Page left intentionally blank

This magazine is best viewed with the pages in pairs, side by side (View menu, page display, two-up), zooming in to see details. Odd numbered pages should be on the right.
FORENSIC DATABASE

Better than a general search engine, the unique NCSTL database instantly pinpoints focused results about forensic science & criminal justice topics. Learn more about the database & about NCSTL.

WWW    NCSTL     ORG
WWW    NCSTL     ORG

DNA
Articles

6 Interview
By Mark Feil, Ed.D.
Dr. John Butler is the first DNA expert we’ve interviewed, and he’s worth the wait. This is the guy who helped figure out how to do DNA fingerprinting in five minutes instead of eight hours. He’s turned the DNA fingerprinting game upside down in a good way and made it possible to run a suspect’s DNA by the time fingerprints and mugshots are squared away.

15 DNA Quiz
By Ted Yeshion, Ph.D.
See how much your students know about the most famous three letters in the world. Some of it is common sense, some of it requires having paid attention in class.

16 Barcode Fingerprints
By Martin Horejsi
DNA fingerprints can look a lot like barcodes if you’re running an agarose gel. This activity requires your students to pay very close attention to get the right answers.

20 Who’s the Daddy?
Students will use colored beads to represent genes in a segment of DNA, then compare several to figure out which of four elephants is the father of a newborn pachyderm.

24 The Innocence Project
Helping prisoners not only get off death row, but out of prison by using DNA is the goal of this group, which has been wonderfully successful. This exercise will let your students feel what it’s like to be part of the team as they dig into real-life cases.

26 Using Eyesight to Learn Forensics
Examining fingerprints seems like an easy job in an age when a computer can compare prints from a crime scene to everyone who’s ever been printed, right? Not so fast. This activity will put your students to the test as they find out there’s waaaay more involved.

Features

2 Editorial
4 Mini-mystery
5 Hot Links
19 Crossword Puzzle
36 Photo Mystery
54 Answer page
56 Morgue Guy
56 What’s Going On?
57 Just For Fun
58 Stoopid Crooks

40 Pig Dig
by Linda Spurlock, Ph.D.
This activity will give your students the ultimate forensic experience as they exhume a murder victim layer by layer in a shallow grave, looking for bones and clues.

48 Who’s Your Mummy?
By Coral Clark
A challenging activity that uses DNA fingerprinting to reconstruct an ancient family tree.
And...We’re Back

By the time you read this you’ve already started your first unit and met your new students. And they’re excited to learn what you have to teach them and show them in the amazing world of forensics. They’ve seen it on TV, they’ve heard about it on the web, and they’re dying to get their hands dirty as they piece together evidence to solve a mystery. All the other disciplines of science, biology, chemistry, physics, Earth science, and the rest are concerned with filling their heads with knowledge. Forensics is wonderful and different because, while they will learn and absorb new information from you, they will be asked to apply what they’ve learned in your classes and in the other science classes to solve puzzles. The closest most other science classes come to asking them to apply what they learned is in the form of an exam. You will be asking them to solve a mystery. And who doesn’t love a mystery, especially when bragging rights are involved?

There’s something deeply satisfying about ferreting out information that’s been overlooked, facts that change the whole game, clues that implicate an unsuspected perpetrator. You know it and they know it. As forensic educators we have a pretty sweet deal. But we mustn’t lose sight of the fact that we should always be forensic students too.

Even if you’re new to teaching forensics I hope your course changes every year. I hope it evolves and grows each time you teach it because there’s always opportunities for us to find ways to make lessons and activities more meaningful and engaging. Ideas for new labs, and activities are all around us from news outlets to social media as we hear about new applications of current and new sciences to solve crimes.

But I’m not telling you anything you don’t know.

Each new school year is a chance to get better at what we do for our students. Yes, summer is over, but I love this new season because it represents a new beginning, a fresh opportunity to liven up anything that didn’t go over that big last year.

Want to get even better? Make up a questionnaire for the end of every unit that asks your students what they wanted to know more about, but didn’t get to. Go ahead, I dare you.

Then act on it next time.

Volume 12, Number 33, Summer 2018

The Forensic Teacher Magazine (ISSN 2332-3973) is published quarterly and is owned by Wide Open Minds Educational Services, LLC. Our mailing address is P.O. Box 5263, Wilmington, DE 19808. Letters to the editors are welcome and should be sent to admin@wideopennminds.com. Submissions are welcome and guidelines are available, as is a rate sheet for advertisers at our website www.theforensicsteacher.com. If you sign up for a subscription you will receive an email when it is ready for download provided your spam filter doesn’t screen it out; sign up at our website. Back issues are available singularly on our website, or all on CD priced as per the website. The Forensic Teacher is copyrighted 2012 Wide Open Minds Educational Services, LLC, all rights reserved. All opinions expressed by contributors represent their own views, and not necessarily the views of the staff or editorial board.

POSTMASTER: Send address changes to The Forensic Teacher, P.O. Box 5263, Wilmington, DE 19808.
EXPERIENCE

THE FIELD OF

FORENSICS

CSI:
THE EXPERIENCE

VISIT CSI: THE EXPERIENCE WEB ADVENTURES
HTTP://FORENSICS.RICE.EDU

WHAT TEACHERS ARE SAYING

"I am delighted to have found your website. It brings all the content we teach together in such a real-life way. It's fantastic! Thank you for an amazing resource!"

"I found this a fascinating site. I went through the first case because I am assigning it to my students as part of a CSI unit. I can't wait to do the other two cases. Thank you for making science fun."

This work was supported in part by a grant from the National Science Foundation to the Fort Worth Museum of Science and History.
The Frequent Flier From Rio

“ANACONDA SKINS!” Thomas P. Stanwick stared blankly at his plate of veal and eggplant parmigiana.

“It’s an unusual smuggling case, yes,” replied FBI special agent Ryan Cooper across the table from him. “Some Asian immigrants grind the skins up and use them as medicine. They’re very valuable.”

“Not to mention very illegal,” added Inspector Walker. The three of them were having dinner at the Casa Italia in Royston.

“Jaime Gandolfo is a Brazilian suspected by the Rio police of smuggling anaconda skins into the U.S.,” Cooper said. “He uses the fortnightly Amazonian Air nonstop flight from Rio to Royston. That’s how Customs, the FBI, and Royston’s finest got involved.”

“And together you want to put the squeeze on Gandolfo,” remarked Stanwick dryly.

“You could put it that way, although I wish you wouldn’t.” Cooper grimaced.

“Each time Gandolfo arrives here,” he continued, “Customs thoroughly, and I mean thoroughly, examines him, his briefcase, and his suitcase, but never finds anything incriminating to deny him entry. Lately the other passengers have been getting the same treatment, just in case. Gandolfo checks into the Palisade Hotel, insisting on the same room every time, and stays for three days. Within a day of his arrival, we get word through our contacts here that skins are being sold in Asian immigrant neighborhoods.”

“How large would the package of skins have to be?” asked Walker.

“Only about the size of a large book. A little anaconda skin goes a long way.”

“Sounds like a slimy, but enterprising fellow,” said Stanwick.

“He would have to get the skins onto the plane somehow.” Stanwick carefully twirled his linguini. “Is he searched at the Rio end before boarding?”


“How large would the package of skins have to be?” asked Walker.

“Only about the size of a large book. A little anaconda skin goes a long way.”

“Is he really fat?” Walker asked, grinning, “or might he have a package under his shirt?”

“No chance. As I said, Customs is thorough.”

“Perhaps he has an accomplice on the flight crew,” suggested Stanwick.

“Nice try, but the crew is changed for every flight. Besides, they have to pass through Customs too. The Rio police have watched several crew members on the off chance, but have seen nothing suspicious.” Walker leaned back and scratched his chin.

“These flights,” he said. “Do they go on from here?”

“No,” replied Cooper. “The plane stays here overnight and then returns to Rio the next day. The airport authority keeps it under tight overnight security. So how do we get Gandolfo? So far we have nothing.”

“Instead of nothing, we have the answer;” said Stanwick. He smiled over a forkful of eggplant. “I can suggest how Gandolfo is smuggling the skins off the plane. Knowing that should enable you to unravel the whole setup.”

How is Gandolfo smuggling the skins?

The solution is on page 54.
Hot Sites

Picked by us for you. And we’re picky. Only about 3% of sites we become aware of make the cut, so you know they’re worth a look.

https://www.fbi.gov/services/laboratory/biometric-analysis/codis
Everything you ever wanted to know about CODIS, and then some.

http://www.crime-scene-investigator.net/csi-collection.html
If you think you want to collect it, this site explains how. Seriously.

The Virtual Museum of Canada features a forensic activity that will keep your students engaged as they work to solve a horrible crime. Like all things Canadian, it’s top notch. Start with the “Recover” tab.

Knife and Saw Toolmark Analysis in Bone: A Manual Designed for the Examination of Criminal Mutilation and Dismemberment. If your students ever look for toolmarks on bones you need this.

Latent Print Examination and Human Factors: Improving the Practice through a Systems Approach. The Bible of this specialty.

https://online.maryville.edu/online-bachelors-degrees/forensic-psychology/forensic-science-lessons-students/
Hosted by Maryville University, this page features a couple dozen worthwhile links to forensic activities.

https://www.nij.gov/publishingimages/latent-print-process-large.jpg
A chart showing the decisions faced by latent print examiners as they handle evidence and how those decisions are made.
Not all crime fighters carry a badge.

Some tote subpoenas, others volunteer footage from their surveillance cameras, and some even fire guns into tanks of water to compare bullet imperfections. But only one guy has ever looked at a gel electrophoresis apparatus filled with thick, unflavored Jello and macerated bits of DNA and thought, ‘there has to be an easier and faster way to do DNA fingerprinting.’ Fast forward a few years and what used to take all night now takes five minutes. Dr. John Butler started out helping the FBI nail bad guys via their DNA, but ended up turning the DNA fingerprinting world upside down in a good way.

**The Forensic Teacher:** We’ve never interviewed a DNA guy, and we’d like to take this opportunity to do so. So, let me ask you-- how did you become interested in DNA? You went for a bachelor’s in chemistry. Was it with that in mind?

**John Butler:** I’ve always been interested in biology. I took biology as a freshman in high school, and then had four years of biology through high school and I really enjoyed that. I had a really fantastic biology teacher. I grew up in Maryville, Missouri, which is in the northwest corner of the state and our high school was very well known for biology. We would compete with other high schools at a local university. I chose to go into chemistry because when I went to Brigham Young University, I felt the chemistry program was more rigorous and I would learn more scientifically there than I would if I went into microbiology, or the zoology department, or something like that. So that’s why I chose chemistry. In terms of getting into forensic DNA, that happened when I was part-way through my undergraduate program. It was 1990. There was a book published the previous year called *The Blooding* and a friend of my dad’s, who was the acting police chief in Fort Collins, Colorado, gave it to me. My family had moved from Missouri to Colorado, and my father had met the police chief there. When he [the police chief] found out that I was interested in forensic science, he said there was this new technology coming out involving DNA and he kindly provided some literature including a copy of *The Blooding*. Of course, I’d taken biology courses and was starting chemistry by this time, but he said why don’t you look into DNA? And that’s when I first started reading about DNA. I decided to go to graduate school and study DNA measurements with analytical chemistry, so I went to the University of Virginia and had the opportunity to do my research work at the FBI Laboratory. I started working there in 1993, developing DNA technology measurement methods for the FBI. The techniques that everybody uses around the world were what I worked on in graduate school; that is capillary electrophoresis. That’s the technology for measuring DNA very quickly.

**FT:** You were involved with capillary electrophoresis?

**JB:** Yes. My PhD dissertation involved measuring polymerase chain reaction products, which is how you copy and label sections of DNA that you’re interested in looking at. We measure how long the DNA molecules are by comparing them to a sizing standard, similar to a ruler. In the late 1980s and the early 90s, everybody was doing slab gels where you’d pour a polyacrylamide gel to separate the DNA and that was kind of messy to do. It took several hours to run, and it wasn’t automated. So, when I came into the field in the early 1990s, the focus was on making the DNA separation process more automated – putting this process and data collection into computers, which were just coming out. Capillary electrophoresis provides rapid, automated DNA separations.

**FT:** With capillaries—do you use ethidium bromide? How do you know where the bands are?

**JB:** We originally used an intercalating dye like ethidium bromide, but it isn’t as toxic. Ethidium bromide is typically used for agarose gels; you put it in there and it binds to the DNA molecules and changes the DNA structure a little bit so when you hit it with UV radiation, it glows purple. We used a molecule called YO-PRO-1, which was developed by Molecular Probes. You put it in the solution and it would intercalate, or go inside the DNA double helix, and make the molecule a little more rigid. This then changes the fluorescent properties of the DNA when it is hit by a laser and it fluoresces around 520 nanometers, which produces...
a peak when light strikes the detector. We are then able to quantify the amount of DNA based on the height of the peak and determine the overall length of the DNA from the size of the peak relative to an internal size standard. So, instead of pouring gels and dealing with acrylamide and ethidium bromide, you can do DNA separation and detection with what is basically an inert solution that includes a sieving polymer. We used hydroxyethylcellulose; that was the name of the molecule. The polymer strands would entangle and make a transient gel, and you would put that inside of the capillary, basically pumping it in like syrup. The intercalating dye will not fluoresce when there is no DNA present, but if double-stranded DNA is present the dye binds and changes the fluorescent properties of the YO-PRO-1 and that would give you the signal that resulted in DNA peaks collected in the computer software.

