

Forensic Detectives

Time: 4-6 sessions (Broken down into 4 to 6-1 hour sessions)

4th Grade CA Science Content Standards

PS 4b. Students know how to identify common rock-forming minerals and ore minerals by using a table of diagnostic properties.

I&E6. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

I&E6a. Differentiate observation from inference (interpretation) and know scientists' explanations come partly from what they observe and partly from how they interpret their observations.

I&E6c. Formulate and justify predictions based on cause-and-effect relationships.

I&E6d. Conduct multiple trials to test a prediction and draw conclusions about the relationships between predictions and results.

I&E6f. Follow a set of written instructions for a scientific investigation.

5th Grade CA Science Content Standards

PS1. Elements and their combinations account for all the varied types of matter in the world.

PS1b. Students know all matter is made of atoms, which may combine to form molecules.

PS1c. Students know metals have properties in common, such as high electrical and thermal conductivity. Some metals, such as aluminum (Al), iron (Fe), nickel (Ni), copper (Cu), silver (Ag), and gold (Au), are pure elements; others, such as steel and brass, are composed of a combination of elemental metals.

PS1f. Students know differences in chemical and physical properties of substances are used to separate mixtures and identify compounds.

PS1i. Students know the common properties of salts, such as sodium chloride (NaCl).

I&E6. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

I&E6a. Classify objects in accordance with appropriate criteria.

I&E6b. Develop a testable question.

I&E6c. Plan and conduct a simple investigation based on a student-developed question and write instructions others can follow to carry out the procedure.

I&E6f. Select appropriate tools (e.g., thermometers, meter sticks, balances, and graduated cylinders) and make quantitative observations.

I&E6g. Record data by using appropriate graphic representations (including charts, graphs, and labeled diagrams) and make inferences based on those data.

I&E6h. Draw conclusions from scientific evidence and indicate whether further information is needed to support a specific conclusion.

6th Grade CA Science Content Standards

I&E7. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

I&E7a. Develop a hypothesis.

I&E7b. select and use appropriate tools and technology to perform tests, collect data, and display data.

I&E7c. Construct appropriate graphs from data and develop qualitative statements about the relationships between variables.

I&E7d. Communicate the steps and results from an investigation in written reports and oral presentations.

I&E7e. Recognize whether evidence is consistent with a proposed explanation.

Topical Objectives:

- Students will use their senses to investigate object exploration (touch, sight, hearing, and smell)
- Students will identify three major fingerprint patterns and collect fingerprint evidence to solve a “mock” crime.
- Students will perform chromatography investigations to determine multiple pen ink patterns in a “mock” crime.
- Students will make observations and test the pH levels of various soil samples found in a “mock” crime.

- Students will perform wheat germ extraction and study common genetic traits for a SciTech population (phenotypes-observable characteristics).
- Students will perform dental impressions to find clues about how old a person is and if there are any animals involved in a crime scene.
- Students will investigate multiple “Mystery Powders” to determine the type of physical/chemical change associated with evidence left at a “mock crime’ scene.
- Students will create a “Crime Scene” and determine the evidence and investigation tools needed to solve their crime.

Safety Precautions:

Students should follow instructions and safety procedures for all investigations. Students should be aware that some solutions used in Forensic Detective can stain (iodine) or may cause vomiting if ingested (isopropyl alcohol).

Day 1: Making Observations

Materials:

- Tray with 8-10 various colorful items on them
- Handkerchief (borrow from Making Sense Box)
- 10 smell canisters sets (borrow some form Insect Inspector box or use new ones)
- Sound eggs (borrow from Making Sense Box)
- Tube socks for Touch (borrow from Making Sense Box-feather, beans, crayon, string, ball, paper clips)
- Fingerprint Pattern sheet (Girl scout box)
- Construction paper
- Black ink pads
- “official” fingerprint document paper (cardstock)
- Fingerprint dusting feathers or soft paint brushes
- Dusting powder
- Fingerprint lifting tape
- Magnifying glasses

Preparation:

1. The first day can be set up in “Station Rotation” or as whole class activities. Prepare observation trays with several items for students to make observations-these can be items found in the classroom-pencils, markers, stapler, etc... Cover trays so the students cannot see the items.
2. Gather materials from the Making Sense workshop box (or make a set of your own) for the Smell activity. You will need cinnamon, coffee, crayon, mint, suntan lotion and vanilla. Use black film canisters with holes punched in the so students cannot “accidentally” see the substance. Note: some of the canisters will be different smells-that’s okay!

