoassay screening of cannabinoids was evaluated for false-negative results with the use of excess fluid ingestion (*72*). A study was conducted to examine the excretion profile of creatinine and marijuana metabolites in a group of six marijuana users who smoked two different doses of marijuana over a four-week period (*73*). An indoor air quality-pharmacokinetic simulation of passive inhalation of marijuana smoke was evaluated (*74*). Immunoassay and GC/MS was used to evaluate the excretion of cannabinoids in urine after ingestion of cannabis seed oil (*75*) and hemp oil (*76*–*78*).

Morphine and Related Narcotics. Evaluation of a sampling procedure for heroin street doses has been reported (*79*). A new spray reagent has been proposed which is highly specific and sensitive for the detection and identification of heroin in street samples (*80*). Simultaneous detection of adulterants and coextractants in illicit heroin by HPTLC with two successive mobile phases has been described (*81*). Methodology has been presented for the analysis of cations and anions in illicit heroin using capillary electrophoresis (CE) with indirect UV detection (*82*). The feasibility of predicting the country of origin of heroin based on the concentration of selected alkaloids and adulterants in seized material has been assessed (*83*). The methodology used for the comparative chemical analyses of illicit drug seizures, and its application to a heroin comparison case, has been described (*84*). The application of isotopic analysis of ^{13}C for forensic purposes has been discussed in the case of heroin (*85*).

A rapid and selective reversed-phase HPLC assay with gradient elution and diode-array detection (DAD) for the determination of heroin and morphine and metabolites in plasma was developed (*86*). Morphine and metabolites have been determined in body fluids by liquid chromatography (LC)/APCIMS (*87*–*89*), GC/FID (*90*), GC/MS (*91*–*94*), HPLC with direct injection and postcolumn derivatization (*95*), HPLC/ECD (*96*), HPLC with fluorescence detection after solid-phase extraction (*97*), and GC/MS and HPLC (*98*). Opiates were determined in hair by GC/MS and the results compared to other body fluids (*99*). Evidence of gestational heroin exposure by comparative analysis of fetal and maternal body fluids, tissues, and hair has been reported in a heroin-related death (*100*). A preliminary study on the distribution of morphine and its glucuronides in the subcompartments of blood has been reported (*101*). Blood toxicological results for deaths attributed to heroin overdose were compared with those of a sample of 100 current heroin users who had injected within the preceding 24 h (*102*).

An improved GC/MS assay has been described for the quantification of codeine and morphine as trimethylsilyl (TMS) derivatives (*103*). GC/MS was used for the simultaneous determination of acetylcodeine, monoacetylmorphine, and other opiates in urine (*104*). A procedure for the determination of morphine has been developed using the nitrosation reaction in a system of flow injection analysis (FIA) with spectrophotometric detection (*105*). The detection of acetylcodeine and 6-monoacetylmorphine in opiate-positive urines has been reported using GC/MS (*106*). Morphine and its analogues have been determined in urine by on-line coupled reversed-phase liquid chromatography/gas chromatography with on-line derivatization (*107*). A new HPLC-chemiluminescence analysis system for morphine has been described (*108*). A system for automatic sample preparation followed by on-line injection of the sample extraction into a gas chromatograph/mass spectrometer has been developed for simultaneous analysis of three opiates in human urine (*109*).

Vitreous humor specimens were analyzed for codeine, morphine, and 6-monoacetylmorphine by FPIA and GC/MS (*110*). Qualitative detection of opiates in sweat by enzyme immunoassay (EIA) has been reported (*111*). Morphine formation from ethylmorphine in urine has been studied using EMIT and GC/MS (*112*). The certification of a human urine standard reference material consisting of morphine-3-β-D-glucuronide has been reported using enzymic hydrolysis and GC/MS (*113*). An evaluation of the role of relative operating characteristic plots in the prediction of heroin use from total codeine and total morphine concentrations in urine has been reported (*114*). A statistical approach has been used for the prediction of verifiable heroin use from total codeine and total morphine concentrations in urine (*115*). Paired blood and urine specimens were tested for opiates by immunoassay to identify the frequency of occurrence and help in the interpretation of results (*116*). 6-Monoacetylmorphine was detected in urine by TLC following liquid–liquid extraction to prevent innocent poppy seed eaters from being falsely accused of drug abuse (*117*). To establish the plausibility of the "poppy seed defense", the concentrations of codeine, norcodeine, morphine, normorphine, and thebaine were determined in various poppy seeds from different countries by GC/MS (*118*).

Five different hair digestion procedures were evaluated by radioimmunoassay (RIA) to determine the most effective method that could be used to liberate morphine from hair (*119*). Acetylcodeine was determined in hair by GC/MS as a specific marker for heroin use (*120*). Morphine and 6-monoacetylmorphine were determined by GC/MS in the hair of a coercive heroin administered overdose victim (*121*). Opiates were determined in hair by GC/MS using acid hydrolysis (*122*–*124*). Two autopsy cases were used to underline the importance of immunohistochemistry in forensic practice (*125*). A postmortem study was completed on heroin-associated nephropathy (*126*).

Cocaine. Using published high-resolution mass measurements as a reference, the mass spectra of several cocaine derivatives were examined (*127*). The detection of cocaine on various denominations of United States currency was reported

using SPE and GC/MS (*128*). Cocaine has been determined in illicit powders by capillary electrophoresis CE (*129*) and HPLC and GLC (*130*). Cocaine free base identification and quantification procedures have been reviewed and discussed (*131*). The rationale for developing cocaine profiling methodology has been described and the current cocaine signature procedures in use at the United States Drug Enforcement Agency's Special Testing and Research Laboratory have been reviewed (*132*). The variations of purity of cocaine seizures in Spain have been surveyed (*133*). Adulterants encountered in the illicit cocaine seized in Rome have been reported (*134*). Electrothermal atomic absorption spectrometry has been used to determine traces of cadmium in cocaine (*135*) and to determine silver, aluminum, cadmium, and manganese in cocaine and heroin powders (*136*). Ecgonidine methyl ester has been determined using a continuous-flow vapor generator preconcentrator/thermal desorption technique for the detection of concealed cocaine (*137*). Comparative determination of total isomeric truxillines in illicit, refined, South American cocaine hydrochloride has been reported using capillary GC/ECD (*138a*). The isolation and comparative determination of ecgonine methyl esters in illicit cocaine samples has been presented using GC/SIM (*138b*). The detection and mass spectral analysis of alkaloids of cocaine-bearing plants has been described (*139–141*).

The qualitative and quantitative analysis of cocaine and eight cocaine-related analytes has been reported using SPE followed by GC/MS (*142*). Cocaine and related analytes have been determined using GC/surface ionization detection (SID) (*143*), HPLC (*144*), HPLC/DAD (*145*), and HPLC/UV (*146*). Cocaine, nicotine, caffeine, and metabolites have been determined in the plasma of neonates (*147*). A retrospective study of autopsy cases has been published relating cocaine blood concentrations to toxicity (*148*).

A liquid–liquid extraction method for isolating cocaine from urine was developed utilizing GC/MS for analysis and quantification (*149*). A large-scale study was conducted to determine whether lowering the initial immunoassay testing and confirmation GC/MS testing cutoffs in urine would significantly affect the positive rates for cocaine and marijuana (THC) (*150*). Cocaine was measured by GC/MS and benzoylecgonine was determined by FPIA in the urine of substance-abuse treatment patients (*151*). Cocaine and its metabolites were detected by SPE and GC/MS in amniotic fluid and umbilical cord tissue (*152*). Saliva concentrations of cocaine and metabolites were measured by GC/MS (*153*). A study has been reported on the stability of cocaine and metabolites in postmortem fluids (*154*).

Cocaine and metabolites have been determined in hair by narrow-bore HPLC in combination with fluorescence and electrospray MS (*155*), positive chemical ionization GC/MS (*156*) and GC/MS (*157*). Isotopically labeled cocaine and benzoylecgonine were determined in hair by GC/MS (*158*). The effect of centrifugation of hair digests on the quantitation of cocaine in human hair has been reported (*159*). Procedures for distinguishing passive contamination from active cocaine consumption have been discussed (*160*). Cocaine detection by hair analysis and skin swab testing has been reported (*161*). The matrix and modifier effects in the SFE of cocaine and benzoylecgonine from human hair has been studied (*162*). Cocaine was determined by GC/MS in the fingernail and toenail specimens obtained from suspected cocaine users (*163*).

