
CONTROLLED SUBSTANCES TRAINING PROGRAM

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Clandestine Laboratory Field Investigations

AUSTIN POLICE DEPARTMENT

FORENSIC LABORATORY

Forensic Science Division
Forensic Chemistry
DRUG CHEMISTRY TRAINING MANUAL
Effective Date: 4/20/2018
Approved by Laboratory Director / Printed Copies are not Controlled

26. [Common Clandestine Laboratories](#)

Appendix:

APPENDIX A Training Schedule
APPENDIX B Study Guide
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Introduction

Purpose

The purpose of this manual is to provide uniform training for forensic drug chemists. The training program also plays a role in instilling an obligation to provide reliable results to customers. The goal is to develop the trainee's base knowledge of controlled substance, their physical and chemical properties and in the development of the trainee's skills in wet chemistry and instrumental analysis.

Program Objectives

Trainees are expected to advance their knowledge of drug chemistry through training and continuing professional development. Trainees are expected to participate fully in the training program in order to learn the material presented. Performance goals should be clarified for each module assignment and/or assessment. Upon approval for independent casework, analysts are encouraged to gain membership in professional organizations in order to maintain awareness of and share new or improved analytical techniques and emerging trends.

Training will be conducted through listed readings, one-on-one instruction, online resources, study questions, and practical exercises. Listed references may be expanded or abridged as necessary. Assessments of competency upon completion of modules may include written and/or oral exams, and a formal mock trial. (ASCLD/LAB 5.2.5)

This program aims to provide the trainee with knowledge on the topics below in order to successfully provide technical and scientific support to our customers.

Training should culminate so that the trainee has the following:

- Knowledge of the basic chemistry, scheduling and penalties of controlled substances;
- Knowledge of the procedures and practices of forensic analytical chemistry related to the analysis of controlled, dangerous, or commonly abused substances;
- Knowledge of the theory and applications of the various instruments and specialized techniques used to analyze controlled substances;
- Knowledge in evidence handling procedures such as safety and security
- Knowledge of the quality assurance program and its role to casework.
- Knowledge of the role of ethics and its practice in relation to casework product and personal responsibilities.
- Knowledge in the basics of clandestine laboratory investigation
- Ability to use the laboratory information management system to document training and casework
- Ability to perform accurate forensic analysis independently and proficiently; and
- Ability to skillfully present and defend analytical findings

Coordination of the Program

The Technical Leader will act as training coordinator of the drug training program and is responsible for the overall training. Qualified chemists may conduct certain duties or blocks of instruction at the direction of the training coordinator. An individual with demonstrated competence in the subject area and in the delivery of training is qualified to conduct training. External training must be arranged through and approved by the supervisor.

Training Period

The length of training period will be left to the discretion of the training coordinator. Generally, training will be no less than four (4) months and may be as many as nine (9) months. The training schedule in Appendix A outlines training topics to be covered. A record will be maintained which will detail training completed, progress made, and areas that need improvement.

Structure and Curriculum

The training program is organized so that the trainee will gain a background of drugs, a reinforcement of general chemistry concepts, marihuana identification, drug analysis, and courtroom testimony. It is broken into two phases: marihuana analysis and drug analysis.

The training program covers a curriculum including but not limited to the following core topics (Decide which will require exams and documentation):

- Drugs of Abuse
- General Chemistry
- Basic Lab Skills
- Chemical Characterization
- Solubility and Extractions
- Microscopy
- Spectrophotometry (Ultraviolet and Infrared)
- Chromatography
- Spectrometry
- Mathematics and Statistics
- Courtroom Testimony

Training will also include specific laboratory practices such as proper evidence handling and the use of the Laboratory Information Management System (LIMS).

Each module includes objectives for learning, definitions, and related literature references to guide the trainee through the material. Technical Lead will determine which parts of the literature reference are pertinent to the module. Modes of instruction may include any combination of listed readings, one-on-one instruction, online resources, demonstrations, and practical exercises of known and unknown samples. Assessments of competency for each module may include study questions, practical exercises, analysis of known and unknown samples, and written and/or oral examinations. **(ASCLD/LAB 5.2.5)**

Throughout the training period, the trainee will shadow a qualified examiner to become familiarized with the different forms of case evidence, packaging, applied analytical techniques and note-taking.

A comprehensive competency examination will be conducted following the successful completion of the marihuana and drug analysis blocks of instruction. Mock casework samples will be prepared to evaluate the trainee's competency in applying techniques and procedures to samples. A mock trial will be arranged using the mock case analysis and results.

If the trainee cannot successfully complete the required modules, assessments, and examinations given during training, then steps must be taken to effect appropriate action. If, after additional training, the trainee is unable to pass the evaluations, then a review of the performance must be done with disciplinary action up to and including termination.

Assessments and Documentation

The progress and completion of each module will be documented and retained. The study guide is not all encompassing. It is general knowledge based and questions and discussion topics may be modified by Technical Lead as needed. (Appendix B) Contents of practical exercise used to test the competency of the trainee will be developed and modified per assessment with the available consumables, reference

standards, chemicals, tools, instrumentation, and other resources as they become available. Copies of the written examinations may be kept by the trainee for reference purposes. The trainer will maintain written evaluations of the trainee throughout the training period, including areas that may need improvement. This feedback should be made available to the Technical Lead for review. Upon completion of the competency examinations and mock trials for marihuana and drug analysis, the trainee will need to be **authorized** by the Laboratory Director to perform casework in the applicable area(s) of analysis. (ASCLD/LAB 5.2.5)

Continuing Education: Professional Development

Training in professional development continues beyond the basics. Analysts are encouraged to continue their professional development by aiming to complete at least twenty hours of training every year. See Appendix C

Retention of skills is annually evaluated through the use of an external proficiency exam.

Drug Chemistry Introduction

There are two major divisions of training in drug analysis. The first division is marijuana identification. Marijuana identification requires the chemist to use the stereomicroscope to identify the physical characteristics of the marijuana plant, and some chemistry techniques to distinguish the cannabinoid alkaloids present in the plant.

The second division of drug training involves other types of drug samples consisting of powders, liquids, pharmaceutical samples, clandestine tablets and capsules, clandestine lab liquids and solids, chemicals, plant materials, and drug paraphernalia. There are volumes of literature and articles pertaining to the identification of drugs, and the chemist should keep abreast of new techniques and methods as they are published.

Drug identification may involve the use of color producing spot tests or screening tests. Each of these tests is extremely important and will be used extensively by the drug chemist.

The instruments that are routinely used in drug analysis are the ultraviolet spectrophotometer, infrared spectrophotometer, gas chromatograph, and gas chromatograph/mass spectrometer (GC/MS). Each of these instruments play an important role in drug identification and the chemist must become familiar with the operation, maintenance, calibration, and scientific principles of each.

The most difficult part of drug analysis training involves the isolation of the drug to be identified. On most occasions, samples to be analyzed are impure. Very often the chemist must isolate the compound of interest, and then use the proper instrumentation to conclusively identify the substance. Training may include techniques used for isolating drugs such as acid/base wet chemical extractions, thin-layer chromatography, and column chromatography.

The Trainee will also receive training on the fundamentals of evidence security, procedures used for evidence handling, and proper worksheet documentation.

1. Drug Chemistry Overview

1.1. Objectives

- 1.1.1. Learn the major drug classes
- 1.1.2. Learn the nomenclature including lawful and street names
- 1.1.3. Learn the chemical and legal classifications of drugs
- 1.1.4. Molecular structures of the most commonly abused drugs as well as relationship of isomers, analogues, homologues, and derivatives
- 1.1.5. Natural, semi-synthetic and synthetic sources of drugs
- 1.1.6. Classification of drugs as acids, neutrals, and bases
- 1.1.7. Simple pharmacology of the major classes of drugs
- 1.1.8. Solubility and salt forms

1.2. Modes of Instruction

- 1.2.1. Recommended reading
- 1.2.2. Study questions (oral, written)
- 1.2.3. Demonstrations of samples
- 1.2.4. Discussion and clarification of questions

1.3. References

- 1.3.1. Drug Enforcement Administration. (2011). *Drugs of Abuse*. Washington, DC: U.S. Department of Justice. http://www.justice.gov/dea/docs/drugs_of_abuse_2011.pdf

- 1.3.2. United Nations Office of Drug Control. (2003). *Terminology and Information on Drugs* (United Nations Publication No. E.03.XI.4). New York: NY: United Nations.
http://www.unodc.org/pdf/publications/report_2003-09-01_1.pdf
- 1.3.3. Canaff, R. (1972). *Basic Training Program for Forensic Drug Chemists*. Washington, DC: U.S. Department of Justice Bureau of Narcotics and Dangerous Drugs.
- 1.3.4. Clarke, E. G. C. (2004). *Clarke's Analysis of Drugs and Poisons in Pharmaceuticals, Body Fluids, and Postmortem Material* (3rd ed., Vol. 1-2). A. C. Moffat, Osselton, M. D., & Widdop, B. (Eds.) Grayslake, IL: Pharmaceutical Press.
- 1.3.5. Bell, S. (2006). *Forensic Chemistry*. Upper Saddle River, NJ: Pearson Education, Inc.
- 1.3.6. Gough, T. (Ed.) (1991). *The Analysis of Drugs of Abuse*. New York, NY: John Wiley & Sons, Ltd.
- 1.3.7. Marnell, Tim (Ed.) (2007) *Drug Identification Bible*. Hard copy and CD versions. Grand Junction: Amera-Chem, Inc.
- 1.3.8. Shulgin, A., & Shulgin, A. (1991). *PiHKAL: A Chemical Love Story*. Berkeley, California: Transform Press.
- 1.3.9. Inaba, D., & Cohen, W. (2007). *Uppers, Downers, and All Arounders*. Medford, OR: CNS Publications, Inc.
- 1.3.10. Hardman, J., & Limbird, L. (Eds.) (1996). *The Pharmacological Basis of Therapeutics* (9th ed.). New York, NY: McGraw-Hill Companies.
- 1.3.11. **Martindale The Extra Pharmacopoeia (Reynolds) - Verify**
- 1.3.12. Beers, M., & Berkow, R. (Ed.) (1999). *The Merck Manual of Diagnosis and Therapy*. Whitehouse Station, NJ: Merck Research Laboratories.

1.4. Assessment

- 1.4.1. Oral and/or written examination
- 1.4.2. Courtroom exercise (final mock trial)

Laboratory Practices

2. Laboratory Safety

2.1. Objectives

- 2.1.1. Knowledge about safe working practices in the laboratory and at crime scene
- 2.1.2. Ability to prevent service-related accidents, injuries, illnesses of personnel and damage to equipment, at laboratory and at crime scene
- 2.1.3. Ability to assess and manage risk and emergency situations
- 2.1.4. Active participation in implementation of safe working systems including evaluations and review. Consequent development of safety consciousness
- 2.1.5. Ability in safety documenting including maintenance of a safety manual, including designated staff, emergency procedures, contact information, training, accommodation, personal protective equipment, general hygiene/safety and biological/radioactivity hazards, risk assessment and risk management

2.2. Modes of Instruction

- 2.2.1. Study questions over:
 - 2.2.1.1. Properties of hazardous materials, including incompatibilities
 - 2.2.1.2. Use/meaning of hazard identification symbols, Risk and Safety phrases
 - 2.2.1.3. Interpretation of Material Safety Data Sheets
 - 2.2.1.4. safety guidelines (in the laboratory and at crime scene), precautions and rules/procedures with respect to handling compressed gases, flammable, toxic and corrosive substances, bio-hazardous materials, glassware, high-intensity light sources (including UV lamps and lasers), including safe transportation, storage and disposal
 - 2.2.1.5. Hazards involved with analytical instruments and apparatuses operation (high temperatures, radiation etc)
 - 2.2.1.6. Dealing with risk and emergency situations
 - 2.2.1.7. Scientific and technical literature on the issue
- 2.2.2. Demonstrations on:
 - 2.2.2.1. Use of (personal) protective equipment and physical barriers that are used both to protect the analyst from the evidence and reagents, and the evidence from the analyst, including capabilities and limitations
 - 2.2.2.2. Use of fire-fighting equipment
 - 2.2.2.3. First aid and emergency procedures
- 2.2.3. Practical exercise on:
 - 2.2.3.1. Implementation of risk assessment of hazardous chemicals/material and situations

2.3. References

- 2.3.1. "Recommended Guidelines for Quality Assurance and Good Laboratory Practices" United Nations Office on Drugs and Crime, ST/NAR/25, 1995
- 2.3.2. "Guidance for the implementation of a quality management system in drug testing laboratories – a commitment to quality and continuous improvement, United Nations Office on Drugs and Crime, ST/NAR/37, 2009
- 2.3.3. "Guidelines for the Safe Handling and Disposal of Chemicals Used in the Illicit Manufacture of Drugs", ST/NAR/36 rev.1, UNODC, 2011.

