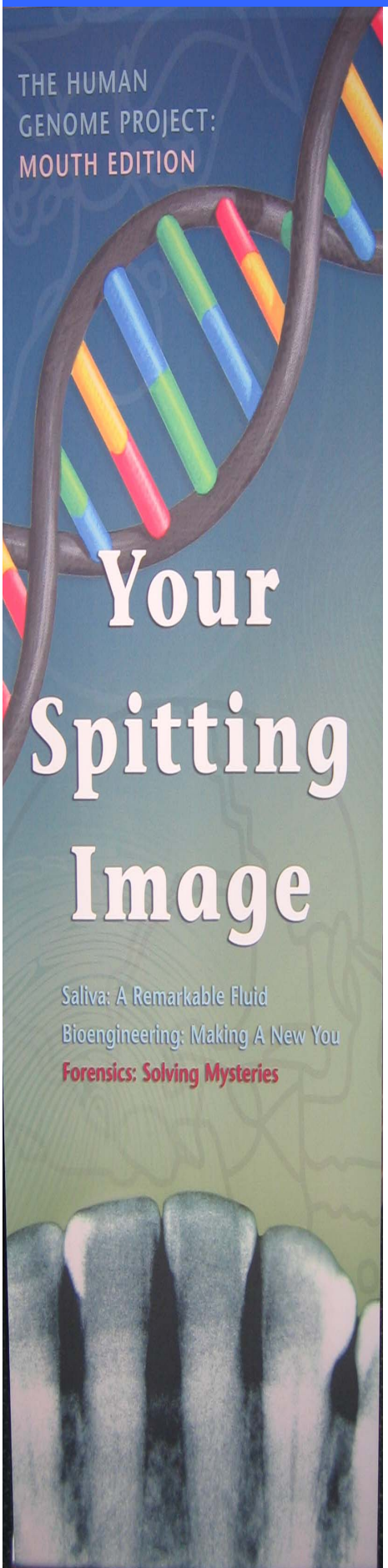


Exhibit Guide for Teachers

Grades 6-12

Smithsonian Affiliate

UNIVERSITY of MARYLAND
SCHOOL OF DENTISTRY
DR. SAMUEL D. HARRIS
NATIONAL MUSEUM OF DENTISTRY

Acknowledgements

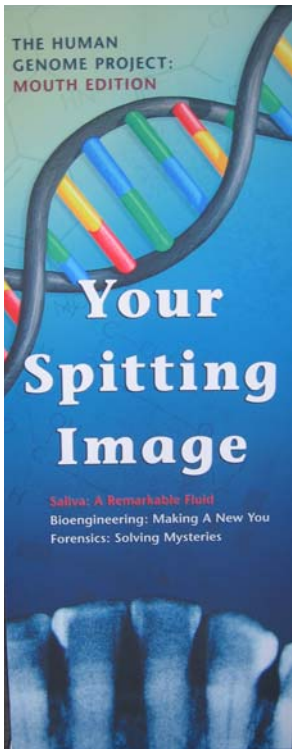
The National Museum of Dentistry would like to thank the following teachers for their expertise and knowledge in offering suggestions and incite during the creation of this guide.

Jeremy Haack
Science Department Chair
Kenwood High School
Baltimore, Maryland

Mary Monte
Forensic Science Teacher
Eastern Technical High School
Essex, Maryland

Table of Contents

Overview and Planning for a Field Trip



What is *Your Spitting Image, The Human Genome Project: Mouth Edition*?

After the completion of the Human Genome Project, the National Museum of Dentistry developed *Your Spitting Image, The Human Genome Project: Mouth Edition* to explore how our DNA is important to our identification and oral health. The exhibit helps student learn the relationship of DNA to the future of dental care and forensic science. At the exhibit, students will explore the topics of saliva, forensics, and bioengineering.

After visiting *Your Spitting Image*, students will understand more about their oral health and possible career choices. They will come away knowing:

- How teeth, bitemarks, and DNA are used in forensic investigations
- What function saliva has in our body
- Advances in oral health
- Career choices related to dentistry

How to Use This Guide

This guide was created to assist teachers in preparing students for the exhibit and discussing what they learned from their field trip experience.

- The activities in this guide are divided by pre- and post-visit. This will allow students to prepare for the exhibit by learning about DNA and then follow-up with post-visit activities to demonstrate their knowledge of the subject.

- Each lesson is divided into a teacher brief and a lesson page.

- The teacher brief includes the purpose of the lesson, exhibit links, standards addressed, and background information about the topic of the lesson.

- The lesson page explains whether the activity is for pre- or post-visit. It also contains a key point, materials, procedure, and questions to aid in discussion.