Amphetamines. The analysis of stimulants has been reviewed (*164*). Amphetamines and related compounds have been analyzed by GC/FT-IR (*165*), HPLC/UV (*166*), negative-ion chemical ionization MS (*167*), capillary zone electrophoresis (CZE) (*168*), and CE and HPLC (*169*). Methlenedioxyamphetamines and related compounds have been characterized by GC/MS (*170*), HPLC with fluorometric detection (*171*), LC and MS (*172*, *173*), GC/FID and GC/MS (*174*), ion trap MS (*175*), GC/CIMS with derivatization (*176*), nuclear magnetic resonance (NMR) (*177–179*), and Fourier transform raman spectroscopy (FTRS) (*180*). Some unusually marked and single-scored tablets were analyzed for illicit drug content to yield 3,4-methylenedioxyethylamphetamine (*181*). 3,4-Methylenedioxycathinone homologues have been characterized (*182*).

Optical isomers of amphetamine-related compounds have been analyzed by two-dimensional column-switching HPLC with fluorescence detection (*183*), HPLC/UV (*184*), CE (*185*, *186*), and infrared spectrophotometry (IR) (*187*). Methamphetamine properties and analytical methods of enantiomer determination have been reviewed (*188*). 4-Bromo-2,5-dimethoxyphenethylamine has been characterized by GC/MS, HPLC/DAD, CE/DAD, FT-IR, and NMR (*189*). Factors influencing the extraction of impurities from Leukart amphetamine have been studied (*190*).

Amphetamine-related compounds have been detected in blood by GC/MS (*191–193*), GC/NPD (*194*), GC/CIMS (*195*), GC/NPD and GC/MS (*196*), HPLC after derivatization (*197*), HPLC/APCIMS and DAD after phenylisothiocyanate derivatization (*198*), and GC and LC procedures with various detectors as well as TLC and CE (*199*). Tissue distribution of amphetamine isomers from a fatal overdose victim have been determined by EMIT, TLC, HPLC, and GC/MS (*200*). The toxicology of amphetamine-related deaths has been discussed (*201*, *202*). The effects of 3,4-methylenedioxymethamphetamine in decomposing tissues have been discussed (*203*). Ephedrine was determined in biological fluids of a suicide victim by GC/MS following liquid–liquid extraction and pentafluoropropionic acid derivatization (*204*).

Amphetamine-related compounds have been detected in urine by HPLC/UV (*205–208*), HPLC with fluorescence detection (*209–211*), GC/MS (*212–214*), CE with laser-induced fluorescence (*215*) and differential pulse polarography (*216*). A systematic evaluation that compares the recoveries of methamphetamine and amphetamine from spiked urine using SPE and GC/MS has been reported (*217*). The derivatization of amphetamine and methamphetamine using SPE for their detection in urine has been described (*218*). GC/FID and GC/FT-IR have been used to quantitatively determine amphetamine enantiomers (*219*). Analysis of methamphetamine and amphetamine in urine has been described using SPME and GC/MS (*220*, *221*), and SPME and GC/NPD (*222*, *223*). The urinary excretion of *d*-amphetamine following oral doses in humans was studied using immunoassays and GC/MS (*224*, *225*).

The determination of stimulants in hair has been done using HPLC with chemiluminescence detection (*226*), GC/MS (*227–232*), ELISA and GC/MS (*233*), Headspace SPME and GC/NPD (*234*), and ion mobility spectrometry (IMS) (*235*, *236*). The

interlaboratory comparison of quantitative determination of amphetamine and related compounds in hair samples has been reported (*237*). Optimization of a simple method for the chiral separation of phenethylamines of forensic interest based on cyclodextrin complexation capillary electrophoresis and its preliminary application to the analysis of human urine and hair has been reported (*238*).

Barbiturates. A reversed-phase HPLC method has been developed for the forensic analysis of 10 frequently used barbiturates (*239*). A FPIA for barbiturates in urine has been described using the Abbott AxSym analyzer (*240*). Barbiturates in urine has been determined by SPME and CE (*241*), SPME and ion trap GC/MS (*242*), HPLC with electrochemical detection using on-line selectable-power photochemical reaction (*243*), and GC/MS (*244*). Barbiturates were determined in larvae (*245*). The various analysis methods for the determination of barbiturates in body fluids has been reviewed (*246*).

Benzodiazepines. The determination of benzodiazepines and their toxicity, pharmacokinetics, pharmacodynamics, and structure have been reviewed (*247*). Triazolam has been determined in a drug tablet by thermal desorption GC (*248*). Diazepam has been determined in cold drinks by high-performance TLC (*249*). Ion trap MS and a quadrapole mass spectrometer were compared using diazepam as model compound (*250*). Alprazolam was detected in biofluids by HPLC (*251*). A HPLC method has been developed for the analysis of several benzodiazepines and some of their metabolites in blood, plasma, and urine (*252*). Flunitrazepam and its main metabolites have been determined in serum and urine by HPLC after mixed-mode SPE (*253*) and HPLC/DAD after SPE (*254*). Flunitrazepam and its main metabolites have been determined in urine by HPLC/UV (*255*) and GC/MS (*256*). Flunitrazepam and its metabolites have been determined in blood by HPLC and APCIMS (*257*). A study was conducted to compare the performance of the OnLine and OnTrak immunoassays for benzodiazepines with GC/MS analysis in detecting flunitrazepam and its metabolites in human urine (*258*). The use of HPLC as an extraction procedure for the analysis of triazolam in decomposed human muscle by GC/MS has been reported (*259*). The stability of diltiazem in whole blood and in postmortem samples has been investigated (*260*). The stability of nitrobenzodiazepines and their metabolites in postmortem blood and water has been studied (*260A*). The postmortem distribution of various benzodiazepines in body fluids has been studied (*261*).

Olanzapine concentrations have been determined by GC/FID in the biological fluids of an overdose victim (*262*) and in the biological fluids of other forensic case victims using GC/NPD and GC/MS (*263*, *264*). A method to determine clozapine in biological fluids has been reported using GC/NPD (*265*). GC/MS was used to identify Alprazolam and metabolites in body fluids and HPLC was used to quantify the drugs (*266*). A review of methods for the determination of benzodiazepines in biological specimens published over the last five years has been presented (*267*). Blood specimens were screened for benzodiazepines by EMIT and GC/ECD and the results confirmed by GC/MS (*268*). Three commercial immunoassay techniques (EMIT, FPIA, OnLine) for the screening of benzodiazepines in urine were evaluated by GC/MS as the reference method (*269*). EMIT, Abbott ADx serum benzodiazepine FPIA, and a radioreceptor assay (RRA) were evaluated in screening for benzodiazepines (*270*). Oxaprozin cross-reactivity was studied in three commercial immunoassays for benzodiazepines in urine (*271*). The CEDIA DAU benzodiazepine assay has been reformulated to include on-line hydrolysis of urinary benzodiazepine glucuronide conjugates (*272*, *273*). Benzodiazepines were determined in hair by GC/NICIMS (*274*–*276*) and GC/MS (*277*).

Miscellaneous Drugs and Poisons. A quantitative method that avoids derivatization has been described for the determination of lysergide (LSD) levels in urine (*278*). LSD has been determined in biological fluids by CE with laser-induced fluorescence detection (*279*, *280*), HPLC coupled to electrospray ionization MS (*281*), automated extaction using the Zymark RapidTrace with LC/MS/MS (*282*), microparticle-based immunoassay (*283*), immunoassay and GC/MS (*284*, *285*), and GC/MS (*286*). The precision and the diagnositic performance of the CEDIADAU LSD assay was evaluated (*287*). LSD concentrations in urine were measured by RIA and HPLC with fluorescence detection (*288*). The effects of chemicals and household agents on an EIA for the detection of LSD in urine were investigated (*289*). The determination of LSD and phencyclidine in biological samples has been reviewed (*290*). A study was conducted to determine the conditions needed to achieve the equilibrium concentrations for the epimerization of *d*-LSD to iso-LSD (*291*).