3. Gather materials again from MSBox for the Hearing and Touch Stations. Extra plastic eggs are in the office if you need to make a set. For the Hearing station you will need six eggs (pennies, pom-poms, dice, sand, bells and macaroni). Seal the edges with masking tape. For the Touch station you will need feathers, beans, crayons, string, ball, and paper clips. You will be placing these items in a sock for students to feel and record observations.

Procedure:

1. Explain to students that they will have a chance to learn about Forensic Detectives/Forensic Scientists and some of the experiments and observations that goes along with the job of being a Forensic Detective.
2. Ask students what they think **forensics science** is? What do they think a Forensic Detectives does?
3. Explain that **forensic science** is the study of evidence discovered at a crime scene and used in a court of law. A Forensic Detectives uses science to make observations, study, compare and eventually interpret pieces of evidence from a crime scene- basically the person tries to find the-WHO, WHAT, WHERE, WHEN and Why.
4. There are many people who help forensic detectives including: Forensic anthropologists (study of bones), handwriting analysis experts, forensic entomologists (study of bugs and how it relates to human remains), forensic geologists (study of soil samples), forensic odontologist (study of teeth), police, and doctors.
5. Place an activity at each table and divide students into four groups. After 10-15 minutes, have students switch to a new table.
 - a. Visual-students have one minute to examine a tray of objects on the table and record observations using good descriptions and drawings in detective journals.
 - b. Odors-students examine various unknown smells and describe them in detective journal.
 - c. Sound-students will gently shake each egg and identify the sound. Students will match the number of egg to the sound picture depicted in their detective journal.
 - d. Touch-students will place their hand in each numbered sock (do not remove object!) and identify what they are feeling. Students will match the number of sock to the picture depicted in their detective journal.
6. Students will record observations in their detective journals. They will be able to take home their journals (and magnifying glasses) once the unit is over.
7. If time permits, introduce fingerprints.

Background Information

Forensic science is the application of science to the law. Dating back to the time of the Romans, "forensic" is a Latin word meaning "forum."

Forensic Scientists play a critical role in the justice system by providing scientific information to investigators and the courts. A forensic scientist must be capable of

integrating knowledge and skills in the examination, analysis, interpretation, reporting, and courtroom testimony of scientific evidence. Forensic scientists usually have a strong background in the chemical, biological, or physical sciences.

Crime Scene Investigation (CSI) is directly related to forensic science. The primary difference between CSI and forensics is that CSI involves on site investigation (field forensics) of the physical scene of a crime, whereas standard forensics takes place in a controlled environment (lab).

Notebook Ideas:

Students should record observations from each activity. Ask them which activity was the hardest to identify? Why? Go over any vocabulary used during the day and have students record the word and definition in the vocabulary section of their science journal.

Day 2: Fingerprinting

Materials:

- Fingerprint Pattern sheet (Girl Scout box)
- Construction paper/index card
- Black ink pads
- “official” fingerprint document paper (cardstock)
- Fingerprint dusting feathers or soft paint brushes
- Dusting powder
- Fingerprint lifting tape
- Magnifying glasses
- Mirrors

Preparation:

1. Make a few large copies of Fingerprint patterns for students to use as a reference.
2. Make copies of “official” fingerprint document paper (for each student).
3. Gather ink pads, clear tape-one for each table, dusting powder, feathers (or soft brushes-girls will have to be gentle with brushes or the print come off) and magnifying glasses.
4. Cut string for magnifying glasses (each student will tie the string to their magnifying glass and take home at end of the unit).
5. Gather mirrors, glasses, clear plastic cup with various fingerprints on them (from other people-educators, kids etc...Just different prints for the students to investigate).

