

# Exhibit Guide for Teachers

## Grades 6-12



## Acknowledgements

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## Overview and Planning for a Field Trip

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### What is Your Spitting Image: What Your Mouth Says About You?

See what's in your saliva, solve crimes and identify victims, and understand how scientists might some day be able to grow replacement teeth. Discover how the genetic secrets unlocked by the Human Genome Project are changing the future of oral health in this interactive exhibition featuring:

#### FORENSICS Solving Mysteries

Step into the role of a member of a disaster recovery team and learn how to identify victims of a mass disaster. Discover how to identify gender and ethnicity from skull structure, create dental charts, and analyze radiographs to make identifications. Then explore how DNA extracted from teeth can identify victims in the absence of dental records.

#### SALIVA A Remarkable Fluid

Take an interactive odyssey through your mouth to discover that oft-ignored, but oh-so-essential liquid that protects your teeth, aids in digestion, and improves your sense of taste. Learn what saliva is made of, how it works in the body, and what happens to your oral health and overall health if the salivary glands become impaired. Plus, learn about what you can do to fight bacteria in your mouth.

#### BIOENGINEERING Making A New You

Can you imagine replacing a missing tooth with a new tooth grown from your own cells? Trace the history of tooth replacement from the ancient Egyptians to today, explore how researchers are using adult stem cells (found in the pulp of baby teeth and adult teeth) to begin growing natural teeth replacements. Discover careers that could help make this research a reality.

Support for *Your Spitting Image* is provided by:

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## 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
<b>Content Standard A</b> Abilities Necessary to Do Scientific Inquiry	<ul style="list-style-type: none"> <li>Identify questions that can be answered through scientific investigations.</li> <li>Think critically and logically to make the relationships between evidence and explanations.</li> </ul>
<b>Content Standard A</b> Understandings About Scientific Inquiry	<ul style="list-style-type: none"> <li>Current scientific knowledge and understanding guide scientific investigations.</li> <li>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.</li> </ul>
<b>Content Standard C</b> Reproduction and Heredity	<ul style="list-style-type: none"> <li>Every organism requires a set of instructions for specifying its traits.</li> <li>Hereditary information is contained in genes, located in the chromosomes of each cell.</li> </ul>
<b>Content Standard C</b> Structure and Function in Living Systems	<ul style="list-style-type: none"> <li>All organisms are composed of cells—the fundamental unit of life.</li> <li>Specialized cells perform specialized functions in multicellular organisms.</li> </ul>
<b>Content Standard E</b> Understandings About Science and Technology	<ul style="list-style-type: none"> <li>Many different people in different cultures have made and continue to make contributions to science and technology.</li> </ul>
<b>Content Standard G</b> Science as a Human Endeavor	<ul style="list-style-type: none"> <li>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.</li> </ul>

## Links to National Science Education Standards

### Grades 9-12

Content Standard	Student Understanding
<b>Content Standard A</b> Abilities Necessary to Do Scientific Inquiry	<ul style="list-style-type: none"><li>• Identify questions and concepts that guide scientific investigations.</li><li>• Design and conduct investigations.</li></ul>
<b>Content Standard A</b> Understandings About Scientific Inquiry	<ul style="list-style-type: none"><li>• Scientists conduct investigations for a wide variety of reasons.</li><li>• Results of scientific inquiry—new knowledge and methods—emerge from different types of investigations and public communication among scientists.</li></ul>
<b>Content Standard C</b> The Cell	<ul style="list-style-type: none"><li>• Cells store and use information to guide their functions.</li></ul>
<b>Content Standard C</b> The Molecular Basis of Heredity	<ul style="list-style-type: none"><li>• 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).</li><li>• Changes in DNA (mutations) occur spontaneously at low rates.</li></ul>
<b>Content Standard E</b> Understandings About Science and Technology	<ul style="list-style-type: none"><li>• Science often advances with the introduction of new technologies.</li></ul>
<b>Content Standard G</b> Science as a Human Endeavor	<ul style="list-style-type: none"><li>• Individuals and teams have contributed to the scientific enterprise.</li></ul>

# DNA and the Human Genome Project

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## 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 oral health advancements.

### **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

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## 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, 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 oral health research.
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?

## 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 extracted DNA.

## 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 oral health research 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 are 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

## **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 their task is to identify victims based on their skulls, dental records, and DNA. Bitemark analysis is also discussed in the exhibit.

## **Background**

In some forensic cases, DNA is used 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 find a DNA comparison sample, oftentimes from hair in a hairbrush, cells in a toothbrush, or teeth.

In addition to DNA, there are other ways to identify suspects of a crime. In cases where a victim has been bitten by someone, the bitemark can be compared to bitemarks made by different suspects. Sometimes, saliva can be obtained from the bitemark 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 antemortem dental records. Using these records, most people in a mass disaster can be identified. Finally, a DNA biologist runs DNA testing on victims who were not 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

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## Post-Visit Activity

### Key Point

Forensic investigation is important in crime scene and mass disaster situations in order to positively identify victims. Odontology helps to identify many victims without having to perform DNA comparisons.

