Teacher's Guide

The Petnapping of Maya – A Forensic Lesson

Grade Level: Elementary (2-4)

Subject area(s): General Science

Time required: 60 minutes

Learning objectives: Through inquiry students will develop scientific reasoning and critical thinking skills.

Summary: This is a forensic lesson plan for grades 2-4. It is designed as a fun activity while developing observational and reasoning skills in students. Everything needed to do the activity is contained in this lesson. This activity is designed to be done in stations situated around the classroom. It can be completed in groups or individually. The children are given the background information before starting the stations. They should have 10 - 15 minutes at each station. The instructor can choose how many stations to present and change who the petnapper is by changing the clues to fit the suspect.

Materials:

- story of Maya's petnapping
- description of suspects
- ransom note
- pictures of Maya (petnapping victim)
- pictures of the suspects
- light microscope images of hair samples
- light microscope images of soil samples
- ink test images
- fingerprints
- paper for the students to write their observations
- color printer
- crayons or colored pencils

Safety Information: none

Advance Preparation: Print out the materials for each of the stations (crime scene evidence and clues), pictures and information for each suspect, and form with the list of possible suspects. Students can make note of which samples match the ones found at the crime scene.

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Samples of hair and dirt are easy to come by. Have the students collect their own samples and look at them under light microscopes. Research Triangle Nanotechnology Network (RTNN; https://www.rtnn.ncsu.edu/education/) and the Remotely Accessible Instruments for Nanotechnology (RAIN; https://www.nano4me.org/remoteaccess) offer free access to light microscopes and scanning electron microscopes. RTNN can visit North Carolina classrooms and do presentations with the students. We also have the ability to image samples on electron microscopes.

Directions for the Activity: The teacher will read the story of Maya's kidnapping (The Crime) to the students. Students will be told that they will be the detectives who will determine who kidnapped Maya. They will be directed to the stations around the classroom and will decide what evidence points to which suspect. They will use the forms to decide on what evidence is for which suspect. Once all the students have completed the stations, the class will name the petnapper. Students will need to defend their choice based on the evidence. The stations will be:

Station 1. Hair Samples (suspects): A hair was found on Sasha's back porch that does not match Sasha's hair. Compare the suspects hair with the one found at the crime scene.

Stations 2. Hair Samples (pets): Pet hair/fur samples were removed from the suspects clothing. If the suspect has come in contact with Maya, then they should have Maya's fur on them. A piece of Maya's fur was removed from one of her brushes. Compare Maya's sample to the samples that were removed from the suspects.

Stations 3. Soil Samples: Sasha has a long dirt driveway and a foot print was found in it. Soil samples were taken from the possible suspects shoes. Compare the samples with a sample taken from the dirt driveway.

Station 4. Fingerprints: The pet-napper left a finger print on the gate handle on the fence in Sasha's yard. Compare the fingerprints of the suspects with the one found at the crime scene.

Station 5. Comparing Ink: The ransom note was written with a blue ink pen. Pigments used in blue inks vary with different manufactures. These pigments can be separated from each other. Examine the different inks from the pens that were found on the suspects.

Described below is the information for each station and the evidence (images) for each.

Criminal: Charlie

The finger print and the human hair sample match. There was no reason that a hair or finger print from Charlie would be at Sasha's house. The ink from the ransom note matched Charlie's pen. Both Boris and Charlie had Maya's fur on them. But Boris had just walked Maya, so it is to be expected that he has Maya's fur on him.

Why she did it: Charlie was worried about Maya. She did not think that Sasha was taking good care of her. She thought that if Sasha paid the ransom that would mean that she really loved Maya. If she did not pay, then Charlie would find someone else that would love and care for Maya. She was planning on donating the ransom money to the local animal shelter.

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The Victims:

Sasha – She is a research scientist and loves her dog, Maya. Sometimes she has to work late, so she employees a dog walker to look after Maya. Sasha has a large, fenced yard that Maya can run and play in. Sasha has a long dirt Sasha has a long dirt driveway that leads up to her house.

Maya -

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The Suspects:

Suspect 1 - Mika – Neighbor who lives directly behind the victim, Sasha. She has complained about Maya's barking and has threated to muzzle Maya in the past. Mika has 2 cats and no dogs.

Suspect 2 - Mr Sato – Neighbor who lives on the street behind the victim. Maya escaped her fenced yard last week and was found in Mr Sato's flowerbed. She had dug up all of Mr Sato's recently planted daisies. He was very unhappy with Maya. Mr Sato has a small black dog.

Suspect 3 - Charlie – She is a dog groomer. Maya was taken to her for grooming after she escaped her fence and was covered in mud from digging in Mr. Sato's flowerbed. Maya's normal dog groomer was out of town and Charlie was filling in for her. Charlie was very upset at Maya's appearance. She suspected that Maya was being neglected in her home and threatened to report Sasha to the animal welfare and the police.

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Suspect 4 - Boris – Sasha's dog walker/pet sitter. He has been Maya's pet sitter and dog walker for 14 months. He was the last person to see Maya. He is a suspect because a year ago one of this other customer's dog was pet napped. That dog was returned safely after the ransom was paid. That crime has gone unsolved.

Background Information for Each Station

Station 1 - Human Hair: Hair is made up of about 85% protein. The protein is called keratin and it is hard and fibrous. There are two parts to a hair, the root and the shaft. The root is the part that is under the skin. This is where the hair grows. The shaft is the part of the hair that we can see. The hair shaft is made up of three layers, the cuticle, the medulla and the cortex.

The **Cuticle** is the outer layer and protects the hair. It is transparent. The cuticle is made up of scales that overlap each other.

The **Cortex** is the next layer. It is in between the cuticle and the medulla. This is the layer that contains the pigment melanin and the protein keratin.

