CSI:

THE EXPERIENCE

EDUCATOR'S GUIDE

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The Teaching Materials were developed by Rice University Center for Technology in Teaching and Learning.
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The Writing on the Wall

PROBLEM:

You are applying for your first job as a document examiner. Your prospective boss wants to test your powers of observation with a short quiz. He has gathered handwriting samples from various office employees and wants you to correctly match each pair of handwriting samples.

ONLINE ACTIVITY:

This activity is available in an on-line format at **http://forensics.rice.edu/html/handwriting.html.** There is no preparation required for the online activity. Each student or group of students can complete the activity on their own computer and print a copy from the website after completion.

CLASSROOM ACTIVITY:

You will need to collect two writing samples from students so they can attempt to match them. The samples should be labeled so you can tell which pair of samples match. Decide which of the two following methods will work best for you.

Method 1: This method has larger groups, but can be completed in one class period. It is not as challenging as Method 2.

1. Give each student two note cards. The kind with lines is preferable but not required. For ease of sorting the cards, you could use one white note card and one colored note card. Or, just put a colored line or dot on one of the white cards you give to each student.
2. Have the student write the word "dictionary", in their normal handwriting, on each card. Remind students to write the word carefully on the lines.
3. As they are writing the words, move around the room and assign numbers/letters so you can tell later which cards match. Have the students write the **number** on **one card** and the matching **letter** on the back of the **other card**. You should copy or print off this key and make assignments from the following list, using each combination only once: A-30; B-29; C-28; D-27; E-26; F-25; G-24; H-23; I-22; J-21; K-20; L-19; M-18; N-17; O-16; P-15; Q-14; R-13; S-12; T-11; U-10; V-9; W-8; X-7; Y-6; Z-5; AA-4; BB-3; CC-2; DD-1.
4. Divide students into groups of six to eight. Have one group member bring paper and pencil to record for the team.
5. In their groups, students should collect all of the cards and then exchange them with another group.
6. Instruct students to lay the colored cards in one column and the white ones in another column. Don't have them match the samples yet. Give the groups two minutes to discuss and record the types of characteristics they think they could use to match up the handwriting samples. The recorder creates a list.
7. Stop the class and have each group share one idea from their list. If they do not include all of the items mentioned in the **Teacher Notes** section, you may fill in with ones they forgot.
8. Instruct them to match the handwriting samples. The recorder may write the matching letters and numbers which the group decides upon and bring them to the teacher to check against the key. Circle ones that are incorrect and let the group try to fix their mistakes. Once all of them are correct, they may exchange cards with another group.

Method 2: For more of a challenge and to create an activity where students can work in smaller groups of one to three, change the activity in the following way:

1. On the day before the activity, pass around a piece of lined paper with two columns drawn on it. Have students write the word "dictionary" in each column right across from each other. You could number the rows to make sure they remember to skip lines and then cut the numbers off later.
2. To make samples for each class period, first, create a key by assigning alphabet letters to one column and random numbers to the second column. Don't do a pattern that is predictable, and don't use the same number twice. Write the numbers and letters next to the sample on the front of the paper next to the word. Label which class period the sample is from and PHOTOCOPY OR RECORD THE LETTER/NUMBER MATCHES TO MAKE YOUR KEY.
3. Cut apart the second column, rearrange the order, and tape the second column back in place. Note that using about 10-15 of the samples will make a workable number for students to match. Photocopy the number needed for your group sizes. You could create a second set with the remaining handwriting samples to be used by students who successfully complete the first matches.
4. The next day, divide into groups of one to three and distribute the sample page. Give the groups two minutes to discuss and record the types of characteristics they think they could use to match up the handwriting samples.
5. Stop the class and have each group share one idea from their list. If they do not include all of the items mentioned in the Teacher Notes, you may fill in with ones they forgot.
6. Instruct your students to match the handwriting samples. The group may record the matching letters and numbers and bring them to the teacher to check against the key. Circle ones that are incorrect and let the group try to fix their mistakes. Once they have all of them correct, they could try the second set of samples (see #3 above.)

TEACHER NOTES

Handwriting analysis is one of the earliest and most prominent forms of questioned document examination. Successful comparison depends on identifying several traits students may instictively grasp—the **slant** of the letters, the **symmetry** of certain "loop" letters (e.g. *e, f, g*, etc.), the **"i" dot** or **"t" crossing**. Additional traits you may want to point out include **height ratios** (the height of the letter "t" compared to the "h", or "c" to the "i," for example), **alignment to baseline** (does the writing slant upwards, downwards, or curve?), and **movement** (the connection between the letters).

Questioned document examination extends beyond handwriting analysis. Examiners may be called on to prove the validity of typed or photocopied documents, postage stamps, currency, money orders, receipts, tickets, or any number of unusual "documents."

MATERIALS:

Method 1: • Two note cards per student, one of them color-coded

Method 2: • Wide lined notebook paper (two pieces per class period)
• Tape and scissors

PROBLEM:

You've discovered a problem with the crime scene photos from a recent case. Someone has tempered with the crime scene. See how many differences you can spot between the two photographs of the same crime scene.

ONLINE ACTIVITY:

This activity is available on-line at:
http://forensics.rice.edu/html/comparison.html

TEACHER NOTES:

Photography is an essential part of crime scene processing. A crime scene investigator may take several hundred, or even several thousand photographs at a crime scene. The photos can provide key evidence as to the placement of certain pieces of evidence and their appearance before analysis. In addition, the photographs establish a chronology of how the crime scene was processed.

MATERIALS:

Copies of images

CLASSROOM MANAGEMENT:

This activity can also be done as a classroom activity. Instruct the students to memorize the position of all the objects in the classroom. Then have several of the students step out of the classroom. While they are gone, move some of the objects in the room. When they return they must identify what has changed. Repeat until all students have had a turn.

For more activities like this, go to
http://spotthedifference.com

I-WITNESS

PROBLEM:

You were the principle crime scene investigator on a case two years ago. It is now time for you to testify in court about your findings. The defense attorney challenges the accuracy of your testimony and implies that your observational skills are not so great. If he can show the jury you are not good at spotting details, he might have chance of getting his client off.

It is often the case in real life situation that the credibility of expert witness testimony is challenged. The thoroughness with which they do their jobs is critical.

Can you prove your observational skills are excellent?

ONLINE ACTIVITY:

This activity is available online at:
http://forensics.rice.edu/html/picture_begin.html

CLASSROOM ACTIVITY:

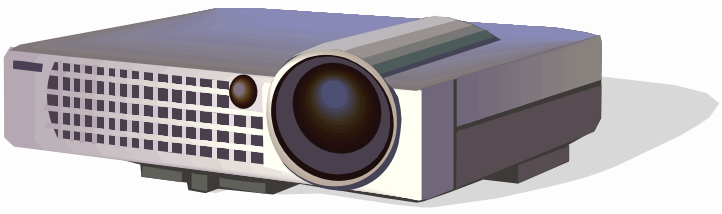
Show a photograph to the students for a set period of time (usually 30 seconds to a minute). Then remove the photograph and have them write down a description of the scene. Remind the students it is important to describe the overall appearance of the scene and as many details as they can remember. Some students may prefer to sketch the scene; others to make written descriptions.

TEACHER NOTES:

The purpose of crime scene photography is to give a documented record of the scene as it is observed. _Everything_ must be photographed, including overview shots of the entire scene, mid range pictures of important objects in context, and close-up shots of every piece of evidence (often from multiple angles and under various lighting conditions). In court the photographer testifies about the pictures, explaining to the jury their relevance to the case and pointing out the important parts of each photograph. As this testimony can occur weeks, months, or even years after the photos were taken, it is important for crime scene investigators to have a keen sense of observation and a very strong memory.

MATERIALS:

Color copies or digital projections of an image.



CLASSROOM MANAGEMENT:

This activity could be completed individually or in pairs. Pairs of students could compare notes to see how different people observe and remember different details. In addition, it may be interesting to have the students evaluate each other's descriptions before they see the photograph again. Scientific studies have shown that eye-witness descriptions can be altered simply by discussing what they remember, or being presented with opposing memories. As the students try to reconcile any differences in their descriptions they may actually move away from what was originally in the photograph.

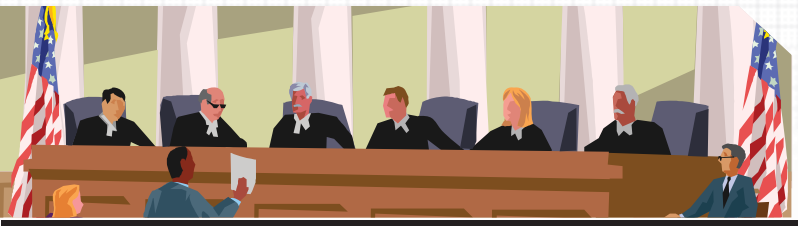
ALTERNATE VERSION:

Instead of having the students view a picture, you can also plan a classroom interruption for the students to view. Plan for a co-conspirator to create an unannounced scene in your classroom (a person searching for lost equipment, a visitor walks into the wrong classroom, etc.) Immediately afterwards, have the students write their own eye-witness accounts of what they saw. Have the students share their different accounts to see how they vary.

POWER OF OBSERVATION

PROBLEM:

A man is on trial for robbing a convenience store, and several witnesses report seeing him at the scene. During the trial, the defense sets up an experiment to discredit the eye-witness testimony. See how you do on this experiment.



ONLINE ACTIVITY:

Have the students watch the video at **http://viscog.beckman.uiuc.edu/grafs/demos/15.html.** Tell the students that during the movie they are to count the number of times the team in white passes the ball to each other. Each student should count to his or her self and make no comments during the movie.

Afterwards, poll the students to see how many "saw something odd" during the movie (don't be specific yet). Some students will have seen the gorilla, and some students will have no idea what you are talking about. Be prepared to show the video again.

TEACHER NOTES:

The video was made as part of an experiment by Harvard professors Daniel Simons and Christopher Chabris designed to test peoples "inattentional blindness." In the original study, only 42% of the people observing the video noticed the gorilla walking through the middle of the scene.

The purpose of this activity is to illustrate the unreliability of eye-witness testimony. People watching this video will either count the number of passes correctly and not see the gorilla, or see the gorilla but not count the correct number of passes (and in some cases, they will both miss the gorilla and incorrectly count the passes).

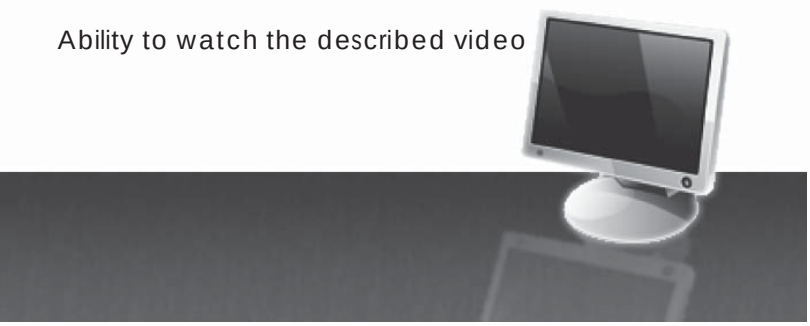
Unreliable eye-witness testimony is an ongoing concern for law enforcement—many convictions that have been overturned by DNA evidence were based on faulty witness testimony. It should be stressed most witnesses do not intentionally lie when on the witness stand—human observation is limited by memory, suggestion, and interpretation. Studies have shown that even the classic "police line-up" can mislead witnesses and even alter their memories.

The faultiness of eye-witness testimony strengthens the importance of forensic science in determining guilt and innocence. Whereas memories can be confused or altered, the evidence stays the same.

For further activities of this nature we recommend: **http://viscog.beckman.uiuc.edu/djs_lab/demos.html**

MATERIALS:

Ability to watch the described video



CLASSROOM MANAGEMENT:

This activity can be done with the students at multiple computers, or the video can be shown to the whole class on one large screen (make sure the students are silent during the video). If the later option is chosen, the teacher can follow up with various oral questions for discussion, or can ask the students to each write down the answers to the questions (or simply ask the students to "write a brief description of what you saw in the video").

A House Divided

PROBLEM:

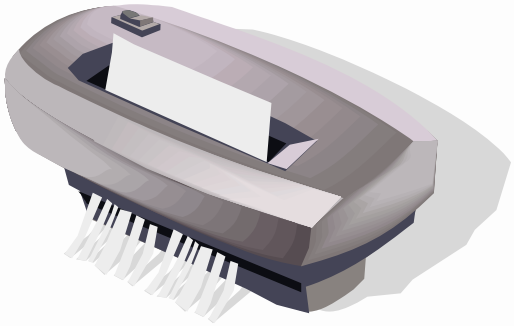
A large mortgage company suspects one of its loan officers is preparing fraudulent loan applications and pocketing the money. They are not sure which officer is involved although they believe they have narrowed it down to three individuals: Cameron Robinson, Luis Rothstein, and Amanda Remillard. However, the culprit learned of the company's suspicions and shredded the evidence! Your lab has been asked to assist in reconstructing the evidence and determine which of the three suspects is guilty of the fraud.

ACTIVITY:

PRE-CLASS PREPARATION:
The following pages are documents that have been "recovered" from the offices of the mortgage company. They include: 4 shredded loan applications, an e-mail describing the purchase of several stolen identities, and a partial list of the stolen identities. These documents need to be photocopied, then individually shredded (either by hand or by using an electric paper shredder). Place the remains of each individual sheet in a separate plastic bag.

IN THE CLASSROOM:
Give each student or group of students a plastic bag containing a shredded document. Supply the students with tape to preserve their document once it has been reassembled. *(Note: In our testing, it took an average of 15 minutes to reassemble the documents using a standard electric strip shredder. Cross-cutting shredders are NOT recommended.)*

Once ALL documents have been pieced together, students will need to examine all of them to piece together the entire puzzle. No one document is enough to incriminate any of the suspects. However, after reviewing all 6 documents, students should be able to reconstruct the crime and answer the questions on page two of the student worksheet.



