LABORATORY ACTIVITY

Developing Latent Fingerprints

One job of the crime scene investigator is to find latent fingerprints, those that are left by perspiration or grease and aren't immediately visible to the naked eye, and develop them, that is, treat them so they can be seen and inspected. There are several physical and chemical methods of visualizing latent fingerprints.

Materials

ceramic tiles
white powder
fingerprint brushes
2" cellophane tape
black or gray fingerprint powder
white paper
smooth black paper
beaker and cover
glossy white or photo paper
iodine crystals
forceps
starch solution
ninhydrin solution in atomizer
zinc chloride solution
gloves
heat gun
UV lamp
silver nitrate solution
"fixer"
paper towels
microscope slides
plastic bags
Styrofoam cups
fuming chamber and cover
superglue
copying machine
clear acetate sheets
red markers

SAFETY ALERT! CHEMICALS USED

PHYSICAL METHODS

Dusting and lifting latent fingerprints: Clean an area on the black lab bench (or a black bathroom tile) and gently press your thumbprint on the edge. Select a contrasting (white) powder and its brush. *Do not mix brushes.* When using a brush to apply powder, first fluff it up by rolling the handle rapidly between your fingers or palms. Then put a little fingerprint powder out on a clean sheet of paper. Lightly touch the brush to the powder and turn the brush. Tap off the excess powder over the paper. Move the brush gently back and forth over the print surface. If a print begins to show, continue brushing in the direction of the ridges. *If you brush too hard, the print will be wiped away or smeared and become useless.* Gently blow off the excess powder from the print. Return any unused, clean powder to its original container. This takes practice; keep at it.

HINT: If you are having difficulty getting enough oil on your fingers for a latent print, run your fingers through your hair several times.

A good start on this first part of the lab is to use a chalkboard and have the students press their fingers into chalk dust then press them against the board. The prints can also be lifted easily off the board.

The dusting activity is a messy one to clean up. You will find black powder everywhere.

Fired, glossy kitchen/bathroom tiles (or pieces) make excellent substrates for practicing lifting, and your lab benches won't get as messy. They come in a variety of colors.

Black dusting powder can be purchased from companies that supply forensic science materials, such as Lightning Powder Company, Inc. (www.redwop.com). Black fingerprint powder costs about $6 for 2 oz, $18 for 8 oz. A good substitute is toner from your copier. Be aware that some people are allergic to either or both powders. Fine charcoal can be used, as can soot, but it is messy to collect.

Magnetic and fluorescent powders are also available. The former is not as messy, but more expensive.

For white dusting powder, talcum powder or chalk dust works well; gray powder can be made by mixing the black and white powders. About 1 percent fine aluminum powder added to the mix increases adhesion.

There are fingerprint brushes specific for this purpose. Good all-purpose brushes are about $4 each. Soft paint brushes or cosmetic brushes may work, but developing is difficult enough even with the right brush.

Lifting tape can be a clear Scotch brand or similar tape; a 2-inch width works best. You will need white paper or cardstock and black smooth paper (copier cartridges are wrapped in such paper). Local printers usually carry a black glossy paper. For skin, use glossy photo paper or a similar white, very glossy paper. See your local print shop.

Dusting technique

Cut 3 inches of lifting tape (cellophane tape). Adhere the tape to the base of the print. Holding the tape taut and beginning at the base of the print, gently begin pressing the tape down as you move upward and beyond the print. This should eliminate air bubbles and smearing. Gently pull back the tape, lift the print, and place it on a 2" × 2" piece of contrasting (black) paper. Tape this in your lab book and label it. Now follow the procedure for a white tile, then glass, then metal, such as a window and a door frame, using gray or black powder. Lift and tape the prints in your notebook with an appropriate description of what you did. Identify the ridge characteristics (minutiae). You may have to develop and lift many prints before you have one that has clear, readable characteristics.

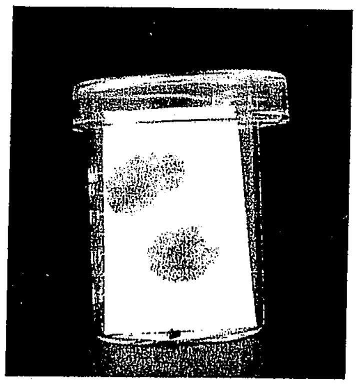
Repeat the above procedure for porous surfaces, such as white paper or an index card using contrasting powder (black). Place the tape on the dusted print to protect it and place it in your notebook.

A latent fingerprint on the surface of human skin can sometimes be lifted before being developed by pressing glossy photographic paper (such as used to print photos on a printer) against the skin for 2 or 3 seconds. Try it by grabbing your wrist, transferring the print to the glossy paper, and developing it with an appropriate powder. What is different about this impression? Protect it with tape and put it in your notebook. Would glass rather than the paper work just as well? Try it. Develop the print with some chemical methods that you think would work (below). It is very difficult to get a good print from skin.

