****

**CHE 113: Forensic Science**

**COURSE INFORMATION**

*Course Website at* [*http://supa.syr.edu/Subjects/Chemistry/syllabi/*](http://supa.syr.edu/Subjects/Chemistry/syllabi/)

**Course Description and Prerequisite Skills**

Chemistry 113, Introduction to Forensic Science, is focused upon the application of scientific methods and techniques to crime and law. Recent advances in scientific methods and principles have had an enormous impact upon science, law enforcement and the entire criminal justice system. In this course, scientific methods specifically relevant to crime detection and analysis will be presented. No prior chemistry instruction is required or assumed but the course should appeal to those who have had high school chemistry. Emphasis is placed upon understanding the science underlying the techniques used in evaluating physical evidence. Topics included are blood analysis, organic and inorganic evidence analysis, fingerprints, hair analysis, DNA, drug chemistry, forensic medicine, forensic anthropology, toxicology, fiber comparisons, soil comparisons, and fire and engineering investigations, among others.

|  |  |  |
| --- | --- | --- |
| IR Heroin | **Introduction to Forensic Science: The Science of Criminalistics***James T. Spencer, Syracuse University* |  |

Table of Contents

*I. Introduction*

**Chpter 1**: Introduction to Forensic Science: *Introduction, Historic Development, and Legal Roles of Forensic Science*

1.1. Introduction to Forensic Science

1.2 Brief History of Forensic Science

1.3 Crime Detection in Literature

1.4 Dynamic Duo of Principles

Locard’s Principle

Principle of Individuality

1.5 Legal Precedent of Science in the Courtroom

First There Was Frye

Trilogy of Cases: Daubert and Friends

Recent Additions: Melendez-Dias

 References and Bibliography

 Glossary of Terms

 Questions for Further Practice and Mastery

**Chapter 2:** *Crime Scene Investigations*

 2.1 Crime Scene Evidence

Introduction

Types of evidence

Comparison Analysis

 2.2 Legal Evidence

 Evidence Collection and the Law

 4th Amendment, Mincy and Tyler cases

 2.3 The Evidence Collection and the Evidence Team

Processing the Crime Scene

Evidence Teams

Types of Crime Scenes

References and Bibliography

Glossary of Terms

Questions for Further Practice and Mastery

 **Chapter 3:** *Science, Pseudoscience and the Law*

 3.1 A Test for Science: Science v. Pseudoscience in the Courtroom

Introduction

What is Science?

The Scientific Method

The Scientific Method and Forensic Science

What is Pseudoscience?

 3.2 Statistics and Probability in Forensic Science

Introduction

Statistics in Forensic Analysis

Probability in Forensic Analysis

 3.3 Ethics in Forensic Science

References and Bibliography

Glossary of Terms

Questions for Further Practice and Mastery

*II. Biological Evidence*

**Chapter 4**: *Methods for Examining Biological Evidence*

4.1 Methods For Biological Evidence – Measurement

Introduction

Observation, Measurement and Forensic Science

Estimating the Reliability of Measurements

4.2 Biological Evidence and Microscopy

Tools for Understanding Biological Evidence

Microscopy Basics

4.3 Optical Microscopy

Bright Field Optical Microscopy

Dark Field Optical Microscopy

Polarized Light Microscopy

Phase Contrast Microscopy

Fluorescence Microscopy

Infrared Microscopy

Stereo Microscopy

Comparison Microscopy

Staining Techniques in Microscope

Other forms of Optical Microscopy

4.4 Electron Microscopy

Electron Microscopy Basics

Scanning Electron Microscopy (SEM)

Transmission Electron Microscopy (TEM)

References and Bibliography

Glossary of Terms

Questions for Further Practice and Mastery

**Chapter 5**: Biochemical Forensic Analysis I: DNA

5.1 DNA: The Genetic Record

Introduction

5.2 How DNA Works

Introduction

DNA Background

5.3 Forensic Applications of DNA

DNA Typing: Restriction Fragment Length Polymorphism

DNA Typing: Polymerase Chain Reaction Methods

DNA STR Typing

Mini-STR and SNP DNA Profiling

5.4 Mitochondrial DNA and Y Chromosomal Typing

Mitochondrial DNA

Y Chromosomal Typing

Plant and Animal DNA typing

5.5 DNA Databanks: CODIS and Beyond

CODIS

Project Innocence

Summary

Interesting DNA Cases for Further Study

References and Bibliography

Glossary of Terms

Questions for Further Practice and Mastery

**Chapter 6**: *Biochemical Forensic Analysis II: Serology*

6.1 Biochemical Forensic Analysis II: Serology, Blood and Immunoassay: The Fluid of Life

 Introduction

 6.2 Blood and Immunoassay

Background and History of Blood Analysis in Crime Detection

General Definitions

Blood Chemistry

Blood Testing

Is It Blood?