TEACHER NOTES:

This is a good exercise to emphasize the attention to detail, patience, and accuracy that are required by many forensic careers. Things don't happen nearly as quickly in real life as they do on television. In this instance, this is a real case from a document examiner. IMPORTANT: ALL IDENTITIES ON THESE DOCUMENTS ARE COMPLETELY FICTITIOUS!

MATERIALS:

- Shredded documents
- Tape
- Plastic Bag

CLASSROOM MANAGEMENT:

Students can work individually or in teams. The activity begins with having each student or group of students reconstruct a single sheet of paper. In the second part of the activity, the different pages must be analyzed by all members of the class. The reconstructed documents can be placed in a central "viewing" location or photocopied so that each student has his or her own copy.

Subject: RE: ID Auction Listing
From: <HaXrUs> anonymous@advicebox.com
Date: Saturday 26 May 2007 16:24:22 -0500
To: "MoneyMaster" mm@pookmail.com

Payment received!
These IDs are fresh, so no one should notice anything wrong for at least a couple of weeks. Use them wisely, and remember—If anyone ever comes asking about these, you never heard of me!

ATTACHMENTS:

ID_List.xls	**Content-Type:** application/zip **Content-Encoding:** base64

> ------Original Message------
> **Subject:** RE: ID Auction Listing
> **From:** "MoneyMaster" mm@pookmail.com
> **Date:** Friday 25 May 2007 16:24:22 -0500
> **To:** <HaXrUs> anonymous@advicebox.com
>
> HaXrUS,
>
> Won your auction on IdentityAction.info. I need the list of stolen IDs delivered ASAP—big deals in the works.

CONFIDENTIAL!
Property of First Bank of Summerland

	First Name	Middle Initial	Last Name	Street Address	City	State	ZipCode	Telephone#	Birthday	SS#
1	Clarence	A	Atkins	2712 Chapmans Lane	Los Lunas	NM	87031	505-865-4979	9/7/1969	585-48-1178
2	Philip	D	Beers	629 Mount Tabor	New York	NY	10005	914-509-2933	10/13/1942	115-64-0860
3	Betty	M	Brown	4050 Ferguson Street	S Boston	MA	2127	508-461-3222	1/3/1969	010-42-1369
4	Maria	D	Carter	4988 Hart Street	Farmington	CT	6032	860-284-0614	10/5/1953	040-80-8147
5	Cody	V	Cha	4869 Vineyard Drive	Rocky River	OH	44116	440-333-3200	4/23/1983	277-74-5375
6	Spencer	V	Conner	2527 Elsie Drive	Sioux Falls	SD	57104	605-241-7032	7/6/1965	504-84-8884
7	Sean	J	Corcoran	592 Joseph Street	New Berlin	WI	53151	262-730-5905	3/6/1959	389-05-2790
8	Charles	M	Delong	2929 Horizon Circle	Tukwila	WA	98188	253-579-0878	3/20/1970	536-78-2911
9	Toni	W	Farrow	849 Hillside Street	Phoenix	AZ	85003	480-612-6645	1/10/1957	765-14-0242
10	Agnes	A	Gonzales	3412 Kennedy Court	Taunton	MA	2780	774-254-1183	11/21/1973	032-88-9781
11	Eric	F	Gray	3702 Farnum Road	New York	NY	10010	212-379-4855	12/9/1979	075-34-7972
12	Cameron	E	Hackett	559 Woodland Terrace	Citrus Heights	CA	95610	916-862-9766	7/22/1960	572-55-6053
13	Holly	A	Hoar	3531 Traction Street	Easley	SC	29640	864-442-0827	10/26/1969	656-03-4945
14	Rosa	E	Isaacson	3061 Rowes Lane	Paducah	KY	42001	270-587-1529	1/29/1943	406-72-6327
15	Laura	R	Johnson	1552 Settlers Lane	Huntington	NY	11743	917-754-2398	8/13/1973	131-94-7231
16	Clarence	A	Kellerman	2712 Chapmans Lane	Los Lunas	NM	87031	505-865-4979	9/7/1969	585-48-1178

Residence for Life, Ltd., Home Mortgage Application

This application is designed to be completed by the applicant(s) with the Lender's assistance. Applicants should complete this form as "Borrower" or "Co-Borrower," as applicable. Co-Borrower information must also be provided when either the income or assets of a person other than the Borrower (including the Borrower's spouse) will be used as a basis for loan qualification or the income or assets of the Borrower's spouse or other person who has community property rights pursuant to state law will not be used as a basis for loan qualification, but his or her liabilities must be considered because the spouse or other person has community property rights pursuant to applicable law and Borrower resides in a community property state, the security property is located in a community property state, or the Borrower is relying on other property located in a community property state as a basis for repayment of the loan.

Loan Applicant

Name:	DOB:	
Matthew M. Davis	4/28/58	
Address:		**Sex:**
1861 Martha Ellen Drive		M
City:	**State:**	**ZIP:**
Sparks	NV	89431
SSN:	**Home Phone #:**	
530-56-2914	775-830-3195	

Loan Co-Signer

Name:	DOB:	
Patricia J. Shah	3/2/75	
Address:		**Sex:**
3892 Broad Street		F
City:	**State:**	**ZIP:**
Sparks	NV	89431
SSN:	**Home Phone #:**	
418-96-0939	775-830-1366	

Each of the undersigned specifically represents to Lender and to Lender's actual or potential agents, brokers, processors, attorneys, insurers, servicers, successors and assigns and agrees and acknowledges that the information provided in this application is true and correct as of the date set forth opposite my signature and that any intentional or negligent misrepresentation of this information contained in this application may result in civil liability, including monetary damages, to any person who may suffer any loss due to reliance upon any misrepresentation that I have made on this application, and/or in criminal penalties including, but not limited to, fine or imprisonment or both under the provisions of Title 18, United States Code, Sec. 1001, et seq.

Matthew Davis
Applicant's Signature

Cameron Robinson
Mortgage Broker's Signature

Patricia J. Shah
Co-Signer's Signature

May 27, 2007
Date

Residence for Life, Ltd., Home Mortgage Application

This application is designed to be completed by the applicant(s) with the Lender's assistance. Applicants should complete this form as "Borrower" or "Co-Borrower," as applicable. Co-Borrower information must also be provided when either the income or assets of a person other than the Borrower (including the Borrower's spouse) will be used as a basis for loan qualification or the income or assets of the Borrower's spouse or other person who has community property rights pursuant to state law will not be used as a basis for loan qualification, but his or her liabilities must be considered because the spouse or other person has community property rights pursuant to applicable law and Borrower resides in a community property state, the security property is located in a community property state, or the Borrower is relying on other property located in a community property state as a basis for repayment of the loan.

Loan Applicant

Name:	DOB:	
Joann S. Hatmaker	12/4/83	
Address:		**Sex:**
3363 Settlers Lane		F
City:	**State:**	**ZIP:**
New York	NY	10016
SSN:	**Home Phone #:**	
095-58-1575	917-795-7657	

Loan Co-Signer

Name:	DOB:	
James H. Morris	7/18/47	
Address:		**Sex:**
653 Harper Street		M
City:	**State:**	**ZIP:**
Adairville	KY	42202
SSN:	**Home Phone #:**	
400-05-2514	270-539-5753	

Each of the undersigned specifically represents to Lender and to Lender's actual or potential agents, brokers, processors, attorneys, insurers, servicers, successors and assigns and agrees and acknowledges that the information provided in this application is true and correct. I agree to submit to a backgound and credit check as part of the mortgage application process. I acknowledge that any intentional or negligent misrepresentation of this information contained in this application may result in civil liability, including monetary damages, to any person who may suffer any loss due to reliance upon any misrepresentation that I have made on this application, and/or in criminal penalties including, but not limited to, fine or imprisonment or both under the provisions of Title 18, United States Code, Sec. 1001, et seq.

Joann Hatmaker
Applicant's Signature

Luis Rothstein
Mortgage Broker's Signature

James H. Morris
Co-Signer's Signature

May 28, 2007
Date

Residence for Life, Ltd., Home Mortgage Application

This application is designed to be completed by the applicant(s) with the Lender's assistance. Applicants should complete this form as "Borrower" or "Co-Borrower," as applicable. Co-Borrower information must also be provided when either the income or assets of a person other than the Borrower (including the Borrower's spouse) will be used as a basis for loan qualification or the income or assets of the Borrower's spouse or other person who has community property rights pursuant to state law will not be used as a basis for loan qualification, but his or her liabilities must be considered because the spouse or other person has community property rights pursuant to applicable law and Borrower resides in a community property state, the security property is located in a community property state, or the Borrower is relying on other property located in a community property state as a basis for repayment of the loan.

Loan Applicant

Name:	DOB:		
Maria D. Carter	10/5/53		
Address:		Sex:	
4988 Hart Street		F	
City:	State:	ZIP:	
Farmington	CT	6032	
SSN:	Home Phone #:		
040-80-8147	860-284-0614		

Loan Co-Signer

Name:	DOB:		
Phillip Beers	10/13/42		
Address:		Sex:	
629 Mount Tabor		M	
City:	State:	ZIP:	
New York	NY	10005	
SSN:	Home Phone #:		
115-64-0860	914-509-2933		

Each of the undersigned specifically represents to Lender and to Lender's actual or potential agents, brokers, processors, attorneys, insurers, servicers, successors and assigns and agrees and acknowledges that the information provided in this application is true and correct as of the date set forth opposite my signature and that any intentional or negligent misrepresentation of this information contained in this application may result in civil liability, including monetary damages, to any person who may suffer any loss due to reliance upon any misrepresentation that I have made on this application, and/or in criminal penalties including, but not limited to, fine or imprisonment or both under the provisions of Title 18, United States Code, Sec. 1001, et seq.

Maria D. Carter
Applicant's Signature

Amanda Remillard
Mortgage Broker's Signature

Phillip Beers
Co-Signer's Signature

May 27, 2007
Date

Residence for Life, Ltd., Home Mortgage Application

This application is designed to be completed by the applicant(s) with the Lender's assistance. Applicants should complete this form as "Borrower" or "Co-Borrower," as applicable. Co-Borrower information must also be provided when either the income or assets of a person other than the Borrower (including the Borrower's spouse) will be used as a basis for loan qualification or the income or assets of the Borrower's spouse or other person who has community property rights pursuant to state law will not be used as a basis for loan qualification, but his or her liabilities must be considered because the spouse or other person has community property rights pursuant to applicable law and Borrower resides in a community property state, the security property is located in a community property state, or the Borrower is relying on other property located in a community property state as a basis for repayment of the loan.

Loan Applicant

Name:	DOB:	
Sean Corcoran	3/6/59	
Address:		**Sex:**
592 Joseph Street		M
City:	**State:**	**ZIP:**
New Berlin	WI	53151
SSN:	**Home Phone #:**	
389-05-2790	262-730-5905	

Loan Co-Signer

Name:	DOB:	
Rosa Isaacson	1/29/43	
Address:		**Sex:**
3061 Rowes Street		F
City:	**State:**	**ZIP:**
Paducah	KY	42001
SSN:	**Home Phone #:**	
406-72-6327	270-587-1529	

Each of the undersigned specifically represents to Lender and to Lender's actual or potential agents, brokers, processors, attorneys, insurers, servicers, successors and assigns and agrees and acknowledges that the information provided in this application is true and correct as of the date set forth opposite my signature and that any intentional or negligent misrepresentation of this information contained in this application may result in civil liability, including monetary damages, to any person who may suffer any loss due to reliance upon any misrepresentation that I have made on this application, and/or in criminal penalties including, but not limited to, fine or imprisonment or both under the provisions of Title 18, United States Code, Sec. 1001, et seq.

Sean Corcoran
Applicant's Signature

Amanda Remillard
Mortgage Broker's Signature

Rosa Isaacson
Co-Signer's Signature

June 4, 2007
Date

TEACHER ANSWER KEY

A HOUSE DIVIDED

Student Activity Worksheet

THE CASE:

Residence for Life, Ltd., a large mortgage company, suspects one of its loan officers is preparing fraudulent loan applications and pocketing the money. They are not sure which officer is involved although they believe they have narrowed it down to three individuals: Cameron Robinson, Luis Rothstein, and Amanda Remillard. However, the culprit learned of the company's suspicions and shredded the evidence! Your lab has been asked to assist in reconstructing the evidence and determine which of the three suspects is guilty of the fraud.

PART ONE: RECONSTRUCT THE EVIDENCE

You will be provided with a bag of evidence containing one shredded document recovered from the offices of Residence for Life. You will need to carefully reconstruct the evidence so it can be analyzed. Use scotch tape to preserve the evidence so it can be presented in court. Once your document has been restored, answer the following questions:

1. What type of document is it?

Answers to this will vary, depending on if the students were given a loan application, the incriminating e-mail, or the list of stolen identities

2. Do any of the suspects' names appear on this document?

The suspects names (Cameron Robinson, Luis Rothstein, and Amanda Remillard) appear on the bottom of the four loan applications (Cameron and Luis each have one; Amanda has two). Their names do not appear on the e-mail or the list of identities.

3. Does this document incriminate a suspect in any way? Which one? How?

Individually, none of the documents incriminates any of the suspects, though many students will begin to have suspicions and theories at this point.

TEACHER ANSWER SHEET

A HOUSE DIVIDED

Student Activity Worksheet

THE CASE:

Residence for Life, Ltd., a large mortgage company, suspects one of its loan officers is preparing fraudulent loan applications and pocketing the money. They are not sure which officer is involved although they believe they have narrowed it down to three individuals: Cameron Robinson, Luis Rothstein, and Amanda Remillard. However, the culprit learned of the company's suspicions and shredded the evidence! Your lab has been asked to assist in reconstructing the evidence and determine which of the three suspects is guilty of the fraud.

PART TWO: THE BIG PICTURE

Once all the documents have been recreated, they need to studied for clues. Examine all the documents recovered from the mortgage company for evidence and to determine the identity of the fraudulent loan officer.