- 2.3.4. "Data Sheets on Substances Frequently Used in the Illicit Manufacture of Narcotic Drugs or Psychotropic Substances", SCITEC/9/REV.1, April 1993
- 2.3.5. "Recommendations", Scientific Working Group for the Analysis of Seized Drugs (SWGDRUG) (link updated Oct. 2012)
- 2.3.6. "NIOSH Pocket Guide to Chemical Hazards", Department of health and human services, National Institute for Occupational Safety and Health, 2005 (link updated oct. 2012)
- 2.3.7. "Guidelines for Laboratory Design: Health and Safety Considerations", Di Berardinis JL, Baum JS and First MW, Wiley, 2nd edition, 1992
- 2.3.8. "DRCHIS: Drugs geRelateerd CHEmicalien Informatie Systeem", A. Elissen, M.L. Hordijk, Dutch National Criminal Intelligence Division, May 1999
- 2.3.9. "Chemicals used in the Clandestine Production of Drugs", US Department of Justice, Drug Enforcement Administration, Office of Diversion Control, Drug and Chemical Evaluation Section
- 2.3.10. Relevant material safety data sheets
- 2.3.11. "Handbook of Laboratory Safety", Furr AK, CRC Press, 5th Ed., 2000
- 2.3.12. "Hazardous Laboratory Chemicals Disposal Guide", Armour M A, 3rd edition, CRC, 2003
- 2.3.13. "Prudent Practices in the Laboratory", National Research Council (U.S.), Committee on "Prudent Practices for Handling, Storage, and Disposal of Chemicals in Laboratories, National Academies Press, 1995
- 2.3.14. "Handbook of Laboratory Health and Safety", Sticoff RS, and Walters DB, 2nd edition, John Wiley & Sons, 1995

2.4. Assessment

- 2.4.1. Study questions (oral and/or written)
- 2.4.2. Practical exercise

3. Legislation

3.1. Objectives

- 3.1.1. Learn the penalty groups for controlled substances in Texas
- 3.1.2. Learn the schedules for controlled substances in Texas
- 3.1.3. Become familiar with the Federal Controlled Substance Act

3.2. Modes of Instruction

- 3.2.1. Self-directed study through recommended reading
- 3.2.2. Discussion, Clarification of questions

3.3. References

- 3.3.1. Texas Controlled Substance Act can be found in Health and Safety Code Title 6. Food, Drugs, Alcohol, and Hazardous Substances Subtitle C. Substance Abuse Regulation and Crimes Chapter 481- 485.
- 3.3.2. Drug Enforcement Agency, Controlled Substances by Alphabetical Order, retrieved from www.deadiversion.usdoj.gov/schedules/alpha/alphabetical.htm
- 3.3.3. U.S. Controlled Substance Act, Title 21 Chapter 13 found at www.usdoj.gov/dea/pubs/csa.html
- 3.3.4. Drug Enforcement Agency, Controlled Substance Analogue Enforcement Act of 1986, retrieved from <http://uscode.house.gov/download/pls/21C13.txt>
- 3.3.5. Federal Analog Act of 1986, retrieved from http://www.erowid.org/psychoactives/law/law_fed_analog_act.shtml
- 3.3.6. USA v. Damon S. Forbes (1992), AET is determined not to be an analog of DET and DMT, retrieved from http://www.erowid.org/psychoactives/law/cases/federal/federal_analog1.shtml
- 3.3.7. United States vs. Nicolas Sand and Robert Timothy Scully (1976), *Court ruling ALD-52 was determined to be analog of LSD*, retrieved from <http://openjurist.org/541/f2d/1370/united-states-v-sand>

3.4. Assessment

- 3.4.1. Oral and/or written examination
- 3.4.2. Courtroom exercise (final mock trial)

4. Quality Assurance and Ethics

- 4.1.1. Awareness of the significance of the quality of analyses and forensic laboratory results for the law enforcement, justice system, crime prevention and health, as well as for the international harmonization and worldwide exchange and coordination of drug information and data
- 4.1.2. Knowledge of the Quality policy of the laboratory
- 4.1.3. Knowledge of the requirements of ISO 17025, as interpreted for forensic laboratories
- 4.1.4. Knowledge of the structure of the Quality Management System of the laboratory or of the Best Practices applied
- 4.1.5. Ability to comply with the technical requirements established in the Quality Management System and/or Quality Standards of the laboratory
- 4.1.6. Ability to comply with the management requirements established in the Quality Management System and/or Quality Standards of the laboratory
- 4.1.7. Ethics & Code of Conduct training to improve employee awareness of your organization's key values.

4.2. Modes of Instruction

- 4.2.1. Self-directed study through recommended reading
- 4.2.2. (Clarification of questions)
- 4.2.3. Presentation by trainer and discussion on:
 - 4.2.3.1. national legislative, jurisdictional and regulatory requirements
 - 4.2.3.2. institutional and organizational requirements of the laboratory
 - 4.2.3.3. client requirements
 - 4.2.3.4. external and/or international instructions, recommendations and guidelines
 - 4.2.3.5. principles of ethical conduct
- 4.2.4. Studying of:
 - 4.2.4.1. Standard ISO/IEC 17025
 - 4.2.4.2. Quality Manual, and/or other relevant documentation of the administrative, organizational and scientific aspects of laboratory work (e.g. Best Practices manual, SOP's etc)
- 4.2.5. Demonstration by trainer with explanations on the laboratory quality management system and the quality standards/protocols implemented with respect to:
 - 4.2.5.1. organization of the laboratory
 - 4.2.5.2. laboratory environment and accommodation
 - 4.2.5.3. responsibilities, duties and skills of the personnel
 - 4.2.5.4. equipment choice and performance - calibration
 - 4.2.5.5. key stages of the drug testing process :
 - 4.2.5.5.1. - case assessment
 - 4.2.5.5.2. - sampling
 - 4.2.5.5.3. - handling of samples and evidentiary material
 - 4.2.5.5.4. - development of methods
 - 4.2.5.5.5. - development of procedures
 - 4.2.5.5.6. - validation/verification of methods
 - 4.2.5.5.7. - quality control (internal-external)
 - 4.2.5.5.8. - interpretation and reporting of the results
 - 4.2.5.6. chain of custody
 - 4.2.5.7. documents and case records
 - 4.2.5.8. handling of services and supplies
 - 4.2.5.9. dealing with clients, requests and complaints
 - 4.2.5.10. audits, corrective and preventive actions

- 4.2.5.11. health and safety
- 4.2.5.12. drug reference materials
- 4.2.5.13. education and training of personnel
- 4.2.5.14. proficiency testing
- 4.2.6. Video and staff based Ethics training
 - 4.2.6.1. Ensuring compliance with federal, state and city laws
 - 4.2.6.1.1. Court Ruling governing analysis and court testimony
 - 4.2.6.1.2. City HR training on City Ethics and policies
 - 4.2.6.1.3. Forensic Ethics Training
 - 4.2.6.2. Resolutions for ethical dilemmas, how they arise and where to turn for help
 - 4.2.6.3. To help building strong teams and fosters professionalism in the workplace
 - 4.2.6.4. Ensure the quality of service provided is not compromised
 - 4.2.6.5. Helps trainee determine if action is legal, right and beneficial
 - 4.2.6.6. Trainee learn actions reflect the organization legally and financially
- 4.2.7. Practical exercises in:
 - 4.2.7.1. Implementation of the quality assurance principles and criteria of the laboratory, at technical and management level
 - 4.2.7.2. use of quality assurance system as a safeguard to legal scrutiny
- 4.2.8. Discussion

4.3. References

- 4.3.1. "Guidance for the Implementation of a Quality Management System in Drug Testing Laboratories", United Nations Office on Drugs and Crime, ST/NAR/37, March 2009
- 4.3.2. "Staff Skill Requirements and Equipment Recommendations for Forensic Science Laboratories", UNODC, 2011 (link updated oct. 2012)
- 4.3.3. "Validation of analytical methodology and calibration of equipment used for testing of illicit drugs in seized materials and biological specimen", United Nations Office on Drugs and Crime, 2009
- 4.3.4. "Glossary of Terms for Quality Assurance and Good Laboratory Practices", United Nations Office on Drugs and Crime, ST/NAR/26/Rev.1, December 2009
- 4.3.5. United Nations Office on Drugs and Crime. (2009). *Guidelines on representative drug sampling* (UNODC & ENFSI DWG, ST/NAR/38). Vienna, Austria: Vienna International Centre.
- 4.3.6. "Recommended Guidelines for Quality Assurance and Good Laboratory Practice" United Nations Office on Drugs and Crime, STR/NAR/25, 1995
- 4.3.7. ISO/IEC 17025:2005 General Requirements for Competence of Testing and Calibration Laboratories, International Organization for Standardization/International Electrotechnical Commission
- 4.3.8. "Guidelines for Forensic Science Laboratories", International Laboratory Accreditation Cooperation, ILAC-G19:2002
- 4.3.9. "Recommendations", Scientific Working Group for the Analysis of Seized Drugs (SWGDRUG) (link updated oct. 2012)

4.3.10. "Guidance on the production of best practice manuals within ENFSI", ENFSI QCC-BPM-008, 2008 (link updated oct. 2012)

4.3.11. Quality Manual of the laboratory

4.4. Assessment

4.4.1. Study Questions*

4.4.2. Practical exercise on the implementation of procedures in compliance with the Quality Management System of the laboratory, at all stages of processes*

4.4.3. Attendance to assigned ethical training (city ethics and forensic ethic) and role play of ethical dilemmas

4.4.4. Courtroom exercise

5. Courtroom Testimony (ISO 5.2.1.2, and 5.2.1.3)

5.1. Objectives

- 5.1.1. Become familiar with the functions of a courtroom criminal proceeding (ISO 5.2.1.3)
- 5.1.2. Become familiar with relevant court decisions, e.g. Daubert, Frye, etc.
- 5.1.3. Learn the court structure (municipal court, juvenile court, district court, federal court)
- 5.1.4. Prepare current curriculum vitae and convey voir dire questioning during testimony
- 5.1.5. Become familiar with proper methods of presenting expert testimony during direct examination
- 5.1.6. Become familiar with proper methods of defending analytical results during cross-examination
- 5.1.7. Item chain of custody and method of identifying item in court. (ISO 5.2.1.2)