- The activities were designed to meet the National Science Education Standards developed by the National Committee on Science Education Standards and Assessment and the National Research Council.

- After your visit to *Your Spitting Image*, consider inviting an odontologist, geneticist, or bioengineer to speak to your class about their profession.

Links to National Science Education Standards

Grades 6-8

Content Standard	Student Understanding
Content Standard A Abilities Necessary to Do Scientific Inquiry	• Identify questions that can be answered through scientific investigations. • Think critically and logically to make the relationships between evidence and explanations.
Content Standard A Understandings About Scientific Inquiry	• Current scientific knowledge and understanding guide scientific investigations. • Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for an investigation, or develop new technologies to improve the collection of data.
Content Standard C Reproduction and Heredity	• Every organism requires a set of instructions for specifying its traits. • Hereditary information is contained in genes, located in the chromosomes of each cell.
Content Standard C Structure and Function in Living Systems	• All organisms are composed of cells—the fundamental unit of life. • Specialized cells perform specialized functions in multicellular organisms.
Content Standard E Understandings About Science and Technology	• Many different people in different cultures have made and continue to make contributions to science and technology.
Content Standard G Science as a Human Endeavor	• Women and men of various social and ethnic backgrounds—and with diverse interests, talents, qualities, and motivations—engage in the activities of science, engineering, and related fields such as the health professions.

Links to National Science Education Standards

Grades 9-12

Content Standard	Student Understanding
Content Standard A Abilities Necessary to Do Scientific Inquiry	• Identify questions and concepts that guide scientific investigations. • Design and conduct investigations.
Content Standard A Understandings About Scientific Inquiry	• Scientists conduct investigations for a wide variety of reasons. • Results of scientific inquiry—new knowledge and methods—emerge from different types of investigations and public communication among scientists.
Content Standard C The Cell	• Cells store and use information to guide their functions.
Content Standard C The Molecular Basis of Heredity	• In all organisms, the instructions for specifying the characteristics of the organism are carried in DNA, a large polymer formed from subunits of four kinds (A, G, C, and T). • Changes in DNA (mutations) occur spontaneously at low rates.
Content Standard E Understandings About Science and Technology	• Science often advances with the introduction of new technologies.
Content Standard G Science as a Human Endeavor	• Individuals and teams have contributed to the scientific enterprise.

DNA and the Human Genome Project

Teacher Brief

Purpose
In this lesson, students will learn about DNA and how the Human Genome Project has advanced our knowledge about the DNA structure, genes, and how DNA research may improve our oral and overall health.

Exhibit Link
Saliva: A Remarkable Fluid, Bioengineering: Making a New You, Forensics: Solving Mysteries
The basis for each of the components of these exhibits is DNA. An understanding of DNA will help students understand its significance in forensic investigations and medical advances.

Background
DNA (deoxyribonucleic acid) is found inside the nucleus of a cell in tight bundles called chromosomes and contains all of our genetic information. This information is necessary to make a complete organism. Every cell in the human body, except red blood cells, has DNA. A person's genetic information is the same in each cell. Unless you are an identical twin, no one else in the world has the same genetic information as you.

The structure of DNA is a double helix with alternating sugar and phosphate along the sides. DNA is made up of four building blocks, which are arranged in pairs along very long strands. These building blocks or nucleotides are adenine (A), thymine (T), cytosine (C), and guanine (G). An A always pairs with a T and a C always pairs with a G. The human genome (complete set of DNA) has about 3 billion nucleotides. The order of the nucleotides in a DNA strand is a sequence.

Each person in the world has a unique sequence. We are all 99.9% the same; but our uniqueness is found in 0.1% of our DNA sequence. This uniqueness in our DNA sequence is what sets us apart from each other. Our DNA can be broken down into smaller parts called genes that are the hereditary units passed from parent to child.

Research on genes, gene therapy, and bioengineering has made significant advances due to a large international study, The Human Genome Project. With the completion of the Human Genome Project in 2003, scientists were able to identify all 21,009 genes in human DNA and read the 3 billion nucleotides that make-up the DNA structure. Through the use of this information, scientists are working on addressing oral health problems and finding ways for people to live healthier lives.

Standards Met
Grades 6-8 Content Standard C – Reproduction and Heredity
Grades 6-8 Content Standard C – Structure and Function in Living Systems
Grades 9-12 Content Standard C – The Cell
Grades 9-12 Content Standard C – The Molecular Basis of Heredity

DNA and the Human Genome Project

Pre-Visit Activity

Key Point
DNA is the structure that contains all of our genetic information. Studying DNA allows us to make advances in our oral and overall health.

