



WPI

CGPS SEED GRANT RECIPIENTS

Industry Stakeholders' Forum
April 30, 2018

iGEM 2017: Building a Better Biosensor for Detecting Lead in Water

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WPI undergraduate students: Locke Bonomo, Haylea Northcott, Aylin Padir, Michael Savoie, Edith Sawyer and Catherine Sherman

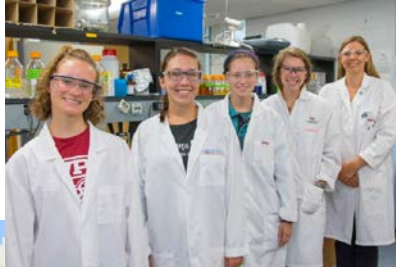


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What is iGEM?



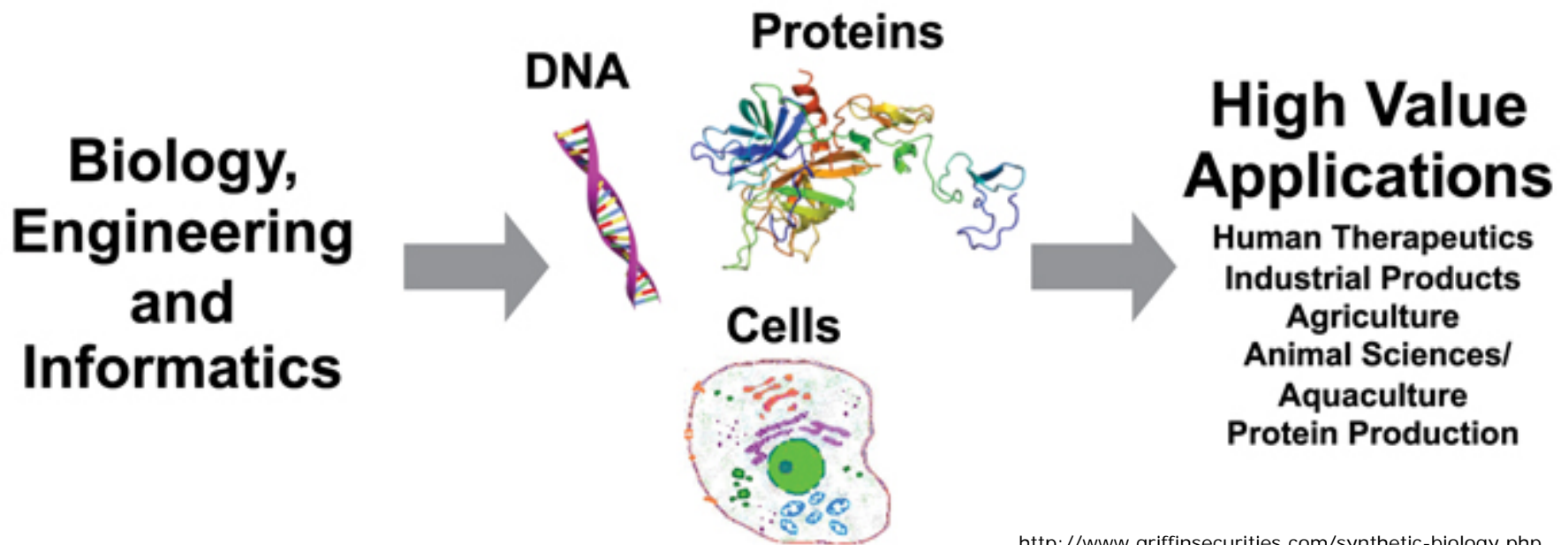
- International Genetically Engineered Machines Competition
- “Synthetic Biology” – applying engineering design principles to the creation of novel biological systems



In 2017:

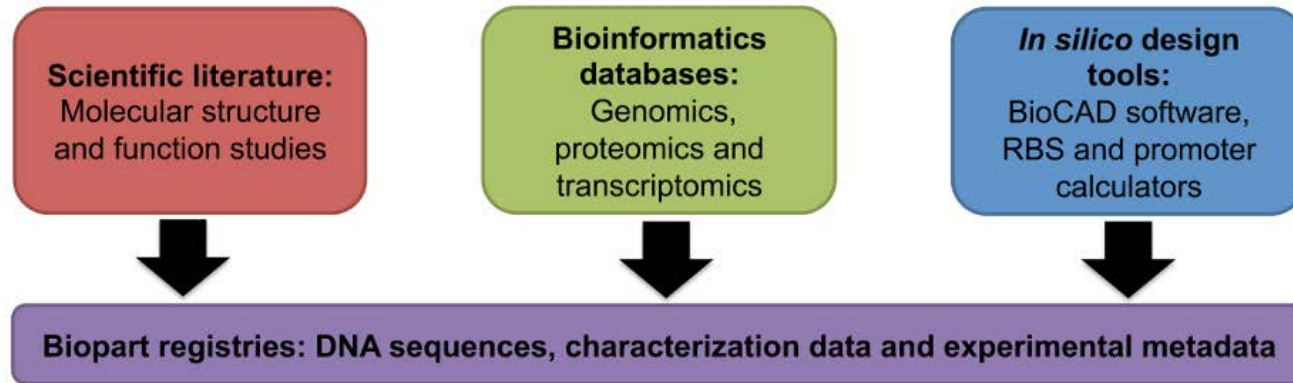
- 339 teams
- 45 countries
- 5000+ participants

What is Synthetic Biology?

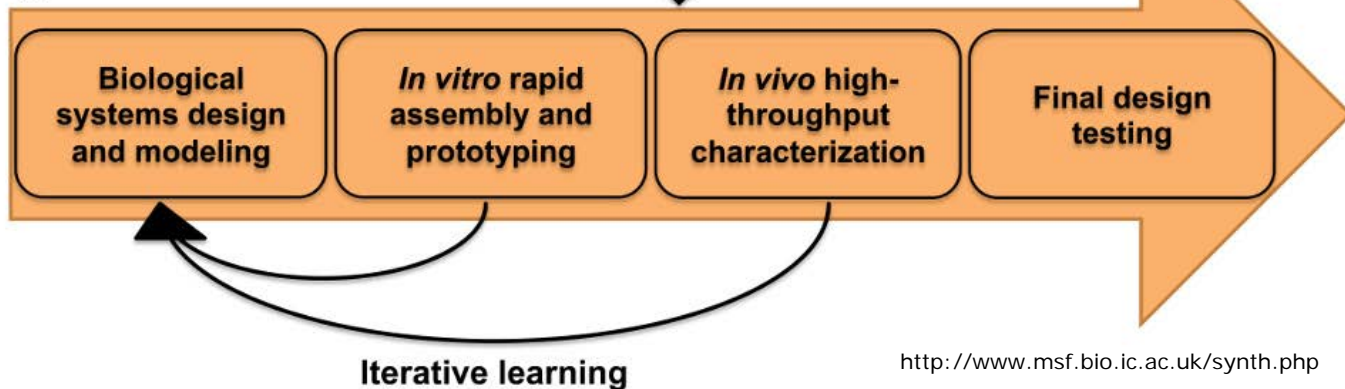


Synthetic Biology Applies Engineering Design Principles to Living Systems

Data Sources

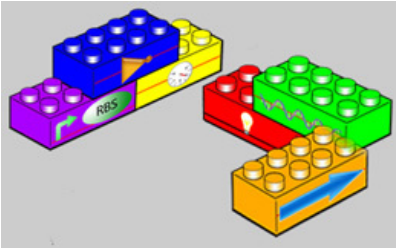


Design-Build-Test



<http://www.msf.bio.ic.ac.uk/synth.php>

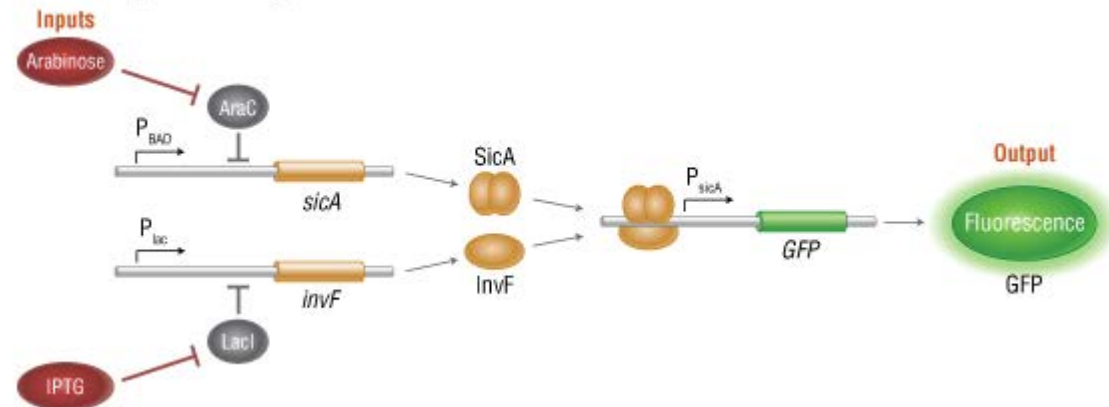
BioBricks: The Building Blocks of Synthetic Biology



