Bay Area Scientists in Schools Presentation Plan

Lesson Name Protect that Pill!

Presenter(s) **BioE Team**

Grade Level 3-5 **Standards Connection(s)** digestive system, engineering

CA Science Standards Connections: 5th Grade, Life Science

5-LS-2. Plants and animals have structures for respiration, digestion, waste disposal, and transport of materials. As a basis for understanding this concept:

a. Students know many multicellular organisms have specialized structures to support the transport of materials.

b. Students know how blood circulates through the heart chambers, lungs, and body and how carbon dioxide (CO2) and oxygen (O2) are exchanged in the lungs and tissues.

Next Generation Science Standards Connections: 4th Grade, Life Science

4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. Develop a model to describe phenomena. (4-PS4-2) Use a model to test interactions concerning the functioning of a natural system. (4-LS1-2)	**LS1.A: Structure and Function** Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)	**Systems and System Models** A system can be described in terms of its components and their interactions. (5-LS2-1)

Common Core Standards:

ELA/Literacy:

W.4.8 Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources.

Mathematics:

MP.2 Reason abstractly and quantitatively.

FOSS Connections:

3rd Grade Module: *Structures of Life*

Investigation 4: *Human Body*

5th Grade Module: *Living Systems*

Investigation 3: *Transport Systems*

Teaser:

If you have ever needed to swallow a pill, you can thank bioengineers for making it a little easier! In this lesson, students will learn about coating that protects the chemical components of a pill in order for it to work correctly. Then, students will engineer their own protective pill coating and put it to the test!

Objective:

Students will reinforce their knowledge of the different parts of the digestive system and explore the concept of simulation by developing a pill coating that can withstand the churning actions and acidic environment found in the stomach. Teams will test the coating durability by using clear soda to simulate stomach acid.

Vocabulary/Definitions: *3 – 6 important (new) words*

- Bioengineering- the use of artificial tissues, organs or organ components to replace damaged or absent parts of the body.
- Biomedical engineer- a person who blends engineering techniques with biology and medicine to improve human health.
- Enteric- a medicine that will treat a patient by passing through the stomach and dissolving in the intestines
- Simulation- Imitating the behavior of something
- Soluble- able to be dissolved or liquefied

Materials:

What will you bring with you?	*What should students have ready?*
Flour Cornstarch Sugar Vegetable oil Paper plates, cups Clear plastic cups, spoons Clear diet soda Color-coated candy (Skittles, Runts) Worksheets	Pencils Permanent markers for groups

Classroom Set-up: *Student grouping, Power/Water, Projector, Light/Dark,*
Students will be set up into groups of 2-3. We will need a sink to dump out the soda after the experiment.

Classroom Visit

1. **Personal Introduction:** _____3____ **Minutes**
   We are bioengineers/scientists from UC Berkeley. We study the human body and try to design and create things to help us get better, faster!

   Topic Introduction: ____5_____ **Minutes**
   What questions will you ask to learn from students? Big Idea(s), vocabulary, assessing prior knowledge…
   How many of you have ever had a fever, headache or stomach ache? What did you do to make yourself feel better? (*listen to answers, see if someone brings up medication*) Taking medication when we are sick can be very important but some people can be very sensitive to medicine. Engineers have come up with protective coatings for pills so that pills don't dissolve in our stomachs, which can make some people feel even worse. These are called enteric medicines and need to dissolve in our intestines, not in our stomachs. Since you have already learned about the digestive system, you know that food passes through our stomach first. Your job will be to make a coating for a pill that is soluble (which means it dissolves) but will not dissolve in the stomach.

2. **Learning Experience(s):** ___25____ **Minutes**
   What will you do, what will kids do? Demonstrations, hands-on activities, images, games, discussion, writing, measuring… Describe in order, including instructions to kids.

   1. Divide the class into groups of two or three students each.
   2. Pass out worksheets and materials to each group (see Figure 1).
   3. Discuss with the class the different properties of each ingredient. Oil helps the dry ingredients stick together, helps make the mixture less sticky, and makes the coating less soluble. Flour and cornstarch are thickening agents with fairly similar properties. They also improve the workability of the overall mixture. Sugar thickens the mixture to some extent and makes the texture grainier, but can also make it less soluble when used in the right proportion, thereby improving its performance as a protective coating.
   4. Before any mixing is done, have student teams decide amongst themselves how much of each ingredient (in spoonfuls) they think they want in their coatings. These become their recipes, which they document on their worksheets.
   5. Following their recipes, direct students to begin mixing their coatings on paper plates (see Figure 1). If a team feels that more of a certain ingredient is called for, have them carefully measure it and add it into the mixture, remembering to make the changes to the recipe on their worksheets.