Materials
Construction paper, tape, colored pencils or markers
Optional: Universal Genetic Code (found at http://learn.genetics.utah.edu/units/basics/transcribe)

Procedure
1. Display the word DNA on the board. Have students work in pairs to answer the following questions.
   - What is DNA? What do you know about it? Why is it important?
2. After a few minutes have a class discussion about these questions. Create a working definition of DNA for the class to use.
3. Discuss the shape of DNA and how its structure is made. Point out nucleotides and how an A always pairs with a T and a C with a G. In order for students to understand this structure, have them use construction paper to make their own DNA model. Each nucleotide should be represented by a different color. Tape nucleotide pairs together, and then tape the pairs to the sugar/phosphate sides.
4. Once students have completed their model, discuss how genes are sections of DNA that are passed on from a parent to a child. Introduce the Human Genome Project to students. Have a class discussion about its research and why it is important to our lives.
5. Have students work in their beginning pairs to discuss how DNA and genes can be used in forensics and medical research, focusing on oral health.
6. Create a list of possible uses of DNA and genes based on class discussion.

Modification
For high school students, introduce the concepts of gene transcription and translation. Talk about RNA and how proteins are made. Using the DNA models the students made, have them cut the DNA in half to form two strands. Place one strand onto a new sheet of construction paper. Label an RNA strand that would be coded for this section of DNA. Show students how to use the RNA strand to code for proteins. Pass out copies of the Universal Genetic Code so students can write down the proteins their RNA strand codes. Have a class discussion of the importance of proteins and how transcription and translation of a gene can affect your health.

Questions
1. What is DNA? Why is it important?
2. What are genes? How are they different from DNA?
3. How does the information from the Human Genome Project help researchers and forensic scientists?
4. What are possible uses of DNA, RNA, and genes?
5. How are DNA and our genes important to our oral health?

Saliva and Your DNA

Teacher Brief

Purpose
In order for students to understand how DNA is important to real-world applications, they will extract their own DNA from their saliva. DNA analysis, gene therapy, and stem cell research all need extracted DNA to complete investigations. Without our DNA, many forms of research could not be conducted.

Exhibit Link
Saliva: A Remarkable Fluid, Bioengineering: Making a New You, Forensics: Solving Mysteries
Each of these exhibits show how DNA extraction is important to different types of studies. Research in stem cells, gene therapy, and forensic DNA analysis all require the use of DNA from extracted from human cells.

Background
Our saliva is a good source of DNA because it contains many mouth and cheek cells. There are many different ways to get saliva for DNA testing. Saliva can be found on a phone after a conversation, on licked envelopes, toothbrushes, and anything else that may come in daily contact with your saliva and/or mouth.

There are many reasons why scientists use DNA to conduct research. It allows them to locate specific genes that cause diseases and learn how our body works and functions based on our genetic makeup. Gene therapy is a new technique used to replace "bad" genes with "good" genes to find cures for inherited diseases. Additionally, DNA research is looking for ways to improve our oral and overall health.

In this experiment, students will extract DNA from their saliva. Students need to swish with salt water as it helps to separate our DNA from RNA in cells. Dish soap is combined with the saliva water to remove the cell membranes so the DNA can be exposed. Alcohol is used in the last step to remove DNA from the soap-saliva liquid since DNA does not dissolve in alcohol. Scientists use DNA extraction not only for medical research to advance oral health but to identify people as well.

Note
If your school district does not allow bodily substances to be used, fruits (kiwis and strawberries work well) can be used in place of the saliva in this experiment. It will be necessary to add a pinch of meat tenderizer (enzyme) to the saliva cup before adding the alcohol.

Standards Met
Grades 6-8 Content Standard C – Reproduction and Heredity
Grades 6-8 Content Standard C – Structure and Function in Living Systems
Grades 9-12 Content Standard C – The Cell
Grades 9-12 Content Standard C – The Molecular Basis of Heredity

Saliva and Your DNA

Pre-Visit Activity

Key Point
DNA is found in most of our cells and can be extracted for scientific study and identification.

Materials

Small, clear drinking cups	Rubbing alcohol	Graduated
Table salt	Water	cylinder/measuring cup
Dish soap	Measuring spoons	Tape

Procedure*
PREP - Place a container of rubbing alcohol in the freezer at least one hour prior to the start of the experiment. Keep the alcohol in the freezer or on ice until ready to use, as the experiment will not work without cold alcohol.

