FORENSIC CHEMISTRY DRUG TRAINING PROGRAM

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Introduction

Purpose

The purpose of this manual is to provide uniform training for entry-level forensic drug chemists in order to maintain the performance of the laboratory. Quality training also plays a role in the obligation to provide reliable results to customers. The goal of training a new chemist is to develop the knowledge of drugs and their properties and develop their skills and abilities in wet chemistry and instrumental analysis. This work follows SWGDRUG and ENFSI guidelines for training to maintain a standard of professional competency.

Training will be conducted through listed readings, one-on-one instruction, online resources, study questions, and practical exercises. Listed references are not intended to be exhaustive, and may be expanded or abridged as necessary. Assessments of competency upon completion of modules will include written and/or oral exams, and a formal mock trial. (ASCLD/LAB 5.2.5)

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;
- Ability to perform accurate forensic analysis independently and proficiently; and
- Ability to skillfully present and defend analytical findings in courts of records.

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.

This program aims to give the trainee information on the topics below in order to successfully provide technical and scientific support.

- Background on drugs of abuse (e.g. control status, chemical and physical characteristics)
- Evidence handling procedures (safety and security, sampling, uncertainty, LIMS)
- Evidence analysis (techniques, methodologies, instrumentation)
- Quality Assurance
- Clandestine laboratory investigations
- Ethics
- Court testimony

In order to guide the trainee through the training program and ensure that the material is thoroughly covered and understood, there are various modes of instruction, references, and assessments included in the outline.

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
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. Although it’s not considered part of the training program, continuing professional development should be ongoing.

Overview

There are two major divisions of training in drug analysis. The first division is marihuana identification. Marihuana identification requires the chemist to use the stereomicroscope to identify the physical characteristics of the marihuana 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.

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
- Solubility and Extractions
- Microscopy
- Spectrophotometry (Ultraviolet and Infrared)
- Chromatography
- Mass Spectrometry
• Chemical Characterization
• 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).

*(Structure the Training Program to follow the City of Austin Training Record.)*

Each module includes objectives for learning, definitions, and related literature references to guide the trainee through the material. 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, analysis of known and unknown samples, and written and/or oral examinations. *(ASCLD/LAB 5.2.5)*

Throughout the training period, the trainee will assist with casework; only under the direct supervision of a qualified examiner to familiarize the trainee with different forms of case evidence, packaging, applied analytical techniques and note-taking.

*Add statement for structure of training. ASCLD/LAB wants to see curriculum, tests taken as a demonstration of training, skills and experience. ASCLD/LAB 5.2.5*

A written competency examination will be conducted following the successful completion of the marihuana and drug analysis blocks of instruction. Case samples will be selected to evaluate the trainee’s competency in applying techniques and procedures to mock casework 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. *(ASCLD/LAB 5.2.1.1 states procedures are needed for retraining and maintenance of skills and expertise.)*

**Assessments and Documentation**

The progress and completion of each module will be documented on the City of Austin HR Individual Career Progression Training Record. The trainee’s successful completion of a competency test will be recorded on the Division Employee Authorization Form; 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 training coordinator for review. Upon completion of the written competency examinations for marihuana and drug analysis, the trainee will be authorized by the Laboratory Director to perform supervised casework in the applicable area(s) of analysis. The trainee will be authorized for independent casework in these areas after the final mock trial. *(ASCLD/LAB 5.2.5)* At that point, the analyst may have independent access to unsealed evidence to separate and analyze samples, compile data, and produce reports for court or investigative purposes.

**Professional Development**

Analysts should continue their professional development by aiming to complete at least twenty hours of training every year. Acceptable forms of training include *(SWGDRUG 3.4):*

• Chemistry or instrumental courses at post-secondary education level
• Instrument operation or maintenance courses taught by vendors
• In-service classes conducted by the employer
• Current literature review
• In-service training taught by external provided (e.g. DEA Forensic Chemist Seminar)
• Clandestine Laboratory Safety Certification training and subsequent annual renewal course
• Participation in relevant scientific meetings or conferences (e.g. delivering oral or poster presentation, attending a workshop, providing reports on conferences)

Additionally, membership in regional or national forensic organizations is encouraged, and certification by the American Board of Criminalistics is desirable.
Introduction

This section of the training will focus on the structures, properties, and basic pharmacology of drugs of abuse…

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

1.3.11. Martindale The Extra Pharmacopoeia (Reynolds) - Verify

1.4. Assessment

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

2.1. Objectives

2.1.1. Learn the penalty groups for controlled substances in Texas
2.1.2. Learn the schedules for controlled substances in Texas
2.1.3. Become familiar with the Federal Analog Act of 1986

2.2. Modes of Instruction

2.2.1. Self-directed study through recommended reading
2.2.2. Discussion, Clarification of questions

2.3. References

2.3.1. 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.

2.3.2. Drug Enforcement Agency, Controlled Substances by Alphabetical Order, retrieved from www.deadiversion.usdoj.gov/schedules/alpha/alphabetical.htm

2.3.3. U.S. Controlled Substance Act, Title 21 Chapter 13 found at www.usdoj.gov/dea/pubs/csa.html


2.3.6. 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

2.3.7. 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

2.4. Assessment

2.4.1. Mock casework
2.4.2. Oral and/or written examination
2.4.3. Courtroom exercise (final mock trial)
2. Cannabis

2.1. Objectives

2.1.1. Description of the cannabis plant including names and synonyms, botany, physical appearance, morphological, microscopic and chemical characteristics, herbal products, cannabis resin, and liquid cannabis

2.1.2. Cultivation of cannabis plant (indoor/outdoor/industrial production, harvesting, yield)

2.1.3. Production of illicit cannabis products (herbal/resin/liquid cannabis)

2.1.4. Pharmacology of cannabis products

2.1.5. Legal aspects including state and federal

2.1.6. Familiarity with Cannabis Receptor Agonists (cannabinomimetic compounds, e.g. ‘spice’ products), including legal aspects

2.1.7. Familiarity with the protocol (tech manual) for the analysis of illicit cannabis products (including sampling, physical examination, microscopy, extraction, color tests, GC/MS, LC/MS, analytical challenges, and special pitfalls)

2.1.8. Ability to perform identification of marihuana

2.2. Modes of Instruction

2.2.1. Self-directed study through recommended reading

2.2.2. Preparation of samples and of analysis by trainer, with explanations

2.2.3. Interpretation of results and discussion including limitations

2.2.4. Application of qualitative analysis on known samples by trainee

2.2.5. Application of qualitative analysis on unknown samples by trainee

2.2.6. Discussion, Clarification of questions

2.3. References


2.3.3. "Training Manual on Drugs", Texas Dept. of Public Safety Crime Laboratory.


