CONTROLLED SUBSTANCES TRAINING PROGRAM

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Appendix:

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

1.3.1. Drug Enforcement Administration (DEA). *Drugs of Abuse*. *2017 Edition: A DEA Resource Guide*. Washington, DC: U.S. Department of Justice. (digital reading)
1.3.2. United Nations Office on Drugs and Crime (UNODC). (2016). *Terminology and Information on Drugs* (United Nations Publication No. E.16.XI.8). New York: NY: United Nations. (digital reading)
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1.3.9. Shulgin, A., & Shulgin, A. (1991). *PiHKAL: A Chemical Love Story*. Berkeley, California: Transform Press.
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1.3.11. Hardman, J., & Limbird, L. (Eds.) (1996). *The Pharmacological Basis of Therapeutics* (9th ed.). New York, NY: McGraw-Hill Companies.
1.3.12. Beers, M., & Berkow, R. (Ed.) (1999). *The Merck Manual of Diagnosis and Therapy*. Whitehouse Station, NJ: Merck Research Laboratories.

1.4. Assessment

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

Laboratory Practices

2. Laboratory Safety

2.1. Objectives

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

2.2. Modes of Instruction

2.2.1. Study questions over:

2.2.1.1. Properties of hazardous materials, including incompatibilities
2.2.1.2. Use/meaning of hazard identification symbols, Risk and Safety phrases
2.2.1.3. Interpretation of Material Safety Data Sheets
2.2.1.4. safety guidelines (in the laboratory and at crime scene), precautions and rules/procedures with respect to handling compressed gases, flammable, toxic and corrosive substances, bio-hazardous materials, glassware, high-intensity light sources (including UV lamps and lasers), including safe transportation, storage and disposal
2.2.1.5. Hazards involved with analytical instruments and apparatuses operation (high temperatures, radiation etc)
2.2.1.6. Dealing with risk and emergency situations
2.2.1.7. Scientific and technical literature on the issue

2.2.2. Demonstrations on:

2.2.2.1. Use of (personal) protective equipment and physical barriers that are used both to protect the analyst from the evidence and reagents, and the evidence from the analyst, including capabilities and limitations
2.2.2.2. Use of fire-fighting equipment
2.2.2.3. First aid and emergency procedures

2.2.3. Practical exercise on:

2.2.3.1. Implementation of risk assessment of hazardous chemicals/material and situations

2.3. References

2.3.1. Forensic Science Bureau Standard Operating Procedures. Chapter 2-Facility Design and Security. Chapter 3.16-DNA Contamination Detection and Prevention. Chapter 6-Laboratory Safety.
2.3.2. Forensic Science Bureau Safety Manual
2.3.3. Forensic Chemistry Section Standard Operating Procedures. Chapter 2.2. Chapter 6.
2.3.4. “Recommended Guidelines for Quality Assurance and Good Laboratory Practices” United Nations Office on Drugs and Crime, ST/NAR/25, 1995 (digital reading)
2.3.5. “Guidelines for the Safe Handling and Disposal of Chemicals Used in the Illicit Manufacture of Drugs”, ST/NAR/36 rev.1, UNODC, 2011. (digital reading)

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
2.3.10. "Handbook of Laboratory Safety", Furr AK, CRC Press, 5th Ed., 2000
2.3.11. "Hazardous Laboratory Chemicals Disposal Guide", Armour M A, 3rd edition, CRC, 2003
2.3.12. "Prudent Practices in the Laboratory", National Research Council (U.S.), Committee on "Prudent Practices for Handling, Storage, and Disposal of Chemicals in Laboratories, National Academies Press, 1995
2.3.13. "Handbook of Laboratory Health and Safety", Sticoff RS, and Walters DB, 2nd edition, John Wiley & Sons, 1995

2.4. Assessment

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

3. Legislation

3.1. Objectives

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

3.2. Modes of Instruction

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

3.3. References

3.3.1. Texas Controlled Substance Act can be found in Health and Safety Code Title 6. Food, Drugs, Alcohol, and Hazardous Substances Subtitle C. Substance Abuse Regulation and Crimes Chapter 481- 485. 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
3.3.3. Title 21 Code of Federal Regulations part 1300-end https://www.deadiversion.usdoj.gov/21cfr/cfr/index.html
3.3.4. U.S. Controlled Substance Act, Title 21 Chapter 13 found at https://www.deadiversion.usdoj.gov/21cfr/21usc/index.html or www.ecfr.gov
3.3.5. Federal Register notices. https://www.deadiversion.usdoj.gov/fed_regs/index.html
3.3.6. Drug Enforcement Agency, Controlled Substance Analogue Enforcement Act of 1986, retrieved from http://uscode.house.gov/download/pls/21C13.txt
3.3.7. Federal Analog Act of 1986.
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
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

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**

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4.3.2. Quality Assurance Section Standard Operating Procedures.
4.3.3. Forensic Chemistry Section Standard Operating Procedures. Chapter 3.
4.3.4. Siegel, Jay, A. *Ethics in Forensic Science.* Chapter 3 General Forensic Ethical Dilemmas. Elsevier, Inc. 2012. (digital reading)
4.3.5. "Guidance for the Implementation of a Quality Management System in Drug Testing Laboratories", United Nations Office on Drugs and Crime, ST/NAR/37, March 2009 (digital reading)
4.3.6. "'Staff Skill Requirements and Equipment Recommendations for Forensic Science Laboratories", ST/NAR/2/REV.1 UNODC, 2011 (digital reading)
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)
4.3.8. "Glossary of Terms for Quality Assurance and Good Laboratory Practices", United Nations Office on Drugs and Crime, ST/NAR/26/Rev.1, December 2009 (digital reading)
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4.3.12. Texas Forensic Science Commission. "Code of Professional Responsibility for Forensic Analysts and Crime Laboratory Management Subject to the Jurisdiction of the Texas Forensic Science Commission." December 2017. 37 Tex. Admin. Code 651.218.
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4.3.16. “Recommendations", Part I and Part IV, Scientific Working Group for the Analysis of Seized Drugs (SWGDRUG) at www.swgdrug.org
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4.3.27. Koehler, D.J. (2018). Root cause analysis PowerPoint presentation [PowerPoint slides].