1. Which document(s) seem particularly suspicious or incriminating?

The e-mail message implies that illegal activities are occurring—the hidden activities, the odd times, the instruction not to leave a paper trail. Some students may also wonder why a "confidential" list of people from a bank would be at a mortgage company.

2. Do any names appear on more than one document?

Four of the names from the list appear as Loan signers and co-signers on Amanda Remilliard's loan applications.

3. Who do you think is the culprit? Why?

Amanda Remilliard is the culprit. It is very suspicious that people from the Bank of Summerland should be filling out her loan application as both signers and co-signers.
Also, some students may notice that the signatures of Amanda's documents bear an interesting resemblance to her own signature (though they are not identical).

4. Explain how the suspect was stealing from the mortgage company.

Amanda Remilliard purchased a list of stolen identities from the black-market auction site IdentityAction.info. She used the identities from this list to submit false loan applications. Once these applications were approved, she kept the money for herself.

Name:_____ Date:_____

A HOUSE DIVIDED

Student Activity Worksheet

THE CASE:

Residence for Life, Ltd., a large mortgage company, suspects one of its loan officers is preparing fraudulent loan applications and pocketing the money. They are not sure which officer is involved although they believe they have narrowed it down to three individuals: Cameron Robinson, Luis Rothstein, and Amanda Remillard. However, the culprit learned of the company's suspicions and shredded the evidence! Your lab has been asked to assist in reconstructing the evidence and determine which of the three suspects is guilty of the fraud.

PART ONE: RECONSTRUCT THE EVIDENCE

You will be provided with a bag of evidence containing one shredded document recovered from the offices of Residence for Life. You will need to carefully reconstruct the evidence so it can be analyzed. Use scotch tape to preserve the evidence so it can be presented in court. Once your document has been restored, answer the following questions:

1. What type of document is it?

2. Do any of the suspects' names appear on this document?

3. Does this document incriminate a suspect in any way? Which one? How?

STUDENT WORKSHEET

Name:_____ Date:_____

A HOUSE DIVIDED

Student Activity Worksheet

THE CASE:

Residence for Life, Ltd., a large mortgage company, suspects one of its loan officers is preparing fraudulent loan applications and pocketing the money. They are not sure which officer is involved although they believe they have narrowed it down to three individuals: Cameron Robinson, Luis Rothstein, and Amanda Remillard. However, the culprit learned of the company's suspicions and shredded the evidence! Your lab has been asked to assist in reconstructing the evidence and determine which of the three suspects is guilty of the fraud.

PART TWO: THE BIG PICTURE

Once all the documents have been recreated, they need to studied for clues. Examine all the documents recovered from the mortgage company for evidence and to determine the identity of the fraudulent loan officer.

1. Which document(s) seem particularly suspicious or incriminating?

2. Do any names appear on more than one document?

3. Who do you think is the culprit? Why?

4. Explain how the suspect was stealing from the mortgage company.

STUDENT WORKSHEET

THE WRITE STUFF

PROBLEM:

A local convenience store was robbed by a masked gunman. He did not speak but handed the clerk a note that said "Give ME all yuor Money!!!" There were no witnesses and the clerk cannot remember any identifying features about the gunman. The investigators have requested the lab examine the note for any identifying information.

ACTIVITY:

PRE-CLASS PREPARATION:
Layer one sheet of paper on top of another. Bearing down very hard, write the following (in printed letters):

Jimmy—
Call Mom (856-348-1971)

Remove the top sheet of paper. On the second sheet write:

Give ME all yuor Money!!!

This will have to be repeated enough times so that each student or group of students will have a note to analyze. Slight variations can be introduced between the notes, both in the written demand and the personal information.

IN THE CLASSROOM:
Each student or group of students should have their own "note" and a flashlight. Instruct the students to use the flashlight to see if they can uncover any identifying information from the note.

If the flashlight is held at an oblique angle (close to and nearly parallel to the paper), the indented writing (with the name and phone number) will be clearly visible.

TEACHER NOTES:

Analysis of indented writing has proven useful in a number of criminal cases. It has been used to discover personal information (as seen here), to match documents found at a crime scene to paper at a suspect's home or place of work, to permit handwriting analysis of larger samples, etc.

Oblique lighting allows us to see the small indentations in the surface of the paper because they produce shadows with greater contrast than the indentations themselves. The small angle of the light results in longer shadows that are easier to see and photograph. A questioned documents lab is often equipped with microscopes with digital cameras and pre-positioned oblique lighting sources to aid in conducting these types of exercises.

Another method of detecting indented writing is to use an Electrostatic Detection Apparatus (EDSA), which gives the paper a slight charge of static electricity. The page is placed under a thin cellophane film, charged, then lightly dusted with black toner powder. Since the electrical charge will be higher in the indented areas, the toner sticks better to these area, making the writing legible.

MATERIALS:

- Bank robbery note with indented writing revealing personal information (one per student)
- Flashlight (one per student)

CLASSROOM MANAGEMENT:

This activity can be performed either by individual students or in small groups.

Given the simplicity in setting up this exercise, students may be interested in devising their own scenarios and notes. This could easily be turned into a reciprocal activity where students create their own documents (criminal or otherwise) with indented writings, then exchange with a classmate so that each may decipher the others.

Students may also want to experiment with this technique to determine how and when it is most effective. For example, how far down in a stack of papers can a note written on the top one be read? Does this technique work better on certain types of papers than on others? Can some other method be used to read the indented writing (e.g. using silly putty to create a mold of the impression, which works well with cardboard).

DIAGNOSTIC FORENSIC SOLUTIONS, INC.

PROBLEM:

Local police were called to the scene of a car accident late last night when a newly-purchased car collided with a street light at the intersection of North and Main. By the time the police arrived the driver had fled the scene. The police couldn't find any witnesses.

The Crime Scene Investigation team was called out to collect evidence. They collected the following:

- **Glass fragments** from the front seat of the car
- **Glass fragments** from around the outside of the car.
- **Blood** on the broken windshield of the car
- **Fingerprints** on the outer door handle
- **Fingerprints** on the steering wheel
- **Footprints** in the mud under the street light.

Police traced the car back to a local dealership, where the salesman identified the owner of the vehicle—a Mr. James Hatfield, who lives with his wife, Joanne Hatfield, 2 miles from the scene of the accident. When the police questioned Mr. Hatfield, he said his car had been stolen earlier that evening, but he had not yet filed a formal report. Mr. Hatfield claimed he saw his neighbor, Mr. Winston McCoy, use a coat-hanger to break into his car earlier that evening. It appears Hatfield and McCoy have been feuding with each other for many months, and the police have been called out on several occasions.

The police questioned Mr. McCoy regarding the matter. Despite his several complaints against Mr. Hatfield and his obvious jealousy over the new car, Mr. McCoy maintains he did not steal the car—he just scratched the exterior paint with a key. He claims he never entered the vehicle.

Police officers were able to obtain DNA samples from both Mr. Hatfield and Mr. McCoy. Mrs. Hatfield refused to give police a DNA sample, but she did allow herself to be fingerprinted along with both men.

Your company, Diagnostic Forensic Solutions, has been asked to analyze the evidence for the local police department. You've been asked to 1) prepare an invoice describing which forensic analyses you recommend performing on the given evidence and 2) write a summary report describing the results of the experiments and your interpretation. The police department has a budget of $2,000 for this investigation.

ACTIVITY:

Students are provided with a blank invoice outlining the available forensic procedures and their costs. Due to the budget constraint, students will not be able to order every possible forensic analysis. Instead, they must choose which test they feel will be most relevant to the investigation.

Once the invoice has been submitted, students are provided with the appropriate results. (NOTE: students are only given the results of the analyses they order). The results of all the analyses are given on the following pages. They should be photocopied onto separate sheets of paper.

We've provided test results for two different cases. You may want to have students try case 1 first; then the more difficult case 2. Both involve the same basic facts of the crime. In the first (marked Case No.1) there is a clear culprit who committed the crime, and all the tests implicate this man. In the second scenario (marked Case No.2) the evidence isn't as revealing, and the students' interpretations will likely depend on which tests they elect to perform. In the second scenario many different interpretations are possible depending on the students' creativity. It is up to the teacher to decide the relative merit of each individual solution. Alternatively, the solutions may be shared with the whole class and discussed as to which is more plausible.

Once the students have obtained the results, they write-up a summary report describing:

- The tests they ordered
- The results of those tests
- Which suspects, if any, are implicated or exonerated by those results
- Their interpretation of how the crime occurred

DIAGNOSTIC FORENSIC SOLUTIONS, INC.

TEACHER NOTES:

This exercise simulates the actual workings of a private forensics laboratory. It is designed to demonstrate the effects of real-world economic constraints on criminal investigations. Providing a set budget limits the number of forensic analyses that can be performed, so students must weigh the relative merits of each analysis and determine which ones will provide the most relevant information.

The two scenarios provided with this exercise both reflect real life possibilities. Often the evidence conclusively incriminates one suspect, and the case is brought to a swift and successful close. Sometimes, however, the evidence is not strong enough to convict a suspect, a case must be solved through further analysis and police work. Not every case can be solved as quickly as it is on television.

MATERIALS:

None

CLASSROOM MANAGEMENT:

This activity can be completed individually, but having the students work in small groups will foster interactivity and debate. There are several possible correct ways to carry-out this assignment, and the student may enjoy debating the merits of their various solutions.

It is suggested the assignment conclude with each student or group of students sharing their own interpretation of the crime. Additionally, several questions are included below which can be discussed among the class as a whole.

DISCUSSION QUESTIONS:

1. **How did the analysis you choose to perform effect your interpretation of the crime?**
2. **Would having more money have affected your final interpretation?**
3. **Is it realistic to spend a large amount on every case the police investigate?**
4. **What should determine how much money gets spent on each investigation?**

TEACHER ANSWER KEY

DIAGNOTIC FORENSIC SOLUTIONS, INC.

INVOICE

EXAMPLE: This is just one of many possible ways to complete this invoice.

I. FACILITIES AND LABOR

ITEM	RATE	NUMBER	TOTAL
FACILITIES	$ 300/DAY	1	$ 300
PROTECTIVE EQUIPMENT	$ 20/DAY	1	$ 20
TESTIMONY	$ 300/DAY	1	$ 300
CLERICAL SUPPORT	$ 60/DAY	1	$ 60
FORENSIC SCIENTIST LABOR	$ 50/DAY	4	$ 200
TRAVEL TIME	$ 500/DAY		$

II. INDIVIDUAL ANALYSES

***The fee for each test will include analysis of ALL the pieces of evidence of that nature.**

ITEM	RATE	NUMBER	TOTAL
A. DNA ANALYSIS (4 HOURS/ANALYSIS)	$ 300/ANALYSIS		$
DNA SAMPLES FROM BLOOD, SALIVA, ETC, ARE COMPARED AGAINST EACH OTHER AND CODIS DATABASE.			
B. FINGERPRINT COMPARISON (2 HOURS/ANALYSIS)	$ 300/ANALYSIS	1	$ 300
COMPARISON OF PROVIDED PRINTS AGAINST ONE ANOTHER AND AGAINST ENTIRE IAFIS DATABASE.			
C. GLASS ANALYSIS (1 HOUR/ANALYSIS)	$ 150/ANALYSIS	1	$ 150
GLASS FRAGMENTS ARE ANALYZED TO DETERMINE ORIGIN, ANY CHEMICAL TREATMENTS, ETC.			
D. TOOLMARK COMPARISONS (2 HOURS/ANALYSIS)	$ 200/ANALYSIS		$
SCRATCHES OR INDENTATIONS CAN BE MATCHED TO THE SPECIFIC TOOL THAT MADE THEM.			
E. TOXICOLOGY ANALYSIS (4 HOURS/ANALYSIS)	$ 300/ANALYSIS		$
BLOOD, URINE, AND OTHER BIOLOGICAL MATERIALS ARE TESTED FOR ALCOHOL, DRUGS, AND OTHER SUBSTANCES.			
F. IMPRESSION EVIDENCE ANALYSIS (1 HOUR/ANALYSIS)	$ 150/ANALYSIS	1	$ 150
FOOTPRINTS ARE COMPARED AGAINST POSSIBLE SOURCES BASED ON CLASS AND INDIVIDUAL CHARACTERISTICS.			

SUBTOTAL	$ 1480
PROFIT MARGIN (30%)	$ 444
GRAND TOTAL	$ 1924

TEACHER ANSWER KEY

DIAGNOSTIC FORENSIC SOLUTIONS, INC.

Student Activity Worksheet

1. Look over the list of evidence collected from the crime scene. What evidence do you think is most important to the investigation? Why?

The blood and fingerprints can tell us who was in the car. The footprints can tell us who was at the scene of the crash. The glass fragments aren't as interesting since they probably come from the broken windshield.

2. Diagnostic Forensic Solutions, Inc. requires that all clients must purchase facilities, protective equipment, testimony, and clerical support. Are there any other facilities or labor the local police need to purchase? How much money is left to for running analyses?

Since this is a local job, travel should NOT be required. However, the client will be required to pay for forensic labor. How many hours they should pay for depends on how many and what kind of analyses are ordered.

3. Which of the following analyses would you suggest the police purchase for this investigation? For each one, explain what you think it will reveal about the crime.

DNA analysis – ***should purchase; could tell whose blood is on the windshield.***

Fingerprint Comparisons – ***should purchase; could tell who opened the door and who was driving the car (whose fingerprints were on the steering wheel).***

Glass Analysis – ***should NOT purchase; could tell us where the class came from inside and outside of the car(but probably came from windshield).***

Toolmark Comparisons – ***should purchase; could determine if Mr. McCoy really did scratch the car with a key and/or if a coat hanger was used to break into the car.***

Toxicology Analysis – ***should NOT purchase; could tell us if the person who left their blood on the windshield had any chemicals in their body (but no indication drugs had a role in the crime).***

Impressing Evidence Analysis – ***should purchase; could tell us whose footprints are at the scene of the crime under the street light.***

4. Complete the invoice on the next page and submit it to your teacher. If he or she approves your invoice, you will learn the results of the tests you have ordered. **Remember—you have a strict budget of $2000**.