6. When a group has finished creating their coating mixture and recipe, have them apply the coating to a piece of candy (see Figure 2). Encourage students to make a thin and sleek design so the pill is easy to swallow, inexpensive to ship, and requires less packaging.
7. When all of the groups are finished, have a representative from each bring their coated candy to the front of the class. For each team, fill a plastic glass half full with clear soda, plus one extra cup of clear soda for an uncoated piece of candy (so students can see their coatings' effect on the dissolving rate of the candy). Label the cups with a marker so each group's cup can be easily identified.
8. With the timer ready, and at the same time, have students drop their coated candies into their cups of clear soda, while the teacher drops an uncoated candy into its cup of clear soda as a control (see Figure 3).
9. Allow the candy to sit in the soda for 10 minutes (see Figure 4). After several minutes, if the coatings do not look like they are dissolving, have one student from each group stir their coated candy in its soda cup until the 10 minutes is over. Ask students: How does this step simulates a pill going through the human digestive tract? (Answer: This simulates the acidic environment of the stomach, as well as its churning and agitating movement.) Why is it better to test the pill in a simulated environment rather than testing it on a human? (Possible answers: The coating could fail and make the person's stomach hurt, it is easier to observe how the pill dissolves in the simulated environment, etc.).
10. After 10 minutes have passed, have students remove their pieces of coated candy from the soda-filled cups (see Figure 5). As a class, make observations about which coating did the best job of protecting the candy "pill" and compare the coating recipes for each group to see what did and did not work. How did the coatings perform, compared to the uncoated control "pill," and compared to the various team recipes?

3. Wrap-up: Sharing Experiences **___20___ Minutes**

Putting the pieces together – how will students share learning, interpret experience, build vocabulary?

Have students calculate on their worksheets the fractions represented by each ingredient in their recipes. Compare recipes among teams, and discuss as a class, as described in the Assessment section. What are the relationships between performance and proportion of certain ingredients? What are the advantages and disadvantages of using certain materials?

Using what they learned from analyzing the testing results and original recipes, direct each group to write down a new and improved coating recipe. Following their new recipes, have each team mix up a new coating batch. Do not allow them to make changes to their recipes during this stage.

Repeat the same procedure for coating and testing, and then compare the results again as a class. What improvements were made?

4. Connections & Close: **___5____ Minutes**

What else might kids relate this to from their real-life experience? How can they learn more? Thanks and good-bye! Clean-up.

Conclude by reflecting on the activity in terms of the universal steps of the engineering design process: Ask, Imagine, Plan, Create and Improve, as described in the Assessment section. These are the steps engineers go through in designing new products and processes.

Total 60 Minutes

Follow-up – After Presentation

List all of the steps in the engineering design process as a class: Ask, Imagine, Plan, Create, Improve. Use the engineering design process graphic at the Museum of Boston's *Engineering is Elementary* website as an overhead transparency or slide for depicting the process to the class:http://www.teachersdomain.org/assets/wgbh/eng06/eng06_doc_lpaengprocess/eng06_doc_lpaengprocess.pdf

Have students research the different materials used as pill coatings and the different mechanical systems used to coat pills.

Redo the experiment and challenge the students to design their coatings based on taste, marketability, cost and ease of shipping and handling while still meeting a certain benchmark protection time (such as 10 minutes, 15 minutes, etc.) during the test phase.

Name: _____ Date: _____

Recipe and Fraction Worksheet

Recipe #1		
	Number of Spoonfuls	Fraction
oil		
sugar		
flour		
corn starch		
Total		

Recipe #2		
	Number of Spoonfuls	Fraction
oil		
sugar		
flour		
corn starch		
Total		

$$\text{Fraction} = \frac{\text{Number of spoonfuls of ingredient}}{\text{Total number of spoonfuls}}$$