2.3.7. Manual on the cultivation of Cannabis (Europol, June 2000)

2.3.8. Clandestine Laboratory Guide for Agents and Chemists (DEA)


2.3.13. Analysis of Drugs Manual (DEA)

2.3.14. The Analysis of Controlled Substances (Cole, Wiley)


2.3.21. AOAC Methods (1980) Section 40.012 and 40.013 (page 686)


2.3.31. Brief Note on the Response of Some Essential Oils and Extracts of Vegetable Origin to the Duquenois-Levine Test for Cannabis (JFS, 1971)


2.3.36. Forensic Chemistry Section, Procedures Manual, Analysis Notes: Marihuana


2.3.38. The Merck Index


2.3.40. "Understanding the ‘Spice’ phenomenon" (EMCDDA, 2009)

2.3.41. “Synthetic cannabinoids and Spice” (EMCDDA)

2.4. Assessment

2.4.1. Written examination
2.4.2. Preparation of samples and reagents (practical)
2.4.3. Distribution and application of analysis on unknown samples (practical)
2.4.4. Courtroom exercise (mock trial, optional)
3. Amphetamine Type Stimulants (ATS)

3.1. Objectives

3.1.1. Learn the classification and respective definitions
3.1.2. Learn the description of compounds, physical and chemical characteristics, stereochemistry
3.1.3. Become familiar with non-ring substituted amphetamines (e.g. amphetamine, methamphetamine, cathine, cathinone, methcathinone, fenetylline)
3.1.4. Become familiar with methylenedioxy- substituted amphetamines (e.g. MD, MDMA, MDEA, FLEA, MBDB)
3.1.5. Become familiar with other ring substituted amphetamines (also in section "Hallucinogens")
   3.1.5.1. – 2,4,5-ring substituted phenethylamines (e.g. 2C-B, 2C-T, WC-T-2, 2C-T-7, 2C-C, 2C-I)
   3.1.5.2. – 2,4,5-ring substituted amphetamines (e.g. TMA-2, STP/DOM, DOB, DOC, DOI, DOET)
   3.1.5.3. Other ring substitution patterns (phenethylamines and amphetamines) (e.g. Mescaline, PMA, PMMA, DMA, TMA, 4-MTA)
3.1.6. Learn the illicit ATS manufacture, including the synthesis of amphetamine, methamphetamine, and rung-substituted ATS (e.g. XTC, etc)
3.1.7. Learn the pharmacology of ATS
3.1.8. Learn the legal aspects concerning ATS in state and national legislation
3.1.9. 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)
3.1.10. Become familiar with additional analytical techniques for the analysis of ATS
3.1.11. Perform identification of ATS in illicit materials
3.1.12. Perform quantification of ATS in illicit materials

3.2. Modes of Instruction

3.2.1. Self-directed study through recommended reading
3.2.2. Study questions
3.2.3. (Clarification of questions)
3.2.4. Preparation of samples and of different reagents necessary for the analysis including review of safety precautions
3.2.5. Demonstrations of samples and of analysis by trainer, with explanations
3.2.6. Interpretation of results and discussion including limitations
3.2.7. 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)
3.2.8. Discussion

3.3. References

3.3.2. “Recommended Methods for the Identification and Analysis of Amphetamine, Methamphetamine and their Ring-substituted Analogues in Seized Materials”, UNODC, ST/NAR/34, January 2006(LINK)
3.3.4. “Colour tests for precursor chemicals of Amphetamine-Type Substances: The use of colour tests for distinguishing between Ephedrine-Derivatives”, UNODC, SCITEC/20, December 2005

3.3.5. “Colour tests for precursor chemicals of amphetamine-type substances: Systematic study of colour tests for safrole and safrole-rich essential oils”, UNODC, SCITEC/21, December 2007


3.3.7. “Multilingual Dictionary of Narcotic Drugs and Psychotropic Substances Under International Control”, UNODC, ST/NAR/10/Rev.2, December 2006 (LINK)


3.3.9. “A practical guide to methamphetamine characterization/impurity profiling: Method procedures, mass spectral data of selected impurities, and literature reference”, UNODC, SCITEC/17, August 2000 (LINK)


3.3.11. “Analysis of Drugs Manual”, United States Department of Justice, Drug Enforcement Administration, Office of Forensic Sciences


3.3.13. “The Analysis of Controlled Substances”, Michael D. Cole, John Wiley & Sons Ltd., The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England


3.3.16. “Clandestine Laboratory Guide for Agents and Chemists”, U.S. Department of Justice, Drug Enforcement Administration, Office of Science and Technology

3.3.17. “Psychotropic Substances of the Amphetamine Type used by Drug Addicts in Bulgaria - Synthesis and Medicinal Forms Analytical Methods of Identification”, UNODC, SCITEC/10, September 1994 (LINK)


3.3.22. “Rapid and sensitive technique for the differentiation of the optical isomeric forms of methamphetamine and amphetamine”, Cunningham, M. D. (1973). Microgram, vol. 6, No. 6, pp. 87-95


3.4. Assessment

3.4.1. Study questions (oral, written)
3.4.2. Preparation of samples and reagents (practical)
3.4.3. Distribution and application of analysis on unknown samples (practical)
3.4.4. Courtroom exercise
4. Cocaine

4.1. Objectives

4.1.1. Become familiar with the coca plant and illicit materials containing cocaine

4.1.1.1. Learn the description of and be able to recognize the coca plant and illicit materials containing cocaine (botany, physical appearance, morphological and chemical characteristics)

4.1.1.2. Learn the production of illicit materials including cocaine (isolation of cocaine from coca leaf, production of coca paste, cocaine base, “crack”) and manufacture of cocaine

4.1.1.3. Chemical constituents of forensic significance of coca plant and illicit materials containing cocaine, including by-products, adulterants and diluents, comparative analysis and establishing links between cocaine samples

4.1.1.4. Structures, physical data and pharmacology of constituents of illicit materials containing cocaine

4.1.1.5. Legal aspects concerning coca plant and illicit materials containing cocaine in state and federal legislation

4.1.2. 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)

4.1.3. Become familiar with additional analytical techniques for the analysis of cocaine

4.1.4. Perform identification of cocaine in illicit materials

4.1.5. Perform quantification of (constituents of illicit materials containing cocaine)

4.2. Modes of Instruction

4.2.1. Self-directed study through recommended reading

4.2.2. Study questions

4.2.3. (Clarification of questions)

4.2.4. Preparation of samples and of different reagents necessary for the analysis including review of safety precautions

4.2.5. Demonstrations of samples and of analysis by trainer, with explanations

4.2.6. Interpretation of results and discussion including limitations

4.2.7. 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)

4.2.8. Discussion

4.3. References


4.3.7. “Analysis of Drugs Manual”, United States Department of Justice, Drug Enforcement Administration, Office of Forensic Sciences

4.3.8. “The Analysis of Controlled Substances”, Michael D. Cole, John Wiley & Sons Ltd., The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England


4.3.10. “Clandestine Laboratory Guide for Agents and Chemists”, U.S. Department of Justice, Drug Enforcement Administration, Office of Science and Technology


4.4. Assessment

4.4.1. Study questions (oral, written)
4.4.2. Preparation of samples and reagents (practical)
4.4.3. Distribution and application of analysis on unknown samples (practical)
4.4.4. Courtroom exercise (mini-mock trial)
5. **Opium Alkaloids and Opium Derivatives**

5.1. **Objectives**

5.1.1. Become familiar with the opium, opium alkaloids, and opium derivatives (heroin), including semi-synthetic opioids (e.g. oxycodone, hydrocodone, etc)

5.1.1.1. Description of and the recognition of illicit opium products (botany, physical appearance, morphological and chemical characteristics, opium preparations)

5.1.1.2. Production of illicit opium products (isolation of morphine from opium, manufacture of heroin from morphine)

5.1.1.3. Chemical constituents of forensic significance of illicit opium products and derivatives, including by-products, adulterants and diluents, comparative analysis and establishing links between samples

5.1.1.4. Structures and pharmacology of constituents of opium, opium derivatives (heroin), and semi-synthetic opioids

5.1.1.5. Legal aspects concerning opium, opium derivatives (heroin), and semi-synthetic opioids in state and federal legislation

5.1.2. 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)

5.1.3. Become familiar with additional analytical techniques for the analysis of illicit opium, opium products, opium derivatives (heroin), and semi-synthetic opioids