TEACHER ANSWER KEY

DIAGNOSTIC FORENSIC SOLUTIONS, INC.

Student Activity Worksheet

After your proposal has been approved, you will learn the results of the forensic analyses you ordered.

Write a letter to the Chief of Police explaining:

- **Which analyses that were performed, and their results**
- **Whether these results incriminate or exonerate any of the suspects**
- **Whether any further analyses need to be performed, and why**
- **Your interpretation of how the crime occurred.**

For the first crime—

No matter which tests the students chose to run, all test results should incriminate Mr. Hatfield. The interpretations as to how the crime occurred may vary, but they should all explain how his fingerprints, blood, and shoe prints wound up at the crime scene.

Sample scenario: Mr. Hatfield lied when he said he saw his neighbor break into his car. He did, however, see the damage Mr. McCoy did when he used a key to scratch the outside surface. Mr. Hatfield then concocted a plan. He decided he would frame Mr. McCoy for the theft of his new car, then sue him for the money to buy a new, non-scratched up vehicle. Mr. Hatfield purposely crashed his own car into the light pole, then calmly walked away from the scene (unknowingly leaving behind incriminating evidence) and waited for the police to call him so he could blame his neighbor for stealing the car.

For the second crime—

Whether any suspects are incriminated of exonerated depends on which tests the students elected to run. Any interpretation should be considered viable so long as it explains the results of any analyses the students chose to run.

Sample scenario: Mr. McCoy did scratch the outside door with a key, but Mrs. Hatfield did not notice before she drove off to her weekly BINGO game that night. As she was driving home later that evening she swerved to avoid a cat in the road and lost control of her vehicle. She crashed into the street light. She called her husband for help, but when he arrived they couldn't get the car door open. Mr. Hatfield used a coathanger to open the door and free his wife. They decided to flee the scene and claim the car had been stolen in order to get money from the insurance company.

Name:_____ Date:_____

DIAGNOSTIC FORENSIC SOLUTIONS, INC.

Student Activity Worksheet

PART 1: THE EVIDENCE

Local police were called to the scene of a car accident late last night when a newly-purchased car collided with a street light at the intersection of North and Main. By the time the police arrived the driver had fled the scene. The police couldn't find any witnesses.

The Crime Scene Investigation team was called out to collect evidence. They collected the following:

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- **Footprints** in the mud under the street light.

Police traced the car back to a local dealership, where the salesman identified the owner of the vehicle—a Mr. James Hatfield, who lives with his wife, Joanne Hatfield, 2 miles from the scene of the accident. When the police questioned Mr. Hatfield, he said his car had been stolen earlier that evening, but he had not yet filed a formal report. Mr. Hatfield claimed he saw his neighbor, Mr. Winston McCoy, use a coat-hanger to break into his car earlier that morning. It appears Hatfield and McCoy have been feuding with each other for many months, and the police have been called out on several occasions.

The police questioned Mr. McCoy regarding the matter. Despite his several complaints against Mr. Hatfield and his obvious jealousy over the new car, Mr. McCoy maintains he did not steal the car—he just scratched the exterior paint with a key. He claims he never entered the vehicle.

Police officers were able to obtain DNA samples from both Mr. Hatfield and Mr. McCoy. Mrs. Hatfield refused to give police a DNA sample, but she did allow herself to be fingerprinted along with both men.

Your company, Diagnostic Forensic Solutions, has been brought in to analyze the evidence for the local police department. Before you can begin work the police department needs to approve the funding for your tests. They only have $2000 to spend on this investigation.

PART 2: THE RESULTS

After your proposal has been approved, you will learn the results of the forensic analyses you ordered.

Based upon the results of those tests, write a letter to the Chief of Police explaining:

- **Which analyses that were performed, and their results**
- **Whether these results incriminate or exonerate any of the suspects**
- **Whether any further analyses need to be performed, and why**
- **Your interpretation of how the crime occurred.**

Diagnotic Forensic Solutions, Inc.

INVOICE

I. Facilities and Labor

Item	Rate	Number	Total
Facilities	$ 300/day	1	$ 300
Protective Equipment	$ 20/day	1	$ 20
Testimony	$ 300/day	1	$ 300
Clerical Support	$ 60/day	1	$ 60
Forensic Scientist Labor	$ 50/day		$
Travel Time	$ 500/day		$

II. Individual Analyses

***The fee for each test will include analysis of ALL the pieces of evidence of that nature.**

Item	Rate	Number	Total
A. DNA Analysis (4 hours/analysis)	$ 300/analysis		$
DNA samples from blood, saliva, etc, are compared against each other and CODIS database.			
B. Fingerprint Comparison (2 hours/analysis)	$ 300/analysis		$
Comparison of provided prints against one another and against entire IAFIS database.			
C. Glass Analysis (1 hour/analysis)	$ 150/analysis		$
Glass fragments are analyzed to determine origin, any chemical treatments, etc.			
D. Toolmark Comparisons (2 hours/analysis)	$ 200/analysis		$
Scratches or indentations can be matched to the specific tool that made them.			
E. Toxicology Analysis (4 hours/analysis)	$ 300/analysis		$
Blood, urine, and other biological materials are tested for alcohol, drugs, and other substances.			
F. Impression Evidence Analysis (1 hour/analysis)	$ 150/analysis		$
Footprints are compared against possible sources based on class and individual characteristics.			

Subtotal	$
Profit Margin (30%)	$
Grand TOTAL	$

Name:_____ Date:_____

DIAGNOSTIC FORENSIC SOLUTIONS, INC.

Student Activity Worksheet

1. Look over the list of evidence collected from the crime scene. What evidence do you think is most important to the investigation? Why?

2. Diagnostic Forensic Solutions, Inc. requires that all clients must purchase facilities, protective equipment, testimony, and clerical support. Are there any other facilities or labor the local police need to purchase? How much money is left to for running analyses?

3. Which of the following analyses would you suggest the police purchase for this investigation? For each one, explain what you think it will reveal about the crime.

DNA analysis –

Fingerprint Comparisons –

Glass Analysis –

Toolmark Comparisons –

Toxicology Analysis –

Impressing Evidence Analysis –

4. Complete the invoice on the next page and submit it to your teacher. If he or she approves your invoice, you will learn the results of the tests you have ordered. **Remember—you have a strict budget of $2000**.

STUDENT WORKSHEET

DNA ANALYSIS RESULTS:

DNA from the blood on the windshield was a match to the DNA sample provided by Mr. James Hatfield. All three samples (Mr. Hatfield, Mr. McCoy, and sample from windshield) were compared to the CODIS database, but no match was found.

FINGERPRINT COMPARISON RESULTS:

There were two fingerprints discovered on the door. One belonged to Mr. Hatfield, one belonged to Mr. McCoy. There were two additional fingerprints on the steering wheel—both belonged to Mr. Hatfield. All four prints were compared to the FBI's IAFIS database but no matches were found.

GLASS ANALYSIS RESULTS:

The glass fragments were equal in density and chemical treatments to the type of glass used in the windshield for that particular car. Both the glass fragments inside the car and outside the car were of the same type.

CASE NO. 1

TOOLMARK COMPARISON RESULTS:

There were many scratches and dings on the outside of the car, mainly caused by the collision with the street light. There were several scratches on the outside of the car consistent with damage from a key. These scratches had the same individual characteristics as a key in Mr. McCoy's possession.

D&F INCORPORATED

TOXICOLOGY ANALYSIS RESULTS:

The blood collected from the windshield was tested for the presence of alcohol, prescription drugs, and illegal drugs. All tests came back negative, indicating the blood donor had no foreign substances in his or her blood stream.

CASE NO. 1

IMPRESSION EVIDENCE RESULTS:

Impressions of the shoeprints collected from the crime scene were compared to shoes collected from the Hatfield and McCoy residences. The class characteristics of the footprints indicated they were made by a pair of men's size 10 Nike shoes. Mr. Hatfield owns such a pair of shoes. In addition, the individual characteristics from the footprint match those on the muddy pair of shoes found in his closet.

DNA ANALYSIS RESULTS:

No match could be found between the three samples provided (Mr. McCoy, Mr. Hatfield, sample from crime scene).

All three samples were compared to the CODIS database, but no match was found.

CASE NO. 2

FINGERPRINT COMPARISON RESULTS:

There were two fingerprints discovered on the door. One belonged to Mr. Hatfield, one belonged to Mr. McCoy.

There were two additional fingerprints on the steering wheel—one from Mrs. Hatfield and one that did not match any of the suspects' prints. All four prints were compared to the FBI's IAFIS database but no matches were found.

GLASS ANALYSIS RESULTS:

The glass fragments were equal in density and chemical treatments to the type of glass used in the windshield for that particular car. Both the glass fragments inside the car and outside the car were of the same type.

CASE NO. 2

TOOLMARK COMPARISON RESULTS:

There were many scratches and dings on the outside of the car, mainly caused by the collision with the street light. There were several scratches on the outside of the car consistent with damage from a key. These scratches had the same individual characteristics as a key in Mr. McCoy's possession. There were also scratches around the driver's side window consistent with using a coat hanger to open the door, but these marks could not be matched to any coat hangers in Mr. McCoy's house.

TOXICOLOGY ANALYSIS RESULTS:

The blood collected from the windshield was tested for the presence of alcohol, prescription drugs, and illegal drugs. All tests came back negative, indicating the blood donor had no foreign substances in his or her blood stream.

CASE NO. 2

IMPRESSION EVIDENCE RESULTS:

Impressions of the shoeprints collected from the crime scene were compared to shoes collected from the Hatfield and McCoy residences. The class characteristics of the footprints indicated they were made by a pair of men's size 10 Nike shoes. Mr. Hatfield owns such a pair of shoes. However, there were not enough individual characteristics in the impression to make a positive identification.

THE Art OF INDUCTION

ACTIVITY:

Five separate logic puzzles are presented on the following pages. These puzzles are of varying difficulty, but it is possible to figure out the solutions based solely on the clues provided in each puzzle.

TEACHER NOTES:

Forensic science relies on the art of induction—reasoning from the specific to the general. At a crime scene, forensic scientist collect many small clues or facts, from which they have to induce or figure out a particular order of events or criminal scenario. Likewise, in order to solve these logic puzzles, students must take a set number of clues and details from them to determine certain identities and relationships. In addition, the logic puzzles may appeal to students' innate sense of challenge and curiosity.

MATERIALS:

Worksheets

CLASSROOM MANAGEMENT:

The exercises are meant to be completed individually. Alternatively, they can be used as homework assignments to get the students interested in forensic science and the CSI universe.

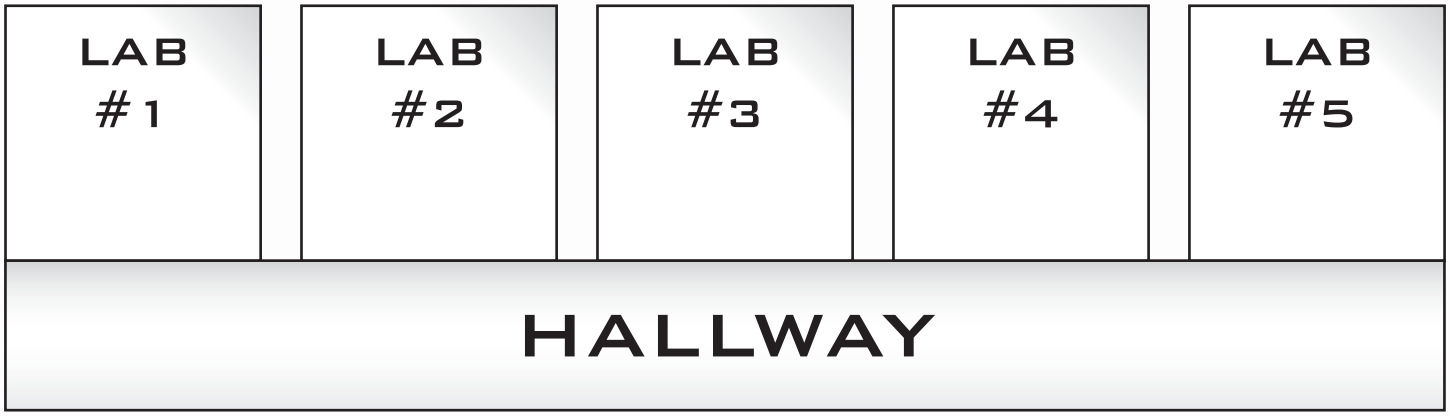
TEACHER ANSWER KEY

FRIENDS AND NEIGHBORS

You've been asked to help layout a new forensics laboratory for the local police department. For convenience sake, the director wants all the laboratories along the same hallway (see below). There are five different labs (Forensic Biology, Fingerprinting, Toxicology, Digital Forensics, and Firearms Examination). Each lab is run by a different specialist (Peggy, Sam, Maria, Danny, and Raymon) who have different preferences on where their lab is located.

Given the following clues, can you determine 1)which specialist works in each lab and 2)how to lay out the labs to please everyone?