5.2. Modes of Instruction

- 5.2.1. Self-directed study through recommended reading
- 5.2.2. (Clarification of questions)
- 5.2.3. Presentation of case studies and demonstrations
- 5.2.4. Direct observation of expert testimony
- 5.2.5. Practical exercises
- 5.2.6. Discussion

5.3. References

- 5.3.1. "Interpreting Evidence - Evaluating Forensic Science in the Courtroom", Robertson B, Vignaux GA, John Wiley & Sons, Chichester, West Sussex
- 5.3.2. Kuzmack, Nicholas T., J.D., M.A. "Legal Aspects of Forensic Science", in Saferstein, Richard, Ph.D., editor. Forensic Science Handbook. Englewood Cliffs, N.J.: Prentice Hall, 1982, pp. 1-27.
- 5.3.3. Houck & Siegel
- 5.3.4. Shellow, James M. "The Expert Witness in Narcotics Cases", in Contemporary Drug Problems, - A Law Quarterly, Sprint 1973, pp. 81-104.
- 5.3.5. Travnikoff, Basil, Jr. and Kvick, Robert J. How to Examine a Chemist in Drug Abuse Cases, First Edition, 1971.
- 5.3.6. Bailey, F.L. and Rothblatt, H.B., Handling Narcotics and Drug Cases, Rochester, NY: The Lawyers Cooperative Publishing Co., 1972.
- 5.3.7. <http://www.ncids.com/forensic/metrology/uncertainty.shtml> [EDIT]
- 5.3.8. [People v. Jabrocki](#) (from above link) [EDIT]ttorney asks, "Is it
- 5.3.9. [State v. Fausto](#) (from above link) [EDIT]
- 5.3.10. [State v. Weimer](#) (from above link) [EDIT]
- 5.3.11. [City of Kent v. McDaniel](#) (from above link) [EDIT]

5.4. Assessment

- 5.4.1. Study questions
- 5.4.2. Formal mock trial

6. Evidence Handling and Security

6.1. Objectives

- 6.1.1. Learn the procedures applied in the collection, receipt, protection, handling, storage, analysis of samples/evidence, as well as documentation, evaluation, report writing and communication of results
- 6.1.2. Learn to choose the best case approach, preparation of samples and handling of evidence, implementation of analytical schemes and methodology, and reporting of results, for each individual case
- 6.1.3. Interpret and handle analytical data and related information so as to create and use respective databases

6.2. Modes of Instruction

- 6.2.1. Self-directed study through recommended reading
- 6.2.2. (Clarification of questions)
- 6.2.3. Demonstration and instruction on proper use of the RMS computer system and LIMS
- 6.2.4. Study questions
- 6.2.5. Practical exercises
- 6.2.6. Discussion
- 6.2.7. Studying of, clarification of questions and discussion on documentation of the administrative, organizational and scientific/analytical aspects of laboratory work (e.g. Quality Manual, Best Practices manual, SOP's etc)
- 6.2.8. Demonstration/guidance by trainer with explanations on standards or protocols implemented with respect to :
 - 6.2.8.1. case approach
 - 6.2.8.2. general analytical schemes for unknown samples / powders / tablets / capsules / herbal material
 - 6.2.8.3. weighing practices
 - 6.2.8.4. sampling practices
 - 6.2.8.5. choice of analytical methodology
 - 6.2.8.6. validation/verification of methods
 - 6.2.8.7. application of techniques per substance(s)
 - 6.2.8.8. development of SOPs
 - 6.2.8.9. equipment performance and control, preventive maintenance
 - 6.2.8.10. quality control
 - 6.2.8.11. interpretation and reporting of the results
 - 6.2.8.12. documents and case records
 - 6.2.8.13. handling/storage of samples/evidentiary material
 - 6.2.8.14. handling/storage of information, access to databases
 - 6.2.8.15. chain of custody
 - 6.2.8.16. communication with clients (including communication language, establishing needs, dealing with undue pressure etc)
 - 6.2.8.17. health and safety
 - 6.2.8.18. responsibilities, duties and skills of the personnel
 - 6.2.8.19. education and training of personnel
- 6.2.9. Practice in implementation of the (best) practices, (quality assurance) principles and criteria of the laboratory, at technical and management level
- 6.2.10. Discussion

6.3. References

- 6.3.1. Procedures Manual(s) of the laboratory

- 6.3.2. "ENFSI Code of Conduct", ENFSI/QCC, Ref.Code BRD-GEN-003, Issue No 002, 16 June 2005 (link updated oct 2012)
- 6.3.3. "Guidance for the Implementation of a Quality Management System in Drug Testing Laboratories", United Nations Office on Drugs and Crime, ST/NAR/37, March 2009
- 6.3.4. "Staff Skill Requirements and Equipment Recommendations for Forensic Science Laboratories", UNODC, 2011 (link updated oct. 2012)
- 6.3.5. "Validation of analytical methodology and calibration of equipment used for testing of illicit drugs in seized materials and biological specimen", United Nations Office on Drugs and Crime, 2009
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- 6.3.23. Canaff, R. (1972). *Basic Training Program for Forensic Drug Chemists*. Washington, DC: U.S. Department of Justice Bureau of Narcotics and Dangerous Drugs.

6.4. Assessment

- 6.4.1. Study questions (oral, written)
- 6.4.2. Practical exercise on the implementation of procedures in compliance with the Quality Management System of the laboratory, at all stages of processes

7. Balances

7.1. Objectives

- 7.1.1. Familiarity with the operation of balances
- 7.1.2. Familiarity with balance calibration and quality assurance practices
- 7.1.3. Ability to record and report weights

7.2. Modes of Instruction

- 7.2.1. Self-directed study through recommended reading
- 7.2.2. (Clarification of questions)
- 7.2.3. Presentations and demonstrations of proper use of balances
- 7.2.4. Study questions
- 7.2.5. Practical exercise
- 7.2.6. Discussion

7.3. References

- 7.3.1. Balance manufacturer's operating manuals
- 7.3.2. Mettler Toledo Good Weighing Practices Guide
- 7.3.3. ADD MORE

7.4. Assessment

- 7.4.1. Written examination
- 7.4.2. Weight recording exercise of known samples (practical)
- 7.4.3. Oral examination or courtroom exercise (optional)

8. Sampling

8.1. Objectives

- 8.1.1. Familiarity with the concepts of sampling
- 8.1.2. Familiarity with sampling procedures for sampling

8.2. Modes of Instruction

- 8.2.1. Self-directed study through recommended reading
- 8.2.2. (Clarification of questions)
- 8.2.3. Presentation of case studies and demonstrations
- 8.2.4. Practical exercises
- 8.2.5. Discussion

8.3. References

- 8.3.1. United Nations Office on Drugs and Crime. (2009). *Guidelines on representative drug sampling* (UNODC & ENFSI DWG, ST/NAR/38). Vienna, Austria: Vienna International Centre.
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8.4. Assessment

- 8.4.1. Selection of samples for analysis on unknown samples (practical)
- 8.4.2. Oral examination and/or courtroom exercise (optional)
- 8.4.3. Written examination

9. Measurement Uncertainty

9.1. Objectives

- 9.1.1. Become familiar with the concepts of measurement of uncertainty for weights and quantitations
- 9.1.2. Become familiar with General metrology to include: terminology, symbols, formulae, publications
- 9.1.3. Learn about the concepts of random and systematic error, accuracy, precision (repeatability, reproducibility, and their conditions), statistical control, standard and expanded uncertainty, correlation and propagation of error
- 9.1.4. Learn the reporting conventions including use of significant figures, truncation and rounding
- 9.1.5. Learn basic statistics (descriptive and inferential) to include: measures of central tendency (e.g., median), measures of variation, statistical modeling, sampling, probability, confidence interval, and significance level

9.2. Modes of Instruction

- 9.2.1. Self-directed study through recommended reading
- 9.2.2. (Clarification of questions)
- 9.2.3. Presentation of case studies and demonstrations
- 9.2.4. Practical exercise
- 9.2.5. Discussion

9.3. References (from SWGDRUG)

- 9.3.1. Eurachem/CITAC Guide: The Expression of Uncertainty in Qualitative Testing, Committee Draft September 2003.
- 9.3.2. GUM, Evaluation of measurement data — Guide to the expression of uncertainty in measurement Published by the Joint Committee for Guides in Metrology (JCGM), JCGM 100:2008.
- 9.3.3. Guidelines for Evaluation and Expressing the Uncertainty of NIST Measurement Results, National Institute of Standards and Technology, NIST Technical Note 1297, 1994 Edition.
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- 9.3.15. ASTM E2655 Standard Guide for Reporting Uncertainty of Test Results and Use of the Term Measurement Uncertainty in ASTM Test Methods.

9.4. Assessment

- 9.4.1. (Practical)
- 9.4.2. Oral examination and/or courtroom exercise (optional)
- 9.4.3. Written examination

DRUGS OF ABUSE

10. Cannabis

10.1. Objectives

- 10.1.1. Description of the cannabis plant including names and synonyms, botany, physical appearance, morphological, microscopic and chemical characteristics, herbal products, cannabis resin, and liquid cannabis)
- 10.1.2. Cultivation of cannabis plant (indoor/outdoor/industrial production, harvesting, yield)
- 10.1.3. Production of illicit cannabis products (herbal/resin/liquid cannabis)
- 10.1.4. Legal aspects including state and federal
- 10.1.5. Familiarity with Synthetic cannabinoids
- 10.1.6. Familiarity with the procedures for the analysis of illicit cannabis products (including sampling, physical examination, microscopy, extraction, color tests, GC/MS, LC/MS, analytical challenges, and special pitfalls)
- 10.1.7. Ability to perform identification of marihuana

10.2. Modes of Instruction

- 10.2.1. Self-directed study through recommended reading
- 10.2.2. Preparation of samples and of analysis by trainer, with explanations
- 10.2.3. Interpretation of results and discussion including limitations
- 10.2.4. Application of qualitative analysis on known samples by trainee
- 10.2.5. Application of qualitative analysis on unknown samples by trainee
- 10.2.6. Discussion, Clarification of questions

10.3. References

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- 10.3.3. "Training Manual on Drugs", Texas Dept. of Public Safety Crime Laboratory.
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- 10.3.6. "Marihuana, Hashish, and Hashish Oil", California Dept. of Justice Training Center, Feb. 1979.
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- 10.3.8. Clandestine Laboratory Guide for Agents and Chemists (DEA)
- 10.3.9. Small, E., "American Law and the Species Problem in Cannabis: Science and Semantics", Bulletin on Narcotics, Vol.XXVII, No.3, July 1975.
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10.4. Assessment

- 10.4.1. Written examination
- 10.4.2. Preparation of samples and reagents (practical)
- 10.4.3. Distribution and application of analysis on unknown samples (practical)
- 10.4.4. Courtroom exercise (mock trial, optional)

