**Background**

This case study discusses a group of six students preparing for the International Genetically Engineered Machine (IGEM) jamboree. The iGEM foundation is a non-profit organization that fosters innovation through competition. The iGEM jamboree is an international competition in which students from universities across the globe compete for the best innovative use of synthetic biology that strives to solve a real-world problem. The case begins with the students discussing potential topics for the IGEM competition, during which time the idea of lead contamination in drinking water is brought up. The students contemplate whether or not this is a problem that could be solved through synthetic biology. When researching the problem further, the team comes across various parts per billion (ppb) levels of lead and the associated response and listed by the Environmental Protection Agency (EPA). The team then questions the source of lead contamination, considering how the contamination increases as the distance from the site of water distribution increases. The case closes when the team discovers the key: water if not treated properly can corrode the lining of pipes, causing lead to leach into the water. Over the course of this 20- to 25-minute case, students are asked to brainstorm to better understand the principle of synthetic biology, to problem solve to apply synthetic biology in order to solve the lead contamination problem, and to interpret tables and graphs in order to predict the cause of the lead contamination problem. Students were able to approach and draw answers to these questions through the use of technology (for example, by using cell phones and computers, among other devices) and through collaboration with other students in small group settings. After roughly five minutes of small-group discussion, the class discussed the questions as a group and the answers were recorded.

**Objectives**

By the end of this case study, students should be able to:

* Understand the principles of synthetic biology
* Describe the application of synthetic biology to decontaminating lead from water
* List lead testing laboratory and home testing techniques
* Understand the mechanism through which drinking water becomes contaminated with lead

**Part I: iGEM (slides 1-6)**

In Part I, students will be introduced to iGEM, synthetic biology and the problem of lead contamination in drinking water. They will also be exposed to a real-life example of synthetic biology catered to decontaminate drinking water by removing the lead. Students will use their resources to better understand synthetic biology and apply it to the problem at hand. This part should take between 10 and 12 minutes to complete.

*Slide 0­­– Title and Credits*

*Slide 1– Objectives*. This slide allows the presenter to clearly state to the class the objectives of the activity while also stating the resources that are available to the students while they are working through the activity.

*Slide 2– Narrative of the case*. Read the case to the students, ask for volunteers to read the case to the class, or instruct the students to read silently on their own.

*Slide 3– Compiled discussion questions*. Allow students to discuss the questions in groups for five minutes while also using devices (cell phones, computers, tablets, etc.) to answer questions. The case narrative is repeated on the right of the slide for reference.

*Slide 4–DQ#1.* Ask for volunteers to give possible definitions for synthetic biology. Ideally, the answers involve the convergence of advances of various life science fields, computer science, and engineering to solve a given problem. However, students may simply give specific examples of synthetic biology such as modifying an existing organism or creating a novel biological system.

*Slide 5–DQ#2.* Ask for volunteers to give predictions for how synthetic biology could be applied to the problem of lead contamination in drinking water. There is no “correct” answer here. Students may discuss creating an ingestible organism or proteins with lead binding capabilities, or an organism that stockpiles lead internally.

*Slide 6­–Example.* Present to the class an example of using synthetic biology to solve the problem of lead contamination in drinking water. The example provided shows pictures of *Bacillus subtilis* force evolved for grow on media with high lead concentrations, suggesting lead binding capabilities.

**Part II: Lead Pollution in Drinking Water (slides 7-9)**

In Part II, students will be shown the benchmark levels as determined by the EPA for various parts per billion (ppb) lead levels and will be asked to consider ways in which the parts per billion level could be determined (either at home or through laboratory techniques) and how the water became contaminated in the first place. This part should take between 5 and 7 minutes to complete.

*Slide 7­­– Narrative of the case and compiled discussion questions*. Read the case to the students, ask for volunteers to read the case to the class, or instruct the students to read silently on their own. Then, allow students to discuss the questions in groups for five minutes while also using devices (cell phones, computers, tablets, etc.) to answer questions.

*Slide 8–DQ#4*. Ask volunteers to give examples of ways in which the amount of lead in drinking water can be quantified. Answers will likely range from at home test kits to laboratory testing devices.

*Slide 9–DQ#5*. Ask volunteers for possible ways in which water could be contaminated with lead. This will prepare the students for part III.

**Part III: The Source of Contamination (slides 10-12)**

In Part III, students will be shown a graph displaying the change in the possible of having drinking water contaminated with lead as the distance from the water source increases. They will be asked to use this information to attempt to understand the most common mechanism by which drinking water becomes contaminated with lead. This part should take between 5 and 7 minutes to complete.

*Slide 10– Narrative of the case and compiled discussion questions*. Read the case to the students, ask for volunteers to read the case to the class, or instruct the students to read silently on their own. Then, allow students to discuss the questions in groups for five minutes while also using devices (cell phones, computers, tablets, etc.) to answer questions.

*Slide 11–DQ#6.* Ask volunteers to examine the relationship between the increase in probability of lead contamination in drinking water as the distance away from the site of water distribution increases. Ideally, students will come to the conclusion that lead leaches from the transport pipes into the water, causing the contamination.

*Slide 12–The source of the contamination.* Present to the class the most common source of contamination: lack of proper corrosion control can cause lead to leach from the pipes into the drinking water.