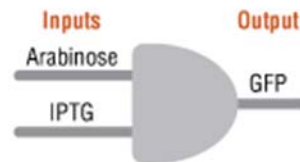
- Standardized DNA sequences
- Ideally fully characterized, measureable and interchangeable

Assembly
of BioBricks
into
functional,
predictable
circuits

A. Molecular Diagram of a Biological Circuit



B. Schematic of an "AND" Gate



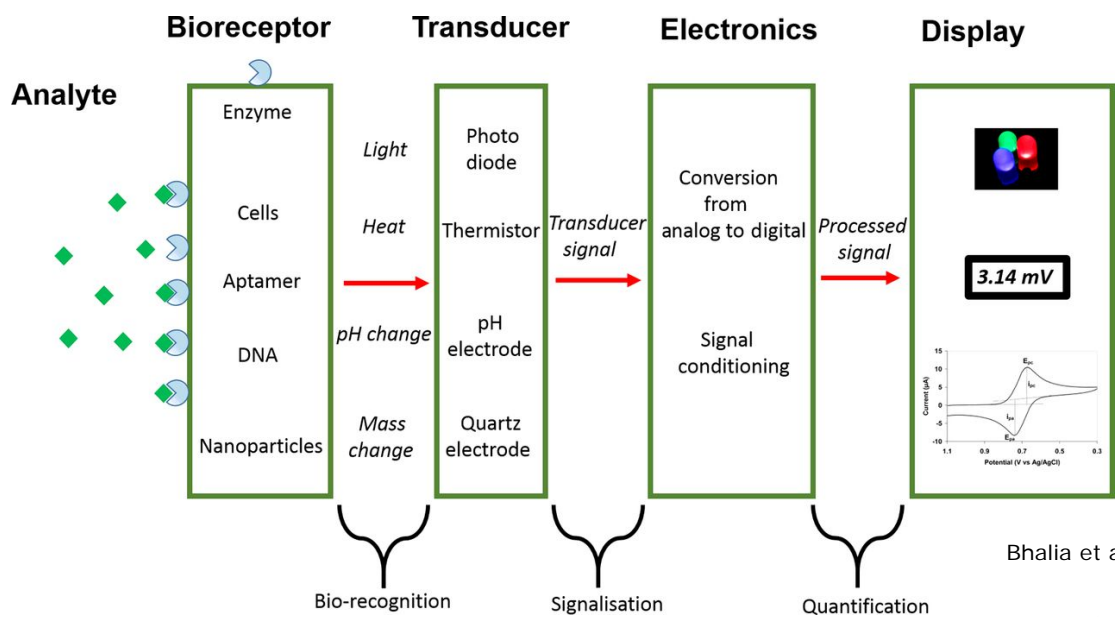
Inputs		Output
Arabinose	IPTG	GFP
—	—	—
+	—	—
—	+	—
+	+	+