11. Amphetamine Type Stimulants (ATS)

11.1. Objectives

- 11.1.1. Learn the classification and respective definitions
- 11.1.2. Learn the description of compounds, physical and chemical characteristics, stereochemistry
- 11.1.3. Become familiar with non-ring substituted amphetamines (e.g. amphetamine, methamphetamine, cathine, cathinone, methcathinone, fenetylline)
- 11.1.4. Become familiar with methylenedioxy- substituted amphetamines (e.g. MD, MDMA, MDEA, FLEA, MBDB)
- 11.1.5. Become familiar with other ring substituted amphetamines (also in section "Hallucinogens")
 - 11.1.5.1. – 2,4,5-ring substituted phenethylamines (e.g. 2C-B, 2C-T, WC-T-2, 2C-T-7, 2C-C, 2C-I)
 - 11.1.5.2. – 2,4,5-ring substituted amphetamines (e.g. TMA-2, STP/DOM, DOB, DOC, DOI, DOET)
 - 11.1.5.3. Other ring substitution patterns (phenethylamines and amphetamines) (e.g. Mescaline, PMA, PMMA, DMA, TMA, 4-MTA)
- 11.1.6. Learn the illicit manufacture of ATS drugs, including the synthesis of amphetamine, methamphetamine, and rung-substituted ATS (e.g. XTC, etc)
- 11.1.7. Learn the basic pharmacology of ATS
- 11.1.8. Learn the legal aspects concerning ATS in state and national legislation
- 11.1.9. Become familiar with the protocol for the analysis of ATS (including sampling, physical description, extraction, presumptive (color) tests, optical isomer analysis, TLC, GC/MS, LC/MS, FTIR, analytical challenges, special pitfalls)
- 11.1.10. Become familiar with additional analytical techniques for the analysis of ATS
- 11.1.11. Perform identification of ATS in illicit materials
- 11.1.12. Perform quantification of ATS in illicit materials

11.2. Modes of Instruction

- 11.2.1. Self-directed study through recommended reading
- 11.2.2. Study questions
- 11.2.3. (Clarification of questions)
- 11.2.4. Preparation of samples and of different reagents necessary for the analysis including review of safety precautions
- 11.2.5. Demonstrations of samples and of analysis by trainer, with explanations
- 11.2.6. Interpretation of results and discussion including limitations
- 11.2.7. Practical exercises (Application of qualitative/quantitative analysis on known samples of ATS by trainee & Application of qualitative/quantitative analysis on unknown samples of ATS by trainee)
- 11.2.8. Discussion

11.3. References

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- 11.3.3. United Nations Office on Drugs and Crime. (1995). *Rapid testing methods of drugs of abuse* (UNODC, ST/NAR/13/Rev. 1). Vienna, Austria: Vienna International Centre. (<http://www.unodc.org/unodc/en/scientists/rapid-testing-methods-of-drugs-of-abuse.html>)

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11.4. Assessment

- 11.4.1. Study questions (oral, written)
- 11.4.2. Preparation of samples and reagents (practical)
- 11.4.3. Distribution and application of analysis on unknown samples (practical)
- 11.4.4. Courtroom exercise

12. Cocaine

12.1. Objectives

- 12.1.1. Become familiar with the coca plant and illicit materials containing cocaine
 - 12.1.1.1. Become familiarized with the description of the coca plant and illicit materials containing cocaine
 - 12.1.1.2. Learn the production of illicit materials from the coca plant including cocaine (isolation of cocaine from coca leaf, production of coca paste, cocaine base, "crack") and manufacture of cocaine
 - 12.1.1.3. Chemical constituents of forensic significance of coca plant and illicit materials containing cocaine, including by-products, adulterants and diluents
 - 12.1.1.4. Legal aspects concerning coca plant and illicit materials containing cocaine in state and federal legislation
- 12.1.2. Become familiar with the protocol for the analysis of illicit materials containing cocaine (including sampling, physical identification, extraction, presumptive (color) tests, TLC, GC/MS, GC/FID, LCMS, FTIR, analytical challenges, special pitfalls)
- 12.1.3. Become familiar with additional analytical techniques for the analysis of cocaine
- 12.1.4. Perform identification of cocaine in illicit materials
- 12.1.5. Perform quantification of (constituents of illicit materials containing cocaine)

12.2. Modes of Instruction

- 12.2.1. Self-directed study through recommended reading
- 12.2.2. Study questions
- 12.2.3. (Clarification of questions)
- 12.2.4. Preparation of samples and of different reagents necessary for the analysis including review of safety precautions
- 12.2.5. Demonstrations of samples and of analysis by trainer, with explanations
- 12.2.6. Interpretation of results and discussion including limitations
- 12.2.7. Practical exercises (qualitative and quantitative)
- 12.2.8. Discussion

12.3. References

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 - 12.3.18. "The Pharmacological Basis of Therapeutics", Goodman & Gilman's, New York, 11/E, 2006, McGraw-Hill
- 12.4. Assessment**
- 12.4.1. Study questions (oral, written)
 - 12.4.2. Preparation of samples and reagents (practical)
 - 12.4.3. Distribution and application of analysis on unknown samples (practical)
 - 12.4.4. Courtroom exercise (mini-mock trial)

13. Opium Alkaloids and Opium Derivatives

13.1. Objectives

- 13.1.1. Become familiar with the opium, opium alkaloids, and opium derivatives (heroin), including semi-synthetic opioids (e.g. oxycodone, hydrocodone, etc)
 - 13.1.1.1. Description of and the recognition of illicit opium products (botany, physical appearance, morphological and chemical characteristics, opium preparations)
 - 13.1.1.2. Production of illicit opium products (isolation of morphine from opium, manufacture of heroin from morphine)
 - 13.1.1.3. Chemical constituents of forensic significance of illicit opium products and derivatives, including by-products, adulterants and diluents, comparative analysis and establishing links between samples
 - 13.1.1.4. Structures and basic pharmacology of constituents of opium, opium derivatives (heroin), and semi-synthetic opioids
 - 13.1.1.5. Legal aspects concerning opium, opium derivatives (heroin), and semi-synthetic opioids in state and federal legislation
- 13.1.2. Become familiar with the protocol for the analysis of illicit opium, opium products, opium derivatives (heroin) and semisynthetic opioids (including sampling, physical examination, microscopy, extraction, presumptive (color) tests, GC/MS, LC/MS, FTIR, UV-VIS, analytical challenges, special pitfalls)
- 13.1.3. Become familiar with additional analytical techniques for the analysis of illicit opium, opium products, opium derivatives (heroin), and semi-synthetic opioids
- 13.1.4. Perform identification of illicit opium, opium products, opium derivatives (heroin), and semi-synthetic opioids
- 13.1.5. Perform quantification of heroin

13.2. Modes of Instruction

- 13.2.1. Self-directed study through recommended reading
- 13.2.2. Study questions
- 13.2.3. (Clarification of questions)
- 13.2.4. Preparation of samples and of different reagents necessary for the analysis including review of safety precautions
- 13.2.5. Demonstrations of samples and of analysis by trainer, with explanations
- 13.2.6. Interpretation of results and discussion including limitations
- 13.2.7. Practical exercises (Application of qualitative/quantitative analysis on known samples by trainee)

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 - 13.3.18. "The Pharmacological Basis of Therapeutics", Goodman & Gilman's, New York, 11/E, 2006, McGraw-Hill
- 13.4. Assessment**
- 13.4.1. Study questions (oral, written)
 - 13.4.2. Preparation of samples and reagents (practical)
 - 13.4.3. Distribution and application of analysis on unknown samples (practical)
 - 13.4.4. Courtroom exercise (mini-mock trial)

14. LSD and Hallucinogens

14.1. Objectives

- 14.1.1. Become familiar with the products containing LSD, Psilocybin/Psilocin (Psilocybe Mushrooms) and other substituted tryptamines, Mescaline (Peyote Cactus – Mescal Buttons), as well as other hallucinogenic phenethylamines (2-CB, STP, DOB, TMA, etc, also referred to in section “Amphetamine Type Stimulants” through
 - 14.1.1.1. Description of and the recognition of illicit products containing LSD, Psilocybin/Psilocin (Psilocybe Mushrooms) and other substituted tryptamines, Mescaline (Peyote Cactus – Mescal Buttons), as well as other hallucinogenic phenethylamines (2-CB, STP, DOB, TMA, etc.)
 - 14.1.1.2. Illicit production/manufacture of LSD, Psilocybin/Psilocin (Psilocybe Mushrooms) and other substituted tryptamines, Mescaline (Peyote Cactus - Mescal Buttons), as well as other hallucinogenic phenethylamines (2-CB, STP, DOB, TMA etc)
 - 14.1.1.3. Chemical compounds, structures and basic pharmacology of LSD products. Chemical constituents of forensic interest in and pharmacology of Peyote Cactus, Mescal Buttons and Psilocybe Mushrooms, as well as other substituted tryptamines and other hallucinogenic phenethylamines
 - 14.1.1.4. Legal aspects concerning LSD, Psilocybin/Psilocin (Psilocybe Mushrooms) and other substituted tryptamines, Mescaline (Peyote Cactus - Mescal Buttons), as well as other hallucinogenic phenethylamines (2-CB, STP, DOB, TMA etc) in state and federal legislation
- 14.1.2. Familiarity with the protocol for the analysis of LSD products (including physical identification, sampling, extraction, presumptive tests (fluorescence, color tests), GC/MS, HPLC, FT-IR, analytical challenges)
- 14.1.3. Familiarity with the protocol for the analysis of Psilocybin/Psilocin (Psilocybe Mushrooms) and other substituted tryptamines (including physical (macroscopic and microscopic) characteristics, identification, sampling, extraction, presumptive (color tests), GC/MS, LC/MS, FT-IR, special pitfalls)
- 14.1.4. Familiarity with the protocol for the analysis of Mescaline (Peyote Cactus - Mescal Buttons), as well as other hallucinogenic phenethylamines (2-CB, STP, DOB, TMA etc) (including physical -macroscopic and microscopic characteristics- identification, sampling, extraction, presumptive (color tests), GC/MS, LC/MS, FT-IR, special pitfalls)
- 14.1.5. Familiarity with additional analytical techniques for the analysis of LSD and hallucinogens (substituted tryptamines and hallucinogenic phenethylamines)
- 14.1.6. Perform identification of LSD, Mescaline, Psilocybin/Psilocin, and other substituted tryptamines and hallucinogenic phenethylamines, in illicit materials, including Peyote Cactus, Mescal Buttons and Psilocybe Mushrooms
- 14.1.7. Perform quantification of LSD, Mescaline, Psilocybin/Psilocin and other substituted tryptamines and hallucinogenic phenethylamines, in illicit materials, including Peyote Cactus, Mescal Buttons and Psilocybe Mushrooms

14.2. Modes of Instruction

- 14.2.1. Studying of suggested references/assignments
- 14.2.2. Clarification on questions
- 14.2.3. Preparation of samples and of different reagents necessary for the analysis including review of safety precautions
- 14.2.4. Demonstrations of samples and of analysis by trainer, with explanations

- 14.2.5. Interpretation of results and discussion including limitations
- 14.2.6. Application of qualitative/quantitative analysis on known samples of illicit materials containing LSD and hallucinogens by trainee
- 14.2.7. Application of qualitative/quantitative analysis on unknown samples by trainee
- 14.2.8. Discussion

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- 14.3.3. "Recommended Methods for Testing Peyote Cactus (Mescal Buttons)/Mescaline and Psilocybe Mushrooms/Psilocybin", UNODC, ST/NAR/19, December 1989
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14.4. Assessment

- 14.4.1. Study questions (oral, written)
- 14.4.2. Preparation of samples and reagents (practical)
- 14.4.3. Distribution and application of analysis on unknown samples (practical)
- 14.4.4. Courtroom exercise (mini-mock trial)