5.1.4. Perform identification of illicit opium, opium products, opium derivatives (heroin), and semi-synthetic opioids

5.1.5. Perform quantification of constituents of illicit opium, opium products, opium derivatives (heroin), and semi-synthetic opioids

5.2. **Modes of Instruction**

5.2.1. Self-directed study through recommended reading

5.2.2. Study questions

5.2.3. (Clarification of questions)

5.2.4. Preparation of samples and of different reagents necessary for the analysis including review of safety precautions

5.2.5. Demonstrations of samples and of analysis by trainer, with explanations

5.2.6. Interpretation of results and discussion including limitations

5.2.7. 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)

5.3. **References**


5.3.2. “Recommended Methods for Testing Opium, Morphine and Heroin”, UNODC, ST/NAR/29/Rev.1, June 1998 (LINK)

5.3.4. “Methods for Impurity Profiling of Heroin and Cocaine”, UNODC, ST/NAR/35, October 2005 (LINK)

5.3.5. “Some Aspects of the Gas Chromatographic (GC) Analysis of Heroin”, UNODC, SCITEC/5, February 1989 (LINK)

5.3.6. “Clandestine Manufacture of Substances under International Control”, UNODC, ST/NAR/10/Rev.2, August 1998 (LINK)


5.3.9. “Analysis of Drugs Manual”, United States Department of Justice, Drug Enforcement Administration, Office of Forensic Sciences

5.3.10. “The Analysis of Controlled Substances”, Michael.D. Cole, John Wiley & Sons Ltd., The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England


5.3.13. “Clandestine Laboratory Guide for Agents and Chemists”, U.S. Department of Justice, Drug Enforcement Administration, Office of Science and Technology


5.4. Assessment

5.4.1. Study questions (oral, written)

5.4.2. Preparation of samples and reagents (practical)

5.4.3. Distribution and application of analysis on unknown samples (practical)

5.4.4. Courtroom exercise (mini-mock trial)
6. LSD and Hallucinogens

6.1. Objectives

6.1.1. 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

6.1.1.1. 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.)

6.1.1.2. 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)

6.1.1.3. Chemical compounds, structures and 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

6.1.1.4. 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

6.1.2. 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)

6.1.3. 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)

6.1.4. 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)

6.1.5. Familiarity with additional analytical techniques for the analysis of LSD and hallucinogens (substituted tryptamines and hallucinogenic phenethylamines)

6.1.6. 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

6.1.7. 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

6.2. Modes of Instruction

6.2.1. Studying of suggested references/assignments
6.2.2. Clarification on questions
6.2.3. Preparation of samples and of different reagents necessary for the analysis including review of safety precautions
6.2.4. Demonstrations of samples and of analysis by trainer, with explanations
6.2.5. Interpretation of results and discussion including limitations
6.2.6. Application of qualitative/quantitative analysis on known samples of illicit materials containing LSD and hallucinogens by trainee
6.2.7. Application of qualitative/quantitative analysis on unknown samples by trainee
6.2.8. Discussion

6.3. References

6.3.2. “Recommended Methods for Testing Lysergide (LSD)”, UNODC, ST/NAR/17, January 1989 (LINK)
6.3.3. “Recommended Methods for Testing Peyote Cactus (Mescal Buttons)/Mescaline and Psilocybe Mushrooms/Psilocybin”, UNODC, ST/NAR/19, December 1989
6.3.8. “The Analysis of Controlled Substances”, Michael D. Cole, John Wiley & Sons Ltd., The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England
6.3.10. “Controlled Substances Training Manual”, Virginia Department of Forensic Science, DFS Document 221-D200, Revision 1, February 2009
6.3.13. “Analysis of Drugs Manual”, United States Department of Justice, Drug Enforcement Administration, Office of Forensic Sciences


6.3.21. “Clandestine Laboratory Guide for Agents and Chemists”, U.S. Department of Justice, Drug Enforcement Administration, Office of Science and Technology


6.5. Assessment

6.5.1. Study questions (oral, written)
6.5.2. Preparation of samples and reagents (practical)
6.5.3. Distribution and application of analysis on unknown samples (practical)
6.5.4. Courtroom exercise (mini-mock trial)
7. Steroids

7.1. Objectives

7.1.1. Familiarity with the illicit materials and pharmaceutical preparations including:

7.1.1.1. Anabolic agents (e.g. steroids) such as stanolone, methanedienone, nandrolone deconoate, testosterone, testosterone propionate
7.1.1.2. Familiarity with steroids classification (androgens, estrogens, adrenals) and steroid preparations
7.1.1.3. Descriptions of steroid formulations (oils, tablets, suspensions)
7.1.1.4. Chemical constituents of forensic significance
7.1.1.5. Structures and pharmacology of steroid preparations
7.1.1.6. Legal aspects concerning steroids
7.1.1.7. Familiarity with the protocol for analysis of steroids, for example, the advantages and limitations of the utilization of extractions, Kovat's indices, TLC, IR and GC/MS.

7.1.2. Description/recogniton of illicit materials and pharmaceutical preparations (physical appearance, morphological characteristics, markings)

7.1.3. Chemical constituents of forensic significance of illicit materials and pharmaceutical preparations containing substances prohibited in doping control

7.1.4. Structures and pharmacology of illicit materials and pharmaceutical preparations containing substances prohibited in doping control

7.1.5. Legal aspects concerning illicit materials and pharmaceutical preparations containing substances prohibited in doping control in state and federal legislation

7.1.6. 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/NPD, GC/MS, LC/MS, analytical challenges, special pitfalls)

7.1.7. Perform identification of illicit materials and pharmaceutical preparations containing steroids

7.1.8. Perform quantification of illicit materials and pharmaceutical preparations containing steroids

7.2. Modes of Instruction

7.2.1. Studying of suggested references/assignments
7.2.2. Clarification on questions
7.2.3. Preparation of samples and of different reagents necessary for the analysis including review of safety precautions
7.2.4. Demonstrations of samples and of analysis by trainer, with explanations
7.2.5. Interpretation of results and discussion including limitations
7.2.6. Application of qualitative/quantitative analysis on known samples of illicit materials containing substances prohibited in doping control by trainee
7.2.7. Application of qualitative/quantitative analysis on unknown samples by trainee
7.2.8. Discussion

7.3. References


7.3.4. “Multilingual Dictionary of Narcotic Drugs and Psychotropic Substances Under International Control (MLD)”, UNODC, ST/NAR/1/rev.2, December 2006


7.3.12. “Analysis of Drugs Manual”, United States Department of Justice, Drug Enforcement Administration, Office of Forensic Sciences


7.3.15. Identadex, Micromedex, website subscription.

7.3.16. DEA Logo Index, printed versions.

7.3.17. Drugs.com


7.3.23. “Analytical Profiles of Anabolic Steroids”, Aubum, Alabama 36831, PO Box 1527, CND Analytical 1989
7.4. Assessment

7.4.1. Study questions (oral, written)
7.4.2. Preparation of samples and reagents (practical)
7.4.3. Distribution and application of analysis on unknown samples (practical)
7.4.4. Courtroom exercise (mini-mock trial)

8. Other Drugs and Pharmaceuticals

8.1. Objectives

8.1.1. Become familiar with the illicit materials and pharmaceutical preparations containing controlled substances, as well as “designer” or new drugs, namely:
   8.1.1.1. benzodiazepine derivatives
   8.1.1.2. barbiturate derivatives
   8.1.1.3. synthetic opioids (pethidine, fentanyl and analogues, methadone, d-propoxyphene etc)
   8.1.1.4. GHB / GBL
   8.1.1.5. PCP and analogues, ketamine

