The Case of the Murdered Mayor
Solve a forensic case using multiple lines of evidence.

In The Case of the Murdered Mayor, students work in investigative teams and apply scientific principles to solve a fictional murder mystery. Through this experience, students:

- Learn knowledge and skills for conducting forensic investigations with fingerprint, hair, tire impression, blood, and entomological evidence.
- Use analytical skills and deductive reasoning to solve a murder mystery that involves multiple individuals and variables.
- Relate science concepts to forensic investigations.

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Forensic Science

Materials

Blood Evidence (per group)

- Plastic Blood Typing Slides
- Marker
- 10 Synthetic Blood Dropper Bottles
  C. Cunningham
  M. Maloy
  P. Preston
  T. Taylor
  V. Velto
  N. Burlington
  Victim
  Victim's Car
  Cabin
  Tire Iron
- Synthetic Anti-A Serum
- Synthetic Anti-B Serum
- Synthetic Anti-Rh (D) Serum
- Mixing Sticks, Blue
- Mixing Sticks, Yellow
- Mixing Sticks, White

Fingerprint Evidence (per group)

- Fingerprint Evidence Slides (skipped during workshop)
- Magnetic Fingerprinting Powder
- Fingerprinting Powder Applicator (magnetic stem with clear plastic sleeve)
- Fingerprint Lifting Tape
- Dual Magnifiers
- Unlined White Index Cards

Entomological Evidence (per group)

- 12 Artificial Maggots
- Small Cups
- Rulers

Hair Evidence (per group)

Note: Data is provided during workshop in place of performing experiment.

- Hair Evidence in Labeled Envelopes
- Microscope Slides
- Coverslips
- Dissecting Forceps
- 3-mL Plastic Pipets and Water
- Microscopes

Impression Analysis (per group)

- Copy of the Impression Evidence Sheet

Safety

Use established laboratory safety practices, including always wearing appropriate personal protective equipment (PPE).

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The Case of the Murdered Mayor

It is time to put your forensic skills to the test! You have been invited to help solve **The Case of the Murdered Mayor**. As part of a forensic investigation team, you will perform realistic simulations of forensic investigation techniques including fingerprint analysis, hair evidence analysis, blood typing, impression analysis, and entomological evidence analysis. To attempt to solve this crime, you must follow these important steps:

1. Read the case background and the descriptions of the suspects.
2. Carefully analyze and consider all of the collected evidence.
3. Determine which suspect (or suspects) had both motive and opportunity to commit the crime.
4. Submit a written report of your findings. Evaluate the evidence, name your primary suspect(s), and describe the most likely series of events leading up to and following the mayor's death.

The following information may help you in your investigations:

- You may have only a small amount of a substance to work with as evidence. Handle evidence carefully and make sure everything you work with is clearly labeled.
- As you work to find the truth, avoid jumping to conclusions. Carefully analyze the evidence and form your opinion based only upon the facts.
- Not all evidence is equally helpful in solving a crime.
- You may process evidence incorrectly or make a mistake, making the evidence inconclusive or unusable. Continue the investigation and revisit the evidence later, if possible.
- Once you have analyzed the evidence and think you know who might have committed the crime, try to determine a motive as well.

Case Background

At first, many residents of Allenville celebrated the election of Robert Burlington as mayor. Burlington had grown up in the rural, working-class town. He went off to college, married, and eventually returned to Allenville, becoming a partner in a struggling local investment firm. As a candidate, Burlington promised to make Allenville a great place to live and work. He ran against incumbent mayor Timothy Taylor, who tried to maintain the sleepy image of Allenville. Though a number of people spoke out against him during the campaign (including local environmentalist Pam Preston), Burlington won by a narrow margin.

