

Trace Evidence and Microscopy
CHE 347
(4 credits)

Cedar Crest College
Department of Chemistry
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Lawrence Quarino, Ph.D.
M8
(610) 606-4666 x3567
laquarin@cedarcrest.edu

Course Syllabus

Trace Evidence and Microscopy

Introduction

Trace evidence analysis is a part of the area of forensic science known as criminalistics. Criminalistics involves the recognition, identification, and individualization of physical evidence from criminal investigations. The attempt at individualization (in other words, trying to determine an unique or particular source of an item of physical evidence) is what separates criminalistics from all other scientific endeavors. Through individualization, criminalistics attempts to link victims with suspects and people with crime scenes that subsequently can lead to the reconstruction of crimes. The purpose of this course is to acquaint the student with the philosophy and methodology of dealing with physical evidence, specifically trace evidence. Trace evidence can be defined as those types of evidence that often require microanalysis. The term trace evidence is associated with physical evidence such as hairs, fibers, glass, paint, and soil. Implicit in the term “microanalysis” is the use of the microscope as an analytical tool. Arguably, the microscope is the most important instrument in the analysis of trace evidence. In this course, students will be introduced to some of the qualitative and quantitative uses of microscopy in trace evidence analysis. In addition to microscopic analysis, other methodologies will be discussed as well. No attempt will be made to provide the student with all the techniques he or she will need to know to work in a forensic science laboratory. Instead, a general approach is designed to give the student a sound, fundamental base upon which to build. The laboratory aspect of this course will consist mainly of work on unknowns designed to simulate physical evidence problems and to stimulate thinking about them. The lecture part of the course will provide much of the theoretical knowledge required to complete the exercises.

Work on the unknowns will begin in the order in which the exercises are presented in this syllabus. However, because certain exercises will require equipment of limited availability, it may be necessary for students to rotate through later exercises. In most cases, students will not work on an exercise prior to the time that the theoretical foundation for the techniques used has been laid in lecture.

Good laboratory procedure should be practiced as an integral part of each and every experiment. Care should be exercised to avoid contamination problems. For example, pipettes should never be placed in a stock reagent bottle, and aliquots of reagents should not be returned to stock bottles. Unfortunately, some methods will require the use of toxic chemicals. The instructor prior to the use of such chemicals will discuss safety guidelines in which all students are expected to follow. In fact, each chemical used should be handled as though it is hazardous, whether or not it is known to have any risk associated with its use.

Course Objectives:

1. To familiarize the student with basic concepts of criminalistics and the role of a criminalist in a forensic investigation.
2. To introduce the student to light and polarized light microscopy as an analytical tool in forensic analysis.
3. To discuss the different types and analyses of trace evidence typically encountered in a forensic investigation and to teach the strengths and limitations of each.
4. To develop good laboratory technique in the handling and analysis of trace materials.
5. To develop good laboratory documentation skills.
6. To introduce the student to the proper documentation and handling of physical evidence containing trace evidence.
7. To introduce the student to forensic science literature.

Course Outcomes:

1. The student will understand basic concepts in criminalistics and the use of the scientific method in a forensic investigation.
2. The student will understand basic theoretical concepts in light and polarized light microscopy. Each student will also understand the basic analytical measurements typically used by forensic microscopists.
3. The student will demonstrate basic competence in the analytical methods presented in the course during laboratory exercises.
4. The student will demonstrate good documentation skill in the description of analyses and of physical evidence.
5. The student will learn the different types of trace evidence typically encountered in a forensic investigation and the strengths and limitations of each.
6. The student will learn the descriptive parameters and techniques of analysis for different types of trace evidence.
7. The student will become familiar with the various peer-reviewed journals in forensic science.