Phencyclidine (PCP) was identified in human body fluids by headspace SPME and GC/SID (*292*). PCP blood concentrations were compared to the subsequent Drug Recognition Expert (DRE) evaluations (*293*). A retrospective study was conducted to determine the stability of PCP in whole blood samples stored for 1–3 years (*294*). GC/MS was used to analyze various drugs in hair such as PCP (*295*–*297*), fenethylline and amphetamine (*298*), and methadone and metabolites (*299*) and polydrug use (*300*). Dextropropoxyphene and its metabolite were quantified in hair using HPLC (*301*). Tricyclic antidepressants were analyzed in hair samples (*302*). Digoxin was detected in hair by immunoassay (*303*). The evaluation of extraction procedures, hair treatments, and development of reference materials in the hair analysis for nicotine and cotinine has been reported (*304*). SPE and HPLC was used to analyze nicotine and cotinine in infants' hair (*305*). The enantioselective separation of methadone and its main metabolite has been accomplished in human hair by LC/ion spray MS (*306*). The enantioselective determination of methadone enantiomers and its major metabolite in human biological fluids has been described using HPLC (*307*). Methadone and its primary metabolite have been determined in meconium using FPIA and HPLC/DAD (*308*). A SPE method for the extraction of methadone and its two metabolites from whole blood has been described (*309*). Quantitative analysis of methadone metabolites in human hair has been accomplished by positive-ion chemical ionization MS (*310*).

A simple method for the urinary identification and blood quantification of meprobamate has been described which uses GC/MS after SPE (*311*). A GC/MS method for the determination of fentanyl in urine has been described (*312*). The prevalence of dextroproxyphene in the total autopsy material in Sweden has been examined (*313*). A compilation of fatal and control concen-

trations of drugs in postmortem femoral blood has been published (*314*). A HPLC/ion spray MS method has been developed for the determination of buprenorphine and norbuprennorphine in biological fluids and hair samples (*315*). Zopidone was determined in the blood and other body fluids by GC/MS (*316*). The concentration of phenol in postmortem blood has been determined by GC/MS and derivatization (*317*). The case history and toxicological findings of a fatal fentanyl intoxication due to the application of multiple transdermal patches has been presented (*318*). The postmortem serum and tissue redistribution of fluoxetine and norfluoxetine has been studied (*319*). Phenmetrazine has been determined in urine by GC/MS after liquid−liquid extraction and derivatization (*320*). Moclobemide, sertraline, and pimozide concentrations were determined by GC and GC/MS in a victim from a fatal interaction of these drugs (*321*). Moclobemide was determined by GC/NPD in the body fluids of a fatal victim (*322*). Anabolic steroids found in the illegal market were analyzed by GC/MS (*323*). Tissue concentrations of ketamine were determined by GC/NPD (*324*). The homogeneity of drug concentrations in cadavers was evaluated (*325*). Cocaine, lidocain, methadone, and destromoramide and metabolites were determined in the hair of a polyintoxication victim by GC/MSD and HPLC (*326*). Xylazine toxicity has been reviewed and two homicide cases involving xylazine have been reported (*327*). GC/MS has been used to detect and quantify phenmetrazine in the urine (*328*, *329*). A method has been developed for the quantitation and identification of γ-hydroxybutyrate (GHB) and its lactone in illegal preparations (*330*). UV-excited resonance Raman spectroscopy has been used to identify narcotics and explosives (*331*). Between-eye differences in electrolyte concentrations were studied in autopsies using an ion-specific electrode system (*332*). The prevalence of drugs of abuse in urine of drivers involved in road accidents in France has been reported (*333*). Drugs of abuse and the correlation with driving in Austria has been studied (*334*). The distribution of phenol in a fatal poisoning case was determined by GC/MS (*335*). Fluoxetine was determined by GC/MS and clozapine was determined by GLC in the body fluids of a victim of a fatal drug interaction between the two drugs (*336*). The stability of tricyclic antidepressants in formalin solutions was studied by GC/MS (*337*).

An alternative and complimentary capillary electrophoresis method was developed for the identification of the hallucinogenic mushroom's *Psilocybe semilanceata* indole alkaloids psilocybin and baeocystin (*338*). Interpretation of drug findings on the skin has been discussed (*339*). GC/MS was used to detect narcotine, papaverine, and thebaine in the seeds of *Papaver somniferum* (*340*). A general screening method for the determination of anabolic steroids in oil-based injectables, tablets, and capsules has been described which used HPLC and UV−visible−particle beam MS (*341*). A review has been published on the comprehensive screening of stimulants, narcotics, and β-blockers (*342*). Methods for detecting hypnotics and sedatives not belonging to the classes of barbiturates and benzodiazepines have been reviewed (*343*). Methods for detecting aniticonvulsants not belonging to the classes of barbiturates and benzodiazepines have been discussed (*344*). The GC/MS quantitation of dextropropoxyphene and norpropoxyphene in hair and whole blood after automated on-line SPE has been described (*345*). The simultaneous identification and quantitation of fluoxetine and its metabolite in biological samples by GC/MS has been reported (*346*). Liquid−liquid extraction followed by HPLC/DAD has been used to detect betaxolol in a fatal poisoning case (*347*). Amlodipine concentrations were determined in body fluids from a fatal poisoning victim (*348*). A method to determine amitriptyline and its metabolite in human plasma has been reported using HPLC/UV and particle beam MS (*349*). Two venlafaxine-related deaths have been reported with comparison of results from the analysis of biological fluids using capillary GC/NPD and HPLC/UV−visible (*350*). LC was used to quantitate colchicine in body fluids and tisses of a fatal poisoning victim (*351*). A method for the determination of *N,N*-dimethyltryptamine in body fluids by GC/SID has been reported (*352*). A method for the quantitation of diester diterpene-type *Aconitum* alkaloids and their hydrolysis products by GC/SIM was applied to the analysis of body fluids of a suicide victim (*353*). An unusual death attributed to the combined effects of choral hydrate, lidocaine, and nitrous oxide has been discussed (*354*). Cyproheptadiene was determined by GC/NPD in the blood of a victim of ethanol and cyproheptadiene intoxication (*355*). Phenethylamine was determined in *P. semilanceata* mushrooms using GC/MS (*356*).

Diltiazem and pentoxifylline was determined in body fluids by GC/NPD and GC/MS from a suspicious death (*357*). Zolpidem concentrations were determined by GC/MS in the body fluids of an overdose victim (*358*). EDTA was analyzed in bloodstains by electropspray LC/MS/MS and ion chromatography (*359*). GLC and FPIA were used to detect valproic acid in the body fluids of an overdose victim (*360*). Buprenorphine-related deaths among drug addicts in France have been reported (*361*). Poppy seeds were examined for opiates, specifically thebaine content, using GC/ion trap MS after extraction with methanol (*362*). The content of thebaine of the *Papaver* species and their F1 hybrid was determined by HPLC (*363*). A study has been presented that developed and validated a LC method with electrochemical detection to measure α-amanitin concentrations in urine after sample pretreatment with double-mechanism (reversed-phase/cation exchange) SPE cartridges (*364*). GC/MS was used to measure chloroquine concentrations in the body fluids of a suicide victim (*365*). The toxicological findings of autopsy results of dextropropoxyphene case in Sweden have been reviewed (*366*). Drug abuse among Finnish male prisoners has been discussed (*367*). Venlafaxine blood concentrations have been presented from a fatal motor vehicle case (*368*). Propoxur was determined in the body fluids of a fatal intoxication victim (*369*). A GC/NPD method for the quantitative determination of *Rocuronium* in postmortem blood has been described (*370*). A new and easy method to screen and to quantify GHB in biological samples has been described (*371*). An automated screen for cholinesterase in postmortem blood has been reported (*372*). Postmortem cases were reviewed where dextromethorphan had been detected and quanitified (*373*). The drug purity content of powders and other illicit preparations in the United Kingdom has been discussed (*374*). 1-Chloroethyl chloroformate was found to be a good reagent for the N-demethylation of tertiary amines to produce drug metabolite reference material for forensic toxicology applications (*375*).

Triazolam, pentobarbital, amitriptyline, and bromazepam were detected in the tissues of a victim of the toxic interaction of these drugs (*376*). Four postmortem cases have been reported in which the analgesic drug tramadol was identified (*377*). Trancylpromine was identified by GC/MS after derivatization with pentafluoropropionic anhydride in the blood, urine, and tissues of a fatal overdose victim (*378*). A simple and rapid method for the analysis of malathion in blood was developed using headspace SPME and GC/MS with selected-ion monitoring (*379*). GC/NPD was used to determine maprotiline and metabolites in postmortem specimens (*380*). Moclobemide was determined in postmortem blood and urine by GC/MS and HPLC/PDA after SPE (*381*). FPIA was used to determine postmortem toxicological analyses for digoxin (*382*). The distribution of drugs in various tissues of the brain was determined by GC/MS (*383*).