1. Discuss with students where they can get DNA from their body. As a class, try to identify good sources of DNA that is easily obtainable. Explain that saliva is an excellent source of DNA as it contains cells from the mouth in it. Ask students if they have any ideas about how you can extract DNA from a cell. Have students work in pairs to complete the DNA extraction experiment. Do each step as a whole class so everyone spends the same amount of time swishing and waiting.
2. Have students work in groups to make a salt-water mixture and soap solution. Each group should collect two cups, salt, and soap. A cup for each group member is also needed.
3. Using tape, label the first cup "salt-water mixture." Measure ½ cup of water (100mL) and put in the cup. Add one tablespoon of salt to the water. Stir until the salt has dissolved into the water.
4. Label the second cup "soap solution." Measure three tablespoons (45 mL) of water and pour into the cup. Add 1 tablespoon (15 mL) of liquid dish soap (a colored one will work best) to the water. Stir to mix.
5. Measure one teaspoon (5mL) of the salt-water mixture from the first cup. Place the mixture into a cup that is labeled with the student's name. Swish the salt-water mixture in your mouth for one minute. When the time is up, spit the salt water back into your labeled cup.
6. Measure 1 teaspoon (5 mL) of the soap solution and add to the student labeled cup that has the salt-water mixture and saliva. Swirl the cup for one minute to gently mix.
7. Measure three tablespoons of rubbing alcohol and carefully add it to the student labeled cup. The experiment will work the best if the alcohol is carefully poured down the side of the cup so it does not mix with the soap.
8. Wait one – two minutes. Bubbles and small white strings will begin to appear. This is the extracted DNA.
9. Have partners discuss why DNA extraction would be important to science and oral health. Let each group write their ideas and report their ideas in a whole-group discussion. Make sure to discuss gene therapy, bioengineering, and forensics.

Questions

1. How can we get DNA from our bodies? What are good sources of DNA?
2. Why is DNA extraction important?

*Adapted from the Museum of Science and Industry

Forensic Investigation

Teacher Brief

Purpose
This lesson investigates how forensics is used in body identification.

Exhibit Link
Forensics: Solving Mysteries
In this exhibit, student have the opportunity to be part of a DMORT team where they have to identify victims based on their skulls, dental records, and DNA. Bitemark analysis is also discussed in the exhibit.

Background
DNA is used in some forensic cases to identify victims when other means of identification are not possible. DNA can also be used to catch a suspect. In order to identify someone based on their DNA, scientists need another sample of the person's DNA to match it to, for example, hair from a hairbrush, cells in a toothbrush, or teeth.

There are also other ways to identify suspects of a crime. In some cases, a victim is bitten by someone. This bite-mark can be compared to bite-marks made by different suspects. Saliva sometimes can be obtained from the bite-mark wound and used in DNA identification.

In the case of mass disasters, DMORT teams (Disaster Mortuary Operation Response Teams) are called in to help identify bodies. These teams are made up of different people specializing in certain fields. Forensic anthropologists are asked to find the gender and ethnic background of victims based on skull analysis. Forensic odontologists create postmortem dental records of each person to compare to ante mortem dental records. Using these records, most people in a mass disaster can be identified. Finally, a DNA biologist runs DNA testing on victims who could not be positively identified through dental records.

Standards Met
Grades 6-8 Content Standard A – Abilities Necessary to Do Scientific Inquiry
Grades 6-8 Content Standard A – Understandings About Scientific Inquiry
Grades 9-12 Content Standard A – Abilities Necessary to Do Scientific Inquiry
Grades 9-12 Content Standard A – Understandings About Scientific Inquiry

Forensic Investigation

Post-Visit Activity

Key Point
Forensic investigation is important for various crime scenes and disasters in order to positively identify victims. Odontology helps to identify many victims without having to perform DNA comparisons.

Materials
Scenario Sheet
Postmortem Dental Chart
Anthropology Chart
Identification Sheet
Investigation Report
Skulls/pictures of skulls (ask school science dept., order from a science supply company, contact a local college or university anthropology department borrow, or get pictures online)
Dental Radiographs (ask your dentist or nearby dental school for expired records to use)
Clue Box (one for each person or one box with folders about each person)

Middle School Prep
1. Obtain 3 radiographs from a dentist or science supply company. Label one as victim. This radiograph will then be used again as Molly Summer's dental record. Label the other x-rays, "Gary Park" and "April Smith."
2. Have one skull (model or pictures) available for students to examine. The skull should be a female, caucasian skull.
3. Make enough scenario, postmortem dental record, anthropology, identification, and investigation report sheets so each group receives one copy of each.
4. Gather 5 barcodes from food items (DNA Analysis). Make sure 2 of these barcodes match. Label the matching barcodes: "victim" and "Molly Summers." The other barcodes should be labeled "Gary Park," "Anne Jones," and "April Smith."
5. Do a run-through of the experiment to make sure all of your materials give a victim identification match to Molly Summers.