FT: Wonderful. About that time I was doing my master’s work in molecular biology and we used RFLPs (restriction fragment length polymorphisms) to solve an ecological puzzle, and I remember all the southern blots, the probes, and all the rest of it. So, when I heard about capillary electrophoresis I thought ‘damn, why didn’t we have that available to us?’

JB: It wasn’t developed yet. The first demonstration that it was possible was done by Bruce McCord, who was my advisor. He was at the FBI and he published a paper in 1992 saying we could do this, and then I came in in 1993 and worked in the research unit and showed that you could do all this testing without gels. We could measure the short tandem repeats, the small STRs. The RFLP technique took a lot more DNA and took a lot more time, and at that time people were dealing with radioactive probes so you had to do autoradiograms and deal with the hazards of that. We actually got separations down to under 5 minutes, so you could get results in that time if you wanted to.

FT: Wow!


FT: Sweet. I remember that magazine. I wish I’d done my work a couple years later. That would seriously really have helped me out a lot. Is capillary electrophoresis the predominant way of running gels today?

JB: Yeah. Almost all of the labs today that do forensic DNA testing of STR markers use capillary electrophoresis. What’s done differently today is that instead of using an intercalating dye, we use a fluorescently labeled primer or a series of them, so now this fluorescent dye, instead of being inside the DNA molecule, is attached to one end. This enables you to do single-stranded analysis where you only pick up one strand and we run that DNA at a higher temperature, which allows us to get better resolution of DNA molecules with similar size. So, you improve the separation of the DNA molecules by only labeling one strand and heating it, which allows the DNA to become denatured. Other than that, the basic technique for CE testing of STR markers is pretty much the same as what I did in graduate school.

FT: I have seen some modern DNA results where Mom and Dad are tested and Mom will give results of 11 and 16 and Dad will be 13 and 22. What do those numbers correspond to?

JB: Those numbers are the numbers or length of short tandem repeats, which essentially corresponds to the overall length of the molecule. You may have a sequence like GATA and it may be repeated 16 times or 22 times or whatever. That number is, well, it could be the overall length of the molecule that you are testing which is maybe 250 bases long; then you use what is called an allelic ladder, which is a mixture of the different repeats, maybe from 11 or 12, all the way up to 25 in terms of the number of repeats. Those are typically four bases apart so you would need to have resolution that can separate things that are four bases apart, or even less if they have fractions of that repeat.

FT: I see. Let me ask you: what do you like best about this field and what you are doing?

JB: It’s fun to discover things, but the main thing I enjoy is sharing that information with other people, so I try to figure out how to explain it as simply as possible. I’ve written five
textbooks that help define the field. When I was a postdoc, I came to NIST, the National Institute of Standards and Technology, after I left the FBI in 1995, and when I came here, I started working on a website which is called STRBase (see strbase.nist.gov). I have been updating it since 1997. It’s a great place to go to learn about short tandem repeat markers, so you can get all the information you need there. And then I started writing textbooks. The first one came out in 2001 and the latest one was published in 2015, so I’ve written five textbooks over a 15-year period to help people understand how to use this information. So, that’s what I enjoy the most—teaching others how to use the techniques. I’ve published about a hundred and sixty-five research articles, but if you can’t get the information out to the people, to me, it’s not as valuable—it’s just doing it yourself. You need to figure out how to share it with others.

FT: You went to the FBI for a reason that makes perfect sense, but why did you leave?

JB: When I went to NIST, I became more interested in the measurement science and research aspects of the field than in directly assisting casework. The FBI’s focus was to develop methods that will help them move forward in their cases. And that’s interesting, but I was interested on a bigger scale, and NIST enabled me to do that. I was at NIST from ’95 to ’97 and then I went to a startup company in Silicon Valley, California. And from May of 1997, until September of 1999, I was working on mass spectrometry, trying to find even faster ways of doing DNA testing. There we ended up being able to do DNA separations and STR measurements in about 5 seconds instead of 5 minutes. I came away with a couple of patents for that. It was fun, but I found one of the things I didn’t like about being in industry was that I couldn’t teach; I couldn’t share what I was learning. So, I came back to NIST in 1999 and I’ve been here ever since. And that’s allowed me to have a place to work where I can collaborate with other government agencies like the FBI, and I can work with academia, I can work with industry, and all the time I can publish what I’m doing and put it on a website to share with people. And I can write books to help people learn. That’s why I’ve enjoyed being here, because NIST has given me a broad base to teach and help others.

FT: That sounds wonderful. That sounds really satisfying.

JB: I’ve enjoyed it. It’s been a fun career. Hopefully, I have a few more years left in me.

FT: So that’s what you like best about the field. What do you hate the most? What’s the most frustrating thing about your field?

JB: Sometimes you don’t get to do as much as you’d like to do; there’s not enough time in the day. I guess what I hate the most is there’s always things I want to do more of. I have lots

![Capillary electrophoresis](image_url) Capillary electrophoresis. Image courtesy David Harvey.
of ideas. I have a couple more ideas for books, but I just don’t have time for them. I don’t have time to do them right now. I guess that’s the biggest thing I hate, not having enough time. (Laughs)

FT: You mentioned that we can examine the short tandem repeats in a piece of DNA in as little as five minutes. When the cops get the DNA, they say the lab won’t have the results for three or four months. Just to be clear for our readers, that’s because of the backlog, right?

JB: Yes. There are several factors to consider there. The first one is the time it takes to get the sample in the door to the lab. It could be sitting in the evidence vault, but it hasn’t made it to the lab yet. So that’s part of the backlog because it might be sitting there for seven or eight months. But some labs are trying to get it down to within 30 days. The actual testing process itself, from extracting the DNA from the bloodstain or whatever, to getting a result is usually one to two days. What I was talking about earlier, about separating a PCR product into its sizes so you can then measure it to figure out what the end result is – that’s what’s done at speeds of around 40 minutes, in an automated fashion, where you are running lots of capillaries simultaneously, typically you run eight to 24 capillaries at once. It is better for the detector to not run quite as fast as what I was doing in grad school, so it’s typically 20 to 40 minutes for that piece. The PCR part of preparing the DNA samples typically takes several hours. And the extraction process before that takes a while. There are lots of factors. But getting the DNA out of the cell, getting the DNA copied at a specific location you want to look at, then separating those PCR products out, usually takes about eight hours total. But it is possible to do it in less than an hour if you use really rapid PCR, which we’ve demonstrated in our lab here at NIST. So, instead of doing the PCR for three hours, you are doing it for 15 or 20 minutes. If you take a sample to a rapid DNA system, you can put a sample in and 90 minutes later it spits out a result. So, this rapid DNA system is doing the extraction, the PCR, the separation, the detection, and the software analysis all automatically. That’s the latest in the field.

FT: That’s amazing! But I’ll bet that kind of a system isn’t cheap.

JB: Oh no. Each sample costs several hundred dollars to do it that way. It’s about 10 times more expensive to do it than the traditional way in a laboratory.

FT: What would you characterize as your strangest case? Or your most memorable case?

JB: I don’t actually do cases. We just do research here at NIST. I get asked a lot to help with cases, but we’re not allowed to testify as a federal employee. It’s nice to be able to help people without having to deal with the issues in court. The most interesting thing I’ve worked on was preparing new methods that assisted in identifying victims following the collapse of the World Trade Center buildings on 9/11. I was on the review panel that provided advice to the New York City Office of Chief Medical Examiner that did the WTC DNA testing. I helped develop some of the technology that was used with the miniSTRs, which involved making new DNA tests that targeted smaller sections of DNA to enable recovery of damaged DNA from the strenuous conditions in the rubble of the World Trade Center with heat and everything else.

FT: Let me ask about DNA databases. Is there one for the entire country?

JB: The FBI runs the national DNA index system. Each state contributes to that, so the database, the national DNA index system is made up of many state DNA systems. There’s the 50 states that contribute and there’s a federal level where the Federal government and Puerto Rico contributes DNA profiles. State databases receive contributions from the local level. I live in Gaithersburg, Maryland, and there’s a county laboratory that does DNA testing at the local level and they put it in their local database. That local database can then be uploaded to the national level, to the FBI, so they can search it across all states. This way Maryland can be compared to California and so on.

FT: What’s the delay in moving information from the local to the federal level? Is it three weeks or three days or three months?

JB: The local level contains all the information, so they’re the ones who actually know who the sample belongs to. When it goes to the state level or to the federal level, all that is provided is a DNA profile and there’s a number associated with it. So, when it goes to the FBI for searching across states, there’s no name associated with that profile. It’s not like...
what you see on TV. Each state uploads on a certain day of
the week, say on a Monday, and then the national database is
searched once or twice a week.

FT: So, once a week the national database goes back and
looks at cold cases with all the new profiles?

JB: I think they’re searched more regularly now, but what
they used to do was upload one day a week and then search
for everything. If you come back with a match on something,
the next thing that is done is to send a notification to the local
laboratory and then they have to verify that sample is what it
is. They typically pull the sample and test it again. This is just
for quality control purposes.

FT: Who’s in the database? Is it everyone who’s arrested or
everyone who’s convicted?

JB: Every state is different. Around 30 States take DNA
from everyone they arrest for violent crimes, but all 50 states
require DNA samples from those convicted of felonies.
The bottom line is that every state has a different law or set
of laws in terms of what is required, how the samples are
retained, or if they’re destroyed after they are tested.

FT: Are all service members in there?

JB: There’s a separate database of samples, which are not yet
tested for DNA, which is maintained by the Armed Forces
DNA Identification Lab. If you join the military and you get
sent off to a conflict zone, your DNA profile is not tested yet,
but rather your blood card is placed into a storage facility.

If you are missing or killed in action, then your blood card
is pulled and your remains are tested and compared to that
DNA profile on that blood card. When the blood is collected,
it stays on a blood card and it just sits in the warehouse until
there’s a need to test it. Because it would be too expensive to
generate millions of DNA profiles and then have them just sit
there if you didn’t need them. You just need them to identify
the unknowns. The purpose is so that there are no more
unknown soldiers.

FT: I understand. But if you had someone in the service
who committed a crime you wouldn’t see that person in the
national DNA database, would you?

JB: No. There’s no searching. That database is only for
missing persons. It’s not connected at all to the criminal
database. There was one case about 15 years ago in which I
think there was an interest in trying to see if a person fathered
a child, and they asked to have access to the military’s DNA
sample collection. But they had to get approval from the
Secretary of Defense and they said that’s not happening again.

FT: You’ve mentioned some of the advances over the last 20
or 30 years, but what advances can we look forward to seeing
in the future?

JB: Well, I think rapid DNA is going to have a big impact
depending on how it gets implemented. When someone is
arrested for a crime they are typically held for about four
hours during which time mugshots are taken, as well as
fingerprints. Police departments may also be able to get a
DNA profile, too. Then they can search the database if the

James Watson shows off a copy of one of John Butler’s books at a recent event. Photo courtesy John Butler.
The Forensic Teacher • Summer 2018

FT: What do you think of the CSI effect? You don’t testify, but I know you are aware of it.

JB: Yeah, there’s a thought that people can’t try a case without DNA being involved somehow, but what impact that really has you’d have to find out by asking each juror. Certainly, it has had an influence on our society with people watching the TV programs that things happen faster than they can really be done. So, what I would tell people is that DNA testing can be done fairly rapidly, but not done in 10 minutes or over the commercial break like they see on TV. But the instruments you see on TV in the labs are usually the actual instruments used. I believe the companies that make them donate them.

FT: I understand with DNA synthesizers it’s possible to fake your own DNA fingerprint. What do you know about that? Is it common place? Is it rare? Is it science fiction?

JB: There was a paper published from a group from Israel about seven or eight years ago where they demonstrated it was possible to create a PCR product and spike it into a system to make it look like someone had been there, even though they had not. So, that’s been demonstrated, but it would require someone who has knowledge of what is being tested. It’s certainly possible but it’s definitely not probable.

FT: What were you like when you were younger, when you were a kid? Curious? Did you like puzzles?

JB: The Rubik’s Cube came out when I was in junior high school and I had about 10 or 15 different types of Rubik’s Cube type things. So, I love puzzles; that’s why I went into this field.

FT: What do your parents do?

JB: My father is a farrier, a blacksmith, and writes textbooks. I think about a dozen books on how to do horse shoeing. He’s taught at three different universities, he has a PhD from Cornell University in horses. So, he’s probably the world’s expert on horse feet. That meant I was always around books, always around him, and learning about how he taught people. There was a book published a couple years ago, (“Conversations with Great Teachers” by Bill Smoot, Indiana University Press, 2010) featuring interviews with 51 of the world’s greatest teachers, and my father was one of the people picked for that. He was always an example to me. My mom was also a teacher and taught elementary school. I’m the oldest of seven children, so after I was born she decided to stay home and move the classroom into the home, but we were always in an environment where there were lots of books, lots of learning. When I was in high school I bought Discover Magazine, Science News, and others all on my own because they were things I wanted to learn about.

FT: You mentioned earlier that you had some teachers who were just amazing. What did those teachers do that made them stick in your mind, or that really brought your learning to life?