8.1.2. Become familiar with the description/recognition of illicit materials and pharmaceutical preparations (physical appearance, morphological characteristics, markings)

8.1.3. Become familiar with the production/manufacture of illicit materials containing controlled substances

8.1.4. Become familiar with the chemical constituents of forensic significance of illicit materials and pharmaceutical preparations containing controlled substances

8.1.5. Learn the structures and pharmacology of illicit materials and pharmaceutical preparations containing controlled substances

8.1.6. Become familiar with applicable Texas Controlled Substances Act penalty groups

8.1.7. Learn legal aspects concerning illicit materials and pharmaceutical preparations containing controlled substances in state and federal legislation

8.1.8. Become familiar with the analytical procedures for pharmaceutical preparations

8.1.9. 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)

8.1.10. Become familiar with additional analytical techniques for the analysis of other drugs and pharmaceuticals

8.1.11. Become familiar with reporting guidelines

8.1.12. Perform identification of illicit materials and pharmaceutical preparations containing controlled substances

8.1.13. Perform quantification of illicit materials and pharmaceutical preparations containing controlled substances

8.2. Modes of Instruction

8.2.1. Self-directed study through recommended reading
8.2.2. (Clarification of questions)
8.2.3. Identification of and demonstrations of proper use of identification sources
8.2.4. Preparation of samples and of different reagents necessary for the analysis including review of safety precautions
8.2.5. Demonstrations of samples and of analysis by trainer, with explanations
8.2.6. Interpretation of results and discussion including limitations
8.2.7. Application of qualitative/quantitative analysis on known samples of illicit materials containing pharmaceuticals and other drugs by trainee
8.2.8. Application of qualitative/quantitative analysis on unknown samples by trainee
8.2.9. Discussion

8.3. References

8.3.2. “Recommended Methods for Testing Barbiturate Derivatives under International Control”, UNODC, ST/NAR/18, December 1989
8.3.4. “The Identification and Analysis of Benzodiazepines under International Control: I. Colour Tests and Chromatographic Methods”, UNODC, SCITEC/1, December 1987
8.3.5. “Recommended Methods for Testing Methaqualone/Mecloqualone”, ST/NAR/15, December 1988
8.3.6. “Studies on Colour Tests for Field Detection of Narcotic Drugs and Psychotropic Substances under International Control (No. II). Screening Colour Test and Specific Colour Test for the Detection of Non-barbiturate Sedatives and Hypnotics: Methaqualone and Mecloqualone”, SCITEC/13, December 1996
8.3.7. “The Analysis of Controlled Substances”, Michael D. Cole, John Wiley & Sons Ltd., The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England
8.3.17. “Analysis of Drugs Manual”, United States Department of Justice, Drug Enforcement Administration, Office of Forensic Sciences

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8.3.19. “Clandestine Laboratory Guide for Agents and Chemists”, U.S. Department of Justice, Drug Enforcement Administration, Office of Science and Technology

8.3.20. “Controlled Substances Training Manual”, Virginia Department of Forensic Science, DFS Document 221-D200, Revision 1, February 2009


8.3.22. "Physician’s Desk Reference”, Montvale, N.J.: Medical Economics


8.3.29. Discussion

8.4. Assessment

8.4.1. Study questions (oral, written)
8.4.2. Preparation of samples and reagents (practical)
8.4.3. Use various sources for identification of pharmaceutical tablets (practical)
8.4.4. Distribution and application of analysis on unknown samples (practical)
8.4.5. Courtroom exercise (mini-mock trial)
Laboratory Practices

9. Evidence handling and security

9.1. Objectives

9.1.1. 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

9.1.2. 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

9.1.3. Interpret and handle analytical data and related information so as to create and use respective databases

9.2. Modes of Instruction

9.2.1. Self-directed study through recommended reading

9.2.2. (Clarification of questions)

9.2.3. Demonstration and instruction on proper use of the RMS computer system and LIMS

9.2.4. Study questions

9.2.5. Practical exercises

9.2.6. Discussion

9.2.7. 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)

9.2.8. Demonstration/guidance by trainer with explanations on standards or protocols implemented with respect to:

9.2.8.1. case approach

9.2.8.2. general analytical schemes for unknown samples / powders / tablets / capsules / herbal material

9.2.8.3. weighing practices

9.2.8.4. sampling practices

9.2.8.5. choice of analytical methodology

9.2.8.6. validation/verification of methods

9.2.8.7. application of techniques per substance(s)

9.2.8.8. development of SOPs

9.2.8.9. equipment performance and control, preventive maintenance

9.2.8.10. quality control

9.2.8.11. interpretation and reporting of the results

9.2.8.12. documents and case records

9.2.8.13. handling/storage of samples/evidentiary material

9.2.8.14. handling/storage of information, access to databases

9.2.8.15. chain of custody
9.2.8.16. communication with clients (including communication language, establishing needs, dealing with undue pressure etc)
9.2.8.17. health and safety
9.2.8.18. responsibilities, duties and skills of the personnel
9.2.8.19. education and training of personnel

9.2.9. Practice in implementation of the (best) practices, (quality assurance) principles and criteria of the laboratory, at technical and management level

9.2.10. Discussion

9.3. References

9.3.1. Procedures Manual(s) of the laboratory
9.3.5. “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
9.3.11. Forensic Science Institutes (ENFSI/002)


9.3.22. “Samples and Standards”, Analytical Chemistry by Open Learning, B.W. Woodget, D. Cooper, John Wiley & Sons, Chichester, West Sussex, UK, 1987


9.4. Assessment

9.4.1. Study questions (oral, written)

9.4.2. Practical exercise on the implementation of procedures in compliance with the Quality Management System of the laboratory, at all stages of processes
10. Laboratory Safety

10.1. Objectives

10.1.1. Knowledge about safe working practices in the laboratory and at crime scene
10.1.2. Ability to prevent service-related accidents, injuries, illnesses of personnel and damage to equipment, at laboratory and at crime scene
10.1.3. Ability to assess and manage risk and emergency situations
10.1.4. Active participation in implementation of safe working systems including evaluations and review. Consequent development of safety consciousness
10.1.5. 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

10.2. Modes of Instruction

10.2.1. Study questions over:
   10.2.1.1. Properties of hazardous materials, including incompatibilities
   10.2.1.2. Use/meaning of hazard identification symbols, Risk and Safety phrases
   10.2.1.3. Interpretation of Material Safety Data Sheets
   10.2.1.4. 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), etc, including safe transportation, storage and disposal
   10.2.1.5. Hazards involved with analytical instruments and apparatuses operation (high temperatures, radiation etc)
   10.2.1.6. Dealing with risk and emergency situations
   10.2.1.7. Scientific and technical literature on the issue

10.2.2. Demonstrations on:
   10.2.2.1. 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
   10.2.2.2. Use of fire-fighting equipment
   10.2.2.3. First aid and emergency procedures

10.2.3. Practical exercise on:
   10.2.3.1. Implementation of risk assessment of hazardous chemicals/material and situations

10.3. References
10.3.1. “Recommended Guidelines for Quality Assurance and Good Laboratory Practices”
United Nations Office on Drugs and Crime, ST/NAR/25, 1995

10.3.2. “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


10.3.4. "Data Sheets on Substances Frequently Used in the Illicit Manufacture of Narcotic Drugs or Psychotropic Substances", SCITEC/9/REV.1, April 1993


10.3.9. “Chemicals used in the Clandestine Production of Drugs”, US Department of Justice, Drug Enforcement Administration, Office of Diversion Control, Drug and Chemical Evaluation Section