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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 testmony
5.2.5. Practical exercises
5.2.6. Discussion

5.3. References

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5.3.9. National Commission on Forensic Science (2014). "Pretrial Discovery in Forensic Evidence Cases Policy Recommendations." https://www.justice.gov/sites/default/files/pages/attachments/2014/10/20/draft_on_discovery.pdf
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5.3.11. Texas District and County Attorneys Association (2014). "Brady Training." (video) http://tdcaa.litmos.com/self-signup/index
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5.4. **Assessment**

5.4.1. Study questions
5.4.2. Formal mock trial

6. Evidence Handling and Security

6.1. Objectives

6.1.1. Learn the procedures applied in the collection, receipt, protection, handling, storage, analysis of samples/evidence, as well as documentation, evaluation, report writing and communication of results

6.1.2. Learn to choose the best case approach, preparation of samples and handling of evidence, implementation of analytical schemes and methodology, and reporting of results, for each individual case

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

6.2. Modes of Instruction

6.2.1. Self-directed study through recommended reading
6.2.2. (Clarification of questions)
6.2.3. Demonstration and instruction on proper use of the RMS computer system and LIMS
6.2.4. Study questions
6.2.5. Practical exercises
6.2.6. Discussion
6.2.7. Studying of, clarification of questions and discussion on documentation of the administrative, organizational and scientific/analytical aspects of laboratory work (e.g. Quality Manual, Best Practices manual, SOP's etc)
6.2.8. Demonstration/guidance by trainer with explanations on standards or protocols implemented with respect to :

6.2.8.1. case approach
6.2.8.2. general analytical schemes for unknown samples / powders / tablets / capsules / herbal material
6.2.8.3. weighing practices
6.2.8.4. sampling practices
6.2.8.5. choice of analytical methodology
6.2.8.6. validation/verification of methods
6.2.8.7. application of techniques per substance(s)
6.2.8.8. development of SOPs
6.2.8.9. equipment performance and control, preventive maintenance
6.2.8.10. quality control
6.2.8.11. interpretation and reporting of the results
6.2.8.12. documents and case records
6.2.8.13. handling/storage of samples/evidentiary material
6.2.8.14. handling/storage of information, access to databases
6.2.8.15. chain of custody
6.2.8.16. communication with clients (including communication language, establishing needs, dealing with undue pressure etc)
6.2.8.17. health and safety
6.2.8.18. responsibilities, duties and skills of the personnel
6.2.8.19. education and training of personnel

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

6.3. References

6.3.1. Forensic Science Bureau Standard Operating Procedures. Chapter 5-Evidence Control.

6.3.2. Forensic Chemistry Section Standard Operating Procedures. Chapter5-Evidence Procedures.
6.3.3. National Institute of Standards and Technology (NIST). The Biological Evidence Preservation handbook: Best Practices for Evidence Handlers. 2013. (digital reading)
6.3.4. Occupational Safety and Health Administration (OSHA). 2011. Laboratory Safety Guide.
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6.3.7. “Glossary of Terms for Quality Assurance and Good Laboratory Practices”, United Nations Office on Drugs and Crime, ST/NAR/26/Rev.1, December 2009 (digital reading)
6.3.8. “Recommended Guidelines for Quality Assurance and Good Laboratory Practice” United Nations Office on Drugs and Crime, STR/NAR/25, 1995 (digital reading)
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6.3.11. Armour M A, “Hazardous Laboratory Chemicals Disposal Guide”, 3rd edition, CRC, 2003
6.3.12. “Prudent Practices in the Laboratory”, National Research Council (U.S.), Committee on Prudent Practices for Handling, Storage, and Disposal of Chemicals in Laboratories, National Academies Press, 1995
6.3.13. “Handbook of Laboratory Health and Safety”, Sticoff RS, and Walters DB, 2nd edition, John Wiley & Sons, 1995
6.3.14. “ASTM E 1492-05: Standard Practice for Receiving, Documenting, Storing, and Retrieving Evidence in a Forensic Science Laboratory”, American Society for Testing and Materials, West Conshohocken, Pennsylvania
6.3.15. “Applications of Reference Materials in Analytical Chemistry”, Barwick V et al, The Royal Society of Chemistry, LGC, Teddington, 2001
6.3.16. “Sample Pretreatment and Separation”, Analytical Chemistry by Open Learning, R. G. Anderson, John Wiley & Sons, Chichester, West Sussex, UK, 1987
6.3.17. “Samples and Standards”, Analytical Chemistry by Open Learning, B.W.Woodget, D.Cooper, John Wiley & Sons, Chichester, West Sussex, UK, 1987
6.3.18. Canaff, R. (1972). *Basic Training Program for Forensic Drug Chemists*. Washington, DC: U.S. Department of Justice Bureau of Narcotics and Dangerous Drugs.

6.4. **Assessment**

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

7. Balances

7.1. Objectives

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

7.2. Modes of Instruction

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

7.3. References

7.3.1. Forensic Science Bureau Standard Operating Procedures. Chapter 3.6-Instruments and Equipment.
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.
8.3.2. Bell, S. *Forensic Chemistry*. Chapter 2. Pearson Education, Inc. Upper Saddle River, NJ. 2006.
8.3.3. United Nations Office on Drugs and Crime. (2009). *Guidelines on representative drug sampling* (UNODC & ENFSI DWG, ST/NAR/38). Vienna, Austria: Vienna International Centre. (digital reading)
8.3.4. "Recommendations" Part III A. Scientific Working Group for the Analysis of Seized Drugs (SWGDrug). www.swgdrug.org.
8.3.5. American Society of Crime Laboratory Directors – Laboratory Accreditation Board (ASCLD/LAB). "ASCLD/LAB Guidance Document on Sampling, Sampling Plans, and Sample Selection." October 2011. (digital reading)
8.3.6. Coulson, Sally A., Ph.D. et al., "How Many Samples from a Drug Seizure Need to Be Analyzed?" Journal of Forensic Science, Volume 46, No. 6 (November 2001), pp 1456-1461.
8.3.7. Colon, aria, B.S. Rodriguez, Gloria, B.S., and Diaz, Ramon Orlando, M.S. "Representative Sampling of "Street' Drug Exhibits", Journal of Forensic Science, Volume, 38, No 3 (May 1993), pp. 641-648.
8.3.8. Tzidony, Dov, and Ravreby, Mark. "A Statistical Approach to Drug Sampling: A Case Study", Journal of Forensic Sciences, Volume 37, No.6 (November 1992), pp 1541-1549.
8.3.9. Frank, Richard S., B.S., Hinkley, Sidney W., Ph.D., and Hoffman, Carolyn G., M.A. "Representative Sampling of Drug Seizures on Multiple Containers", Journal of Forensic Sciences, Volume 36, No 2 (March 1191), pp. 350-357.