JB: Well, Kermit Posten was my biology teacher in high school, and he was inspirational because he made our classes challenging. He raised the bar and expected everyone to do their best and in my junior year we dissected around 30 different animals. We were in a little school. I think we had 500 people in the entire building. So, my graduating class was a little over a hundred people. He cared enough about making sure we demonstrated excellence in science, and in particular biology. When I took biology in college, these classes were easier than the classes I had in high school. He set a bar of excellence in terms of wanting us to do our best. Last year (in June 2017), I went back for my 30th high school reunion and I tracked him down and thanked him, and I gave him a copy of one of my books as a way of showing my gratitude for everything he taught me. It’s kind of fun to track down old teachers. A friend and I went and tracked down our high school history teacher, because I liked history a lot, and thanked him. We went and found our speech teacher—I’ve spoken in about 30 countries and given a couple hundred talks all over the world, and I didn’t like to speak in high school. And she coached me a lot and really helped me improve. And I went to my English teacher and thanked her for helping me to learn how to write, and I told her I’ve written five textbooks now.

FT: I’ll tell you what—there is no greater gift you can give to a teacher than to find them later in life and tell them what an influence they had on you.

JB: I took a picture with each of them too and I cherish those.

FT: That’s neat. What do you think are the biggest misconceptions the public has about DNA?

JB: They think it can solve everything. One of the challenges with DNA, especially when you’re doing PCR, is that it’s very, very sensitive. Just a few cells left behind can contaminate a sample. If you touch a surface you are leaving a little bit of DNA behind and that’s going to mix with the DNA from other people who touched the same surface. And that could be transferred. Sometimes people think DNA from a bloodstain, or semen, or a vaginal swab or something like that is very solid. But when you’re doing touch evidence it’s not as solid. So, one of the things we are working on now is helping people understand the difference.

FT: I understand exactly what you’re saying about having high expectations as a teacher. What do you think is the most important thing a teacher can do for his or her students?
JB: I think they should expect a lot from their students. I think one of the problems we have today, as I see my kids going through school, is they’re not challenged enough in terms of them having more abilities, and too often things are given to the students and we don’t expect them to use their brains as much as they could, or to really challenge them to do their very best. Mr. Posten, what he did for me, was to push me to do my best. My senior year we had a biology competition for the whole region, for Missouri, Iowa, Nebraska, and Kansas. And our team took first, second, and third. There were almost a thousand kids there. That’s the level of the teaching we enjoyed in my high school biology experience.

FT: What was the competition like? What did you have to do?

JB: We had to take a written test. In a previous year, we had a lab competition and we had to dissect a frog and find the sciatic nerve and the gallbladder. I still remember doing that. My laboratory partner and I got first place in that, just because we’d had so much experience dissecting things because like I said, we dissected about 30 organisms. My sophomore year in high school, I took genetics and microbiology. I was doing things in those classes, like breeding fruit flies, that most people don’t do until college.

FT: What do you think teachers can or should do to make forensic education more effective? Besides having high standards?

JB: I think one of the challenges people have in talking to students that have gone to high school and are in college, is that sometimes there is too much entertainment, like they’ll show an episode of CSI and then talk about it. That’s good for drawing people in, but you also want to show them the real core science—how do you make a measurement, and where is there uncertainty when it’s done? And get a healthy respect for uncertainty and the fact that you need to think critically about problems. I think that’s not done enough in our society sometimes. We take things at face value; we want to entertain instead of to educate. Education is learning to think critically about a problem.

FT: Do you have any tips for students who might want to make a career out of forensic DNA?

JB: I think the thing to do is to go and observe in a laboratory and see if that’s something you’re really interested in. Casework can be pretty mundane for some people. You need to see if you’re ready to pay attention to the level of detail that’s required. As a scientist you must be able to pay attention to details really well. You also have to document what you’re doing. If you don’t like writing down what you’re doing or typing up your notes, then it’s probably not for you. My advice is to go and actually experience it and see some of those things and see if this is really what you want to do.

2017 CODIS Changes
By Jeanette Hencken

The pilot for the Combined DNA Index System better known as CODIS began in 1990. Today more than 90 law enforcement agencies in over 90 countries use the CODIS software and over 190 public law enforcement laboratories use the database. (fbi.gov, 2017) A specific thirteen loci have been used since 1997 for this system. The addition of seven loci, chosen by the CODIS Core Loci Working Group, to the National DNA Index System allows for the data to be used in counter terrorism and other international law enforcement efforts, as well as identification of humans and familial relationships. It also allows for greater discrimination in local law enforcement DNA comparisons.

Earlier versions of the system required the use of either the Profiler or CoFiler kits to generate profiles for inclusion in the CODIS database. These kits identified the number of repeats, for example, of GATA found on a highly polymorphic site on the DNA. These are called Short Tandem Repeats or STRs. Prior to January 1, 2017, the FBI required the use of the kits that identified repeats on a specific set of 13 locations on the DNA. They were CSF1PO, D3S1358, D5S818, D7S820, D8S1179, D13S317, D16S539, D18S51, D21S11, FGA, TH01, TPOX, and vWA.

The current version of CODIS requires the use of either the Globalfiler or PowerPlex Fusion kits which generate profiles for the original thirteen and seven more loci. Those new loci, chosen by the CODIS Core Loci Working group for inclusion are D1S1656, D2S441, D2S1338, D10S1248, D12S391, D19S433, and D22S1045.

Sounds pretty simple, right. A lot of testing had to happen along the way. Which loci to choose took a lot of research into frequency of occurrence of STRs in different populations. It also required development of kits to generate profiles for these loci and testing of the accuracy and reliability of the kits. Work that took place from 2010 to the 2015 announcement of the deadline to be ready for use of the new CODIS.

Forensic laboratories frequently use more than the required 20 loci. For example, the amelogenin loci is only required for use in CODIS in missing person cases, but most labs include it on all samples. For mitochondrial submissions hypervariable region 1 and hypervariable region II are required.

If you have questions about the new CODIS or DNA STR testing, I can recommend the following websites:


https://www.fbi.gov/services/laboratory/biometric-analysis/codis/codis-and-ndis-fact-sheet

https://www.fbi.gov/services/laboratory/biometric-analysis/codis

I do need to add a disclaimer though. I am not a DNA expert or even a biologist. I am a chemist, and retired forensic science teacher, enthusiastic in my interest in forensics.
And the only way to do that is to get in there. It can be tedious at times, but it’s exciting at times. I love it for the discovery and the things that you learn. In the research environment that we have at NIST, I love that if I wanted to research new things and push the envelope, push back the frontiers of understanding of some aspect, I can do it.

FT: If you had one wish for the field of DNA, what would it be? What is a frustration from your point of view that you wish would get cleared up?

JB: People get too focused on protocols and they don’t think about what they’re doing. They have to follow protocols as far as the quality assurance of what they’re doing, but I think people get so caught up on ‘did I do step one, did I do step two, did I do step three?’ and don’t think about why they’re doing it. If something goes wrong and they have to troubleshoot something, sometimes people struggle with that because they get so used to following all the steps that they don’t think about why they’re doing what they’re doing. So, the thing I wish would change is that people would think more about why they’re doing what they’re doing and try to understand it better.

DNA trivia

The DNA in your body is so tightly compacted that if all of it from a single cell were stretched out it would be about two meters (six feet, six inches) long. You have ten trillion cells in your body. If the DNA from all those cells was stretched out it would be about 10 billion miles long, over twice the diameter of our solar system. Granted, most of that is mitochondrial DNA, but, still. Wow.

DNA Quiz

(T/F)

Name_________________________________________________  Date_____________  Period_______

1. ______Whenever possible, biological evidence should be packaged in airtight plastic bags for DNA analysis.

2. ______DNA relies on the statistical probability of a match over at least several different genetic markers, not just one marker.

3. ______Mitochondrial DNA analysis reflects only the paternal side of inheritance.

4. ______The gender of an individual cannot be determined by DNA analysis of a saliva stain.

5. ______To determine a genetic profile of an individual, his/her hair, blood, saliva, or semen/vaginal secretion can be analyzed and one would obtain exactly the same result regardless of which sample was tested.

6. ______RFLP technology is commonly used to conduct DNA analysis on hair.

7. ______Nuclear DNA is found only in nucleated cells; that is, all cells except red blood cells.

8. ______Unless hair is being analyzed by the mitochondrial DNA methodology, it is necessary for the hair to have viable root material.

9. ______The very first time RFLP/DNA was used to resolve a criminal case, it resulted in the elimination of the suspect.

10. ______In order to apply statistical values to DNA findings, it is necessary for the genes being tested to be on different chromosomes or if on the same chromosome, to be far apart from each other to allow for independent inheritance.

11. ______Because PCR/STR technology is an excellent tool for identifying multiple contributors of DNA to a mixed stain, crime scene technicians do not have to worry about contaminating objects when collecting or processing evidence.

12. ______If 12 DNA markers are analyzed and only one is different between a known reference standard from a suspect and an evidence sample, the suspect would be considered innocent of the crime.

Answers on page 55
Ever since the 1995 O.J. Simpson trial DNA evidence has been a critical and accepted piece of evidence in the courtroom. But even though DNA evidence is widely used, the mechanics of DNA analysis are not widely understood by the general public.

DNA is essentially a chemical code for an organism with enough minute variations that it is possible to link a specific piece of DNA to a particular individual. But more likely, DNA is used to break the circumstantial link between an individual and a crime proving that the DNA does not belong to a suspect. (Learn about the Innocence Project at http://www.innocenceproject.org).

By using UPC codes which are found on the packaging of everything for sale, many of the facets of DNA analysis can be mimicked in the classroom without the egregious nature for which crime scene DNA is collected. For example, imagine your dog got into a bag of groceries and the only evidence left of what he ate was a portion of the package’s UPC code. Could you identify what the canine consumed?

Progressing from straightforward to more complex, students match a crime scene DNA-UPC barcode with a set of known subject codes. The students soon realize that it is easier to look for markers or pieces of the code that stand out such as two thick lines next to each other or four thin ones. And just as quickly, they realize that their marker allows them to quickly eliminate suspects reducing the number of samples that require closer inspection.

An educational by-product at this point is that the students appreciate important aspects in the process of science, namely that in hypothesis testing, one needs only a single contrary piece of evidence to force a theory to be modified or abandoned. In the pursuit of a criminal, there is a constant back and forth logic argument until enough of the jigsaw pieces of evidence are in place to bridge across all contrary challenges to the conclusion. Unfortunately, sometimes the prosecution doesn’t want to spend the time to test DNA because they think their case is strong enough without it. And sometimes this causes an innocent person to be convicted.

To create the pieces for the DNA UPC activity, ultimately the students only need the crime scene DNA and some comparables. By using a photocopy machine, it is possible to amplify the DNA both in size and number. Then compare the DNA to a worksheet full of UPC barcodes. In this basic scenario, there is one crime scene sample and one correct choice on the worksheet of suspects. However, it is easy to modify the activity at this point to increase the difficulty or address other educational objectives. For example, the following changes or additions can be made:

1. The crime scene DNA can be incomplete such as just a portion of the right edge, the left edge, or a part of the center.
2. The sample can be damaged to various degrees including water soaking and wrinkling.
3. The sample can be of odd shape. Similar to an incomplete sample, a non-standard shape, like a scalene triangle or star, may require some extrapolation such as sketching out a larger piece of the code.
4. Chain of custody issues can be embedded such as how the sample was collected, who had access to it, and if there is any chance the sample could be contaminated. Imagine the students’ hand covered post-it notes while they work with the crime scene sample. Is there any chance that one of the post-it notes could fall off and accidently (or on purpose) wind up in the crime scene evidence bag?
5. The students can be asked to define the probability that a crime scene sample matches a subject. While the intricacies of the universal product code system could add a fact-based grounding here, it is possible to make educated guesses about how likely it is that a particular portion of code could be found in a complete sample of code. For example, if a code is five centimeters wide, and you have a two-centimeter sample that matches at least one subject, is there a chance that the crime scene sample could match another subject as well? But be aware of the Prosecutor’s Fallacy (click HERE for an explanation) where the probability of multiple DNA matches does not equate to matches across all other aspects of the case.

Once the lab work is done, there is great potential for visuals in a defense or prosecution argument. An authentic assessment for this activity would be to place the student on the (figurative) witness stand to defend their processes and conclusions. And they have to have a conclusion!
Getting started:

On the next page you will find a table of 15 UPC codes. Every code belongs to a different individual, and this sheet should be photocopied as a student reference sheet.

For evidence found at the scene you should choose one code for each group of students and cut it out from the reference sheet, and then enlarge or reduce it. You can give the entire UPC code to your students as is, or you give them a portion that is wet, dirty, or smeared by moving it as it is photocopied. Be imaginative! Remember, DNA evidence comes in all conditions, from pristine to unusable. Plus, this approach can be used later in your course if you have a mystery that involves several forensic disciplines combined with DNA.

To really make things interesting obscure the numbers under the UPCs and/or ask students to cut out/off UPCs from items at home and bring them in and collect them over a period of weeks or months. If you remove the numbers the activity gets harder because the students will be looking at dozens or even hundreds of codes. Plus, just like in real life, the code they're looking for might not be among those being considered at the moment.
### UPC-DNA List of Suspects

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><code>23456 78901</code></td>
<td><code>1501265854</code></td>
<td><code>Code 128</code></td>
</tr>
<tr>
<td>2</td>
<td><code>1234567890</code></td>
<td><code>1234567890128</code></td>
<td><code>12345670</code></td>
</tr>
<tr>
<td>3</td>
<td><code>00345675</code></td>
<td><code>9934567890129</code></td>
<td><code>123456789012345678</code></td>
</tr>
<tr>
<td>4</td>
<td><code>0 74470 03462 9</code></td>
<td><code>1 23456 78901 2</code></td>
<td><code>23456 78901</code></td>
</tr>
<tr>
<td>5</td>
<td><code>Code 128B</code></td>
<td><code>1600066060</code></td>
<td><code>0 123456 5</code></td>
</tr>
</tbody>
</table>
Crossword Puzzle

DNA Profiling

Name__________________

Across
7. Using DNA from relatives to suggest a suspect
8. The V in VNTR
9. The sugar in DNA
11. DNA cutting enzymes
13. The S in STR
16. The US Supreme Court has ruled it acceptable for authorities to collect your DNA from here.
17. In 2009 this country demonstrated it is possible to plant fake DNA at a crime scene
18. Pairs with thymine
19. This type of electrophoresis involves a narrow tube

Down
1. Pairs with guanine
2. Invented DNA profiling in 1984
3. The P in PCR
4. Restriction fragment length ______________
5. Determining fatherhood
6. DNA passed on only by mothers
10. This type of blot fixes DNA to nitrocellulose
12. Cheek swab
14. Codiscoverer of DNA (James)
15. The Federal DNA database
16. This type of electrophoresis involves a slab of agar

Answer on page 54.
WHO’S THE DADDY?