Is It Human Blood?

Whose Blood Is It?

Blood Inheritance and Parental Testing

 6.3 Blood Pattern Analysis

 Introduction

Blood Patterns

Passive bloodstains

Active bloodstains

Transfer bloodstains

Collecting and Preserving Blood Evidence

 6.4 Serology and Other Biological Fluids

Introduction

Saliva

Semen

Urine

Other Body Fluids

 Interesting DNA Cases for Further Study

References and Bibliography

Glossary of Terms

Questions for Further Practice and Mastery

**Chapter 7**: Anatomical Evidence: The Outside Story

7.1 Anatomical Evidence

Introduction

7.2 Fingerprints

Background and Introduction

Skin: the Amazing Organ

Development and Structures of Fingerprints

Fingerprint Patterns

Comparing Fingerprints

Computerized Methods: IAFIS, NGI, and Beyond

Uses of Fingerprints: Identification vs. Authentication

Observing Fingerprint Patterns

Preserving Visualized Fingerprints

Legal Challenges to Fingerprint Evidence

Palm and Footprint Evidence

Ear and Lip Pattern Evidence

7.3 Hair Analysis

Introduction

Hair and Fur

Composition of Hair

Hair Structure

How Hair Grows

Sex and Ethnic Differences in Hair Structure

Hair Treatment

Diseases of the Hair

Hair Toxicology

Hair Comparison and Identification

Nails

7.4 Fiber Analysis

Introduction

What Are Fibers?

Natural Fibers

Regenerated Fibers

Synthetic Fibers

Polymers

Forensic Analysis of Fibers

Collection of Fibers in Larger Pieces

7.5 Biometrics

History of Biometrics

Biometrics Basics

Biometric Methods

Types of Biometric Traits

Automated Biometric Identification System (IDENT)

References and Bibliography

Glossary of Terms

Questions for Further Practice and Mastery

**Chapter 8**: Forensic Medicine: The Inside Story

8.1 Forensic Pathology and Medicine

Introduction

History

Medicolegal Practice

Medicolegal Death Investigation

When Are Autopsies Performed?

Information from an Autopsy

The Autopsy

Major Organ Systems Examined

Common Types of Trauma

Mass Disasters

8.2 Forensic Radiology

Introduction to Forensic Radiology

History of Biomedical Imaging

Radiology in Forensic Investigations

X-ray Imaging Methods

Magnetic Resonance Imaging (MRI)