C. Higher-order Circuit

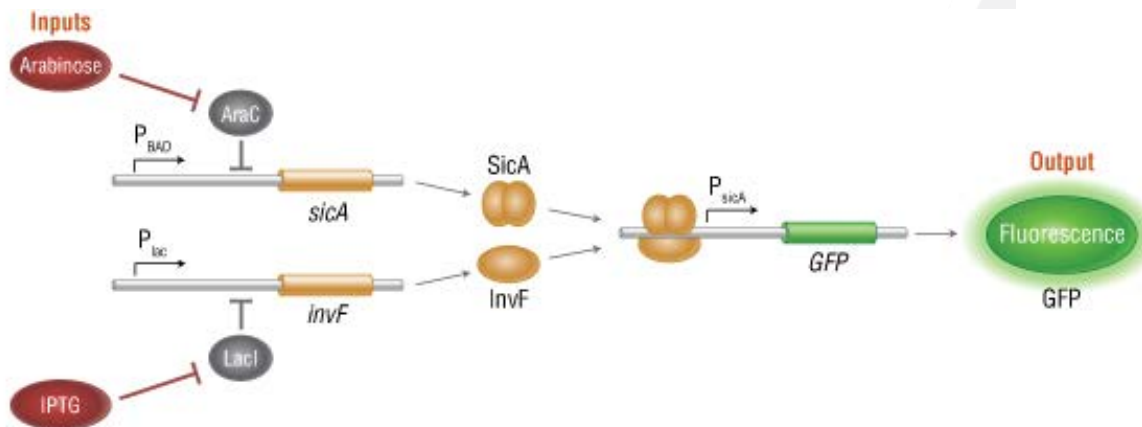
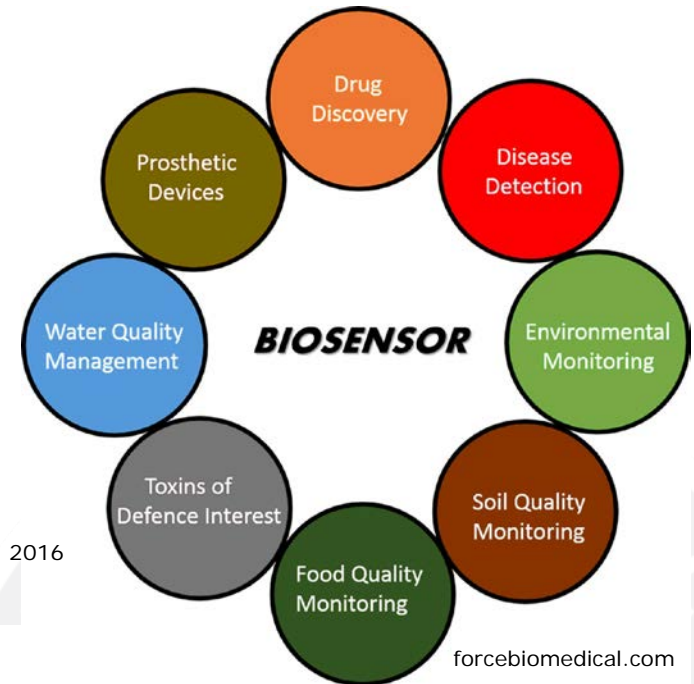


