CSI: Crime Solvers, Inc. Forensics

Activities for the Classroom

Introduction

On their journey to become junior forensics experts, your students will work together to solve mysteries. They will learn how to apply science-based detective work along with chemistry concepts to solve crimes. Not only will students have the opportunity to become proficient in behaving like scientists, but they will also learn vital communication techniques used by expert witnesses and attorneys during criminal trials.

This activity kit includes an overview of the course, activities and investigations you can do with your class and a resource list of web sites and books.

Overview

The science of forensics has been applied to solve mysteries since the seventh century, AD when a Chinese magistrate used logic and forensic evidence to investigate crimes. Many aspects of his pioneering efforts are utilized today, including collaborating with a team of investigators, studying the crime scene, examining physical evidence and interviewing witnesses and suspects. Modern forensic science also embodies new technologies, which enable detectives to better solve cases, even those that are many years old.

The essential questions to explore are:

- What types of evidence can forensic scientists use to solve a case?
- How do criminologists use evidence and inference to solve a case?
- Why is comparison an important component of forensic analysis?
- What does the concept of "reasonable doubt" mean to scientists like us?

Your students will use critical thinking strategies as well as observation skills to unlock puzzles and provide the answers to secrets. They will explore the distinction between evidence and inference, connecting facts to unravel clues. They will also apply the skills of a forensic scientist and create experiments using observation and inquiry to tackle mysteries. Your students will learn to be scientists by collecting, organizing and analyzing data, as they spend time comparing different elements in order to confirm their findings. In addition, they will develop communication skills that are often used in courtrooms to present evidence during trials.

Individually and in cooperative groups, students will explore these elements and apply their knowledge to new situations as they unravel mini-mysteries.

This course consists of the following scientific explorations:

- Differentiate between evidence and inference
- Use fingerprint analysis to solve a crime
- Analyze handwriting samples
- Compare, evaluate and present evidence
- Use paper chromatography to analyze ink samples
- Develop and analyze alternate explanations for a mystery
- Identify unknown substances using chemistry experimentation
- Determine the role of DNA as evidence in solving crimes
- Examine fibers as a source of evidence
- Examine teeth, footprints, lip-prints, and bone structure to identify suspects

Suggested Projects For Your Students

Fingerprinting

Dusting for Fingerprints

In this project, your students can dust for fingerprints like a detective does at a crime scene. You can then lift the fingerprints to take back to the crime lab for investigation.

To do this you will need:

- Drinking glasses
- Cocoa powder
- Small, soft paintbrushes
- Transparent tape
- Light-colored construction paper

Steps:

1. Have your friends or family members put a fingerprint on different drinking glasses.
2. Coat the glasses with a dusting of cocoa powder and gently brush with the paintbrush to find their fingerprints.
3. Put the sticky side of the tape over each fingerprint. Lift the tape and place it on a sheet of the construction paper.
4. Your prints are now ready to take to the lab!

Questions:

1. Why do you have to be careful handling the glass while you look for the fingerprints?
2. What could you do to try to match the fingerprints you lifted to each of your friends or family members?

Chromatography

Chromatography involves understanding changes in the properties of matter.

Leaf Chromatography
In this project, you can do a chromatograph to find out which colors are in leaves.

To do this you will need:

- Leaves (you can pick a variety of different leaves)
- Small jars with lids, or aluminum foil
- Rubbing alcohol
- A spoon or knife
- Paper coffee filters
- A shallow pan
- Hot water
- Tape

Steps:

1. Take your leaves and tear them into small pieces. Put each type of leaf into a separate jar.
2. Pour rubbing alcohol into the jars until the leaves are just covered.
3. Use the spoon or knife to grind the leaves in the alcohol.
4. Loosely cover the jars and place them in the shallow pan, filled with hot tap water.
5. Let the jars sit in the water for 30 minutes, swirling the jars every 5 minutes and refilling the water as needed to keep it hot.
6. Cut a long, thin strip of coffee filter for each jar and label it.
7. Remove the jars and then place one end of a filter into each jar so that it touches the alcohol. Bend the paper filter over the jar top and secure it with tape.
8. Wait 30-90 minutes, as the alcohol evaporates and the colors travel up the strip of paper.
9. Remove the paper filters and let them dry.