Course Assessment

Progress in lecture will be monitored through 3 written in-class examinations (2 of which will be given during the semester and 1 during the final examination period) and 1 take home examination. The professor reserves the right to give pop-quizzes at any point (each quiz will be worth two points to be subtracted or added to the final grade). The professor also reserves the right to give additional credit to those students who answer correctly (or at least on the right track) when called upon in class and to deduct credit from those students that answer inadequately.

Each student will also submit one typed written report on forensic science literature and give one class presentation on a journal article related to trace evidence analysis.

Required Text: Forensic Science Handbook, Volume I, Second Edition
R Saferstein, editor.
Pearson Education (Prentice-Hall), 2002.

CHE 347 Lab Manual, L. Quarino

Required Reading: Forensic Science Handbook, Volume II,
R Saferstein, editor,
Prentice-Hall, 2005
Chapters 4-6

Forensic Examination of Fibres,
JR Robertson, M. Grieve, editors
CRC Press, 1999
Chapters 8 and 10

Forensic Examination of Glass and Paint,
B Caddy, editor
CRC Press, 2001
Chapter 11

Other Readings May Be Assigned During the Semester

Other Materials: Laboratory supply box

Lecture Time: Tu, Th 8-9:15

Lecture Outline

Topic

Reading Assignment

August 26, 28

I. Course Introduction

II. An Introduction to Trace Evidence

Saferstein, Volume II, Chapter 5

- A. Collection of Trace Evidence
from Crime Scene and Physical
Evidence

September 2, 4

III. Drug Analysis

Saferstein, Volume II, Chapter 4

- A. Survey of controlled substances
- B. Spot and microcrystalline tests
- C. Chromatographic methods of
analysis
- D. Spectrophotometric methods of
analysis

September 9, 11

IV. Optics

Saferstein, Volume I, Chapter 5

- A. Reflection
 - a. Image Formation
 - 1. Plane mirrors
 - 2. Concave mirrors
 - 3. Convex mirrors
- B. Refraction
 - a. Refractive Index and Dispersion
 - 1. refractive index
at normal incidence
 - 2. refractive index at
other than normal incidence
 - 3. critical angel of reflection
 - b. Simple lenses
 - 1. lens theory
 - 2. magnification
 - 3. aberrations

Topic

Reading Assignment

September 16, 18, 23

V. Types of Microscopes

Saferstein, Volume I, Chapter 5

- A. Simple
- B. Stereomicroscope
- C. Comparison
- D. Compound
 - a. objectives
 - b. substage condenser
 - c. numerical aperture
 - d. resolution and Abbe's theory of image formation
 - e. oculars
 - f. illuminators and illumination
 - i. color temperature
 - ii. Kohler illumination
 - g. visibility and image contrast
 - i. phase images
 - ii. absorption images
 - iii. contrast techniques
- E. Phase Contrast
- F. Dark Field

September 25,30

VI. Microspectrophotometry

Robertson, Grieve, Chapters 8, 10

October 7

Exam #1

October 9

VII. An Introduction to Forensic Science Literature

Paper, Literature Search, and Presentation Assigned

October 16

VIII. Forensic Hair Examination

Saferstein, Volume I, Chapter 7

October 21, 23, 28

IX. Polarized Light

- A. polarization by reflection, absorption, and double refraction
- B. components of PLM
- C. image formation by interference
- D. orthoscopic observations
- E. conoscopic observations

Topic

Reading Assignment

October 30

X. Fiber Examination

Saferstein, Volume II, Chapter 6

Titles for Presentation Due

November 4 - Exam #2

November 6

XI. Soil Examination

Saferstein, Volume I, Chapter 11

November 11

XII. Paint Examination

Saferstein, Volume I, Chapter 8

Literature Search Due

November 13

XIII. Glass Examination

Saferstein, Volume I, Chapter 4

November 18

XIV. Scanning Electron Microscopy

Caddy, Chapter 11

November 20

XV. Arson and Explosives Debris

Saferstein, Volume I, Chapter 9

November 25, December 2,4

Student Presentations

Take Home Exam Assigned – November 25

Take Home Exam Due – December 2

Paper Due – December 4

There will be a **cumulative** final examination that will be held during the final exam week.

