MICROSCOPIC MYSTERIES

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This set of activities is to show you how **Scope-On-A-Rope (SOAR)** can enhance your lessons, especially when it comes to forensic analyses. With the popularity of CSI-themed television programs, teaching lessons incorporating these topics is sure to capture your students' attention! The activities included within can be modified for just about any age and skill level.

Objective

To improve students' observation skills and to introduce them to science in the real world. This activity is divided into three different types of "evidence": fingerprints, fibers, and anti-counterfeiting features of U.S. currency.

The following **National Science Education Standards** are just a few that are addressed by using SOAR with these activities. Below that you will see the **Louisiana Grade Level Expectations** that can be met for Grades K-8.

SCIENCE AS INQUIRY: CONTENT STANDARD A

K-4:

- Ask a question about objects, organisms, and events in the environment
- Plan and conduct a simple investigation
- Employ simple equipment and tools to gather data and extend the senses
- Use data to construct a reasonable explanation
- Understandings about scientific inquiry (simple instruments, such as magnifiers, provide more information than scientists obtain using only their senses)

5-8:

- **Design and conduct a scientific investigation**
- Use appropriate tools and techniques to gather, analyze, & interpret data
- Develop explanations using evidence
- Think critically and logically to make the relationships between evidence and explanations

LOUISIANA GRADE LEVEL EXPECTATIONS – SCIENCE AS INQUIRY

Gr. K: 4, 6, 10	Gr. 1: 5, 7, 11	Gr. 2: 6, 8, 12
Gr. 3: 6, 8, 15	Gr. 4: 7, 9, 17	Gr. 5-8: 6, 29

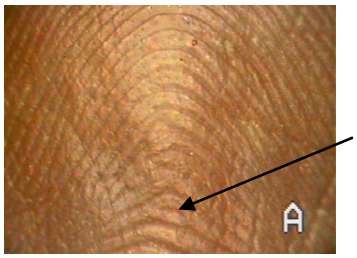
- Check out this introduction to crime investigation on the FBI's Youth Page: **www.fbi.gov/kids/6th12th/6th12th.htm**
- This website has an overall introduction to different areas of forensic science, including details about fingerprints and other trace evidence: **forensicsciencesimplified.org**

This work is supported in part by a grant to Louisiana State University from the Howard Hughes Medical Institute through the Precollege and Undergraduate Science Education Program.

FINGERPRINTS

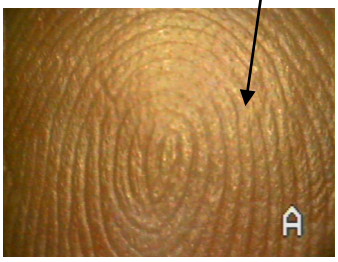
Why are fingerprints so important in a crime scene?
Each person's fingerprints are unique to them. Crime labs can match up known prints with ones found at a crime scene to determine who was present. The first thing to notice is the overall pattern– a fingerprint is first categorized overall as an **arch**, **loop**, or **whorl** (see images and descriptions below). Patterns can also be further categorized as right or left loops, tented arches, or types of whorls. After determining the pattern of the fingerprint, investigators look for secondary features (such as bifurcations, dots, etc.) and use computer programs to take measurements between the ridges (raised areas) and furrows (valleys between ridges). We can do all this with the SOAR!

Three main classes of fingerprints:



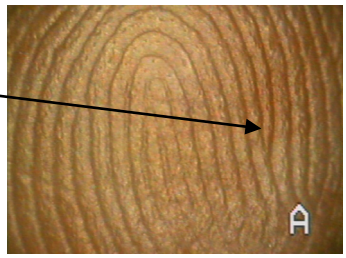
secondary character = enclosure

ARCH: ridges start on one side of finger, go up in the center, then back down on the opposite side of the finger, resembling a hill. This is the rarest type, found in only 6% of fingerprints. A **tented arch** will come to a point at the top of the hill.



secondary character = bifurcation

WHORL: ridges form a swirl resembling a bulls-eye, with at least one ridge making a complete circle. This pattern is found in 30% of all fingerprints.



LOOP: ridges start at one side of the finger, loop around in the center, and return to the same side of finger. They can be **left** or **right**; this one is right, because it begins and ends on the right side of the finger. This pattern is found in 60% of prints.

