CONTROLLED SUBSTANCES TRAINING PROGRAM

TABLE OF CONTENTS

Training Program Overview
- Purpose
- Program Objectives
- Coordination of Program
- Training Period
- Structure and Curriculum
- Professional Development

Introduction
1. Drug Overview

Laboratory Practices
2. Laboratory Safety
3. Legislation
4. Quality Assurance (Ethics)
5. Courtroom Testimony
6. Evidence Handling and Security
7. Balances
8. Sampling
9. Measurement Uncertainty

Drugs of Abuse
10. Cannabis
11. Amphetamine Type Stimulants
12. Cocaine
13. Opium Alkaloids and Opium Derivatives
14. LSD and Hallucinogens
15. Steroids
16. Other Drugs and Pharmaceuticals

Analytical Techniques
17. Color Tests
18. Stereomicroscopes
19. Thin Layer Chromatography (TLC)
20. Gas Chromatography (GC)
21. Gas Chromatography/Mass Spectrometry (GC/MS)
22. High Performance Liquid Chromatography including Liquid Chromatography/Mass Spectrometry (LC/MS)
23. Ultraviolet/Visible Spectroscopy (UV/VIS)
24. Fourier Transform-Infrared Spectroscopy (FTIR)
25. Separations and Extractions

Clandestine Laboratory Field Investigations
26. Common Clandestine Laboratories

Appendix:

APPENDIX A  Training Schedule  
APPENDIX B  Study Guide  
APPENDIX C  Continuing Education
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 it’s role to casework.
- Knowledge of the role of ethics and it 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 or electronic 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 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.
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


1.4. 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

2.3.2. Forensic Science Bureau Safety Manual
2.3.3. Forensic Chemistry Section Standard Operating Procedures. Chapter 2.2. Chapter 6.
2.3.6. “Data Sheets on Substances Frequently Used in the Illicit Manufacture of Narcotic Drugs or Psychotropic Substances”, SCITEC/9/REV.1, April 1993 (digital reading)
2.3.7. "NIOSH Pocket Guide to Chemical Hazards", Department of health and human services, National Institute for Occupational Safety and Health, 2005 (link updated oct. 2012)
2.3.8. “Chemicals used in the Clandestine Production of Drugs”, US Department of Justice, Drug Enforcement Administration, Office of Diversion Control, Drug and Chemical Evaluation Section
2.3.9. Relevant material safety data sheets

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. [https://statutes.capitol.texas.gov/Docs/HS/htm/HS.481.htm](https://statutes.capitol.texas.gov/Docs/HS/htm/HS.481.htm)
3.3.2. Texas Schedules of Controlled Substances. [https://dshs.texas.gov/drugs/controlled-substances.aspx](https://dshs.texas.gov/drugs/controlled-substances.aspx)
3.3.8. 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](http://www.erowid.org/psychoactives/law/cases/federal/federal_analog1.shtml)
3.3.9. 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](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 the 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 lean 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

4.3.2. Quality Assurance Section Standard Operating Procedures.
4.3.3. Forensic Chemistry Section Standard Operating Procedures. Chapter 3.
4.3.7. "Validation of analytical methodology and calibration of equipment used for testing of illicit drugs in seized materials and biological specimen", ST/NAR/41. United Nations Office on Drugs and Crime, 2009 (digital reading)
4.3.10. "Recommended Guidelines for Quality Assurance and Good Laboratory Practice" United Nations Office on Drugs and Crime, STR/NAR/25, 1995 (digital reading)
4.3.27. Koehler, D.J. (2018). Root cause analysis PowerPoint presentation [PowerPoint slides].

4.1. **Assessment**

4.1.1. Study Questions*
4.1.2. Practical exercise on the implementation of procedures in compliance with the Quality Management System of the laboratory, at all stages of processes*
4.1.3. Attendance to assigned ethical training (city ethics and forensic ethic) and role play of ethical dilemmas
4.1.4. 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


### 5.4. 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


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


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**

7.3.2. Forensic Chemistry Section Standard Operating Procedures. Chapter 3.6 regarding Balances.
7.3.3. Forensic Chemistry Section Technical Manual. “Procedure for weighing a sample” and “Balance Uncertainty Determination”
7.3.4. Balance manufacturer’s operating manuals
7.3.5. Mettler Toledo Good Weighing Practices Guide

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. Forensic Chemistry Section Technical Manual.

