CLS Investigation: Exploiting the Forensics Craze I

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There are similarities between clinical laboratory science (CLS) and forensic laboratory science that educators can exploit for recruitment and public relations activities. Many CLS techniques are also used in forensics and some relatively simple forensics techniques can be brought into the CLS laboratory for a cohesive laboratory experience that simultaneously exposes interested students to both fields.

ABBREVIATIONS: AAFS = American Academy of Forensic Science; CLS = clinical laboratory science; CODIS = combined DNA index system; DNA = deoxyribonucleic acid; FBI = Federal Bureau of Investigation; PCR = polymerase chain reaction; RFLP = restriction fragment length polymorphisms; STR = short tandem repeats; VNTR = variable numbers of tandem repeats.

INDEX TERMS: clinical laboratory science; forensic science; student recruitment.

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Recruitment into the clinical laboratory science (CLS) field has been challenging for at least the last two decades, but the recent popularity of crime investigation television shows has sparked interest in science and laboratory work. Students are often dazzled by the idea of solving crimes without any real sense of the division of labor for criminal investigation, the nature of real laboratory work, the education required, or the job market, including salaries. CLS educators have a unique opportunity to introduce realism into students' career choices and to discuss CLS as a viable career choice.

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THE TRUTH ABOUT FORENSICS

Television shows often depict characters who show up at crime scenes to gather evidence, interview suspects, and then head to the laboratory to do all the analyses. Students therefore have a poor sense of the compartmentalization that occurs in the real world. Sworn police officers who carry weapons typically do the interviewing and investigation. Specialized crime scene technicians arrive at the scene to gather and label evidence. Many forensic scientists who are the ones who actually do the various analyses rarely work outside the laboratory. Further, these scientists are typically highly specialized, doing only toxicology or DNA analysis, for example. What, then, do educators do when students say they want to major in "forensics"?

ADVISING THE "FORENSICS" STUDENT

The American Academy of Forensic Science (AAFS) website (www.aafs.org) lists the following divisions within the organization: criminalistics, engineering sciences, general, jurisprudence, odontology, pathology/biology, physical anthropology, psychiatry and behavioral science, questioned documents, and toxicology.[1] AAFS lists the typical job profile and education required for work in each area. Students interested in majoring in "forensics" should know that there are a multitude of specialties within the field, each requiring a unique combination of education, training, and skills. As examples, a degree in dentistry with additional forensic training is required for odontology, a medical degree with pathology and forensic pathology training is required to be a medical examiner, and a PhD in anthropology with emphasis in osteology and anatomy is required for a forensic anthropologist. Further, many career choices require graduate school and/or fellowships and internships after graduate school, so there is no simple way to major in "forensics".

The good news is, however, that AAFS recommends that students first earn a bachelor's degree in science with solid foundational courses in chemistry, biology, math and English composition.[1] After that, students should focus on particular career choices, training programs, and/or graduate schools. This is obviously where discussion of the CLS major fits, particularly for students interested in laboratory work. The typical prerequisites for CLS programs would satisfy many of the requirements for forensic science, and the CLS degree would give students an immediately marketable degree and extensive laboratory skills that could easily be transferred to another career choice. It has always been true that CLS educators are aware of multiple career paths that graduates can take, but given that there is currently significant interest in "forensics", CLS educators should also consider being able to accurately and ethically advise students who may be benefit from using the CLS degree as a conduit for a forensics career goal.

RECRUITMENT ACTIVITIES

Our CLS program has participated in various types of recruitment activities too numerous to list here. Lecture-type recruitment presentations may be easier, but they are often less effective. A common theme of our most successful efforts has been using hands-on laboratory activities, and students have generally enjoyed doing a variety of medical laboratory tests, sometimes using their own specimens. What's missing from this type of activity, though, is a motivation to know the test result to answer a specific question. The beauty of combining CLS and forensics is that motivation is given to solve a "crime" by not only doing a laboratory test but doing it correctly.

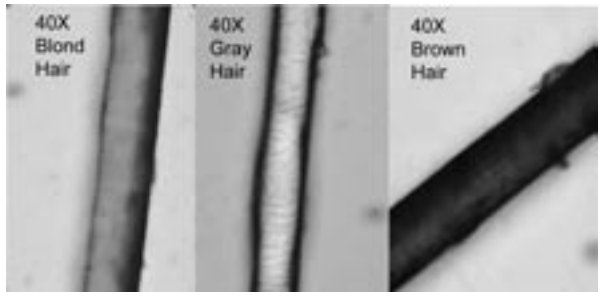
First, CLS educators should familiarize themselves with laboratory techniques used in forensics. The texts cited in the reference list are good resources because they contain some actual laboratory protocols, including exact directions for making reagents. Sources on the Internet are numerous. Enough detail is presented in part two of this article for our program to be easily imitated. However, anyone interested in a providing a forensics program would benefit from obtaining a better sense of forensics from professionals rather than the entertainment industry.

Next, CLS educators should inventory their labs to see what equipment and reagents can be incorporated into solving a "case". Most CLS programs have access to microscopes, blood and blood typing reagents, and spectrophotometric chemistries. Therefore, typing and analyzing blood from a crime should be simple. Since red blood cells from many animals are nucleated, simple microscopy to determine if a blood spot is human can be easily performed. As molecular diagnostics becomes more integrated into CLS programs, the tools for nucleic acid analysis are also available. Tests kits specifically designed for molecular biology education are readily available, reasonably priced, and easily used or adapted for a forensics-type application. Toxicology tests using spectrophotometric and chromatographic techniques also may be easily incorporated into the typical CLS laboratory. In most situations, a case that is solved based on the tests available can be constructed. As part of CLS recruitment, students can also be provided with information on how the tests they are doing are used in clinical situations.