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

9.3.1. Forensic Chemistry Section Technical Manual. Chapter 7-Estimation of Uncertainty.
9.3.2. American Society of Crime Laboratory Directors – Laboratory Accreditation Board (ASCLD/LAB). “ASCLD/LAB Guidance on the Estimation of Measurement Uncertainty – Overview.” May 2013. (digital reading)
9.3.3. American Society of Crime Laboratory Directors – Laboratory Accreditation Board (ASCLD/LAB). “ASCLD/LAB Gidance on the Estimation of Measurement Uncertainty – ANNEX B. Drug Chemistry Three Examples – Weight, Volume and Purity Determination.” May 2013. (digital reading)
9.3.4. “Recommendations” Part IV C. Scientific Working Group for the Analysis of Seized Drugs (SWGDrug). www.swgdrug.org
9.3.5. “Supplemental Document SD-3” Scientific Working Group for the Analysis of Seized Drugs (SWGDrug). www.swgdrug.org
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.
9.3.7. “Guidelines for Evaluation and Expressing the Uncertainty of NIST Measurement Results, National Institute of Standards and Technology”, NIST Technical Note 1297. www.nitst.gov/pml/mist-tehnical-note-1297
9.3.8. General requirements for the competence of testing and calibration laboratories International Organization for Standardization, ISO/IEC 17025: 2017.
9.3.9. National Research Council, Committee on Scientific Principles for Education Research. 2002. Scientific Research in Education.
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9.3.14. Guide for the use of the International System of Units (SI), Taylor, B.N., National Institute of Standards and Technology, March 2008.
9.3.15. ISO 3534-1 Statistics — Vocabulary and symbols Part 1: General statistical terms and terms used in probability, ISO 3534-2 Statistics — Vocabulary and symbols Part 2: Applied statistics International Organization for Standardization, Switzerland, 2006.
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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.
9.3.18. The Uncertainty of Measurements. Physical and Chemical Metrology Impact and Analysis. Kimothi, S.K., Milwaukee: American Society for Quality, 2002.
9.3.19. Fundamentals of Analytical Chemistry, 8th Edition, Skoog, D.A., et al. Brooks Cole, 2003.
9.3.20. ASTM E2655 Standard Guide for Reporting Uncertainty of Test Results and Use of the Term Measurement Uncertainty in ASTM Test Methods.

9.4. **Assessment**

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

DRUGS OF ABUSE

10. Cannabis

10.1. Objectives

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

10.2. Modes of Instruction

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

10.3. References

10.3.1. Drug Enforcement Administration (DEA). *Drugs of Abuse. 2017 Edition: A DEA Resource Guide*. Washington, DC: U.S. Department of Justice. (digital reading)
10.3.2. *Drug Identification Bible, 2014/2015 Edition*. Hard copy and CD versions. Grand Junction: Amera-Chem, Inc,
10.3.3. Moffat, A. C., Osselton, M. D., Widdop, B. *Clarkes's Analysis of Drugs and Poisons in Pharmaceuticals, Body Fluids and Postmortem Material*. 3rd Edition. Pharmaceutical Press. 2004.
10.3.4. Bell, S. *Forensic Chemistry*. Pearson Education, Inc. Upper Saddle River, NJ. 2006. Pg. 299-306.
10.3.5. Smith, F.P., Siegel, J. A. *Handbook of Forensic Drug Analysis*. Elsevier Inc. 2005. Chapter 3.
10.3.6. Inaba, D. S., Cohen, W. E. *Uppers, Downers, All Arounders*. 5th Edition. CNS Publications, Inc. Ashland, OR. 2004.
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10.3.11. Clandestine Laboratory Guide for Agents and Chemists (DEA)
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10.3.14. "Rapid testing methods of drugs of abuse" (ST/NAR/13/Rev. 1). United Nations Office on Drugs and Crime (UNODC). Vienna, Austria: Vienna International Centre. 1995. (digital reading)
10.3.15. Canaff, R. (1972). *Basic Training Program for Forensic Drug Chemists*. Washington, DC: U.S. Department of Justice Bureau of Narcotics and Dangerous Drugs.
10.3.16. Analysis of Drugs Manual (DEA)
10.3.17. The Analysis of Controlled Substances (Cole, Wiley)
10.3.18. Gough, T. (Ed.) (1991). *The Analysis of Drugs of Abuse*. New York, NY: John Wiley & Sons, Ltd.
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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)
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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, fenetylline)
11.1.4. Become familiar with methylenedioxy- substituted amphetamines (e.g. MD, MDMA, MDEA, FLEA, MBDB)
11.1.5. Become familiar with other ring substituted amphetamines (also in section "Hallucinogens")
  11.1.5.1. – 2,4,5-ring substituted phenethylamines (e.g. 2C-B, 2C-T, WC-T-2, 2C-T-7, 2C-C, 2C-I)
  11.1.5.2. – 2,4,5-ring substituted amphetamines (e.g. TMA-2, STP/DOM, DOB, DOC, DOI, DOET)
  11.1.5.3. Other ring substitution patterns (phenethylamines and amphetamines) (e.g. Mescaline, PMA, PMMA, DMA, TMA, 4-MTA)
11.1.6. Learn the illicit manufacture of ATS drugs, including the synthesis of amphetamine, methamphetamine, and rung-substituted ATS (e.g. XTC, etc)
11.1.7. Learn the basic pharmacology of ATS
11.1.8. Learn the legal aspects concerning ATS in state and national legislation
11.1.9. Become familiar with the protocol for the analysis of ATS (including sampling, physical description, extraction, presumptive (color) tests, optical isomer analysis, TLC, GC/MS, LC/MS, FTIR, analytical challenges, special pitfalls)
11.1.10. Become familiar with additional analytical techniques for the analysis of ATS
11.1.11. Perform identification of ATS in illicit materials
11.1.12. Perform quantification of ATS in illicit materials

