

# National Museum of Health and Medicine

## Resolved: A Forensic Mystery Workshop

### Teacher's Guide Grades 6-12

This guide will help you prepare for your visit to the National Museum of Health and Medicine. It outlines the major ideas and exhibitions that will be presented during the visit and suggests activities to help extend your museum experience into your classroom.

#### **About your tour**

You and your class will investigate the remains of an unknown person using the tools of forensic anthropology and military identification. Your visit will consist of brief introduction to military forensics, followed by 7 stations of hands on activities in our Collections Gallery and Human Identification Exhibit.

At the conclusion of this workshop, students should be able to:

1. Define forensics, forensic anthropology and forensic pathology.
2. List at least six characteristics of the human body that can be used for identification.
3. List two additional sources of information that may be used for identification.
4. Describe two situations in which anthropology would be used for identification.
5. List at least three tools used in the lines of evidence for identification.
6. List at least three organizations that help with the process of Military Identification.

#### **Major identification items used in forensic identification**

- Fingerprint analysis
- Sex and age determination (pelvis and humorous)
- Height estimation
- Trauma/pathology
- Dental identification
- Material evidence
- DNA analysis
- Pathology

## Pre-visit classroom activities

- Review *Visiting our Museum* and what they will be doing on their visit.
- Discuss the different types of forensics, such as anthropology, psychology, Medical Examiners, accounting, etc.
- Review the human skeleton and how people can be identified using only their bones
- Have the students research a story involving forensic anthropology.
- Review the mathematical methods of converting centimeters to inches and inches to feet.
- **Have the students build a DNA molecule:**

### Objectives:

- To introduce students to DNA
- To review DNA structure and complementary base-pairing with a hands-on activity

### Materials:

- ✓ Small colored gum drops or marshmallows
- ✓ Toothpicks
- ✓ Twizzlers

**Overview:** DNA (deoxyribonucleic acid) is found in the chromosomes of all living things. Chromosomes, located in the nucleus of cells, contain genetic information in long sequences of DNA. DNA provides a set of instructions on how to build the proteins in every living organism, what proteins are needed to create the organism, and in which sequence amino acids are needed to build all of the different proteins required for the organism's growth. All DNA is composed of three parts: a five-carbon sugar called deoxyribose, a phosphate group, and a nitrogen-containing base (there are four potential bases called adenine, guanine, cytosine and thymine). Nucleotide chains are formed as the phosphate group of one nucleotide attaches to the sugar of the following nucleotide--adenine combines with thymine and guanine combines with cytosine. The structure of DNA is double helix, which looks like a ladder that has been twisted. The phosphate/sugar attachments make up the outside of the ladder, while the combination of bases and phosphate attachments cause the DNA to twist.

### Procedure:

1. Discuss the chemistry, shape and information about the DNA molecule. You may also want to discuss the history of DNA research and discovery. Then have the students construct their own DNA molecule from candy.
2. Have the students choose 4 different colors of gum drops or marshmallows. These will represent the base pairs for the molecule.
3. The twizzlers will represent the phosphate backbone of the molecule. Each student will need two twizzlers.
4. The toothpicks will be used to hold the molecule together.
5. Have the students create a legend by writing down which color gumdrop or marshmallow corresponds with the base pair (i.e. green=adenine, red=thymine and so on).
6. Have the students create the base pairs and stick the gum drops on the toothpick. Do this for all of the base pairs. Explain to the students that the order of the pairs make up the information of the DNA.
7. Finally have the students attach the pairs to the twizzler backbone. Once all of the pairs are attached, slowly twist the molecule to form a double helix or what looks like a twisting ladder. Review the importance of the shape of the molecule. Have each student explain his/her nitrogen-containing base legend and define complementary base pairing to reinforce knowledge and understanding. Now they can enjoy the candy!

- **Have students make a dental impression:**

**Overview:** Odontology or forensic dentistry is the application of dentistry in a legal setting. The use of dentistry is an excellent method of identification of individuals, either alive or deceased. This is due to everyone teeth and teeth patterns are unique. Most people have been to the dentist, where they have recorded an antemortem dental chart, which can be used for comparison in the future. Teeth can also withstand destruction, decay and extreme temperatures up to 1600 F. As a result, teeth can be used as a better method of identification than fingerprints.

This activity will allow students to match dental patterns with an individual.

**Materials:**

- ✓ Styrofoam plate or cups
- ✓ Pen(s)
- ✓ Scissors
- ✓ Data sheet

**Prep:**

- ✓ Prior to the beginning of the class/activity, choose one student to be the victim. This person will need to make two dental impressions, one as an unknown individual and one as a known for comparison. Choose four to five other students in addition to the first for comparison that may be a possible victim.
- ✓ Have the students make their dental impression on the Styrofoam plate or cup and place these with their names on a paper plate on a table for future observation.