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

9.3.6. “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.
9.3.17. ISO 5725-1 Accuracy (Trueness and Precision) of Measurement Methods and Results Part 1: General Principles and Definitions International Organization for Standardization, Switzerland, 1994.

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

10.3.10. Manual on the cultivation of Cannabis (Europol, June 2000)
10.3.11. Clandestine Laboratory Guide for Agents and Chemists (DEA)


10.3.16. Analysis of Drugs (DEA)

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


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


10.3.35. Forensic Chemistry Section Technical Manual.

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, fenetyline)
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 ring-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


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


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


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 familiar 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


12.3.10. “Analysis of Drugs Manual”, United States Department of Justice, Drug Enforcement Administration, Office of Forensic Sciences
12.3.11. “The Analysis of Controlled Substances”, Michael.D. Cole, John Wiley & Sons Ltd., The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England
12.3.13. “Clandestine Laboratory Guide for Agents and Chemists”, U.S. Department of Justice, Drug Enforcement Administration, Office of Science and Technology

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 semi-synthetic 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)

13.3. References


13.3.12. “Analysis of Drugs Manual”, United States Department of Justice, Drug Enforcement Administration, Office of Forensic Sciences
13.3.15. “Clandestine Laboratory Guide for Agents and Chemists”, U.S. Department of Justice, Drug Enforcement Administration, Office of Science and Technology

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

14.3. References


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


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


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, methanedienone, 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

15.3. References


15.3.12. “Analysis of Drugs Manual”, United States Department of Justice, Drug Enforcement Administration, Office of Forensic Sciences
15.3.15. DEA Logo Index, printed versions.
15.3.16. Drugs.com
15.3.21. “Analytical Profiles of Anabolic Steroids”, Auburn, Alabama 36831, PO Box 1527, CND Analytical 1989
15.3.22. Forensic Chemistry Section Technical Manual.

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. Synthetic Chemicals

16.1. Objectives

16.1.1. Become familiar with the class of compounds referred to as Synthetic Chemicals (Synthetic Cannabinoids). Including Molecular structures and functional groups.

16.1.2. Become familiar with the description/recognition of seized material containing Synthetic Chemicals.

16.1.3. Become familiar with Texas State Controlled Substance Act and Federal Regulations regarding this compounds.

16.1.4. Become familiar with APD Forensic Science Bureau policy on Synthetic Chemicals.

16.2. Modes of Instruction

16.2.1. Recommended reading/references

16.2.2. Lecture and PowerPoint Presentations

16.2.3. Demonstration of sample preparation and reporting

16.3. References


16.3.4. “Synthetic Cannabinoids in Herbal Products” United Nations Office on Drugs and Crime (UNODC). (digital reading)


16.3.10. Spice/K2 Cannabinoids. Drug Enforcement Administration (DEA) www.deadiversion.usdoj.gov


16.4. Assessment

16.4.1. Study questions (oral, written)

16.4.2. Preparation of samples and reagents (practical)

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

16.4.4. Courtroom exercise (mini-mock trial)
17. Other Drugs and Pharmaceuticals

17.1. Objectives

17.1.1. Become familiar with the illicit materials and pharmaceutical preparations containing controlled substances, as well as “designer” or new drugs, namely:

- 17.1.1.1. benzodiazepine derivatives
- 17.1.1.2. barbiturate derivatives
- 17.1.1.3. synthetic opioids (pethidine, fentanyl and analogues, methadone, d-propoxyphene etc)
- 17.1.1.4. GHB / GBL
- 17.1.1.5. PCP and analogues, ketamine

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

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

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

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

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

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

17.1.8. Become familiar with the analytical procedures for pharmaceutical preparations

17.1.9. 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)

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

17.1.11. Become familiar with reporting guidelines

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

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

17.2. Modes of Instruction

17.2.1. Self-directed study through recommended reading

17.2.2. (Clarification of questions)