GC/MS was used to identify and quantify malathion in the body fluids of a suicide victim (*384*). A simple and reliable method for the isolation of benzhexol from blood and urine has been presented using SPE and papaverine as an internal standard (*385*). A simple method to quantify fenthion in postmortem matrixes with SPE, HPLC/DAD, and GC/MS has been described (*386*). Baygon, carbaryl, and carbofuran were detected in forensic toxicological specimens by TLC (*387*). The main hydrolysis products of organophosphorus nerve agents, methylphophonic acids, in human serum by indirect photometric detection ion chromatography were determined (*388*). A method for the determination of trace levels of blood cyanide has been developed using headspace GC/NPD (*389*). A method to detect cyanide in body fluids by fluorometry has been reported (*390*). An ion chromatography method with fluorescence and UV detection for the simultaneous determination of cyanide and thiocyanate in blood has been developed (*391*). Capillary GC/MS was employed to quantitate drugs in biological fluids and stomach contents of a homicidal poisoning victim (*392*). The toxicological analysis of postmortem material for silver was performed by flame atomic absorption (FAA) (*393*). A method for measuring sodium azide concentrations in aliquots of blood and other tissues by ion chromatography has been reported (*394*). Five abused drugs in nitrite-adulterated urine have been determined by immunoassays and GC/MS (*395*). Nitrite concentrations were measured to determine adulteration of urine drug-testing specimens (*396*).

General Procedures. The use of CE in the analysis of illicit drug seizures has been detailed (*397*). CE was interfaced with a time-of-flight mass spectrometer and evaluated for the analysis of drugs of abuse (*398*). The application of micellar electrokinetic capillary chromatography (MECC) to the analysis of illicit drug seizures has been presented (*399*). CE for the separation of chiral compounds of forensic interest has been reviewed (*400*). The use of GC/MS in forensic science has been reviewed (*401*). A practical approach to determining laboratory GC/MS limits of detection has been presented (*402*). Modification of a chemstation data analysis program for addition of automated extraction ion chromatographic groups for the detection of opiates, barbiturates, and benzodiazepines was reported (*403*). Positive-ion electron impact, positive-ion chemical ionization, and negative-ion chemical ionization mass spectra of cocaine and related compounds have been presented and each fragmentation mode was analyzed (*404*). A method of sample preparation has been proposed that permits identification by FT-IR microspectrophotometry of the components of illicit drugs (*405*). In situ surface-enhanced FT-Raman (SERS) detection of heroin, codeine, and cocaine samples after separation on a Kieselgel 60-type chromatography thin layer has beeen performed (*406*). Software has been introduced for processing qualitative analysis data from two parallel TLC analyses (*407*). A method for improving detection limits using a novel sample concentrator has been described (*408*).

The detection of drugs of abuse in biological fluids has been reported using GC/MS (*409*, *410*), HPLC/DAD (*411*–*413*), CE (*414*–*416*), CEC (*417*), LC/MS (*418*–*420*), LC/APCIMS (*421*), and SPME (*422*). Applications of AAS in toxicology and the criminalistics field have been presented (*423*). SPE procedures in the systematic toxicological analysis have been reviewed (*424*). The analysis of methaqualone in biological matrixes by CE has been compared with GC/MS (*425*). A survey of drugs-of-abuse testing in the European Union has been reported (*426*). The laboratory validation study of a drug evaluation and classification program has been published (*427*). Recent developments in analytical toxicology have been discussed (*428*). Drug screening in biological fluids has been reviewed (*429*). A method for correcting HPLC retention data has been produced using HPLC/DAD (*430*). Therapeutic, toxic, and lethal concentrations in human fluids of 90 drugs affecting the cardiovascular and hematopoietic systems have been tabulated (*431*). The transmission of the results of drug tests for the International Olympic Committee has been described (*432*). A review of the quality assurance in forensic toxicological analysis has been published (*433*). A field evaluation of "on-site" multianalyte drug testing devices was performed to determine the best device available for the purpose of rapidly detecting drivers under the influence of drugs (*434*).

The determination of drugs of abuse in blood has been reviewed (*435*). Methods to detect drugs of abuse in blood have included immunoassay techniques (*436*, *437*), GC/MS (*438*), CZE (*439*), HPLC/DAD and capillary GC/FID (*440*), and SPE and FIA/tandem MS (*441*). A review of reference values for therapeutic and toxic levels for a large number of drugs has been published (*442*).

Screening for drugs of abuse in urine has been reviewed (*443*). Drugs of abuse have been analyzed in urine by GC/MS (*444*), immunochromatographic techniques (*445*), immunoassay and GC/MS (*446*–*448*), solid-phase immunoextraction and HPLC/ECD (*449*), and SPE and GC/MS (*450*). A totally automated procedure has been developed for the preparation and analysis of drugs in urine by GC (*451*). Findings from a multisite laboratory evaluation comparing on-site urinalysis drug-test results to results from EMIT and GC/MS were reported (*452*). Vitamin B_2 interference with immunoassays has been discussed (*453*). The integrity of urine specimens for toxicological analyses with specific reference to adulteration, mechanism of action, and laboratory detection has been discussed (*454*). Urinanalysis was performed on body packers/smugglers (*455*).

A special publication issue has been dedicated to the analysis of hair for drugs of abuse (*456*). Testing of drugs of abuse has been reviewed (*457*–*462*). Drugs of abuse have been analyzed in hair by GC/MS (*463*), HPLC/DAD and GC/MS after SPE

(*464*), infrared microscopy (*465*, *466*), RIA and GC/MS (*467*), GC/MS/MS (*468*), CZE (*469*), CE (*470*), and SFE (*471*). Literature data related to the merit of hair as a chronological diary of drug exposure, as examined by segmental analysis, are reviewed with emphasis on the mechanisms of drug incorporation, physiology of hair growth, and findings resulting from the research effort and routine analytical results (*472*). One laboratory has reported their experience for the past 10 years with hair testing for drugs of abuse (*473*). A biochemical approach on the conservation of drug molecules during hair fiber formation has been reported (*474*). The concordance between self-reported drug use and findings in hair about cocaine and heroin has been reported (*475*). The effect of cosmetically treated hair on the stability of drugs of abuse has been discussed (*476*). The effect of pigmentation on the drug deposition in hair has been reported (*477*). Use of the hair of children to determine drug exposure has been demonstrated (*478*). Hair analysis as a potential index of therapeutic compliance in the treatment of epilepsy has been reported (*479*).

Screening of drugs in synovial fluid of the knee joint and in vitreous humor has been reported using fluorescence (*480*). Testing of drugs of abuse has been reported in saliva and sweat (*481*), in meconium (*482*), and in nails (*483*). The chemical factors involved in accumulation and retention of fentanyl in hair after external exposure or in vivo deposition have been discussed (*484*).

FORENSIC DNA ANALYSIS

It is striking to note that publication on conventional forensic serology techniques have virtually disappeared from the citation literature in the past few years. In fact, all but two of the following papers pertain specifically to aspects of forensic DNA typing. The other two discuss issues of blood chemistry that directly impact DNA analysis. Of the DNA papers, almost all present optimization, validation, or population studies of PCR-based marker systems, with the most recent emphasis on development of short tandem repeat (STR) loci. Papers discussing automated systems for the analysis of STR loci have begun to predominate. Studies on mitochondrial DNA typing are also beginning to appear. We have arranged the survey primarily by technique or typing system, and then as general methodology, reviews, and case studies. A few papers have been consolidated under a "multisystem" heading where the study covered more than one major typing system.