**Procedure:**

1. At the beginning of the activity, discuss with the students the importance of dental charting, radiographs and how teeth are used for identification of individuals.
2. Divide the students into groups or pairs and distribute 1 Styrofoam plate, pen and scissors to each group.
3. Have the students cut the plate into "bite-sized" sections for the group to take their own dental impressions. The students should mark any unique characteristics with a pen and record their findings on a separate sheet of paper that can be their Data Sheet.
4. Create a scenario in which an individual was recovered from a crime scene or site. Explain that we have dental impressions as the information on the individual. Have the students look at the impressions at the table and determine a match.
5. Discuss the class' findings and observation. You may want to discuss the difficulty some odontologists have when there is not complete information on the individual for comparison.

**Vocabulary:** a list of terms used through out the workshop

**Forensic Anthropology:** a field of science that analyzes the human skeleton to create biological profile.

**Biological Profile:** the estimation of the skeleton's (or unidentified person's) age, sex, stature, ancestry and any signs of trauma or pathology.

**Mass Fatality Incident:** an incident that has a high fatality count that local emergency personnel cannot handle on their own. This may include Hurricane Katrina, airplane crashes, or September 11<sup>th</sup>.

**Minimum Number of Individuals:** the total minimum number of individuals or people found among the remains or at a site.

**Sexual dimorphism:** differences between the sexes of the same species

**Skeletal degeneration:** natural deterioration of the skeleton

**Epiphyses:** the rounded end of the long bone, where growth plates are located.

**Endochondral ossification:** the replacement of cartilage with bone

**Erupted:** Teeth that are exposed through the gum

**Unerupted:** teeth that have not protruded through the gum line.

**Pubic symphyses:** the midline cartilage joint that joins the left and right pubic bones

**Population:** is the collection of people, or organisms of a particular species, living in a given geographic area,

**Allometry:** the correlation of the size of a bone to a person's height.

**Return of the Dead Program:** WWII program to recover, return and identify the remains of WWII soldiers.

**Medico-legal:** pertaining to the legal aspects of practicing medicine

**Improvised Explosive Devices (IEDS):** a bomb constructed and deployed in ways other than conventional military action or warfare.

## **Post-visit activities**

- Have the students write a fictional story using the concepts they learned from the workshop.
- Have the students research the educational and career path of a forensic anthropologist or medical examiner or interview a local forensic scientist.
- Have students write a brief article about what they learned during the visit.
- Have the students review a current event that involves a mass causality situation and what methods of forensics identification might be used to identify the victims.
- [DNA extraction Activity](#) :

**Overview:** During this activity, you will extract DNA from a strawberry or a kiwi. You will pulverize the fruit; mix it with a solution of water, dish detergent and salt; filter it into a test tube; add a layer of ethanol; and then stir the mixture so that it collects on a stick so that you can view the DNA.

Strawberries and kiwis work well in this activity because they are soft and easy to pulverize. Also, these ripe fruits produce pectinases and celluloses, which break down the cell walls. Most interestingly, these fruits have enormous genomes. They are octoploid, which means they have eight of each type of chromosome. Since there are so many chromosomes containing DNA, it is easy to extract and see the DNA with the naked eye. When you add liquid dish detergent to the pulverized fruit, it helps to dissolve the phospholipids bilayers of the cell membrane and organelles. The addition of salt helps to keep the proteins in the extract layer so they are not precipitated with the DNA. DNA is not soluble in ethanol—this means that when you mix ethanol with DNA molecules, they clump together and become visible. The colder the ethanol, the less soluble the DNA will be in it. This is why it is important for the ethanol to be kept in the freezer or in an ice bath.

This process is very similar to extracting DNA from ancient bones. The bone is placed in a blender until it becomes a powder; soap is added to the mixture and then alcohol. From this solution, technicians are able to extract and sequence DNA to be used during identification.

**Materials:**

- ✓ Ripe frozen or fresh strawberries or kiwis
- ✓ Buffer solution (Liquid dish soap, such as Dawn or Palmolive mixed with water and salt in a small test tube. Should be between 30-50 ml of the buffer solution)
- ✓ 10 ml ethanol in a test tube, chilled on ice
- ✓ Plastic Ziploc bags
- ✓ Cheesecloth or a coffee filter (1-2 layers thick)
- ✓ Clear test tubes
- ✓ Wire or sticks
- ✓ Funnel
- ✓ Small beaker or cup

**Procedure:**

1. Divide the students into small groups depending on class size. Dispense the following to each group: 1 ziploc bag, 1 strawberry or kiwi, buffer solution, chilled ethanol, cheesecloth, funnel, beaker/cup and wire.
2. Have the students place the fruit in the plastic bag and mash it until it is almost a liquid, this should take about 2 minutes.
3. Add the buffer solution to the pulverized fruit and mix for 1 minute
4. Next, drain and filter the solution into the beaker/cup through the funnel covered with cheese cloth. This is the solution from which the DNA will be extracted.
5. Pour this mixture into the clear test tube. Add the 10ml of chilled ethanol
6. The ethanol will sit on top of the fruit mixture and will cause the DNA to separate from the solution. After a few moments the students will be able to see a white cloudy layer form between the fruit buffer solution and the ethanol. This is the fruit DNA.
7. Have the students spool the DNA on the wire or stick and extract it from the solution. It should look like a cloudy mucous. Have the students record the observations.