Questions:

1. Which colors do you see from your leaves?
2. Do different leaves have different colors?
3. Do you think it matters in which season the leaves are picked?

Wearable Chromatography
In this project your students can use the process of chromatography that he or she learned about to create designs for T-shirts!

To do this you will need:

- A white T-shirt
- A piece of cardboard
- A plastic bag
- Permanent markers
- Rubbing alcohol
- A small paper cup
- Eyedropper

Steps:

1. Put the cardboard inside the plastic bag and put the plastic bag inside the T-shirt, to keep the ink from running through.
2. Use markers to make circles with dots on the T-shirt.
3. Pour rubbing alcohol into the paper cup and fill the eyedropper with alcohol. Carefully squeeze the alcohol one drop at a time into the middle of the circles.
4. As the alcohol moves outward, it will make a chromatograph with the ink, creating designs.
5. You can experiment with different colors and designs.
6. Make sure to let the first side of the T-shirt dry completely before working on the second side.

Questions:

1. Which colors do you see from the different colored markers?
2. Do different designs work better than others? Why do you think so?

Chemical Analysis

Scientific investigations of evidence can involve chemical analysis. This type of testing can be extended in an outdoor environment since both natural soil and water sources have either acid or base characteristics. Let your students design some simple experiments to determine possible water pollution in the environment.

Some quick facts about water pollution:

- There are two basic types of water pollution: point-source which comes from a pipe or clear point of discharge (such as a sewer pipe) and nonpoint-source, which enters waterways from various places that cannot be clearly identified (such as run-off from chemicals)
- Water in a creek or stream is normally slightly acidic
- Living things prefer neutral water, or that which is neither very acidic nor very basic.
- pH 7 is considered neutral

Testing Water for pH

Help your students set up an experiment to explore the affects of pollution on water in your neighborhood. He or she should ask a question, develop a hypothesis, set up procedures, collect and record data, analyze the data and come to a conclusion.

To do this you will need:

- Writing tools to prepare the experiment
- A chart to record data with columns labeled as follows: Sampling Site, Color of pH Paper and pH, Acid or Base?
- pH (Hydronium) paper from a chemical supply or drug store
- Key to the pH paper
- Jars or cups for collecting water samples
- A method of labeling the jars

Steps:

1. Write the experimental question on a sheet of paper. An example might be, "Is the water in my local neighborhood creek polluted?"
2. Write a hypothesis (educated guess) in response to the question.
3. Take jars or cups to the local creek to collect water samples. You should get samples from different locations along the bank. Label the jars with different indicators.
4. Take a sample of your home's tap water for comparison purposes.
5. Set up a chart to record the pH of each sample.
6. Dip a pH strip into each container of water and record the ph number.
7. Determine if your local creek water has pollution characteristics based on its pH reading.

Questions to ask:

1. Are there any known sources of discharge into the creek/stream above the places where you took your water sample?
2. Has your local paper or news show recently reported instances of pollution in your creek/stream?
3. What are some other signs of pollution in your creek/stream?

Invisible Ink

Invisible inks have been used since early times to convey secret messages. Your class can do the following investigations to explore how two types of inks and their chemical properties can be used to create and read documents. The first type of inks, called sympathetic, are visible when applied, dry colorless and are read by adding other chemicals, called reagents, to make them visible again. The second type, called organic inks, consists of natural substances that are colorless when applied and reactivated with heat.

Using Organic Ink
Write a message with lemon juice or vinegar and use heat to make it visible.

To do this you will need:

- A paper cup
- Lemon juice or white vinegar
- Toothpicks
- Several sheets of thin white paper
- A lamp with a 100-watt light bulb
- A magnifying glass, optional
- Red cabbage
- Measuring cup
- Pot of water
- Stove
- Timer
- Cotton swabs
- Litmus paper

Steps for Part 1:

1. Fill the paper cup with lemon juice or vinegar.
2. Dip a toothpick into the colorless lemon juice or vinegar and use it to write a message on several sheets of the white paper.
3. Allow time for the messages to dry completely. Save some for Part 2.
4. Examine the sheets with a magnifying glass.
5. Take one of the paper sheets and hold it up near a glowing 100-watt light bulb. BE CAREFUL! A 100-watt bulb is very hot!
6. Examine the sheet again with a magnifying glass.