Within a year, however, rumors began to circulate that Burlington was taking bribes from businessmen lobbying to build an industrial park in Allenville. The proposed industrial site was home to a few small businesses and a wilderness area called Lake Larson Park. Burlington did in fact support the industrial park, and he argued that a new road should be built to access it. If approved, the project would destroy much of the forested area surrounding Lake Larson Park as well as some adjacent farmland. The local newspaper published editorials accusing the mayor of destroying small businesses, the environment, and the tourist trade. Concerned citizens Matthew Maloy and Vic Velto started a petition to remove the mayor from office, but failed to get enough signatures. Shortly thereafter, the mayor was seen having a heated and very public argument with his wife, Nicole. The following day, observant citizens saw Nicole Burlington driving through town in a new car and wearing an expensive fur coat.

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The last town council meeting held before Burlington's death was a nightmare for residents. A critical vote to annex the land for the industrial park and for approval of the connecting road was coming up in 3 days. Burlington had thus far bullied the town council into approving his plans, and many felt that Allenville would be forever changed by the results of the upcoming meeting. In front of the town council, the mayor dismissed his opponents' criticism as "small-town thinking" and stated that he was on a mission to make Allenville more prosperous. When residents objected, Burlington angrily replied that he was the mayor and that no one in town could stop him. At this point in the proceedings, councilman Chris Cunningham publicly accused the mayor of lying and taking bribes. The mayor abruptly ended the meeting and stormed out of the building as the town hall erupted into chaos.

One day before the planned town council vote, Nicole Burlington reported her husband missing. She claims that he told her he was going to "a silly meeting," but he never returned. Five days after the town council meeting, Burlington's car was found on an unpaved, isolated road near Lake Larson. The mayor was not there, but his keys were in the ignition. Several drops of blood were found on the front seat. A tire iron, smudged with blood, was found in the woods near the car. A second set of tire tracks was found near the mayor's car. The tracks followed a muddy road to a deserted cabin deeper in the woods.

Entering the cabin, the investigators immediately knew they were looking at a crime scene. A glass window was shattered and the furniture in the cabin was scattered and broken, suggesting a struggle had taken place. Mayor Robert Burlington lay on his side, a single bullet hole in his chest. He also had a large wound on the back of his head. It was apparent that he had been dead for a while; the stench of decay was present and maggot activity was evident on the body.

The investigators gathered 5 different types of evidence for comparison and further analysis as described below. They also identified 6 murder suspects who are described on the page titled "The Suspects."

1. **Entomological Evidence.** Investigators collected insect larvae (maggots) from the victim's head and chest wound sites. This evidence is useful in conjunction with the alibi interviews of the murder suspects.

2. **Hair Evidence.** Investigators collected samples of hair from the victim's clothing, the victim's car, and the cabin floor. Later, they collected and analyzed hair samples from the 6 suspects' vehicles.

3. **Blood Evidence.** Investigators collected samples of blood from the victim, the victim's car, the cabin floor, and the tire iron. Later, they collected blood samples from the 6 suspects.

4. **Fingerprint Evidence.** Investigators obtained fingerprint samples from the victim, from a piece of broken glass in the cabin, from a bloodstained piece of wood in the cabin, and from the tire iron. Later, they collected fingerprint samples from the 6 suspects.

5. **Impression Evidence.** Investigators photographed the tire impression found at the cabin crime scene. Later, they photographed the tires of vehicles belonging to the 6 suspects.

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The Suspects

While the evidence was being collected and processed for analysis by your team, police detectives identified their primary suspects—those who had been most outspoken against the mayor, the mayor's business associates, and the mayor's wife. Detectives deemed the following information relevant. Under the description of each suspect, identify a potential motive for murdering the mayor.

Chris Cunningham (CC). Cunningham is a senior partner in Burlington's investment firm and a member of the Town Council. He recruited Burlington to the firm and encouraged him to run for mayor. He is known for being honest with his investing clients and has always been an outspoken critic of corruption in government. The police have been called on several occasions recently to break up heated arguments between Cunningham and Robert Burlington.

Motive: _____

Matthew Maloy (MM). Maloy is Allenville's local veterinarian and a prominent animal rights activist. His business would be displaced by the proposed industrial park. Maloy has worked for years, without success, to expand and protect the boundaries of Lake Larson Park. Still a bachelor, he has been actively courting Pam Preston, also without success.