Virtual Autopsy: Virtopsy

References and Bibliography

Glossary of Terms

Questions for Further Practice and Mastery

**Chapter 9**: Forensic Anthropology

9.1 Forensic Anthropology: The Enduring Record

Background and Introduction

Forensic Information Provided by Forensic Anthropology

Human Skeletal Anatomy

Five Central Questions of Forensic Anthropology

Facial Reconstructions

Crime Scene Processing

9.2 Forensic Taphonomy

Background and Introduction

Postmortem Modifications

 Interesting Forensic Anthropology Cases for Further Study

References and Bibliography

Glossary of Terms

Questions for Further Practice and Mastery

**Chapter 10**: Forensic Ecology

Forensic Ecology

Forensic Entomology

Forensic Botany

Forensic Palynology and Mycology

Forensic Zoology

*III. Chemical Evidence*

**Chapter 11:** *Overview of Chemical Evidence*

Methods in Analytical Chemistry

Atoms, Molecules and Separation Sciences

Basic Atomic Theory

Molecules and Compounds

Purification Methods

Physical Separations

Chromatography: GS, LC, HPLC

Chemical Separations

Classical Chemical Analysis

Combustion Analysis

Gravimetric Analysis

Volumetric (Titrimetric) Analysis

**Chapter 12:** *Forensic Spectroscopy*

Introduction to Forensic Spectroscopy

Spectroscopy Basics: the Strange World of Quantum Mechanics

Atomic Spectroscopy

Atomic Absorption Analysis

Atomic Emission Spectroscopy

Atomic Fluorescence Spectroscopy

Neutron Activation

ESCA, Auger, and Other Related Forms of Atomic Spectroscopy

Molecular Spectroscopy

UV-Visible

Infrared Spectroscopy

Microwave, Terahertz, X-ray, and Related Spectroscopies

Mass Spectrometry

Radiochemical Analysis

**Chapter 13:** *Forensic* *Toxicology*

Introduction

Poisons and Toxins

Medicinal Chemistry and Pharmaceuticals

Drugs of Abuse

Alcohol

Forensic Toxicology Sampling and Analysis

**Chapter 14:** *Explosives and Arson*

*IV. Physical Properties in Evidence*

**Chapter 15:** *Physical Properties:* *Mineralogical, Soil, Glass, and Paint Analysis*

15.1 Physical property measurements

Introduction

Chemical and Physical Properties

Intrinsic and Extrinsic Properties

Density

Viscosity

Refractive Index

Birefringence

Color and Optical Properties

Electrical Properties

15.2 Forensic Geology, Soil and Minerals

Introduction

Forensic Geology

15.3 Forensic Glass and Plastic Analysis

Introduction

Glass

Plastic

 15.4 Paints and Coatings

Introduction

Paint Composition

Forensic Paint Analysis

**Chapter 16:** *Firearms, Ballistics, and Impression Evidence*

**Chapter 17:** *Forensic Document Analysis, Paleography, Audio, Photographic and Video Analysis*

Forged Documents

Handwriting Analysis

Photographic and Video alterations

Audio Analysis and Forensic Linguistics

**Chapter 18:** *Engineering* *and Computer Forensics*

Forensic Engineering and Failure Analysis

Computer and Internet Forensics

Cybersecurity

*V. Behavioral Forensic Evidence*

**Chapter 19:** *Behavioral Social Sciences: Psychology and Sociology*

Introduction to Behavioral Science: Psychology and Sociology

Background for Behavioral Forensic Sciences

Forensic Psychology

Uses of Forensic Psychology

Pretrial Uses of Forensic Psychology

Crime Scene Analysis

Victimology

Interrogations and Interviews

Eyewitnesses

False Confessions

Profiling

Other Uses

Trial Uses of Forensic Psychology

Jury Selection

Competency to Stand Trial

Defenses based upon mental diseases or defects

Legal Insanity

Diminished Capacity

 Other Uses

Post-trial Uses of Forensic Psychology

 19.2 Forensic Psychological Testing

General Psychological Tests

Projective Tests

Personality Inventories

Intelligence and Cognitive Function Tests

Brain Function and Impairment Tests

Specific Disorder Tests

Specialized Forensic Tests

Psychological Autopsy

Conclusions

**CHE 113 LAB**

Rules and Regulations

1. You will work in pairs in the laboratory, but you are required and responsible for doing your own laboratory write-up.

2. Students are expected to complete their lab on their assigned day and hand-in the laboratory write-up at the end of the laboratory that same day. If a student wants to switch days one week, permission must be obtained from one of the instructors at least one week before the scheduled lab.

3. Each student is expected to present at the start of the laboratory, during this time the experimental set-up and safety procedures for each lab is discussed by the instructors. Students who show up late will be penalized.

4. Late labs will be penalized. After five days you will receive a zero for the lab.

5. Each person is responsible for wiping down his/her work area with a damp sponge or paper towel and washing all glassware with soap and water at the end of each lab period.

6. If you are in violation of any safety guidelines, you will be asked to remedy the situation only once. The next time you will be asked to leave lab for that day. There will be no make-up labs.

Safety Guidelines

1. Safety glasses must be worn at all times while in lab. You will be given one warning. If it happens a second time you will be asked to leave lab and you will receive a zero for the lab.

2. Do not wear contacts in lab. Wear your glasses.

3. If glassware breaks and/or chemicals spill, inform the instructor. Do not try and clean the spill and/or glass yourself without contacting the instructor FIRST.

4. If you cut/burn yourself and/or spill anything on your clothing and/or skin in lab, inform the instructor immediately.