Steps for Part 2:

1. Shred about a cup of the red cabbage and place in a pot of water on the stove.
2. Boil it for 20 minutes.
3. Allow the solution to cool.
4. Take a cotton swab and dip it into the cooled cabbage water solution.
5. Spread it over the writing on one of the invisible message sheets of paper.
6. Examine the sheet with a magnifying glass.
7. Use the litmus strip to analyze the pH of the cabbage water and lemon juice or vinegar. Use the key to determine the acidity of the solutions.

Questions to ask:
Which type of ink and testing was done in each part? Explain why.
What is the difference in the way acidic and basic substances react to heat or solutions?
Why do you think they react this way?

If you mix equal parts of cabbage water and lemon juice or vinegar, what is the pH and how do they react?

Hair Analysis

Scientists collect hair and fiber evidence by using tweezers to collect samples. They usually place the samples on slides by making either a wet or dry mount. Examination of a hair strand under a microscopic lens can yield valuable information about a suspect's age or race. Melanin, a pigment in hair and skin cells, changes as a person gets older.

Scientists often refer to sample sheets and make comparisons with their evidence to determine these characteristics. Create your own sample sheet that shows how hair color changes as a human ages.

***Reference Samples for Human Hair*

To do this you will need:

- Tweezers
- Hair samples from at least five people of different ages but having the same general natural hair color (family members might be the best source of similar hair)
- Small sheets of white paper
- Microscope or magnifying lens
- Microscope slide (if using microscope)
- Clear tape
- Plain paper for drawing and labeling samples
- Colored pencils

Two matching hairs identified with the comparisons microscope.

Steps:

1. Ask your sample givers for one or two hairs from their heads.
2. Use the tweezers to place the hair samples on white paper sheets and clearly label each one with the person's name and age.
3. Use tape to place the hairs on microscope slides.
4. Examine each hair, one at a time beginning with the youngest person and looking at the others sequentially.
5. Illustrate the hair on drawing paper using colored pencils. Be sure to keep the illustrations next to each other in ascending age order.
6. Label each hair with the person's age.

Questions:

1. What happens to the color of a hair follicle as a human ages?
2. Can you determine the approximate age of a person by his or her hair color?

DNA: A Blueprint of Life

DNA is an acid found in the nucleus of the cell. It is shaped like a twisted ladder (also known as a double helix) and contains genetic information. The information stored in DNA is unique to all individuals except identical twins.

A great way to learn about DNA is through webquests. Webquests are inquiry-oriented methods of learning on the internet. Because links are provided, students are able to spend time reading and absorbing material rather than searching for it.

Here are links to webquests concerning DNA:

Webquest: DNA and Forensic Science
http://www.bjbarton.com/DNAweb.html
This site is fairly in-depth and gives information about the structure, replication and transcription of DNA. Students can take part in several virtual labs and learn how DNA is used both in crimes and to identify people in non-criminal circumstances.

Who Did It? Using Forensics to Hone Science and Laboratory Skills
http://www.teachersfirst.com/lessons/forensics/dnaquest-notes.html
This webquest is focused on DNA and blood types with a virtual lab on DNA extraction.

DVDs on DNA:

Billy the Kid: Unmasked DVD
www.discovery.com
The Discovery Channel investigates the mystery of Billy the Kid, an infamous outlaw of the Wild West. Watch as forensic scientists and DNA experts test the elderly man claiming to be Billy the Kid, as well as the person who was thought to be Billy the Kid and was buried under his gravestone.

Bill Nye the Science Guy:Forensics (DVD or VHS)
This video shows the Science Guy at a crime scene as he explores the world of forensic science. See how through using bloodhounds, fingerprints and DNA, detectives can reconstruct events, plus learn how scientists can identify a person using only a tiny drop of blood or a flake of skin.