High School Prep
1. Create Clue Boxes for each possible victim. There should be 14 boxes to choose from. To keep data organized, set-up the lab so the following victims will be identified:
    a. Victim 1: Bob Manns
    b. Victim 2: Josh Beller
    c. Victim 3: Barry Jones
    d. Victim 4: Hillary Mott
    e. Victim 5: Vanessa Parkes
2. Gather 5 skulls or pictures for students to view. Make sure the skulls are as follows: 1 African-American female (Victim 5), 1 caucasian female (Victim 4), 1 African-American male (Victim 3), and 2 caucasian males (Victims 1 and 2). Label the skulls with the appropriate victim number.
3. Obtain 14 radiographs from a dentist or dental school. Choose five to be the victims' records and label them by victim number. These five records will be used by the students to create

postmortem dental records. Once students return the radiographs to you, relabel them by the victim's name and place in their proper files. These radiographs will be used for antemortem records. If you have problems obtaining 14 radiographs, see if you can locate 5 to use for the victims. The others could be antemortem dental records that you can make ahead of time using the postmortem dental chart template (pg. 15).

4. When students are working on their investigations make sure not hand out Bob Manns' or Josh Beller's antemortem dental records. Explain to the students that there were no antemortem dental records found for them.
5. Gather 19 barcodes. There should be two matching pairs. Have 5 labeled by victim numbers. Make sure victim 1 and victim 2 each have a match. Place names randomly on the last barcodes (DNA evidence).
6. Do a run-through of the experiment to make sure all of your materials work. Students should be able to identify victims 3-5 through anthropology and dental records. Victims 1 and 2 need DNA analysis to positively identify.

Procedure

1. Have students recall what they learned at the museum about forensics and identification. Explain to the class that they will be investigators today on an important case.
2. Middle school students will each complete the same investigation. High school students need to be placed into 5 different groups. Each group will work on identification of a particular victim.
3. Pass out the Scenario Sheet to each group of 3-5 students. Explain that they must go in order on their checklist. Papers to do activities will be kept with the Lead Investigator (the teacher) so one member from each group will need to ask you for all charts and pages when needed. Students may ask for information about a specific person but they may only collect the dental record first before they can receive DNA evidence.
4. Tell students to collect their data on the sheets they receive. Explain that investigations are confidential to protect the victims, so groups should not discuss their information with other groups.
5. Students should identify their victim's gender and race before creating the postmortem dental record. This postmortem dental record will be compared to antemortem radiographs/dental records.
6. For high school students, have a class discussion about victim identification after each group finished analyzing anthropology and dental evidence. See how many groups have made a positive identification and what made them successful. At this point, all but two victims should be identified. Have the whole class work on DNA analysis of the last two victims.
7. When each group has finished collecting evidence from anthropology, odontology, and DNA they will be required to write a group Investigation Report to be given to the Lead Investigator.
8. Have a class discussion about results, how they were obtained, and how different types of forensic evidence is needed to solve a person's identification. See if students know of other situations where this type of investigation would be helpful in victim identification.

Modifications

The Activity Sheets for the activity are separated for middle school and high school. These present an easier and harder version of a forensic investigation. You can also make the

investigation easier or harder by handing out more or less information. You may make it more difficult by not having many antemortem dental records available for students to compare. This would translate into more groups needing to complete DNA analysis to determine identification.

Questions

1. How do teeth aid in the identification of a victim?
2. What clues helped solve the case?
3. How can your investigation be compared to real-life situations?
4. Can you find a real case that used odontology to identify a victim?

Scenario

Middle School

Henry, an avid outdoors enthusiast, decided to go on a hiking trip with his friends. Throughout the day, they continued walking through the woods to reach the top of a mountain. As it was starting to get late, Henry and his friends decided to return to their car by taking a different trail. Halfway down the trail, they noticed something peculiar lying in the ground just a few yards away from the path. They decided to check it out. They couldn't believe their eyes! Coming out of the ground was a skeleton. The group decided to call the police to tell them what they discovered.

You are a crime scene investigator who has been called to look into this case. Your job is to:

- ☐ identify the person's gender and race
- ☐ create a postmortem dental record
- ☐ compare your evidence to missing person records
- ☐ run a DNA comparison, if needed

Keep all of your information in a journal to create a report at the end of your investigation.

If you have questions, you may ask the lead investigator (your teacher) at any time.

Good luck!