5. Long hair must be tied back.

6. Avoid wearing loose clothing and jewelry.

7. Wash your hands before leaving lab and going to the bathroom.

8. Do not sit on the lab benches.

9. Do not eat or drink in lab at any time.

10. No open-toed shoes, sandals or shorts may be worn in lab at any time.

11. Use the disposable gloves provided when required and change them frequently.

**LABORATORY SAFETY NOTES**

**Chemistry 113**

**Safety is the MOST important issue that you will deal with this semester. Take the laboratory and its risks seriously. Understanding these risks and minimizing them is the best way to avoid accidents. If you follow these guidelines and stay alert to possible hazards, your experience in this course should be a safe and productive one.**

**SAFETY GLASSES MUST ALWAYS BE WORN IN LAB!!**

**Hazards** - The main potential hazards in the laboratory are fire and exposure to toxic and/or reactive substances. Though toxicity and reactivity of compounds varies tremendously, an excellent policy is to handle EVERY chemical with respect and caution. Be aware that you may be exposed to chemicals in several ways: inhalation, skin contact (some chemicals go right through the skin), and ingestion.

 In case an accident occurs, report it immediately! Do not try to hide anything out of embarrassment - you will be making the situation worse, endangering yourself and others. Let the instructors decide on the proper course of action. Those not involved should clear the area.

 The following is taken in part from “The Organic Chem Lab Survival Manual”, by James W. Zubrick. Please excuse the jokes he uses, I will not claim any responsibility for them.

**SAFETY FIRST, LAST, AND ALWAYS**

Disobeying safety rules is not at all like flouting many other rules. You can get seriously hurt. No appeal. No bargaining for another 12 points so you can get into medical school. Perhaps as a patient, but certainly not as a student.

1. SAFETY FIRST! When in doubt, ask the instructor!

2. Always wear your goggles. Eye injuries are extremely serious, but they can be mitigated or often prevented if you keep your goggles on at all times. There are several types of eye protection available, some acceptable, some not, according to the local, state, and federal laws. I like the clear plastic jobbers that leave an unbroken red line on your face when you remove them. Sure they fog up a bit, but the protection is superb. Also, think about getting chemicals, or chemical fumes trapped under your contact lenses. Then don't wear them to lab. Ever.

3. Touch not thyself. Not a biblical injunction, but a bit of advice. You may have gotten chemicals on your hands, in a concentration that is not noticeable. Sure enough, up go the goggles for an eye wipe with the fingers. Enough said.

4. There is no "away". Getting rid of chemicals is a very big problem. (Throw all waste in appropriately labeled jars)

5. Bring a friend. If you have a serious accident when you are all by yourself, you might be unable to get help before you fall over.

6. Don't fool around. Chemistry is a serious business. Don't be careless or clown around the lab. You can hurt yourself or other people. Try not to be somber about it; just serious.

7. Drive defensively. Work in the lab as if someone else were going to have an accident that might affect you. Keep the goggles on because someone else is going to point a loaded, boiling test tube at you. Someone else is going to spill hot, concentrated acid on your body. Get the idea?

8. Eating, drinking, smoking in the lab. Are you kidding? Eat in a chem lab?? Drink in a chem lab??? Smoke, and blow yourself up!!!!

9. Keep it clean. Work neatly. You don't have to make a fetish out of it, but try to be neat. Clean up spills. Turn off burners or water or electrical equipment when not in use.

10. Where it's at. Learn the location and proper use of the fire extinguishers, fire blankets, safety showers, and eyewashes.

11. Make the best-dressed list. No open-toed shoes or sandals. No loose-fitting cuffs on pants or shirts. Keep the midsection covered. Tie back that long hair. A small investment in a lab coat can pay off, projecting that professional touch. It gives a lot of protection.

**ACCIDENTS WILL NOT HAPPEN**

 That's the attitude you should hold while working in the laboratory. You are NOT going to do anything, or get anything done to you, that will require medical attention. If you do get cut, and the cut is not serious, wash the area with water. If there's serious bleeding, apply direct pressure with a clean, preferably sterile dressing. For a minor burn, let cold water run over the burned area. For chemical burns to the eyes or skin, flush area with lots of water. In every case get to see a physician.

 If you have an accident, tell your instructor immediately. Get help! This is no time to worry about your grade in lab. If you put your grades ahead of your personal safety, be sure to see a psychiatrist after the internist finishes.