Designing and Optimizing Whole-Cell Biosensors for the Detection of Heavy Metals in Water

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The purpose of this project is to engineer E.coli to design an optimum biosensor for the detection of lead, cadmium, and zinc in heavy-metal contaminated water. This experiment works towards developing a biotechnological test which will be inexpensive and easy to use for people in developing countries and areas under safe drinking water stress. Design one used GFP as a biomarker to indicate the presence of cadmium in water. A promoter was inserted upstream of GFP gene through digestion and ligation to bring the biomarker under the control of cadmium. The biosensor was built successfully. In order to optimize the color of detection, another biosensor was designed. Design two uses a biomarker called mCherry protein to indicate the presence of arsenic in the environment. An arsenic promoter was inserted upstream of mCherry gene that produced red fluorescent protein using same methods as before to bring the mCherry gene under the regulation of arsenic. This biosensor partially worked because it also glowed in the absence of arsenic. That occurred because the E.coli cells would be overwhelmed by excess amounts of engineered plasmids in the cell and would not be able to control all the promoters in each plasmid, therefore, the biomarker would always stay turned on. A third biosensor was built using amilCP gene that produces blue chromoprotein in the presence of cadmium. The main purpose of the third design was to further optimize the color so that the detection would not require any UV light to clearly see. The third biosensor was successful as well. The next step is to insert an activator gene next to the amilCP gene to optimize the color to even a darker blue color so that it can be easily used in the real world for practical purposes.