17.2.3. Identification of and demonstrations of proper use of identification sources

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

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

17.2.6. Interpretation of results and discussion including limitations

17.2.7. Application of qualitative/quantitative analysis on known samples of illicit materials containing pharmaceuticals and other drugs by trainee

17.2.8. Application of qualitative/quantitative analysis on unknown samples by trainee

17.2.9. Discussion

17.3. References


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


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

17.3.11. International Control (MLD)”, UNODC, ST/NAR/1/rev.2, December 2006


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

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


17.3.27. Forensic Chemistry Section Technical Manual.

17.4. **Assessment**

17.4.1. Study questions (oral, written)
17.4.2. Preparation of samples and reagents (practical)
17.4.3. Use various sources for identification of pharmaceutical tablets (practical)
17.4.4. Distribution and application of analysis on unknown samples (practical)
17.4.5. 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.

18. Color Tests

18.1. Objectives

18.1.1. Knowledge of the theory and principles of the color, crystal and anion tests
18.1.2. Become familiar with preparation, storage, and proper handling procedures of the reagents
18.1.3. Become aware of the mechanisms for color test reactions
18.1.4. Learn the advantages, disadvantages, and limitations of color tests
18.1.5. Knowledge of the possibilities and limitations of the technique
18.1.6. Knowledge of quality assurance and method validation requirements
18.1.7. Ability to execute color tests on drugs most commonly encountered in the illicit traffic
18.1.8. Ability to interpret the results obtained and become proficient in the use of chemical color tests

18.2. Modes of Instruction

18.2.1. Self-directed study through recommended reading
18.2.2. (Clarification of questions)
18.2.3. Preparation of different reagents including review of safety precautions
18.2.4. Demonstrations of color tests
18.2.5. Interpretation of results and discussion including limitations
18.2.6. Application of color tests on known samples by trainee (practical)
18.2.7. Application of color tests on unknown samples by trainee (practical)
18.2.8. Discussion

18.3. References

18.3.5. “Screening Colour Test and Specific Colour Tests for the Detection of Methylenedioxyamphetamine and Amphetamine Type Stimulants” SCITEC/16. United Nations Office on Drugs and Crime (UNODC) 2009. (digital reading)
18.3.11. “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

18.4. Assessment
18.4.1. Study questions
18.4.2. Preparation of color test reagents (Practical)
18.4.3. Application of color tests on unknown samples (Practical)
18.4.4. Courtroom exercise
19. Stereomicroscopes

19.1. Objectives

19.1.1. Knowledge of microscope vs stereoscope
19.1.2. Knowledge of light source used
19.1.3. Knowledge of what magnification to use per application
19.1.4. Knowledge of sample preparation and sample size limitation

19.2. Modes of Instruction

19.2.1. Self-directed study through recommended reading
19.2.2. (Clarification of questions)
19.2.3. Presentation of case studies and demonstrations
19.2.4. Practical exercises
19.2.5. Discussion

19.3. References

19.3.1. Microscope manufacturer’s operating manual

19.4. Assessment

19.4.1. Selection of samples for analysis on unknown samples (practical)
19.4.2. Written examination
19.4.3. Oral examination for courtroom exercise (optional)
20. Thin Layer Chromatography (TLC)

20.1. Objectives

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

20.1.1.1. Awareness of the factors which affect separations (stationary phase, mobile phase, sample, conditions)
20.1.1.2. Knowledge of the criteria for selection of solvent systems, including safety and cost
20.1.1.3. Familiarity with visualization techniques
20.1.1.4. Knowledge of various visualization spray reagents for various applications
20.1.1.5. Awareness of possible problems and likely causes/solutions
20.1.1.6. Knowledge of quality assurance and method validation requirements

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

20.1.2.1. Familiarity with the TLC equipment and associated operational procedures (pretreatment of plates, selection of suitable solvent systems, application of samples, running the plates, location procedures, visualization, storage of chromatograms)
20.1.2.2. Ability to design and use multi-development and two-dimensional TLC experiments
20.1.2.3. Ability to resolve issues such as spot overlapping and tailing
20.1.2.4. Practice in the use of high-performance TLC (HPTLC)
20.1.2.5. Experience with preparative techniques
20.1.2.6. Experience in quantitative TLC
20.1.2.7. Ability in the execution of TLC to reference/known samples as well as on drugs most commonly encountered in the illicit traffic