15. Steroids

15.1. Objectives

- 15.1.1. Familiarity with the illicit materials and pharmaceutical preparations including:
 - 15.1.1.1. Anabolic agents (e.g. steroids) such as stanolone, methanediene, nandrolone deconoate, testosterone, testosterone propionate
 - 15.1.1.2. Familiarity with steroids classification (androgens, estrogens, adrenals) and steroid preparations
 - 15.1.1.3. Descriptions of steroid formulations (oils, tablets, suspensions)
 - 15.1.1.4. Chemical constituents of forensic significance
 - 15.1.1.5. Structures and basic pharmacology of steroid preparations
 - 15.1.1.6. Legal aspects concerning steroids
 - 15.1.1.7. Familiarity with the protocol for analysis of steroids, for example, the advantages and limitations of the utilization of extractions, TLC, IR and GC/MS.
- 15.1.2. Description/recognition of illicit materials and pharmaceutical preparations (physical appearance, morphological characteristics, markings)
- 15.1.3. Chemical constituents of forensic significance of illicit materials and pharmaceutical preparations containing steroids
- 15.1.4. Structures and basic pharmacology of illicit materials and pharmaceutical preparations containing steroids
- 15.1.5. Legal aspects concerning illicit materials and pharmaceutical preparations containing substances prohibited in doping control in state and federal legislation
- 15.1.6. Become familiar with the protocol for the analysis of illicit materials and pharmaceutical preparations containing substances prohibited in doping control (including sampling, physical identification, presumptive tests, GC/MS, LC/MS, analytical challenges, special pitfalls)
- 15.1.7. Perform identification of illicit materials and pharmaceutical preparations containing steroids

15.2. Modes of Instruction

- 15.2.1. Studying of suggested references/assignments
- 15.2.2. Clarification on questions
- 15.2.3. Preparation of samples and of different reagents necessary for the analysis including review of safety precautions
- 15.2.4. Demonstrations of samples and of analysis by trainer, with explanations
- 15.2.5. Interpretation of results and discussion including limitations
- 15.2.6. Application of qualitative/quantitative analysis on known samples of illicit materials containing steroids
- 15.2.7. Application of qualitative analysis on unknown samples by trainee
- 15.2.8. Discussion

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 - 15.3.23. "Analytical Profiles of Anabolic Steroids", Auburn, Alabama 36831, PO Box 1527, CND Analytical 1989

15.4. Assessment

- 15.4.1. Study questions (oral, written)

- 15.4.2. Preparation of samples and reagents (practical)
- 15.4.3. Distribution and application of analysis on unknown samples (practical)
- 15.4.4. Courtroom exercise (mini-mock trial)

16. Other Drugs and Pharmaceuticals

16.1.Objectives

- 16.1.1. Become familiar with the illicit materials and pharmaceutical preparations containing controlled substances, as well as “designer” or new drugs, namely:
 - 16.1.1.1. benzodiazepine derivatives
 - 16.1.1.2. barbiturate derivatives
 - 16.1.1.3. synthetic opioids (pethidine, fentanyl and analogues, methadone, d-propoxyphene etc)
 - 16.1.1.4. GHB / GBL
 - 16.1.1.5. PCP and analogues, ketamine
- 16.1.2. Become familiar with the description/recognition of illicit materials and pharmaceutical preparations (physical appearance, morphological characteristics, markings)
- 16.1.3. Become familiar with the production/manufacture of illicit materials containing controlled substances
- 16.1.4. Become familiar with the chemical constituents of forensic significance of illicit materials and pharmaceutical preparations containing controlled substances
- 16.1.5. Learn the structures and pharmacology of illicit materials and pharmaceutical preparations containing controlled substances
- 16.1.6. Become familiar with applicable Texas Controlled Substances Act penalty groups
- 16.1.7. Learn legal aspects concerning illicit materials and pharmaceutical preparations containing controlled substances in state and federal legislation
- 16.1.8. Become familiar with the analytical procedures for pharmaceutical preparations
- 16.1.9. Become familiar with the protocol for the analysis of illicit materials and pharmaceutical preparations containing controlled substances (including sampling, physical identification, presumptive tests, TLC, GC, GC/MS, HPLC, LC/MS, FT-IR, analytical challenges, special pitfalls)
- 16.1.10. Become familiar with additional analytical techniques for the analysis of other drugs and pharmaceuticals
- 16.1.11. Become familiar with reporting guidelines
- 16.1.12. Perform identification of illicit materials and pharmaceutical preparations containing controlled substances
- 16.1.13. Perform quantification of illicit materials and pharmaceutical preparations containing controlled substances

16.2. Modes of Instruction

- 16.2.1. Self-directed study through recommended reading
- 16.2.2. (Clarification of questions)
- 16.2.3. Identification of and demonstrations of proper use of identification sources
- 16.2.4. Preparation of samples and of different reagents necessary for the analysis including review of safety precautions
- 16.2.5. Demonstrations of samples and of analysis by trainer, with explanations
- 16.2.6. Interpretation of results and discussion including limitations
- 16.2.7. Application of qualitative/quantitative analysis on known samples of illicit materials containing pharmaceuticals and other drugs by trainee
- 16.2.8. Application of qualitative/quantitative analysis on unknown samples by trainee
- 16.2.9. Discussion

16.3. References

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16.4. Assessment

- 16.4.1. Study questions (oral, written)
- 16.4.2. Preparation of samples and reagents (practical)
- 16.4.3. Use various sources for identification of pharmaceutical tablets (practical)
- 16.4.4. Distribution and application of analysis on unknown samples (practical)
- 16.4.5. Courtroom exercise (mini-mock trial)

Analytical Techniques

This section covers all basic methods available for drug analysis. The trainee must become thoroughly familiar with these techniques. This will include the theory behind the operation of instruments used, basic routine maintenance, and ultimately competence in each area. This knowledge will be used during the formal mock trial.

17. Color Tests

17.1. Objectives

- 17.1.1. Knowledge of the theory and principles of the color, crystal and anion tests
- 17.1.2. Become familiar with preparation, storage, and proper handling procedures of the reagents
- 17.1.3. Become aware of the mechanisms for color test reactions
- 17.1.4. Learn the advantages, disadvantages, and limitations of color tests
- 17.1.5. Knowledge of the possibilities and limitations of the technique
- 17.1.6. Knowledge of quality assurance and method validation requirements
- 17.1.7. Ability to execute color tests on drugs most commonly encountered in the illicit traffic
- 17.1.8. Ability to interpret the results obtained and become proficient in the use of chemical color tests

17.2. Modes of Instruction

- 17.2.1. Self-directed study through recommended reading
- 17.2.2. (Clarification of questions)
- 17.2.3. Preparation of different reagents including review of safety precautions
- 17.2.4. Demonstrations of color tests
- 17.2.5. Interpretation of results and discussion including limitations
- 17.2.6. Application of color tests on known samples by trainee (practical)
- 17.2.7. Application of color tests on unknown samples by trainee (practical)
- 17.2.8. Discussion

17.3. References

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- 17.3.5. "Modern Microcrystal Tests for Drugs", Fulton, C.C., (1969), "Wiley-Interscience, NY
- 17.3.6. "Spot Tests: A Colour Chart Reference for Forensic Chemists", Johns, S. H., Wist, A. A., and Najam, A. R. *Journal of Forensic Sciences*, July 1979
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 - 17.3.9. "Spot Tests in Organic Analysis", Feigl F., Feigl F. and Anger V., Butterworth Heinemann, 7th edition, 2006
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 - 17.3.11. "Spot Test Analysis; Clinical, Environmental, Forensic, and Geochemical Applications", Jungreis E, 2nd edition, Wiley-Interscience, New York, 1984/1997
 - 17.3.12. "Staff Skill Requirements and Equipment Recommendations for Forensic Science Laboratories", United Nations Office on Drugs and Crime, 2011 (link updated oct. 2012)
 - 17.3.13. United Nations Office on Drugs and Crime. (2009). *Guidelines on representative drug sampling* (UNODC & ENFSI DWG, ST/NAR/38). Vienna, Austria: Vienna International Centre.
 - 17.3.14. "Guidance for the Validation of Analytical Methodology and Calibration of Equipment used for Testing of Illicit Drugs in Seized Materials and Biological Specimens - ST/NAR/41", UNODC, 2009
 - 17.3.15. U.S. Pharmacopeia National Formulary, USP XX, 1980

17.4. Assessment

- 17.4.1. Study questions
- 17.4.2. Preparation of color test reagents (Practical)
- 17.4.3. Application of color tests on unknown samples (Practical)
- 17.4.4. Courtroom exercise

18. Stereomicroscopes

18.1. Objectives

- 18.1.1. Knowledge of microscope vs stereoscope
- 18.1.2. Knowledge of light source used
- 18.1.3. Knowledge of what magnification to use per application
- 18.1.4. Knowledge of sample preparation and sample size limitation

18.2. Modes of Instruction

- 18.2.1. Self-directed study through recommended reading
- 18.2.2. (Clarification of questions)
- 18.2.3. Presentation of case studies and demonstrations
- 18.2.4. Practical exercises
- 18.2.5. Discussion

18.3. References

- 18.3.1. Microscope manufacturer's operating manual
- 18.3.2. Saferstein, Richard, Ph.D. *Criminalistics: An Introduction to Forensic Science, Eighth Edition*, Upper Saddle River, NJ: Prentice hall, 2004, pp 175-176.
- 18.3.3. Saferstein, Richard, Ph.D., Editor. *Forensic Science Handbook*. Englewood Cliffs: Prentice Hall, 1982, pp. 416-434.
- 18.3.4. "History of the Microscope" , History-of-the-microscope.org.

18.4. Assessment

- 18.4.1. Selection of samples for analysis on unknown samples (practical)
- 18.4.2. Written examination
- 18.4.3. Oral examination for courtroom exercise (optional)

19. Thin Layer Chromatography (TLC)

19.1. Objectives

- 19.1.1. Knowledge of the principle/theory of Thin Layer Chromatography in drug analysis
 - 19.1.1.1. Awareness of the factors which affect separations (stationary phase, mobile phase, sample, conditions)
 - 19.1.1.2. Knowledge of the criteria for selection of solvent systems, including safety and cost
 - 19.1.1.3. Familiarity with visualization techniques
 - 19.1.1.4. Knowledge of various visualization spray reagents for various applications
 - 19.1.1.5. Awareness of possible problems and likely causes/solutions
 - 19.1.1.6. Knowledge of quality assurance and method validation requirements
- 19.1.2. Knowledge of the principle/theory of Thin Layer Chromatography in drug analysis
 - 19.1.2.1. Familiarity with the TLC equipment and associated operational procedures (pre-treatment of plates, selection of suitable solvent systems, application of samples, running the plates, location procedures, visualization, storage of chromatograms)
 - 19.1.2.2. Ability to design and use multi-development and two-dimensional TLC experiments
 - 19.1.2.3. Ability to resolve issues such as spot overlapping and tailing
 - 19.1.2.4. Practice in the use of high-performance TLC (HPTLC)
 - 19.1.2.5. Experience with preparative techniques
 - 19.1.2.6. Experience in quantitative TLC
 - 19.1.2.7. Ability in the execution of TLC to reference/known samples as well as on drugs most commonly encountered in the illicit traffic
- 19.1.3. Ability to interpret the results obtained
- 19.1.4. Knowledge of the possibilities and limitations of the technique

19.2. Modes of Instruction

- 19.2.1. Studying of suggested references/assignments
- 19.2.2. Clarification on questions
- 19.2.3. Preparation of different development solvents/visualization reagents including review of safety precautions
- 19.2.4. Demonstrations by trainer: execution of TLC, with explanations
- 19.2.5. Interpretation of results and discussion
- 19.2.6. Application of TLC on reference/known samples by trainee
- 19.2.7. Application of TLC on unknown samples by trainee
- 19.2.8. Discussion