The **Medulla** is the middle layer. It is made up of large cells. Sometimes this layer is broken or absent.

http://summerwinds.com/downloads/howtodocs/ANATOMY-OF-HAIR.pdf

There are two main types of melanin – eumelanin and pheomelanin. Eumelanin is a dark pigment and is found in brown and black hair. Pheomelanin is a light pigment and is found in blonde and red hair. The amount of these pigments influences the color of the hair. White hair contains no pigment and gray hair contains just a little pigment.

Hair is evidence that is commonly found at crime scenes. It can help investigators determine if a suspect was at the crime scene or not. It is used with other evidence collected at the crime

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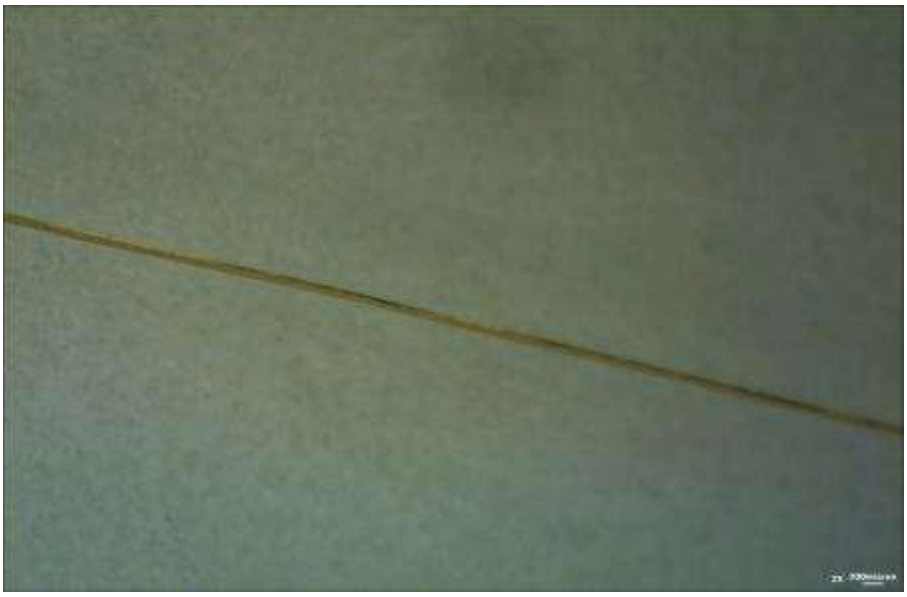
scene to help prove the investigators case. Hair is examined by light microscopes and scanning electron microscopes.

A hair was found on Sasha's back porch that does not match Sasha's hair. Compare the suspects hair with the one found at the crime scene.



Hair found at the crime scene.

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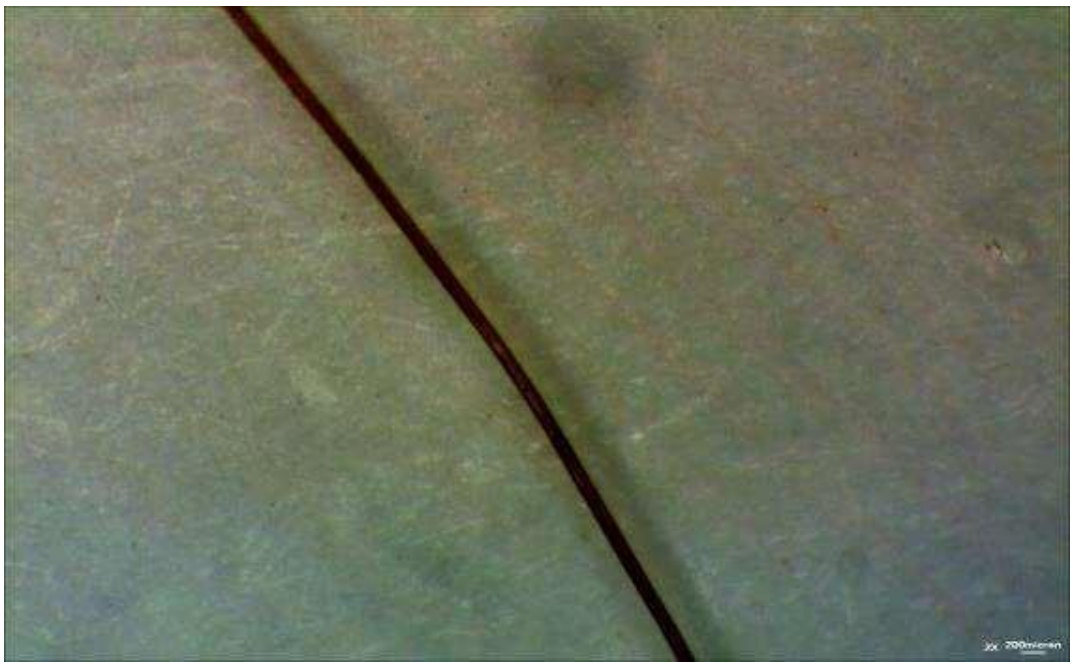

