

A sensing array of radically coupled genetic ‘biopixels’

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Background

- Quorum sensing – used by bacteria to coordinate gene expression
- Biopixels – small oscillating bacterial colonies on the microfluidic chip
- Hydrogen peroxide – oxygen-oxygen single bond
- Redox signalling – when free radicals act as biological messengers
- Arsenite – compound poisonous to multicellular life

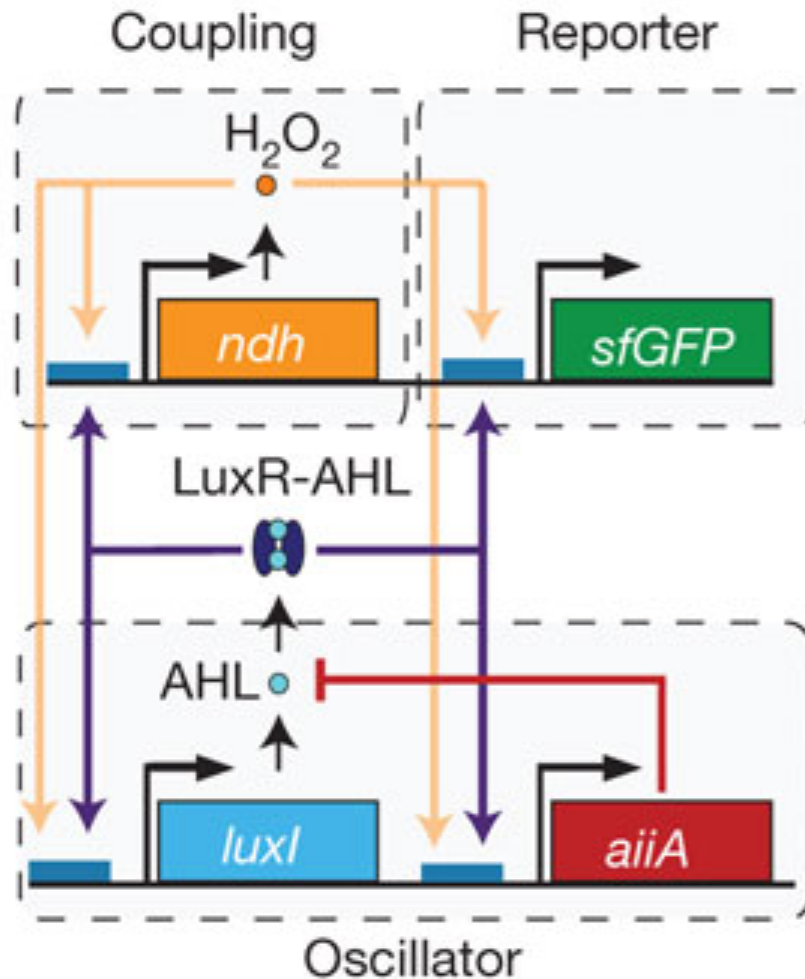
Overview

Purpose: To construct a robust circuit in a noisy cellular environment

- I. Construct microfluidic array
- II. Test sensing array
- III. Engineer arsenic-sensing biosensor
- IV. Characterize arsenic biosensor

Construct microfluidic array

Network diagram



Quorum sensing:

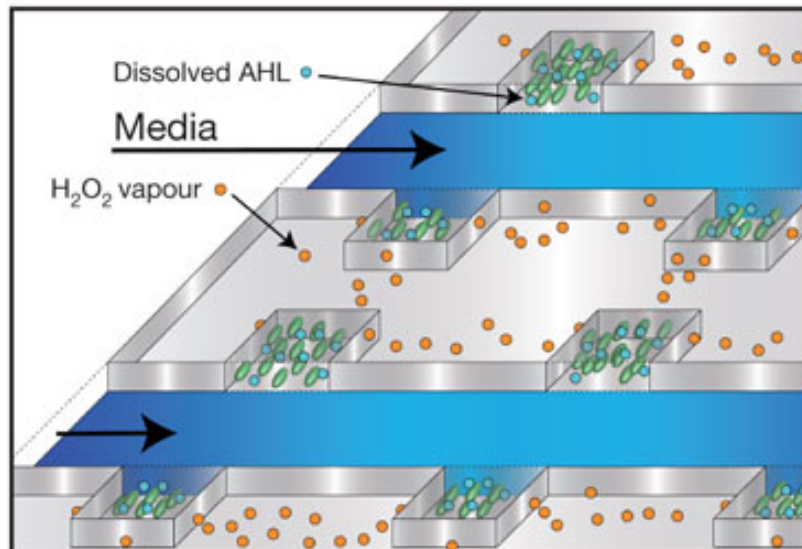
- *luxI*: produces AHL
- *aiiA*: degrades AHL