Procedure:

Part 1: Identifying Students Fingerprints

1. Discuss with the class that forensic detectives use fingerprints to help catch people who committed a crime (someone stole “Fluffy” the worlds most expensive cat or you suspect your brother took your candy bar from your room). Working as a forensic detective you can examine fingerprints to see who the suspect may be.
2. Explain to the students that fingerprints are the tiny ridges, whorls, and valley patterns on the tip of each finger. No two people have been found to have the same fingerprints, they are totally unique, even more so than DNA. Scientist look at the arrangement, shape, and size, and number of lines in these fingerprint patterns to distinguish one form another.
3. Have students study the patterns of fingerprints in their detective journals.
4. Have students identify what kinds of fingerprints are located in their detective journal. Use the information from the previous page to help students identify the fingerprints.
5. Ask students, “Just by looking at your finger prints, can you identify your own pattern?”
6. Students can now take a print of their fingerprint using an inkpad and a blank index card. Have student choose either their thumb or index finger to identify.
7. Students should firmly place their finger on the inkpad and move their finger from side to side to cover the entire tip of their finger.
8. Next, have the students transfer their ink finger to a blank index card and “lightly” rock the finger back and forth. If the print is smudged or does not come out, have the student try to transfer the print again by simply making another print-do not use more ink!

Part 2: Identifying Unknown Prints

1. Explain to the students that when you came into the classroom this afternoon, you noticed that the eraser from the white board was missing. You also noticed some things were moved around and some prints were found on the blackboard, mirrors, and plastic containers. You suspect an afternoon Prime time assistant or teacher had borrowed your eraser without asking or writing a note!
2. Demonstrate how to dust a fingerprint. **Important: Make sure the girls wear gloves and just a tiny, tiny, tiny bit of dusting powder is needed!!! The powder tends to get everywhere!**
3. Using a feather, students should spread a thin layer of powder on a print, then use wide clear tape to transfer the print from the object to the “official” fingerprint document paper.
4. Have students observe fingerprints and record their evidence in their detective journal. Students should look for unique features and characteristics of the prints and partial prints found on the items.

Background Information

- You can outgrow your shoes but not your prints as they will stay the same no matter how old you are;
- Fingerprints are considered to be the very basis of criminal history of every police agency;
- That the fingerprint database of the FBI is ten times larger than their DNA’s;
- You can’t change or alter your fingerprints by cutting, burning or scraping them. Its pattern will remain the same as a new skin is developed;
- Koala’s fingerprints can be mistakenly identified from that of a human being’s;
- The FBI’s fingerprint database is the largest in the world;

- It was Mark twain who first used the fingerprinting evidence to solve a crime in one of his fictional novels, “Life on the Mississippi” (1883);
- Birds do have fingerprints. They are evident in their eggs that they lay;
- Experts say that an Egyptian mummy still has very clear fingerprints even if they were embalmed for a handful of years ago;
- A cat’s nose has ridges like that of human and is capable of producing prints;
- As humans get identified through their fingerprints, the dogs are by their nose prints;

Notebook Ideas:

Encourage students to write vocabulary words and any questions in the back of their Forensic Detective journals.

Day 3: Chromatography and Handwriting Analysis

Materials:

- Chromatography markers- various varieties. You will need 5 different brands-it’s okay for one not to separate- i.e. permanent (Forensic Detective Box)
- Tall, clear, plastic containers filled with 2 inches of water
- Coffee filter
- Tape

Preparation:

1. Gather various markers (color-coded by type/brand).
2. Cut coffee filters into 1-inch strips for chromatography.
3. Fill containers with 2 inches of water and set aside.

Procedure:

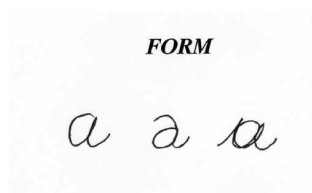
Part 1: Chromatography

1. OH, NO!! The blackboard eraser is missing again! But look, the suspect left a note! (conveniently on a coffee filter- did not write a lot of information on it and suspect did not leave a name). How can we use this note to see who took our blackboard eraser? You can tell the students that each pen came from a different person-a teacher (letting the SciTech school teacher know ahead of time that they are involved in a mock crime), the principle, prime time assistant, custodian or school secretary. Each suspect having a “motive” but ending with the teacher because she borrowed yours and was in a hurry and forgot to sign the note-something along those lines.
2. Give a quick overview of chromatography. Take the note that was left on the blackboard and demonstrate the procedure of chromatography to the students. Allow the water to create the ink pattern of the suspect’s pen. This is the pattern (included in students detective journal) that students will compare each pen to.
3. Tell students that pen ink is made up of many colors and some of these colors are separated by water. Black pens used in chromatography look different because different types of black pens are made up of different colors. Forensic Detectives can identify which pen was used in a crime by studying the pen’s unique ink pattern.