Motive: _____

Pam Preston (PP). Preston is a biologist, environmental scientist, and a lifelong resident of Allenville. She has been conducting long-term research around Lake Larson for the last 6 years and owns the cabin where Mayor Burlington was killed. She claims to have not been to the cabin in over a month because she has been spending long hours analyzing her research data in her lab in downtown Allentown. Regarding her research, she recently told colleagues that she is on the verge of a major breakthrough but needs more time to complete her studies. She had a rocky romantic relationship with Robert Burlington long before he was married, and she never misses an opportunity to oppose him. She has spent time with Matthew Maloy at local restaurants and on walks around the lake, but she says that they are just friends and not romantically involved.

Motive: _____

Timothy Taylor (TT). Taylor, the former mayor of Allenville, was narrowly defeated by Robert Burlington. Taylor owns and operates a sheep farm, which has been in his family for 3 generations. If built, the proposed highway would cut across his grazing land, forcing him to abandon the farm. Taylor recently made a profitable deal with a clothing manufacturer, which he will lose if forced to sell the farm.

Motive: _____

Vic Velto (VV). This outspoken businessman operates an outdoor recreation shop on the shore of Lake Larson. Two years ago, he borrowed a large sum of money to expand his business. He purchased 5 sailboats and added camping and hunting supplies, including guns and ammunition, to his list of goods for sale. He is deeply in debt while his business grows, and it is no secret that he does not want to see any changes to the Lake Larson area.

Motive: _____

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Nicole Burlington (NB). Nicole's marriage to Robert Burlington is rumored to be an unhappy one. The ambitious daughter of a wealthy big-city businessman, Nicole admits that she does not enjoy the small-town life; it is "too quiet and there is too much nature," she says. She also hates animals, partly because she is highly allergic to animal hair. She is disappointed with her husband's lack of financial success, and she encouraged her husband to realize greater political ambitions and move away from Allenville. She has been taking sailing lessons from Vic Velto.

Motive: _____

Suspect Alibis

Police detectives interviewed all 6 suspects and recorded their alibis for the last 11 days. The investigators were able to confirm some but not all of the suspects' alibis. The following table is a summary of their results. A confirmed alibi (C) means that the suspect's whereabouts at the time are known, and therefore he or she could not have committed the murder on that day. An unconfirmed alibi (U) means that the suspect's alibi for that day could not be verified, and therefore he or she could potentially have committed the murder on that day.

Days ago	Chris Cunningham	Matthew Maloy	Pam Preston	Timothy Taylor	Vic Velto	Nicole Burlington
1	C	U	C	U	C	U
2	C	C	C	U	U	U
3	C	U	C	C	U	U
4	U	C	U	C	C	C
5	C	U	U	C	U	C
6	C	U	U	U	U	U
7	U	U	U	C	U	U
8	C	U	C	C	C	C
9	C	C	C	U	U	U
10	C	U	C	U	U	U
11	U	C	C	U	C	C

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1. Entomological Evidence (Estimating the Time of Death)

A valuable piece of evidence in some murder cases is the entomological (insect-related) evidence that can be found on a decomposing body. Once death occurs, flies, beetles, mites, and bacteria begin to utilize the body as a resource. Flies may locate a body and lay eggs on it. The eggs hatch into larvae (maggots) that use the body as a source of food. These larvae grow, pupate, undergo metamorphosis, and finally emerge as adult flies ready to find a site to lay their own eggs.

Forensic entomologists study the insect activity on the body to determine, among other things, the age of the oldest larvae living on the body. These larvae would have emerged from the first eggs laid on the body, which can happen within minutes after death. These larvae are collected, measured, and identified. By knowing the life cycle characteristics of the fly in question, forensic entomologists may provide an estimate of the time of death to crime investigators.

Investigators collected insect larvae (i.e., maggots) from the victim's head and chest wound sites. While a number of variables can affect fly development (including temperature, light exposure, and chemicals in the body), these factors do not affect your investigation.