19.3. References

- 19.3.1. Canaff, R. (1972). *Basic Training Program for Forensic Drug Chemists*. Washington, DC: U.S. Department of Justice Bureau of Narcotics and Dangerous Drugs.
- 19.3.2. Clarke, E. G. C. (2004). *Clarke's Analysis of Drugs and Poisons in Pharmaceuticals, Body Fluids, and Postmortem Material* (3rd ed., Vol. 1-2). A. C. Moffat, Osselton, M. D., & Widdop, B. (Eds.) Grayslake, IL: Pharmaceutical Press.
- 19.3.3. "Thin Layer Chromatography" - Analytical Chemistry by Open Learning R. Hamilton, S. Hamilton, John Wiley & Sons, Chichester, West Sussex, U.K., 1987 ISBN 0-471-91377-4 (paperback)
- 19.3.4. "Handbook of Thin-Layer Chromatography", Sherma J, Fried B and Sherma S, CRC Press; 3rd Rev&Ex, 2003

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- 19.3.5. "Thin Layer Chromatography: Reagents and Detection Methods", Jork H, Funk W, Fischer W and Wimmer H, Volume 1b, VCH Verlagsgesellschaft mbH, BRD, 1994
 - 19.3.6. "Thin-Layer Chromatography", Stahl, E., 1969. Springer-Verlag, 1969, NY
 - 19.3.7. "Thin-Layer Chromatography", Randerath, Kurt. "Second Edition. New York: Academic Press, 1968
 - 19.3.8. "Thin Layer Chromatography", Bauer, Karin, et. al. Heidelberg, Germany: EM Science, 1991
 - 19.3.9. "Thin-layer chromatographic Rf values of toxicologically relevant substances on standardized systems", Deutsche Forschungsgemeinschaft (DFG) / The International Association of Forensic Toxicologists (TIAFT), 2nd, revised and enlarged edition, 1992.
 - 19.3.10. "Staff Skill Requirements and Equipment Recommendations for Forensic Science Laboratories", United Nations Office on Drugs and Crime, 2011 (link updated oct 2012)
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 - 19.3.12. "Guidance for the Validation of Analytical Methodology and Calibration of Equipment used for Testing of Illicit Drugs in Seized Materials and Biological Specimens - ST/NAR/41", UNODC, 2009

19.4. Assessment

- 19.4.1. Study questions (oral, written)
- 19.4.2. Preparation of reagents (practical)
- 19.4.3. Distribution and application of TLC on unknown samples (practical)
- 19.4.4. Courtroom exercise (mini-mock trial)

20. Gas Chromatography (GC)

20.1. Objectives

- 20.1.1. Learn the theory and operation of the gas chromatograph
- 20.1.2. Learn to tune the mass spectrometer and perform tune evaluations
- 20.1.3. Become familiar with GC/MS software and the procedures for entering data in sequence table
- 20.1.4. Analyze mixtures of substances and identify each component
- 20.1.5. Learn to search available libraries

20.2. Modes of Instruction

- 20.2.1. Self-directed study through recommended reading
- 20.2.2. (Clarification of questions)
- 20.2.3. Demonstrations by trainer: execution of GC and GC/MS analysis, with explanations
- 20.2.4. Interpretation of results and discussion
- 20.2.5. Application of GC and GC/MS on reference/known samples by trainee
- 20.2.6. Application of GC and GC/MS on unknown samples by trainee, qualitative and quantitative determination
- 20.2.7. Discussion

20.3. References

- 20.3.1. Moffat, A.C. editor. *Clarke's Isolation and Identification of Drugs*. London: The Pharmaceutical Press, 1986.
- 20.3.2. Canaff, R. (1972). *Basic Training Program for Forensic Drug Chemists*. Washington, DC: U.S. Department of Justice Bureau of Narcotics and Dangerous Drugs.
- 20.3.3. *Basic Training Program for Forensic Chemists*, U.S. Department of Justice, Drug Enforcement Administration, Office of Science and Technology, pp. 5-31 through 5-47.
- 20.3.4. Stafford, David T., Ph D, "Forensic Capillary Gas Chromatography" in Saferstein, Richard, Ph.D., editor, *Forensic Science Handbook, Volume II*. Englewood Cliffs, J.J.: Prentice Hall, 1988, pp. 38-67.
- 20.3.5. Agilent Technologies GC instrument manuals.
- 20.3.6. Clarke, E. G. C. (2004). *Clarke's Analysis of Drugs and Poisons in Pharmaceuticals, Body Fluids, and Postmortem Material* (3rd ed., Vol. 1-2). A. C. Moffat, Osselton, M. D., & Widdop, B. (Eds.) Grayslake, IL: Pharmaceutical Press.
- 20.3.7. "Gas Chromatography" - Analytical Chemistry by Open Learning, Ian A. Fowles, (Paperback), John Wiley & Sons Ltd, Baffins Lane, Chichester, West Sussex P019, England, 1999
- 20.3.8. "A Practical Guide to the Care, Maintenance and Troubleshooting of Capillary Gas Chromatographic Systems", Rood, Dean, Wiley-VCH, New York, 1999
- 20.3.9. "Modern Practice of Gas Chromatography", Grob RL and Barry EF, New York, Wiley-Interscience; 3rd Ed., 1995
- 20.3.10. "Split and Splitless Injection for Quantitative Gas Chromatography, Concepts, Process, Practical Guidelines, Sources of Error", Grob K, Wiley-VCH, 4th Ed., 2001
- 20.3.11. "Gas Chromatography", Prichard E and Stuart B, Royal Society of Chemistry, 2003
- 20.3.12. "Derivatisation Techniques for Gas Chromatography, Chromatography Today", Poole CF, Poole SK, Elsevier, 1991
- 20.3.13. "Mass Spectrometry – Principles and Applications", Hoffmann, E.de & Stroobant, V., editor, England, Wiley, 2001

- 20.3.14. "Advances in Forensic Applications of Mass Spectrometry", Yinon J, 2004
- 20.3.15. "Chromatographic Separations" - Analytical Chemistry By Open Learning, Peter A. Sewell, Brian Clarke, David Kealey, John Wiley & Sons Ltd, 1988
- 20.3.16. "Quantitative analysis using chromatographic techniques" - Analytical Chemistry By Open Learning, Elena Katz, John Wiley & Sons Ltd, 1987
- 20.3.17. "Mass Spectrometry – Analytical Chemistry by open Learning" - 2nd edition, James Barker, John Wiley & Sons Ltd, University of Greenwich, 1999
- 20.3.18. "Controlled Substances Training Manual", Virginia Department of Forensic Science, DFS Document 221-D200, Revision 1, February 2009
- 20.3.19. ENFSI DWG Mass Spectral Library
- 20.3.20. "Instrumental Data for Drug Analysis", Terry Mills III and J.Conrad Robertson, second edition, 1993
- 20.3.21. "Controlled Substances Procedures Manual", Virginia Department of Forensic Science, DFS Document 221-D100, Revision 8, Augusta 2012
- 20.3.22. "Staff Skill Requirements and Equipment Recommendations for Forensic Science Laboratories", United Nations Office on Drugs and Crime, 2011 (link updated oct. 2012)
- 20.3.23. United Nations Office on Drugs and Crime. (2009). *Guidelines on representative drug sampling* (UNODC & ENFSI DWG, ST/NAR/38). Vienna, Austria: Vienna International Centre.
- 20.3.24. "Guidance for the Validation of Analytical Methodology and Calibration of Equipment used for Testing of Illicit Drugs in Seized Materials and Biological Specimens - ST/NAR/41", UNODC, 2009
- 20.3.25. GC instrumental manuals of laboratory.
- 20.3.26. GC/MS instrumental manuals of laboratory

20.4. Assessment

- 20.4.1. Study questions (oral, written)
- 20.4.2. Preparation and GC and GC/MS qualitative analysis of unknown samples (practical)
- 20.4.3. Preparation and GC and GC/MS quantitative analysis of unknown samples (practical)
- 20.4.4. Courtroom exercise (final mock trial)

21. Gas Chromatography/Mass Spectrometry (GC/MS)

21.1. Objectives

- 21.1.1. Learn the theory of gas chromatography/mass spectrometry (GC/MS)
 - 21.1.1.1. Awareness of the mechanism of separations, including support materials, stationary phases, carrier gas and operating temperature, and relevant criteria
 - 21.1.1.2. Familiarity with the various instrumental components and their functions, including injection port, column and detectors (FID, NPD, ECD, MS)
 - 21.1.1.3. Familiarity with the MS components and their functions, including sample inlet, ionisation, ion separation, ion detection and amplification, output of results
 - 21.1.1.4. Knowledge of the theory and mechanism of GC/MS as an identification technique, fragmentation process and spectra interpretation
 - 21.1.1.5. Knowledge of derivatisation techniques, advantages and disadvantages
 - 21.1.1.6. Knowledge of qualitative and quantitative determinations using GC
 - 21.1.1.7. Awareness of common operational problems and causes, pitfalls and troubleshooting, preventive maintenance
 - 21.1.1.8. Knowledge of concept of quality assurance and method validation
- 21.1.2. Ability in the application of GC and GC/MS in drug analysis
 - 21.1.2.1. Ability to prepare samples and avoid cross contamination
 - 21.1.2.2. Familiarity with/practice in the GC instrumentation and software
 - 21.1.2.3. Familiarity with/practice in the GC/MS instrumentation and software
 - 21.1.2.4. Familiarity with the operational procedures, including control of instrument
 - 21.1.2.5. Knowledge of choice criteria and ability to determine suitable conditions and to design experiments aiming at optimum separations
 - 21.1.2.6. Practice in the application of GC and GC/MS methodology for qualitative and quantitative analysis of drugs most commonly encountered
- 21.1.3. Capacity of interpretation of the results obtained. Ability to perform library search (GC/MS) and interpret spectra
- 21.1.4. Understanding the possibilities and limitations of the technique
- 21.1.5. Become familiar with Agilent ChemStation® software and features of the MS including parametric retrieval, library searches, and ion extraction

21.2. Modes of Instruction

- 21.2.1. Self-directed study through recommended reading
- 21.2.2. (Clarification of questions)
- 21.2.3. Demonstrations by trainer: execution of GC and GC/MS analysis, with explanations
- 21.2.4. Interpretation of results and discussion
- 21.2.5. Application of GC and GC/MS on reference/known samples by trainee
- 21.2.6. Application of GC and GC/MS on unknown samples by trainee, qualitative and quantitative determination
- 21.2.7. Discussion

21.3. References

- 21.3.1. Moffat, A.C., editor. *Clarke's Isolation and Identification of Drugs*. London: The Pharmaceutical Press, 1986, pp. 251-263.
- 21.3.2. Canaff, R. (1972). *Basic Training Program for Forensic Drug Chemists*. Washington, DC: U.S. Department of Justice Bureau of Narcotics and Dangerous Drugs.
- 21.3.3. *Basic Training Program for Forensic Chemists*, US Department of Justice, Drug Enforcement Administration, Office of Science and Technology, pp. 5-61 through 5-72.
- 21.3.4. Saferstein, Richard. "Forensic Applications of Mass Spectrometry". *Forensic Science Handbook, Volume I*. Englewood Cliffs, N.J.: Prentice hall, 1982, pp. 92-138.