Redox signalling:

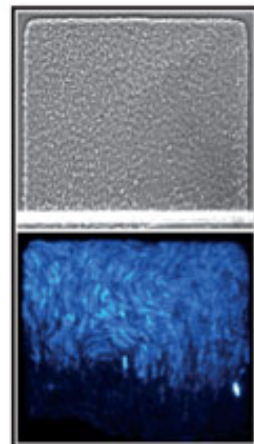
- *ndh*: produces H_2O_2

Construct microfluidic array

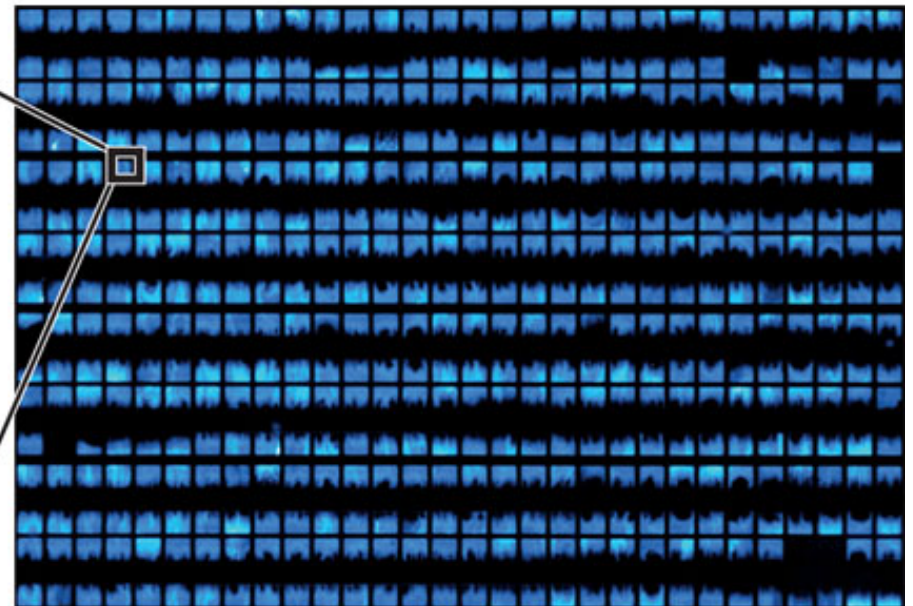
Device setup



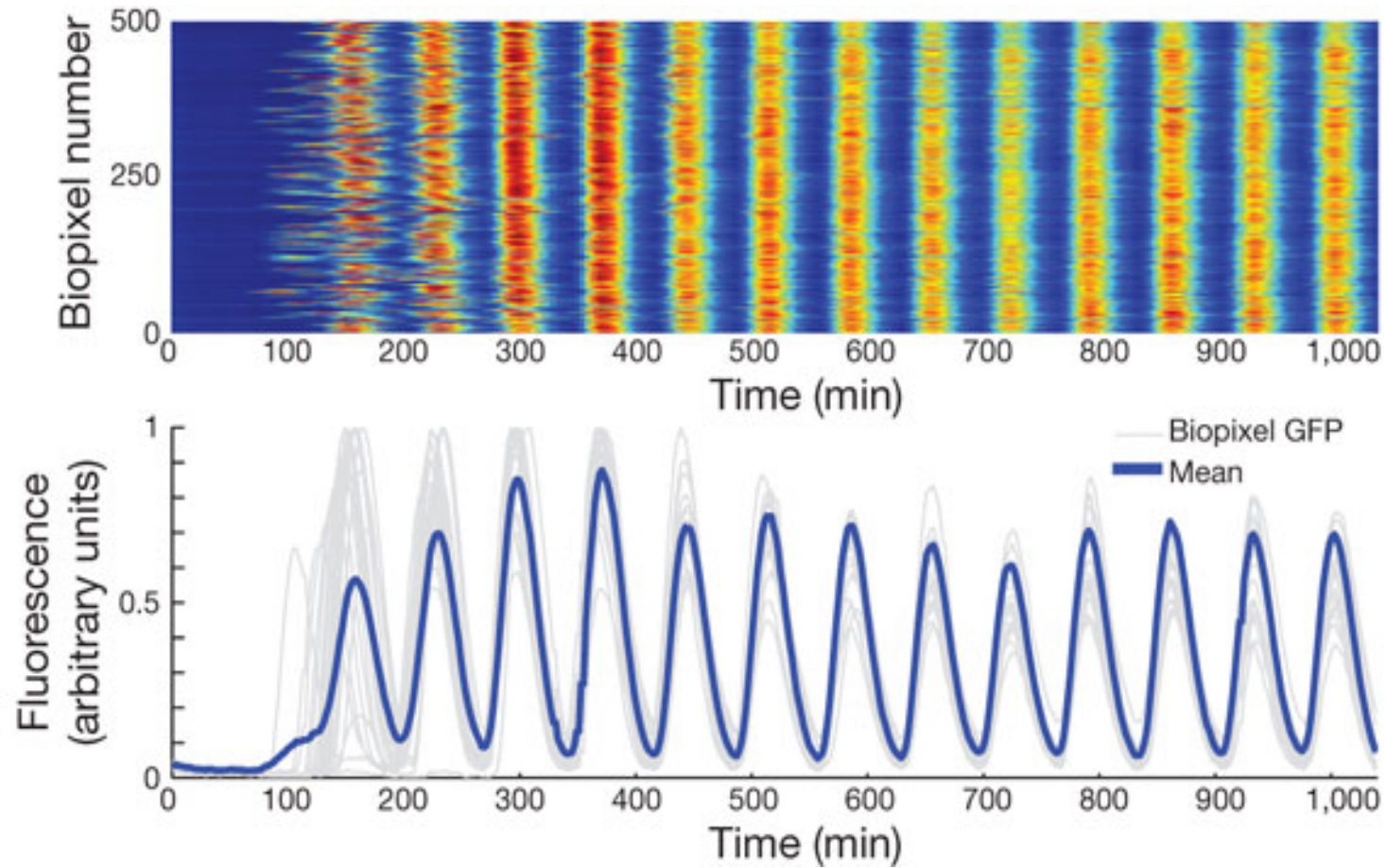
<http://www.nature.com/nature/journal/v481/n7379/extref/nature10722-s3.mov>