You will be given approximately 12 maggots to measure. Identify the largest (and therefore, the most mature) maggot specimens. Separate them from the other larvae. Measure these mature specimens, and then determine the average length of these larvae. Note: The maggots are slightly curved so you may have to estimate their length slightly. Compare your average number to the growth chart below.

In Table 2 of the Evidence Tables on page 15, write your estimate for the number of days since Burlington's death and incorporate this data into your evidence summary.

Fly Larvae Growth Chart

Average size of most mature larvae (mm)	Estimated days since death
1–2	1
3–5	2
6–8	3
9–11	4
12–14	5
15–18	6
19–21	7
22–25	8
26–28	9
29–31	10
32–33	11
Pupation occurs	12

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2. Hair Evidence

An important concept in forensic science is the Locard Exchange Principle, which states that every contact between 2 objects results in an exchange of physical materials. In other words, potentially identifiable evidence may be transferred from one object to another if 2 objects come in contact. For example, if you hold a pencil, skin cells are transferred from you to the pencil and tiny flecks of paint may be transferred from the pencil to you. If the forensic investigator can find this evidence and determine its source, he or she may come closer to understanding the crime.

At the crime scene, investigators collected samples of hair from the victim's clothing, the victim's car, and the cabin floor. Later, they collected hair samples from the suspects' vehicles. The hair samples from the suspects' vehicles were analyzed by another investigative team, who identified the hairs as either animal or human, and then submitted their results to your team for analysis. This data appears in Table 2. Your team will analyze the hair samples found at the crime scene and compare them with the evidence from the suspects' vehicles.

Hair is composed of three main parts: the cuticle, the medulla, and the cortex. The cuticle is an outer layer composed of overlapping scales. The medulla is the central core of the hair; it may be continuous, broken, or even absent, as is the case sometimes in humans. The cortex is a protein structure that surrounds the medulla and contains pigment. Humans lose hairs every day, and any of these can be used for identification. If there is an intact "root" or "bulb" with a hair shaft, nuclear DNA (y-DNA) can be extracted. For a hair shaft without the root or bulb, only mitochondrial DNA (mt-DNA) can be extracted.

Animal Hair
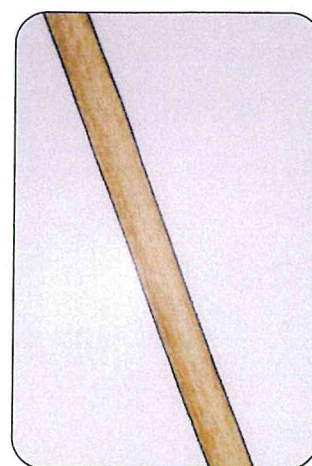(thick medulla)

Human Hair
(absent medulla)

For this investigation, you will microscopically analyze hairs to see if they have similar color and structural characteristics. Also, distinguish animal and human hairs by differences in their core, or medulla. Animal hairs have thick medullas, typically more than half of the diameter of the hair, and they may appear fragmented. Human hairs typically have a thin medulla, occupying less than one-third of the diameter of the hair; in some cases the medulla is absent, as shown in the image.

In the classroom, students would be provided hair samples to make wet mounts with and view under the microscope. For the purposes of our workshop, images of the hair samples discovered are provided on the next page instead.