11.2. Modes of Instruction

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

11.3. References

11.3.1. "Terminology and Information on Drugs 3rd Edition", United Nations Office on Drugs and Crime (UNODC), E.16.XI.8 2016. (digital reading)
11.3.2. "Recommended Methods for the Identification and Analysis of Amphetamine, Methamphetamine and their Ring-substituted Analogues in Seized Materials." ST/NAR/34. United Nations Office on Drugs and Crime (UNODC) January 2006. (digital reading)
11.3.3. "Recommended Methonds for the Identification and Analysis of Synthetic Cathinones in Seized Materials" ST/NAR/49. United Nations Office on Drugs and Crime (UNODC). September 2015. (digital reading).
11.3.4. Bell, S. *Forensic Chemistry*. Upper Saddle River, NJ. Pearson Education, Inc. 2006. Pg. 356-376.
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11.3.6. Inaba, D., Cohen, W. (2007) *Uppers, Downers, All Arounders, 5th Edition*. CNS Publications, Inc. Ashland, OR. Pg. 102-112.
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11.3.8. "Rapid testing methods of drugs of abuse" (ST/NAR/13/Rev. 1). United Nations Office on Drugs and Crime (UNODC). Vienna, Austria: Vienna International Centre. 1995. (digital reading)
11.3.9. "Colour tests for precursor chemicals of Amphetamine-Type Substances: The use of colour tests for distinguishing between Ephedrine-Derivatives." SCITEC/20. United Nations Office on Drugs and Crime (UNODC). December 2005 (digital reading)
11.3.10. "Colour tests for precursor chemicals of amphetamine-type substances: Systematic study of colour tests for safrole and safrole-rich essential oils." SCITEC/21. United Nations Office on Drugs and Crime (UNODC). December 2007. (digital reading)
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11.3.13. Canaff, R. (1972). *Basic Training Program for Forensic Drug Chemists*. Washington, DC: U.S. Department of Justice Bureau of Narcotics and Dangerous Drugs.
11.3.14. "Analysis of Drugs Manual", United States Department of Justice, Drug Enforcement Administration, Office of Forensic Sciences
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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
11.3.17. Gough, T. (Ed.) (1991). *The Analysis of Drugs of Abuse*. New York, NY: John Wiley & Sons, Ltd.
11.3.18. Shulgin, A., & Shulgin, A. (1991 / 1995). *PiHKAL: Phenethylamines I have Known and Loved: A Chemical Love Story*. Berkeley, California: Transform Press.
11.3.19. "Clandestine Laboratory Guide for Agents and Chemists", U.S. Department of Justice, Drug Enforcement Administration, Office of Science and Technology
11.3.20. *Drug Identification Bible, 2014/2015 Edition*. Hard copy and CD versions Grand Junction: Amera-Chem, Inc.
11.3.21. "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
11.3.22. Forensic Chemistry Section Technical Manual.

11.4. **Assessment**

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

12. Cocaine

12.1. Objectives

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

12.1.1.1. Become familiarized with the description of the coca plant and illicit materials containing cocaine
12.1.1.2. Learn the production of illicit materials from the coca plant including cocaine (isolation of cocaine from coca leaf, production of coca paste, cocaine base, "crack") and manufacture of cocaine
12.1.1.3. Chemical constituents of forensic significance of coca plant and illicit materials containing cocaine, including by-products, adulterants and diluents
12.1.1.4. Legal aspects concerning coca plant and illicit materials containing cocaine in state and federal legislation

12.1.2. Become familiar with the protocol for the analysis of illicit materials containing cocaine (including sampling, physical identification, extraction, presumptive (color) tests, TLC, GC/MS, GC/FID, LCMS, FTIR, analytical challenges, special pitfalls)
12.1.3. Become familiar with additional analytical techniques for the analysis of cocaine
12.1.4. Perform identification of cocaine in illicit materials
12.1.5. Perform quantification of (constituents of illicit materials containing cocaine)

12.2. Modes of Instruction

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

12.3. References

12.3.1. "Terminology and Information on Drugs", United Nations Office on Drugs and Crime (UNODC), E.16.XI.8 2016. (digital reading)
12.3.2. Drug Enforcement Administration (DEA). *Drugs of Abuse. 2017 Edition: A DEA Resource Guide*. Washington, DC: U.S. Department of Justice. (digital reading)
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12.3.10. "Analysis of Drugs Manual", United States Department of Justice, Drug Enforcement Administration, Office of Forensic Sciences
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12.3.13. "Clandestine Laboratory Guide for Agents and Chemists", U.S. Department of Justice, Drug Enforcement Administration, Office of Science and Technology
12.3.14. *Drug Identification Bible, 20014/2015 Edition.* Hard copy and CD versions. Grand Junction: Amera-Chem, Inc.
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12.3.16. Forensic Chemistry Section Technical Manual.

12.4. **Assessment**

12.4.1. Study questions (oral, written)
12.4.2. Preparation of samples and reagents (practical)
12.4.3. Distribution and application of analysis on unknown samples (practical)
12.4.4. Courtroom exercise (mini-mock trial)

13. Opium Alkaloids and Opium Derivatives

13.1. Objectives

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

13.1.1.1. Description of and the recognition of illicit opium products (botany, physical appearance, morphological and chemical characteristics, opium preparations)
13.1.1.2. Production of illicit opium products (isolation of morphine from opium, manufacture of heroin from morphine)
13.1.1.3. Chemical constituents of forensic significance of illicit opium products and derivatives, including by-products, adulterants and diluents, comparative analysis and establishing links between samples
13.1.1.4. Structures and basic pharmacology of constituents of opium, opium derivatives (heroin), and semi-synthetic opioids
13.1.1.5. Legal aspects concerning opium, opium derivatives (heroin), and semi-synthetic opioids in state and federal legislation

13.1.2. Become familiar with the protocol for the analysis of illicit opium, opium products, opium derivatives (heroin) and semisynthetic opioids (including sampling, physical examination, microscopy, extraction, presumptive (color) tests, GC/MS, LC/MS, FTIR, UV-VIS, analytical challenges, special pitfalls)
13.1.3. Become familiar with additional analytical techniques for the analysis of illicit opium, opium products, opium derivatives (heroin), and semi-synthetic opioids
13.1.4. Perform identification of illicit opium, opium products, opium derivatives (heroin), and semi-synthetic opioids
13.1.5. Perform quantification of heroin

13.2. Modes of Instruction

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

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13.3.13. "The Analysis of Controlled Substances", Michael.D. Cole, John Wiley & Sons Ltd., The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England
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13.3.15. "Clandestine Laboratory Guide for Agents and Chemists", U.S. Department of Justice, Drug Enforcement Administration, Office of Science and Technology
13.3.16. *Drug Identification Bible, 20014/2015 Edition.* Hard copy and CD versions. Grand Junction: Amera-Chem, Inc.
13.3.17. "The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals", O'Neil, Maryadele J. et al, 14th Edition, 2006, 2009 by Merck & Co., Inc., Whitehouse Station, New Jersey, USA
13.3.18. "The Pharmacological Basis of Therapeutics", Goodman & Gilman's, New York, 11/E, 2006, McGraw-Hill
13.3.19. Forensic Chemistry Section Technical Manual.

