The Future of Oral Health

Teacher Brief

Purpose
This lesson will explore the future of oral health and a visit to the dentist.

Online Activities Link
Bioengineering Activity

Exhibit Link
Saliva: A Remarkable Fluid, Bioengineering: Making a New You
The Saliva exhibit investigates the mouth-body connection of health. Both of these sections of the exhibit show advances in oral healthcare as a result of gene therapy and bioengineerring research completed by various professionals with different kinds of backgrounds.

Background
Through emerging scientific research, a visit to the dentist will be different in the future. Current steps are underway to learn about a connection between oral health and a person's overall health. Once this can be determined, dentistry will not only pertain to teeth but taking care of your whole body as well. With this new mouth-body connection, scientists are conducting research to find ways for people to have healthy smiles that will last a lifetime.

Currently, dentures and implants are used to help a person maintain a healthy smile if he loses his teeth. Scientists are discovering ways to grow teeth in the future by using stem cells from baby and wisdom teeth. With these breakthroughs, people will have more options when deciding how to maintain their smiles.

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Lesson Plan

Key Point
Researchers are studying ways to grow teeth in the future and use gene therapeutics to improve a person's oral and overall health.

Materials
Tooth Timeline Module
Exhibit Text Worksheet

Procedure
1. Ask students what happens if they don't take good care of their teeth. Have them talk about what happens if you are missing teeth. Explain that currently implants and dentures are the only ways to replace lost teeth.
2. Ask students if they know of any research about growing teeth.
3. As a class, watch the Bioengineering Activity found on the YSI website (http://www.dentalmuseum.org/ysi/activities/) to see advances in oral care.
4. Explain that soon, we may be able to grow new teeth if we need a replacement.
5. As a class, discuss these advances in oral health and how they might change dentistry and the dental office.
6. Have each student explore the future of dentistry and oral health by reading the Exhibit Text Worksheet. If time permits, students may research the internet or read journal articles to find more information.
7. Once they have gathered some information, have each student write a creative writing piece about the future of dentistry and/or a dental visit in the future. They may write a poem, short story, essay, or any other style of their choosing.
8. If needed, allow students time to brainstorm in small groups.
9. Let each student share their writing piece with the class.

Questions
1. What is the future of dentistry and oral health?
2. What might a visit to the dentist look like in the future?
3. How are scientists growing teeth to replace missing teeth?
4. What do you think scientists could study in the future to improve our oral health?

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Exhibit Text

I've Lost a Tooth: Now What?
The earliest form of bioengineering began with the use of biomaterials – any substance other than foods or drugs used for patient treatment. Those uses have evolved from holding teeth in place with gold wires and bands to filling holes in teeth with gold, platinum, tin and silver amalgam to using metallic implants as replacements for lost teeth. Imagine a time when you will be able to replace a diseased or missing tooth with a new one grown from your own stem cells.

The next step in the evolution of bioengineering is the advancement of tissue engineering and gene therapy. Tissue engineering researchers are developing ways to design and fabricate new tissues and organs while other bioengineering researchers are studying ways to treat oral and systemic diseases using genes.

Growing Teeth: Is That Possible?
Researchers are working on ways to grow teeth right now – and they are using adult stem cells found in and around teeth to do it.

What is the ideal replacement for a lost tooth?
A natural tooth formed from adult dental stem cells obtained from the patient's own teeth would make the best replacement for a lost tooth. Why?

- Natural teeth are held in place by fibers that allow it to move
  - An artificial implant is embedded in bone and cannot move.
- The fibers holding a tooth in place (periodontal ligament) cushion biting forces, which maintains the surrounding bone.
  - Artificial implants do not have periodontal ligaments to cushion forces, which can lead to bone resorption and ultimately implant failure.
- Natural teeth can tell your body when something is wrong with it; an implant cannot.
- Gum tissue will attach to a natural tooth. Gum tissue does not attach to an implant.

Where are stem cells that form dental tissue found?

- On the inside wall (dentin) next to the nerve and blood vessels (pulp) and in the pulp itself of baby teeth that have fallen out
- In the nerve and blood vessels (pulp) from extracted adult teeth
- At the developing tip of the tooth root
- In the fibers that hold the teeth into their sockets (periodontal ligament)

How are researchers using them?
Researchers have used stem cells obtained from pig teeth and the baby teeth from rats to successfully grow structures resembling perfectly formed small tooth crowns.

- The cells are placed into/onto biodegradable scaffolds. After 12-30 weeks tiny crown-like structures were observed.
- These structures were made up of all of the various cells that make up a naturally formed tooth crown and were shaped much like normal tooth crowns.

Researchers have also used stem cells harvested from the tips of tooth roots and the fibers that hold the teeth into their sockets (periodontal ligament) of adult wisdom teeth to grow tooth roots.

- The stem cells were placed into/onto a root-shaped biomaterial scaffold.
- This structure was then inserted as a replacement for a tooth extracted from a pig.
- After three months, the new bio-root was uncovered and an artificial porcelain crown was attached to the new root structure. The bio-root/artificial crown unit functioned during a four-week observational period.

Finding a Cure: Are Genes the Key?
The completing of the Human Genome Project has advanced our understanding of human genes and their function. Today, research is exploring ways to use genes as diagnostic tools and for treatments and cures for systemic disorders such as diabetes.

Gene Therapeutics
Gene therapeutics is a promising approach for the treatment of some systemic disorders like diabetes. Scientists are even beginning to learn how to customize or individualize drug therapy (often termed pharmacogenomics). Gene therapeutics involves placing the gene of the missing protein into cells that normally do not make protein. Those cells then begin to make that protein.

- Getting the gene into target cells is called gene transfer and involves using an inactive virus (viral vector) to carry the gene.
- Millions of viral vectors carrying the gene are injected or infused into the desired site.
- The viruses infect the target cells inserting the genes into the cells.
- Once inside the cell, the gene causes the cell to make the desired protein.

Why salivary glands make great protein factories.

- They are covered with connective tissue (encapsulated), limiting the spread of the viral vector carriers and gene.
- Getting to them is relatively easy.
- They make large amounts of protein that either goes into saliva or the blood stream.
- A single salivary gland is not critical for life and can be removed if there is a problem.

How does it work?
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Gene therapeutics is just one of the many advances made possible by the Human Genome Project that will affect the oral and systemic health of future generations.

Gene Transfer: Restoring Saliva, Restoring Hope
The debilitating condition of dry mouth may soon be cured by transferring the gene coding for the Aquaporin-1 protein into the duct cells of non-functioning salivary glands. The Aquaporin-1 protein opens microscopic holes in cell walls allowing water to pass through them. This allows salivary gland duct cells to produce saliva.

Steps to Restore Salivary Gland Function
- Identify the gene that codes for the Aquaporin-1 protein
- Choose an appropriate vector (usually an inactive virus)
- Multiply the gene and vector
- Place one copy of the gene into one vector
- Infuse the vectors into the salivary gland
- Test the results
    - Possible Outcomes
        - Correction (cure) of the disease or condition
        - No change in the disease or condition
        - Side effects – immune response to the vector or diffusion of the vector outside the target organ

The Future
- There is currently no cure for permanent salivary gland damage; therefore, altering salivary gland function through gene therapy has become one of dentistry's chief concerns. The promise of current gene transfer research may soon result in the day when people with chronic dry mouth celebrate a cure by recycling their plastic sip-cups and enjoying a life without the constant worry of moistening their mouths.