Using the known human and animal hair samples as a guide, try to establish matches or possible matches between the crime-scene hair samples and the already analyzed samples from the 6 suspects. Record your observations and notes in your Evidence Tables on page 15.
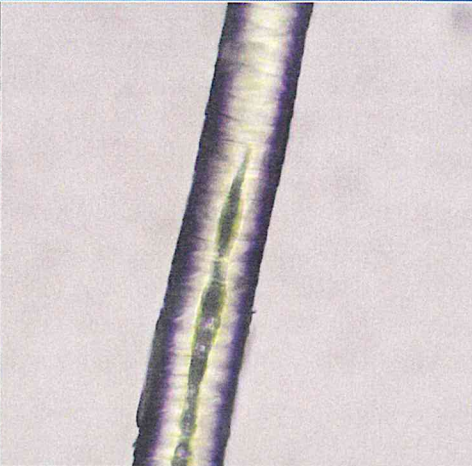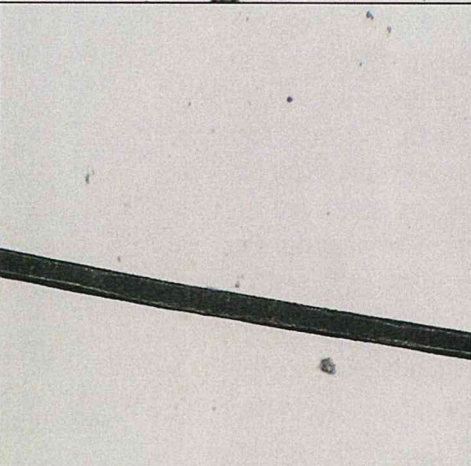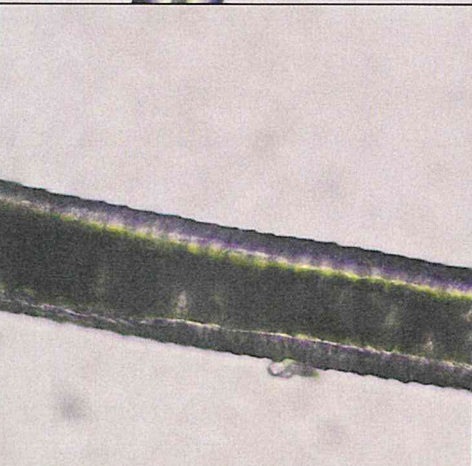
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Evidence/Location	Low Magnification	High Magnification
Victim **(Robert Burlington)**		
Victim's Car		
Cabin		

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3. Blood Evidence

Investigators collected samples of blood from the victim, the victim's car, the cabin floor, and the tire iron. Each of the 6 suspects also submitted a blood sample for analysis. Before your team tests the blood sample evidence, review the following information about blood groups and the Rh factor.

Blood Groups

The ABO blood groups result from the presence or absence of 2 antigens, A and B, on the surface of the red blood cells. The immune system produces an antibody in the plasma for the antigen not present. Usually, it is necessary for exposure to an antigen to occur before antibodies are produced. In this instance, however, the antibodies are already present. Type A blood has the A antigen on its red blood cells and anti-B antibodies in the plasma. Type B blood has the B antigen on its red blood cells and anti-A antibodies in the plasma. Type AB blood has both A and B antigens on the red blood cells but no antibodies in the plasma. Type O blood has neither A or B antigens on the red blood cells and there are both A and B antibodies in the plasma. The relationships of the ABO blood groups to the antigens and antibodies are summarized in the table below.

ABO Blood Groups

Blood Group	Red Cell Antigen	Serum Antibody in Plasma	Anti-A serum test results (coagulation?)	Anti-B serum test results (coagulation?)
A	A	Anti-B	Yes	No
B	B	Anti-A	No	Yes
AB	A and B	Neither	Yes	Yes
O	Neither	Both Anti-A and Anti-B	No	No

Blood Typing Instructions

1. Use a permanent marker or pen to label the white blood typing slide with the source or name of the blood sample (found on label of the dropper bottle) you will test. You may also need to highlight the label for each well (A, B, and Rh) using the permanent marker if these labels are too hard to see. Place 1 drop of the synthetic blood sample in each of the 3 wells of the blood typing slide. Close the cap on the dropper bottle. To prevent cross-contamination, always close the cap on one bottle before opening another bottle.

2. Add 1 drop of synthetic anti-A serum (blue) to well A. Close the cap.

3. Add 1 drop of synthetic anti-B serum (yellow) to well B. Close the cap.

4. Add 1 drop of synthetic anti-Rh serum (clear) to well Rh. Close the cap.

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5. Use a different colored mixing stick to stir each well; use blue for anti-A, yellow for anti-B, and white for anti-Rh. Gently stir the synthetic blood and anti-serum drops for 15 to 45 seconds each. To avoid contaminating the samples, discard each mixing stick after a single use.