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**

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14.3.16. "Analysis of Drugs Manual", United States Department of Justice, Drug Enforcement Administration, Office of Forensic Sciences
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14.3.21. "The Pharmacological Basis of Therapeutics", Goodman & Gilman's, New York, 11/E, 2006, McGraw-Hill
14.3.22. "Clandestine Laboratory Guide for Agents and Chemists", U.S. Department of Justice, Drug Enforcement Administration, Office of Science and Technology
14.3.23. Forensic Chemistry Section Technical Manual.

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

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15.3.21. "Analytical Profiles of Anabolic Steroids", Aubum, 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

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16.3.12. Forensic Chemistry Section Technical Manual.
16.3.13. Drug Identification Bible, 2014/2015 Edition. Hard copy and CD versions. Grand Junction: Amera-Chem, Inc.

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

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17.3.26. Chappell, J. S. “The Non-equilibrium Aqueous Solution Chemistry of Gamma-Hydroxybutyric Acid: Journal of the Clandestine laboratory Investigating Chemists Associations, Vol.12, No.4, 2002.
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

18.3.1. “Rapid testing methods of drugs of abuse” ST/NAR/13/Rev.1. United Nations Office on Drugs and Crime (UNODC) Vienna, Austria: Vienna International Centre. 1995.
18.3.2. “Chemistry and Reaction Mechanisms of Rapid Tests for Drugs of Abuse and Precursor Chemicals” SCITEC/6. Kovar, K., Laudszun, M. United Nations Office on Drugs and Crime (UNODC) February 1989. (digital reading)
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18.3.4. Clarke, E. G. C. (2004). *Clarke’s Analysis of Drugs and Poisons in Pharmaceuticals, Body Fluids, and Postmortem Material* (3rd ed., Vol. 1-2). A. C. Moffat, Osselton, M. D., & Widdop, B. (Eds.) Grayslake, IL: Pharmaceutical Press.
18.3.5. “Screening Colour Test and Specific Colour Tests for the Detection of Methaylenedioxyamphetamine and Amphetamine Type Stimulants” SCITEC/16. United Nations Office on Drugs and Crime (UNODC) 2009. (digital reading)
18.3.6. “Colour Tests for Precursor Chemicals of Amphetamine-Type Substances: The Use of Colour Tests for distinguishing between Ephedrine-Derivatives” SCITEC/20. United Nations Office on Drugs and Crime (UNODC). December 2005. (digital reading)
18.3.7. Bell, S. *Forensic Chemistry*. Pearson Education, Inc. Upper Saddle River, NJ. 2006. Pg. 270-293.
18.3.8. “Modern Microcrystal Tests for Drugs”, Fulton, C.C., (1969), “Wiley-Interscience, NY
18.3.9. “Spot Tests: A Colour Chart Reference for Forensic Chemists”, Johns, S. H., Wist, A. A., and Najam, A. R. Journal of Forensic Sciences, July 1979

18.3.10. "Spot Tests in Organic Analysis", Feigl F., Feigl F. and Anger V., Butterworth Heinemann, 7th edition, 2006
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
18.3.12. "Spot Test Analysis; Clinical, Environmental, Forensic, and Geochemical Applications", Jungreis E, 2nd edition, Wiley-Interscience, New York, 1984/1997
18.3.13. "Staff Skill Requirements and Equipment Recommendations for Forensic Science Laboratories" ST/NAR/2/Rev.1. United Nations Office on Drugs and Crime (UNODC). 2011 (digital reading)
18.3.14. "Guidelines on representative drug sampling" ST/NAR/38. United Nations Office on Drugs and Crime (UNODC). 2009. (digital reading)
18.3.15. "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. United Nations Office on Drugs and Crime (UNODC). 2009. (digital reading)
18.3.16. Forensic Chemistry Section Technical Manual.

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
19.3.2. Saferstein, Richard, Ph.D. *Criminalistics: An Introduction to Forensic Science, Eighth Edition,* Upper Saddle River, NJ: Prentice hall, 2004, pp 175-176.
19.3.3. Saferstein, Richard, Ph.D., Editor. *Forensic Science Handbook, 2nd Edition*. Englewood Cliffs: Prentice Hall, 2002/1982, Chapter 5.
19.3.4. Bell, S. *Forensic Chemistry*. Pearson Education, Inc. Upper Saddle River, NJ. 2006. Pg. 134-148.
19.3.5. "History of the Microscope" , History-of-the-microscope.org.
19.3.6. Forensic Chemistry Section Technical 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 (pre-treatment 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**

20.3.1. Canaff, R. (1972). *Basic Training Program for Forensic Drug Chemists*. Washington, DC: U.S. Department of Justice Bureau of Narcotics and Dangerous Drugs.
20.3.2. Clarke, E. G. C. (2004). *Clarke's Analysis of Drugs and Poisons in Pharmaceuticals, Body Fluids, and Postmortem Material* (3rd ed., Vol. 1-2). A. C. Moffat, Osselton, M. D., & Widdop, B. (Eds.) Grayslake, IL: Pharmaceutical Press.
20.3.3. Bell, S. Forensic Chemistry. Pearson Education, Inc. Upper Saddle River, NJ. 2006. Pg. 116-120.
20.3.4. "Thin Layer Chromatography" - Analytical Chemistry by Open Learning R.Hamilton, S.Hamilton, John Wiley & Sons, Chichester, West Sussex, U.K., 1987 ISBN 0-471-91377-4 (paperback)
20.3.5. "Handbook of Thin-Layer Chromatography", Sherma J, Fried B and Sherma S, CRC Press; 3rd Rev&Ex, 2003

20.3.6. “Thin Layer Chromatography: Reagents and Detection Methods”, Jork H, Funk W, Fischer W and Wimmer H, Volume 1b, VCH Verlagsgesellschaft mbH, BRD, 1994
20.3.7. “Thin-Layer Chromatography”, Stahl, E., 1969. Springer-Verlag, 1969, NY
20.3.8. Thin-Layer Chromatography”, Randerath, Kurt. “Second Edition. New York: Academic Press, 1968
20.3.9. “Thin Layer Chromatography”, Bauer, Karin, et. al. Heidelberg, Germany: EM Science, 1991
20.3.10. “Thin-layer chromatographic Rf values of toxicologically relevant substances on standardized systems”, Deutsche Forschungsgemeinschaft (DFG) / The International Association of Forensic Toxicologists (TIAFT), 2nd, revised and enlarged edition, 1992.
20.3.11. "Staff Skill Requirements and Equipment Recommendations for Forensic Science Laboratories” ST/NAR/2/Rev.1. United Nations Office on Drugs and Crime (UNODC), 2011. (digital reading)
20.3.12. “Guidance for the Validation of Analytical Methodology and Calibration of Equipment used for Testing of Illicit Drugs in Seized Materials and Biological Specimens” ST/NAR/41. United Nations Office on Drugs and Crime (UNODC) 2009. (digital reading)
20.3.13. Forensic Chemistry Section Technical Manual.