Scenario

High School

InspiraCorp, Inc., a leading marketing firm in the United States, just underwent recent building renovations. The updates proved to be disasterous. A massive fire occurred in the building due to faulty wiring and many personnel were not able to escape from the fire. Fourteen staff members need to be identified.

You are a crime scene investigator who has been called to look into this case. You have been given one of the victims to identify. Your job is to:

- ☐ identify the person's gender and race
- ☐ create a postmortem dental record
- ☐ compare your evidence to missing person records
- ☐ run a DNA comparison, if needed

Keep all of your information in a journal to create a report at the end of your investigation.

If you have questions, you may ask the lead investigator (your teacher) at any time.

Good luck!

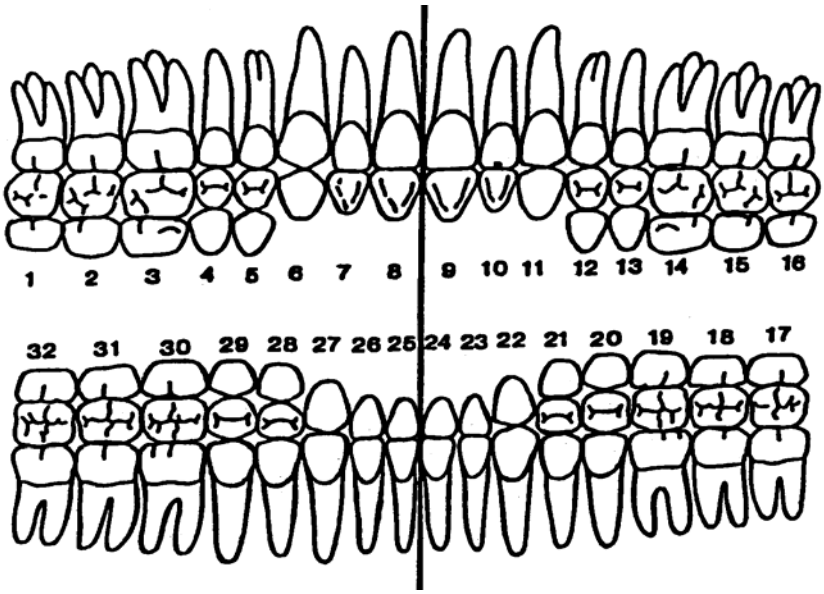
Postmortem Dental Record

Middle and High School

Case or Victim #: _____ Date: _____

Sex: _____ Ancestry: _____

Team Members: _____



Code	Name	Definition
MOA	Mesial Occlusal Amalgam	• On biting surface & surface closest to chin/nose • Silver material
DOA	Distal Occlusal Amalgam	• On biting surface & surface farthest from chin/nose • Silver material
OA	Occlusal Amalgam	• On biting surface • Silver material
OR	Occlusal Resin	• On biting surface • Tooth-colored resin
X	Missing	• Tooth is missing from mouth

Tooth #	Code
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
31	
32	

Identification Sheet – Possible Victims

Middle School

Gary Park
Age: 38
Dental Records: Available
DNA Sample: Sample from toothbrush if needed
Last Seen: Driving home from work 3 years ago

Anne Jones
Age: 63
Dental Records: None available
DNA Sample: Sample from toothbrush available
Last Seen: 4 years ago at a park with her dog

Molly Summers
Age: 23
Dental Records: None available
DNA Sample: Hair strand available
Last Seen: Walking from her apartment building a year ago

April Smith
Age: 27
Dental Records: Available
DNA Sample: Hair strand available
Last Seen: 2 years ago at a friend's party

Damian Winters
Age: 32
Dental Records: None Available
DNA Sample: None Available
Last Seen: Leaving work 6 months ago

