BioMath Connections

Synthetic biology

Life 2.0

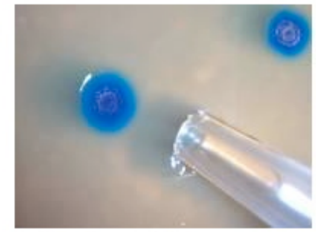
Aug 31st 2006 | BERKELEY, CAMBRIDGE, MASSACHUSETTS, AND ROCKVILLE, MARYLAND

From *The Economist* print edition

The new science of synthetic biology is poised between hype and hope. But its time will soon come

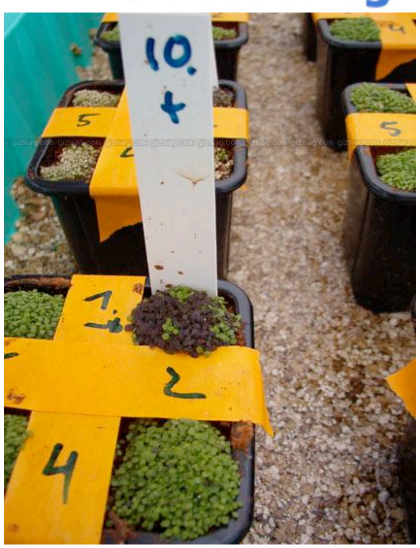
Scientists Use 'Synthetic Biology' To Create New Bacteria

By Jessica Berman
Washington
29 June 2007



Colonies of the transformed Mycoplasma mycoides bacterium

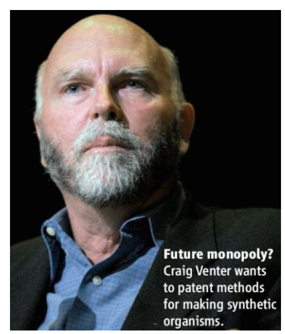
Land-mine detecting Plants created



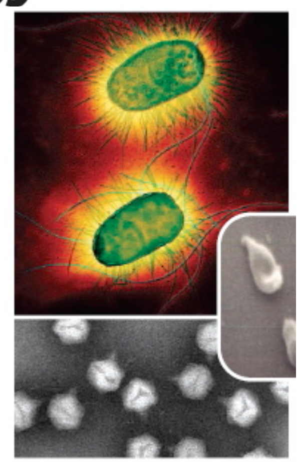
Synthetic Biology Remakes Small Genomes

SYNTHETIC BIOLOGY

Attempt to Patent Artificial Organism Draws a Protest

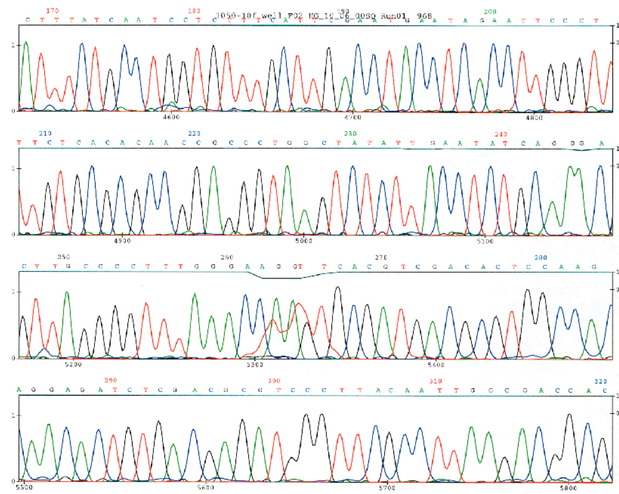


Future monopoly? Craig Venter wants to patent methods for making synthetic organisms.



Designer bugs. *E. coli* (*above*), mycoplasma (*inset*), and bacterial virus (*lower*) studies are leading to customized chromosomes.

How reliable are genetic tests?



Genetic Testing for Cystic Fibrosis

Prevalence (P of having disease) = 0.0004
Sensitivity (P + test if have disease) = 0.85
Specificity (P - test if disease free) = 0.999

Use Baye's Rule to Find Out

Prevalence (P of having disease) = 0.0004
Sensitivity (P + test if have disease) = 0.85
Specificity (P - test if disease free) = 0.999

$$\begin{aligned} P(CF \mid +) &= \frac{P(+ \mid CF)P(CF)}{P(+ \mid CF)P(CF) + P(+ \mid \text{no } CF)P(\text{no } CF)} \\ &= \frac{0.85 \times 0.0004}{0.85 \times 0.0004 + 0.001 \times 0.9996} \approx 0.2538. \end{aligned}$$

If you test positive,
only 25% chance that you actually have CF!