6. Examine the liquid mixture left behind. If you see evidence of a reaction (namely, clumping of the liquid), there is agglutination. If a liquid mixture remains uniform in appearance, there is no agglutination. In the appropriate table below, answer "yes" or "no" as to whether agglutination occurred. Next, determine the blood type of the sample by consulting the "ABO Blood Groups" table.

7. Record the blood typing result for the sample in your Evidence Tables **on page 15.**

8. Repeat steps 1 through 7 for the remaining blood samples.

Suspects' Blood Samples – Agglutination Results (Yes or No?)

	Chris Cunningham	Matthew Maloy	Pam Preston	Timothy Taylor	Vic Velto	Nicole Burlington
Anti-A						
Anti-B						
Rh						
Blood Type						

Blood Evidence – Agglutination Results

	Victim	Victim's Car	Tire Iron (TI)	Cabin
Anti-A				
Anti-B				
Rh				
Blood Type				

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4. Fingerprint Evidence

Investigators obtained fingerprint samples from the victim, from a piece of broken glass in the cabin, from a doorknob in the cabin, and from the tire iron. Later, all 6 suspects provided a fingerprint sample on a microscope slide. Your team will lift and transfer several fingerprints, and other teams will do likewise. After all 10 fingerprints in the slide set have been lifted, compare the crime scene evidence prints [RB, Cabin print 1, Cabin print 2, and Tire iron (TI)] with the prints provided by the suspects. To be successful in this part of the investigation, you must work carefully, cooperate, share information, and manage data effectively. When lifting the fingerprints, they can be difficult to see unless they are processed or made visible. This can be done using many different methods. For this investigation, you will dust the print on the slide with fingerprinting powder, lift the print with the fingerprint lifting tape, and place it on a labeled index card. This makes the print more durable, and it will allow you to more easily compare the various prints.

In the classroom, students are provided with a set of 10 prepared fingerprint slides to perform the lift on. For the purposes of our workshop, you are provided with the data that would have been observed on these 10 slides.

Instead, we will practice lifting and identifying fingerprints by creating a slide of your own print, lifting it, and identifying it—following the procedure below.

Fingerprinting Instructions

1. Handle a slide by its edges to avoid introducing extraneous prints. Lay out a slide.

2. Rub your forehead or run your fingers through your hair to increase the oil content of your fingerprints. Then, gently touch the center of the first slide with one finger, and slightly roll the finger; the fingerprint should be faintly visible and somewhat square.

3. Locate the plastic fingerprint powder applicator. Insert the magnetic stem (rod) into the clear plastic applicator sleeve.

4. Dip this assembly into the jar of magnetic fingerprinting powder. Collect a quantity of powder on the end of the applicator.

5. Brush the powder lightly over the fingerprint on the slide, completely covering it. Return the remaining powder to the jar by holding the applicator over (or just inside) the mouth of the jar and moving the magnet in and out past the cover flare until all the powder releases.

6. With the magnet inserted, use the applicator to pick up any excess powder not adhering to the print. Release the powder back into the jar as you did in the previous step. Pick up the slide by the short edges. Turn the slide 90 degrees and gently tap it to remove any excess powder.

7. Attach a piece of adhesive tape to the print on the slide and peel it off.

8. Attach the tape to an unlined white index card.

9. Examine your fingerprint with your hand lens. Use the fingerprint reference sheet on the next page to identify the patterns of your fingerprint.