10.3.10. Relevant material safety data sheets


10.4. Assessment

10.4.1. Study questions (oral, written)

10.4.2. Practical exercise
11. Balances

11.1. Objectives
   11.1.1. Familiarity with the operation of balances
   11.1.2. Familiarity with balance calibration and quality assurance practices
   11.1.3. Ability to record and report weights

11.2. Modes of Instruction
   11.2.1. Self-directed study through recommended reading
   11.2.2. (Clarification of questions)
   11.2.3. Presentations and demonstrations of proper use of balances
   11.2.4. Study questions
   11.2.5. Practical exercise
   11.2.6. Discussion

11.3. References
   11.3.1. Balance manufacturer’s operating manuals
   11.3.2. Mettler Toledo Good Weighing Practices Guide
   11.3.3. ADD MORE

11.4. Assessment
   11.4.1. Written examination
   11.4.2. Weight recording exercise of known samples (practical)
   11.4.3. Oral examination or courtroom exercise (optional)
12. Sampling

12.1. Objectives

12.1.1. Familiarity with the concepts of sampling
12.1.2. Familiarity with sampling procedures for sampling

12.2. Modes of Instruction

12.2.1. Self-directed study through recommended reading
12.2.2. (Clarification of questions)
12.2.3. Presentation of case studies and demonstrations
12.2.4. Practical exercises
12.2.5. Discussion

12.3. References


12.3.2. “Sampling for Analytical Purposes”, Gy P, John Wiley & Sons Ltd., 1998


12.4. Assessment

12.4.1. Selection of samples for analysis on unknown samples (practical)
12.4.2. Oral examination and/or courtroom exercise (optional)
12.4.3. Written examination
13. Measurement Uncertainty

13.1. Objectives

13.1.1. Become familiar with the concepts of measurement of uncertainty for weights and quantitations
13.1.2. Become familiar with General metrology to include: terminology, symbols, formulae, publications
13.1.3. 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
13.1.4. Learn the reporting conventions including use of significant figures, truncation and rounding
13.1.5. 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

13.2. Modes of Instruction

13.2.1. Self-directed study through recommended reading
13.2.2. (Clarification of questions)
13.2.3. Presentation of case studies and demonstrations
13.2.4. Practical exercise
13.2.5. Discussion

13.3. References (from SWGDRUG)

13.3.2. 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.

13.3.7. Quantifying Uncertainty in Analytical Measurements, Eurachem, 2000, 2nd ED.


13.3.11. ISO 5725-1 Accuracy (Trueness and Precision) of Measurement Methods and Results Part 1: General Principles and Definitions International Organization for Standardization, Switzerland, 1994.


13.4. Assessment

13.4.1. (Practical)
13.4.2. Oral examination and/or courtroom exercise (optional)
13.4.3. Written examination
14. Quality Assurance

14.1. Objectives

14.1.1. 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

14.1.2. Knowledge of the Quality policy of the laboratory

14.1.3. Knowledge of the requirements of ISO 17025, as interpreted for forensic laboratories

14.1.4. Knowledge of the structure of the Quality Management System of the laboratory or of the Best Practices applied

14.1.5. Ability to comply with the technical requirements established in the Quality Management System and/or Quality Standards of the laboratory

14.1.6. Ability to comply with the management requirements established in the Quality Management System and/or Quality Standards of the laboratory

14.2. Modes of Instruction

14.2.1. Self-directed study through recommended reading

14.2.2. (Clarification of questions)

14.2.3. Presentation by trainer and discussion on:

   14.2.3.1. national legislative, jurisdictional and regulatory requirements
   14.2.3.2. institutional and organizational requirements of the laboratory
   14.2.3.3. client requirements
   14.2.3.4. external and/or international instructions, recommendations and guidelines
   14.2.3.5. principles of ethical conduct

14.2.4. Studying of:

   14.2.4.1. Standard ISO/IEC 17025
   14.2.4.2. 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)

14.2.5. Demonstration by trainer with explanations on the laboratory quality management system and the quality standards/protocols implemented with respect to:
14.2.5.1. organization of the laboratory
14.2.5.2. laboratory environment and accommodation
14.2.5.3. responsibilities, duties and skills of the personnel
14.2.5.4. equipment choice and performance - calibration
14.2.5.5. key stages of the drug testing process:
   14.2.5.5.1. - case assessment
   14.2.5.5.2. - sampling
   14.2.5.5.3. - handling of samples and evidentiary material
   14.2.5.5.4. - development of methods
   14.2.5.5.5. - development of procedures
   14.2.5.5.6. - validation/verification of methods
   14.2.5.5.7. - quality control (internal-external)
   14.2.5.5.8. - interpretation and reporting of the results
14.2.5.6. chain of custody
14.2.5.7. documents and case records
14.2.5.8. handling of services and supplies
14.2.5.9. dealing with clients, requests and complaints
14.2.5.10. audits, corrective and preventive actions
14.2.5.11. health and safety
14.2.5.12. drug reference materials
14.2.5.13. education and training of personnel
14.2.5.14. proficiency testing

14.2.6. Practical exercises in:
   14.2.6.1. implementation of the quality assurance principles and criteria of the laboratory, at technical and management level
   14.2.6.2. use of quality assurance system as a safeguard to legal scrutiny

14.2.7. Discussion

14.3. References


14.3.3. “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


14.3.11. Quality Manual of the laboratory

14.4. Assessment

14.4.1. Study Questions*
14.4.2. Practical exercise on the implementation of procedures in compliance with the Quality Management System of the laboratory, at all stages of processes*
14.4.3. Courtroom exercise

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.

15. Stereomicroscopes

15.1. Objectives

15.1.1. ADD

15.2. Modes of Instruction

15.2.1. Self-directed study through recommended reading
15.2.2. (Clarification of questions)
15.2.3. Presentation of case studies and demonstrations
15.2.4. Practical exercises
15.2.5. Discussion

15.3. References

15.3.1. Microscope manufacturer’s operating manual

15.4. Assessment

15.4.1. Selection of samples for analysis on unknown samples (practical)
15.4.2. Written examination
15.4.3. Oral examination for courtroom exercise (optional)
16. Color Tests

16.1. Objectives

16.1.1. Knowledge of the theory and principles of the color, crystal and anion tests
16.1.2. Become familiar with preparation, storage, and proper handling procedures of the reagents
16.1.3. Become aware of the mechanisms for color test reactions
16.1.4. Learn the advantages, disadvantages, and limitations of color tests
16.1.5. Knowledge of the possibilities and limitations of the technique
16.1.6. Knowledge of quality assurance and method validation requirements
16.1.7. Ability to execute color tests on drugs most commonly encountered in the illicit traffic
16.1.8. Ability to interpret the results obtained and become proficient in the use of chemical color tests

16.2. Modes of Instruction

16.2.1. Self-directed study through recommended reading
16.2.2. (Clarification of questions)
16.2.3. Preparation of different reagents including review of safety precautions
16.2.4. Demonstrations of color tests
16.2.5. Interpretation of results and discussion including limitations
16.2.6. Application of color tests on known samples by trainee (practical)
16.2.7. Application of color tests on unknown samples by trainee (practical)
16.2.8. Discussion

16.3. References


16.3.2. “Chemistry and Reaction Mechanisms of Rapid Tests for Drugs of Abuse and Precursor Chemicals”, UNODC, SCITEC/6, February 1989