Some secondary fingerprint features to look for:

Bifurcation: the point where one ridge divides into two ridges
Dot: an isolated ridge whose length and width are equal in size
Enclosure: a ridge that bifurcates and then goes back into a single ridge
Spur: a bifurcation with one short ridge branching off a longer one
Trifurcation: the point where one ridge divides into three ridges

🌎 Websites for additional information:
http://www.onin.com/fp/fmiru/fppatterns.gif (patterns)
http://www.onin.com/fp/fpmeritbdg.html#positively_identify (great info!)

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How to examine fingerprints with SOAR:

1. Set up SOAR with the **30x lens**. Make sure the light is **NOT polarized**. To do this, hold the lens to the tip of your finger and examine the image. If you can see your print pattern, then you are on the correct setting. If you can't see the ridges and valleys very well, press the ON/LIGHT button to un-polarize. [Hint: just press the ON/LIGHT button a couple of times and just choose which setting looks best.]
2. Begin by having students learn to identify the overall pattern of some prints (arch, loop, whorl). Use the websites on the previous page for assistance.
3. Use the RECORD and PLAY buttons on the scope when comparing two different fingerprints.

Encourage questions from students during their observations:

1. What are those glistening dots on my finger?
2. Are the patterns on every finger the same?
3. How are fingerprints left behind? (See answer below.)

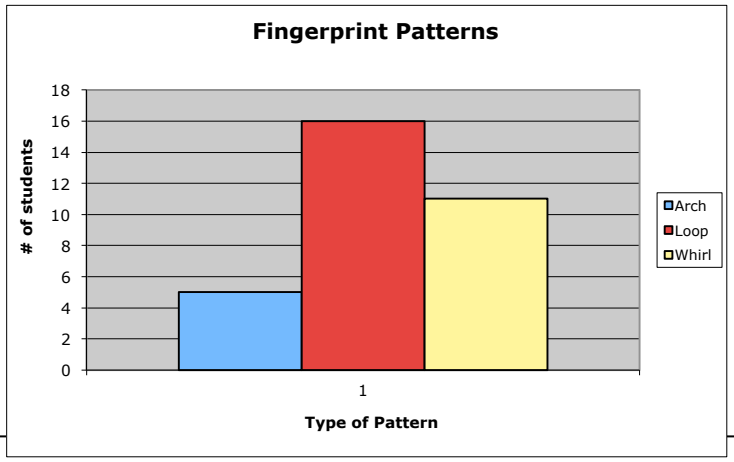
How are fingerprints left behind?

Your fingerprint is made from the ridges and valleys in your skin. Where the ridges touch a surface, the oils in your sweat causes a mark to be left behind. The areas between the ridges, called valleys, do not touch the surface, so that's why your print looks like a pattern of lines. Everyone has sweat glands; sweat is exuded through pores in your skin. You can examine your sweat glands using SOAR. Just look at glistening dots on your fingertip!

Assessment and Extensions

1. Have students draw a picture of each fingerprint pattern. Use the attached worksheet.
2. Devise a mock crime scene, and have students try to match prints found at the scene with possible suspects.
3. Students can make a graph showing the total of each type of fingerprint within your class. Have each student categorize the type of pattern found on the majority of their fingers, pick a particular finger (like the right index finger), or count the patterns on all ten fingers of each student–it's your choice! What is the frequency (percentage) of each pattern type? Is it the same as the national average? Is there a difference between male and female students?

Example Of Class Data Chart



Math GLE's:

K: 21-31
1: 32
2: 25, 26, 28
3: 39, 42
4: 34, 36
5: 28, 31
6: 29-20
7: 32
8: 34, 39

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FIBERS

What kind of fiber is it?

Fibers are often found at crime scenes. Usually this evidence consists of a small piece of fabric or just a single thread. It is nearly impossible to pinpoint a fiber to its exact source–they are not unique like fingerprints. However, fibers can be very helpful in establishing a link between crime scenes or people, and they can help narrow down a search for suspects. We will begin our investigation learning to distinguish fabric types.

Where do fibers come from?

There are two main sources of material used to make fiber–natural and synthetic.