Test paternity with this simple model

DNA fingerprinting is often seen in today’s media. This simplified model helps students visualize the analysis process, understand the underlying concepts and applications of DNA fingerprinting, and develop collaboration skills as young scientists.
Materials required

For each activity station of two students:

- Pony beads, 96 Yellow and 60 orange
- Six straws, coffee stirrer size, 7” (~18 cm) long
- Binder clips, 12
- Labels, 6
- DNA bead patterns – see page 1

Scenario: A new baby elephant (calf) was born in the city zoo a few weeks ago. A team of zoologists took blood samples from the calf, the mother, and four male elephants (potential fathers). You’ve been asked to lead the team in identifying the calf’s father by isolating and analyzing segments of DNA from the samples.

How to build it (for 2 students)

1. Using the bead pattern as a guide, slide beads onto the straw to represent the DNA fingerprint for the mother elephant. Make sure the bead arrangement matches the graphic and is in the correct order from left-to-right. See figure 1.

   Note: A common mistake is to put beads on the straws in the wrong order. Writing the bead sequence with letter abbreviations for the colors helps students with the order. For example, if the sequence from left to right is yellow, yellow, orange, yellow in the graphic, students can write down YYOY and string the beads in that order, then cross them out of the written sequence. This also helps to avoid erroneous repeats.

2. Attach a binder clip to both ends of the straw, making sure beads are held tightly in position. To prevent the straw from falling out, adjust the straw so it is clamped securely at the ends of each binder clip rather than in the middle of the binder clips. See figure 2.

3. Label the binder clip on the left side of the DNA fingerprint model as “Mother”. See figure 3.

4. Repeat steps 1-3 for the calf and four potential father elephants (see graphic on title page).
To do and notice

1. The orange beads represent specific non-coding regions along the DNA fingerprint that are inherited by the elephant calf. The mother strand: Numbering the beads from left to right, observe the mother strand and note that there are orange beads in places 1, 3, 4, 8, 10, 14, 15, 16, 20, and 23 (see Figure 4).

![Figure 4](image)

2. Calf & mother: Line up the calf’s DNA fingerprint model with the mother’s DNA fingerprint model and note that a number of orange beads are in the same location for both the mother and the calf: places 4, 8, 14, and 15 (see Figure 5).

![Figure 5](image)

3. Calf, mother, & father 1: Place the calf’s DNA fingerprint model between the DNA fingerprints of the mother and father 1. For each orange bead position on the calf’s fingerprint, check the mother fingerprint and the father 1 fingerprint to see if there is an orange bead in the same position. Since the mother is known, any orange bead on the calf DNA fingerprint that is not present on the mother fingerprint must be present on the father’s fingerprint in that position. Potential fathers can be ruled out if this is not the case (see Figure 6).

![Figure 6](image)

4. Remove father 1 fingerprint and replace with father 2 fingerprint. Repeat step 3.

5. Remove father 2 fingerprint and replace with father 3 fingerprint. Repeat step 3.

6. Remove father 3 fingerprint and replace with father 4 fingerprint. Repeat step 3.

7. For the DNA fingerprint that cannot be ruled out, notice the number of orange bead father-calf matches not shared with the mother elephant. Did you find the daddy?

Note: Students can count the number of father-calf orange bead matches for the ruled out samples and compare numbers to that of the actual father elephant, then explain reasons for any differences in the context of inherited traits.
The science behind the activity

The human genome consists of more than three billion nucleotides in its DNA molecules that form the rungs in the double-helical structure. In cell nuclei DNA is wrapped around proteins called histones to form complexes called nucleosomes. The nucleosomes coil around themselves to form solenoids, which coil further to form chromatin loops. Chromosomes are composed of several layers of chromatin loops. Chromosomes are the genetic units passed on from parent cells to offspring. Human body cell nuclei contain 46 chromosomes, 23 from each parent. Along the length of a chromosome are DNA-protein subunits called genes that code for specific proteins and determine the traits of an individual.

The human cell has 21,000 protein-coding genes. There are large quantities of DNA that do not code for proteins called noncoding, or “junk”, DNA that appear to be non-functional. The importance of this DNA becomes apparent when trying to establish paternity because although the material is noncoding it is still passed on to offspring on the chromosomes. Since 50% of the genetic material in most organisms comes from each parent it is possible to analyze the noncoding sequences and characterize an individual, a process called DNA Fingerprinting.

DNA fingerprinting uses proteins called restriction enzymes that cut, or cleave, the noncoding DNA at specific places called recognition sites. The bead strands in this activity represent the cleaved portions of DNA from the mother elephant, the elephant calf, and potential father elephants. The lengths of the cleaved portions of DNA in the activity are the same but in reality the fragments are usually different sizes. DNA from different individuals rarely has exactly the same array of restriction sites and distances between sites, so the restriction fragment patterns for different individuals will be different. The fragments are separated and analyzed using a technique called gel electrophoresis.

The beads in the activity represent genetic material along the cleaved fragments, the orange beads being the material of interest. Paternity can be established by comparing the mother, calf, and father strands and moving along the calf strand from left to right and noting the positions of the orange beads. This information is used to rule out potential fathers much the same way it is used in the laboratory to rule out suspects in DNA probes. DNA researchers and forensic scientists spend much time trying to narrow a list of candidates/suspects down to identify specific individuals of interest rather than determine the genetic attributes of every suspect.

Field biologists use DNA Fingerprinting on specimens to provide evidence of evolutionary relationships between organisms. Although evolutionary theory depends on many sources and types of evidence for support, applied genetics and modern biotechnology have allowed scientists to confirm or modify findings of previous scientists and enhance our understanding of the biosphere.

Learn more

- Create your own set of DNA: Mom, baby, and possible fathers. See if another person can solve the set.
- Create longer DNA fingerprints using 10-12” skewers (points removed).
- Make each of the six DNA fingerprints a different length to model size variances seen in real cleaved DNA fragments.
- Use UV beads or glow-in-the-dark beads for genetic material.
- Extend this activity with the following suggestions:
  - Create a fictional crime scene with several types of evidence, including simulated blood or hair from 5 or more suspects.
  - Develop clues describing the results of restriction enzyme applications and the resulting fragments. Have students model fragments using clues and enzyme results to build the models.
  - Assign a research team to analyze the models and compare to other evidence to develop a plausible scenario.

Reprinted with permission from Resource Area for Teaching (www.raft.net)
Imagine the police barging in. They arrest you and suddenly you’re facing a charge of murder. You didn’t do it, you have an alibi, there’s no evidence, but it doesn’t matter.

You’re found guilty and sentenced to death.

But you’re INNOCENT.

Tough.

But there’s evidence you’re INNOCENT!

Too bad. No one cares.

One group does, though. Can you get your students to help?
The Innocence Project is a group who have used DNA tests to free hundreds of wrongly convicted people, many on death row. Below are two cool ways to expose your students to the group’s work and let them see first hand what it’s like to be involved.

1. Not Guilty: Students Discover How Science Can Free the Innocent
   [https://www.edutopia.org/innocence-project-dna-testing](https://www.edutopia.org/innocence-project-dna-testing)

2. Wrongful Convictions and DNA Exonerations: Understanding the Role of Forensic Science
   [https://nij.gov/journals/279/Pages/wrongful-convictions-and-dna-exonerations.aspx](https://nij.gov/journals/279/Pages/wrongful-convictions-and-dna-exonerations.aspx)
   - Present students with data and causes of wrongful conviction - have them create tables or graphs of the data and discuss.
   - Assign each student a case from NIJ or Innocence project and have them investigate and report on what led to the wrongful conviction, how the conviction was overturned, and what changes were made to the system based on the outcome of the case.
Most Americans think they know everything about forensics because they’ve seen it on TV. However, students and teachers of forensics know the nonsense of Hollywood: cases solved in 44 minutes, every case is tied up neatly, every lab has all the equipment and people they need, and all crime scene technicians look and dress like models.

But what about fingerprint examiners?

Do you mean the people who dust for fingerprints? Or do you mean the people who operate the computers that conveniently spit out the name of the fingerprint owner in only a few seconds? Or do you mean the people who look through all the possible matches to a print lifted from a crime scene because all of them bear some resemblance to the one entered into the database for searching?

The work of fingerprint examiners does not make for compelling television, but it does make for compelling evidence. A search on AFIS usually turns up a number of prints all with traits consistent with the one found at the scene. The fingerprint examiner’s job is to look at all possible matches carefully. You can read more about this here.

But let’s say you want to give your students a taste of what exactly is involved. If you can project websites on a screen in your classroom go to https://www.nist.gov/node/1203696/take after you tell your students to take out a piece of paper and number it from one to eight. Now show them the questions, but only give them a certain amount of time, like 15 or 30 seconds per question. If you’re feeling generous print out the following pages and let them take the quiz at their seats and give them more time per question. Any way you do it, they will gain a greater appreciation for the job.

The answers are below.

Fingerprint Examiner Exam Answers

1. H
2. F
3. N
4. D
5. B
6. B
7. A
8. G
Do You Have What It Takes to be a Forensic Fingerprint Examiner?

Question 1

Ability to judge the Orientation of a Line

As a fingerprint examiner, one of the first things you’ll have to do when analyzing a print is to use information in the print’s ridges (line orientation, width, and curvature) to orient the fingerprint in the upright, or “tip up,” position. This question tests your ability to compare and judge the orientation of a line.

Instructions:
Select the line whose orientation matches that of the line on the left.
Question 2

Ability to Perceive Width

To determine if a fingerprint collected as evidence at a crime scene matches the fingerprint of a known individual, you will need to assess the width (thickness) of the ridges in both prints. This question tests your ability to correctly match curved lines based on their width.

Instructions:
Select the line whose line width (thickness) matches the line on the left.
Question 3

Ability to Judge Rotations and Conduct Visual Search

You will also need to mentally rotate patterns and conduct visual searches to find features in both the evidence fingerprint and the known fingerprint to determine if they share common features. This question tests your ability to mentally rotate and match visual patterns.

Instructions:
Find the image that most closely matches the image on the left.
Question 4

Ability to Judge and Compare Features

As a fingerprint examiner, one of your primary tasks will be to detect features of interest in an evidence fingerprint and compare them with features in a known fingerprint. This question tests your ability to compare complex images for features that are similar and for features that are different.

Instructions:
Select the image that most closely matches the image on the left.
Question 5

Ability to Separate Superimposed Images

When working on a case, you might receive an evidence fingerprint with a pattern superimposed on top of it. For example, if a person touches an item twice, they may leave an area of overlapping patterns, one superimposed on top of the other. This question tests your ability to separate overlapping patterns.

Instructions:
Filter out background noise to find the image that most closely matches the image on the left.

A
B
C
D
Question 6

Ability to Filter out Background Noise

Sometimes a fingerprint is found on an item that has its own pattern of lines and curves. For instance, if a fingerprint is found on a twenty-dollar bill, you will need to separate the fingerprint pattern from the background pattern. This question tests your ability to correctly identify a complex image from a set of alternative images that contain overlaid or background patterns.

Instructions:
Filter out background noise to find the image that most closely matches the image on the left.
Question 7

Ability to Detect if Small Pattern is Present Within Larger Pattern

As a fingerprint examiner, you will look for “target groups”—clusters of features in both the evidence fingerprint and the known fingerprint—to determine if they share common features. This question tests your ability to match a small partial image to a larger image that contains it.

Instructions:
Select the image that contains within it the smaller image on the left.
Question 8

Ability to Follow Ridge Lines

As a fingerprint examiner, you will have to trace the ridges of a fingerprint. This question tests your ability to correctly follow a line in a poor-quality image.

Instructions:

Trace the line that begins at position D to determine where it ends.
The images on the next two pages comprise a crime. The idea is to present them to your students and challenge them to solve the crime by looking at the photographs and reading the descriptions.

If you want to make a class set of the pages and have your students work on them in pairs, you’re going to need a printer (and then a copier) capable of printing in color or gray scale. A printer or copier that only turns out black and white products just isn’t going to work. OR, you could transfer the images to a projector that allows every student to see them all at once.

These pages are from Scotland Yard Photo Crimes, used with permission of Dorling Kindersley Publishers. The answers are on page 54.

Get started now
AN END to LIFE

In cases of suspected suicide intent is often inferred from a person’s behaviour. However, it also may be established on the basis of an examination of existing evidence.

1 One morning as Miss Moffat was walking downstairs, she smelled gas. She knocked on the door of Mr. Bickerstaff’s ground-floor room. There was no answer. She tried to open the door, but it wouldn’t budge.