MAKE A DNA MODEL![1]

Every living thing on this earth is made up of cells. Within cells are DNA, which is what makes each organism unique. Though you can't see DNA, you can make a model of it. Remember that DNA is shaped like a double helix, or a twisted ladder.

To do this you will need:

- Colored construction paper
- Scissors
- Pencil
- Magic markers
- Box of toothpicks (not the colored ones)
- Ruler
- String/masking tape

What your students should do:

1. Cut two strips of paper, the same color, at least two feet long and one inch wide. If your paper isn't long enough, tape a couple pieces together.
2. Using the ruler, mark with a pencil every inch along the strip.
3. Next, you'll create the steps of the ladder. In DNA, these steps are made of four bases: adenine (A), thymine (T), cytosine (C) and guanine (G). Select four different colored markers to represent the four bases. Write down which color you're going to use for each base.
4. Take 10 toothpicks. On each toothpick, color half the toothpick the color you chose for A and the other half the color you chose for T. Then, take ten more toothpicks and do the same thing with the colors you chose for C and G (remember, they are all different colors). The colors for A and T should always be together, as should the colors for C and G.
5. Now you will construct your double helix by taking both strips of paper and putting one on top of the other. Tape them together at each end.
6. Using the toothpicks, poke a toothpick through the middle of the strip at each inch mark. You can put these in any order you want. Put toothpicks all the way down the strip, leaving a little room at each end.
7. Gently slide the strips apart until your model looks like a ladder. If any of the toothpicks fall out, use a little bit of glue to secure them.
8. Hang one end of your double helix on a wall, gently give it a couple twists and tape the other end to the wall (make sure this space is ok with your parents!). Congratulations, you've made a DNA model!

You can also do this using other materials, such as popsicle sticks or pipe cleaners!

BOOKS

Doyle, Sir Arthur Conan. **The Extraordinary Cases of Sherlock Holmes.** Puffin Books, 1995.
This is a collection of eight stories of the famous Sherlock Holmes. The detective solves the mysteries behind crimes in Victorian London.

Owen, David. **Police Lab: How Forensic Science Tracks Down and Convicts Criminals.** Sagebrush, 2003.
This book describes current forensic methods and 20 real-life investigations. It includes photographs and illustrations.

Silverstein, Herma. **Threads of evidence: Using Forensic Science to Solve Crimes.** Twenty First Century, 1996
Using recent popular cases, this book helps the student to better understand the role of forensics in solving crimes.

Wiese, Jim. **Detective Science: 40 Crime-Solving, Case-Breaking, Crook-Catching Activities for Kids.** Wiley, 1996.
This book uses a variety of forensic techniques that can be used at home to solve crimes and mysteries.

Yeats, Tabitha A. **Forensics: Solving the Crime. Innovators Series No. 9.** 2001.
Named to the "Best Books of 2001" list by The Center for Children's Books, "Forensics" examines crime solving through storytelling, and explaining important scientific concepts along the way.

Deductive Reasoning

Deductive Reasoning is the thought process used by detectives to assemble the pieces of evidence in a crime and reach a logical conclusion. The game of Clue is a good example of this method. There are a number of logic game books that can be purchased to help develop this type of reasoning skill.

Baker, Michael. **Mind Benders**. The Critical Thinking Company.
This series of books is for students Pre-K through high school. These books help develop problem solving, reading comprehension and analytical skills through reading a story with clues and identifying associations among the characters, places and objects in the stories. There is software to accompany the books; however, each can be used independently of the other.

Flansburg, Scott. **Math Magic for Your Kids: Hundreds of Games and Exercises from the Human Calculator to Make Math Fun and Easy.**
Though mostly focused on math, this book provides puzzles and riddles to encourage students to think about problems using logic. It also includes activities that incorporate writing into mathematics.

Hall, Jody. **Super Silly Mazes.**
This book of mazoons (a combination of maze/cartoons) is fun from start to finish. These silly mazes are both challenging and entertaining.

Mandell, Muriel and Elise Chanowitz (Illustrator). **Fantastic Book of Logic Puzzles.**
This book includes popular logic puzzles using magicians, ogres, dragons, genies and wizards.