Hair from Suspect 1

Hair from Suspect 2

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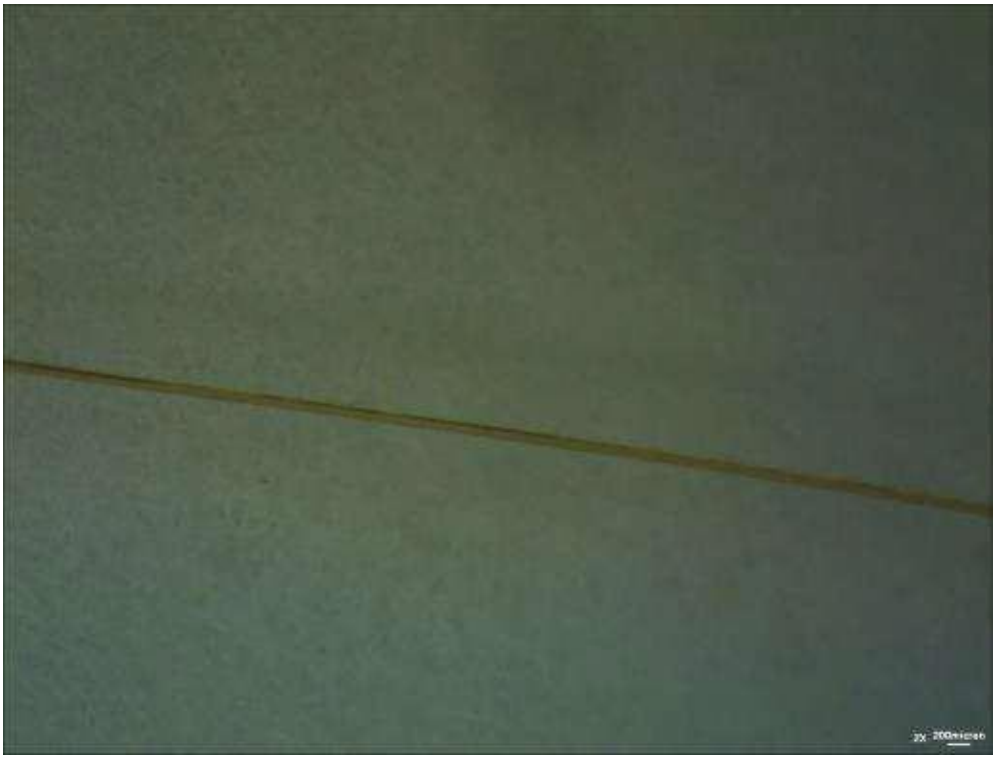
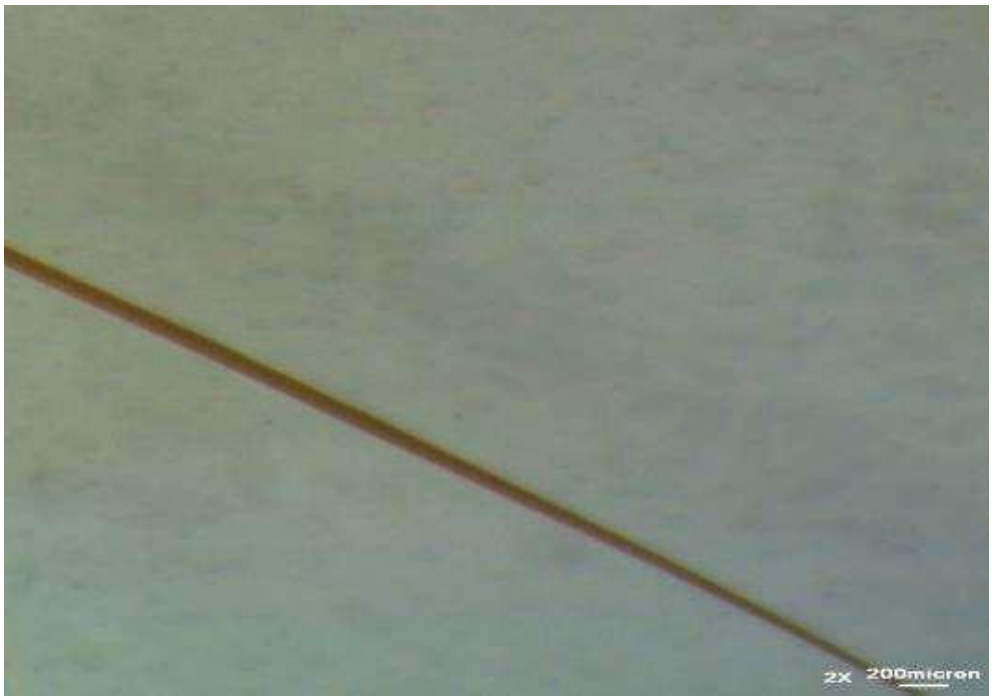


Hair from Suspect 3



Hair from Suspect 4

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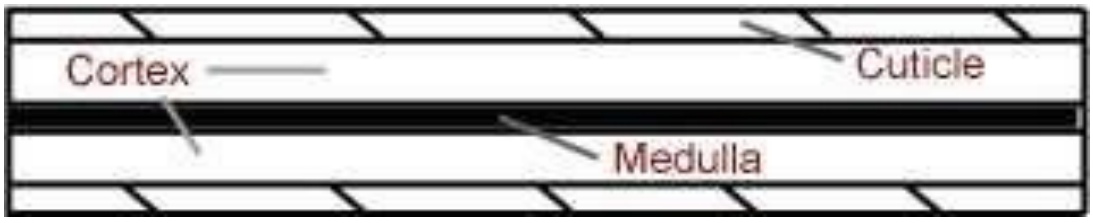
Station 2 - Animal Fur

Animal fur is made of the same protein as human hair (keratin). The name fur has more to do with where it is and how it grows than what it is made up of. Fur grows all over the animal's body and usually only grows to a fixed length. Fur also contains a top coat and a softer undercoat.

The animal fur shaft is made up of the same three layers as human hair; the cuticle, the medulla and the cortex. In animal fur, the medulla can be thicker and have a more constant width.



http://summerwinds.com/downloads/howtodocs/ANATOMY-OF-HAIR.pdf

Animal fur is evidence that is commonly found on suspects. It can help investigators determine if a suspect was in contact with animals at a crime scene. It is used with other evidence collected at the crime scene to help prove the investigator's case.

Animal fur samples were removed from the suspects clothing. If the suspect has come in contact with Maya, then they should have Maya's fur on them. A piece of Maya's fur was removed from one of her brushes. Compare Maya's sample to the samples that were removed from the suspects.