2 Inspector Black was immediately sent for. When he arrived, he too tried the door, but it was stuck fast. Then he shoved hard with his shoulder and burst the door open. He saw at once that it had been sealed along the edges with newspaper.

3 Too late to save him

The Inspector rushed into the room, holding a handkerchief to his face. He opened wide one of the windows. Then he turned off the gas and waited by the door for the air to clear. When he thought it was safe, the Inspector came back and examined Mr. Bickerstaff. He was dead. There was a severe bruise on the back of his head — possibly caused by his falling heavily onto the floor.

4 Then Inspector Black surveyed the room. At one side was a small table set with a plate, knife, cup, saucer and teaspoon. He noticed that the other window in the room was opened slightly.

5 The only objects on the mantelpiece were a small clock and a pair of leather gloves. A cheap mirror hung above.

6 In the corner next to the fireplace was a pillow and two folded blankets. The Inspector learned that Mr. Bickerstaff had only moved in the day before, and had brought very little with him.

7 Strips of newspaper had been stuck to the door with sealing wax, and four used safety matches were lying on the floor.
8 Inspector Black emptied the dead man's pockets. They contained a bunch of keys, a handkerchief, three crumpled letters, and a few coins. The contents of the letters were trivial.

9 A closer examination of the table showed that it contained, in addition to the objects already mentioned, a slice of bread, a jam jar, a stick of sealing wax, a coloured pencil and a sheet of the previous day's newspaper, which was opened to the obituary page. Had someone close to Bickerstaff just died?

10 The Inspector opened the small cupboard next to the fireplace and found a plate with a slice of bread, an empty cup and saucer, two empty tins, half a loaf, and tea wrapped in paper. Mr. Bickerstaff had not led a luxurious life.

11 Behind the door hung an overcoat and a scruffy old hat. The pockets of the overcoat contained a few bits of paper, some crumbs of food and three farthings. The print on the old papers was hardly legible, but one piece looked like a bus ticket.

12 The clock on the mantelpiece had stopped, but the Inspector couldn't say how long ago. The leather gloves seemed just the right size for the dead man. By now, the Inspector had just about completed his investigation.

13 Finally, he searched Bickerstaff's shoes, the windows, walls and door for scratches, but didn't find any.

The answer is on page 54.
BRIDAL GRIEF

All good detective work is based on the recognition of significant details and the proper evaluation of their meanings. If an inference is to be correct it must be borne out by a number of circumstances.

1 stammered a distraught Mr. Davenport to the police. "I think she's dead. . . ."

2 Inspector Black was soon there. He was impressed at the opulence around him, but not surprised; everyone knew that the new Mrs. Davenport was worth millions.

3 Davenport led Inspector Black upstairs. When they approached the door to the master bedroom, he puffed nervously on his cigarette. The Inspector could see a young woman lying across the bed.

The husband's sad story

4 "Today was our first anniversary," Davenport began after composing himself. "We had reservations for dinner at The Paradise Lounge — our favourite restaurant. Clarissa seemed in a good mood. She even asked me to select which of her gowns she should wear. Once dressed she looked a vision! I told her she'd never looked more beautiful. Then I went downstairs for a drink while she applied her finishing touches.

5 I sat downstairs for about ten minutes, relaxing over my gin and tonic. Suddenly I heard a loud bang! I jumped to my feet and ran upstairs. When I rushed into the room, there she was, lying across the bed. I got to the phone as quickly as I could."
6 Inspector Black examined the body. The bullet had entered the temple and passed through her skull. The gun was still in Mrs. Davenport’s hand.

7 No, Davenport couldn’t think why his wife would have killed herself. “She was very upset about a letter she received yesterday, but she wouldn’t show it to me.”

8 The Inspector then asked if he might use the telephone. He went downstairs and phoned The Paradise Lounge. Yes, they did have a reservation in the name of Davenport. It was for a table for two at 9 o’clock.

9 When Inspector Black returned, he continued his investigation. The Davenport’s room was full of objets d’art, but nothing seemed out of place. He did, however, find two hairpins on the carpet.

The answer is on page 54.

10 Then he examined the dressing table. There were the usual items: lipstick, powder, rouge and perfumes.

11 In the drawer he found a number of unpaid bills for men’s clothing from the best Saville Row shops, but no letter.
Pig Dig

by Linda Spurlock, Ph.D.

I came up with this activity because I was an archaeologist for many years who eventually switched her focus to biological anthropology. I vividly remember my prehistoric archaeology field school, and we didn’t find much at all: a few flint flakes, some stains in the soil, one or two fire-cracked rocks. I barely got to take depth measurements, there wasn’t much to make a map of, I didn’t need half the equipment in my little archaeology kit. After I got interested in bones, comparative osteology, and forensics it seemed like a great idea to bury something that archaeology students could FOR SURE find and map and interpret. The first time I did it the pigs didn’t completely skeletonize, I had the students dig up everything in one long day, and it was not ideal. But I learned so much each time I did it, and once I finally had all the protocol established (this fall will be the 12th time I set up a Pig Dig) I felt I should share how to do it with other educators. And since then forensic science has become more and more popular, there is always a big waiting list to get into the course.

I have also tried having students dig up fire features, in which all kinds of things are burned in a fire pit including butchered pig bones (which we pretend are human), mimicking a forensic case I worked on several years ago in which a very bad man killed an 18-year-old female and tried to destroy the evidence. Students have to sort bone from non-bone and then pig bone from non-pig. It’s very interesting. For non-pig bones I have bones from several species that I put in there (chicken wings, turkey drum sticks, beef long bones that were sawed for soup and beef ribs that were sawed to make short ribs, and/or huge cow bones that I buy at Pet Smart that are sold for dogs to chew). I make the burn unit look like a pit where rural folks are burning their household trash, so also put in cans, bottles, old broken toys, metal springs, etc. It’s important not to let things burn too hot or for too long, because the cut up pig parts, including bones, literally disappear! I found this out the hard way and had to do it twice. So, this combination of many things is why the student must first sort bone from non-bone, and then “human” (pig) from non-human. It is very much like a real attempt to hide a homicide.

I buy whole roasting hogs at the local butcher (what a person would buy to have a pig roast party). They are gutted but otherwise intact. For hogs ranging in weight between 100 and 150 lbs, it costs $1.99 a pound. This is a good size—so is anything over about 75 pounds—and having them gutted is ideal, as there is a great surface area of cut open tissue in which blow flies will lay eggs, and maggot masses gets huge quickly, and consume a lot of the tissue in just a few weeks.

The pigs we use are going to run about $200 each, which is going to limit teachers who will have to pay for them out of pocket. It is worth asking your butcher about other species of animals. Maybe a goat would work. We have considered getting large dogs that have been euthanized that day at an animal shelter, but there will be hair that is not going to decompose, which is why pigs ready for roasting are ideal. I’ve used some smaller pigs in the past (only dressed them in underwear) and this worked out fine. Yes, it can be an expensive exercise but it is SO authentic, the students will remember it their whole lives.

Another reason you want the whole hog is that you can dress it in human clothing, such as a cotton short-sleeved shirt or cotton short skirt. But don’t put too much clothing on it, it will be hard to excavate later. Students can cut the clothing and lay it open to continue excavating the bones, but not if...
the clothing is several layers thick. Really old cotton, nearly threadbare, is good because it will partially rot. Old cut-off shorts made out of heavily worn denim are OK, much of the cloth will rot except the inseam and waistband.

Thinking up backstories for your homicide “victims” is a very creative aspect of this course. If you are burying more than one pig, you will see that students will try to attempt a linkage between the victims—they want to believe that there is one overall crime to account for multiple bodies. Although many scenarios could account for two or more linked victims, I often want each victim to have a different story, with different types of evidence planted in the grave (shell casings, ID, a purse or wallet etc…), and we will pretend that the burial site is a body dump for bad guys. It’s convenient to take stories from the newspaper headlines. Once I had a Mafia-style hit, and buried the skull and hands separate from the body. The local butcher did the cutting for me. This way there were two excavation units for one pig: two students with the head/hands burial, and five or so students with the body burial.

How is your junior forensic team to know where to search for the clandestine burials? A popular backstory is that a prisoner who is already incarcerated agrees to share some information about the body he buried or one he knows someone else buried, so he will get less prison time (striking a deal). He will draw a crude map of where the body (or bodies) is. Students get this map and a survey of the area is organized, much like archaeologists do a surface survey of an area suspected to contain archaeological sites. Everything the students notice is pin-flagged for possible importance, photographed in situ with a scale, etc. They will find the graves, you’ll be amazed.

A challenge is finding a burial locale where the smell will not bother anyone. It smells terrible for at least 3 weeks, while the carcasses are undergoing the initial decomposition and the graves are open. The smell travels at least 80 feet away. Vultures will be circling overhead. You must check often that coyotes or dogs have not somehow breached your wire/cinder block defenses. But the gang of people who help to set this up LOVE it. We have so much fun hatching the backstories, collecting and planting clues, wondering which clues will stay intact for next year’s excavations. We do the hard work initially, and later the students do the hard work while we watch and guide them.

The initial decomposition phase is ideal for an activity on forensic entomology. Even if it is just a brief visit by students during the maggot mass phase, to see the rove beetles preying on them, or to stick a long thermometer into the mass and see that it is much warmer than the air. The corpse is a mini ecosystem with decomposers, and waves of insects colonizing it, and even the predatory rove beetles as carnivores. It’s like a fallen “nurse” log that sprouts little fungi and tiny plants. Collect some maggots of different sizes and examine their hind ends under a microscope. Yes, kids, they breathe through their butts! The second instars will have two slits/spiracle and the third instars will have three! See 3rd instar and maggot mouth parts images. Students can identify various insects and other arthropods that are attracted to the decomposing body using Forensic Identification Cards (James L. Castner and Jason H. Byrd), or by searching Google.

Figure 1 is a photo of a moldy grave is one with the too-steep sides that the maggots couldn’t crawl out of. We have recently found that it is best to only cover graves with tarps during the decomposition phase if rain is in the forecast. Graves need a LOT of fresh air or they will grow mold. We learned this the hard way. You must bail out water that is lying on the tarp after rain and remove tarp. Yes, this is a lot of work.
I make a 1x1 meter string grid to aid with mapping the skeleton, from PVC pipe as the frame & strings set at 10 cm. intervals. This can be positioned over the excavation unit & the students draw on graph paper – what they see through a 10 square centimeter window can be drawn in miniature in the 1 square centimeter of the paper. No measuring tapes for mapping the bones are necessary.

About five or six students work at a grave without getting in each other’s way because one or two can be screening. You must screen, as these are immature skeletons and there are many unfused epiphyses. I bury three pigs at some distance from each other, and have 18 students in a class. Figure 2 shows how if the grave is pretty big five students can work at it, when they are in the troweling phase. A sixth student would be screening the dirt. Figure 3 is the same skeleton, but now it is ready for its photo shoot.

We use standard 1/4 inch mesh hardware cloth screens for the excavated soil. Hardware cloth is metal, it is often used for making fences (I’ve used it to make cages for monkeys), and is good for making the shake screens in archaeology. It comes in rolls. It is available in many places like Lowe’s, Home Depot, and Wal-Mart. Some screens are simple wooden boxes with a hardware cloth bottom, like gardeners use, others are bigger and stand on two wooden legs while two people hold/shake them.

We routinely use 1/4-inch mesh (only finer if there is some very special circumstance, which is not the case on a Pig Dig).

The traditional soil sifter is a simple, lightweight device that fits on top of a wheelbarrow or garden cart (or can be used without one if you prefer) and filters out stones and the pig bones. An example can be seen HERE.

A word about adipocere: it forms in damp environments, it is hydrolyzed fat, and in the early stage of formation looks like Crisco. It is a post-mortem decomposition product of soft tissue, and typically smells terrible. The pig skeletons may have patches of it. We scrape this off the bones with wooden tongue depressors. The adipocere can be deposited into paper cups and later buried. It should not be pushed through the screens.

Once the skeletons have been carefully excavated, photographed and mapped, it is time to remove the bones. Place them into labelled paper bags, not plastic, because bones in plastic will grow mold. Be sure to mark which bones are from the forelimb vs. the hindlimb.

As for lab activities, as mentioned in the article, have students glue the epiphyses of the bones onto the shafts, put the small parts of each vertebra together—Duco cement is good for this. Get a good diagram of a pig skeleton and lay the pig bones out in anatomical order like in Figure 4. Students can string the vertebral column together once the bones that make up each vertebra are glued together. Compare the pig to the human. Pigs have short stubby legs, no clavicle (makes their locomotion more stable), and tighter, extra vertebrae. You can talk about quadrupedal vs. bipedal locomotion, how the pelvis of the human is very different—the human’s is built for balancing the trunk over the hind limbs, in an upright posture. Point out how the radius and ulna of the pig forelimb is very different from human, since they don’t pronate and supinate; those two bones are shaped so they fit very tightly together and are weight-bearing in the pig. Our radius and ulna are very mobile and not weight-bearing.

Safety Protocol:
In archaeological field work, we always wear long pants and boots. There can be ticks in the tall grasses and it is surprisingly easy to drop heavy equipment on one’s feet. You must not let students wear sandals. Many institutions now require a stricter protocol, especially when digging up decomposed remains. This includes (additionally) a long sleeved shirt, gloves, and having disinfecting wipes handy in case any products of decomposition get on the students’ skin.

Shovels: instruct the students, when they lay down their shovels, to have the concave side of the blade DOWN. This way, if someone steps on the blade the handle doesn’t rise up and hit them in the face.