Grading

Your final grade will be determined as follows:

| | |
|-------------------|-----|
| Exam #1 | 20% |
| Exam #2 | 20% |
| Take Home Exam #3 | 20% |
| Final Examination | 30% |
| Paper | 5% |
| Presentation | 5% |

If the grade on the final examination is higher than any grade on exams #1-3, it will replace the grade on exam #1-3 provided the grade on the final is 70 or above.

Letter grades will be assigned as follows:

| | |
|---------|----|
| 90-100% | A |
| 88-89% | B+ |
| 80-87% | B |
| 78-79% | C+ |
| 70-77% | C |
| 68-69% | C- |
| 60-67% | D |
| <59% | F |

Community Standards for Academic Conduct

Academic integrity and ethics remain steadfast, withstanding technological change. Cedar Crest College academic standards therefore apply to all academic work, including, but not limited to, handwritten or computer-generated documents, video or audio recordings, and telecommunications.

As a student at Cedar Crest College, each student shall:

- Only submit work which is her own.
- Adhere to the rules of acknowledging outside sources, as defined by the instructor, never plagiarizing or misrepresenting intellectual property.
- Neither seek nor receive aid from another student, converse with one another when inappropriate, nor use materials not authorized by the instructor.
- Follow the instructions of the professor in any academic situation or environment, including taking of examinations, laboratory procedures, the preparation of papers, properly and respectfully using College facilities and resources, including library and computing resources to ensure that these resources may be effectively shared by all members of the College community.
- Abide by the Cedar Crest Computer Use Policy.
- If a student perceives a violation of the Academic Standards, he/she will go to their instructor.
- If you are unable to resolve the problem with the instructor, you should go to the chair of the department. If you need further assistance after consultation with the instructor and the chair, you should see the Provost.

Classroom Protocol

Appropriate classroom behavior is defined and guided by complete protection for the rights of all students and faculty to a courteous, respectful classroom environment. That environment is free from distractions such as late arrivals (students will be deducted one point from each late arrival after the second time), early departures, inappropriate conversations and any other behaviors that might disrupt instruction and/or compromise students' access to the Cedar Crest College education.

Attendance in lecture and laboratory are mandatory. It is understood that students may need to miss class or laboratory due to illness or personal obligations. Students needing to be absent from class must contact the instructor prior to class or laboratory. Students with valid reasons will not be penalized. In all cases, students will be responsible for all material covered in the missed class. Make-up exams will be given only in the event of illness or compelling personal matter. If a make-up exam is not granted, the final examination will include the percentage for the missed exam. If the instructor is not notified prior to the exam, documentation explaining the reason for the absence may be required.

Students will not be allowed any unexcused absences. For each unexcused absence, students will be deducted 1% from their final grade.

Honor Philosophy

The Cedar Crest College Honor Philosophy states that students should uphold community standards for academic and social behavior in order to preserve a learning environment dedicated to personal and academic excellence. Upholding community standards is a matter of personal integrity and honor. Individuals who accept the honor or membership in the Cedar Crest College community of scholars pledge to accept responsibility for their actions in all academic and social situations and for the effect their actions may have on other members of the College community.

Violations of the academic honor code will be dealt with according to the Cedar Crest College Forensic Science Program Policy and Procedures Manual.