Identification Sheet

High School

Harry White

Bob Manns

Barry Jones

Jan McNeil

Joan Harris

Matt Simms

Veronica Hall

Thomas Boyd

Natalie Keys

Vanessa Parkes

Tony Franks

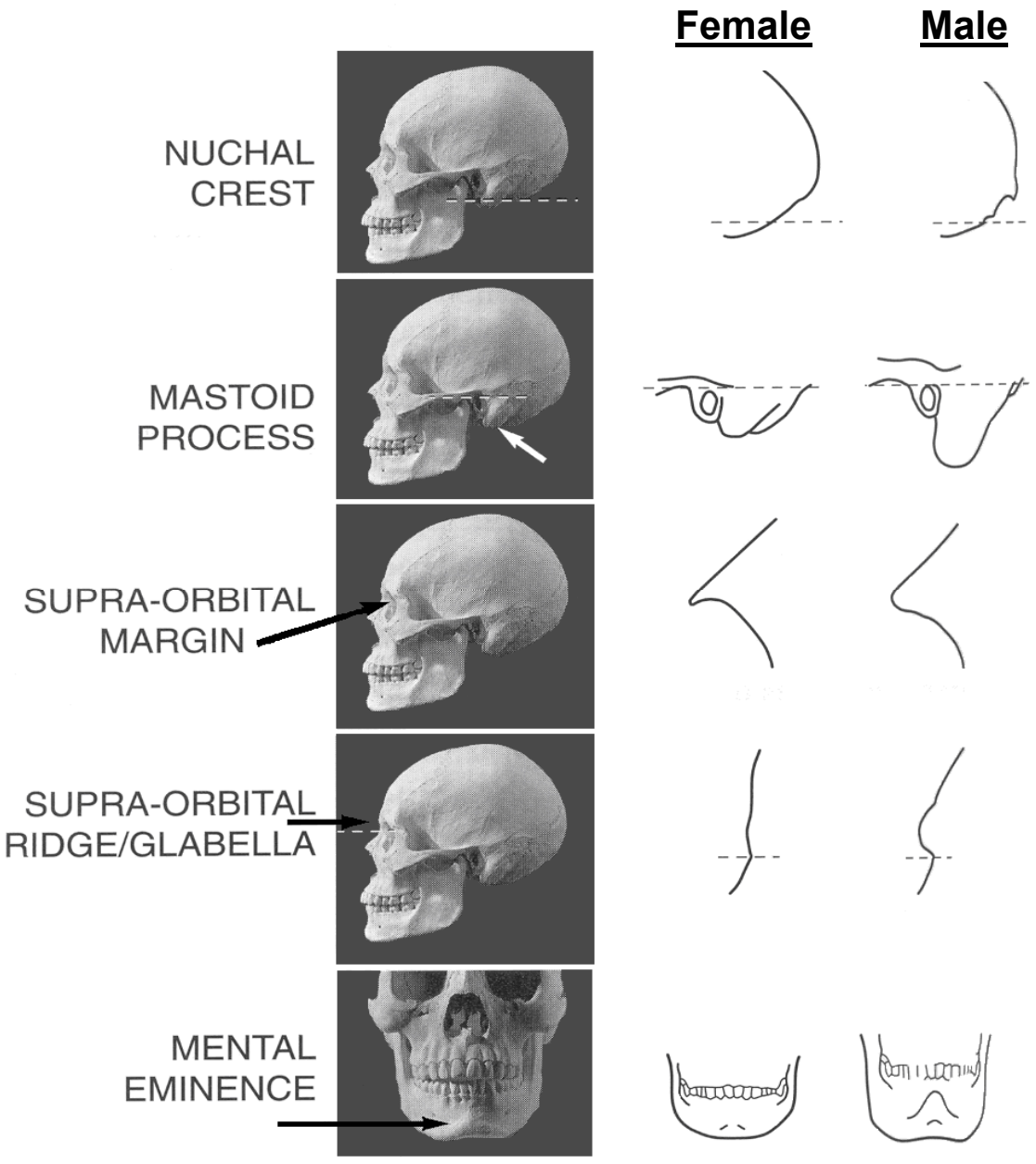
Hilary Mott

Josh Beller

Jada Watts

Anthropology Chart

Middle and High School



To determine ethnicity, measure the nasal opening on the skull. Use the following calculation:

Measurement ÷ 2 – 13 = _____

If your answer is less than 0, the skull is from Caucasian ancestry. If your answer is greater than 0, the skull is from African American ancestry.

Investigation Report

Middle and High School

Names of Investigators _____

Evidence
What evidence helped you identify the victim?

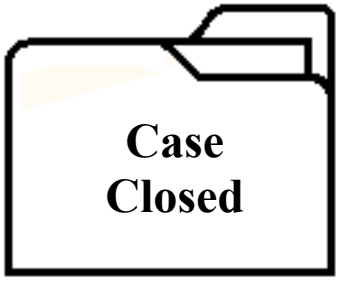
_____
_____
_____
_____
_____

Identification
Who did you identify? Write the victim number, if applicable.

_____
_____

Explanation
How do you know you postively identified the victim?

_____
_____
_____
_____
_____
_____
_____
_____
_____



The Future of Oral Health

Teacher Brief

Purpose
This lesson shows that advances in DNA have been made due to a large number of diverse researchers. These scientists are providing medical advances to help us have better oral health.

Exhibit Link
Saliva: A Remarkable Fluid, Bioengineering: Making a New You
Both of these exhibits show advances in oral healthcare as a result of gene therapy and bioengineerring through the work of different people in various professions.