Maya's fur

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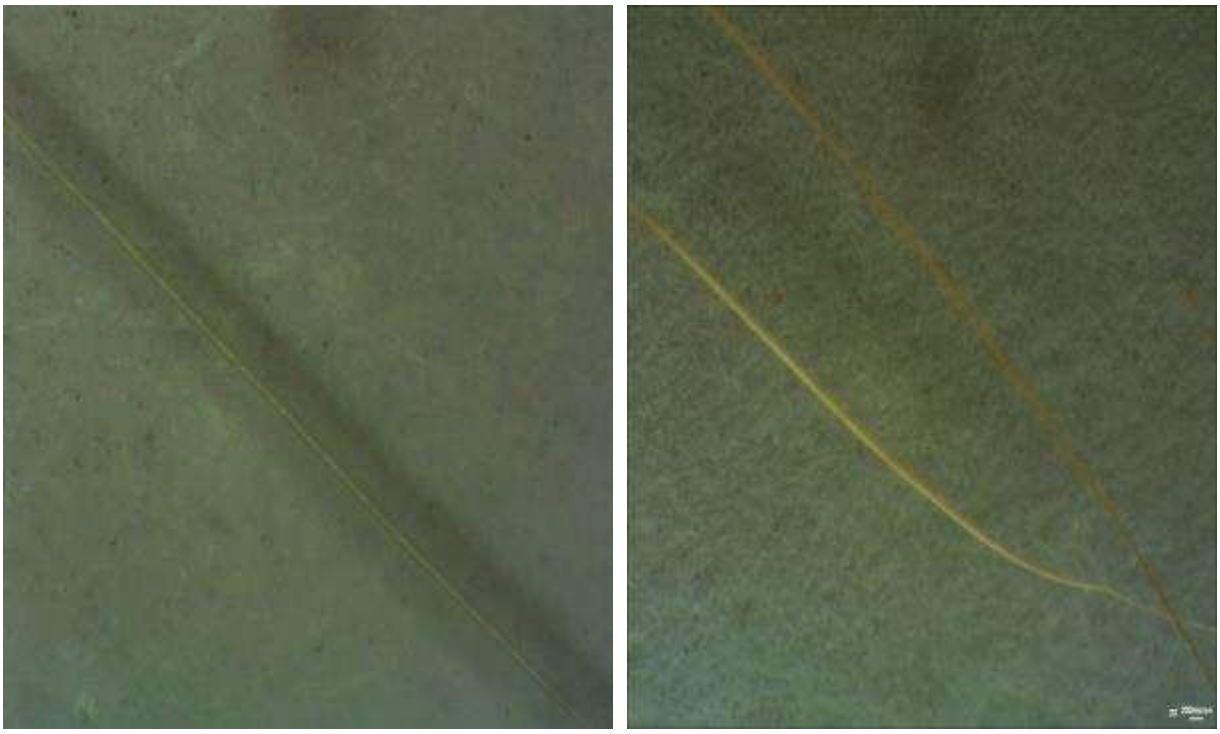

Samples from Suspect 1

Sample from Suspect #2

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Samples from Suspect 3

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Samples from Suspect 4

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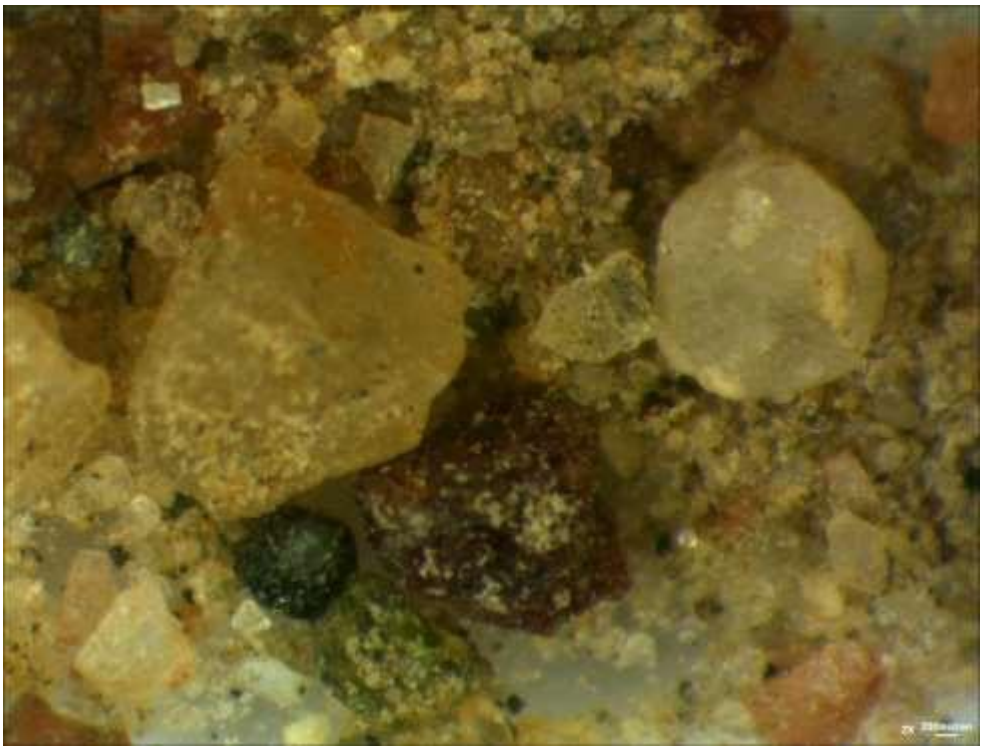
Station 3 - Soil Samples

Soil is a mixture of many different things. It can contain minerals, animal material, plant material, and other particles like glass, plastics and metal. Soil is not a uniform material. It's composition can change in a few feet or even inches.

When investigators look at soil samples they look at the color, the shape of particles and the make-up of the soil. Soil samples can be taken from shoes, clothing, tires, carpet, floor mats and many other places. Soil samples are used with other evidence to build a case against a suspect. Soil samples can put a suspect in the area of a crime but cannot tell investigators the exact time the suspect was there.