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- 21.3.5. Agilent MS instrument manuals
 - 21.3.6. Clarke, E. G. C. (2004). *Clarke's Analysis of Drugs and Poisons in Pharmaceuticals, Body Fluids, and Postmortem Material* (3rd ed., Vol. 1-2). A. C. Moffat, Osselton, M. D., & Widdop, B. (Eds.) Grayslake, IL: Pharmaceutical Press.
 - 21.3.7. "Gas Chromatography" - Analytical Chemistry by Open Learning, Ian A. Fowles, (Paperback), John Wiley & Sons Ltd, Baffins Lane, Chichester, West Sussex P019, England, 1999
 - 21.3.8. "A Practical Guide to the Care, Maintenance and Troubleshooting of Capillary Gas Chromatographic Systems", Rood, Dean, Wiley-VCH, New York, 1999
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 - 21.3.11. "Gas Chromatography", Prichard E and Stuart B, Royal Society of Chemistry, 2003
 - 21.3.12. "Derivatisation Techniques for Gas Chromatography, Chromatography Today", Poole CF, Poole SK, Elsevier, 1991
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 - 21.3.14. "Advances in Forensic Applications of Mass Spectrometry", Yinon J, 2004
 - 21.3.15. "Chromatographic Separations" - Analytical Chemistry By Open Learning, Peter A. Sewell, Brian Clarke, David Kealey, John Wiley & Sons Ltd, 1988
 - 21.3.16. "Quantitative analysis using chromatographic techniques" - Analytical Chemistry By Open Learning, Elena Katz, John Wiley & Sons Ltd, 1987
 - 21.3.17. "Mass Spectrometry – Analytical Chemistry by open Learning" - 2nd edition, James Barker, John Wiley & Sons Ltd, University of Greenwich, 1999
 - 21.3.18. ENFSI DWG Mass Spectral Library
 - 21.3.19. "Instrumental Data for Drug Analysis", Terry Mills III and J.Conrad Robertson, second edition, 1993
 - 21.3.20. "Staff Skill Requirements and Equipment Recommendations for Forensic Science Laboratories", United Nations Office on Drugs and Crime, 2011 (link updated oct. 2012)
 - 21.3.21. United Nations Office on Drugs and Crime. (2009). *Guidelines on representative drug sampling* (UNODC & ENFSI DWG, ST/NAR/38). Vienna, Austria: Vienna International Centre.
 - 21.3.22. "Guidance for the Validation of Analytical Methodology and Calibration of Equipment used for Testing of Illicit Drugs in Seized Materials and Biological Specimens - ST/NAR/41", UNODC, 2009
 - 21.3.23. GC instrumental manuals of laboratory.
 - 21.3.24. GC/MS instrumental manuals of laboratory

21.4. Assessment

- 21.4.1. Study questions (oral, written)
- 21.4.2. Preparation and GC and GC/MS qualitative analysis of unknown samples (practical)
- 21.4.3. Preparation and GC and GC/MS quantitative analysis of unknown samples (practical)
- 21.4.4. Courtroom exercise (final mock trial)

22. High Performance Liquid Chromatography including Liquid Chromatography/Mass Spectrometry (LC/MS)

22.1. Objectives

- 22.1.1. Knowledge of the principle/theory of HPLC including LC/MS in drug analysis
 - 22.1.1.1. Knowledge of the mechanism of separations, including stationary phases (columns, criteria of choice), mobile phase (types, uses, composition) and temperature
 - 22.1.1.2. Familiarity with the various instrumental components and their functions including injections port, column and detector (DAD, MS).
 - 22.1.1.3. Familiarity with the MS components and their functions, including sample inlet, ionisation, ion separation, ion detection and amplification, output of results
 - 22.1.1.4. Awareness of the mechanism of HPLC incl. LC/MS as an identification technique
 - 22.1.1.5. Qualitative and quantitative determinations using HPLC and LC/MS
 - 22.1.1.6. Awareness of common operational problems and causes, pitfalls and troubleshooting, preventive maintenance
 - 22.1.1.7. Knowledge of quality assurance and method validation requirements
- 22.1.2. Knowledge of the application of HPLC and LC/MS in drug analysis
 - 22.1.2.1. Familiarity with the HPLC and LC/MS instrumentation and software
 - 22.1.2.2. Familiarity with the operational procedures including control of instrument
 - 22.1.2.3. Ability to design experiments aiming at selecting operating conditions for optimum separations
 - 22.1.2.4. Practice in the application of HPLC and LC/MS methodology in the qualitative and quantitative analysis of drugs most commonly encountered
- 22.1.3. Capacity of understanding and interpretation of the results obtained
- 22.1.4. Ability to perform library search (LC/MS) and interpret spectra
- 22.1.5. Become familiar with Waters Empower® software and features of the LC
- 22.1.6. Understanding the possibilities and limitations of the technique

22.2. Modes of Instruction

- 22.2.1. Self-directed study through recommended reading
- 22.2.2. (Clarification of questions)
- 22.2.3. Demonstrations by trainer: execution of HPLC and LC/MS analysis, with explanations
- 22.2.4. Interpretation of results and discussion
- 22.2.5. Application of HPLC and LC/MS on reference/known samples by trainee
- 22.2.6. Application of HPLC and LC/MS on unknown samples by trainee, qualitative and quantitative determination
- 22.2.7. Discussion

22.3. References

- 22.3.1. Canaff, R. (1972). *Basic Training Program for Forensic Drug Chemists*. Washington, DC: U.S. Department of Justice Bureau of Narcotics and Dangerous Drugs.
- 22.3.2. Clarke, E. G. C. (2004). *Clarke's Analysis of Drugs and Poisons in Pharmaceuticals, Body Fluids, and Postmortem Material* (3rd ed., Vol. 1-2). A. C. Moffat, Osselton, M. D., & Widdop, B. (Eds.) Grayslake, IL: Pharmaceutical Press.
- 22.3.3. "High Performance Liquid Chromatography" - Analytical Chemistry by Open Learning, 2nd Edition, S.Lindsay, John Wiley & Sons, Chichester, West Sussex, U.K., 1992, ISBN 0-471-93115-2 (paperback)
- 22.3.4. "High-Performance Liquid Chromatography in Forensic Chemistry", Lurie IS, 1983

- 22.3.5. "Liquid Chromatography/Mass Spectrometry – Application in Agricultural, Pharmaceutical, and Environmental Chemistry", Mark A. Brown, Editor, American Chemical Society, Washington DC, 1990
- 22.3.6. "Chromatographic Separations" - Analytical Chemistry By Open Learning Peter A. Sewell, Brian Clarke, David Kealey, John Wiley & Sons Ltd, 1988
- 22.3.7. "Quantitative analysis using chromatographic techniques" - Analytical Chemistry By Open Learning, Elena Katz, John Wiley & Sons Ltd, 1987
- 22.3.8. "Mass Spectrometry – Principles and Applications", Hoffmann, E.de & Stroobant, V., editor, England, Wiley, 2001
- 22.3.9. "Mass Spectrometry" – Analytical Chemistry by open Learning - 2nd edition, James Barker, John Wiley & Sons, University of Greenwich, 1999
- 22.3.10. "Instrumental Data for Drug Analysis", Terry Mills III and J.Conrad Robertson, second edition, 1993. – LC/MS
- 22.3.11. "Liquid Chromatography/Mass Spectrometry, Systems and Applications", W.H. Mc Fadden, J.Chromatogr. Sci., 1980, 18, 97-102
- 22.3.12. "Staff Skill Requirements and Equipment Recommendations for Forensic Science Laboratories", UNODC, 2011 (link updated oct 2012)
- 22.3.13. United Nations Office on Drugs and Crime. (2009). *Guidelines on representative drug sampling* (UNODC & ENFSI DWG, ST/NAR/38). Vienna, Austria: Vienna International Centre.
- 22.3.14. "Guidance for the Validation of Analytical Methodology and Calibration of Equipment used for Testing of Illicit Drugs in Seized Materials and Biological Specimens - ST/NAR/41", UNODC, 2009
- 22.3.15. HPLC instrumental manuals of laboratory
- 22.3.16. LC/MS instrumental manuals of laboratory
- 22.3.17. Analysis of illicit diamorphine preparations by high-pressure liquid chromatography. Journal of Chromatography. 1975, 104(1), 205-10.

22.4. Assessment

- 22.4.1. Perform analysis of known samples (Practical)
- 22.4.2. Perform quantitation of known samples (Practical)
- 22.4.3. Perform extraction and analysis of unknown samples (Practical)
- 22.4.4. Written examination

23. Ultraviolet/Visible Spectroscopy (UV/VIS)

23.1. Objectives

- 23.1.1. Learn the theory of UV/VIS spectrophotometry in drug analysis

- 23.1.1.1. Theory and mechanism of molecular light absorption and electronic transitions. Awareness of the electromagnetic spectrum.
- 23.1.1.2. Parameters that define electromagnetic radiation (frequency, wavelength, wavenumber)
- 23.1.1.3. Laws of absorption : The Beer-Lambert Law
- 23.1.1.4. Mechanism of UV/VIS as an identification technique, including limitations
- 23.1.1.5. The influence of solvents and PH on spectra (wavelength maxima and band intensities)
- 23.1.1.6. Mechanism of UV/VIS as an quantitation technique (basic laws, single components, multi-component systems, colourimetric measurements, difference spectrophotometry, derivative spectrophotometry)
- 23.1.1.7. Knowledge of quality assurance and method validation requirements
- 23.1.2. Knowledge of the application of UV/VIS in drug analysis
 - 23.1.2.1. Instrumentation (colourimeters, single-beam spectrophotometers, double-beam spectrophotometers, rapid-scanning spectrophotometers, absorption cells)
 - 23.1.2.2. Preparation and handling of various kinds of samples
 - 23.1.2.3. Application of UV/VIS methodology in the qualitative analysis of drugs
 - 23.1.2.4. Application of UV/VIS methodology in the quantitative analysis of drugs
 - 23.1.2.5. Awareness of common operational problems and causes, troubleshooting, preventive maintenance
- 23.1.3. Familiarity with the UV/VIS instrumentation and software
- 23.1.4. Familiarity with the operational procedures
- 23.1.5. Ability to select operating parameters aiming at best results
- 23.1.6. Practice in the application of UV/VIS methodology in the analysis of drugs most commonly encountered
- 23.1.7. Understanding the advantages and limitations of the technique
- 23.1.8. Capacity of interpretation of the results obtained
- 23.1.9. Experience in quantitative UV/VIS analysis
- 23.1.10. Become familiar with Varian Cary® software and features
- 23.1.11. Become familiar with sources for identification such as Clarke and Mills
- 23.1.12. Learn how contaminants can affect UV analysis
- 23.1.13. Learn extraction techniques for UV analysis
- 23.1.14. Learn the application of UV analysis for quantitation

23.2. Modes of Instruction

- 23.2.1. Self-directed study through recommended reading
- 23.2.2. (Clarification of questions)
- 23.2.3. Demonstrations by trainer: execution of UV/VIS analysis, with explanations
- 23.2.4. Interpretation of results and discussion
- 23.2.5. Application of UV/VIS on reference/known samples by trainee
- 23.2.6. Application of UV/VIS on unknown samples by trainee, qualitative and quantitative determination
- 23.2.7. Discussion

23.3. References

- 23.3.1. UV/Vis Absorption Spectroscopy Tutorial
<http://teaching.shu.ac.uk/hwb/chemistry/tutorials/molspec/uvvisab3.htm>
- 23.3.2. Visible and UV Spectroscopy
<http://www.cem.msu.edu/~reusch/VirtualText/Spectrpy/UV-Vis/spectrum.htm>
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 - 23.3.6. "UV Spectroscopy, Techniques, Instrumentation and Data Handling", Clark BJ, Frost T and Russell MA, Springer, 1993
 - 23.3.7. "Spectrometric Identification of Organic Compounds", Silverstein RM, Webster FX and Kiemle D, 7th Ed., New York, Wiley, 2005
 - 23.3.8. "Instrumental Data for Drug Analysis", Terry Mills III and J. Conrad Robertson, second edition, 1993.
 - 23.3.9. "Staff Skill Requirements and Equipment Recommendations for Forensic Science Laboratories", UNODC, 2011 (link updated oct. 2012)
 - 23.3.10. United Nations Office on Drugs and Crime. (2009). *Guidelines on representative drug sampling* (UNODC & ENFSI DWG, ST/NAR/38). Vienna, Austria: Vienna International Centre.
 - 23.3.11. "Guidance for the Validation of Analytical Methodology and Calibration of Equipment used for Testing of Illicit Drugs in Seized Materials and Biological Specimens - ST/NAR/41", UNODC, 2009
 - 23.3.12. UV/VIS instrumental manuals of laboratory