DNA Extraction and Quantitation. A protocol for increasing DNA extraction yield from saliva stains is presented (*485*). Various DNA extraction strategies for STR typing were evaluated (*486*). The recovery and DNA typing of saliva stains from human skin was investigated (*487*). A protocol for extraction of DNA from human skeletal remains is presented (*488*). A procedure for the extraction of liquid blood using the QIAamp spin column is presented (*489*). A procedure suitable for isolating DNA from samples in the field is described (*490*). Three DNA extraction methods for aged blood and bone samples were evaluated (*491*). A procedure for the removal of PCR inhibitors from ancient bone samples using silica-based spin columns was investigated (*492*). Methods for the extraction and successful amplification of DNA from ancient bone are described (*493*). DNA suitable for PCR-based testing could be extracted from cytological smears, histological sections, and paraffin-embedded tissues (*494*). A technique for rapid quantitation of a DNA sample extracted from buccal scrapes is presented (*495*).

Restriction Fragment Length Polymorphisms (RFLPs). A comparison of interlaboratory variation in autoradiographic DNA profiling measurements is presented (*496*). Partial digestion products of genomic DNA using *Hae*III were characterized (*497*). Partial digestion products of genomic DNA using *Hae*III were characterized and the results used to interpret casework data (*498*). A three-banded pattern due to an internal restriction site in the VNTR D5S43 is described (*499*). Chemiluminescent labeling systems were found to give similar results for RFLP DNA typing as isotopic systems (*500*). Population data for the VNTR loci D1S7, D2S44, D4S139, D5S110, D10S28, and D14S13 were studied in a population from Rio de Janeiro, Brazil (*501*). The allelic frequency distribution for three VNTR markers, D6S132, D7S467, and D17S26, was determined for a population in Rio de Janeiro, Brazil (*502*). A comparison study of RFLP profiles showed that concordance between Canadian laboratories is higher than that between U.S. laboratories due to use of a single analytical protocol for all Canadian laboratories (*503*). Various DNA databases constructed from convenience samples were found to be statistically similar to each other (*504*).

Amplified Fragment Length Polymorphisms (AMP-FLPs). The VNTR loci APOB, PAH, and D1S80 were characterized with regard to human specificity (*505*). The validation and implementation of the D1S80 locus for forensic casework is described (*506*). Aspermic semen was successfully typed for the PCR-amplified VNTR locus, D1S80 (*507*). The D1S80 locus was studied in a population from the province of Messina, Italy (*508*).

Short Tandem Repeats (STR). Sequence variation at the STR locus D12S391 was investigated (*509*). Duplex and triplex amplifications of the STR loci D3S1359, THO1, TPO, FESFPS, and vWFA3131A were evaluated (*510*). The STR loci FESFPS, FOLP23, GABRB15, and CYAR04 were studied in the Korean population (*511*). The STR loci CSF1PO, TPOX, and THO1 were studied using a single-stranded conformation polymorphism (SSCP) technique (*512*). The STR locus D21S1 was studied in Japanese and Chinese populations (*513*). The European DNA profiling group (EDNAP) reported on the STR loci D21S11 and FIBRA (FGA) (*514*). Three STR loci, D5S818, D7S820, and D13S317, were studied in sixteen worldwide indigenous human populations and one chimpanzee population (*515*). The STR loci D8S1179, D18S51, D21S11, and FIBRA and the amelogenin locus were amplified as a pentaplex and studied in the French Caucasian population (*516*). The STR locus vWF was studied in the Palestinian population (*517*). The STR loci vWFA31 and THO1 were studied in an Austrian population (*518*). The results of validation studies performed on the CTT STR multiplex (CSF1PO, TPOX, and THO1) are presented (*519*). Thirteen STR loci were studied in a Taiwanese Chinese population (*520*). A worldwide population study was conducted using twenty different STR loci (*521*). A heptaplex DNA amplification system containing the STR loci, D1S103, THO1, D21S11, and D18S51, FIBRA, and the amelogenin locus was optimized for forensic use (*522*). Three STR loci, CSF1PO, TPOX, and THO1, were studied in a general Australian, an Australian Caucasian, and an Australian Asian population (*523*). Six STR loci, FGA, D8S1179, THO1, vWFA31, D18S51, and

D21S11, and amelogenin were coamplified and studied in the Australian population (*524*). The ISFH's recommendations for STR nomenclature are presented (*525*). EDNAP's recommendations for STR nomenclature are presented (*526*). The development of two quadruplex amplification systems for the analysis of STR loci (CSF1PO, TPOX, THO1, vWFA31; F13A01, FESFPS, BFXIII, LIPOL) is reported (*527*). The STR locus, CD4, was studied in an Austrian population and validation experiments were performed (*528*). The results of an interlaboratory study of the STR triplex CTT (CSF1PO, TPOX, THO1) and the STR quadruplex CTTv (CSF1PO, TPOX, THO1, vWFA31) were evaluated (*529*). The STR loci CSF1PO, TPOX, THO1, F13A01, FESFPS, and vWA were studied in the French Canadian population of Quebec (*530*). The STR quadruplex THO1, vWA, FESFPS, and F13A01 and amelogenin was studied in an Austrian population (*531*). The effect of degradation on the amplification and typing of the STR loci ACTBP2, CMAG, THO1, CYP19, and LPL was investigated (*532*). A protocol for the multiplex amplification of four Y chromosome-specific STR loci is presented (*533*). A quadruplex system of Y chromosome STRs is presented (*534*). Eight STR loci on the Y chromosome were studied in the Basque and Catalan Iberian populations (*535*). The same allele designations were obtained for STR fragments analyzed by capillary electrophoresis and gel-based systems (*536*). A logical framework was established for taking account of peak areas when interpreting mixed DNA−STR profiles (*537*). Sizing precision of a capillary electrophoresis system was shown to allow for accurate genotyping of fluorescently labeled STR fragments differing in length by a single nucleotide (*538*). German population data were reported for three STR loci, D3S1744, D12S1090, and D18S849 (*539*). Sequencing data and allele distribution for the D12S391 STR locus in an Austria population is reported (*540*). A validation study of the STR ACTBP2 is reported (*541*). Matrix-assisted laser desorption/ionization was used for the detection of tetranucleotide STRs using a time-of-flight mass spectrometer (*542*). Allele frequencies of four STR loci, CD4, THO1, D21S11, and SE33, were reported for the Belgian population (*543*). The AMFLSTR Blue PCR amplification kit, which coamplifies the STR loci D3S1358, vWFA31, and FGA, was validated according to TWGDAM guidelines (*544*). The STR locus D12S391 was analyzed in a German and three Asian populations (*545*). The accuracy of an automated fluorescent detection system for the STR locus D12S391 was investigated using band shift analysis relative to an allelic ladder (*546*). The STR locus D3S1358 was studied in the German population (*547*). The STR locus vWFA31 was studied in a Qatari population (*548*). The STR locus D3S1359 is described (*549*). A study was performed to detect changes in absorbance and fluorescence of complexes of DNA−STR fragments with specific intercalating dyes (*550*). The STR locus B8S306 was studied in a German population (*551*).

Gender Identification. Because some males apparently lack a Y copy of amelogenin, the PCR gender test based on this gene incorrectly typed them as females (*552*). A de novo deletion of Yq resulted in a failure to detect any signal with a DYZ1 probe (*553*).

AmpliType PM and HLA-DQA1. The frequency of HLA-DQA1 alleles, including the subtypes 4.1 and 4.2/4.3, was studied in a Swiss population (*554*). Conclusions from a previous paper about PCR DNA typing from stamps were challenged (*555*). Comments regarding a previous paper about PCR DNA typing from stamps were answered (*556*). An optimized and validated protocol for co-amplifying the amelogenin and HLA-DQA1 genes is presented (*557*). Validation studies from twenty-six forensic laboratories using the AmpliType PM PCR amplification and typing kit are presented (*558*). The allele and genotype frequencies of the AmpliType PM and HLA-DQA1 loci were studied in an Italian population (*559*). The allele and genotype frequencies of the AmpliType PM and HLA-DQA1 loci were studied in populations from the Central Pyrenees and Teruel, Spain (*560*). Single-strand conformation polymorphism (SSCP) analysis of HLA-DQA1 amplification products was investigated as a screening tool (*561*). The AmpliType PM + DQA1 marker system was studied in two New York City Jewish populations (*562*). The AmpliType PM + DQA1 marker system was studied in Arab and Pakistani populations living in Abu Dhabi, United Arab Emirates (*563*). The five loci in the AmpliType PM system were studied in a Japanese population (*564*). Using the AmpliType PM + DQA1 PCR typing system, the possible effect of substructure on probability calculations of DNA profiles was investigated in Caucasian, Arabic, Korean, Sioux/Chippewa, Navajo, Pueblo, African American, Southeastern Hispanic, and Southwestern Hispanic populations (*565*). A review of hypothetical problems with the DQA1 + PM forensic typing kit based on theoretical optimums for primer hybridization was presented (*566*). A population study of the markers in the AmpliType PM + DQA1 PCR typing system was performed in a German Caucasian population (*567*).