neb.com

Biosensors



Bhalia et al., 2016



Building a Better Biosensor for Lead

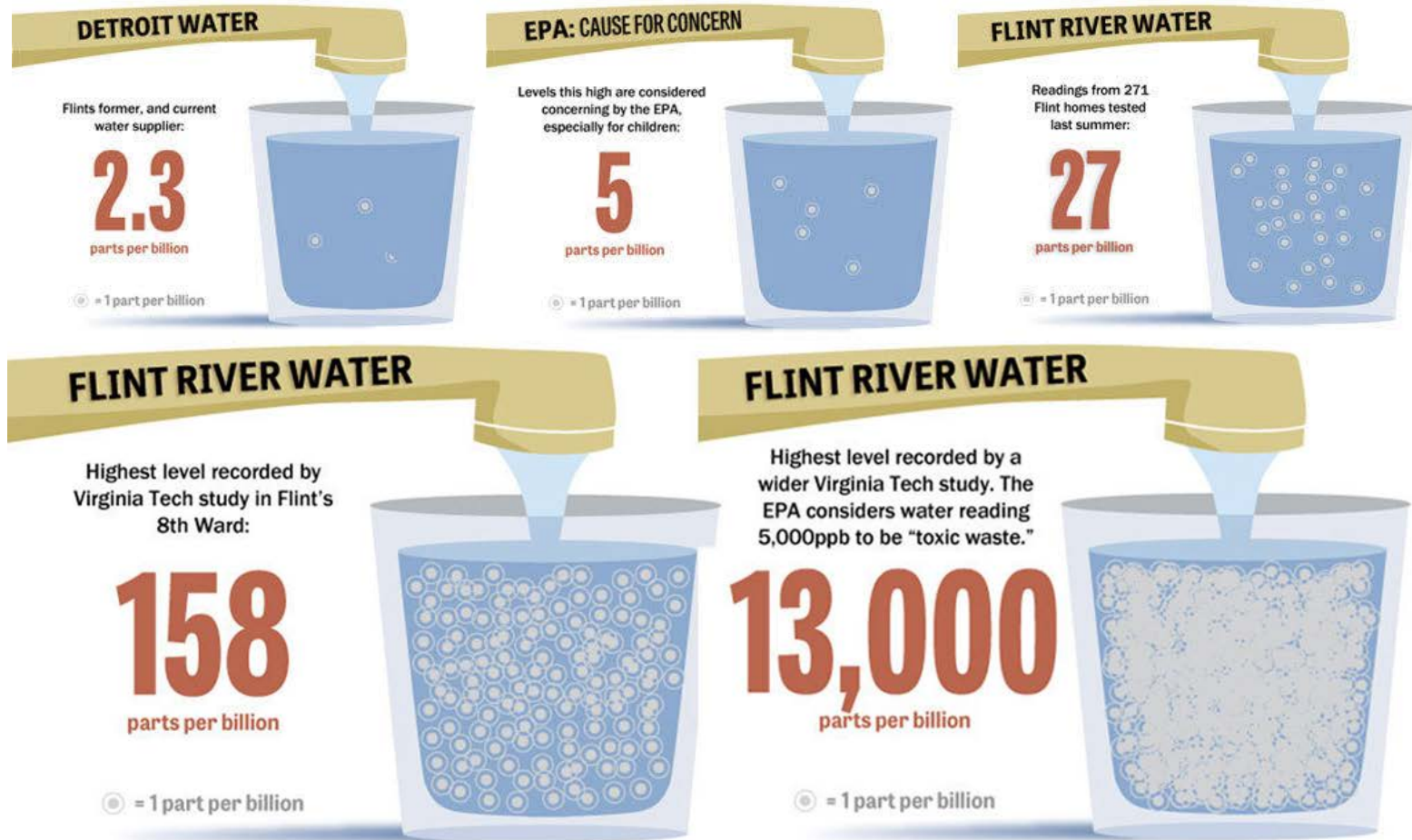


Tap water in a Flint hospital on Oct. 16, 2015.

JOYCE ZHU / FLINTWATERSTUDY.ORG



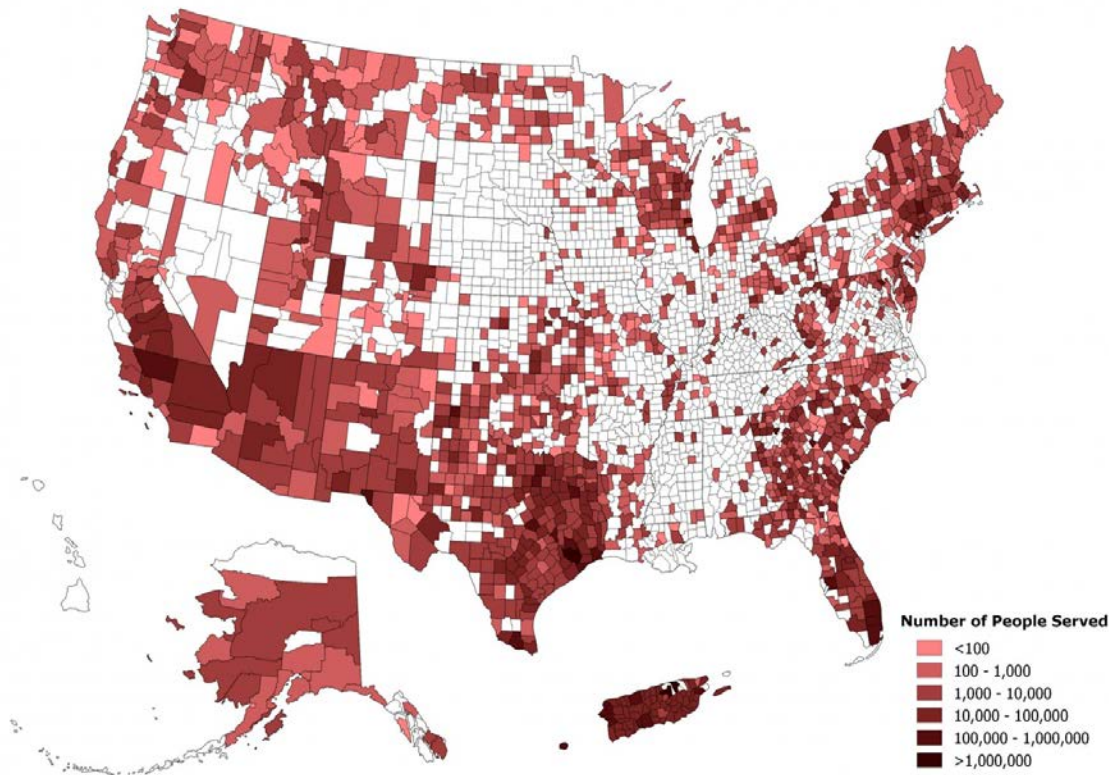
Flint, Michigan



Graphic by Milt Klingensmith | MLive.com

Lead Contamination is a National Problem

Number of People Served Water with over 15 ppb of Lead



In Massachusetts:
Many school districts including Boston and Worcester must provide bottled water for students

The Boston Globe

High lead levels found more than 160 school buildings in Mass.