23.4. Assessment

- 23.4.1. Study questions (oral, written)
- 23.4.2. Sample preparation and UV/VIS qualitative analysis of unknown samples (practical)
- 23.4.3. Sample preparation and UV/VIS quantitative analysis of unknown samples (practical)
- 23.4.4. Courtroom exercise (mini-mock trial)

24. Infrared Spectroscopy (FTIR)

24.1. Objectives

- 24.1.1. Learn the theory of FTIR in drug analysis
 - 24.1.1.1. Knowledge of the electromagnetic spectrum
 - 24.1.1.2. Knowledge of the theory and mechanism of absorption and of vibrational and rotational spectroscopy
 - 24.1.1.3. The Beer-Lambert Law
 - 24.1.1.4. Knowledge of the mechanism of IR as an identification technique, (characteristic IR group frequencies and structure/spectra correlations)
 - 24.1.1.5. Fourier transform infrared spectroscopy (FTIR) and the different techniques (KBr, ATR etc)
 - 24.1.1.6. Familiarity with the various instrumental components and their functions
 - 24.1.1.7. Awareness of common operational problems and causes, troubleshooting, preventive maintenance
 - 24.1.1.8. Knowledge of quality assurance and method validation requirements
- 24.1.2. Knowledge of the application of IR in drug analysis
 - 24.1.2.1. Familiarity with the (FT)IR instrumentation and software (dispersive and interferometric spectrophotometers, data processing)
 - 24.1.2.2. Familiarity with the operational procedures (sample purification and preparation, identification and interpretation of spectra)
 - 24.1.2.3. Practice in the application of IR methodology in the qualitative and quantitative analysis of drugs most commonly encountered
 - 24.1.2.4. Proper use of spectral manipulations (e.g. subtraction, baseline correction, library searching)
 - 24.1.2.5. Learn techniques associated with FTIR analysis, e.g. DRIFTS, ATR, KBr pellets
- 24.1.3. Ability to select operating parameters aiming at best results
- 24.1.4. Practice in the preparation and handling of various kinds of samples
- 24.1.5. Practice in the application of IR methodology in the analysis of drugs most commonly encountered
- 24.1.6. Understanding the advantages and limitations of the technique
- 24.1.7. Capacity of interpretation of the results obtained
- 24.1.8. Experience in quantitative IR analysis
- 24.1.9. Become familiar with Thermo-Nicolet OMNIC® software and features including baseline subtraction, library searching, data storage, and printing options
- 24.1.10. Become familiar with sources for identification such as Clarke and Mills
- 24.1.11. Learn extraction techniques for FTIR analysis

24.2. Modes of Instruction

- 24.2.1. Self-directed study through recommended reading
- 24.2.2. (Clarification of questions)
- 24.2.3. Demonstrations by trainer: execution of FTIR analysis, with explanations
- 24.2.4. Interpretation of results and discussion
- 24.2.5. Application of FTIR on reference/known samples by trainee
- 24.2.6. Application of FTIR on unknown samples by trainee, qualitative and quantitative determination
- 24.2.7. Discussion

24.3. References

- 24.3.1. Clarke, E. G. C. (2004). *Clarke's Analysis of Drugs and Poisons in Pharmaceuticals, Body Fluids, and Postmortem Material* (3rd ed., Vol. 1-2). A. C. Moffat, Osselton, M. D., & Widdop, B. (Eds.) Grayslake, IL: Pharmaceutical Press.
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- 24.3.3. Thermo Nicolet Instrument Manuals
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- 24.3.13. "Controlled Substances Training Manual", Virginia Department of Forensic Science, DFS Document 221-D200, Revision 1, February 2009
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- 24.3.15. "Instrumental Data for Drug Analysis", Terry Mills III and J.Conrad Robertson, second edition, 1993.
- 24.3.16. "Staff Skill Requirements and Equipment Recommendations for Forensic Science Laboratories", UNODC, 2011 (link updated to last revision of document - oct. 2012)
- 24.3.17. United Nations Office on Drugs and Crime. (2009). *Guidelines on representative drug sampling* (UNODC & ENFSI DWG, ST/NAR/38). Vienna, Austria: Vienna International Centre.
- 24.3.18. "Guidance for the Validation of Analytical Methodology and Calibration of Equipment used for Testing of Illicit Drugs in Seized Materials and Biological Specimens - ST/NAR/41", UNODC, 2009
- 24.3.19. IR instrumental manuals of laboratory

24.4. Assessment

- 24.4.1. Study questions (oral, written)

- 24.4.2. Sample preparation and IR qualitative analysis of known samples (practical)
- 24.4.3. Sample preparation and IR quantitative analysis of unknown samples (practical)
- 24.4.4. Courtroom exercise (final mock trial)

25. Separations and Extractions

25.1. Objectives

- 25.1.1. Knowledge of the principle/theory of Separations and Extractions in drug analysis
 - 25.1.1.1. Awareness of the factors which affect separations
 - 25.1.1.2. Knowledge of the criteria for selection of solvent systems, including safety and cost
 - 25.1.1.3. Familiarity with extraction techniques
 - 25.1.1.4. Awareness of possible problems and likely causes/solutions
 - 25.1.1.5. Use of solubility to separate mixtures of drugs and diluents
 - 25.1.1.6. Definition of pKa and the Henderson Hasselbach equation
 - 25.1.1.7. Basic drug extractions using aqueous/organic solvents
 - 25.1.1.8. Acidic drug extractions using aqueous/organic solvents
 - 25.1.1.9. Amphoteric drug extractions using aqueous/organic solvents
 - 25.1.1.10. Neutral drug extractions using aqueous/organic solvents
 - 25.1.1.11. Specialty (difficult) type extractions
- 25.1.2. Knowledge of the application of Solid Phase extraction (SPE) in drug analysis
- 25.1.3. Knowledge of chromatographic separation techniques
 - 25.1.3.1. Use of preparative column
 - 25.1.3.2. Use of Silica and Fluorasil columns
 - 25.1.3.3. Column preparation, loading and eluting
- 25.1.4. Knowledge of the possibilities and limitations of the technique
- 25.1.5. Learn the acid/base properties of drugs
- 25.1.6. Learn different extraction and separation methods

25.2. Modes of Instruction

- 25.2.1. Self-directed study through recommended reading
- 25.2.2. (Clarification of questions)
- 25.2.3. Preparation of different extraction solvent reagents including review of safety precautions
- 25.2.4. Demonstrations by trainer: execution of extraction techniques, with explanations
- 25.2.5. Interpretation of results and discussion
- 25.2.6. Application of extractions on reference/known samples by trainee
- 25.2.7. Application of extractions on unknown samples by trainee
- 25.2.8. Discussion

25.3. References

- 25.3.1. Moffat, A.C., editor. *Clarke's Isolation and Identification of Drugs*. London: The Pharmaceutical Press, 1986.
- 25.3.2. Clarke, E.G.C., *Isolation and Identification of Drugs*, London: The Pharmaceutical Press, 1972, Vol. 1, 2.
- 25.3.3. Higuchi, T. et al. "Ion Pair Extraction of Pharmaceutical Amines" *Analytical Chemistry*, Vol. 39, 1967, p. 974.
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 - 25.3.14. The Merck Index, 14th or Current Edition, Budavari, Susan, Ed., Merck and Co., Inc., General reference.

25.4. Assessment

- 25.4.1. Study questions (oral, written)
- 25.4.2. Sample preparation and separation of known samples (practical)
- 25.4.3. Sample preparation and separation of unknown samples (practical)
- 25.4.4. Courtroom exercise (Final mock trial)

Clandestine Laboratory Field Investigations

26. Common Clandestine Laboratories

26.1. Objectives

- 26.1.1. Become familiar with common clandestine laboratory synthesis methods
- 26.1.2. Knowledge of the substances used in the clandestine production/manufacture of narcotic drugs and psychotropic substances
- 26.1.3. Knowledge of the production/manufacture of controlled substances
- 26.1.4. Knowledge of the investigation and dismantling of clandestine laboratories

26.2. Modes of Instruction

- 26.2.1. Self-directed study through recommended reading
- 26.2.2. Accompany chemist at laboratory sites to observe functions
- 26.2.3. Practical exercise on investigation, risk assessment, risk management, processing of the laboratory, registration, documenting, sampling, disposal
- 26.2.4. Discussion

26.3. References

- 26.3.1. Forensic Division Safety Manual safety guidelines for investigating and dismantling a clandestine lab
- 26.3.2. Weaver, K. and Yeung, E. An Analyst's Guide to the Investigation of Clandestine Laboratories, 3rd edition. Health Protection Branch, Ontario Region Health Canada, 1995.
- 26.3.3. Clandestine Lab Basic Guide, presented at the 12th Annual Clandestine Laboratory Investigating Chemists Training Seminar, 2002.
- 26.3.4. Ely, Roger, et al. A Review of the Syntheses and Analyses of Phenyl-2-propanone, Amphetamine, and Methamphetamine. Clandestine Laboratory Investigating Chemists, 1995.
- 26.3.5. Clandestine Laboratory Investigating Chemists monographs.
- 26.3.6. Strike. Total Synthesis II, San Antonio, TX: Panda Ink, 1999.
- 26.3.7. Uncle Fester. Advanced Techniques of Clandestine Psychedelic & Amphetamine Manufacture. Port Townsend, WA: Loompanics Unlimited, 1988.
- 26.3.8. "Understanding clandestine synthetic drugs", UNODC, June 2001
- 26.3.9. "Data Sheets on Substances Frequently Used in the Illicit Manufacture of Narcotic Drugs or Psychotropic Substances", SCITEC/9/REV.2, 2009 (in preparation)
- 26.3.10. "Clandestine Manufacture of Substances under International Control", UNODC, ST/NAR/10/Rev.2, August 1998
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- 26.3.12. "Clandestine Laboratory Guide for Agents and Chemists", United States Department of Justice, Drug Enforcement Administration, Office of Forensic Sciences
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- 26.3.14. Canaff, R. (1972). *Basic Training Program for Forensic Drug Chemists*. Washington, DC: U.S. Department of Justice Bureau of Narcotics and Dangerous Drugs.

- 26.3.15. "DRCHIS: Drugs geRelateerd CHemicalien Informatie Systeem", A. Elissen, M.L. Hordijk, Dutch National Criminal Intelligence Division, May 1999
- 26.3.16. "Manual on the production of Synthetic Drugs", Europol, The Hague, July 1999
- 26.3.17. "European Union Training Course for Trainers on the combating of Illicit Synthetic Drugs Laboratories, Course Standard", Europol, The Hague, 1999
- 26.3.18. "Forensic Investigation of Clandestine Laboratories", Donnell RC, CRC Press, 2004.
- 26.3.19. "Advanced Techniques of Clandestine Psychedelic and Amphetamine Manufacture", Uncle Fenster, Loompanics Unlimited, 1998.

26.4. Assessment

- 26.4.1. Study questions
- 26.4.2. Practical exercise in a simulated environment of a clandestine laboratory :
Investigation, risk assessment, risk management, processing of the laboratory,
registration, documenting, sampling
- 26.4.3. Courtroom exercise (mini-mock trial)