Footprints from a running shoe were found in Sasha's driveway. They did not match any of Sash's shoes. Running shoes were collected from the suspects and soil samples were removed. Match the soil from these shoes to a sample from Sasha's driveway.



Soil sample from Sasha's driveway

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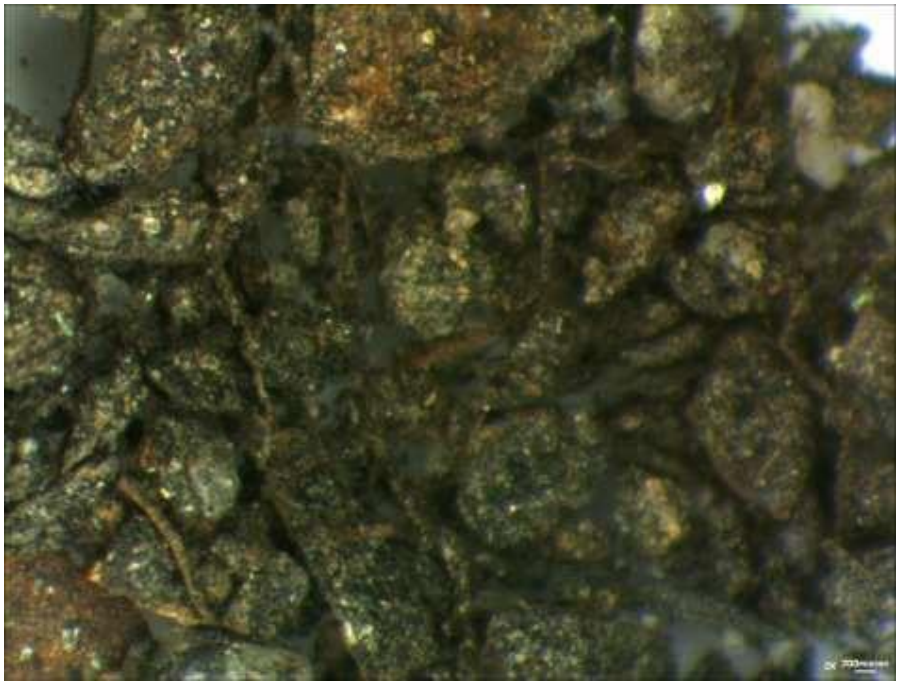
Soil from Suspect 1's Shoes



Soil from Suspect 2's Shoes

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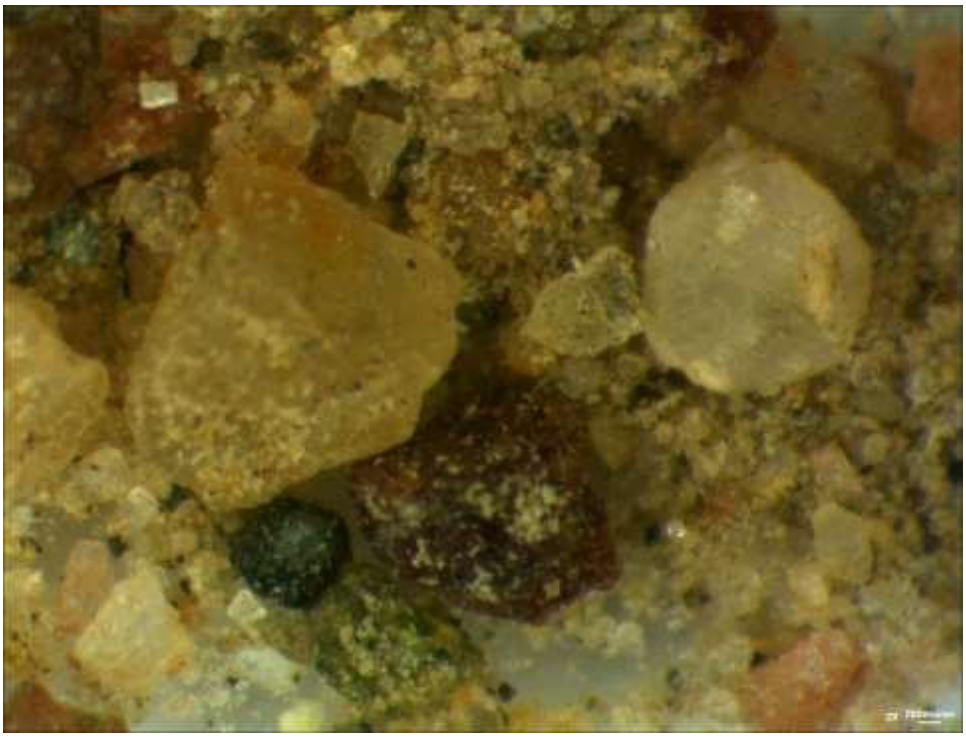
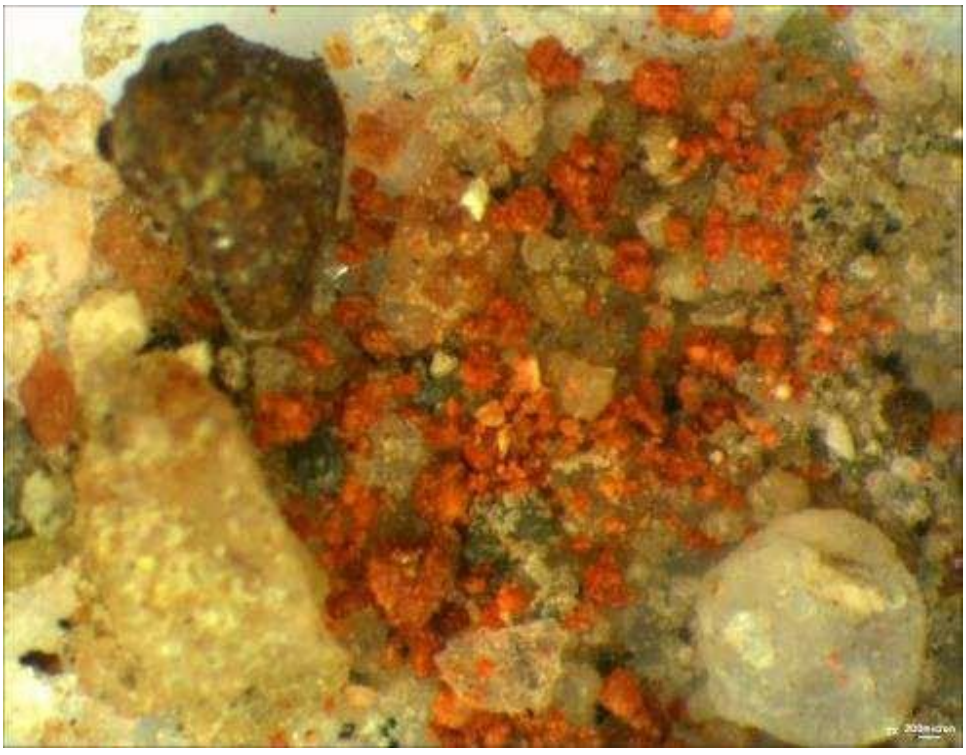