4. Students will test each pen and determine which one was used to write the note.
5. Select 4 strips of filter paper.
6. Draw a horizontal line approximately 1 inch from the bottom of the strip.
7. Repeat for pens #2, #3, #4, and #5.
8. Place each strip in the cup of water so that the water touches the filter paper just below the ink line.
9. Wait 1-2 minutes for the ink to separate completely.
10. Carefully remove the filter strips from the cup and place them on a paper towel.
11. Compare the results from each pen to the picture in student detective journal.
12. Which pen (who does it belong to) most resembles the pen from the crime scene
13. Explain to students that the blackboard eraser was returned and the teacher will promise to write her name down the next time she wants to borrow it.

Part 2 Handwriting Analysis:

1. Ask the students how they would have been able to figure out who took the blackboard eraser if the ransom note was written with a pencil or a pen that a chromatography test would not work on?
2. Explain to the students that just like fingerprints have special characteristics and patterns, peoples' handwriting also has special characteristics and patterns that are fairly unique to an individual.
3. Forensic Detectives can study signatures and compare them to a suspect in a crime. For example, say a suspect tried to cash a check for 1 million dollars. The bank knew this was not right and took the check to the forensic detective at the police station. The forensic detective then studied the signature of the suspect who wrote the check and compare it to a list of known bank robbers. They were able to tell exactly who wrote the check by studying the characteristics of the signature.
4. Clues for Handwriting Analysis:
 - a. Slant-the angle of inclination // the slant can indicate a right or left-handed person.
 - b. Form-how the individual letter is written. I.e. Looking at an "a". Is the "a" closed at the top, is it written in cursive or does it have a hat above it?
 - c. Proportions-refers to the symmetry of an individual letter or word. I.e. the letter "B" is the bulb on the top the same size as the bulb on the bottom. Does the word start off big and then end small.
 - d. "i" dots and "t" crossing-can come in all sizes and shapes to help identify a signature.
5. Have student write their name and compare their handwriting to the person sitting next to them. Everyone has a unique name and signature!



Notebook Ideas:

Encourage students to write vocabulary words and any questions in the back of their Forensic Detective journals. Students can practice writing and comparing their name in the back of their journals.

Day 4: Identifying Soil Samples

Materials:

- Containers with four soil samples (labeled 1-4)
- Small spoons (labeled 1-4)
- Dixie cups
- Stir sticks/straws
- pH strips
- tweezers
- Paper towels

Preparation:

1. Gather Soil samples, pH strips, tweezers, pH identification cards and Dixie cups-FD Box.
2. Cut pH strips in half for soil sample activity.
3. Gather soil sample from your SciTech school site to demonstrate describing physical properties of soil samples.

Procedures:

Part 1: Soil Samples

1. Explain to students that soil samples can be linked to a specific place or area. Soils in the mountains look and even smell different than soil found in the desert. Soils have different pH levels (meaning how acidic or basic soils can be. The range is from 1-14. 1 is the most acidic and 14 being the most basic), properties (color, texture and different sized grains).
2. Show students a sample of soil you picked up in their schoolyard. Have one student come up and describe what they see. These are the physical properties of schoolyard sand. You would have to do a test to identify the pH level.
3. Demonstrate how students take the pH of the four soil samples.
4. With a marker, have students label four cups 1, 2, 3, and 4.
5. Use the spoons to place one small spoonful of soil #1 into cup #1. Do the same thing for samples #2, #3 and #4. BE SURE TO USE THE CORRECT SPOON FOR EACH SOIL SAMPLE.
6. Use the magnifying lens to observe the four soil samples and record each sample's physical properties (color, texture, presence of organic matter-leaves, bark? Etc...) in detective journals.
7. Gently squeeze the distilled water into each cup of soil until the water just covers the soil sample.
8. Gently stir each cup of soil with a straw or Popsicle stick.