Multisystem. The ability to detect mixtures in individuals with blood transfusions using the AmpliType PM + DQA1, D1S80, and the STR CTT (CSF1PO, TPOX, THO1) marker systems was studied (*568*). The efficacy of the PCR-amplified forensic DNA typing systems AmpliType PM, HLA-DQA1, THO1, vWFA31, F13B, and FESFPS was investigated for stained cytological smears (*569*). The effect of using different reference databases to estimate the frequency of a DNA profile using the PCR-based systems AmpliType PM + DQA1 and D1S80 was investigated (*570*).

Mitochondrial DNA Typing. Mitochondrial DNA sequencing was used to compare DNA from the nephew of Tzar Nikolai II Romanov with DNA from the putative remains of the Tzar (*571*). Detection of mitochondrial DNA variants using (SSCP) analysis of superposed restriction enzyme fragments from PCR-amplified products was investigated (*572*). The rate and pattern of intergenerational substitutions in the human mitochondrial DNA control region was investigated (*573*). The extent of mitochondrial DNA heterogeneity in European populations is described (*574*). A family exhibiting heteroplasmy in the human mitochondrial DNA control region was studied for somatic mosaicism and segregation of mitotypes (*575*). Sequence variation in the mitochondrial DNA control region in the Korean population was studied (*576*). A procedure was reported for mitochondrial DNA typing using restriction enzyme digestion of PCR amplicons (*577*). Forensic applications of mitochondrial DNA typing are reviewed (*578*). Mitochondrial DNA typing for the legal and law enforcement community is reviewed (*579*). The results of mitochondrial DNA sequencing on evidence samples from three robberies were reported (*580*). A protocol for washing hair shafts before mitochondrial DNA sequencing was developed (*581*). The decision,

Tennessee vs Ware, in which mitochondrial DNA sequencing was admitted for the first time in a U.S. court, was reviewed (*582*).

General Methodology. Using degenerate oligonucleotide primed PCR, as little as 15 pg of human genomic DNA was uniformly amplified (*583*). The results of using a four-color capillary array electrophoresis scanner for DNA sequencing are reported (*584*). Instability in minisatellite repeat DNA appears to be controlled by flanking recombination initiation elements (*585*). The ability to perform PCR DNA testing on stained tissue samples was investigated (*586*). The results of high-speed DNA genotyping using microfabricated capillary array electrophoresis chips are presented (*587*). A protocol for direct PCR amplification from paraffin-embedded tissue is described (*588*). The efficacy of PCR-based forensic DNA typing systems was evaluated for formalin-fixed and formalin-fixed paraffin-embedded tissues (*589*). A procedure was developed for sequential multiplex amplification in forensic samples (*590*). The different mobility of complementary DNA strands on denaturing polyacrylamide gels depends on the proportion of AC/GT (*591*). Fluorescence in situ hybridization (FISH) was determined to be unsuitable for determination of sex in telogen hairs (*592*). The electrophoretic behavior of DNA fragments in denaturing and nondenaturing polyacrylamide gels was compared (*593*). Improvements in PCR yield and specificity using the AmpiTaq Gold DNA polymerase enzyme were reported (*594*).

Reviews, Cases, and Miscellaneous. Forensic DNA analysis systems, including RFLP and HLA-DQA1, are reviewed (*595*). RFLP and PCR methods for forensic DNA analysis are reviewed (*596*). The history of forensic DNA analysis is reviewed (*597*). Forensic DNA analysis in Europe, with an emphasis on standardization efforts, is reviewed (*598*). The state of forensic DNA typing is reviewed (*599*). Past and future uses of capillary electrophoresis are reviewed (*600*). The National Research Council's report, *The Evaluation of Forensic DNA Evidence* was summarized (*601*). Also note The Proceedings of the European Symposium: Ethical and Legal Issues of DNA Typing in Forensic Medicine (*602*). A PCR method for genotyping the ABO blood group II A^2 and O^2 alleles is presented (*603*). PCR methods for genotyping the ABO subtypes A^1, A^2, O^A, O^G, and O^2 are presented (*604*). The analysis of ribosomal DNA as a tool for the identification of *C. sativa* L. specimens was investigated (*605*). A procedure for the detection and identification of cannabis by DNA typing is reported (*606*). The possibilities for using DNA analysis in toxicology are discussed (*607*). The results of forensic DNA tying as an identification tool in several mass disasters are presented (*608*). DNA typing was used for identification of mass disaster victims (*609*). Five cases are described in which STR typing was performed (*610*). In a paternity case, two mutations out of nineteen PCR-based markers tested were observed (*611*). DNA typing of skeletal remains was discussed in the context of identifying bodies from mass graves (*612*). The resolution of a paternity case involving apparently conflicting single-locus and multilocus DNA typing results is discussed (*613*). The results of genetic investigation into the origin and gender of dried blood on a statue of the Virgin Mary suggest blood of human, female origin (*614*). DNA analysis in the case of Christine Jessop is described (*615*). The results of a case involving a blood mixture were interpreted using a tree diagram (*616*). A procedure is suggested for the estimation of bloodstain age by HPLC (*617*). A reliable method (CE/MS) for detecting low concentrations of EDTA in human plasma samples is presented (*618*).

TRACE EVIDENCE

Paint. A survey of the evidential value of paint in traffic accident cases has been undertaken (*619*). A paint database developed in Canada has proven valuable in forensic identifications (*620*). The frequency of occurrence of paint chips and glass fragments on clothing has been determined (*621*). Several different quinacridone pigments have been identified in single-layer U.S. automobile original topcoats (1974–1989) by infrared spectroscopy (*622*, *623*). FT-IR microscopy and SEM/energy dispersive X-ray analysis (EDX) have been applied for the examination of multilayer fragments of automobile paints (*624*). FT-IR microspectroscopy has been applied for examination of paints transferred onto different kinds of fabrics (*625*). Recent changes in automotive paint formulations have been investigated using pyrolysis-gas chromatography/mass spectrometry (*626*).

Fibers. On the basis of microscopic characteristics, fluorescent properties, and microspectrophotometry, a majority of red, blue, and green cotton fiber samples were discriminated (*627*). Observations with regard to dyes on fibers have been made with the aid of FT-IR (*628*). X-ray fluorescence microanalysis was reported to significantly increase the discrimination power between colorless fibers (*629*). The forensic analysis of microfibers has been reviewed (*630*). A review of the studies of fiber transfer and persistence and determinations of the significance of fiber evidence has been presented (*631*). The forensic value of common fibers when they appear in certain garments or combinations has been evaluated (*632*). The retention and recovery of transferred fibers following the washing of clothing has been evaluated (*633*). Fiber transfer of wool to vinyl and leather vehicle seats has been studied (*634*). The frequency of the fiber population on car seats has been studied (*635*, *636*). The frequency of fibers on outdoor surfaces has been evaluated (*637*). The frequency of occurrence of blue wool fibers on seats in pubs has been undertaken (*638*). The frequency of occurrence of a red acrylic fiber on various items of clothing was studied (*639*). A significant number of common fibers have been found in the head hair of individuals (*640*). The value of fibers as forensic evidence has been studied from a statistical point of view (*641*). A pattern-recognition algorithm combined with near-IR reflectance spectroscopy has been modified to function as a nondestructive analytical technique for identifying dyes present on textiles (*642*). Provided the dye concentration in the fiber is sufficient, it is possible to make some general observations on the type of dyes that have been used with FT-IR microspectroscopy (*643*). A diffuse reflectance Fourier transform IR spectroscopy (DRIFTS) investigation was performed on a series of poplin cotton fabrics treated with a bifunctional reactive dye (*644*). A set of fibers, mainly synthetic, were successfully examined by Raman microprobe spectroscopy (*645*). FT-Raman microscopy has been used to characterize the natural plant fibers flax, jute, ramie, cotton, kapok, sisal, and coconut fiber (*646*). Pyrolysis gas chromatography has been used to identify minute samples of wool fiber (*647*). FT-IR microspectroscopy, SEM/EDX, microscopy, and X-ray diffraction have been successfully applied to the characterization of thermally changed fibers (*648*). Polariza-

tion FT-IR microspectroscopic data have been obtained from unstretched and stretched poly(ethylene terephthalate) single fibers (*649*).