- **Fingerprints Activities :**

**Activity #1: Identifying Fingerprints**

**Overview:** Fingerprints are an important tool in identification of individuals for both criminal and postmortem identification. Every person has unique fingerprints, based on three major types: arches, whorls and loops. FBI personnel have become experts in analyzing fingerprints. They have collected over 8,000 references from government and military members and also aid local authorities in scenarios such as mass disasters. Fingerprints can be retrieved from a variety of surfaces such as glass, plastic, and deceased individuals. This activity will give students to create and identify their own prints.

**Materials:**

- ✓ White paper
- ✓ Ink pads
- ✓ Wet wipes
- ✓ Fingerprint identification chart

**Procedure:**

1. Begin the activity by reviewing the history of fingerprinting and the most common types of prints that are used to identify individuals.
2. Have the students fold the white piece of paper in half and mark the columns with left and right hands. Also, make sure that the students have written their name on the document.
3. Have the students take their prints and place them on the white paper. Make sure the students label each print with thumb, index finger, etc. The students will need to leave room on the sheet to identify the type of print.
4. Next have the students trade prints with a partner or friend. Have the students identify the type of prints on the paper from the identification chart.
5. Discuss the process and difficulty of identifying fingerprints. You may use these prints for future activities.

## Activity #2: Latent Cocoa Powder Fingerprinting

**Overview:** The oils, perspiration and amino acids on the skin allow for prints to be left on a variety of objects, especially those with hard surfaces. One method to retrieve prints from hard surfaces such as glass is to dust the area with a powder. Different powders are used on different colored surfaces to show the print in a contrasting color on the object. This activity will be using cocoa powder to retrieve prints on clear glass.

### Materials:

- ✓ Cocoa powder
- ✓ Clear glass slides
- ✓ Clear tape
- ✓ Fingerprint identification chart
- ✓ Makeup blush brush
- ✓ Student fingerprint charts from previous activity or white piece of paper

### Procedure:

1. Begin by reviewing the different types of fingerprints and how fingerprints are left on objects.
2. Have the students run their fingers over their nose or through their hair to retrieve extra oils on their fingers.
3. Next, have the students make a print on the clear glass slide or object.
4. Using the cocoa powder and the makeup brush, dust the glass slide for the print.
5. Once you are able to see the print, take a piece of clear tape and place it over the print, slowly rubbing the tape down on the slide from one edge to the other. Slowly lift the tape from the slide and place the print on a white piece of paper or the student fingerprint charts.
6. Finally, have the students identify and match the print with their own fingerprint chart. Discuss the process and difficulty of lifting prints for analysis.

## Activity #3 Latent Chemical Fixing Fingerprinting

**Overview:** Another method to retrieve prints from hard objects is to use chemical fixing. Certain chemicals will react with the oils and amino acids from the skin visualize the latent or hidden the print. Ninhydrin creates a blue-purple color on the print when it reacts with amino acids, while silver nitrate reacts with the salt from the skin to create a reddish-brown print when seen under ultraviolet light. This activity will be using super glue fuming to show prints on a hard plastic or glass surface. This print will produce an off-white shade.

### Materials:

- ✓ Super glue
- ✓ Small pieces of metal or plastic
- ✓ large jar with lid (one per group)

### Procedure:

1. Discuss with the students the process and reasons for using chemical fixing to visualize fingerprints.
2. have the students split into small groups each with a piece of plastic or metal, large jar and super glue.
3. Have the students make a fingerprint on the object and place it in the jar.
4. Next place a few small drops of super glue next to the object in the jar, avoiding getting any glue on the object.
5. Place the lid on the jar, do not inhale fumes and let the jar sit for 30 minutes.
6. Following the 30 minutes or during the next class, students should be able to see their prints on the object. Have the students record and discuss their observations.

## Resources

### *Websites*

- Death Online, [www.deathonline.net](http://www.deathonline.net)
- [www.all-about-forensic-science.com](http://www.all-about-forensic-science.com)
- Office of the Armed Forces Medical Examiner, <http://www.afmes.mil>
- Joint POW/MIA Accounting Command, <http://www.jpac.pacom.mil/>
- DNA Information, [www.dnai.org](http://www.dnai.org)

### *Books*

- The Forensic Casebook: The Science of Crime Scene Investigation, Ngaire E. Genge, 2002
- The Bone Detectives: How Forensic Anthropologists Solve Crimes and Uncover Mysteries of the Dead, Donna M. Jackson and Charlie Fellenbaum, 1996
- Talking Bones: The Science of Forensic Anthropology (Facts on File Science Sourcebooks), Peggy Thomas, 1995
- Soldier Dead: How we recover, identify, bury and honor our military fallen, Michael Sledge, 2007