Finally:
Other sources of information loaded with helpful hints and suggestions can be found at the following sites:
Remember, as it says in the article, after you do the decomp study you’re in it for the long haul. The pig needs at least a year in the ground to fully decompose. Lay it in the ground over the winter. In the spring take off the fencing & cinder blocks and allow the vegetation to grow up. Then you can dig the pigs up in the summer or the fall. In a place that is warm year round I guess that laying in the ground 9 months might be enough.

THE PIG DIG: A MOCK CRIME SCENE EXERCISE FOR A FORENSIC ARCHAEOLOGY FIELD SCHOOL

By Linda Spurlock, Linda Whitman, and Heather York

Abstract

An archaeological field school based on excavation of pig burials provides many advantages to both students and instructors. Students conduct a surface survey to find the burials and excavate complex features utilizing all the standard techniques of field archaeology. Because the burials are interpreted as unnatural deaths, students must follow many lines of evidence to answer the questions “What can we deduce about the identity of the victim?” and “What might have been the manner and cause of death?” Instructors are not absolutely certain what students will find, as some “evidence” may not have been preserved, but know that many bones will come back to the lab for cleaning and analysis.

Key words: archaeological field school, mock crime scene, clandestine graves

Introduction

Students often want to know “Is it real?” when examining bones, artifacts, and historical documents, etc. Student attention appears to be more engaged when they handle anthropological artifacts if the objects are not casts or facsimiles. Recognizing this, we have developed a three-week intensive forensic archaeological field school using pig carcasses as proxies for human remains. The mock crime scene is carefully engineered, including the use of clothing and other artifacts. The carcasses are buried a year before the field school commences to facilitate decomposition.

The most powerful aspect of working the mock crime scene is that many of the elements are real. The bones (although pig) are real, and the staining of the soil by the decomposition of the pig carcass is real. The foul smells are real, adipocere has often formed, and the clothing has partially decomposed and faded. Often, rodents have left evidence of burrows through the features, and some bones may have moved to the surface through a variety of taphonomic processes. Although students know instructors set up the scene a year prior, their sense of anticipation is high. Likewise, we as teachers are quite curious to see how well the carcasses have decomposed, which clues left on the bodies and their clothing have survived, and what will actually be recovered as the students undertake excavation.

Because we feel this kind of hands-on experience is vital to strong undergraduate learning and because we have had significant success with this model, what follows is a distillation of our best practices for the field school that we hope readers may choose to adapt for their own students.

Seasonality

This type of crime scene must be set up during warm weather, as the key to getting skeletonized remains (instead of rotten meat on skeletons) is blowfly maggot activity; they consume most of the flesh within about ten to fourteen days.

Composing the Back Story

Everyone loves a good story, and in a mock crime scene, the story can be taken from the daily news. Drug deal gone bad, jealous spouse kills a lover, drunk driver attempts to hide the evidence of a vehicular homicide, religious cult kills runaway members—we have used all of these as back stories. Once the background is agreed upon, clothing must be obtained to dress the “victims” appropriately. For decomposition of the remains, best results are attained using a minimum of clothing. We found out the hard way that a costume that includes a suit jacket with dress shirt, slacks, underwear, and socks is “too much.” Decomposition will be delayed, and it will be difficult for students to see the bones as they excavate. Clothes that work well include old worn out jeans with many holes in them, new or old underwear (Figure 1), miniskirts and camisoles, and tee shirts. Scarves, earrings or bracelets, a wallet or money in the pants pockets, ropes or wires to bind wrists or legs—these are all very
Obtaining Pigs

Acquiring freshly slaughtered pigs may be a challenge in some areas. In our fairly urban region, creating a relationship with a butcher was necessary. Our butcher knows what we are up to and revels at our arrival. We recommend immature pigs that weigh between seventy-five and 100 pounds. This is a size that can, with effort, be managed in transportation and is likely to fit in human clothing. Eviscerated pigs will decompose faster. And, of course, remember the fore and hind limbs of pigs are very short relative to their weight; so long pants and long-sleeved shirts will not fit properly.

Leaving Trauma on the Pig Carcasses

This is a perfect opportunity to ensure that students will find evidence of blunt force trauma, sharp force trauma, and/or gunshot wounds. A pig carcass can be run over by a car, van, or truck to create numerous crushing fractures. Hammers work well on the skull, and sometimes the dimensions of the hammer head can be estimated by the fracture size. Stabbing with a long knife in the thorax, ribs, scapulae, sternum, or vertebrae will usually exhibit vivid examples of sharp force trauma.

With gunshots, using weapons of different calibers can present an analytic challenge, as these will leave varying paths of destruction on the bone. Shell casings can be collected at the time of shooting and left near the burial pits (if shooting near the burial site is part of the back story) and found later during surface survey or with metal detectors.

Documenting Preparation

As the crime scene is created, we take many photographs and video to document the process. These will be shown to the students on the final day of the field school, after the students have reported their findings.

Achieving Maximum Skeletonization of the Pig Carcasses

Burial pits should not be too deep. The pits should be deep enough to allow the whole pig to be (eventually) covered by no more than about twenty cm of soil. The sidewalls of the pit should be slanted, not vertical (more about this below).

Place the dressed, traumatized pigs in the burial pits but do not backfill. Cover the burial pits with hardware cloth, fence wire, or chicken wire, and weigh the wire down with cinder or patio blocks (Figure 2). Depending on the width of the hardware cloth, two sheets may be needed, and these can be secured together with cable ties. Hardware cloth is easily cut with wire cutters. The blocks rest outside the pit on the ground surface. This allows entry and exit of blowflies and other insects that aid in the destruction of the soft tissues and prevents animals such as coyotes and raccoons from disturbing the pigs. Above the hardware cloth, spread a tarp and hold this down loosely with rocks or patio block. This will prevent rain from filling up the pits during the time the pigs are decomposing. It is imperative to leave this top layer loose, as the insects that will consume the pig flesh are air-breathing animals.

Blowflies will begin egg-laying immediately, possibly even before you have a chance to totally dress the “victims,” and eggs hatch about a day later. By about day four, the third instar maggots will be present, and they are responsible for most of the tissue consumption. It is worthwhile as instructors to watch the life cycle of blowflies, the arrival of beetles that prey on blowfly maggots, and how other insects are drawn to the carcasses. And this can all be documented by photography for class purposes.

Once the third instar maggots have eaten much of the soft tissue, bones will begin to protrude from the carcass.

Figure 2. Victim in a Shallow Grave. The backstory for this individual was that she was run over by a drunken motorist while she was walking her dog (note that the killer has put the dog leash in the pit). Photo shows depth of the grave, the mesh over top, and the cinder blocks weighing down the mesh.
further work by the insects might backfill. This is important because is defleshed and visible, it is time to
Once much of the vertebral column context of the “hasty burial” scenario.
leaving a thick brown layer of pupal
pate right on the carcass, eventually
they cannot crawl away and will pupate. If the sidewalls are vertical,
can leave the pit and find a place to
burial pit is so that these tiny animals
for having slanted sidewalls in the
ing away like a pale river. The reason
sight—thousands of maggots stream-
ingation” of the third instar maggots as
they leave the carcass to seek shelter
lay eggs, and soon maggot masses
blowflies will continue to visit and
this may take up to twenty days. New
blowflies will continue to visit and
for pupation. This is a remarkable
sation will be less obvious.
Depending on the ambient temperature,
big. You may be lucky
enough to see the “post feeding mi-
gation” of the third instar maggots as
they leave the carcass to seek shelter
For the “grave” features. This is a remarkable
sight—thousands of maggots stream-
ing away like a pale river. The reason
for having slanted sidewalls in the
burial pit is so that these tiny animals
can leave the pit and find a place to
pupate. If the sidewalls are vertical,
they cannot crawl away and will pupate right on the carcass, eventually
leaving a thick brown layer of pupal
cases, which is not desirable in the
context of the “hasty burial” scenario.

Once much of the vertebral column
is defleshed and visible, it is time to
backfill. This is important because
further work by the insects might
cause the bones to tumble out of
anatomical position. There will still
be some soft tissue present, especially
mummified skin. Remove the pro-
tective wire over the pits, backfill,
tamp down the soil, and then replace
the wire and blocks. There is still a
strong possibility that wild or domes-
tic animals will be attracted to the
remains and try to dig them up.
Keep this setup intact over the
winter (or for about nine months if in
a climate that is warm year-round).
A few weeks before the class begins,
remove the patio blocks and hardware
cloth. This will allow time for spring
vegetation to grow, making the scene
more “real,” and the “grave” loca-
tions will be less obvious.

Preparing Course Elements
Outside of Excavation

Before we hit the field, several
lectures and visitors are arranged.
Lectures and videos we employ usu-
ally include material on human and/or
pig osteology, forensic entomology,
archaeological survey, and excava-
tion. Visiting lecturers can be the
local medical examiner or coroner,
police or investigative detectives,
and/or archaeologists who have
excavated mass graves for poten-
tial identification. Field trips to the
regional state crime investigation
office are arranged or, in our case, to
the Hamann-Todd Osteological Col-
lection at the Cleveland Museum of
Natural History to look at trauma on
human bone.

Finding the Clandestine Graves

This is a good opportunity to teach
students about setting a baseline
to define a site and doing surface
survey as a group. Students are given
instructions for locating clandestine
graves (noticing clumps of subsoil,
unusual vegetation, secondary depres-
sions, cracks around the pit fill, stray
bone, etc.), and each carries pin flags
for marking anything of note, includ-
ing artifacts.

Once the graves are located,
students clear away any leaves or
branches covering them (these are
saved on a tarp and gone through
carefully to look for stray bone or
trace evidence), and they set up their
excavation units via triangulation.

At this point, some of the students
can make a map of the site that indicates
the location of the baseline, nearby
roads, buildings, paths, surface finds,
and location of the “grave” features.

Excavating

We recommend excavation units of
two by three meters dug in arbitrary
ten cm levels until the outline of the
burial pit is obvious and the matrix
screened through ¼ inch hardware
cloth. The burial pit contents alone
can be excavated as a feature in ten
levels. Bones should be pedes-
taled (Figure 3) and plan views drawn
more of the skeleton is revealed.
Bones and evidence should be bagged
by unit and level. This excavation
of a very complex feature is excel-
ent archaeological experience, and
students get practice taking depth
measurements, triangulating, drawing
plan views and profiles, and recogniz-
ging pit fill versus matrix. We set up
two teams of students and establish
a pattern in which teams visit each
other’s units for periodic reports and
exchanges of ideas (e.g., Do you
think your “victim” is a male or fe-
male? Could these deaths be related?
Does your “victim” seem to miss any
body parts?).

Once all the remains and evidence
are removed, the burial pits should be
excavated down further so that the pits’
entire contents can be examined. Side-
wall profiles of each unit should then
be drawn as well as one last plan view.

Taking It to the Laboratory

Bones and clothing can be washed
in the field in buckets of water
with liquid dishwashing soap and
brushes. If there is too much adip-
cere, clothing can be documented,
photographed, and buried in the
field. Bringing back unwashed bones
into the university laboratory can be

Figure 3. An Excellent Excavation of Remains That Had Been in the Ground for Two Years. Victim had been dressed in very faded, ripped jeans, an old tee shirt, and a red plastic bracelet. Most of the clothing decomposed. Note epiphyses adjacent to long bones.
risky since they may have a strong odor, and people in your building will become alarmed and/or annoyed. Note: if the pigs have been left in the ground for two to three years, there is very little odor.

After the bones have dried, further analysis is possible. If you have selected immature animals (most likely since mature pigs weigh hundreds of pounds), students will be able to see epiphyses that have not fused to long bones and vertebrae with unfused elements. We provide diagrams of pig osteology and have the students glue the separate pieces of bone to simplify the analysis. This experience with immature bone is quite valuable, as in many osteology classes only adult bones are studied. The skeletal elements should be laid out in anatomical order on lab tables, and students should be able to determine if any parts are missing (as some back stories include the severing of body parts). The pig bones, at this point, can be compared to human bones. There are many interesting differences and similarities.

Trauma to the bones is often identified in the field and can be further examined during the washing and gluing phases. This is evidence that students should incorporate into their scenarios of the deaths. We ask the students to determine as much as they can about “victim” identities and how they may have died based on their research.

Presenting Findings

Students, having worked in teams during excavation and analysis, present their findings as a team. Our students have primarily used PowerPoint presentations featuring their map of the site, floor plans, profiles, photographs of excavation, and photographs of evidence and trauma to bone. We have found that students really rise to this occasion. They have researched the labels and brands on the clothing and artifacts and used these as clues to the “victim’s” body size, socioeconomic status, and ethnicity. In one case, students inferred that the “victim” was probably Caucasian because the foundation makeup in “her” purse was very pale. In another case, they determined the “victim” was a baseball player, identified his team as the Akron Aeros, and even (they thought) his name, based on rosters and trades made the previous year. Our students put equally impressive energy into determining bullet trajectories and distinguishing between exit wounds.

Following student presentations on the final day of class, we reveal the back stories and show photographs and video from the crime scene set up—the dressing and traumatizing of the carcasses. For these students, who have been studying the bones and pondering the possible scenarios, this is very satisfying (and often entertaining) conclusion to the class.

Feedback from Students about this Course

They love it. They bond over the highly unusual, intense shared experience. Student feedback and course reviews are excellent; many write that this is the best course they have ever had at the university and that more courses should feature this kind of experiential learning.