We have made use of three forensic techniques that can easily and inexpensively be used to supplement the CLS-type testing. The first is microscopic trace evidence examination. Locard's Exchange Principle states that when a criminal and an object come in contact, a cross-transfer of material occurs.[2,3] Thus, a criminal who drives the getaway car may have carpet fibers from the car on his clothes and his hair may be left behind in the car. Students can be given trace evidence samples (hair, fibers, soil, feathers) from known suspects or sources and asked to compare them to trace evidence found at a crime scene. Hairs and fibers are easily taped to glass slides, and granular samples such as soil are easily taped under coverslips. See Figure 1. CLS educators merely need slides, coverslips, microscopes, and vivid imaginations to create trace evidence for a case.

A set of fingerprints from "suspects" is easy to create using a black ink stamp pad. An unknown fingerprint can be given to students on paper to try to make a match. For more am-

Figure 1. Photomicrographs of hair



Significant differences in hair color are easily seen even by a novice to trace microscopy.
Photograph courtesy of Johanna Wilson Laird

bitious laboratory sessions, students can try to chemically develop their own fingerprints. Several chemical methods exist (ninhydrin for amino acid residues, silver nitrate, "super glue" and so on),[2] and investigators choose the technique best suited to the surface(s) being investigated. Iodine fuming, described more fully in part two of this article, is a cheap and simple method that can easily be used in CLS labs using iodine crystals.

Since criminals would usually be expected to walk into and back out of a crime scene, trace evidence such as soil from a suspect's shoes can be examined; however actual shoe prints at the crime scene would be important to detect and identify. Again, a collection of known samples is needed, and CLS educators can simply gather old shoes. For these labs, sneakers work well because the soles are not smooth and have many identifying characteristics. However, it should be explained to students that even if a perfect match exists between a shoe and a shoe print that manufacturers make thousands of the same shoe in the same size and that there must be evidence that the shoe print was made by that specific shoe.[2,3] In this case, shoes that are old and worn work best because if unique patterns of wear and tear on a particular shoe can be linked to a shoe print, then this is much stronger evidence. Although it can be great fun to try to match shoes to prints made in dirt and mud, a chemical technique more controllable in the laboratory is described in part two of this article to develop bloody shoe prints. The ingredients used are familiar to anyone who has done serum protein electrophoresis.

The laboratory activities described in both parts one and two of this article have worked well with high school graduates that are both science and non-science majors. Obviously, all laboratory activities have to be tailored to the age and expected backgrounds of the students. This particularly includes safety concerns and minimizing exposure to biohazards.

CONCLUSION

No two CLS educational labs are alike, and situations in which recruitment can be done may be severely limited by circumstance. CLS educators may choose to select one or two of the activities above to provide abbreviated laboratory experiences to an audience or they may package several activities into a summer-camp type experience over the course of a few days.

To borrow a phrase from a colleague, we've done some of these laboratory activities "the way a cooking show is done-showing all the steps and then pulling the finished product out of the oven". Procedures can be partially done, and then completed by the students. Students can be shown gel preparation and electrophoresis equipment and given pipettes to see what it's like to pipette small amounts of solutions. Then, they can interpret the bands in a completed, stained gel. See Figures 2 and 3. We've pre-migrated some thin-layer chromatography so only drug visualization and interpretation remain. We've premixed blood and antisera and sealed the top of the test tube so that all that remains to be done is to spin it for 15 seconds and interpret agglutination. Trace evidence microscopes are easily set up ahead of time, and if time is limited the case can be constructed so that fewer specimens need to be analyzed. Even if a procedure is illustrated by faculty demonstration rather than hands-on, this is generally more interesting than a lecture.

Figure 2. Student loading agarose gel for DNA analysis

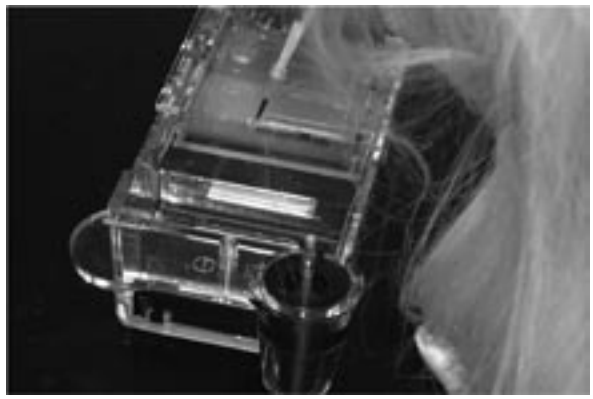


Figure 3. DNA gel done by students

Samples as follows: 1 = crime scene, 2 = suspect A, 3 = suspect B, 4 = suspect C, 5 = victim. A match is shown between the crime scene and suspect C

We have used some of the above laboratory modifications with shortened cases for middle school students, high school students, and families. Hands-on sessions have been presented in as little as an hour or two, and demonstration sessions in 30 minutes. For example, during the campus Family Weekend we set up laboratory workstations for families with the senior CLS students providing demonstrations for children, parents, and grandparents. Families filled out their case worksheets and came back to the classroom to compete for the correct solution. Prizes were CLS cups stuffed with candy and CLS literature. It was also an effective way to showcase our students to their families and the public.

In part two of this article, a successful university-level experience will be described that incorporates numerous techniques and occurs over several days. Ideally, these two articles will provide CLS educators with enough ideas to exploit the current interest in forensics in their own labs, introduce the CLS major, and wisely counsel students on career choices.

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