9. Use tweezers to remove a strip of pH paper from the container.
10. Using the tweezers, quickly dip the pH paper into soil sample #1.
11. Immediately compare the color of the pH paper to the pH charts and record this information in student's detective journal.
12. Repeat steps 6-8 for samples #2, #3, and #4.
13. Compare the information in journals to the results obtained from the soil found at the crime scene.
14. Based on student's results, which soil sample most closely resembles the crime scene evidence?

****If time permits, introduce Wheat Germ DNA**

Notebook Ideas:

See if students can remember what a person who studies soil around a crime scene is called- a forensic geologist. Encourage students to come up with an idea or a solution about finding missing items found in soil-like a ring or money? They know where an item is, how are they going to find it quick and easy? What techniques could they use?

Day 5: Wheat Germ DNA

Materials:

- Wheat germ
- Large plastic test tubes (50 mL) and racks
- 4 squeeze bottles filled with isopropyl alcohol
- 15 mL conical tubes filled with dish soap
- Skewers (to obtain DNA)
- Coffee stirrers
- Water
- pipettes
- Small microcentrifuge tubes (keep collected DNA)
- Sharpies
- Paper towels
- Stop watch

Preparation:

1. Gather DNA materials from LL1-DNA box.
2. Fill isopropyl alcohol into squeeze bottles.
3. Fill large plastic test tubes with 10mL water and set into racks.
4. Place wheat germ into 4-6 Dixie cups (enough for each table).

Procedure:

1. Explain that DNA is a unique blueprint that every living thing carries in its genes that is unique to each individual.
2. Like fingerprints, DNA (deoxyribonucleic acid) is unique to every individual, though traits are shared between parents and offspring and siblings. DNA is found in the nucleus of your cells and is the blueprint for who you are.
3. Briefly explain that DNA is built like a ladder. There are four bases (adenine, guanine, cytosine, and thymine) It is the sequence of these nucleotide bases that determines different characteristics of an organism. ATGCCTGATCAAGT.
4. Explain that in order to study DNA, scientist first had to find a way to get it out of the cell. We are going to follow a simple procedure for extracting DNA from wheat germ.

DNA Extraction:

1. Tell students they will need a 50 ml conical tube with 10 mL of water already in the tube.
2. Have the students add a large pinch of wheat germ to their tube and stir with a coffee stirrer for 1 minute (use stopwatch).
3. Tell students to add 3 ml of soap solution (one pipette full is about 3 mL) to the wheat germ mixture.
4. Student will twirl their wrist and gently swirl their tubes for 1 minute (use stopwatch)..
5. This next step, have students put on their goggles-we don't want any alcohol to get into their eyes.
6. Demonstrate how to add a squirt of alcohol (3mL) into the conical tube. Remind students to squeeze the alcohol into the wheat germ mixture, they should squeeze it down the side of the tube so they do not disturb the wheat germ at the bottom.
7. Have the students add 3ml of alcohol and then carefully place the tubes in their racks to wait for the DNA to precipitate.
8. While waiting, have the students add 1ml of alcohol to each microcentrifuge tube (if you have not done this ahead of time). Pass out Sharpies and have each student put his/her initials on one of the tubes.
9. Pass out the bamboo skewers and show students how to spool the DNA. (The DNA will be located in the top layer – at the boundary between the alcohol and water. By gently swirling the skewer around in this layer, the DNA will stick to the skewer.)
10. Have the students transfer the DNA from the 50 ml conical tube to the microcentrifuge tube using the bamboo skewer (They may need toothpicks to “scrape” the DNA off the bamboo skewers).
 - Discuss the steps of the extraction as a class and have students try to determine the purpose of each step. Draw a rough diagram of a plant cell on the board to assist them.
 - Ask students why we stirred the wheat germ mixture in step 3 (*to physically break down the cell wall*).

- Ask students why we added the soap solution (*to break up the lipid bilayer of the cell membrane*).
- Ask students why the DNA precipitated out when we added alcohol (*because DNA is soluble in water, but not in alcohol*).
- Explain that the DNA extraction we performed was very basic and the DNA is not very “clean”. We did not perform any steps to break up the proteins that are attached to the DNA, so our DNA sample also contains quite a bit of protein.