Background
Misspellings of our DNA can sometimes cause problems for us. If the misspelling affects our genes they in turn can produce a wrong protein which can lead to disease. Gene therapy is currently being studied to fix harmful misspellings. One disease being studied is Sjögren's Syndrome, a disease that causes severe dry mouth. Another technique being implemented in medical advancement is stem cell research.

A stem cell is an unspecialized cell that has the ability to renew itself for a long period of time and is able to turn into a specialized cell when given the appropriate signal. Every cell in the body start out as a stem cell before turning into a specialized cell. Stem cells divide slowly until they receive the signal to differentiate, or change, into a specific cell type. When the stem cells start to differentiate, the signal turns on specific genes to have the cell make new proteins. These proteins, in turn, help the cell look and function like the specialized cell. Once a stem cell has finished changing into a specialized cell it stops dividing itself.

Stem cell research is being studied to replace faulty cells with new ones. These new cells would be reintroduced into the body in order to correct the problem. Current studies are underway to improve oral health. Using stem cells from wisdom teeth and recently extracted baby teeth, scientists are researching ways to grow new teeth to replace ones we have lost.

Standards Met
Grades 6-8 Content Standard E – Understandings About Science and Technology
Grades 9-12 Content Standard E – Understandings About Science and Technology
Grades 6-8 Content Standard G – Science as a Human Endeavor
Grades 9-12 Content Standard G – Science as a Human Endeavor

The Future of Oral Health

Post-Visit Activity

Key Point
Misspellings in our DNA can cause our genes to code wrong proteins. This can result in a person developing a disease. Current research by scientists around the world are looking at DNA, genes, and bioengineering to help improve our oral health.

Materials
Tissues or cotton balls, clock, and computer with internet access or books, journals, and articles about oral health advances

Procedure
1. Explain to the class that you are going to do an experiment today. Tell students that they will each receive two tissues or a few cotton balls to put in their mouths and leave them there for a few minutes. Have the students start and stop at the same time. Make sure they leave the tissues/cotton balls in their mouths for 1-2 minutes.
2. Have a class discussion about what happened to their mouths. Ask if anyone can recall learning about a similar problem while at the museum (Sjögren's Syndrome).
3. Let students work in small groups or pairs to talk about what they know about Sjögren's Syndrome. Gather the class back together for a group discussion about the condition.
4. Discuss how DNA research has helped our oral health. Ask students to recall what they learned about gene therapy and bioengineering. Also, discuss with student who they think is doing these scientific investigations. Explain that people of different genders and ethnicities are working on improving our health.
5. Students will investigate further the topics of DNA, gene therapy, and bioengineering as they research advancements in oral health care on the internet or through library resources. Students should also note who is conducting the research and where they are from.
6. Have each group present a report on what they found and how this research will affect a future visit to the dentist. Each group will also come up with at least three ideas of what else scientists could study to improve our oral health (ex. gene therapy to end oral cancer).

Modifications
High school students may research one of their ideas that could improve oral health and see what research has been done on the topic. They could even write a theory about how to conduct research on the specific problem, why there needs to be a cure, and what the positive outcomes would be.

Have a class discussion specifically on stem cells and what types are being studied to improve oral health and grow teeth. Be sure to consider what this research means for the future and if people should bank their teeth to use the stem cells in the future.

Questions
1. How does the condition of dry mouth feel?
2. Why would scientists research a cure for Sjögren's Syndrome?
3. What has been done so far in DNA research, gene therapy, and bioengineering?
4. What do you think scientists could study in the future to improve our oral health?

Glossary

Bioengineering	Use of engineering to solve problems in medicine and biology
Cell	Basic unit of any living organism
Chromosome	Long strand of DNA that is bundled in the nucleus of a cell
DNA	Also known as deoxyribonucleic acid, it is found inside the nucleus of a cell and contains all genetic information
Enzyme	A protein that encourages a biochemical reaction, usually speeding it up
Forensic science	Use of science to answer questions for the legal system
Gene	Unit of heredity from DNA passed from parent to child
Gene therapy	A technique used to treat inherited disease
Genetics	Study of inheritance patterns of specific traits
Genome	Complete set of genes
Genomics	Study of genes and their function
Human Genome Project	International research project to map each human gene and to completely sequence human DNA
Nucleus	Central cell structure that contains chromosomes
Odontology	The scientific study of teeth. In forensics, it is often used to identify a victim by his/her teeth or a suspect by his/her bite-mark
Protein	A large complex molecule made up of amino acids that performs a variety of activities in the cell
Stem cell	Unspecialized cell that has the ability to renew itself for a long period of time and is able to turn into a specialized cell when given the appropriate signal