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.
21.1.4. Become familiar with GC/MS Software and the procedures for entering data in the sequence table.
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.
21.1.8. Knowledge of derivatization techniques, advantages and disadvantages.

21.2. Modes of Instruction

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

21.3. References

21.3.1. Skoog, D. A., Holler, F. J., Nieman, T. A. *Principles of Instrumental Analysis, 5th Edition*. Harcourt Brace College Publishers. 1998. Chapters 26, 27 and 20.
21.3.2. Smith, F. P., Siegel, J. A. *Handbook of Forensic Drug Analysis*. Elsevier Inc. 2005.
21.3.3. Bell, S. Forensic Chemistry. Pearson Education, Inc. Upper Saddle River, NJ. 2006. Pg. 192-203.
21.3.4. Moffat, A.C., editor. *Clarke's Isolation and Identification of Drugs.* London: The Pharmaceutical Press, 1986.
21.3.5. Canaff, R. (1972). *Basic Training Program for Forensic Drug Chemists*. Washington, DC: U.S. Department of Justice Bureau of Narcotics and Dangerous Drugs.
21.3.6. *Basic Training Program for Forensic Chemists*, US Department of Justice, Drug Enforcement Administration, Office of Science and Technology, pp, 5-61 through 5-72.

21.3.7. "Staff Skill Requirements and equipment recommendations for Forensic Science Laboratories." ST/NAR/2/Rev.1. United Nations Office on Drugs and Crime (UNODC) 2011. (digital reading)
21.3.8. Saferstein, Richard. *Forensic Science Handbook, Volume I and II*. Englewoord Cliffs, N.J.: Prentice hall, 1982, pp. 92-138.
21.3.9. Agilent MS instrument manuals
21.3.10. Clarke, E. G. C. (2004). *Clarke's Analysis of Drugs and Poisons in Pharmaceuticals, Body Fluids, and Postmortem Material* (3rd ed., Vol. 1-2). A. C. Moffat, Osselton, M. D., & Widdop, B. (Eds.) Grayslake, IL: Pharmaceutical Press.
21.3.11. Mills, T., Roberson, J. C., et al. *Instrumental Data for Drug Analysis, 3rd Edition*. CRC Press. 2005.
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
21.3.13. Yinon, J. *Forensic Applications of Mass Spectrometry*. CRC Press. 1995.
21.3.14. "A Practical Guide to the Care, Maintenance and Troubleshooting of Capillary Gas Chromatographic Systems", Rood, Dean, Wiley-VCH, New York, 1999
21.3.15. "Modern Practice of Gas Chromatography", Grob RL and Barry EF, New York , Wiley-Interscience; 3rd Ed., 1995
21.3.16. "Split and Splitless Injection for Quantitative Gas Chromatography, Concepts, Process, Practical Guidelines, Sources of Error", Grob K, Wiley-VCH, 4th Ed., 2001
21.3.17. "Gas Chromatography", Prichard E and Stuart B, Royal Society of Chemistry, 2003
21.3.18. "Derivatization Techniques for Gas Chromatography, Chromatography Today", Poole CF, Poole SK, Elsevier, 1991
21.3.19. "Mass Spectrometry – Principles and Applications", Hoffmann, E.de & Stroobant, V., editor, England, Wiley, 2001
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
21.3.23. "Mass Spectrometry – Analytical Chemistry by open Learning" - 2nd edition, James Barker, John Wiley & Sons Ltd, University of Greenwich, 1999
21.3.24. NIST 2011 Mass Spectral Library
21.3.25. Scientific Working Group for the Analysis of Seized Drugs (SWGDrug) Monographs. www.swgdrug.org
21.3.26. "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. United Nations Office on Drugs and Crime (UNODC). 2009. (digital reading)
21.3.27. Forensic Chemistry Section Standard Operating Procedures.
21.3.28. Forensic Chemistry Section Technical Manual.

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

22.3.1. Skoog, D. A., Holler, F. J., Nieman, T. A. Principles of Instrumental Analysis, 5th Edition. Harcourt Brace College Publishers. 1998. Chapter 28. Pg. 725-748, 509-511.
22.3.2. Saferstein, R. Forensic Science Handbook, 2nd Edition. Pearson Education, Inc. Upper Saddle River, NJ. 2002. Chapter 2 and pg 141.
22.3.3. Bell, S. Forensic Chemistry. Pearson Education, Inc. Upper Saddle River, NJ. 2006. Pg. 192-203.
22.3.4. Canaff, R. (1972). *Basic Training Program for Forensic Drug Chemists*. Washington, DC: U.S. Department of Justice Bureau of Narcotics and Dangerous Drugs.
22.3.5. Clarke, E. G. C. (2004). *Clarke's Analysis of Drugs and Poisons in Pharmaceuticals, Body Fluids, and Postmortem Material* (3rd ed., Vol. 1-2). A. C. Moffat, Osselton, M. D., & Widdop, B. (Eds.) Grayslake, IL: Pharmaceutical Press.

22.3.6. "High Performance Liquid Chromatography" - Analytical Chemistry by Open Learning, 2nd Edition, S.Lindsay, John Wiley & Sons, Chichester, West Sussex, U.K., 1992,ISBN 0-471-93115-2 (paperback)
22.3.7. "High-Performance Liquid Chromatography in Forensic Chemistry", Lurie IS, 1983
22.3.8. "Liquid Chromatography/Mass Spectrometry – Application in Agricultural, Pharmaceutical, and Environmental Chemistry", Mark A. Brown, Editor, American Chemical Society, Washington DC, 1990
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
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22.3.12. "Mass Spectrometry" – Analytical Chemistry by open Learning - 2nd edition, James Barker, John Wiley & Sons, University of Greenwich, 1999
22.3.13. "Liquid Chromatography/Mass Spectrometry, Systems and Applications", W.H. Mc Fadden, J.Chromatogr. Sci., 1980, 18, 97-102
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22.3.15. "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. United Nations Office on Drugs and Crime (UNODC). 2009. (digital reading)
22.3.16. Analysis of illicit diamorphine preparations by high-pressure liquid chromatography. Journal of Chromatography. 1975, 104(1), 205-10.
22.3.17. Forensic Chemistry Section Standard Operating Procedures.
22.3.18. Forensic Chemistry Section Technical Manual.