- **Sam doesn't want his forensic biology lab to be at either end of the hallway**
- **Maria wants to be immediately to the right of the fingerprinting lab.**
- **The person who runs the toxicology lab wants to be immediately left of Peggy's lab.**
- **Danny wants his lab somewhere right of the firearms examination lab, but he doesn't care where.**
- **The middle lab has to be either the digital forensics lab or the fingerprinting lab.**



	Lab Name	Specialist
Lab #1	*Firearms*	*Raymon*
Lab #2	*Forensic Biology*	*Sam*
Lab #3	*Fingerprints*	*Danny*
Lab #4	*Toxicology*	*Maria*
Lab #5	*Digital Forensics*	*Peggy*

Name:_____ Date:_____

FRIENDS AND NEIGHBORS

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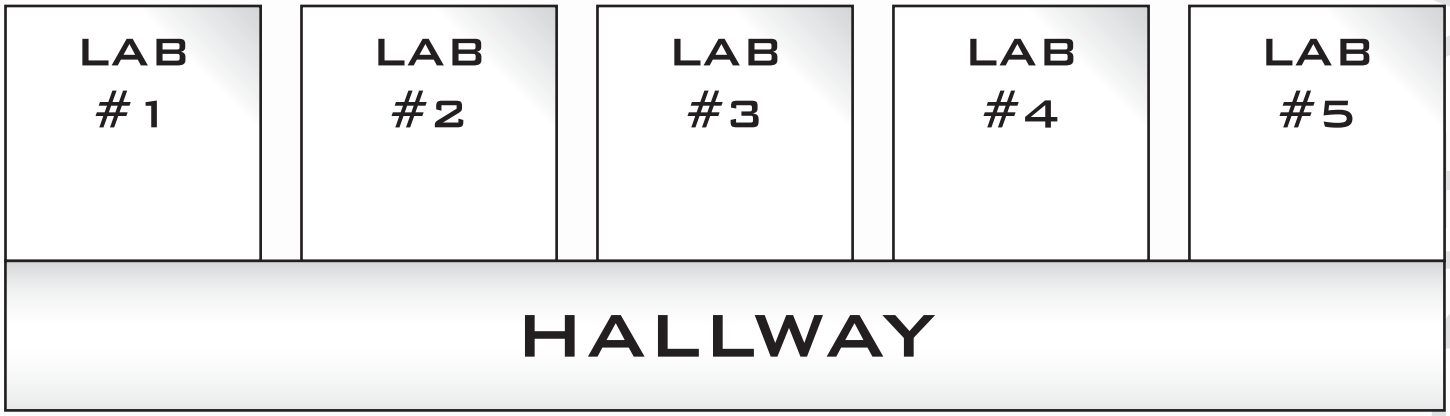

	Lab Name	Specialist
Lab #1		
Lab #2		
Lab #3		
Lab #4		
Lab #5		

STUDENT WORKSHEET

Name:_____ Date:_____

FRIENDS AND NEIGHBORS

	Forensic Biology	Fingerprints	Firearms	Digital Forensics	Toxicology	Peggy	Sam	Maria	Danny	Raymon
Lab #1										
Lab #2										
Lab #3										
Lab #4										
Lab #5										
Peggy										
Sam										
Maria										
Danny										
Raymon										

STUDENT WORKSHEET

TEACHER ANSWER KEY

CSI ON VACATION

The Las Vegas CSIs have been working hard. They've definitely earned a rest. Five CSIs (Grissom, Catherine, Nick, Sara, and Warrick) put in for vacation time this month, each after they solved a different type of investigation (fraud, arson, murder, robber, hit-and-run). Each person's vacation started at a different time, and each went to a different city (Los Angeles, San Francisco, Seattle, Denver, and Houston). Finally, each person spent their vacation doing a different activity (camping, hang-gliding, clubbing, fishing, or horseback riding).

Given the following clues, can you determine when the CSIs started their vacation, where they went, what they did, and which case they solved before they left?

- **The five CSIs who went on vacation were: Catherine; the one who's going to Houston; the male lab member who likes to go hang-gliding; the CSI who's been working on a fraud investigation; and the female lab member who likes to go camping.**
- **Three weeks before Nick went on vacation, the CSI investigating the murder spent some time horseback riding.**
- **Grissom went on vacation two weeks before the male CSI who was working robbery case and one week after the CSI who solved her murder investigation.**
- **Warrick and the CSI who took his vacation on the 9th both went to California to relax.**
- **The CSI who went clubbing was on vacation before the CSI who went fishing, but neither went to Seattle or San Francisco.**
- **The CSI who went to Los Angeles solved either the fraud or the robbery case. He went on vacation two weeks before Sara went to Denver.**
- **The person who solved the arson case was on vacation when the hit-and-run occurred.**

DATE	CSI	CASE	LOCATION	ACTIVITY
2ND	*Catherine*	*Murder*	*Seattle*	*Horseback Riding*
9TH	*Grissom*	*Arson*	*San Francisco*	*Hand-Gliding*
16TH	*Warrick*	*Fraud*	*Los Angeles*	*Clubbing*
23RD	*Nick*	*Robbery*	*Houston*	*Fishing*
30TH	*Sara*	*Hit-and-Run*	*Denver*	*Camping*

Name:_____ Date:_____

CSI ON VACATION

The Las Vegas CSIs have been working hard. They've definitely earned a rest. Five CSIs (Grissom, Catherine, Nick, Sara, and Warrick) put in for vacation time this month, each after they solved a different type of investigation (fraud, arson, murder, robber, hit-and-run). Each person's vacation started at a different time, and each went to a different city (Los Angeles, San Francisco, Seattle, Denver, and Houston). Finally, each person spent their vacation doing a different activity (camping, hang-gliding, clubbing, fishing, or horseback riding).

Given the following clues, can you determine when the CSIs started their vacation, where they went, what they did, and which case they solved before they left?

- **The five CSIs who went on vacation were: Catherine; the one who's going to Houston; the male lab member who likes to go hang-gliding; the CSI who's been working on a fraud investigation; and the female lab member who likes to go camping.**
- **Three weeks before Nick went on vacation, the CSI investigating the murder spent some time horseback riding.**
- **Grissom went on vacation two weeks before the male CSI who was working robbery case and one week after the CSI who solved her murder investigation.**
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Date	CSI	Case	Location	Activity
2nd				
9th				
16th				
23rd				
30th				

STUDENT WORKSHEET

Name:_____ Date:_____

CSI ON VACATION

	Grissom	Catherine	Warrick	Nick	Sara	Hit-and-Run	Fraud	Arson	Robbery	Murder	Denver	San Francisco	Seattle	Houston	Los Angeles	Camping	Hang-gliding	Horse-back Riding	Fishing	Clubbing
2nd																				
9th																				
16th																				
23rd																				
30th																				
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Fishing																				
Clubbing																				
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San Francisco																				
Seattle																				
Houston																				
Los Angeles																				
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Fraud																				
Arson																				
Robbery																				
Murder																				

STUDENT WORKSHEET

TEACHER ANSWER KEY

SO YOU WANT TO BE A CSI?

Grissom's been thinking about hiring a new CSI for his team. The interviews started this week, and he's had some promising candidates. Four people applied for the job. They all majored in different fields at different universities. In addition, each person had a different hobby that he or she talked about during the interview.

Using the clues below, can you determine the first and last names of the applicants, what school they graduated from, their major, and their hobby?

- **The four people who interviewed were Teresa; the one who graduated from Rice University; an amateur astronomer; and a Political Science major.**
- **Neither the chemistry major nor the political science major went to Arizona State. The UNLV graduate couldn't stop talking about his stamp collection.**
- **Natalia didn't go to Notre Dame, and her last name isn't Curran. Sandeep's last name isn't Ranney.**
- **Ms. Jones can't juggle. Ms. Ranney, who majored in English, has never been to a hockey game.**
- **The English major didn't go to Notre Dame, and John Garcia didn't go to Arizona State.**
- **The Arizona state graduate majored in biology while he was in college.**
- **Natalia didn't go to Notre Dame. Teresa didn't major in chemistry.**

FIRST NAME	LAST NAME	COLLEGE	MAJOR	HOBBY
SANDEEP	*Curran*	*Arizona State*	*Biology*	*Astronomy*
NATALIA	*Jones*	*Rice*	*Chemistry*	*Hockey*
TERESA	*Ranney*	*UNLV*	*English*	*Stamp Collecting*
JOHN	*Garcia*	*Norte Dame*	*Political Science*	*Juggling*

Name:_____ Date:_____

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FIRST NAME	LAST NAME	COLLEGE	MAJOR	HOBBY
SANDEEP				
NATALIA				
TERESA				
JOHN				

STUDENT WORKSHEET

Name:_____ Date:_____

SO YOU WANT TO BE A CSI?

	Jones	Garcia	Curran	Ronney	Arizona State	Notre Dame	Rice	UNLV	English	Political Science	Biology	Chemistry	Amateur Astronomy	Juggling	Stamp Collecting	Hockey
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Natalia																
Teresa																
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Amateur Astronomy																
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Hockey																
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Political Science																
Biology																
Chemistry																
Arizona State																
Notre Dame																
Rice																
UNLV																

STUDENT WORKSHEET

TEACHER ANSWER KEY

THE DOCTOR WILL SEE YOU NOW

Doc Robbins has had a busy night. Six bodies have been delivered to the morgue—all at different times and with different causes of death. Using the following information, can you determine the first and last name of each person, the cause of death, and the order in which they arrived?

- **The bodies arrived in the following order: First was David; then Mr. Daniels; the man who died by electrocution; Phillippe; the hit-and-run casualty; and last was Mr. Archer.**
- **Sayid was not killed by electrocution or by an aneurysm, but he did arrive after Mr. Klein (who was also not electrocuted).**
- **Mr. Metzger (who came in before Wesley) was stabbed to death by a former business associate.**
- **Mr. Santos was not the victim of a hit-and-run, nor did he die of electrocution.**
- **Robert (who did not die by drowning or an aneurysm) is neither Mr. Chang nor Mr. Klein.**
- **Dajan was not electrocuted.**

TIME OF ARRIVAL	FIRST NAME	LAST NAME	HOBBY
9:12 PM	*David*	*Metzger*	*Stabbing*
9:45 PM	*Robert*	*Daniels*	*Heart Attack*
10:34 PM	*Wesley*	*Chang*	*Electrocution*
11:14 PM	*Philippe*	*Santos*	*Aneurysm*
12:04 AM	*Dajan*	*Klein*	*Hit-and-Run*
1:11 AM	*Sayid*	*Archer*	*Drowning*

Name:_____ Date:_____

STUDENT WORKSHEET

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TIME OF ARRIVAL	FIRST NAME	LAST NAME	HOBBY
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10:34 PM			
11:14 PM			
12:04 AM			
1:11 AM			

Name:_____ Date:_____

THE DOCTOR WILL SEE YOU NOW

	Robert	Wesley	Dajan	Phillipe	Sayid	David	Archer	Santos	Chang	Klein	Daniels	Metzger	Stabbing	Electrocution	Aneurysm	Hit-and-Run	Drowning	Heart Attack
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Santos																		
Chang																		
Klein																		
Daniels																		
Metzger																		

STUDENT WORKSHEET

NO BONES ABOUT IT

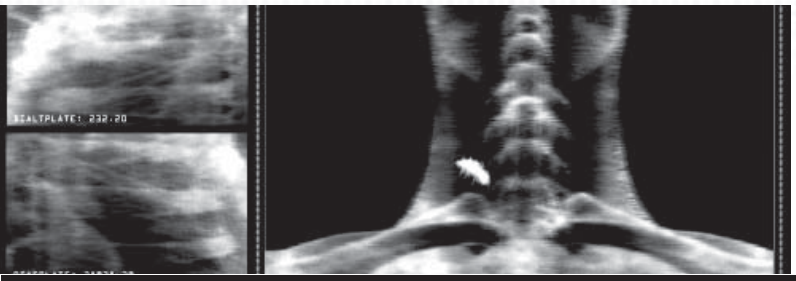
PROBLEM:

At a nearby construction zone, workers have made a startling discovery. They uncovered several bones that look like they were buried some time ago. You are part of a team of **forensic anthropologists** who have been called in to analyze these bones.

Unfortunately, the bones were heavily damaged by the construction equipment. The bones have all been mixed up, and several have been crushed. However, you think you can use the bones that are left to:

1) determine how many people were buried at this location and

2) determine the heights of the different individuals.



ACTIVITY:

In the first part of the lesson students use their own bodies to explore how the lengths of various bones are related to a person's height. Using data collected from the entire class, they will construct graphs comparing the length of the humerus and femur to a person's height.

In the second part, students are provided with pictures of various bones and a table of standard equations for computing height. All bones pictured are life size. Students measure the bones and, using the tables, calculate the heights of the individuals. Using this information, students can then determine how many different individuals were buried in the grave.

Lastly, students use their newly acquired information to search a fictional database of missing persons. If the students correctly identify the heights of the various individuals, they should determine the six bones come from three different missing persons. Note: Though the students' calculated heights should be in cm, the heights recorded in the database are in feet and inches (as they are in most public records in the United States). In order to accurately "search" the database, the students must convert the measurements. **One inch = 2.54 cm.**

TEACHER NOTES:

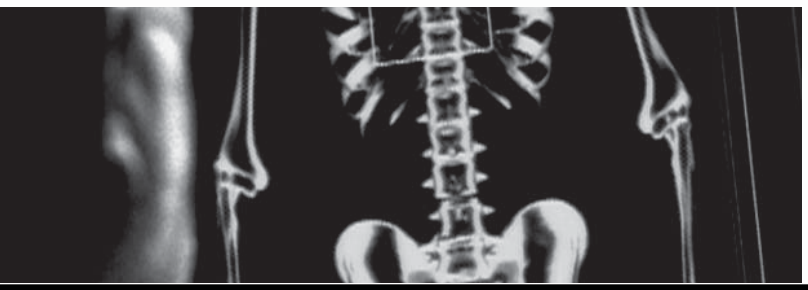
Forensic anthropology is a unique forensic discipline that studies the human skeleton to answer various questions about an individuals race, sex, age, height, illness, and trauma. In this particular exercise students will explore 1) how a single bone can reveal a person's overall height and 2) how this information can be used to make presumptive identifications.

A person's height can be affected by several variables: age, sex, race, health, etc. Anthropologists have compiled several formulas for determining the approximate height of an individual given the length of any of the long bones of the human body. It is important to stress to the students that these formulas only give approximations of height—they are not exact.

One of the main factors affecting a person's height is age. The formulas provided were designed for individuals between 23 – 30 years old. Before the ages of 18-23 a person's bones have yet to full ossify. **Ossification** is the natural replacement of cartilage with bone; it is responsible for nearly all bone growth. Because these bones are still growing, the relationship between bone length and an individual's height is extremely variable. Be sure that your class realizes that the data they collect from each other is only applicable to their same age group. It would NOT apply to adults.