20.1.3. Ability to interpret the results obtained
20.1.4. Knowledge of the possibilities and limitations of the technique

20.2. Modes of Instruction

20.2.1. Studying of suggested references/assignments
20.2.2. Clarification on questions
20.2.3. Preparation of different development solvents/visualization reagents including review of safety precautions
20.2.4. Demonstrations by trainer: execution of TLC, with explanations
20.2.5. Interpretation of results and discussion
20.2.6. Application of TLC on reference/known samples by trainee
20.2.7. Application of TLC on unknown samples by trainee
20.2.8. Discussion

20.3. References


20.4. Assessment

20.4.1. Study questions (oral, written)
20.4.2. Preparation of reagents (practical)
20.4.3. Distribution and application of TLC on unknown samples (practical)
20.4.4. Courtroom exercise (mini-mock trial)
21. Gas Chromatography/Mass Spectrometry (GC/MS)

21.1. Objectives

21.1.1. Learn the theory and operation of the gas chromatograph.
   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, MS, etc.).
   21.1.1.3. Quality assurance procedures.
   21.1.1.4. Knowledge of qualitative and quantitative determinations using GC.
   21.1.1.5. Awareness of common operational problems and causes, pitfalls and troubleshooting as well as maintenance.

21.1.2. Learn the theory and operation of the mass spectrometer.
   21.1.2.1. Familiarity with the MS components and their functions, including sample inlet, ionization, ion separation, ion detection and amplification, output of results.
   21.1.2.2. Quality assurance procedures.
   21.1.2.3. Awareness of common operational problems and causes, pitfalls and troubleshooting as well as maintenance.

21.1.3. Knowledge of the theory and mechanism of GC/MS as an identification technique, fragmentation process and spectra interpretation.


21.1.5. Become familiar with GC/MS methods in the APD Forensic Chemistry Section Laboratory.

21.1.6. Practice in the application of GC/MS methodology for qualitative analysis of drugs most commonly encountered.

21.1.7. Learn to search available libraries.


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


21.3.6. *Basic Training Program for Forensic Chemists*, US Department of Justice, Drug Enforcement Administration, Office of Science and Technology, pp, 5-61 through 5-72.


21.3.9. Agilent MS instrument manuals


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


21.3.20. “Advances in Forensic Applications of Mass Spectrometry”, Yinon J, 2004

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

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


21.3.24. NIST 2011 Mass Spectral Library


21.3.27. Forensic Chemistry Section Standard Operating Procedures.


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 and 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 detectors (PDA, SQD, ESI).

22.1.1.3. Familiarity with the PDA and SQD components and their functions, including sample inlet, ionization, 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. Become familiar with Waters Empower® software and features of the LC

22.1.5. 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


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


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

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


22.3.17. Forensic Chemistry Section Standard Operating Procedures.


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
   23.1.1.2. 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


23.3.4. UV/Vis Absorption Spectroscopy Tutorial
   [http://teaching.shu.ac.uk/hwb/chemistry/tutorials/molspec/uvvisab3.htm](http://teaching.shu.ac.uk/hwb/chemistry/tutorials/molspec/uvvisab3.htm)


23.3.13. Forensic Chemistry Section Standard Operating Procedures.


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


24.3.8. *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.


24.3.19. Forensic Chemistry Section Standard Operating Procedures

24.3.20. Forensic Chemistry Section Technical Manual

### 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 Fluorisil 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


25.4. **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

26.3.7. Clandestine Laboratory Investigating Chemists monographs.
26.3.15. “Clandestine Laboratory Guide for Agents and Chemists”, United States Department of Justice, Drug Enforcement Administration, Office of Forensic Sciences
26.3.16. "Chemicals used in the Clandestine Production of Drugs”, US Department of Justice, Drug Enforcement Administration, Office of Diversion Control, Drug and Chemical Evaluation Section


26.3.22. Forensic Chemistry Section Standard Operating Procedures.


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)