### Materials

Postmortem Dental Radiographs Sheets  
Antemortem Dental Radiograph Sheets  
Scenario Sheet  
Postmortem Dental Chart  
Investigation Report  
File Folders

### Prep

1. Print off 5 copies of the scenario sheets, postmortem dental charts, antemortem dental radiograph sheets, and investigation reports. Each group will receive one copy of each paper.
2. Print off one set of postmortem dental radiograph sheets. Each group will only receive one postmortem dental radiograph from one victim.
3. Create five file folders. Label each folder with a victim number (victim #1-#5). Place one scenario sheet, postmortem dental chart, investigation report, and the corresponding dental record for the victim in the folder.

### 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. Divide the class into five groups. Each group will have a different victim to identify (victims 1-5).
3. Pass out one file folder to each group of 4-6 students. Explain that they must go in order on their checklist. Make sure each group has a different victim.
4. Explain to the class that you are the Lead Investigator for the disaster scene. All questions should be directed to you. Tell students that after they have completed their postmortem dental chart, based on the radiograph they received, one representative from the group will need to report to the Lead Investigator to obtain antemortem dental radiographs.
5. Tell students to collect their data on the Investigation Reports. Explain that investigations are confidential to protect the victims, so groups should not discuss their information with other groups.
6. In groups, have students work together to complete the postmortem dental chart of their victim. When finished, give one set of antemortem dental radiographs to a group representative.
7. Once all groups have made proper identifications, have each group complete the investigation report.
8. As a class, discuss victim identification and how dental evidence is used. Talk about how it would be different if you were not able to make a positive identification based on dental

evidence. Make sure to also discuss the results of the investigation. See if students know of other situations where this type of investigation would be helpful in victim identification.

### **Modifications**

To make the investigation even harder, you may want to find some skulls to do gender and ancestry identification. In addition, a dna analysis could be performed to find additional victims.

### **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?

### **Teacher Answer Key**

Victim #1 – Damian Winters

Victim #2 – Natalie Keys

Victim #3 – Josh Beller

Victim #4 – April Smith

Victim #5 – Harry Manns

Note: None of the names are of actual victims. The scenario and victims are fictitious.

## Scenario

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InspiraCorp, Inc., a leading marketing firm in the United States, just underwent recent building renovations. The updates proved to be disastrous. 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:

- create a postmortem dental record
- compare your evidence to antemortem dental records
- complete investigation report

Keep all of your information in your file folder to complete your investigation report .

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

Good luck!

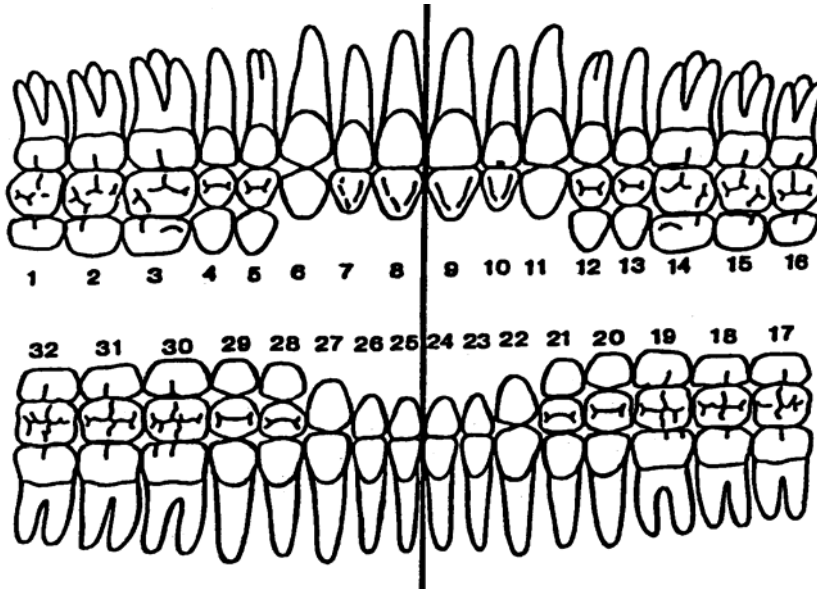


# Postmortem Dental Record

Team Members: \_\_\_\_\_

Victim #: \_\_\_\_\_

Date: \_\_\_\_\_



Tooth #	Code
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
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Code	Name	Definition
MOA	Mesial Occlusal Amalgam	<ul style="list-style-type: none"> <li>On biting surface &amp; surface closest to chin/nose</li> <li>Silver material</li> </ul>
DOA	Distal Occlusal Amalgam	<ul style="list-style-type: none"> <li>On biting surface &amp; surface farthest from chin/nose</li> <li>Silver material</li> </ul>
OA	Occlusal Amalgam	<ul style="list-style-type: none"> <li>On biting surface</li> <li>Silver material</li> </ul>
OR	Occlusal Resin	<ul style="list-style-type: none"> <li>On biting surface</li> <li>Tooth-colored resin</li> </ul>
X	Missing	<ul style="list-style-type: none"> <li>Tooth is missing from mouth</li> </ul>

# Investigation Report

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Names of Investigators: \_\_\_\_\_

## Identification

Who did you identify? Write the victim number and the name of the victim.