Glass. Refractive index and elemental compositions have been used to classify glass (*650*). Changes in refractive index after reannealing have been used to characterize windshield glass (*651*). The interpretation of elemental composition measurements from forensic glass evidence has been explored (*652*). The interpretation of elemental composition measurements from forensic glass evidence has been explored (*653*). Studies have been carried out to investigate the number of glass fragments transferred to the clothing of a person in the vicinity of a breaking window (*654*, *655*). The transfer of glass between a person who has broken a window and other person in close vicinity has been investigated (*656*). The transfer of glass from the surface of a card bound box to the cloth of the person carrying the box has been investigated (*657*). The distribution of glass fragments on the ground near a vehicle when the windshield has been broken has been examined (*658*). It has been found that glass fragment shapes cannot be used to distinguish glass acquired by backward fragmentation from a broken window or glass acquired through contact with a broken window (*659*). A statistical treatment for grouping glass fragments recovered in a forensic case has been described (*660*). The evidential value of glass from a statistical point of view has been presented (*661*). Sampling problems in glass analyses have been studied from a statistical point of view (*662*). A statistical approach to the significance of glass evidence has been proposed using independent physicochemical measurements and chemometrics (*663*).

Gunpowder and Primer Residue Detection. During the course of a study, fireworks were found that generated gunshot residue (GSR)-similar particles, those particles being found both on the hands of professional fireworks technicians and in the combustion plume of consumer-grade devices (*664*).The comparison of properties of adhesive tapes, tabs, and liquids used for the collection of gunshot residue and other trace materials for SEM analysis has been reported (*665*). The mechanism of GSR deposition on the hands of a shooter has been studied. GSR has been characterized by SEM/EDX (*666*). The concentrations of antimony, barium, and lead in gunshot residue collection swab extract solutions were determined using inductively coupled plasma-mass spectrometry (*667*). It was found that 86% of the mercury was vaporized after discharge from mercury fulminate primed ammunition, 88% of which was not detectable by SEM (*668*). Shooting tests were carried out using ammunition having antimony-free primers and in which the highest content of antimony on the surface of projectiles was observed. A very small percentage of gunshot residue particles containing antimony was found in these tests (*669*). X-ray microfluoresence spectrometry has been successfully evacuated as a technique for the elemental analysis of firearm discharge residues on the hands of a firer (*670*). A proposed criterion for uniquely characterizing GSR has been offered (*671*). The smokeless powders in 22 kinds of ammunitions were analyzed by SEM/EDX. This study demonstrates that smokeless powder could be the source of some of the elements detected in GSR (*672*). Potential sources of GSR contamination has been investigated (*673*). A database was devised for the identification of ammunition from gunshot residues and other cartridge-related materials (*674*). A review of all aspects of analysis associated with gunshot residues has been published (*675*). Sampling protocols for the detection of smokeless powder organic residues using capillary electrophoresis have been reported (*676*).

Petroleum Products. A review of common techniques for characterizing accelerants recovered from fire scenes has been published (*677*). Retention of gasoline and diesel fuel samples on charcoal has been assessed (*678*). In the course of a routine fire investigation, three commonly available fuel injector cleaners were analyzed by GC (*679*). An overall scheme has been presented for the comprehensive analysis of flammable and combustible liquid residues in fire debris, mainly utilizing passive adsorption onto Tenax followed by thermal desorption (*680*). The utility of individual mass spectrometer ion profiles vs summed ion profiles in the analysis of petroleum residues related to arson investigations has been demonstrated (*681*). Selected ion profiles of fire debris extracts for the purpose of differentiating background residues produced by burning asphalt from liquid petroleum distillates have been investigated (*682*). GC/MS/MS has been shown to be a highly sensitive technique for identifying the presence of gasoline residues (*683*). Motor oils were examined with respect to changes in their elemental composition during their use in an automobile (*684*). Electronic aroma detection technologies for the detection and identification of accelerants and their residues in suspected arson debris were investigated (*685*).

Explosives. Capillary electrochromatography has been used to separate a series of nitroaromatic and nitramine explosive compounds (*686*). Micellar electrokinetic capillary chromatography has been used to separate organic explosive constituents (*687*). Capillary electrophoresis was applied to the analysis inorganic ions in low-explosive residues (*688*). A novel electrolyte has been developed for the effective separation by capillary electrophoresis of cations detected in low-explosive residues (*689*). The use of micellar electrokinetic capillary chromatography has been applied for the separation and identification of high-explosive components in postexplosive samples (*690*). The application of solid-phase microextraction to the recovery of residues of organic explosives by headspace sampling has been discussed (*691*). A systematic approach to the identification of water-gel explosives has been described (*692*). A capillary-based displacement flow immunosensor has been successfully evaluated for the detection of the explosive, 2,4,6-trinitrotoluene (TNT) (*693*). A Raman microspectroscope has been developed and successfully used to detect a range of narcotics and explosives, both pure and contaminated (*694*).

Fingerprints. A new class of reagents, 1,2-indanediones, was successfully evaluated for latent print visualization on paper (*695*). An IR wide-band tunable pulse laser has been used to detect latent fingerprints (*696*). FT-IR analysis has been used to measure the quantity of polymer deposition associated with cyanoacrylate-fumed fingerprints (*697*). A lipid-specific europium bioconjugate method for latent fingerprint detection has been evaluated (*698*, *699*). A lipid-specific lanthanide-based method of latent fingerprint detection on currency has been described (*700*). A latent fingerprint development method using ruthenium tetroxide has been described (*701*). A hydrogen peroxide solution was used to clean cartridge cases and to aid in the development of latent prints

on cartridge cases (*702*). The application of image enhancement techniques in fingerprints has been reviewed (*703*). Visualization of latent prints has been reported by placing the fingerprint inside a corona discharge induced plasma (*704*). Fingerprints have been developed on fired cartridge cases by metal vapor deposition (*705*). A potential replacement for the CFC113-based ninhydrin formulation has been proposed (*706*, *707*). A design allows the real-time observations of latent fingerprints by short- wave UV luminescence (*708*). A design allows the real-time observation of latent fingerprints by short-wave UV luminescence (*709*). Visualized fingerprints on unfired brass cartridge cases developed by palladium deposition were examined by Auger electron spectroscopy, SEM, and electron probe microscopy (*710*). The observation that the fingerprints of children disappear from surfaces more quickly than those of adults initiated a study to characterize the chemical components in fingerprints (*711*).

Miscellaneous. The capillary zone electrophoresis of water-soluble inks was examined (*712*).

CE was used to analyze roller ball pen inks (*713*). Writing and printing inks were analyzed by micellar electrokinetic capillary chromatography (*714*). CE was applied to the analysis of fountain pen inks (*715*). Writing inks have been analyzed by TLC and FT-IR analysis (*716*). Printing inks have been analyzed by TLC (*717*). The stability of different writing inks to fading on different paper products was examined (*718*). The chemical reactions occurring on paper between different liquid erasures and writing inks have been studied (*719*). Colored toner samples were characterized by FT-IR and GC/MS (*720*). Black toner samples were characterized by FT-IR and SEM/EDX (*721*, *722*). Black toner samples were characterized by DRIFTS, SEM/EDX, and pyrolysis gas chromatography (*723*).

Forensic soil analysis has been applied to the investigation of an airplane crash (*724*). A technique for the forensic comparison of soils based on automated SEM has been devised (*725*). The forensic value of the pollen content of soil for forensic evaluations has been investigated (*726*). Purge-and-trap gas chromatography was used as a direct analytical technique for lipstick smears (*727*). Raman spectroscopy has been studied for its utility as an analytical technique for lipstick smears (*728*).

The analysis of wax-based products by capillary GC/MS has been reported (*729*).

Lachrymators have been identified by ambient temperature ion mobility spectrometry (*730*). Different formulations of the lachrymator oleoresin capsicum have been distinguished by chemical and elemental analysis (*731*). The detection, identification, persistence, and ballistic properties of lachrymators were studied (*732*). A hand-held ion mobility spectrometer was used to characterize the vapors produced by samples of CN and CS tear gas sprays (*733*).