Linda Spurlock
(lspurloc@kent.edu) received her Ph.D. in Biomedical Sciences from Kent State and held a post-doctoral position in the Department of Anatomy at Northeast Ohio Medical University, where she refined techniques of forensic facial reconstruction. She teaches courses in biological anthropology, forensic anthropology, and archeology. She has had an extensive career as a teacher of anatomy and physiology in colleges and universities throughout northern Ohio. Spurlock is a forensic facial reconstruction artist and provides sketches of unidentified persons for medical examiner and coroner’s offices throughout the region. She is also a scientific illustrator who specializes in primate fossil reconstruction and worked on reconstructing the fossil Ardipithecus ramidus pelvis. In 2006, she co-edited Caves and Culture: 10,000 Years of History in Ohio, Kent State University Press.

Linda Whitman
(whitman@uakron.edu) holds an MS degree in Anthropology and a Certificate in Museum Studies from the University of Wisconsin-Milwaukee. She joined the Department of Anthropology and classical Studies in 2001 after conducting Cultural Resource Management archaeological investigations for twelve years. She teaches Introduction to Archaeology, Ohio Prehistory, Historical Archaeology, The Archaeological Field School, and directs the Community Archaeology Program, an outreach of faculty and students to the local and regional community. Its goal is to assist community organizations and agencies by identifying prehistoric and historic archaeological cultural resources present on the properties for educational, management, and historic preservation purposes. This research provides interpretation and enhancement of the local history through archaeological methodology and analysis.

Heather York
(h.york@snhu.edu) teaches courses in anthropology, ecology, and biology. She has a BA in Anthropology from Vassar College and an MA in Anthropology from The University of Oklahoma. She has completed partial requirements for a Ph.D. in Biomedical Sciences from Kent State University with an emphasis in skeletal biology and forensic anthropology. She has also worked as a technical writer in the College of Public Health at the University of Arizona. She is primarily a forensic anthropologist and has worked extensively in the recovery and identification of human remains following international conflicts.
Who’s Your Mummy?

Using DNA Fingerprinting to Reconstruct an Ancient Family Tree

Students apply their knowledge of DNA fingerprinting and play the role of archaeologist in this activity that unravels to reveal a complex Egyptian family tree.

To Do and Notice
1. Examine the mummy DNA fingerprints (barcodes) on the following page.
2. Each column models the DNA fingerprint (barcode) of a mummified individual. The first line notes the mummy’s number designation, the second line notes gender (male or female), and the third line notes the age at time of death. The remaining 30 lines contain the DNA information.
3. Follow the instructions on pages 3 and 4 of this activity, and use the barcodes to fill-in the mummy family tree.

Teacher suggestions:
- Do this activity after the RAFT Idea Who is the Daddy? which provides students an opportunity to practice Paternity Testing in a simpler scenario.
- Solve this activity personally before presenting it in a classroom situation.
- Students can either use pre-cut strips or cut the barcode strips themselves.
- If using pre-cut strips, review DNA fingerprinting with students and guide them through the examples presented on the barcode page.
- Direct students to work in groups of 2 or 3 to fill in the family tree. Each student, however, should have a set of barcodes.

The Content Behind the Activity
DNA fingerprinting utilizes the highly variable, noncoding pieces of an individual’s genetic code (minisatellites) to create a “barcode”. Through the electrophoresis process, long and short minisatellites travel varying distances in a gel. All genetic material comes from a combination of both parents, so all genetic material that did not come from the mother must come from the father, and vice versa. Unlike actual fingerprints that only identify an individual, DNA fingerprinting also can identify an individual’s parents.

This simplified model illustrates the process of identifying relationships through DNA fingerprinting. In each case, a fictitious barcode contains 12 “bars” in 30 possible spaces, with exactly 6 “bars” coming from each parent. Students should be clear that reality is significantly more complicated, illustrated by the actual image of DNA fingerprints on page 2. Information about an individual determined by DNA analyses increases with improved technology and our knowledge of DNA structure.
Professionals use DNA testing to verify identities, establish relationships, and solve mysteries. When biologists developed and refined DNA fingerprinting processes, anthropologists immediately saw applications, such as identifying mummified individuals, as modeled in the scenario. When piecing together ancient cultures, archaeologists often face challenges presented by broken or damaged artifacts. Every scientific process available is utilized to gather as much data as possible for stronger conclusions. Mummified individuals are X-rayed and scanned to produce MRIs. Increased medical technology provides archaeologists with an array of less invasive procedures that preserve delicate artifacts. Archaeologists use a small amount of mummy tooth dentin as the genetic testing material of choice because it provides better results than flesh samples.

Although this activity models a fictitious family, the results are consistent with Ancient Egyptian family relationships. The family patriarch married twice; polygamy, re-marriage after the death of a female partner, and divorce were common in Ancient Egypt. Egyptian women had little say regarding their future husbands as parents arranged marriages after puberty, generally at age 12 or 13. Mummy 12 was relatively young when she died (age 16-20). This woman may have died in childbirth or from illness, or possibly been the victim of jealous stepchildren from a first marriage (as seen in the historic “Letters of Hekanakhte”). The other “DNA surprise” involves mummies 9 and 10. Mummy 10 is not the biological offspring of mummy 8. This could point to infidelity, but also might reveal an adoption (a common practice among the Ancient Egyptians).

The correct answer in this model is:

Note: Students should find that mummy 8 is not the genetic father of mummy 10, but placement of this individual on the family tree is by default. Teachers can share that adoptions were common in Ancient Egypt, and this situation may reflect an adoption. Students may also offer other explanations. Advancements in genetic testing in the past couple of decades have solved many mysteries, but in some cases, questions are still left unanswered.

Taking it Further
- To make this activity easier, guide students through the process step by step.
- To make this activity extremely challenging for advanced students, have the students create the family tree on their own, using only the clues, barcodes, and gender and age data. In this case, students should conclude that mummies 9 and 10 have no direct link to the rest of the family tree. Allow students to use any plausible explanation for these mummy appearances in this tomb as a hypothesis (distant relatives, adoption, attendants).

Web Resources (Visit www.raft.net/raft-idea?isid=463 for more resources!)
For detailed information of how DNA Fingerprints are made and used in legal situations, visit “How Stuff Works” at: http://www.howstuffworks.com/dna-evidence.htm
See the following websites for more information about Ancient Egypt:
http://www.egyptianmuseum.org
http://www.watson.org/~leigh/egypt.html
Who’s Your Mummy?
Unraveling an Ancient Family Tree

Archaeologists have made an incredible new find: an Egyptian family tomb from the new kingdom containing remains of 12 individuals! Unfortunately, thieves have ransacked the tomb in search of treasures. Each mummy was found removed from its sarcophagus and unwrapped. Burial chamber contents were also damaged. Scientists have used tooth material to create DNA fingerprints (barcodes) from each mummy in an effort to recreate the family tree.

The Task:
Use the DNA fingerprints (barcodes) provided and the hints to fill-in the family tree.

The Hints:
- Archaeologists created the family tree based on writings from each sarcophagus and other notations inside the tomb. Each mummy has a place on the family tree.
- Mummy 5 is the male head of the family.
- Mummy 6 is the son of mummy 5 and mummy 7.
- Mummy 6 had 2 children.

Notes on reading a family tree:
- Triangles represent males
- Circles represent females
- “Equals” symbols represent a union (marriage)
### Mummy DNA Fingerprints (barcodes)

<table>
<thead>
<tr>
<th>Mummy 1</th>
<th>Mummy 2</th>
<th>Mummy 3</th>
<th>Mummy 4</th>
<th>Mummy 5</th>
<th>Mummy 6</th>
<th>Mummy 7</th>
<th>Mummy 8</th>
<th>Mummy 9</th>
<th>Mummy 10</th>
<th>Mummy 11</th>
<th>Mummy 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>M</td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age 1-2</th>
<th>Adult</th>
<th>Age 4-6</th>
<th>Adult</th>
<th>Adult</th>
<th>Adult</th>
<th>Adult</th>
<th>Adult</th>
<th>Adult</th>
<th>Adult</th>
<th>Adult</th>
<th>16-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>21</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>23</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>26</td>
<td>26</td>
<td>26</td>
<td>26</td>
<td>26</td>
<td>26</td>
<td>26</td>
<td>26</td>
<td>26</td>
<td>26</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>27</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>28</td>
<td>28</td>
<td>28</td>
<td>28</td>
<td>28</td>
<td>28</td>
<td>28</td>
<td>28</td>
<td>28</td>
<td>28</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>29</td>
<td>29</td>
<td>29</td>
<td>29</td>
<td>29</td>
<td>29</td>
<td>29</td>
<td>29</td>
<td>29</td>
<td>29</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

1. Each column models the DNA fingerprint (barcode) of a mummified individual. The first line notes the mummy’s number designation, the second line notes gender (male or female), and the third line notes the age at time of death. The remaining 30 lines contain the DNA information.

2. Notice that each mummy barcode contains 12 colored bands. The dark bands represent the presence of genetic material coming from a combination of both parents. For example, if a child has a dark band in location 3 on the barcode, then at least 1 parent must also have a dark band in location 3 on their barcode. When comparing a child with 2 possible parents, the child's barcode must share every dark band with at least 1 parent. Close does not count! Even 1 dark band not shared with a potential parent will rule out the possibility. Matching dark bands is the key; light bands do not matter.

3. Example: Could 11 be the offspring of 10 and 12? Mummy 11’s first dark band (band 4) also appears in the barcodes of 10 and 12. The next dark band (band 6), however, does not appear in either mummy 10’s or mummy 12’s barcode. The absence of dark band 6 in either potential parent rules out the possibility.

4. Cut the paper DNA fingerprint models (barcodes) into column strips.

5. Use the barcodes to fill-in the mummy family tree.

Reprinted with permission from Resource Area for Teaching (www.raft.net)
Do your students kick butt?

Are they independent thinkers?

Ask them to write about it.

We’ll showcase their talent and even pay them.

admin@theforensicteacher.com

Do you have a lab your students love?

Want to get paid for sharing it?

Email us, tell us about it!

admin@theforensicteacher.com

Precision Forensic Testing, LLC

Quality Forensic Educational Kits

Precision Forensic Testing has developed educational kits to provide accurate, quality resources for teachers who want to incorporate Forensic Science into their curriculum. To enhance the students’ understanding of forensics, all laboratory exercises are the same as those currently used in crime laboratories across the country.

- Created by Forensic Analysts with decades of experience
- Power Point presentation packed with pictures and teacher notes to assist in lecturing
- Lab exercises include real world samples
- 100% Reusable
- Coming soon...Trajectory/Reconstruction Kit

www.precisionforensictesting.com
“A fun and engaging way to support NGSS!”

Enjoyed by teachers and students across the US and around the world

Try a free demo at MurderAtOldFields.com

Murder at Old Fields
Forensic Science Lab Activity

• Easy to use
• Works on desktops, laptops, Chromebooks, and iPads
• Game-like 3-D crime scene
• Blended activity: virtual and real world labs
• Problem-based learning
• Based on actual double murder from 1842
• Recommended for grades 7-12

By the Numbers:

1,356 Pages
444 Articles
156 Labs/Activities
30 Back Issues
3 clicks to order
1 CD
$0 shipping fee
$29.95 (That’s it!)

http://www.theforensicteacher.com/back_issues.html

The Forensic Teacher • Summer 2018
An End to Life (from page 36)

Poor Mr. Bickerstaff may have been destitute, but he didn’t take his own life. In order for him to have melted the sealing wax used to seal up the door he would have needed matches. Although I did find some used matches on the floor near the door, they were safety matches. This type of match must be struck against a box in order to light, but there was no box in the room. While safety matches can be struck against glass or some other surface, they always leave marks, and I could find no marks or scratches anywhere. Bickerstaff, then, could not have sealed the door. Someone else must have knocked him out, sealed the door, turned on the gas, and escaped through the window, which he left slightly open in his haste.

Bridal Grief (from page 38)

Here is where my skill in observing details was called to the fore. I noticed there was a change in pictures over the fireplace (see pics 8 and 10). The bullet passed through Mrs. Davenport’s head at an upward angle, and lodged in the picture frame, cracking the glass. If she’d shot herself before falling across the bed, the bullet would have gone into the wall behind the bed. Not above the fireplace, which is on the opposite side of the room. Davenport’s changing the pictures when I left the room was sufficient ground for suspicion. The hairpins on the carpet near the fireplace might have fallen during a heated argument.

The Frequent Flier From Rio (from page 4)

Based on the assumptions that a) Gandolfo gets the skins onto the plane at Rio, b) he does not bring the skins off the plane himself, but c) regains possession of the skins quickly once he is in the city, Stanwick hypothesized that Gandolfo paid a confederate to take the skins off the plane for him. Who could it be? Not one of the other passengers, who are also thoroughly searched. Nor could it be one of the flight crew, for the reasons Cooper gave. Stanwick realized, however, that the airport authority had to employ a local crew to clean and tidy up the interior of the plane between its arrival at Royston and its departure for Rio the next day. It would be fairly simple for Gandolfo to bring the package aboard in his briefcase, hide it under his seat or in the magazine pocket (especially since he had no seating companion) and have an accomplice on the cleaning crew retrieve the package for him. The accomplice could conceal the package in his cleaning cart and not have to go through Customs. He could then meet Gandolfo in the city, hand over the package, and get paid. This proved to be so.