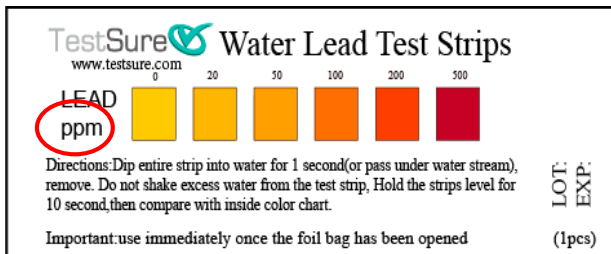
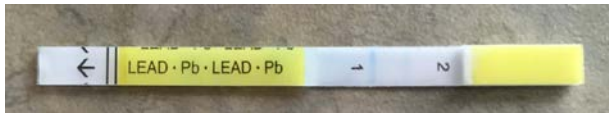
SHUTTERSTOCK

By [Matt Rocheleau](#) and [Travis Andersen](#) | GLOBE STAFF NOVEMBER 16, 2016

Can't we already test for lead?

- Cause for concern: 5 ppb
- EPA Action level: 15 ppb
- Irreversible neurological damage: 800 ppb
- EPA hazardous waste: 5,000 ppb

Home Testing



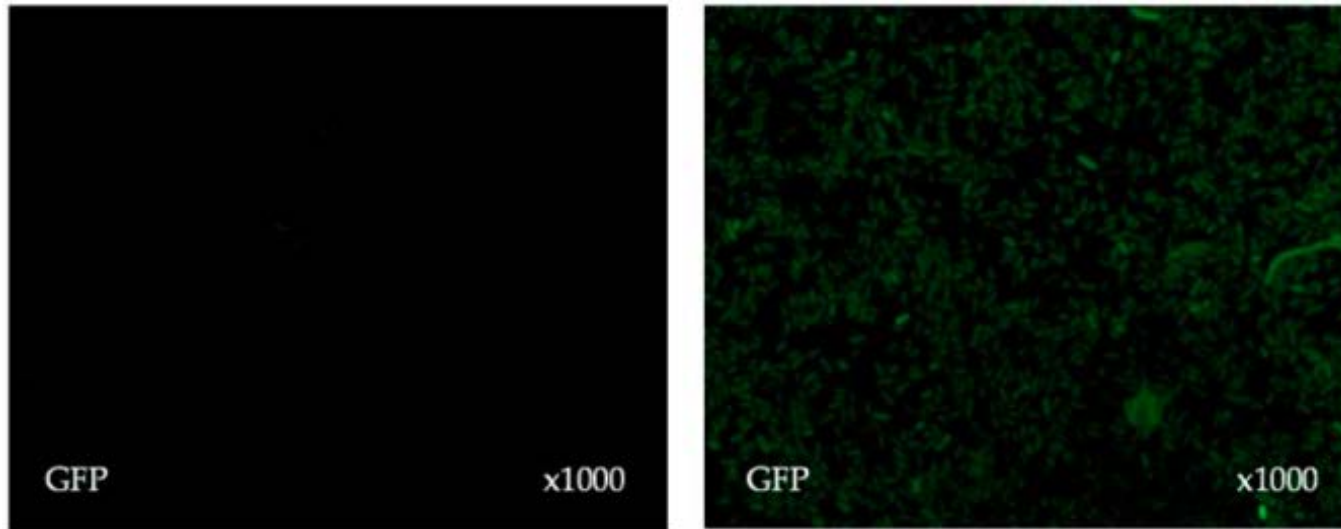
- Yes/No answers
- Not sensitive enough in the actionable range

Laboratory Testing



- Expensive
- Off-site

Existing Lead Biosensors



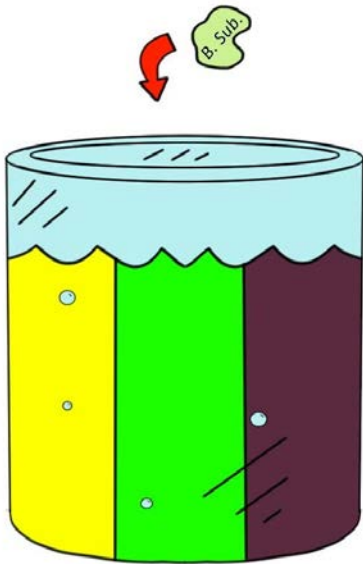
(a) $0 \mu\text{g ml}^{-1} \text{Pb(II)}$

(b) $100 \mu\text{g ml}^{-1} \text{Pb(II)}$

Bereza-Malcolm et al., 2015

- Can we create a biosensor that gives quantitative (or semi-quantitative) information about lead concentration?
- Can a lead biosensor be sensitive within the necessary detection range (5-15 ppb)?