16.3.7. “Studies on Colour Tests for Field Detection of Narcotic Drugs and Psychotropic Substances under International Control (No. II). Screening Colour Test and Specific Colour Test for the Detection of Non-barbiturate Sedatives and Hypnotics: Methaqualone and Mecloqualone”, UNODC, SCITEC/13, December 1996


16.3.10. “Rapid and sensitive technique for the differentiation of the optical isomeric forms of methamphetamine and amphetamine”, Cunningham, M. D. (1973). Microgram, vol. 6, No. 6, pp. 87-95


16.3.15. U.S. Pharmacopeia National Formulary, USP XX, 1980

16.4. Assessment

16.4.1. Study questions
16.4.2. Preparation of color test reagents (Practical)
16.4.3. Application of color tests on unknown samples (Practical)
16.4.4. Courtroom exercise
17. Thin Layer Chromatography (TLC)

17.1. Objectives

17.1.1. Knowledge of the principle/theory of Thin Layer Chromatography in drug analysis

17.1.1.1. Awareness of the factors which affect separations (stationary phase, mobile phase, sample, conditions)
17.1.1.2. Knowledge of the criteria for selection of solvent systems, including safety and cost
17.1.1.3. Familiarity with visualization techniques
17.1.1.4. Knowledge of various visualization spray reagents for various applications
17.1.1.5. Awareness of possible problems and likely causes/solutions
17.1.1.6. Knowledge of quality assurance and method validation requirements

17.1.2. Knowledge of the principle/theory of Thin Layer Chromatography in drug analysis

17.1.2.1. 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)
17.1.2.2. Ability to design and use multi-development and two-dimensional TLC experiments
17.1.2.3. Ability to resolve issues such as spot overlapping and tailing
17.1.2.4. Practice in the use of high-performance TLC (HPTLC)
17.1.2.5. Experience with preparative techniques
17.1.2.6. Experience in quantitative TLC
17.1.2.7. Ability in the execution of TLC to reference/known samples as well as on drugs most commonly encountered in the illicit traffic

17.1.3. Ability to interpret the results obtained
17.1.4. Knowledge of the possibilities and limitations of the technique

17.2. Modes of Instruction

17.2.1. Studying of suggested references/assignments
17.2.2. Clarification on questions
17.2.3. Preparation of different development solvents/visualization reagents including review of safety precautions
17.2.4. Demonstrations by trainer: execution of TLC, with explanations
17.2.5. Interpretation of results and discussion
17.2.6. Application of TLC on reference/known samples by trainee
17.2.7. Application of TLC on unknown samples by trainee
17.2.8. Discussion

17.3. References

17.4. Assessment

17.4.1. Study questions (oral, written)
17.4.2. Preparation of reagents (practical)
17.4.3. Distribution and application of TLC on unknown samples (practical)
17.4.4. Courtroom exercise (mini-mock trial)

18. Gas Chromatography (GC)

18.1. Objectives

18.1.1. Learn the theory and operation of the gas chromatograph
18.1.2. Learn to tune the mass spectrometer and perform tune evaluations
18.1.3. Become familiar with GC/MS software and the procedures for entering data in sequence table
18.1.4. Analyze mixtures of substances and identify each component
18.1.5. Learn to search available libraries

18.2. Modes of Instruction

18.2.1. Self-directed study through recommended reading
18.2.2. (Clarification of questions)
18.2.3. Demonstrations by trainer: execution of GC and GC/MS analysis, with explanations
18.2.4. Interpretation of results and discussion
18.2.5. Application of GC and GC/MS on reference/known samples by trainee
18.2.6. Application of GC and GC/MS on unknown samples by trainee, qualitative and quantitative determination
18.2.7. Discussion

18.3. References


18.3.3. 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.


18.3.5. Agilent Technologies GC instrument manuals.


18.3.7. “Gas Chromatography” - Analytical Chemistry by Open Learning, Ian A. Fowlis, (Paperback), John Wiley & Sons Ltd, Baffins Lane, Chichester, West Sussex P019, England, 1999


18.3.15. “Chromatographic Separations” - Analytical Chemistry By Open Learning, Peter A. Sewell, Brian Clarke, David Kealey, John Wiley & Sons Ltd, 1988

18.3.16. “Quantitative analysis using chromatographic techniques” - Analytical Chemistry By Open Learning, Elena Katz, John Wiley & Sons Ltd, 1987


18.3.18. “Controlled Substances Training Manual”, Virginia Department of Forensic Science, DFS Document 221-D200, Revision 1, February 2009

18.3.19. ENFSI DWG Mass Spectral Library


18.3.25. GC instrumental manuals of laboratory.
18.3.26. GC/MS instrumental manuals of laboratory

18.4. Assessment

18.4.1. Study questions (oral, written)
18.4.2. Preparation and GC and GC/MS qualitative analysis of unknown samples (practical)
18.4.3. Preparation and GC and GC/MS quantitative analysis of unknown samples (practical)
18.4.4. Courtroom exercise (mini-mock trial)

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

19.1. Objectives

19.1.1. Learn the theory of gas chromatography/mass spectrometry (GC/MS)

19.1.1.1. Awareness of the mechanism of separations, including support materials, stationary phases, carrier gas and operating temperature, and relevant criteria
19.1.1.2. Familiarity with the various instrumental components and their functions, including injection port, column and detectors (FID, NPD, ECD, MS)
19.1.1.3. Familiarity with the MS components and their functions, including sample inlet, ionisation, ion separation, ion detection and amplification, output of results
19.1.1.4. Knowledge of the theory and mechanism of GC/MS as an identification technique, fragmentation process and spectra interpretation
19.1.1.5. Knowledge of derivatisation techniques, advantages and disadvantages
19.1.1.6. Knowledge of qualitative and quantitative determinations using GC
19.1.1.7. Awareness of common operational problems and causes, pitfalls and troubleshooting, preventive maintenance
19.1.1.8. Knowledge of concept of quality assurance and method validation

19.1.2. Ability in the application of GC and GC/MS in drug analysis
   19.1.2.1. Ability to prepare samples and avoid cross contamination
   19.1.2.2. Familiarity with/practice in the GC instrumentation and software
   19.1.2.3. Familiarity with/practice in the GC/MS instrumentation and software
   19.1.2.4. Familiarity with the operational procedures, including control of instrument
   19.1.2.5. Knowledge of choice criteria and ability to determine suitable conditions and to design experiments aiming at optimum separations
   19.1.2.6. Practice in the application of GC and GC/MS methodology for qualitative and quantitative analysis of drugs most commonly encountered

19.1.3. Capacity of interpretation of the results obtained. Ability to perform library search (GC/MS) and interpret spectra
19.1.4. Understanding the possibilities and limitations of the technique
19.1.5. Become familiar with Agilent ChemStation® software and features of the MS including parametric retrieval, library searches, and ion extraction

19.2. Modes of Instruction
   19.2.1. Self-directed study through recommended reading
   19.2.2. (Clarification of questions)
   19.2.3. Demonstrations by trainer: execution of GC and GC/MS analysis, with explanations
   19.2.4. Interpretation of results and discussion
   19.2.5. Application of GC and GC/MS on reference/known samples by trainee
   19.2.6. Application of GC and GC/MS on unknown samples by trainee, qualitative and quantitative determination
   19.2.7. Discussion