5,000 cells per biopixel
2.5 million total cells

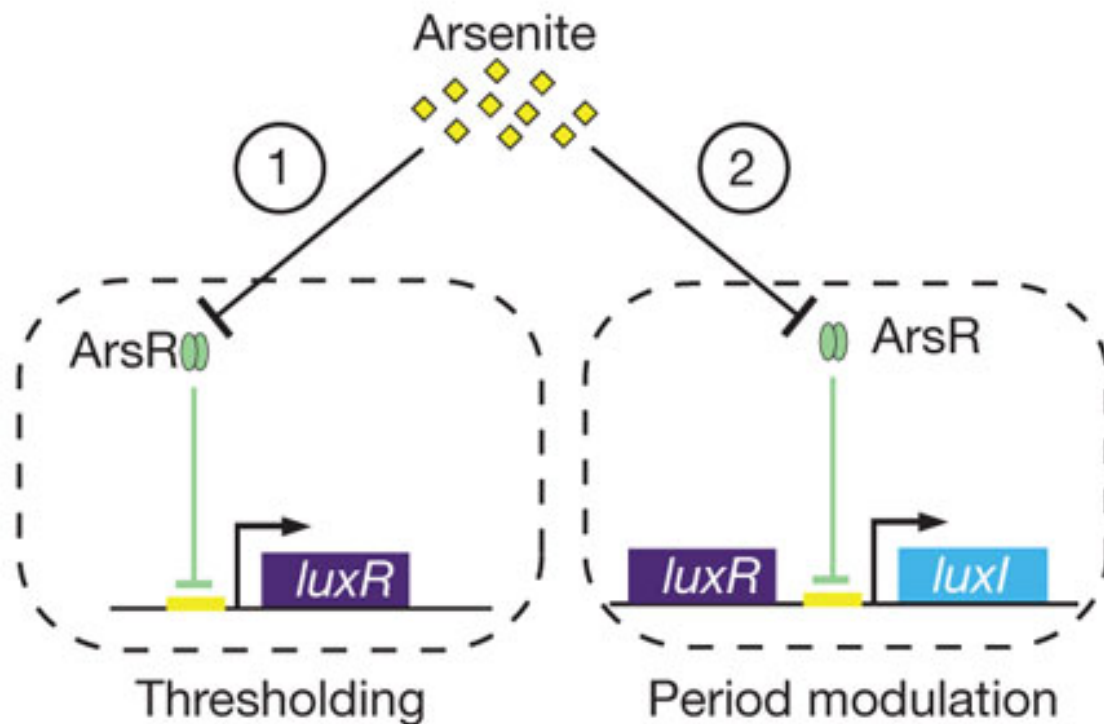


Test sensing array