An Introduction to Forensic Science Peer-Reviewed Literature

Like other scientific disciplines, the primary vehicle for the advancement of forensic science occurs through publications in peer-reviewed journals. Journal articles are published that deal with research into new methods or technology, the evaluation of existing methods for forensic purposes, case reports, reviews of textbooks, and general reviews of forensic topics. Members of the journal's review board who decide whether the article is deemed worthy of publication scrutinize submitted articles. Other scientists familiar with the content of the article perform review of articles. Publication in a peer review journal allows for any scientist to judge the value of the work. Such mass review allows for the free flowing exchange of ideas between scientists. Scientists wishing to comment on the article can do so by writing a letter to the journal's editorial board. Publications can also be discussed at scientific meetings and conferences. The general acceptance by the forensic science community of a particular test or procedure begins with both publications in peer review journals and presentations at scientific meetings. As stated in both the Frye and Daubert decisions dealing with the admissibility of scientific evidence, one criterion needed for acceptance of expert testimony dealing with a particular scientific test or procedure is publication in a peer review journal. Publication lends credibility to a scientist's work.

This assignment is designed to introduce you to peer reviewed forensic science journals and literature. Students are expected to be familiar with the forensic science journals available through the Cressman library. There are six such journals (three are on-line and three are hard copy only). At random, students will be asked questions about the contents of all volumes submitted to the library since January 2006. All students should make their first visit to the library by October 16. Credit will be added or subtracted from your paper/literature grade depending on the quality of your answers.

The instructor will also discuss the accepted style for citation of sources in forensic science peer-reviewed journals.

Assignment

1. List the **peer reviewed** forensic science journals in the Cressman library and find an additional forensic science journal on-line. What professional organizations are each associated with?
2. How many times a year is each journal published?
3. Examine the table of contents of each publication for the 4 library journals published in calendar year 2006, 2007, and so far in 2008. Tabulate the number of articles dealing with different areas of forensic science (e.g. fiber analysis, DNA, pathology). What does this tell you about the direction of forensic science research?

4. Find a research article on **trace evidence** that interests you (this article must be different than the one used for your presentation). If possible, find an article that deals with subject matter you studied in this course. Consider the following:
 - A. What is the purpose of the article? Is it clearly stated by the author?
 - B. What is the experimental hypothesis?
 - C. What methods did the author use to investigate the topic?
 - D. What was the research design (e.g. number of samples tested, what kind of statistical evaluation was used)?
 - E. What evidence does the author produce in proving or disproving the hypothesis? What are the strengths and weaknesses of the evidence presented by the author?
 - F. Give an evaluation of the article. How much benefit do you believe the article will have on forensic science? Who will benefit?
5. Find a previous publication that the author cited in the article and which served as an influence or reason that the current work was conducted. Find and read that article. How did the earlier work influence the article? Did the work presented in the article expand or improve on the earlier work?
6. What future work should be done to improve on the current article?

This will be the only assignment that needs no entry in your laboratory notebook. Prepare the assignment in a 2-4 page typed report. Write the report in essay form and do not break up the paper into the six sections outlining the assignment.

Presentation

Using the guidelines below, each student must give a 10-minute class presentation on the article they selected. You must submit the name and citation of your article by October 30 to avoid duplication. It must be a different article than the one you select for your paper. The names of the articles will be submitted to each student in order for each student to have the opportunity to read them.

Guidelines for Projection of Paper Presentation

1. Dark background and light text give good contrast and show up well in a darkened room. Avoid color combinations such as red and blue, yellow and green, etc.
2. Times New Roman is the recommended font style.
3. Do not use a font below 24 pt.
4. Limit a frame to a single idea or point.
5. Do not crowd the frame. Limit the number of text lines per frame to a maximum of seven.
6. Use simple graphs and illustrations with a minimum of captions. Avoid using thin lines, dots, dashes, or other specialty lines unless they are very bold and black.
7. Do not read off slide.

Guidelines for Format of Paper Presentation

The presentation should follow the following outline:

1. Title slide.
2. Goals and objective of study.
3. A history of previous work in the subject area and how the presented paper hopes to contribute to the body of knowledge in the subject area.
4. Methods.
5. Data and data analysis (including statistics).
DO NOT PRESENT TABULATED DATA, Use graphs or charts
6. Conclusions.
7. Significance of study and future considerations.