19.3. References
   19.3.3. Basic Training Program for Forensic Chemists, US Department of Justice, Drug Enforcement Administration, Office of Science and Technology, pp, 5-61 through 5-72.
   19.3.4. Austin Police Department, “Systematic Analysis of Drug – GC/MS” (?)
   19.3.6. Agilent MS instrument manuals
   19.3.8. “Gas Chromatography” - Analytical Chemistry by Open Learning, Ian A. Fowlis, (Paperback), John Wiley & Sons Ltd, Baffins Lane, Chichester, West Sussex P019, England, 1999
19.3.15. “Advances in Forensic Applications of Mass Spectrometry”, Yinon J, 2004
19.3.16. “Chromatographic Separations” - Analytical Chemistry By Open Learning, Peter A. Sewell, Brian Clarke, David Kealey, John Wiley & Sons Ltd, 1988
19.3.17. “Quantitative analysis using chromatographic techniques” - Analytical Chemistry By Open Learning, Elena Katz, John Wiley & Sons Ltd, 1987
19.3.19. ENFSI DWG Mass Spectral Library
19.3.24. GC instrumental manuals of laboratory.
19.3.25. GC/MS instrumental manuals of laboratory

19.4. Assessment
19.4.1. Study questions (oral, written)
19.4.2. Preparation and GC and GC/MS qualitative analysis of unknown samples (practical)
19.4.3. Preparation and GC and GC/MS quantitative analysis of unknown samples (practical)
19.4.4. Courtroom exercise (mini-mock trial)

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

20.1. Objectives
20.1.1. Knowledge of the principle/theory of HPLC including LC/MS in drug analysis
20.1.1.1. Knowledge of the mechanism of separations, including stationary phases (columns, criteria of choice), mobile phase (types, uses, composition) and temperature
20.1.1.2. Familiarity with the various instrumental components and their functions including injections port, column and detector (DAD, MS).

20.1.1.3. Familiarity with the MS components and their functions, including sample inlet, ionisation, ion separation, ion detection and amplification, output of results

20.1.1.4. Awareness of the mechanism of HPLC incl. LC/MS as an identification technique

20.1.1.5. Qualitative and quantitative determinations using HPLC and LC/MS

20.1.1.6. Awareness of common operational problems and causes, pitfalls and troubleshooting, preventive maintenance

20.1.1.7. Knowledge of quality assurance and method validation requirements

20.1.2. Knowledge of the application of HPLC and LC/MS in drug analysis

20.1.2.1. Familiarity with the HPLC and LC/MS instrumentation and software

20.1.2.2. Familiarity with the operational procedures including control of instrument

20.1.2.3. Ability to design experiments aiming at selecting operating conditions for optimum separations

20.1.2.4. Practice in the application of HPLC and LC/MS methodology in the qualitative and quantitative analysis of drugs most commonly encountered

20.1.3. Capacity of understanding and interpretation of the results obtained

20.1.4. Ability to perform library search (LC/MS) and interpret spectra

20.1.5. Become familiar with Waters Empower® software and features of the LC

20.1.6. Understanding the possibilities and limitations of the technique

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 HPLC and LC/MS analysis, with explanations

20.2.4. Interpretation of results and discussion

20.2.5. Application of HPLC and LC/MS on reference/known samples by trainee

20.2.6. Application of HPLC and LC/MS on unknown samples by trainee, qualitative and quantitative determination

20.2.7. Discussion

20.3. References


20.3.4. “High-Performance Liquid Chromatography in Forensic Chemistry”, Lurie IS, 1983

20.3.5. “Liquid Chromatography/Mass Spectrometry – Application in Agricultural, Pharmaceutical, and Environmental Chemistry”, Mark A. Brown, Editor, American Chemical Society, Washington DC, 1990
20.3.6. “Chromatographic Separations” - Analytical Chemistry By Open Learning Peter A. Sewell, Brian Clarke, David Kealey, John Wiley & Sons Ltd, 1988

20.3.7. “Quantitative analysis using chromatographic techniques” - Analytical Chemistry By Open Learning, Elena Katz, John Wiley & Sons Ltd, 1987


20.3.15. HPLC instrumental manuals of laboratory

20.3.16. LC/MS instrumental manuals of laboratory


20.4. Assessment

20.4.1. Perform analysis of known samples (Practical)

20.4.2. Perform quantitation of known samples (Practical)

20.4.3. Perform extraction and analysis of unknown samples (Practical)

20.4.4. Written examination

21. Ultraviolet/Visible Spectroscopy (UV/VIS)

21.1. Objectives
21.1.1. Learn the theory of UV/VIS spectrophotometry in drug analysis


21.1.1.2. Parameters that define electromagnetic radiation (frequency, wavelength, wavenumber)

21.1.1.3. Laws of absorption: The Beer-Lambert Law

21.1.1.4. Mechanism of UV/VIS as an identification technique, including limitations

21.1.1.5. The influence of solvents and PH on spectra (wavelength maxima and band intensities)

21.1.1.6. Mechanism of UV/VIS as a quantitation technique (basic laws, single components, multi-component systems, colorimetric measurements, difference spectrophotometry, derivative spectrophotometry)

21.1.1.7. Knowledge of quality assurance and method validation requirements

21.1.2. Knowledge of the application of UV/VIS in drug analysis

21.1.2.1. Instrumentation (colourimeters, single-beam spectrophotometers, double-beam spectrophotometers, rapid-scanning spectrophotometers, absorption cells)

21.1.2.2. Preparation and handling of various kinds of samples

21.1.2.3. Application of UV/VIS methodology in the qualitative analysis of drugs

21.1.2.4. Application of UV/VIS methodology in the quantitative analysis of drugs

21.1.2.5. Awareness of common operational problems and causes, troubleshooting, preventive maintenance

21.1.3. Familiarity with the UV/VIS instrumentation and software

21.1.4. Familiarity with the operational procedures

21.1.5. Ability to select operating parameters aiming at best results

21.1.6. Practice in the application of UV/VIS methodology in the analysis of drugs most commonly encountered

21.1.7. Understanding the advantages and limitations of the technique

21.1.8. Capacity of interpretation of the results obtained

21.1.9. Experience in quantitative UV/VIS analysis

21.1.10. Become familiar with Varian Cary® software and features

21.1.11. Become familiar with sources for identification such as Clarke and Mills

21.1.12. Learn how contaminants can affect UV analysis

21.1.13. Learn extraction techniques for UV analysis

21.1.14. Learn the application of UV analysis for quantitation

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 UV/VIS analysis, with explanations

21.2.4. Interpretation of results and discussion

21.2.5. Application of UV/VIS on reference/known samples by trainee

21.2.6. Application of UV/VIS on unknown samples by trainee, qualitative and quantitative determination

21.2.7. Discussion

21.3. References

21.3.1. UV/Vis Absorption Spectroscopy Tutorial

http://teaching.shu.ac.uk/hwb/chemistry/tutorials/molspec/uvvisab3.htm

21.3.2. Visible and UV Spectroscopy

http://www.cem.msu.edu/~reusch/VirtualText/Spectrpy/UV-Vis/spectrum.htm


21.3.12. UV/VIS instrumental manuals of laboratory

21.4. Assessment

21.4.1. Study questions (oral, written)

21.4.2. Sample preparation and UV/VIS qualitative analysis of unknown samples (practical)

21.4.3. Sample preparation and UV/VIS quantitative analysis of unknown samples (practical)

21.4.4. Courtroom exercise (mini-mock trial)

22. Infrared Spectroscopy (FTIR)
22.1. Objectives

22.1.1. Learn the theory of FTIR in drug analysis
   22.1.1.1. Knowledge of the electromagnetic spectrum
   22.1.1.2. Knowledge of the theory and mechanism of absorption and of vibrational and rotational spectroscopy
   22.1.1.3. The Beer-Lambert Law
   22.1.1.4. Knowledge of the mechanism of IR as an identification technique, (characteristic IR group frequencies and structure/spectra correlations)
   22.1.1.5. Fourier transform infrared spectroscopy (FTIR) and the different techniques (KBr, ATR etc)
   22.1.1.6. Familiarity with the various instrumental components and their functions
   22.1.1.7. Awareness of common operational problems and causes, troubleshooting, preventive maintenance
   22.1.1.8. Knowledge of quality assurance and method validation requirements