MATERIALS:

- Metric Rulers
- Calculators



CLASSROOM MANAGEMENT:

Students should be divided into pairs or small groups for the first part of the activity to make height measurement easier. Each student will be required to collect data from six different classmates. If desired, the teacher can collect data from the entire class and create one large data set. The data should reveal a positive correlation between bone length and overall height. If desired, this activity could be repeated for other bones of the human body (or assigned as homework for students to complete with their families).

The second and third parts of the activity are designed to be completed individually by each student.

TEACHER ANSWER KEY

NO BONES ABOUT IT

When a body is discovered, it is important to learn as much as possible from the remains. Forensic anthropologists use mathematical formulas to estimate someone's height from the lengths of certain bones in their body. But where do these formulas come from?

1. **Using a metric ruler, measure the length of your femur (thigh bone) in centimeters. This is the large bone that runs from your hip socket to your knee cap. Record this information in the table below.**
2. **Have a partner measure your actual height in centimeters. Record this information in the table below.**
3. **Collect the same information (femur length and height) from several of your classmates. Leave the "calculated height" row blank for now.**

TABLE 1: CLASSROOM MEASUREMENTS

NAME						
FEMUR LENGTH (CM)						
HEIGHT (CM)						
CALCULATED HEIGHT (CM)						

4. **Use the graph paper on the next page to graph the data you've collected. Use Femur Length for the x-axis and Height for the y-axis**
5. **Use your graph to answer the following question:**
   What relationship is there between the length of someone's femur bone and their height?

Taller people tend to have longer femur bones.

TEACHER ANSWER KEY

NO BONES ABOUT IT

Anthropologists have performed hundreds of calculations like the one we just did. Their calculations showed that a person's height can be estimated using the lengths of the long bones of the body—the femur, tibia, and fibula in the leg, and the ulna, radius, and humerus of the arm.

However, the relationship between the length of these bones and a person's height is different for men and women, and for people from different races. The table below lists all the different equations forensic anthropologist use to estimate a person's height

TABLE 2: FORMULAS FOR CALCULATING HEIGHT

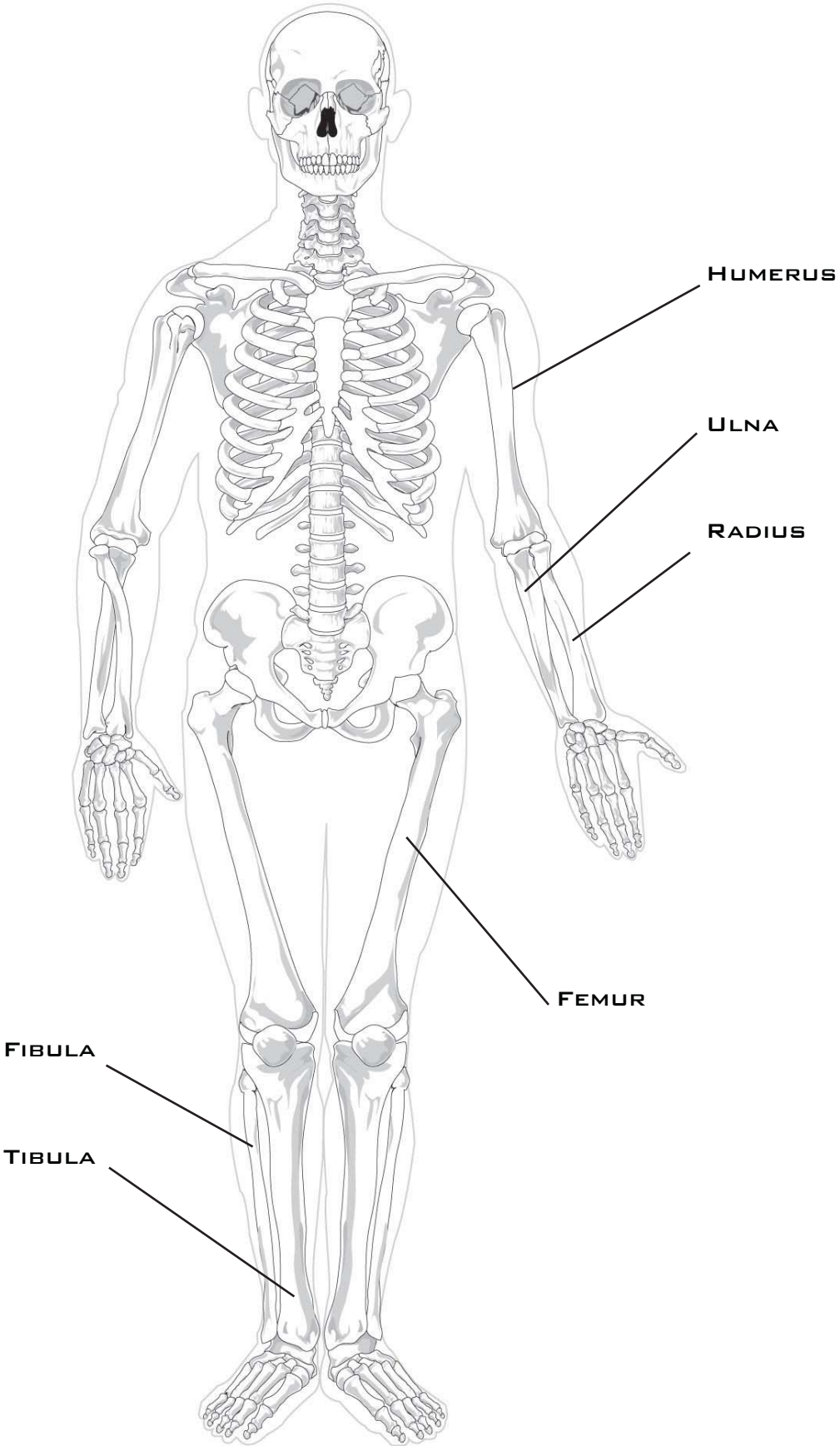
BONE	RACE	MALE EQUATION	FEMALE EQUATION
FEMUR	CAUCASIAN	2.32 * **length** + 65.53 cm	2.47 * **length** + 54.13 cm
	AFRICAN-AMERICAN	2.10 * **length** + 72.22 cm	2.28 * **length** + 59.76 cm
	ASIAN	2.15 * **length** + 72.57 cm	Not Available
TIBIA	CAUCASIAN	2.42 * **length** + 81.93 cm	2.90 * **length** + 61.53 cm
	AFRICAN-AMERICAN	2.19 * **length** + 85.36 cm	2.45 * **length** + 72.56 cm
	ASIAN	2.39 * **length** + 81.45 cm	Not Available
FIBULA	CAUCASIAN	2.60 * **length** + 75.50 cm	2.93 * **length** + 59.61 cm
	AFRICAN-AMERICAN	2.34 * **length** + 80.07 cm	2.49 * **length** + 70.90 cm
	ASIAN	2.40 * **length** + 80.56 cm	Not Available
HUMERUS	CAUCASIAN	2.89 * **length** + 78.10 cm	3.36 * **length** + 57.97 cm
	AFRICAN-AMERICAN	2.88 * **length** + 75.48 cm	3.08 * **length** + 64.67 cm
	ASIAN	2.68 * **length** + 83.19 cm	Not Available
ULNA	CAUCASIAN	3.76 * **length** + 75.55 cm	4.27 * **length** + 57.76 cm
	AFRICAN-AMERICAN	3.20 * **length** + 82.77 cm	3.31 * **length** + 75.38 cm
	ASIAN	3.48 * **length** + 77.45 cm	Not Available

These formulas are calculated for **ADULT males and females. (from Bass, W.M. (1987) Human Osteology: A Laboratory and Field Manual (3rd ed.). Missouri Archeaological Society, Columbia.)*

Use the table to fill in the "Calculated Height" row on Table 1. Are the results close to the actual heights? What are some possible sources of error?

Results will vary. Possible sources of error include—difficulty in accurately measuring bones inside the body, natural variation among different people (equations only predict the average), and age. These equations were designed for adults; teenager height to bone length ratios are much more variable.

LONG BONES OF THE HUMAN SKELETON



TEACHER ANSWER KEY

NO BONES ABOUT IT

The following bones were recovered from the construction site. A fellow forensic anthropologist has already classified the bones by sex and race. Using the mathematical formulas from **Table 2**, calculate the approximate height of each individual.

TABLE 3: ANALYSIS OF BONES FROM CONSTRUCTION SITE

Bone#	Type of Bone	Length(cm)	Race	Sex	Calculated Height (cm)
1	Humerus	38.2	Caucasian	Male	***188.5***
2	Femur	44.0	African-American	Female	***160.1***
3	Ulna	25.4	Caucasian	Male	***171.1***
4	Femur	52.4	Caucasian	Male	***187.1***
5	Femur	43.9	African-American	Female	***159.9***
6	Tibia	43.7	Caucasian	Male	***187.7***

Is it possible any of these bones came from the same person? Which bones?

Bones #1, 4, and 6 could have come from the same person.
Bones #2 and 5 could have come from the same person.
Bone #3 must have come from a different individual.

What is the minimum number of bodies buried at this site? What is the maximum number of bodies?

At least three different bodies were at this site, though there may be more. For example, bones #1, 4, and 6 could have come from three different people who were all roughly the same height.

Do all bones from the same body give exactly the same height? If not, why would the heights be different?

Different bones from the same body can give different heights due to natural variations in arm and leg length. Also, these equations only estimate a person's height, and estimations are rarely specific to the exact millimeter. However, we expect the heights to be close (e.g. a few millimeter different, but not a few centimeters different).

TEACHER ANSWER KEY

NO BONES ABOUT IT

Another forensic anthropologist on the team estimates the remains have been buried three to four years. A search of the local missing person's database shows that the following people disappeared during that time:

MISSING PERSONS DATABASE

Missing Person #1

NAME: Dana Grant
AGE: 27
SEX: F
RACE: African-American
HEIGHT: 5'0"
HAIR COLOR: Black
EYE COLOR: Brown

DISTINGUISHING MARKS:
Small rose tattoo on left ankle; appendectomy scar

Missing Person #2

NAME: Rosalyn Fairbanks
AGE: 36
SEX: F
RACE: Caucasian
HEIGHT: 5'7"
HAIR COLOR: Black
EYE COLOR: Green

DISTINGUISHING MARKS:
Wears glasses or corrective lenses

Missing Person #3

NAME: Devon Bailey
AGE: 45
SEX: M
RACE: African-American
HEIGHT: 5'8"
HAIR COLOR: Black
EYE COLOR: Brown

DISTINGUISHING MARKS:
None

TEACHER ANSWER KEY

NO BONES ABOUT IT

MISSING PERSONS DATABASE

Missing Person #4

NAME: Wayne Aughney
HEIGHT: 6'2"
AGE: 36
HAIR COLOR: Black
SEX: M
EYE COLOR: Brown
RACE: Caucasian

DISTINGUISHING MARKS:
Tattoo of a dragon on upper right arm

Missing Person #5

NAME: Crystal Wilson
HEIGHT: 5'3"
AGE: 47
HAIR COLOR: Black
SEX: F
EYE COLOR: Brown
RACE: African-American

DISTINGUISHING MARKS:
Large birthmark on upper back

Missing Person #6

NAME: Jessie Anderson
HEIGHT: 5'4"
AGE: 46
HAIR COLOR: Black
SEX: M
EYE COLOR: Brown
RACE: African-American

DISTINGUISHING MARKS:
Surgical scars on the back and legs due to injuries in an automobile accident

Missing Person #7

NAME: Herman Arbas
HEIGHT: 5'8"
AGE: 29
HAIR COLOR: Blond
SEX: M
EYE COLOR: Brown
RACE: Caucasian

DISTINGUISHING MARKS:
Scars on the forehead and right cheek from construction accident

TEACHER ANSWER KEY

NO BONES ABOUT IT

Using the database, can you determine the possible identities of the people buried at the site?

Bones #1, 4, and 6 could have come from Missing Person #4
Bones #2 and 5 could have come from Missing Person #5
Bone #3 could have come from Missing Person #7

Are the heights exactly what you expected them to be? Why or why not?

Answers will vary. The heights ar slightly different than the calculated values, and the possible reasons for this are varied, including:
These bones do not belong to that missing person, but someone of similar height
Natural variation in bone length, even between the same person's two arms
The computed heights are estimates
etc

What are some possible sources of error in your identification?

If the person buried here had unusually long arms or legs the height estimation tables may not be accurate.
If the people that are buried here are not listed as missing persons, they identifications will be wrong.
If the estimations of time, sex, or ethnicity are off, the heights will not be accurate.
Etc…

What other forensic tests could you do to test your deductions?

The next step would be to try and collect DNA samples from the bones. These samples can be used to confirm which bones came from the same buried body, and could be used to positively identify the bodies if DNA samples from the missing persons or their family members are available.
Another possibility would be hiring a forensic artist to do facial reconstruction, if any skulls were found at the site.