Dusting for fingerprints

CHEMICAL METHODS

1. *Iodine fuming:* Place a fingerprint on two pieces of paper. Put each in a beaker containing several crystals of iodine and cover the beaker. Solid iodine sublimes; that is, it passes directly from the solid phase to the vapor phase without going through a liquid phase. Both mothballs and dry ice also do this. When the prints become visible, remove them with forceps or tweezers. Dip one in a starch solution. What happens? Why? (We will be using the starch–iodine reaction in other areas of forensic investigations, such as qualitative analysis and document examination.) Dry the samples, cover them with clear tape, and place them in your notebook. Check them in a day or two and note any changes. Explain. Be sure to wash your hands thoroughly with soap and water. Identify five ridge characteristics. *Caution: Iodine is toxic by ingestion and inhalation.*



Iodine fuming

2. *Ninhydrin:* Place a fingerprint on a piece of paper, hang it in the hood or in a well-ventilated place, and spray it with ninhydrin solution. You should wear gloves for this method because ninhydrin turns purple when it reacts with the proteins in your skin. Warm the paper with a heat gun or in an oven with a beaker of water in it (high humidity hastens development) or press it between sheets of paper with a hot steam iron; otherwise, wait 24 hours. Identify five ridge characteristics. *Caution: Ninhydrin will stain skin and clothing.*

[Optional] Dipping the paper developed with ninhydrin in zinc chloride solution may make the print easier to see, turning it orange. Check the print under a black light (UV lamp). What happens? Dry the prints and place them in your notebook with your comments. The zinc chloride treatment causes the prints to **fluoresce**. Basically, fluorescence occurs when a material absorbs light and then re-emits it at wavelengths longer than those of the light source. Discos used fluorescence extravagantly. Many substances are added to textiles and papers to cause them to fluoresce white (optical brighteners). Many fingerprint powders now contain fluorescent agents. *Caution: Zinc chloride solution is a skin irritant; you may wish to wear gloves.*

3. *Silver nitrate [Optional]:* Place a fingerprint on a piece of paper and, using forceps, immerse it in silver nitrate solution for five to ten minutes. Remove the paper and drain the excess liquid. Consider wearing gloves for this one because silver nitrate will darken your skin when it is exposed to sunlight. Sandwich the paper between paper towels and dry it, then expose the paper to bright sunlight or long-wave UV light. Watch the development of the print carefully because the paper can easily become overexposed, eliminating any contrast. To develop and "fix" the print, immerse it in the fixer solution for 15 to 20 minutes, remove it, and blot it to dry. With very old fingerprints, all that remains is the sodium chloride from perspiration, so silver nitrate may be the only method that works. It also works well with fingerprint impressions on wood. Try it.

4. *Superglue (Cyanoacrylate) fuming:* Wipe clean a microscope slide, a portion of a plastic bag, and/or a piece of Styrofoam cup; label it; add fingerprints; and place it in the developing chamber. Squeeze four to five drops of superglue on the aluminum foil or bottle cap that rests upon the heater (a lightbulb with a can over it). Put the lid on the chamber, and turn on the light. Prints should be

All the chemicals listed here are pretty standard; your chemistry department should have iodine crystals (I_2). If not, they are available from standard chemical suppliers such as Flinn Scientific, P.O. Box 219, Batavia, IL 60510; (800) 452-1261; www.flinnsci.com. Note that iodine is toxic by inhalation and ingestion.

For cornstarch or any starch product, make up a 2 percent solution by adding 2 g of starch to about 100 ml cold water and bringing to a boil while stirring. Cool.

Ninhydrin is available from most scientific supply houses, such as Carolina Biological Supply Company (www.carolina.com), as a biological reagent; the cost is about $9 for 5 grams. Make up a 5 percent solution in acetone or alcohol (stir 5 g into 95 ml acetone or alcohol). Caution: Ninhydrin is a body tissue irritant.

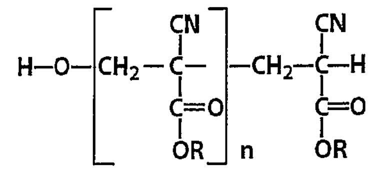
For zinc chloride solution, add 3 g zinc chloride (ZnCl2), 25 ml ethyl alcohol, and 5 ml acetic acid to 70 ml of water. Caution: Zinc chloride is a severe skin irritant; work with gloves in the preparation.

A black light (ultraviolet lamp) positioned over a dark box eliminates the need of darkening the room and makes it a lot safer. Carolina Biological Supply sells a portable long- and short-wave lamp for about $100. Fisher Science Education (www.fisheredu.com) has a line of good UV lamps also. Lightning Powder sells a long-wavelength UV light battery operated (AA) for about $30, but visualization is severely limited in many applications of chromatography. Caution: Do not look directly into a black light; the UV radiation can harm your eyes.