Mini-Mystery Answer

DNA Profiling

Name__________________

1. Pairs with guanine [CYTOSINE]
2. Invented DNA profiling in 1984 [JEFFREYS]
3. The P in PCR [POLYMERASE]
4. Restriction fragment length polymorphism [RESTRICTION]
5. Determining fatherhood [PATERNITY]
6. DNA passed on only by mothers [MITOCHONDRIAL]
7. Using DNA from relatives to suggest a suspect [FAMILIAL]
8. The V in VNTR [VARIABLE]
9. The sugar in DNA [RIBOSE]
10. This type of blot fixes DNA to nitrocellulose [SOUTHERN]
11. DNA cutting enzymes [RESTRICTION]
12. Cheek swab [BUCCAL]
13. The S in STR [SHORT]
14. Codiscoverer of DNA (James) [WATSON]
15. The Federal DNA database [CODIS]
16. This type of electrophoresis involves a slab of agar [GEL]
17. In 2009 this country demonstrated it is possible to plant fake DNA at a crime scene [ISRAEL]
18. Pairs with thymine [ADENINE]
19. This type of electrophoresis involves a narrow tube [CAPILLARY]

Crossword Puzzle (from page 19)
DNA Quiz KEY: (from page 15)

1. False - Paper or cardboard containers must be used to allow for the evidence to breathe and dry.
2. True
3. False – Mitochondrial DNA reflect only the maternal side of inheritance.
4. False – The Amelogenin marker used in STR kits is the gender determinant.
5. True – Regardless of where cells are obtained on a person, they will all give the same profile.
6. False – RFLP is not sensitive enough to obtain a DNA profile from hair; STRs must be done.
7. True – Only red blood cells lack a nucleus, and therefore don’t contain DNA.
8. True – mtDNA can be successfully done on the shaft of a hair but STRs require a root end that is typically in the anagen growth phase that provides rich DNA on the follicular tag.
9. True – This has to do with the case in England that Joseph Wambaugh wrote about in *The Blooding*.
10. True
11. False – This would create unnecessarily sloppy findings that would be very difficult to resolve.
12. False – The suspect would be eliminated from being the donor of that DNA sample but innocence or guilt is a decision made by a jury or a judge.

“A fun and engaging way to support NGSS!”

Enjoyed by teachers and students across the US and around the world

- Easy to use
- Works on desktops, laptops, Chromebooks, and iPads
- Game-like 3-D crime scene
- Blended activity: virtual and real world labs
- Problem-based learning
- Based on actual double murder from 1842
- Recommended for grades 7-12

Try a free demo at MurderAtOldFields.com
Ask the Morgue Guy

Q: One of my students from last year was particularly engaged when we did our unit on entomology. He saw maggots not as disgusting larvae, but as the heroes of decomposition, a perspective he shared with everyone who would listen. He did good in my course and intends to study entomology when he goes to college next year. I was thrilled to play a part in helping him discover his life’s passion. Not so much anymore.

I received an email from him over the summer asking if I needed any help with the decomposition study my classes will be doing. I thanked him and told him I had everything I needed. He offered to procure dead animals for me to use with my classes, but I told him I was all set. Then the corpses began showing up.

He denied leaving them near the rear door of the school where I park my car. First it was a cat, then a dog, then a small deer, all obviously killed by a motor vehicle. All were fresh kills. Flies were buzzing around, but no maggots yet. I know he’s the one leaving them for me because after I find one he always makes a point to stop by my classroom and ask me if I’m going to use it. How do I get this little ghoul out of my hair? Monica Hath, Salem, MA.

A: Start by explaining to him how unsanitary it is to be touching and transporting dead animals. Thank him for his enthusiasm and tell him again that everything is under control and you don’t need his help. Then tell that if he continues he will be talking to the principal who shares your concerns, and the step after that we’ll be to get his parents involved and there might be disciplinary actions taken.

Online (and otherwise) forensic education opportunities

http://projects.nfstc.org/ Free. A variety of subjects sponsored by the National Forensic Science Technology Center who works closely with the National Institute of Justice and others.

http://www.nij.gov/training/Pages/forensics.aspx No Fee for many. Sponsored by the National Institute of Justice this site features courses both online and in a classroom.

http://forensicscience.ufl.edu/ Online degree programs in forensic science from the University of Florida.

https://www.ashworthcollege.edu/career-diplomas/forensic-science-training/ An online certificate program from Ashworth College.

http://www.amu.apus.edu/lp2/forensics/undergraduate-certificate.htm/ An online certificate program from the American Military University. Some family military affiliation may be required.

http://www.bestvalueschools.com/cheap/online/forensic-science-degree-programs-bachelors/ If you’re serious about getting an online forensics degree this site breaks down five institutions by cost.

http://www.guidetoonlineschools.com/degrees/criminal-justice/forensic-science A guide to a number of online forensic science degrees with reviews, information about each, and tuition costs. Of course, it may be possible to take courses without finishing a degree for targeted, personal development.

https://www.forensicscienceeducation.org/forensic-education/courses-and-workshops/ The Center For Forensic Science Research & Education has a rolling schedule of both online and in-person courses.

https://webdata.aafs.org/public/Meetings/Listings.aspx American Academy Of Forensic Sciences Meetings Listings. Many of these meetings are open to educators.

https://www.forensiced.org/index.cfm Offers online forensic education and training.
What's Going On?

For those who teach forensics one of the most magical times of the year is approaching. I’m not talking about J Edgar Hoover’s birthday, but Halloween.

Halloween is all about dressing up and/or being as gory as possible. And getting candy. And everyone knows the best candy can be had the day after Halloween. The stores want to dump their inventory and this usually means big savings. But there’s savings on things besides candy.

Many drugstores sell fake blood, but it’s the big stores like Target and Walmart to visit immediately after Halloween, or even on Halloween itself (some sales start early). These places not only sell candy and fake blood, but they also sell everything you would ever want to decorate your yard or front porch. I’m talking skeletons. And all kinds of other things that you would never think about until you get to the store and see them marked down, things you can use to decorate a crime scene.

Last year I was fortunate enough to find an anatomically correct, realistic-looking skeleton that stood about 5 feet tall at Target. It retailed for about $60, but I only had to pay $10. I can bury it in the ground for my students to dig up, I can dress it and plant clues on it before leaving it to be discovered as a very old cold case, or I can use it in my classroom to talk about anatomy. The one thing I do not want to do is forget about this opportunity.

So, set a reminder. You don’t want to forget because prices will never be lower on this stuff and other people already know about the sales.

http://www.henryleeinstitute.com/. The Henry C. Lee Institute Of Forensic Science offers training at their location. Check back as new courses are always being added.

https://sites.uco.edu/forensics/z%20HS%20Teacher%20FSI%20training%20and%20Curriculum/index.asp. University of Central Oklahoma Forensic Science Institute offers forensic training to middle and high school teachers during the summer.

Do you or your organization have a workshop, seminar, conference, training opportunity, or announcement you’d like to share and have included free? Please email us at admin@theforensicteacher.com and tell us about it!

http://www.henryleeinstitute.com/ The Henry C. Lee Institute Of Forensic Science offers training at their location. Check back as new courses are always being added.

https://sites.uco.edu/forensics/z%20HS%20Teacher%20FSI%20training%20and%20Curriculum/index.asp. University of Central Oklahoma Forensic Science Institute offers forensic training to middle and high school teachers during the summer.

Do you or your organization have a workshop, seminar, conference, training opportunity, or announcement you’d like to share and have included free? Please email us at admin@theforensicteacher.com and tell us about it!

http://www.henryleeinstitute.com/ The Henry C. Lee Institute Of Forensic Science offers training at their location. Check back as new courses are always being added.

https://sites.uco.edu/forensics/z%20HS%20Teacher%20FSI%20training%20and%20Curriculum/index.asp. University of Central Oklahoma Forensic Science Institute offers forensic training to middle and high school teachers during the summer.

Do you or your organization have a workshop, seminar, conference, training opportunity, or announcement you’d like to share and have included free? Please email us at admin@theforensicteacher.com and tell us about it!

http://www.henryleeinstitute.com/ The Henry C. Lee Institute Of Forensic Science offers training at their location. Check back as new courses are always being added.

https://sites.uco.edu/forensics/z%20HS%20Teacher%20FSI%20training%20and%20Curriculum/index.asp. University of Central Oklahoma Forensic Science Institute offers forensic training to middle and high school teachers during the summer.

Do you or your organization have a workshop, seminar, conference, training opportunity, or announcement you’d like to share and have included free? Please email us at admin@theforensicteacher.com and tell us about it!

http://www.henryleeinstitute.com/ The Henry C. Lee Institute Of Forensic Science offers training at their location. Check back as new courses are always being added.

https://sites.uco.edu/forensics/z%20HS%20Teacher%20FSI%20training%20and%20Curriculum/index.asp. University of Central Oklahoma Forensic Science Institute offers forensic training to middle and high school teachers during the summer.

Do you or your organization have a workshop, seminar, conference, training opportunity, or announcement you’d like to share and have included free? Please email us at admin@theforensicteacher.com and tell us about it!

http://www.henryleeinstitute.com/ The Henry C. Lee Institute Of Forensic Science offers training at their location. Check back as new courses are always being added.

https://sites.uco.edu/forensics/z%20HS%20Teacher%20FSI%20training%20and%20Curriculum/index.asp. University of Central Oklahoma Forensic Science Institute offers forensic training to middle and high school teachers during the summer.

Do you or your organization have a workshop, seminar, conference, training opportunity, or announcement you’d like to share and have included free? Please email us at admin@theforensicteacher.com and tell us about it!

http://www.henryleeinstitute.com/ The Henry C. Lee Institute Of Forensic Science offers training at their location. Check back as new courses are always being added.

https://sites.uco.edu/forensics/z%20HS%20Teacher%20FSI%20training%20and%20Curriculum/index.asp. University of Central Oklahoma Forensic Science Institute offers forensic training to middle and high school teachers during the summer.

Do you or your organization have a workshop, seminar, conference, training opportunity, or announcement you’d like to share and have included free? Please email us at admin@theforensicteacher.com and tell us about it!

http://www.henryleeinstitute.com/ The Henry C. Lee Institute Of Forensic Science offers training at their location. Check back as new courses are always being added.

https://sites.uco.edu/forensics/z%20HS%20Teacher%20FSI%20training%20and%20Curriculum/index.asp. University of Central Oklahoma Forensic Science Institute offers forensic training to middle and high school teachers during the summer.

Do you or your organization have a workshop, seminar, conference, training opportunity, or announcement you’d like to share and have included free? Please email us at admin@theforensicteacher.com and tell us about it!
Stoopid Crooks

The police just dream about geniuses like these guys...

Michael Gale Nash of Anchorage, Alaska really, really needed money. So, he set out to rob the first National Bank of Alaska. He entered the bank with a large backpack and a note for the teller that read, “This is a hold-up. Please put the money in the bag. God help us!!” According to the FBI this case was one of the quickest apprehensions in history, but not because Nash used the backside of a form for affordable housing that had all this personal information on it for his note. He did something even dumber. When police arrived a few minutes later they found Nash sitting outside the bank counting his money.

Kelsie Mast, 23, and Samantha Toope, 20, were serving time for drug trafficking, theft, and robbery in Alberta Canada, but managed to escape. The next day they passed a shopping center and saw an escape room business where people pay money to be locked in a room and they have to figure out clues that will eventually allow them to leave. The owner’s wife was happy to answer their questions and give them a tour of the facilities. Afterwards, they turned to leave and found half a dozen cops waiting patiently for them. It turns out after their escape the media posted their images everywhere and someone called the police after seeing the ladies in the parking lot.

A drug dealer in Kentucky got the bright idea to use Snapchat to advertise his wares. Unfortunately, he switched some of the digits in his phone number. When Roy Hancock, 51, of Morganfield, KY, called that number to buy drugs he was connected to Eric McAllister, a Kentucky State Trooper. McAllister and his partner busted Hancock and a juvenile when they came to buy drugs. An interview led to the identity of the drug dealer, and he was arrested too.

Robert Hardister was first arrested as a teen in 2009, and his mugshot looks harmless enough. But Robert kept getting into trouble and he was arrested on a nearly yearly basis. When he was first arrested he had no tattoos. On each subsequent mugshot he displayed more tattoos he’d acquired on his face. And it must have been habit forming because he couldn’t stop. Robert’s quest to be different is on full display when you go to http://crimefeed.com/2018/05/florida-man-busted-again-adds-to-evolving-face-tattoo-mug-shots-pics/.

Police in Lawrenceville, Georgia were frustrated because it appeared the same man had robbed several banks in the area without being caught. Thanks to cameras in the banks they had his image, but they didn’t know his identity. After Eric Rivers robbed a Chase Bank and fled without being caught the police were frustrated again until the local news came on television that evening. After robbing the Chase Bank Rivers saw a television crew interviewing locals about public transit. He decided he had an opinion that needed to be heard and he happily agreed to go on camera. Unfortunately, for him, he gave the reporter his real name, which appeared, at the bottom of the screen when the segment aired. Police picked him up shortly thereafter and he was charged with robbing five banks in the area.

Leverne Doran, 68, claimed a bottle was thrown out of a school bus full of children and hit his car. Enraged, he pounded on the door of the bus demanding to be admitted. The school bus driver, concerned for his passengers, refuse to open the door. Doran then stood in front of the school bus and refused to move. The bus inched forward so Doran climbed up on the hood of the bus and began banging his fist on the hood as the bus picked up speed. The incident was captured on dashboard video as the driver moved the bus in the direction of the nearest police precinct. An off-duty officer was in the area and after he separated Doran from the bus he arrested him for disorderly conduct and other charges.
Stoopid Movies

More stoopid criminals; these guys are priceless.

Click on the cameras below to see the movies (internet connection required).