An ICPMS method measured the percentage of antimony, amounts of trace elements, and lead isotopic ratios of the bullets. This approach was shown to be feasible for comparing bullet alloys (*734*). A number of reagents have been tested for determining metal traces on the hand emanating from firearms (*735*). Latent imprints that are formed by the close contact between the metallic parts of a weapon and the palm of the hand were visualized by the application a pyrdyldiphenyltriazine (PDT) reagent (*736*, *737*). Counterfeit coins were investigated using X-ray fluorescence (XEF) and by microscopy (*738*). The application of pyrolysis GC to the detection of art forgeries has been described (*739*). The underlying theory for the electrostatic imaging of forensic evidence has been reviewed (*740*). The analysis of EDTA in dried bloodstains by electrospray LC/MS/MS and ion chromatography has been reported (*741*). An introduction to CE techniques relative to forensic science has been published (*742*). Recent advances in CE techniques relative to forensic science has been reviewed (*743*). The application and limitations of color comparisons in forensic science has been reviewed (*744*). A Bayesian approach to interpreting footwear impressions has been developed (*745*). The use of a white adhesive lifter to remove footwear imprints in dust and then their subsequent enhancement with a pH indicator has been described (*746*). Various methods for chemical enhancement of footwear impressions in blood have been evaluated (*747*). The potential role the Internet can have in forensic science services has been explored (*748*). A review of forensic science sites on the Internet has been presented (*749*). The identifying characteristics of paper lunch bags have been studied (*750*). The criteria for firearms and toolmark identification have been reviewed (*751*). A new approach to decision making in the forensic science laboratory base on the principles of Bayesian inference has been described (*752*). The technology of computerized image analysis for the identification of bullets and cartridge casings has been described (*753*). Problems associated with the interpretation of scientific evidence were evaluated with the aid of the Bayesian theory (*754*).

The introductory textbook *Criminalistics: An Introduction to Forensic Science* (*755*) has been revised. Case readings and overviews of forensic science topics can be found in *More Chemistry and Crime* (*756*), *Science and the Detective* (*757*), and *Crime Scene to Court* (*758*). Appropriate techniques for conducting a crime scene investigation have been described in *First Unit Responder* (*759*). Three detailed books have been published on the subject of blood spatter interpretation (*760*–*762*). An essential reference text for analysts involved in arson investigation is *GC–MS Guide to Ignitable Liquids* (*763*). Two standard textbooks relating to arson investigating have been revised (*764*, *765*). An in-depth treatment of forensic aspects of explosion investigation can be found in *Forensic Investigation of Explosions* (*766*). An excellent reference text relating to all aspects of forensic drug analyses is the *Drug Abuse Handbook* (*767*). Also, *A Brief History of Cocaine* (*768*) has been published. Excellent reference texts have been published in forensic toxicology. They are *Analytical Toxicology for Clinical Forensic and Pharmaceutical Chemists* (*769*) and *Handbook of Drug Analysis* (*770*).

A comprehensive treatise on fingerprint analysis has been published (*771*). Formerly titled *DNA Demystified*, this revision, now *An Introduction to Forensic DNA Analysis*, retains a basic introduction to scientific and legal issues in forensic DNA typing and adds chapters on interpretation and quality assurance (*772*). *DNA Fingerprinting* is another readable introductory book on the subject of forensic DNA profiling and paternity testing (*773*). A number of other books have been published on forensic aspects of DNA analysis (*774*–*778*). The *Proceedings of the 14th Meeting of the International Association of Forensic Sciences* has been released (*779*). An excellent book entitled *Spot Test Analysis* (*780*) as has been published, as has *Atlas of Human Hair* (*781*), an

essential reference for analysts engaged in hair comparisons. The widely used reference book *Gunshot Wounds* (*782*) has been revised.

Thomas A. Brettell *is Chief Forensic Scientists of the New Jersey State Police Forensic Science Bureau. He received his B.A. degree (1973) in chemistry from Drew University, Madison, NJ; a M.S. degree (1975) in chemistry from Lehigh University, Bethlehem, PA. Dr. Brettell joined the New Jersey State Police Forensic Science Bureau in 1976. Dr. Brettell was awarded The Chromatography Forum of the Delaware Valley Award in 1997. He has been a member of the faculty of the New Jersey Governor's School in the Sciences since 1984 and teaches forensic science in the Law and Justice Departments of The College of New Jersey and Rider University. He is a past-president of the Chromatography Forum of the Delaware Valley and has served on the A-Page Advisory Board of Analytical Chemistry. Dr. Brettell is on the Board of Governors of the Eastern Analytical Symposium, a Fellow in the American Academy of Forensic Scientists, and a certified Fellow of the American Board of Criminalistics. He also holds memberships in the American Chemical Society, the New Jersey Association of Forensic Scientists, and the Northeastern Association of Forensic Scientists. His present research interests include headspace analysis in gas chromatography.*

Keith Inman *is currently employed as a senior criminalist by the California Department of Justice DNA Laboratory. Mr. Inman holds a B.S. and M.Crim., both from the University of California at Berkeley. In his professional career he has been employed as a criminalist by the Orange County Sheriff's Department, the Los Angeles County Sheriff's Department, the Los Angeles County Chief Medical Examiner–Coroner, and the Oakland Police Department. He was in private practice for six years at Forensic Science Services of CA Inc., a private crime laboratory. Mr. Inman has coauthored An Introduction Forensic Analysis, a book that has become the preeminent reference for both attorneys and crime laboratories. He teaches a variety of general forensic and forensic DNA courses for the University of California at Berkeley extension, on-line for Knowledge Solutions, and a criminal investigation course for California State University at Hayward. Mr. Inman is a member of California Association of Criminalists and a Fellow of the American Board of Criminalistics.*

Norah Rudin *is a private forensic DNA consultant, author, and educator. She was previously a DNA research consultant with the California Department of Justice DNA Laboratory and is currently Acting Technical Leader for the Idaho State Department of Law Enforcement DNA Laboratory. She is coauthor of An Introduction to Forensic DNA Analysis (CRC Press, 1997) and author of Dictionary of Modern Biology (Barron's, 1997). Dr. Rudin earned a B.A. in zoology at Pomona College in Claremont, CA, and received her Ph.D. from the Department of Biology at Brandeis University with a concentration in molecular biology and genetics. She is an instructor for the University of California at Berkeley Extension, teaching both forensic DNA and general forensic science courses. She is also developer and instructor of on-line forensic DNA and forensic science courses with Knowledge Solutions. She is a published author of numerous general and academic articles. Her work has appeared in Genetics, Molecular and Cell Biology, San Francisco Daily Journal, CAC News, Jurimetrics, TIE-LINE, and other professional journals. Dr. Rudin lectures and has presented abstracts and scientific papers on genetics and forensic DNA analysis throughout the United States and internationally. Dr. Rudin is a provisional member of California Association of Criminalists.*

Richard Saferstein *is a forensic science consultant. He retired as Chief Forensic Scientist of the New Jersey State Police Laboratory in 1991. He received B.S. and M.A. degrees from the City College of New York in 1963 and 1966, respectively. He received his Ph.D. degree in chemistry from the City University of New York in 1970. Prior to his coming to the New Jersey State Police in 1970, he was employed as a forensic chemist with the Treasury Department (1964–1968) and served as an analytical chemist with Shell Chemical Co. (1969–1970). Dr. Saferstein is the author of a number of technical papers covering a variety of forensic topics. He has also written a book (six editions) on the subject titled Criminalistics: An Introduction to Forensic Science (Prentice-Hall, 1998) and has edited Forensic Science Handbook, Volumes I–III (Prentice-Hall, 1982, 1988, 1993), and More Chemistry and Crime (Oxford University Press, 1997). Dr. Saferstein has served on the editorial boards of the Journal of Forensic Sciences, Journal of Applied and Analytical Pyrolysis, and Microchemical Journal. He is a member of the American Chemical Society, the American Academy of Forensic Science, the American Microchemical Society, The Forensic Science Society, the Society of Forensic Toxicologists, the Canadian Society of Forensic Scientists, the Northeastern Association of Forensic Scientists, the Northwestern Association of Forensic Scientists, and the Mid-Atlantic Association of Forensic Scientists.*

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