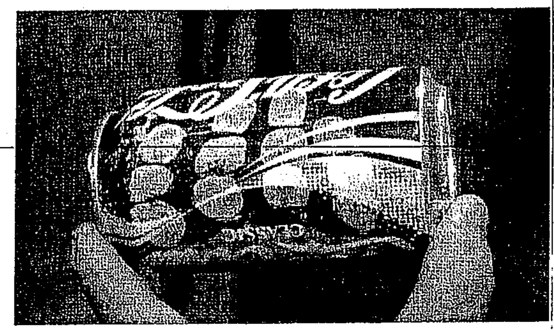
fluorescence: the absorption of light at one wavelength (often in the ultraviolet range) and its reemission at a longer wavelength (often in the visible part of the spectrum)

Make up a 1 percent solution of silver nitrate, 1 g $AgNO_3$ in 100 ml H_2O, and store it in the dark. Caution: Silver nitrate is a corrosive solid, quite toxic by ingestion. For a fixer, use 20 g of sodium thiosulfate ("hypo") plus 14 g of sodium bisulfite per 100 g of water.

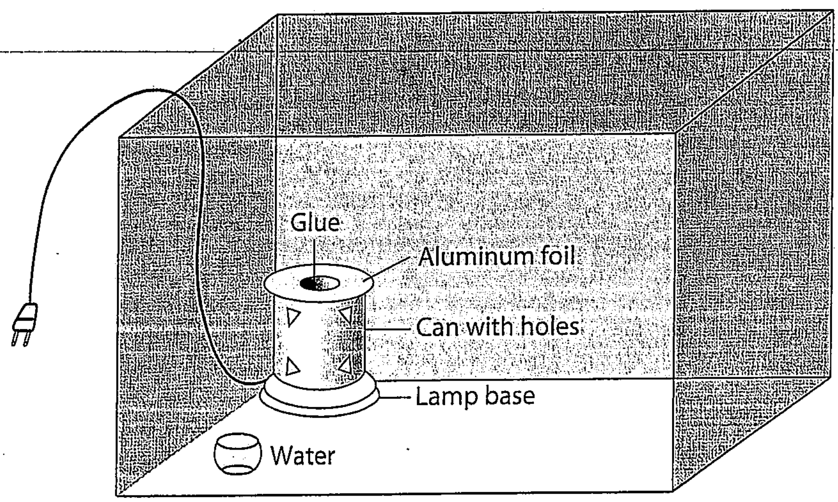
visible after five to ten minutes. After removing the object from the tank, use a magnifying glass to identify ridge characteristics (Figure 6). Can you enhance the prints even more with powder? Lift the dusted print and place it in your lab book. The prints can be lifted several times because the cyanoacrylate is so durable. Identify five ridge characteristics. Which print impression was more readable—the original or the dusted one? *Caution: Do not get superglue on your skin and do not breathe the fumes because they irritate the mucous membranes. Keep your face away from the top of the developing chamber when you slowly remove the top.*



A cyanoacrylate polymer has a structure such as this, with R = a methyl, ethyl, or butyl group. Polymerization is catalyzed by a base, even water.



Prints developed by fuming



Superglue developing tank

A superglue developing tank can be made from an aquarium, even one with cracked sides (tape them with duct tape). Line three sides with aluminum foil to prevent eventual clouding by cyanoacrylate polymer (superglue) and insert a 40-watt light bulb and socket, covered by a tin can with a few holes punched in it. Place aluminum foil or a bottle cap on top of the can. Insert a small container of water in the tank (this catalyzes faster development of prints) and a rack to hold objects to be fumed. Use a cover for the aquarium (a piece of cardboard will do) because the fumes are quite irritating to the eyes and throat. *It is recommended that you place the chamber in a hood or where there is good ventilation.*

5. Using the finger that gave you the best inked impression on your 10-print card, make and prepare a latent print using the method that worked best for you in these exercises. Compare your best latent fingerprint with the inked print.

One method that can be used to compare a latent print to an inked one is to use a photocopier to uniformly enlarge the prints. Overlay a clear acetate sheet on the inked print and delineate points of reference, such as the core, delta(s), and arch top, with a red marker. Now use the marker to outline particular minutiae—**bifurcations** are good ones to use because they are easy to see and there are many of them—working out from each reference point. This "known" print can then be overlaid on the latent print for comparison.

Figure 11 shows an example of two fingerprints for comparison. The one on the left is the same as the one in Figure 7. Is the latent print on the right from the same finger?

bifurcations: a common minutiae, shaped like a two-pronged fork

You may now wish to set up a mock B and E in the classroom and ask the students to sketch the "crime scene" and locate where to look for fingerprints and the best methods to use.

If you use the fingerprint lab early in the school year, you might have the students make a latent print in some out-of-the-way place so that, at the end of the year, they can see if it still can be visualized. This will test the longevity of undisturbed fingerprints.