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Fingerprint Reference Sheet

| General	Specific	Description	Example
Loops	Radial Loop		**Radial Loops (right hand)**
	Ulnar Loop		**Ulnar Loops (right hand)**
Arches	Plain Arch		
	Tented Arch		
Whorls	Plain		
	Central Pocket		
	Double Whorl		
	Accidental		

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5. Impression Analysis

Another important principle in forensic science is that no 2 objects are ever exactly alike, even if they are mass manufactured. As objects become worn, used, or exposed to the environment, they begin to take on even more differences. A person who buys a pairs of shoes and wears them for even a week can find small changes in the shoes—changes such as scuffs and scratches, a tread wear pattern, and perhaps even an embedded pebble.

Investigators photographed the tire impression found at the cabin crime scene. Later, they photographed the tires of vehicles belonging to the suspects. **Study the photo of the tire impression from the crime scene and compare it to the photographs taken of each suspect's vehicle's tire treads. If necessary, use a hand lens to help you see at a greater level of detail. Try to determine which tread matches the tire impression found at the crime scene. Add this information to your Evidence Tables on page 15.**

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Impression Evidence
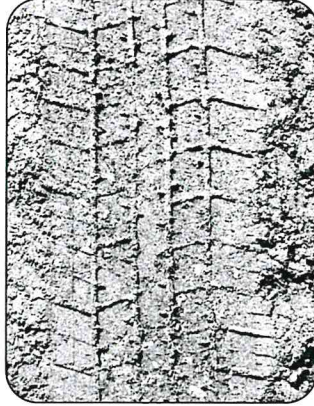
Crime Scene Impression

Chris Cunningham

Matthew Maloy

Pam Preston

Timothy Taylor

Vic Velto

Nicole Burlington

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Evidence Tables

Table 1: Crime Scene Data

Evidence/ Location	Blood Type	Hair Analysis (human or animal)	Fingerprint Analysis (describe findings)	Impression Analysis (which suspect's tire track matches the one found at the scene?)	Notes
Victim (Robert Burlington)			Print matches one cabin (crime scene) print.		
Victim's Car			No print recovered.		
Cabin			One print is victim's. One print is Maloy's.		
Tire Iron			Print matches Matthew Maloy's.		
Tire Tracks					

Table 2: Evidence Summary

	Blood Type	Hair Type* (found in suspects' cars)	Fingerprint Match (yes or no?)	Impression Match (yes or no?)	Alibi for Time of Death (yes or no?)	Notes
Chris Cunningham		Human				
Matthew Maloy		Animal				
Pam Preston		Human				
Timothy Taylor		Animal				
Vic Velto		Human				
Nicole Burlington		Animal				
Victim (Robert Burlington)			Estimated Days Since Death:			

*Note: Investigators collected hair samples from the suspects' vehicles and identified them as either human hair or animal hair.

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Report to the District Attorney's Office

Now look at all of the gathered evidence. Begin eliminating suspects based upon the evidence collected from entomological evidence, hair, blood, fingerprints, and tire tracks. After narrowing the list to a prime suspect, try to establish a motive for the murder based upon the information gathered by detectives during their background investigation.

After agreeing upon the suspect(s) and motive(s), prepare a written report of your findings, along with documentation supporting your reasoning. Your report should include the following information:

1. A summary of all the evidence collected. Describe the different types of evidence collected and the process by which each piece of evidence was examined.

2. Give a detailed statement of the results of each analysis. Support all statements with specifics from the data you collected.

3. Name your primary suspect(s). How does the forensic evidence incriminate the suspect(s)? How does information from the police detective's report mesh with the physical evidence to support the innocence or guilt of the suspects?

4. What do you think happened? Describe the most likely series of events leading up to and following the mayor's death, as indicated by the evidence.

5. What additional information is necessary to further this investigation? What additional work could be done to extend or improve this investigation?

The DA will enter the time and date of the report into the network system, then the report will be given to a Deputy District Attorney for review. Depending on the quality of the evidence evaluation and the logic and presentation of the report, the Deputy DA will decide whether or not to press charges for the murder of Mayor Robert Burlington.

The Case of the Murdered Mayor Kit
(catalog no. 699830)

- Designed for 10 groups of 3 students
- 5 forensic activities in 1 kit
- Can be reused with refill kit (699830R)

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