Natural fibers: come from plants or animals. They can be spun or twisted into yarn or woven or knitted into a fabric. Cotton is the most common natural fiber used to make thread. Other natural fibers include: wool, hemp and linen. Natural fibers are generally not as uniform as synthetic fibers, which means they look fuzzier. The exception is silk. It is a natural fiber (obtained from silkworms in their cocoons), but it looks very uniform under magnification.

Synthetic fibers: are made from various chemicals (similar to making plastics). Example synthetic threads include: polyester, nylon, acetate, and rayon. Synthetic fibers look very uniform and have smooth surfaces.

Here are some common fabrics:

Cotton knit*: natural fiber made of rows of interlocking loops; it can stretch while keeping its shape

Polyester knit*: synthetic fibers that are in horizontal and vertical rows, and interlaced together (look for "cleanness" of thread)

Fleece: synthetic fiber (polyester) made of many randomly looped fibers that trap air for insulation; it is very light weight, but keeps you warm

Flannel: designed the same way as fleece (randomly looped fibers to trap air), but made of cotton, which is a natural fiber

Blue jeans: made from blue fibers twisted around the outside of white thread; they fade over time because the blue fibers wear away

*Knitted fabrics can be made in different weave patterns, from simple to very complex. Patterns include plain weave, satin weave, twill, and leno. Check out the websites below for pictures.

Websites for additional information:

http://www.uen.org/Lessonplan/preview.cgi?LPid=5085 (weave types)
http://www.teonline.com/fiber-history.html (history of fibers)
http://www.microscopy-uk.org.uk/dww/home/marhome.htm (images)

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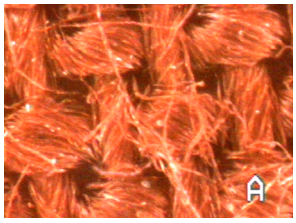
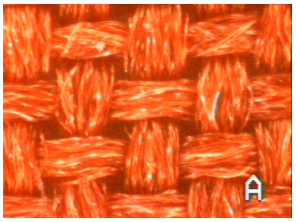
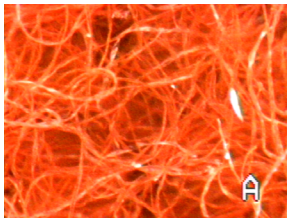
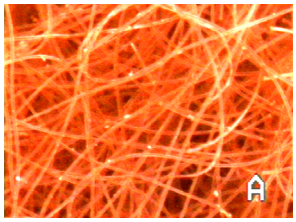
How to examine fibers with SOAR:

1. Set up SOAR with the **200x lens.** Students can start with the 30x to see overall patterns, but the details are best viewed with higher magnification.
2. Begin by having students explore viewing different types of fabrics. Supply some scraps of fabric made up of one material, 100% cotton or polyester, for example (it is difficult to distinguish fabric types in blends). After viewing samples of different fabrics, they can try to identify what type of fibers are in their clothing.
3. Use the RECORD and PLAY buttons on the SOAR when comparing two different fabrics.

Encourage questions from students during their observations, such as:
"How do they make fabric different colors?" and "How do scientists identify a single fiber found at crime scene?"

Assessment and Extensions

1. Students can make a table of their fabric drawings, putting the fabrics in categories according to color, weave pattern, and material. (See table below and attached worksheet.) Providing fabric samples that are the same color force students to really examine each one closely!

	Natural	**Synthetic**
Plain weave pattern	 100% cotton knit	 100% polyester knit
No weave pattern	 cotton flannel	 polyester fleece

2. For advanced students, give them a small sample of unidentified fibers from a mock crime scene. Have them use their table to narrow down what type of fabric it is. It's harder than you think! [Hint: Scientists use chemical tests to narrow down the fiber composition further.]
3. Make your own nylon: "Mystery Nylon Factory" (from Flinn Scientific, www.flinnsci.com). This is a great chemistry activity to show students how synthetic fabrics are made.

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Anti-counterfeiting: Money

Counterfeiting is a fairly common crime. Advances in technology and personal computers have made this crime harder to prevent. The U.S. Government designs new bills every 7-10 years with increased security measures to stay on top of the technology of counterfeitors!

What are some of the new security features of money?