22.1.2. Knowledge of the application of IR in drug analysis
   22.1.2.1. Familiarity with the (FT)IR instrumentation and software (dispersive and interferometric spectrophotometers, data processing)
   22.1.2.2. Familiarity with the operational procedures (sample purification and preparation, identification and interpretation of spectra)
   22.1.2.3. Practice in the application of IR methodology in the qualitative and quantitative analysis of drugs most commonly encountered
   22.1.2.4. Proper use of spectral manipulations (e.g. subtraction, baseline correction, library searching)
   22.1.2.5. Learn techniques associated with FTIR analysis, e.g. DRIFTS, ATR, KBr pellets

22.1.3. Ability to select operating parameters aiming at best results

22.1.4. Practice in the preparation and handling of various kinds of samples

22.1.5. Practice in the application of IR methodology in the analysis of drugs most commonly encountered

22.1.6. Understanding the advantages and limitations of the technique

22.1.7. Capacity of interpretation of the results obtained

22.1.8. Experience in quantitative IR analysis

22.1.9. Become familiar with Thermo-Nicolet OMNIC® software and features including baseline subtraction, library searching, data storage, and printing options

22.1.10. Become familiar with sources for identification such as Clarke and Mills

22.1.11. Learn extraction techniques for FTIR analysis

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 FTIR analysis, with explanations

22.2.4. Interpretation of results and discussion

22.2.5. Application of FTIR on reference/known samples by trainee

22.2.6. Application of FTIR on unknown samples by trainee, qualitative and quantitative determination

22.2.7. Discussion

22.3. References


22.3.3. Thermo Nicolet Instrument Manuals


22.3.5. Basic Training Program for Forensic Chemists, U.S. Department of Justice, Drug Enforcement Administration, Office of Science and Technology, pp. 5-17 through 5-29.

22.3.6. “Introduction to FTIR and Raman”, Vibrational Spectroscopy, Varian Inc., Randolph, MA.


22.3.13. “Controlled Substances Training Manual”, Virginia Department of Forensic Science, DFS Document 221-D200, Revision 1, February 2009


22.3.18. “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

22.3.19. IR instrumental manuals of laboratory

22.4. Assessment

22.4.1. Study questions (oral, written)

22.4.2. Sample preparation and IR qualitative analysis of known samples (practical)

22.4.3. Sample preparation and IR quantitative analysis of unknown samples (practical)

22.4.4. Courtroom exercise (mini-mock trial)
23. Separations and Extractions

23.1. Objectives

23.1.1. Knowledge of the principle/theory of Separations and Extractions in drug analysis
   23.1.1.1. Awareness of the factors which affect separations
   23.1.1.2. Knowledge of the criteria for selection of solvent systems, including safety and cost
   23.1.1.3. Familiarity with extraction techniques
   23.1.1.4. Awareness of possible problems and likely causes/solutions
   23.1.1.5. Use of solubility to separate mixtures of drugs and diluents
   23.1.1.6. Definition of pKa and the Henderson Hasselbach equation
   23.1.1.7. Basic drug extractions using aqueous/organic solvents
   23.1.1.8. Acidic drug extractions using aqueous/organic solvents
   23.1.1.9. Amphoteric drug extractions using aqueous/organic solvents
   23.1.1.10. Neutral drug extractions using aqueous/organic solvents
   23.1.1.11. Specialty (difficult) type extractions

23.1.2. Knowledge of the application of Solid Phase extraction (SPE) in drug analysis

23.1.3. Knowledge of chromatographic separation techniques
   23.1.3.1. Use of preparative column
   23.1.3.2. Use of Silica and Flurosil columns
   23.1.3.3. Column preparation, loading and eluting

23.1.4. Knowledge of the possibilities and limitations of the technique

23.1.5. Learn the acid/base properties of drugs

23.1.6. Learn different extraction and separation methods

23.2. Modes of Instruction

23.2.1. Self-directed study through recommended reading

23.2.2. (Clarification of questions)

23.2.3. Preparation of different extraction solvent reagents including review of safety precautions

23.2.4. Demonstrations by trainer: execution of extraction techniques, with explanations

23.2.5. Interpretation of results and discussion

23.2.6. Application of extractions on reference/known samples by trainee

23.2.7. Application of extractions on unknown samples by trainee

23.2.8. Discussion

23.3. References


23.3.9. Modern Methods of Pharmaceutical Analysis Schirmer, Roger E.,


### 23.4. Assessment

23.4.1. Study questions (oral, written)

23.4.2. Sample preparation and separation of known samples (practical)

23.4.3. Sample preparation and separation of unknown samples (practical)

23.4.4. Courtroom exercise (mini-mock trial)
Clandestine Laboratory Field Investigations

24. Common Clandestine Laboratories

24.1. Objectives

24.1.1. Become familiar with common clandestine laboratory synthesis methods
24.1.2. Knowledge of the substances used in the clandestine production/manufacture of narcotic drugs and psychotropic substances
24.1.3. Knowledge of the production/manufacture of controlled substances
24.1.4. Knowledge of the investigation and dismantling of clandestine laboratories

24.2. Modes of Instruction

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

24.3. References

24.3.1. Forensic Division Safety Manual safety guidelines for investigating and dismantling a clandestine lab
24.3.5. Clandestine Laboratory Investigating Chemists monographs.
24.3.8. "Understanding clandestine synthetic drugs", UNODC, June 2001
24.3.9. "Data Sheets on Substances Frequently Used in the Illicit Manufacture of Narcotic Drugs or Psychotropic Substances", SCITEC/9/REV.2, 2009 (in preparation)
24.3.12. “Clandestine Laboratory Guide for Agents and Chemists”, United States Department of Justice, Drug Enforcement Administration, Office of Forensic Sciences

24.3.13. “Chemicals used in the Clandestine Production of Drugs”, US Department of Justice, Drug Enforcement Administration, Office of Diversion Control, Drug and Chemical Evaluation Section


24.3.15. “DRCHIS: Drugs geRelateerd CHeimalien Informatie Systeem”, A. Elissen, M.L. Hordijk, Dutch National Criminal Intelligence Division, May 1999


24.4. Assessment

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

Courtroom Testimony

25. Courtroom Testimony (ISO 5.2.1.2, and 5.2.1.3)

25.1. Objectives

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

25.2. Modes of Instruction

25.2.1. Self-directed study through recommended reading
25.2.2. (Clarification of questions)
25.2.3. Presentation of case studies and demonstrations
25.2.4. Direct observation of expert testimony
25.2.5. Practical exercises
25.2.6. Discussion

25.3. References

25.3.1. “Interpreting Evidence - Evaluating Forensic Science in the Courtroom”, Robertson B, Vignaux GA, John Wiley & Sons, Chichester, West Sussex
25.3.3. Houck & Siegel
25.3.8. People v. Jabrocki (from above link) [EDIT]ttorney asks, “Is it
25.3.9. *State v. Fausto* (from above link) [EDIT]
25.3.10. *State v. Weimer* (from above link) [EDIT]
25.3.11. *City of Kent v. McDaniel* (from above link) [EDIT]

25.4. Assessment

25.4.1. Study questions
25.4.2. Formal mock trial

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<td>1. 11/15/2012</td>
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