Soil from Suspect 3's Shoes



Soil from Suspect 4's Shoes

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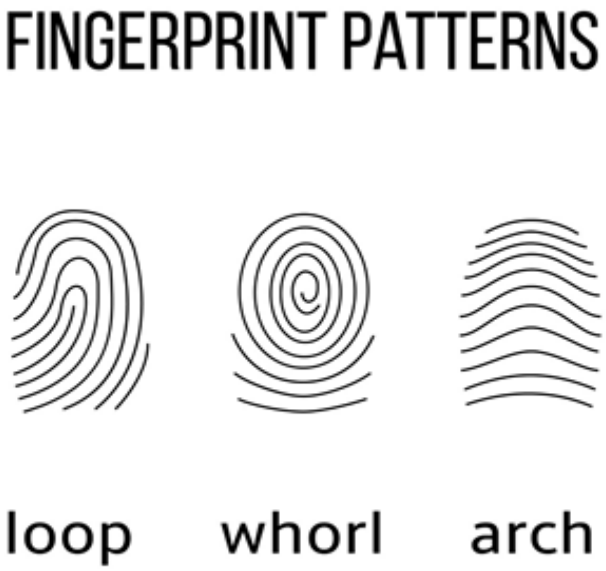
Station 4 - Fingerprints

Fingerprints are the tiny ridges and patterns on the end of our fingers. The prints are actually the imprint left by our fingers on a material. Fingerprints are formed by pressure when our fingers are developing in the womb. No two people have the same fingerprints and they are absolutely unique. Fingerprints are even more distinctive than DNA. Although identical twins share the same DNA, they do not have the same fingerprints.

If you would like to pursue forensic fingerprinting further, you can have students perform fingerprinting in the class room. This is easy to do but can be messy. You would just need a stamp pad, paper and magnifying glasses. Have the students do a thumb print onto the paper. Then look at them under a magnifying glass. Pick out the loops and swirls as well as the smaller features. You can also use fingerprint activities designed for the elementary level which are listed in the resource section.

Arches, whorls and loops are the large patterns in fingerprints as shown below.



There are also smaller features in fingerprints like ridges, forks, dots, eyes, hooks and bridges as shown in the figure below. Image courtesy of Crime Scene Investigator Network https://www.crime-scene-investigator.net/FingerprintRidgePatternsAndCharacteristics.html.

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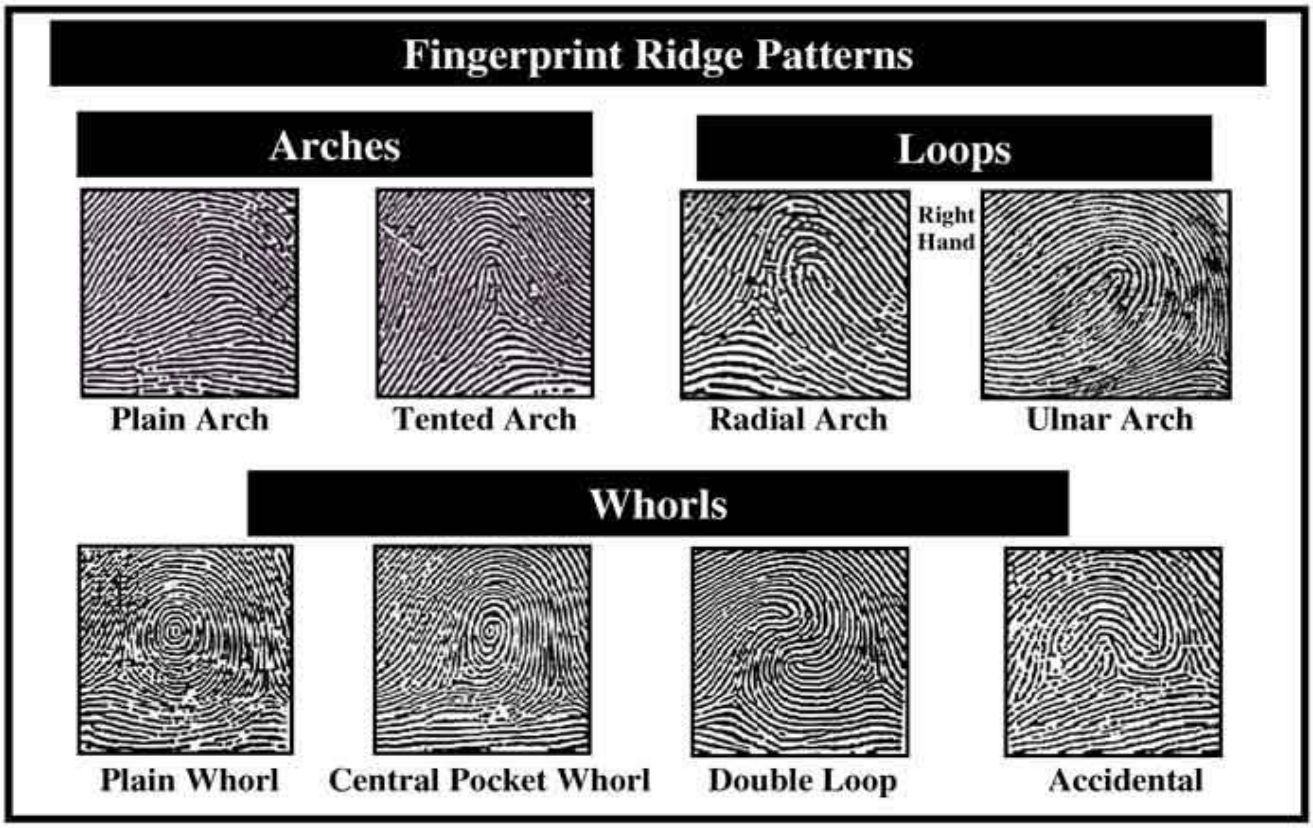