Mandell, Muriel and Margaret C. Edmiston. **The Wizard's Book of Puzzles.**
Help solve the Wizard's puzzles by proving your logical skills. You will figure out how many anti-ogre potions he has to hand out and determine which disguises each of five squires is wearing. These, plus many more challenges are included in this book.

Sukach, Jim and Lucy Corvino (Illustrator). **Challenging Whodunit Puzzles: Dr. Quicksolve's Mini-Mysteries.**
Dr. Quicksolve and his son Junior solve 50 crimes, including a murder case where one suspect plays loud music while the other one is hearing-impaired. Readers can also help select the correct heir to a millionaire's estate. Reading carefully for clues is a must!

Web Sites

Boy Scouts of America
http://onin.com/fp/fpmeritbdg.html
The Boy Scouts of America provide excellent information about the science of fingerprinting.

Cyberbee's Who Dunnit?
http://www.cyberbee.com/whodunnit/crime.html
This web site provides information on forensic techniques, the history of forensic science, and additional activities to try at home.

DNA Webquests
http://www.teachersfirst.com/lessons/forensics/dnaquest-notes.html
There are a number of webquests that allow you to explore the application of DNA technology in the area of forensic science.

Dragonfly TV
http://pbskids.org/dragonflytv/show/forensics.html
This PBS web site includes a description of a case, details on how it was solved and suggested activities for the reader.

Forensic Files
http://www.trutv.com/shows/forensic-files/index.html
TruTV's web site for its popular television show includes forensic techniques, a glossary and a timeline of the field. Also included is a "virtual forensics lab."

NOVA Science Programming On Air and Online
http://www.pbs.org/wgbh/nova/sheppard/analyze.html
If you loved cracking cases at NYSP, you'll want to check out NOVA's web site to determine who licked Jimmy Sweet's prized holographic lollypop.

Who Stole the Minister's Malibu? Want to be a forensic investigator/scientist?
http://www.abc.net.au/science/forensic/forensicscience.htm
This Australian web site has information on the field of forensic science as well as the stories behind several big forensics cases.

Places to Visit

The Franklin Institute, Philadelphia, PA
http://sln.fi.edu/explore.html
The Franklin Institute in Philadelphia features exhibitions focused on Physics, environmental biology and the science advancements of Ben Franklin himself.

Liberty Science Center, Jersey City, New Jersey
http://www.lsc.org/
The Liberty Science Center offers Invention, Health and Environmental-themed floors, along with hands-on experimentation and an in-house IMAX theater.

Marian Koshland Science Museum, Washington, D.C.
http://www.koshland-science-museum.org/
"Putting DNA to Work," an exhibit at the Marian Koshland Science Museum, allows visitors to uses multimedia activities to explore the many uses of DNA, including solving crimes and tracing the origin of the SARS virus.

The New York Hall of Science, Queens, New York
http://www.nyhallsci.org/
With over 400 exhibits, the New York Hall of Science is one of the largest in the New York Metropolitan Area, and the city's only hands-on science and technology center. It has a Biochemistry Discovery Lab and an exhibition of Nobel Prize winners as well as a science playground.

The Science Museum of Virginia, Richmond, VA
The Science Museum of Virginia contains a "Science of Investigation" exhibition, along with an IMAX theater and exhibits focusing of life sciences and physics.

The Smithsonian Institution Museums, Washington, D.C.
The Smithsonian Institution is composed of 15 museums in Washington, D.C., along with research centers and archives in the area. The exhibits change frequently, and it's best to call ahead to a specific museum to inquire about programming.

Resources used in preparing these activities

Walker, Pam and Elaine Wood, Crime Scene Investigations: Real-Life Science Activities for Elementary Grades; Jossey-Bass, 1999

Walker, Pam and Elaine Wood, Crime Scene Investigations: Real-Life Science Labs for Grades 6-12; Jossey-Bass, 1998

Rainis, Kenneth G., Crime-Solving Science Projects: Forensic Science Experiments; Enslow, 2000

[1] "Stuff to Do: Make a DNA Model." American Museum of Natural History. <http://www.ology.amnh.org/genetics/stufftodo/model.html>. Accessed 09 August 2005.

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Accepting nominations online at:
www.cylc.org/JrNYLCnom