22.4. **Assessment**

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

23. Ultraviolet/Visible Spectroscopy (UV/VIS)

23.1. **Objectives**

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

23.1.1.1. Theory and mechanism of molecular light absorption and electronic transitions. Awareness of the electromagnetic spectrum.
23.1.1.2. Parameters that define electromagnetic radiation (frequency, wavelength, wavenumber)
23.1.1.3. Laws of absorption : The Beer-Lambert Law
23.1.1.4. Mechanism of UV/VIS as an identification technique, including limitations
23.1.1.5. The influence of solvents and PH on spectra (wavelength maxima and band intensities)
23.1.1.6. Mechanism of UV/VIS as an quantitation technique (basic laws, single components, multi-component systems, colourimetric measurements, difference spectrophotometry, derivative spectrophotometry)
23.1.1.7. Knowledge of quality assurance and method validation requirements

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

23.1.2.1. Instrumentation (colourimeters, single-beam spectrophotometers, double-beam spectrophotometers, rapid-scanning spectrophotometers, absorption cells)
23.1.2.2. Preparation and handling of various kinds of samples
23.1.2.3. Application of UV/VIS methodology in the qualitative analysis of drugs
23.1.2.4. Application of UV/VIS methodology in the quantitative analysis of drugs
23.1.2.5. Awareness of common operational problems and causes, troubleshooting, preventive maintenance

23.1.3. Familiarity with the UV/VIS instrumentation and software
23.1.4. Familiarity with the operational procedures
23.1.5. Ability to select operating parameters aiming at best results
23.1.6. Practice in the application of UV/VIS methodology in the analysis of drugs most commonly encountered
23.1.7. Understanding the advantages and limitations of the technique
23.1.8. Capacity of interpretation of the results obtained
23.1.9. Experience in quantitative UV/VIS analysis
23.1.10. Become familiar with Varian Cary® software and features
23.1.11. Become familiar with sources for identification such as Clarke and Mills
23.1.12. Learn how contaminants can affect UV analysis
23.1.13. Learn extraction techniques for UV analysis
23.1.14. Learn the application of UV analysis for quantitation

23.2. **Modes of Instruction**

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

23.3. **References**

23.3.1. Skoog, D. A., Holler, F. J., Nieman, T. A. *Principles of Instrumental Analysis, 5th Edition*. Harcourt Brace College Publishers. 1998. Chapters 13 and 14.
23.3.2. Moffat, A. C. Clarke's *Isolation and Identification of Drugs in Pharmaceuticals, body fluids, and post-mortem material, 2nd Edition. The Pharmaceutical Press. London.* 1986.

23.3.3. Bell, S. *Forensic Chemistry*. Pearson Education, Inc. Upper Saddle River, NJ. 2006. Pg. 149-161.
23.3.4. UV/Vis Absorption Spectroscopy Tutorial http://teaching.shu.ac.uk/hwb/chemistry/tutorials/molspec/uvvisab3.htm
23.3.5. Canaff, R. (1972). *Basic Training Program for Forensic Drug Chemists*. Washington, DC: U.S. Department of Justice Bureau of Narcotics and Dangerous Drugs.
23.3.6. Clarke, E. G. C. (2004). *Clarke's Analysis of Drugs and Poisons in Pharmaceuticals, Body Fluids, and Postmortem Material* (3rd ed., Vol. 1-2). A. C. Moffat, Osselton, M. D., & Widdop, B. (Eds.) Grayslake, IL: Pharmaceutical Press.
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23.3.13. Forensic Chemistry Section Standard Operating Procedures.
23.3.14. Forensic Chemistry Section Technical Manual.

23.4. **Assessment**

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

24. Infrared Spectroscopy (FTIR)

24.1. Objectives

24.1.1. Learn the theory of FTIR in drug analysis

24.1.1.1. Knowledge of the electromagnetic spectrum
24.1.1.2. Knowledge of the theory and mechanism of absorption and of vibrational and rotational spectroscopy
24.1.1.3. The Beer-Lambert Law
24.1.1.4. Knowledge of the mechanism of IR as an identification technique, (characteristic IR group frequencies and structure/spectra correlations)
24.1.1.5. Fourier transform infrared spectroscopy (FTIR) and the different techniques (KBr, ATR etc)
24.1.1.6. Familiarity with the various instrumental components and their functions
24.1.1.7. Awareness of common operational problems and causes, troubleshooting, preventive maintenance
24.1.1.8. Knowledge of quality assurance and method validation requirements

24.1.2. Knowledge of the application of IR in drug analysis

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

24.1.3. Ability to select operating parameters aiming at best results
24.1.4. Practice in the preparation and handling of various kinds of samples
24.1.5. Practice in the application of IR methodology in the analysis of drugs most commonly encountered
24.1.6. Understanding the advantages and limitations of the technique
24.1.7. Capacity of interpretation of the results obtained
24.1.8. Experience in quantitative IR analysis
24.1.9. Become familiar with Thermo-Nicolet OMNIC® software and features including baseline subtraction, library searching, data storage, and printing options
24.1.10. Become familiar with sources for identification such as Clarke and Mills
24.1.11. Learn extraction techniques for FTIR analysis