Notebook Ideas:

Encourage students to write vocabulary words and any questions in the back of their Forensic Detective journals. Scientist can gather DNA from any living cell-strawberries, bananas, even a lollipop or a piece of gum that someone threw down on the ground. Encourage students to think about what a Forensic Detectives can look for at a scene of a crime? (blood, saliva, hair or skin tissues)-Clues that would point to a suspect.

Day 6: Identifying Dental Impressions and Mystery Powder

Materials:

- Styrofoam (paper plates or foam board)
- Dental castings/impression examples (Adaptation Box in LL1)
- Petri dishes (with three sections)
- White powder samples (baking soda, cornstarch, baby powder, chalk)
- Dropper bottles with vinegar, iodine, indicator solution
- Magnifying glasses
- Dental impression handout

Preparation:

1. Cut Styrofoam plates into small pieces (easy to fit into student’s mouth)
2. Gather Petri dishes and place white powder samples (baking soda, cornstarch, baby powder, chalk) in the Petri dishes.
3. Prepare dropper bottles with vinegar, iodine, indicator solution (in LL1 refrigerator)

Part 1: Dental Impressions

1. Explain to students that teeth are unique to individuals and animals. When solving a crime, forensic scientist can use bite marks from human and animals to identify a suspect. Braces, missing teeth, wisdom teeth, etc... can be used to identify a person. Dogs, cats, guinea pigs, and other creatures all have a certain tooth orientation and special teeth to help identify animal bites.
2. Students will make their own dental impressions and identify characteristics of their dental impressions.
3. Briefly go over the major divisions of teeth, incisors, molars, canine, premolar etc...
4. Have students look at different casting of teeth (Adaptation Box LL1) and see if they can identify the different teeth or animals they came from.
5. Have students write “top” and “bottom” on 2 place pieces of Styrofoam.

6. Next, student will place both pieces of Styrofoam into their mouth and bite hard to gather dental impressions. (Both pieces of Styrofoam will be back to back and performed at the same time).
7. Can students identify types of teeth, missing or the angle of teeth?

Part 2: Mystery Powder:

1. Explain to students that forensic detective can use physical and chemical properties to identify substances found at a crime scene.
2. Students will remove the lids from the Petri dishes.
3. Next, students will observe each of the powder samples with a magnifying lens and fill in the "Appearance & Texture" column (gritty, fine, smooth, bumpy) in their journals.
4. Place 1-2 drops of vinegar on top of each of the powder samples and observe the reaction. Students will record observations in their journals.
5. Now test each of the powders with 1-2 drops of iodine. (Be sure to use a new section of the Petri dish for each of the tests.)
6. Test each of the powders with 1-2 drops of indicator solution and record observations.
7. Compare the results in your data table with the results obtained from the powder at the crime scene. Based on your findings, what is the mystery powder?

Notebook Ideas:

Encourage students to write vocabulary words and any questions in the back of their Forensic Detective journals.

Day 7: Create the Crime Scene

Materials:

- Student magnifying glasses
- Student detective journals
- All materials used throughout out the week should be made available to students for "Create the Crime!" does not have to be the full set of materials, students will be picking just 3 items as evidence.

Preparation:

1. Gather supplies need for today's Create a Crime scene. (pens, mystery powder, dental supplies, soil sample-can exclude DNA activity due to time restraints.

Procedure:

1. Explain to students that each table group will create a crime that the rest of the class will solve. Any **THREE** pieces of evidence solvable by experiments we have used over the unit may be planted.
2. Crime scene scenarios must be written up in detective journals along with evidence to be used, what experiment must be done to analyze the evidence, and supplies each table will need to set up their scenario.

3. Students will see instructor for supplies and help in creating their crime.
4. Students will examine at least two crime scenes and perform needed experiments to solve the crime.
5. All data should be rerecorded in student's journals (include list of evidence, the scientific procedure used to process the data, and any pertinent details that will lead to solving the crime).
6. Remember, a good forensic scientist is a great observer and takes great notes that can be looked at and understood later to be able to solve a crime.

Possible crimes:

Someone took your very special pencil out of your backpack and you noticed a soil footprint, a dropped pen and a fingerprint on your notebook.

Your prize pooch is missing for a very important dog show this weekend and now Rover is missing. You noticed footprints, teeth marks and fingerprints all over the gate.