Use the **30x lens** of SOAR to see the following features:

1. **Fine line printing:** look at the added detail behind the portrait and other illustrations on the back of each bill; these fine lines make it harder to replicate
2. **Paper:** our paper bills are actually made of cotton interspersed with a few red and blue fibers
3. **Optically variable ink:** look for shiny ink that changes colors when lighted from different angle. Toggle the "ON" button of SOAR to see the difference between reflected and polarized light. (This ink is only found on bills higher than $10.)
4. **Microprinting:** there are very tiny, hidden words (on bills higher than $1) that most printers aren't able to resolve. Use the 30x lens of SOAR to look for them in the following places:
    - $5 (old design) – border on each side of front; bottom rim of portrait
    - $5 (new design) – border on each side of front; top of the purple shield
    - $10 (old) – inside number 10 on lower left; bottom rim of portrait
    - $10 (new) – side borders on front; above Hamilton's name; around the bottom of the large red torch (to the left of the portrait)
    - $20 (old) – inside the number 20 on the lower left; bottom rim of portrait
    - $20 (new) – around the first three letters of the "TWENTY USA" light blue ribbon (right of the portrait); border below Treasurer's signature

Use a **black light** or backlighting and the **1x lens** of SOAR to view:

5. **Security thread:** a plastic thread embedded in the bill in a different location on each denomination; it says the denomination of the bill and glows under an ultraviolet light
    - $5 – to the left of portrait (through the seal); glows blue under UV
    - $10 – to the right of portrait; glows orange under UV
    - $20 – to the far left of portrait; glows green under UV

Other security features visible with the **1x lens** of SOAR with **backlighting**:

6. **Watermark:** a duplicate of the president's portrait that is embedded within the bill (it's not pressed on after the bill is made like the other drawings); it does not show up on photocopies, which is why is it hard to counterfeit

Websites for additional information:

www.secretservice.gov/money_characteristics.shtml (Anti-counterfeiting)
www.moneyfactory.com (Bureau of Engraving and Printing) – FREE STUFF!
www.usmint.gov (Kids pages with games and teacher guides)
www.treas.gov (US Department of the Treasury)

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Extensions

1. Magnify a part of a bill and see if your students can figure out which denomination it came from (this would work by showing the portrait with the 1x lens too).
   [GLE: Social Studies: Economics - Grade 6: #13]
2. Research the history of money and create a timeline.
   [GLE's: Social Studies: History – Grade 2: #47, Grade 3: #46, Grade 4: #50, Grade 5: #21]
3. Print the smallest size of legible font with a regular printer and compare with the size of microprinting on bills. Use the 30x lens of SOAR to examine the difference.
4. Students can design their own money by drawing a self-portrait and developing their own security features. [Visual Art Benchmarks – Elem: VA-CE-E5, Middle: VA-CE-M1 & M2, High: VA-CE-H2 & H6]

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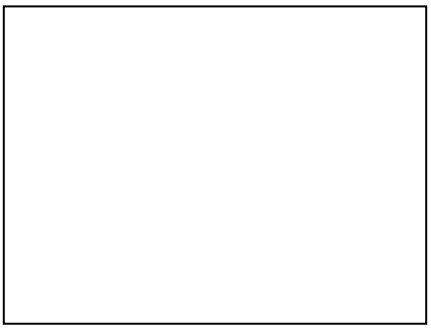
Fingerprint Worksheet

Name _____

Date _____ Class _____

The fingerprint pattern I see most on my fingers is _____.

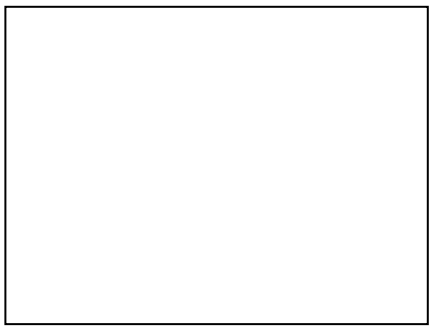
Draw what this pattern looks like with SOAR (magnified 30 times).



Name a different pattern that you found on your hand or on a friend's hand:

_____

Draw what your this different fingerprint looks like with SOAR.



Why are fingerprints important evidence in a crime scene?

_____

_____

_____

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Fiber Analysis Worksheet

Name _____

Date _____ Class _____

Draw what your fabric samples looked like when magnified 200 times with the Scope-On-A-Rope. Organize them by material (natural or synthetic), and by weave pattern.

Weave Pattern ↓	**Natural**	**Synthetic**

What type of fabric(s) are you wearing today? _____

_____

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