24.2. Modes of Instruction

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

24.3. References

24.3.1. Clarke, E. G. C. (2004). *Clarke's Analysis of Drugs and Poisons in Pharmaceuticals, Body Fluids, and Postmortem Material* (3rd ed., Vol. 1-2). A. C. Moffat, Osselton, M. D., & Widdop, B. (Eds.) Grayslake, IL: Pharmaceutical Press.
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24.3.4. Skoog, D. A., Holler, F. J., Nieman, T. A. *Principles of Instrumental Analysis, 5th Edition*." Harcourt Brace College Publishers, 1998. Chapters 16 and 17.
24.3.5. Gough, T. A. *The Analysis of Drugs of Abuse*. John Wiley & Sons Ltd. 1991.
24.3.6. Smith, F. P., Siegel, J. A. *Handbook of Forensic Drug Analysis.* Elsevier, Inc. 2005.
24.3.7. Canaff, R. (1972). *Basic Training Program for Forensic Drug Chemists*. Washington, DC: U.S. Department of Justice Bureau of Narcotics and Dangerous Drugs.
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.
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24.3.10. "Infrared Spectroscopy – Analytical Chemistry by Open Learning" W.O. George, P.S. Mcintyre, Editor: David J. Mowthorpe, John Wiley &Sons 1987
24.3.11. "Fundamental of Fourier Transform Infrared Spectroscopy, Brian C. Smith, CRC Press, 1996
24.3.12. "IR Spectroscopy: An Introduction", Günzler H and Gremlich HU, Wiley-VCH; 1st Ed., 2002
24.3.13. "Handbook of Fourier Transform Raman and Infrared Spectra of Polymers", Kuptsov AH and Zhizhin GN, Elsevier Science, 1998
24.3.14. "Infrared Spectroscopy: Fundamentals and Applications (Analytical Techniques in the Sciences)", Stuart BH, John Wiley & Sons, 2004
24.3.15. Mills, T., Robertson, J. C. *Instrumental Data of Drug Analysis, 3rd Edition.* CRC Press, 2005.
24.3.16. Scientific Working Group for the Analysis of Seized Drugs (SWGDrug) Monographs. www.swgdrug.org
24.3.17. "Staff Skill Requirements and Equipment Recommendations for Forensic Science Laboratories" ST/NAR/2/Rev.1. United Nations Office on Drugs and Crime (UNODC) 2011. (digital reading)
24.3.18. "Guidance for the Validation of Analytical Methodology and Calibration of Equipment used for Testing of Illicit Drugs in Seized Materials and Biological Specimens" ST/NAR/41. United Nations Office on Drugs and Crime (UNODC). 2009. (digital reading)
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 Flurosil columns
25.1.3.3. Column preparation, loading and eluting

25.1.4. Knowledge of the possibilities and limitations of the technique
25.1.5. Learn the acid/base properties of drugs
25.1.6. Learn different extraction and separation methods

25.2. **Modes of Instruction**

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

25.3. **References**

25.3.1. Moffat, A.C., editor. Clarke's *Isolation and Identification of Drugs*. London: The Pharmaceutical Press, 1986.
25.3.2. Bell, S. *Forensic Chemistry*. Pearson Education, Inc. Upper Saddle River, NJ. 2006. Pg. 85-115, 296-379.
25.3.3. Higuchi, T. et al. "Ion Pair Extraction of Pharmaceutical Amines" *Analytical Chemistry,* Vol. 39, 1967, p. 974.
25.3.4. Watson, D.G. *Pharmaceutical Analysis* New York: Churchill Livingstone, 1999, pp. 17-47.
25.3.5. Canaff, R. (1972). *Basic Training Program for Forensic Drug Chemists*. Washington, DC: U.S. Department of Justice Bureau of Narcotics and Dangerous Drugs.
25.3.6. Clarke, E. G. C. (2004). *Clarke's Analysis of Drugs and Poisons in Pharmaceuticals, Body Fluids, and Postmortem Material* (3rd ed., Vol. 1-2). A. C. Moffat, Osselton, M. D., & Widdop, B. (Eds.) Grayslake, IL: Pharmaceutical Press.
25.3.7. The Systematic Identification of Organic Compounds, 6th Edition, Shriner, R. L., Fuson, R. C., Curtin, D. Y., and Morrill, T. C., 1980,pp. 371-373.
25.3.8. Theory and Practice in the Organic Laboratory, 3rd Edition, Landgrebe, J., D. C. Heath & Co., Lexington, Massachusetts, 1982, pp. 78-86.

25.3.9. Martindale The Extra Pharmacopoeia, 36th Ed., Reynolds, James, E. F., Ed., The Pharmaceutical Press, London, 1989. General reference
25.3.10. The Merck Index, 14th or Current Edition, Budavari, Susan, Ed., Merck and Co., Inc., General reference.
25.3.11. Forensic Chemistry Section Technical Manual.

25.4. **Assessment**

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

Clandestine Laboratory Field Investigations

26. Common Clandestine Laboratories

26.1. Objectives

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

26.2. Modes of Instruction

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

26.3. References

26.3.1. Weaver, K. and Yeung, E. An Analyst's Guide to the Investigation of Clandestine Laboratories, 3rd edition. Health Protection Branch, Ontario Region Health Canada, 1995.
26.3.2. Clandestine Lab Basic Guide, presented at the 12th Annual Clandestine Laboratory Investigating Chemists Training Seminar, 2002.
26.3.3. Ely, Roger, et al. A Review of the Syntheses and Analyses of Phenyl-2-propanone, Amphetamine, and Methamphetamine. Clandestine Laboratory Investigating Chemists, 1995.
26.3.4. Bell, S. *Forensic Chemistry*. Pearson Education, Inc. Upper Saddle River, NJ. 2006. Pg. 360-375.
26.3.5. Smith, F. P., Siegel, J. A. Handbook of Forensic Drug Analysis. Elsevier, Inc. 2005. Chapter 8.
26.3.6. *Drug Identification Bible, 2014/2015 Edition*. Amera-Chem, Inc. Grand Junction, CO.
26.3.7. Clandestine Laboratory Investigating Chemists monographs.
26.3.8. Strike. Total Synthesis II, San Antonio, TX: Panda Ink, 1999.
26.3.9. Uncle Fester. Advanced Techniques of Clandestine Psychedelic & Amphetamine Manufacture. Port Townsend, WA: Loompanics Unlimited, 1988.
26.3.10. "Understanding clandestine synthetic drugs." Global Illicit Drug Trends 2001. United Nations Office on Drugs and Crime (UNODC). (digital reading)
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26.3.12. "Clandestine Manufacture of Substances under International Control", UNODC, ST/NAR/10/Rev.2, August 1998
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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

26.3.17. Canaff, R. (1972). *Basic Training Program for Forensic Drug Chemists*. Washington, DC: U.S. Department of Justice Bureau of Narcotics and Dangerous Drugs.
26.3.18. “Manual on the production of Synthetic Drugs”, Europol, The Hague, July 1999
26.3.19. “European Union Training Course for Trainers on the combating of Illicit Synthetic Drugs Laboratories, Course Standard”, Europol, The Hague, 1999
26.3.20. “Forensic Investigation of Clandestine Laboratories”, Donnell RC, CRC Press, 2004.
26.3.21. “Advanced Techniques of Clandestine Psychedelic and Amphetamine Manufacture”, Uncle Fenster, Loompanics Unlimited, 1998.
26.3.22. Forensic Chemistry Section Standard Operating Procedures.
26.3.23. Forensic Chemistry Section Technical Manual.

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)