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## Evidence

How do you know you made a positive identification?

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## Explanation

Why are teeth important in the identification of a victim?

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## Further Investigation

Besides using dental records and radiographs, what else can be used to identify a person? How?

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### **Purpose**

This lesson will explore the connection between oral and overall health. In addition, students will look into current oral health research and see what advancements are being made to improve our lives in the future.

### **Exhibit Link**

*Saliva: A Remarkable Fluid, Bioengineering: Making a New You*

The Saliva exhibit investigates the mouth-body connection of health. Both of these exhibits show advances in oral healthcare as a result of gene therapy and bioengineering research completed by various professionals with different kinds of backgrounds.

### **Background**

Emerging scientific research suggests a link between periodontitis, advanced gum disease, and some health problems. Bacteria that causes periodontitis can enter the bloodstream and have an affect on other systemic conditions, such as heart disease, diabetes, and stroke. Oral bacteria entering the bloodstream due to advanced gum disease may attach to fatty plaques in the arteries surrounding the heart helping to form clots and could lead to a heart attack. The link between advanced periodontal disease and diabetes may be a two-way street. Diabetics develop gum disease more easily because diabetes slows the body's natural healing process and blood-sugar levels may be adversely affected by advanced gum disease. Oral bacteria entering the bloodstream due to advanced gum disease may attach to fatty plaques in the arteries of the brain helping to form clots, which can block blood flow and lead to a stroke.

In addition to a mouth-body connection, researchers are trying to find ways to improve oral health for the future. These studies include gene therapy and bioengineering. To end oral diseases, such as Sjögren's Syndrome, scientists are looking into gene therapy techniques to correct misspellings in DNA. Through bioengineering, researchers are using stem cells from wisdom teeth and recently extracted baby teeth to find ways to grow new teeth to replace lost permanent teeth.

### **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

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## Post-Visit Activity

### Key Point

Researchers are studying DNA, gene therapy, and bioengineering to understand the mouth-body health connection and improve oral health in the future.

### Materials

Computers with internet access or books, journals, and articles about oral health advances

### Procedure

1. Display the words “Mouth-Body Connection” on the board. Explain to the class that the mouth-body health connection was discussed on their field trip visit. Have students discuss what the mouth-body connection means and how it can affect oral and overall health.
2. Gather the class back together for a whole group discussion on this topic. Explain that our oral health can help us know more about our overall health. Tell students that the healthier we can keep our mouth, through regular brushing, flossing, mouthrinse use, healthy eating and regular dental visit, the better our oral health will be. This in turn may even help our overall health. Even if we keep our mouths in tip-top shape, there are some oral health issues that may affect us.
3. Ask students what other oral health issues they learned about at their museum visit (Sjögren’s Syndrome, bioengineering, and gene therapy).
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 various backgrounds are working on improving our oral and overall health.
5. Have the class divide into four groups. Each group will be assigned one topic to investigate: the mouth-body health connections, DNA, gene therapy, and bioengineering. The groups will research their topic, noting what advances are being made, who is conducting the research, and how this research may affect our oral and overall health in the future.
6. Have each group give an oral presentation and write a report on their findings.
7. After the presentations, have the class come up with more ideas that researchers could investigate to improve our oral health.

### Questions

1. What is the mouth-body health connection?
2. How can scientific research improve our oral and overall health?
3. What has been done so far in DNA research, gene therapy, and bioengineering to improve oral health?
4. What do you think this research will mean to the future of dentistry?
5. What do you think scientists could study in the future to improve our oral health?

# Glossary

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<b>Bioengineering</b>	Use of engineering to solve problems in medicine and biology
<b>Cell</b>	Basic unit of any living organism
<b>Chromosome</b>	Long strand of DNA that is bundled in the nucleus of a cell
<b>DNA</b>	Also known as deoxyribonucleic acid, it is found inside the nucleus of a cell and contains all genetic information
<b>Enzyme</b>	A protein that encourages a biochemical reaction, usually speeding it up
<b>Forensic science</b>	Use of science to answer questions for the legal system
<b>Gene</b>	Unit of heredity from DNA passed from parent to child
<b>Gene therapy</b>	A technique used to treat inherited disease
<b>Genetics</b>	Study of inheritance patterns of specific traits
<b>Genome</b>	Complete set of genes
<b>Genomics</b>	Study of genes and their function
<b>Human Genome Project</b>	International research project to map each human gene and to completely sequence human DNA
<b>Nucleus</b>	Central cell structure that contains chromosomes
<b>Odontology</b>	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
<b>Protein</b>	A large complex molecule made up of amino acids that performs a variety of activities in the cell
<b>Stem cell</b>	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