Name:_____ Date:_____

NO BONES ABOUT IT

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STUDENT WORKSHEET

Name:_____ Date:_____

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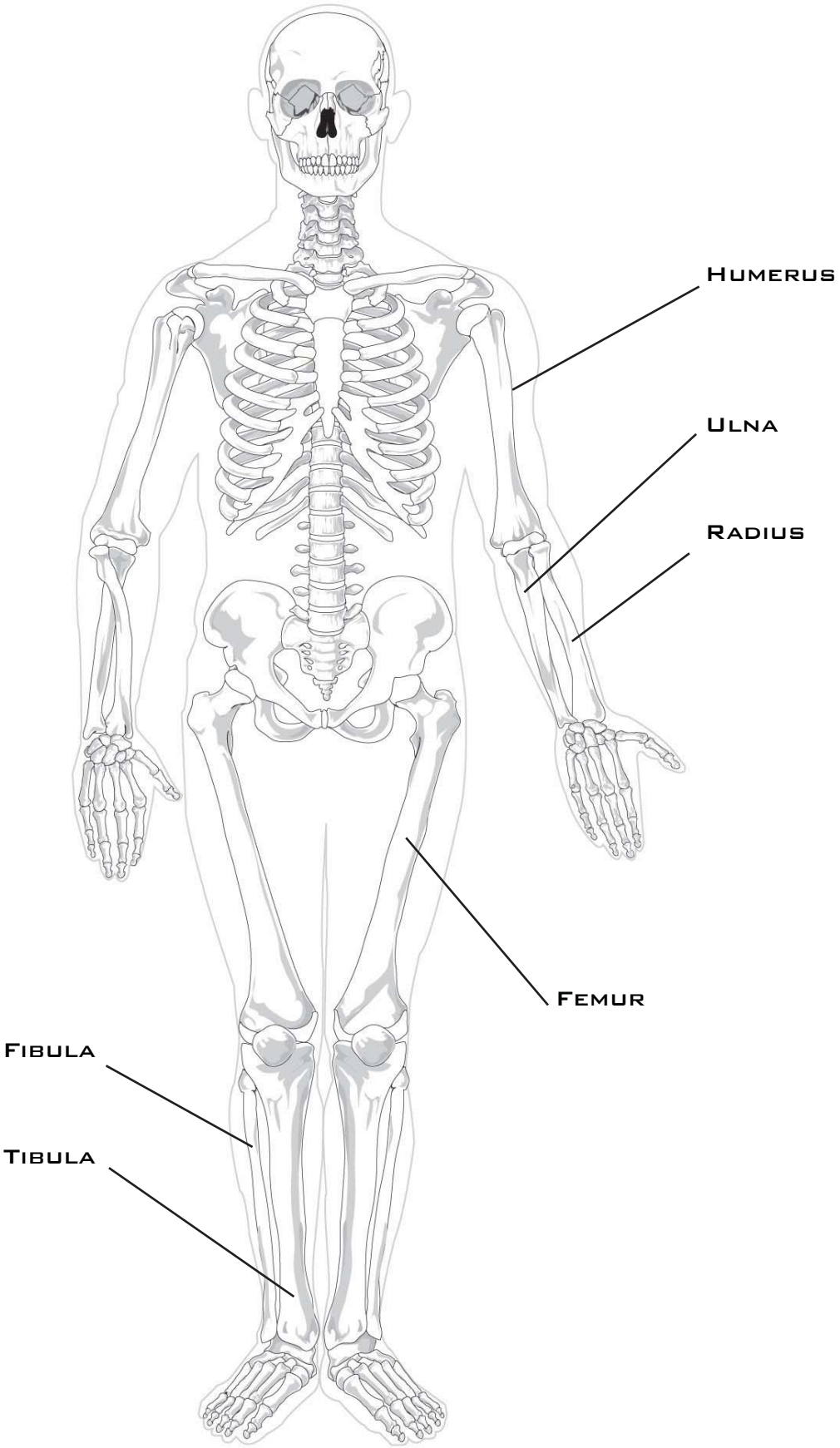
STUDENT SHEET

LONG BONES OF THE HUMAN SKELETON



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Is it possible any of these bones came from the same person? Which bones?

What is the minimum number of bodies buried at this site? What is the maximum number of bodies?

Do all bones from the same body give exactly the same height? If not, why would the heights be different?

STUDENT WORKSHEET

Name:_____ Date:_____

NO BONES ABOUT IT

Another forensic anthropologist on the team estimates the remains have been buried three to four years. A search of the local missing person's database shows that the following people disappeared during that time:

MISSING PERSONS DATABASE

Missing Person #1

NAME: Dana Grant **HEIGHT:** 5'0"
AGE: 27 **HAIR COLOR:** Black
SEX: F **EYE COLOR:** Brown
RACE: African-American

DISTINGUISHING MARKS:
Small rose tattoo on left ankle; appendectomy scar

Missing Person #2

NAME: Rosalyn Fairbanks **HEIGHT:** 5'7"
AGE: 36 **HAIR COLOR:** Black
SEX: F **EYE COLOR:** Green
RACE: Caucasian

DISTINGUISHING MARKS:
Wears glasses or corrective lenses

Missing Person #3

NAME: Devon Bailey **HEIGHT:** 5'8"
AGE: 45 **HAIR COLOR:** Black
SEX: M **EYE COLOR:** Brown
RACE: African-American

DISTINGUISHING MARKS:
None

STUDENT WORKSHEET

Name:_____ Date:_____

NO BONES ABOUT IT
MISSING PERSONS DATABASE

Missing Person #4

NAME: Wayne Aughney **HEIGHT:** 6'2"
AGE: 36 **HAIR COLOR:** Black
SEX: M **EYE COLOR:** Brown
RACE: Caucasian

DISTINGUISHING MARKS:
Tattoo of a dragon on upper right arm

Missing Person #5

NAME: Crystal Wilson **HEIGHT:** 5'3"
AGE: 47 **HAIR COLOR:** Black
SEX: F **EYE COLOR:** Brown
RACE: African-American

DISTINGUISHING MARKS:
Large birthmark on upper back

Missing Person #6

NAME: Jessie Anderson **HEIGHT:** 5'4"
AGE: 46 **HAIR COLOR:** Black
SEX: M **EYE COLOR:** Brown
RACE: African-American

DISTINGUISHING MARKS:
Surgical scars on the back and legs due to injuries in an automobile accident

Missing Person #7

NAME: Herman Arbas **HEIGHT:** 5'8"
AGE: 29 **HAIR COLOR:** Blond
SEX: M **EYE COLOR:** Brown
RACE: Caucasian

DISTINGUISHING MARKS:
Scars on the forehead and right cheek from construction accident

STUDENT WORKSHEET

Name:_____ Date:_____

NO BONES ABOUT IT

Using the database, can you determine the possible identities of the people buried at the site?

Are the heights exactly what you expected them to be? Why or why not?

What are some possible sources of error in your identification?

What other forensic tests could you do to test your deductions?

STUDENT WORKSHEET

STICKY FINGERS

PROBLEM:

Three weeks ago a local bakery was robbed at gunpoint. The thief wore a mask, so even when the police found a suspect the bakery owner couldn't make a positive ID. However, as the CSI processing the scene, you collected several fingerprints from various parts of the bakery.

The police have identified a suspect, but he says he's never been to that bakery. It's your job to see if the suspect's fingerprints match any of those recovered at the scene of the crime.

ACTIVITY:

Students are first introduced to the three main types of fingerprints: **loops, whorls, and arches**. Using a balloon and a number two pencil, each student will determine the total numbers of loops, whorls, and arches on his or her ten fingers. The teacher can then add the individual totals to determine the total numbers of loop, whorl, and arch fingerprints in the class as a whole. Students should record this information on their worksheets.

The students are then shown a bar graph illustrating the percentage of loop, whorl, and arched fingerprints in the United States population. After answering several questions about his graph, they are prompted to construct a similar bar graph using their classroom percentages for each type of print. The students are then asked a series of questions designed to test their understanding of the activity.

Lastly, students are presented with copies of the suspect's fingerprints and those obtained from the crime scene. The students are instructed on how to identify various **ridge characteristics** (island, ridge ending, bifurcation, etc.). Using the ridge characteristics of the prints, the students should be able to identify which of the prints at the crime scene were left by the suspect—even to the point of which finger they came from. One of the crime scene prints (from the display case) will not match the suspect. This is to be expected in a public crime scene where several people (customers, owner, workers) have been present.

TEACHER NOTES:

Fingerprints have been used for identification throughout history, but it was Sir William Herschel in Jungipoor, India, who first recognized their true potential. He was the first to espouse the theory that all fingerprints are unique to an individual and are permanent throughout a person's lifetime. These principles were later scientifically investigated and promulgated by Sir Fracis Galton, a British anthropologist. A student of his, Juan Vucetich, made the first criminal fingerprint identification in 1892 when he used Francis Rojas bloody fingerprint to convince a jury she had murdered her two sons. Today, we now accept as common fact that 1) all fingerprints are unique, and no two are exactly identical, 2) a fingerprint will remain unchanged during a person's lifetime, and 3) fingerprints have distinct patterns that can be classified and used for comparison.

Fingerprints can be divided into three main types: loops, whorls, and arches. Loops are the most common type of fingerprint; on average 65% of all fingerprints are loops. Approximately 30% of all fingerprints are whorls, and arches only occur about 5% of the time. There are subcategories for each of these. Loops are subdivided into radial loops (the loop enters and exits the finger on the side closest to the thumb) and ulna loops (the loop enters and exits the finger on the side closest to the pinky finger). Arches can be plain (the ridges are flat or only show a slight peak) or tented (sharp, well defined peak). Whorls can be plain, central pocket (elevated, usually smaller whorl pattern), double loop (whorl made of two distinct loop patterns), or accidental (combination of all of the above).

In order to conclusively match individual fingerprints, fingerprint examiners use **ridge characteristics**, also known as minutia. The most common types of ridge characteristics are bifurcations, ridge endings, and islands, though there are several different categories and subcategories for each of these. A single rolled fingerprint may have more than 100 different ridge characteristics. In the United States there in no minimum number of ridge characteristics that must be used to match up two fingerprints (though eight or more is considered "standard" and twelve is "sufficient"). However, the match must be made by one verified fingerprint examiner (usually trained by the International Association for Identification (IAI)) and verified by second verified examiner.

MATERIALS:

- White latex balloons (at least one per student)
- #2 pencils (one per student)

CLASSROOM MANAGEMENT:

For the most part this activity is designed to be completed individually by each student, though the data from all students will be pooled together during the first part. If desired, students can work together in pairs or small teams. There will be considerable interest in sharing and comparing the fingerprints on the various balloons, especially if certain rare or unique fingerprints are discovered (e.g. arches, double whorls, etc.). These balloons can also be used to discuss why certain fingerprints, which look very similar, are still different and unique. The ridge characteristics should be relatively easy to identify on the expanded balloons.

TEACHER ANSWER KEY

STICKY FINGERS

Part 1: Are some kinds of fingerprints more common than others?

1. Fill in each of these squares using a #2 pencil. Make sure each square is dark and shiny.

Thumb	1st Finger	2nd Finger	3rd Finger	Pinky

2. Blow up a balloon to about the same size as a baseball and tie it loosely.

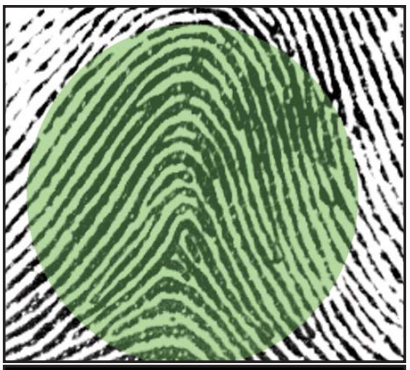
3. Press each finger into one of the boxes, then gently press it against the balloon. Use a different part of the balloon for each finger!

4. Blow up the balloon larger. Watch the fingerprints EXPAND.

5. Compare each fingerprint to the provided examples. Determine whether it is a **loop, whorl, or arch**.

LOOP
The most common type of print; some ridges enter and exit on the same side of the finger.

WHORL
The ridges form a circular pattern



ARCH
The least common type of print; ridges run from one side of the finger to the other.

6. Record your data below:

	Thumb	Index	Middle	Ring	Pinky
Right Hand					
Left Hand					

TEACHER ANSWER KEY

STICKY FINGERS

Using the data from both your hands, count the total numbers of loops, whorls, and arches.

Total# **Loops**: _____

Total# **Whorls**: _____

Total# **Arches**: _____

As a class, calculate the total number of loop, whorl, and arch fingerprints for the entire class. Record that data here:

Classroom Total# **Loops**: _____

Classroom Total# **Whorls**: _____

Classroom Total# **Arches**: _____

Classroom Total# **All Fingerprints**: _____

Next, calculate the **percentage** of each type of fingerprint in your classroom population.
For example, the Percentage of Loops = (Total# Loops / Total# All Fingerprints) x 100

Percentage **Loops**: _____

Percentage **Whorls**: _____

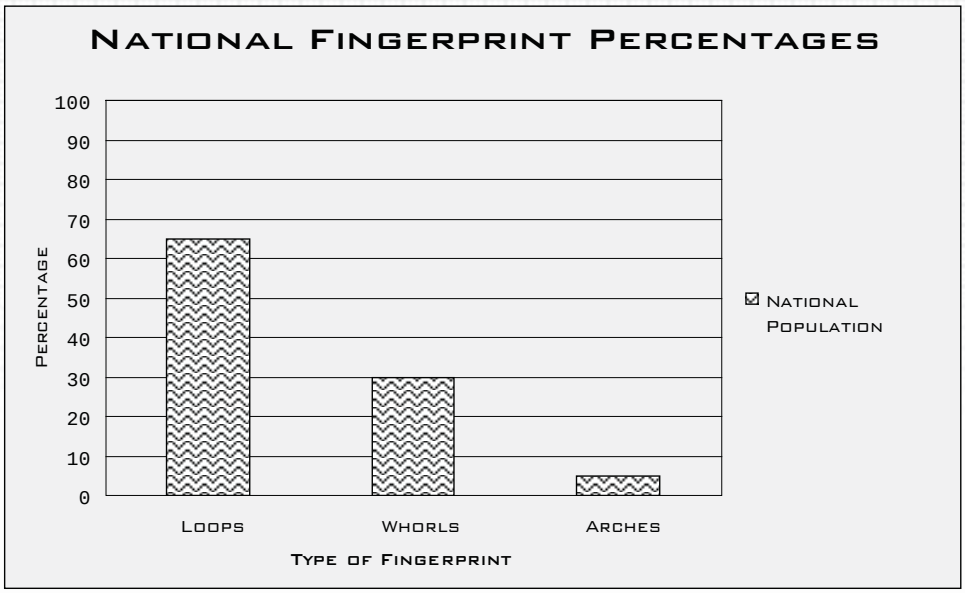
Percentage **Arches**: _____

Total Percentages: 100%

TEACHER ANSWER KEY

STICKY FINGERS

The chart below shows the how often each of these types of fingerprints occur in the national population. Use this chart to answer the following questions.