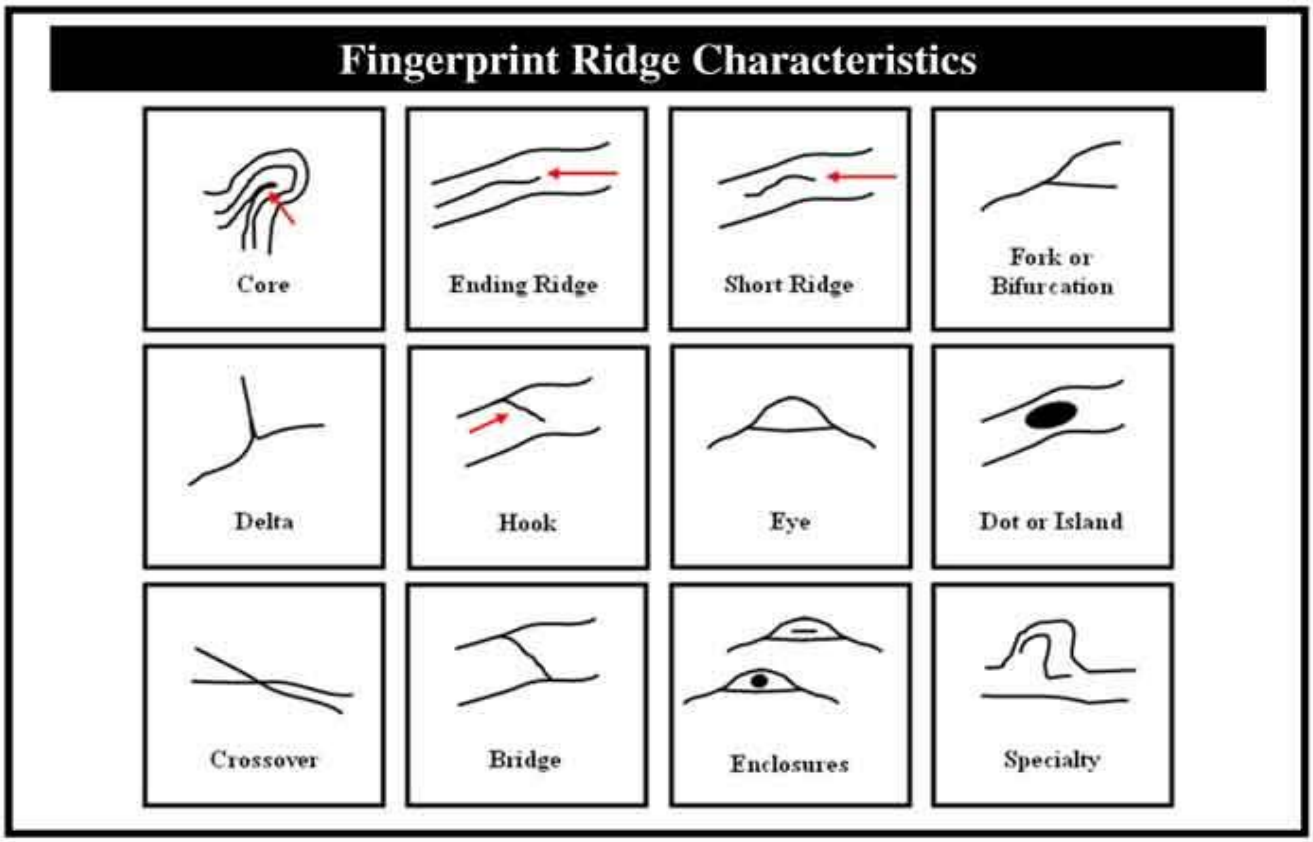

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Fingerprints help investigators solve crimes by proving a suspect was at the crime scene. But they cannot tell the investigators when the suspect was there. Fingerprints are formed when the moisture and oils on a finger leave impressions on surfaces such as glass, metal, paper and plastic.

A fingerprint was left on the gate handle on the fence in Sasha's yard. This fingerprint does not match Sasha's. Compare the fingerprints of the suspects with the one found at the crime scene.

Crime scene fingerprint

Suspect 1

Suspect 2

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Suspect 3

Suspect 4

Station 5 - Ink Test

Inks found in pens are made up of different materials called pigments and dyes. The ink in a blue pen made from two different manufacturers can be composed of different pigments or dyes even though they look like the same blue color.