Engineer arsenic-sensing biosensor

Network diagram



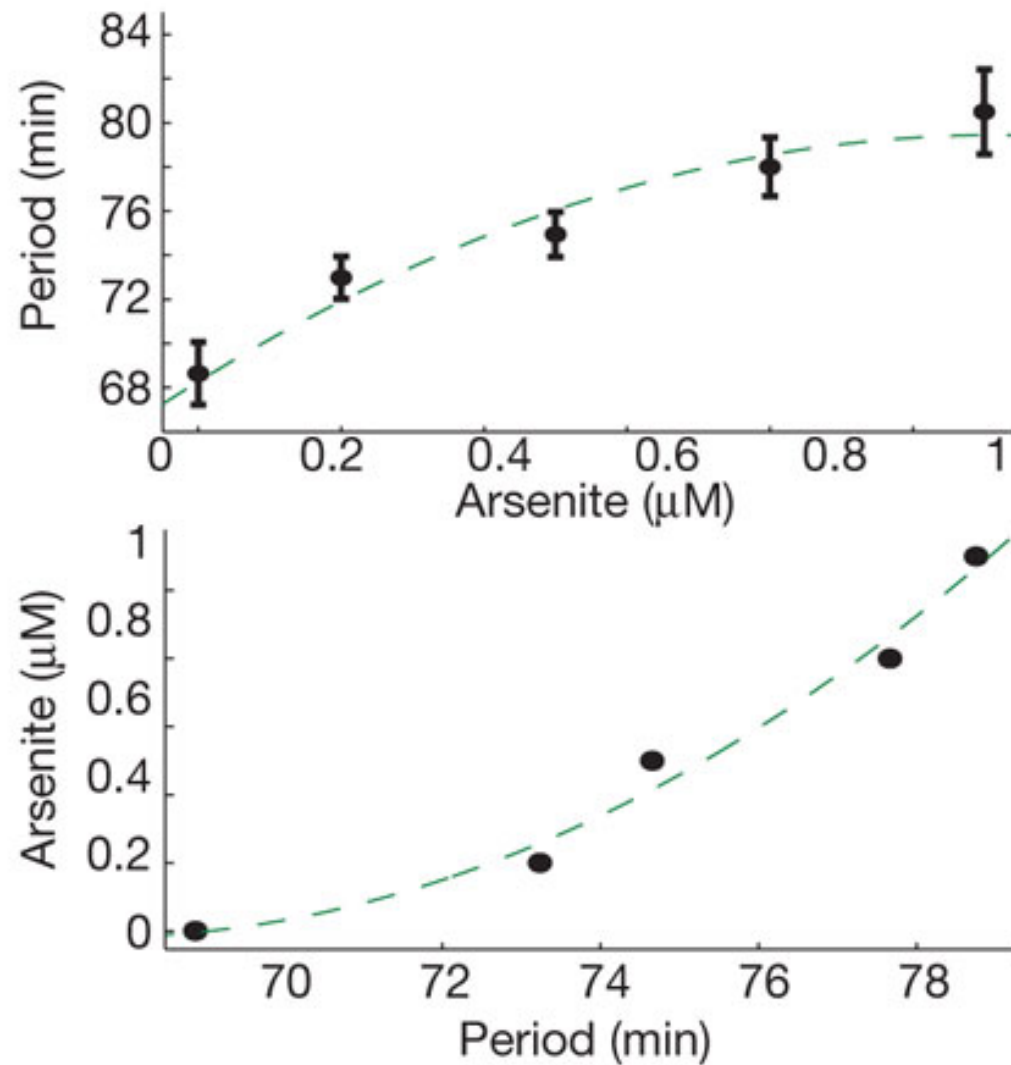
Thresholding:

- *luxR*: produces LuxR
- ArsR: inhibits *luxR*

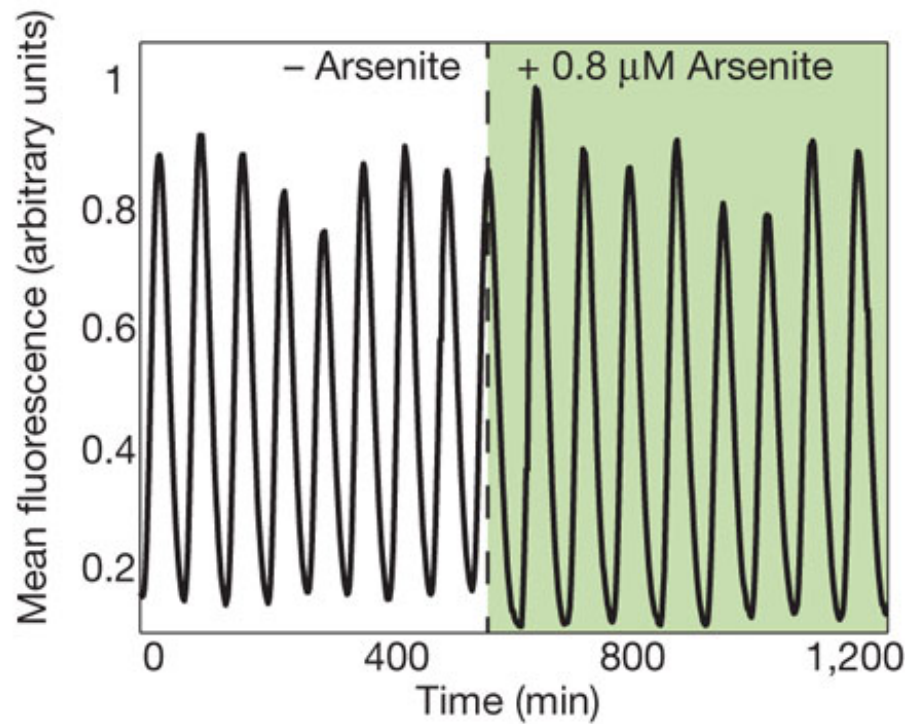
Period modulation:

- *luxI*: produces AHL
- ArsR: inhibits *luxI*

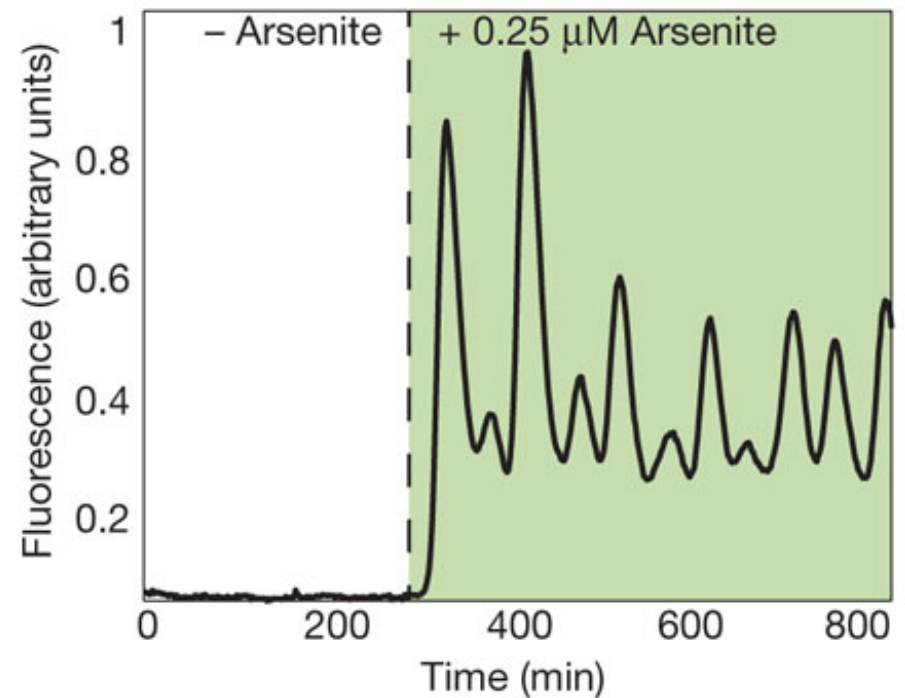
Characterize arsenic biosensor



Characterize arsenic biosensor



Period modulation



Thresholding: ON/OFF

Concerns

- Not a lot of points on the sensor calibration curve
- Arsenic sensor: “reliably quantify arsenite levels”
- Used 0.8 μM for sample period modulation sensor output

Conclusions

- Combine two modes of communication:
 - Quorum sensing
 - Redox signalling
- Modify sensing array to detect arsenite:
 - Thresholding
 - Period modulation

Significance

- Coordinate bacteria behavior over large length scales
- Foundation for low cost genetic biosensors
- Biosensor used for detecting heavy metals and pathogens

Questions?



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