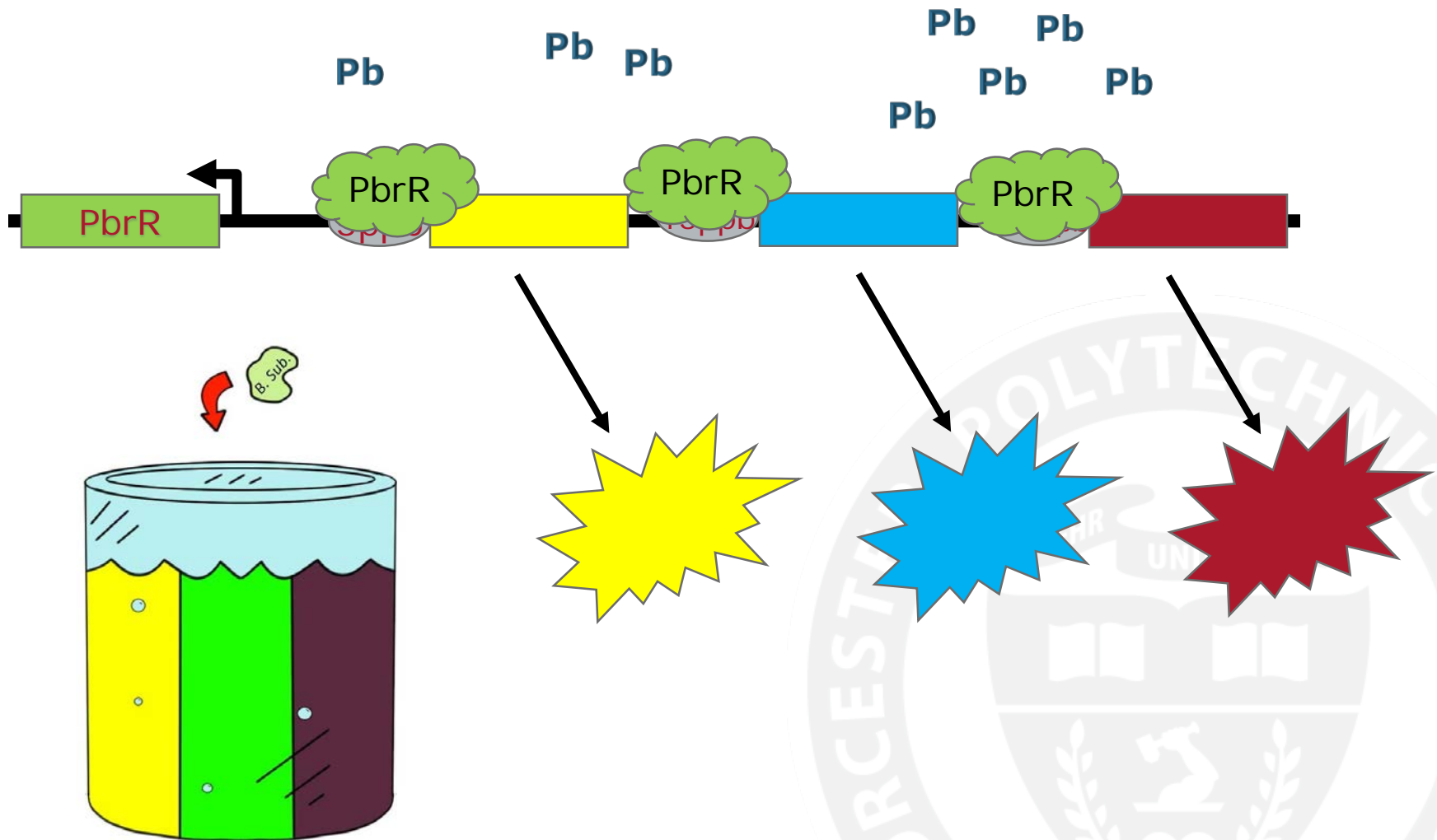
Experimental Approach



Goal: Create a biosensor that produces different chromoproteins (pigments) in response to different lead concentrations:

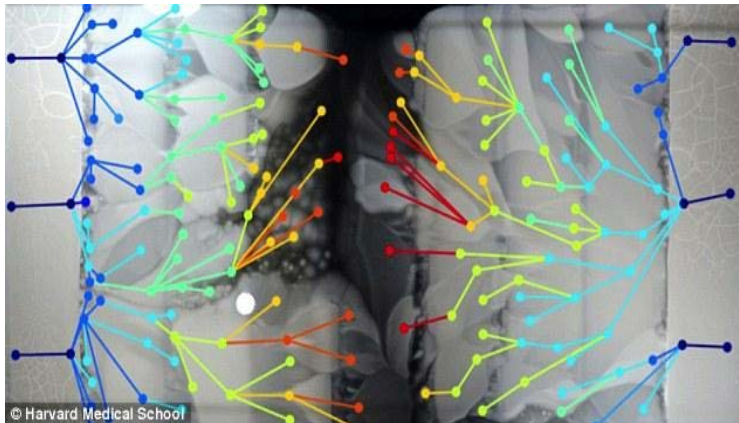
1. 5 ppb = yellow
2. 15 ppb = yellow + blue (transition to green)
3. 800 ppb = yellow + blue + red (transition to brown)

Biosensor Design

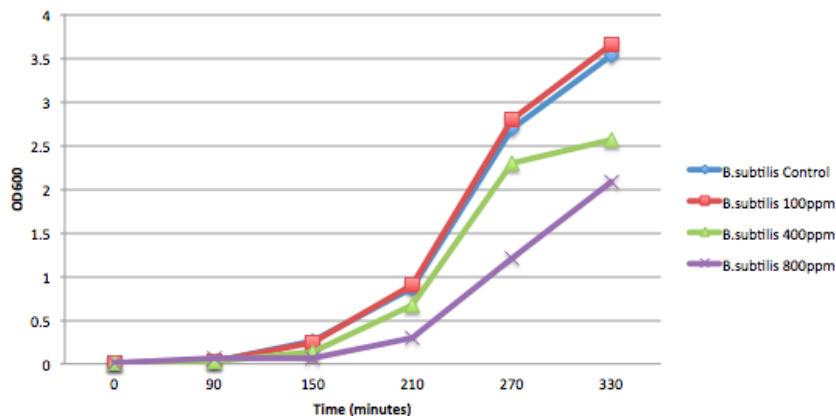


Ideas for Generating Novel Biosensors

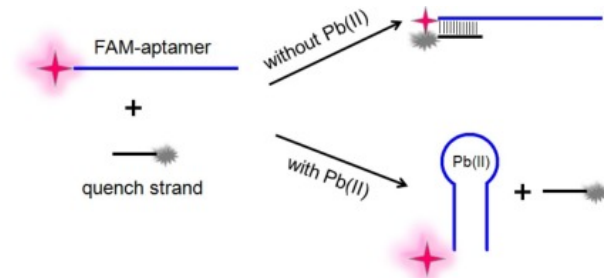
Facilitated Evolution



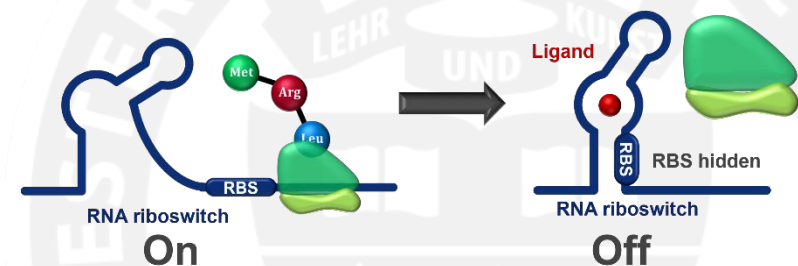
B.subtilis Average Growth in Lead LB



Lead-binding Nucleic Acids



Chen et al., 2018



Exeter iGEM 2015

Seed Grant Activities

Funds will support the 2018 iGEM team:

- Design and test the next generation of biosensors
- Expanded and more interdisciplinary team, and additional resources
- Support dissemination of the work at the 2018 iGEM Jamboree
- Foster a collaboration and joint activities with Tsinghua iGEM