We can use a test called chromatography to test what the ink is made up of. This test uses paper (stationary phase) and a solution with the ink (mobile phase) to separate the different parts of the ink. How does it work? When a sheet of paper comes in contact the solution in which the ink is dissolved, capillary action will carry the mixture up the paper However, the pigment's components will not all travel at the same rate. The largest molecules travel more slowly while the smallest ones move more quickly up the paper. This movement causes the paper to develop discrete bands of color corresponding to each part of the mixture. Chromatography deals with molecules which form on the nanoscale and microscale.

If you would like the students to learn more about chromatography, there are activities developed for elementary students which can be found in the resource section.

Pens have been collected from the suspects. A small part of the ransom note was cut off to compare to the ink from the pens to the ink from the ransom note. See which one matches.

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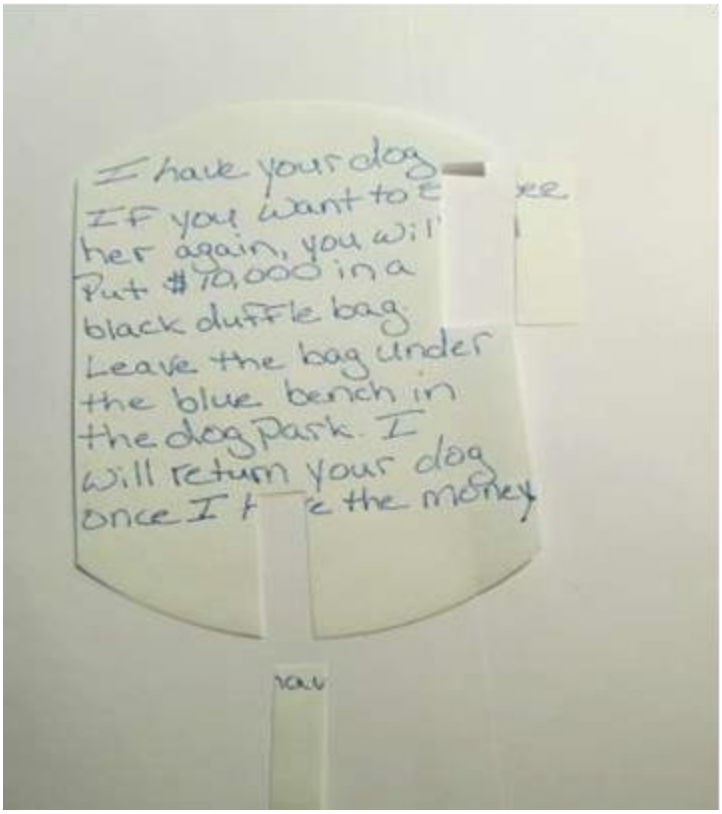

Pen from suspect 1

Pen from suspect 2

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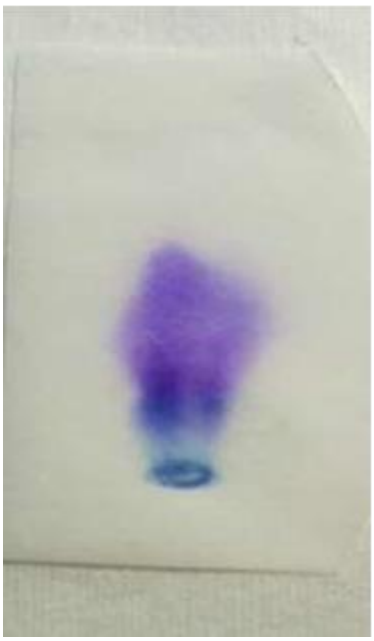
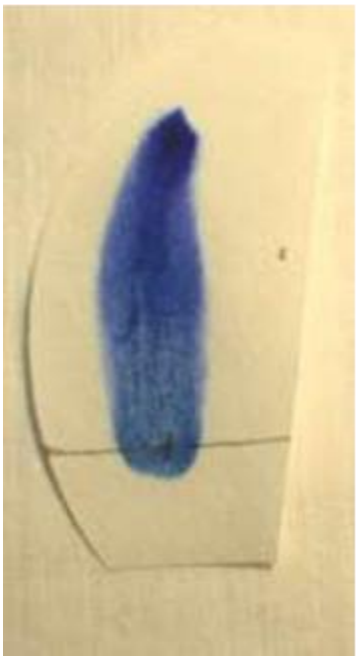


Pen from suspect 3



Pen from suspect 4

Assessment: The assessment will be a group discussion. The groups will present their hypotheses on who pet napped Maya and how they came to this conclusion. Once finished, the instructor will read who the criminal was and why he/she committed the crime. The instructor will also present the evidence that supports this. There should be time for more discussion after this. The instructor can also pick up the forms the students filled out.

Additional Resources:

- Forensic Science & Fingerprint Activity Ideas for Elementary. School Specialty: https://blog.schoolspecialty.com/forensic-science-fingerprint-activity-ideas-elementary/
- Sense of Touch: Arches, Loops and Whorls - All About Fingerprints. Elementary School Science: https://www.elementaryschoolscience.com/fivesenses-touch-fingerprints
- How to do a kids forensic fingerprint activity. Cub Scouts Ideas: https://cubscoutideas.com/8152/kids-fingerprint-activity/
- Instructions for testing ink samples. Accessed at: http://www.sciencebuddies.org/science-fair-projects/project_ideas/Chem_p008/chemistry/paper-chromatography.shtml#summary
- Investigating Compositions: Using Chromatography to Explain Color Patterns. Suzanne Bot, Kimberly Lane Elementary School, Plymouth, MN, Minnesota Science Teachers Education Project: https://serc.carleton.edu/sp/mnstep/activities/35510.html

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- Investigating Chromatography: Separating Pigments. Sybil Haas Victoria Elementary School Victoria, MN. Minnesota Science Teachers Education Project: https://serc.carleton.edu/sp/mnstep/activities/27397.html

Next Generation Science Standards:

- 2-PS1-1 Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.
- Science and Engineering Practices
    - Asking Questions and Defining Problems Asking questions and defining problems

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