1. What percentage of fingerprints in the national population are loops?

65%

2. What percentage of fingerprints in the national populations are whorls?

30%

3. What percentage of fingerprints in the national population are arches?

5%

4. Which is greater: the number of loop fingerprints in the national population, or the number of whorl fingerprints plus the number of arch fingerprint?

The number of loop fingerprints
(65% > (35%+5%))

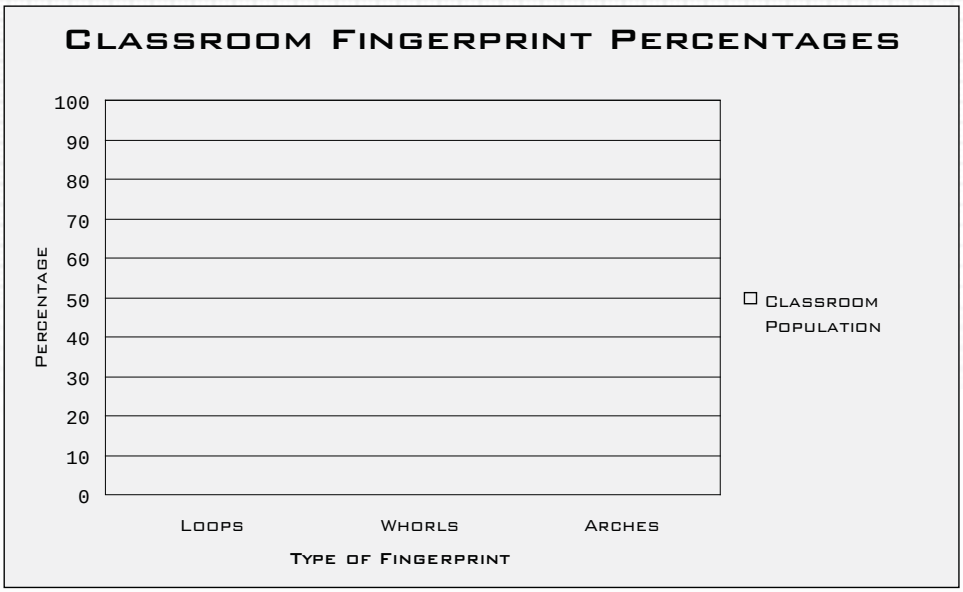
5. In a random sampling of 1000 fingerprints from the national population, approximately how many arch fingerprints can you expect to find?

0.05 x 1000 = approximately 50 arch fingerprints

TEACHER ANSWER KEY

STICKY FINGERS

Use the data collected from your class as a whole to fill in the next graph. Use the data from both graphs to answer the following questions.



1. Does the graph of fingerprints in your class look the same as the graph of the national averages? Why or why not?

Though the graphs will probably be similar, they may not be identical. There is natural variation in all populations. The first graph only shows the averages for the US population.

2. Would you predict that a graph of fingerprint patterns from another class would look the same as your graphs? Why or why not? How could you find out if your prediction is correct?

A graph of fingerprints from another classroom would probably look similar, but not identical to both graphs (the classroom and the national population). Again, this is due to naturally occurring variations. The only way to see what the graph of the other classroom would look like is to repeat the experiment in that classroom

3. The fingerprints from a recent crime scene are shown on the next page. Using the data from the national population would you say this suspect has common fingerprints? Why or why not?

Of the suspects 10 fingerprints, 3 (30%) are arches, 3 (30%) are whorls, and 4 (40%) are loops. He has an unusually high number of arches, making his fingerprints highly unusual.

TEACHER ANSWER KEY

STICKY FINGERS

Evidence from Case #4589241-B

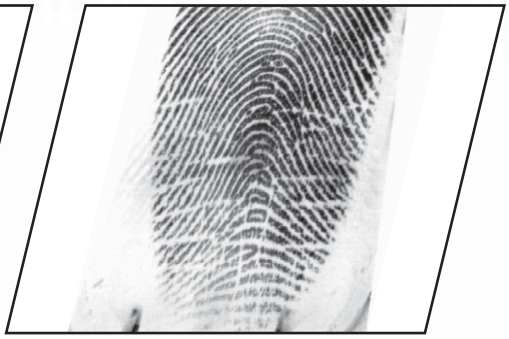
Fingerprints from Crime Scene

From Cash Register

From Display Case

From Cash Register

From Door



From Door

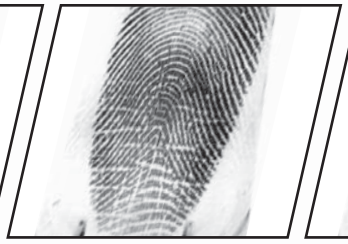
Suspect's Fingerprints

Right Hand

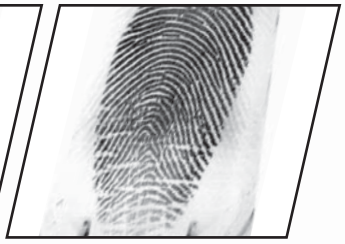
Thumb

Index

Middle



Ring



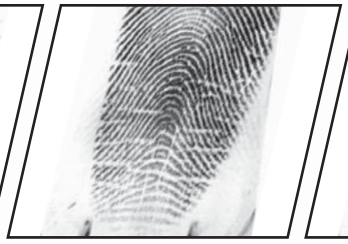
Pinkie

Left Hand

Thumb

Index

Middle



Ring

Pinkie

TEACHER ANSWER KEY

STICKY FINGERS

Part 2: Do the suspect's fingerprints match those at the crime scene?

In the previous exercise, you should have noticed that everybody has similar fingerprints. For example, many students in your class may have fingerprints that are all loops, or nine loops and a whorl. If everyone's fingerprints are so similar, how can forensic scientists link certain fingerprints to a specific individual?

Forensic scientists use ridge characteristics to identify an individuals' fingerprints. These include:

Ridge Ending

Lake (enclosure)

Bifurcation

Hook (Spur)

Dot

Double Bifurcation

Island (short ridge)

Opposed Bifurcation

TEACHER ANSWER KEY

STICKY FINGERS

Three weeks ago a local bakery was robbed at gunpoint. The thief wore a mask, so even when the police found a suspect the bakery owner couldn't make a positive ID. However, as the CSI processing the scene, you collected several fingerprints from various parts of the bakery.

The police have identified a suspect, but he says he's never been to that bakery. It's your job to see if the suspect's fingerprints match any of those recovered at the scene of the crime.

1. Can you identify any ridge characteristics on the suspects prints? on the prints from the crime scene? Circle and label any ridge characteristics you find.

There are a variety of ridge characteristics. The most common will be ridge endings, lakes, and bifurcations, but there are also hooks, dots, and islands.

2. Do any of the crime scene fingerprints match the suspect's fingerprints? Label any matching crime scene fingerprints with the hand and finger they come from.

From Cash Register (top row) = Left Thumb
From Display Case = NO MATCH
From Cash Register (bottom row) = Right Thumb
From Door = Left Pinkie
From Door = Left Ring

3. Do any of the crime scene prints NOT match the suspect's prints? Who do you think could have contributed these prints?

The print from the display case does not match the suspect. This print could belong to the shop owner or a customer.

4. Do you think the suspect committed this crime? Why or why not?

Answers may vary, but students should point out that 1) the suspect has defiantly been to the bakery, which contradicts his earlier statement, and 2) one of his prints was found on the cash register. Even if he was in the bakery as a customer, why would his print be on the cash register?

Name:_____ Date:_____

STICKY FINGERS

Part 1: Are some kinds of fingerprints more common than others?

1. Fill in each of these squares using a #2 pencil. Make sure each square is dark and shiny.

Thumb	1st Finger	2nd Finger	3rd Finger	Pinky

2. Blow up a balloon to about the same size as a baseball and tie it loosely.

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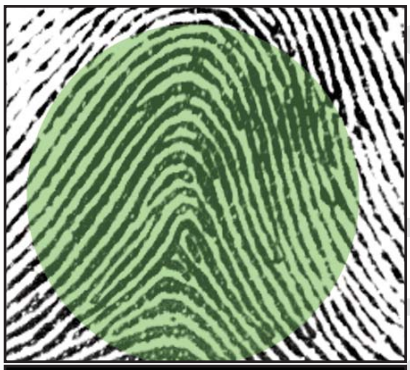
The ridges form a circular pattern



ARCH
The least common type of print; ridges run from one side of the finger to the other.

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Left Hand					

STUDENT WORKSHEET

Name:_____ Date:_____

STICKY FINGERS

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As a class, calculate the total number of loop, whorl, and arch fingerprints for the entire class. Record that data here:

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Next, calculate the **percentage** of each type of fingerprint in your classroom population.
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Percentage **Loops**: _____

Percentage **Whorls**: _____

Percentage **Arches**: _____

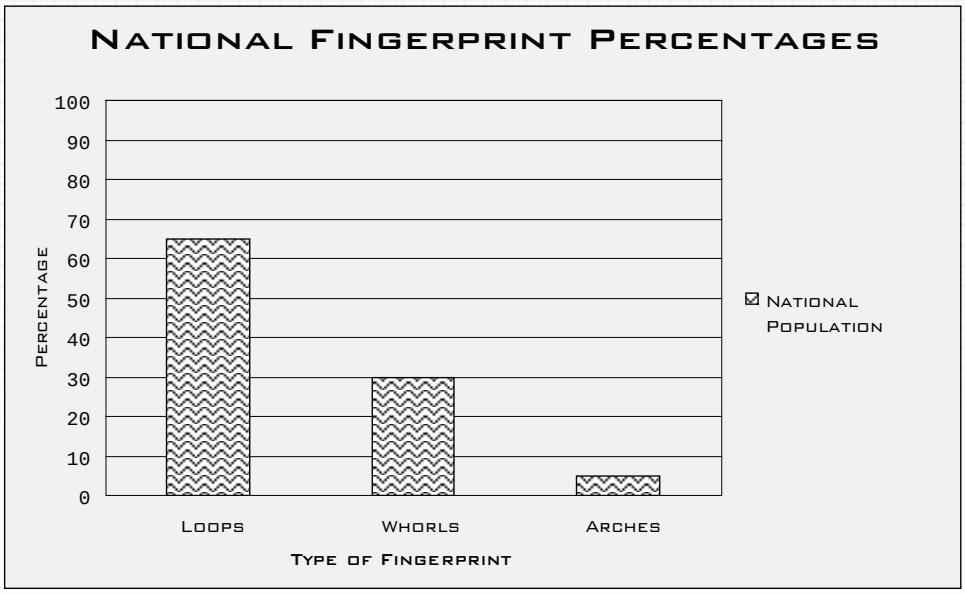
Total Percentages: 100%

STUDENT WORKSHEET

Name:_____ Date:_____

STICKY FINGERS

The chart below shows the how often each of these types of fingerprints occur in the national population. Use this chart to answer the following questions.



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3. What percentage of fingerprints in the national population are arches?

4. Which is greater: the number of loop fingerprints in the national population, or the number of whorl fingerprints plus the number of arch fingerprint?

5. In a random sampling of 1000 fingerprints from the national population, approximately how many arch fingerprints can you expect to find?

STUDENT WORKSHEET

Name:_____ Date:_____

STICKY FINGERS

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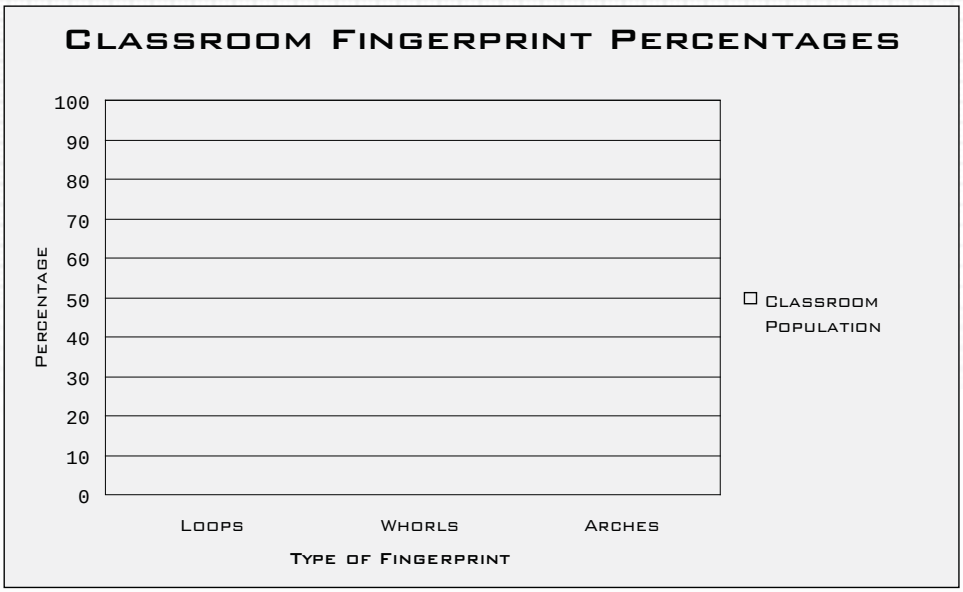

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STUDENT WORKSHEET

Name:_____ Date:_____

STUDENT WORKSHEET

STICKY FINGERS

Evidence from Case #4589241-B

Fingerprints from Crime Scene

From Cash Register

From Display Case

From Cash Register

From Door

From Door

Suspect's Fingerprints

Right Hand

Thumb | Index | Middle | Ring | Pinkie

Left Hand

Thumb | Index | Middle | Ring | Pinkie

Name:_____ Date:_____

STICKY FINGERS

Part 2: Do the suspect's fingerprints match those at the crime scene?

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Dot

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Island (short ridge)

Opposed Bifurcation

STUDENT WORKSHEET

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STUDENT WORKSHEET