Creating an Arsenic Biosensor

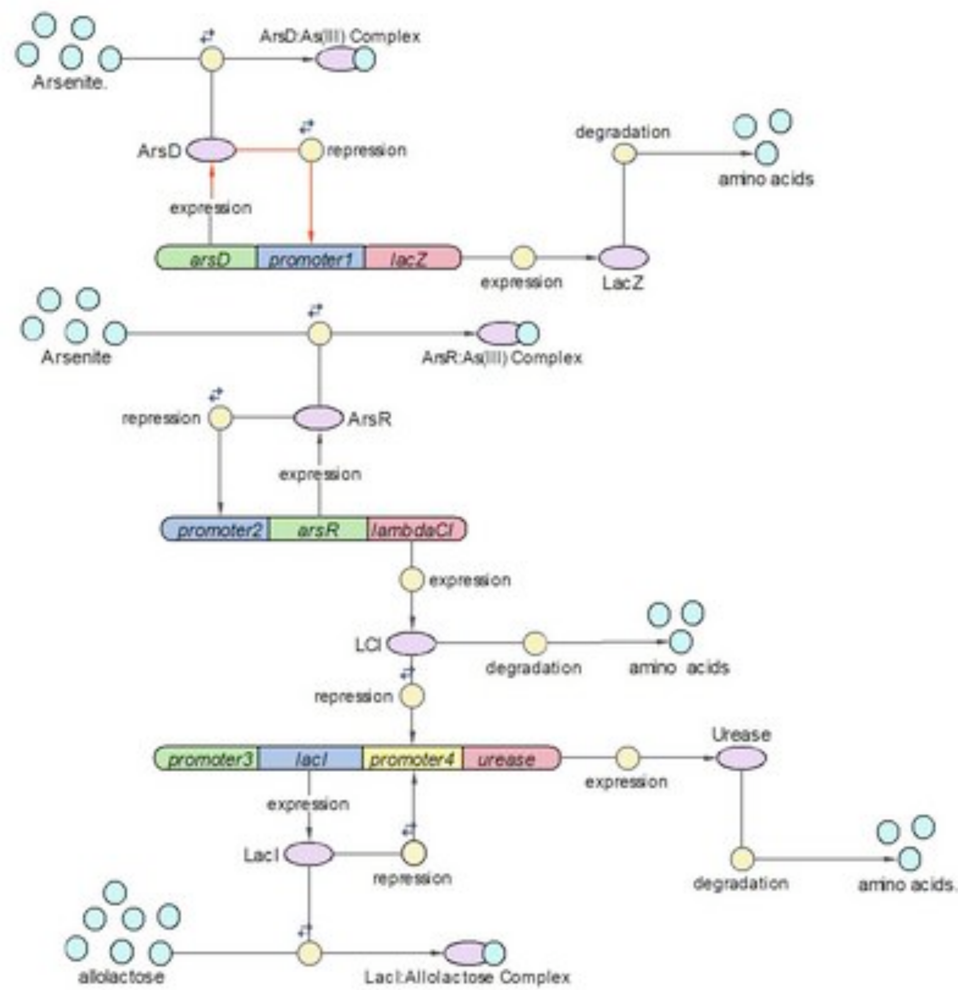
THE UNIVERSITY of EDINBURGH

9 students and 4 professors from Biology, Informatics, and Engineering departments are working together to develop a bacterial biosensor that responds to arsenic concentrations. Up to 100 million people across the world are being poisoned due to the presence of arsenic in their drinking water. This project could provide a low-cost, easy way to test groundwater for dangerous contamination.

VISIT THEIR WIKI

Engineering an Arsenic Biosensor

- Input arsenate/arsenite
- Output pH
- *E. coli* LacZ
- Sensitivity



Mathematical Modeling

Find the Formulas

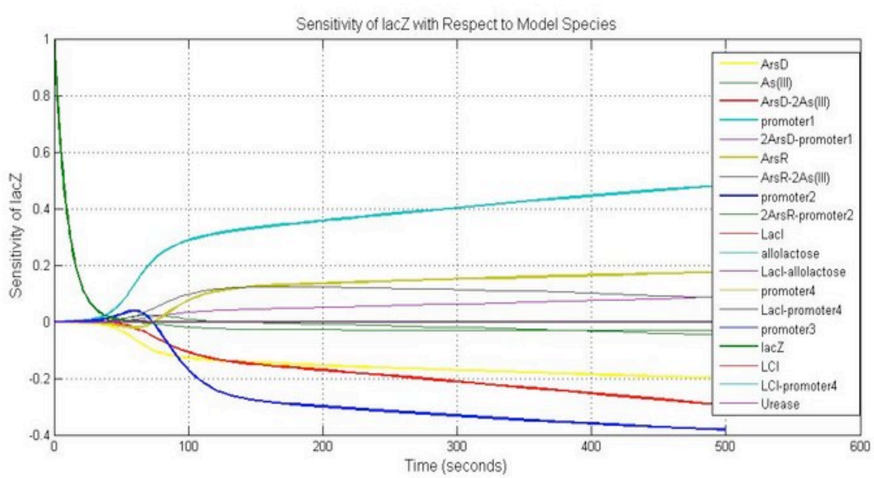
$$(1)\frac{d[ArsD]}{dt}=\frac{V_{4M}\times[promoter1]}{K_{4M}+[promoter1]}-K_3\times[ArsD]\times[As(III)]-K_1\times[ArsD]\times[As(III)]+K_{-1}\times[ArsD-As($$

$$(2)\frac{d[ArsD-2As(III)]}{dt}=K_1\times[ArsD]\times[As(III)]^2-K_{-1}\times[ArsD-2As(III)]$$

$$(3)\frac{d(Ar(III))}{dt}=-2\times(K_1\times[ArsD]\times[As(III)^2]-K_{-1}\times[ArsD-2As(III)])-2(K_5\times[ArsR]\times[As(III)]^2-$$

$$(4)\frac{d([2ArsD-promoter1])}{dt}=K_2\times[ArsD]^2\times[promoter1]-K_{-2}\times[2ArsD-promoter1]$$

Generating and Using Graphs



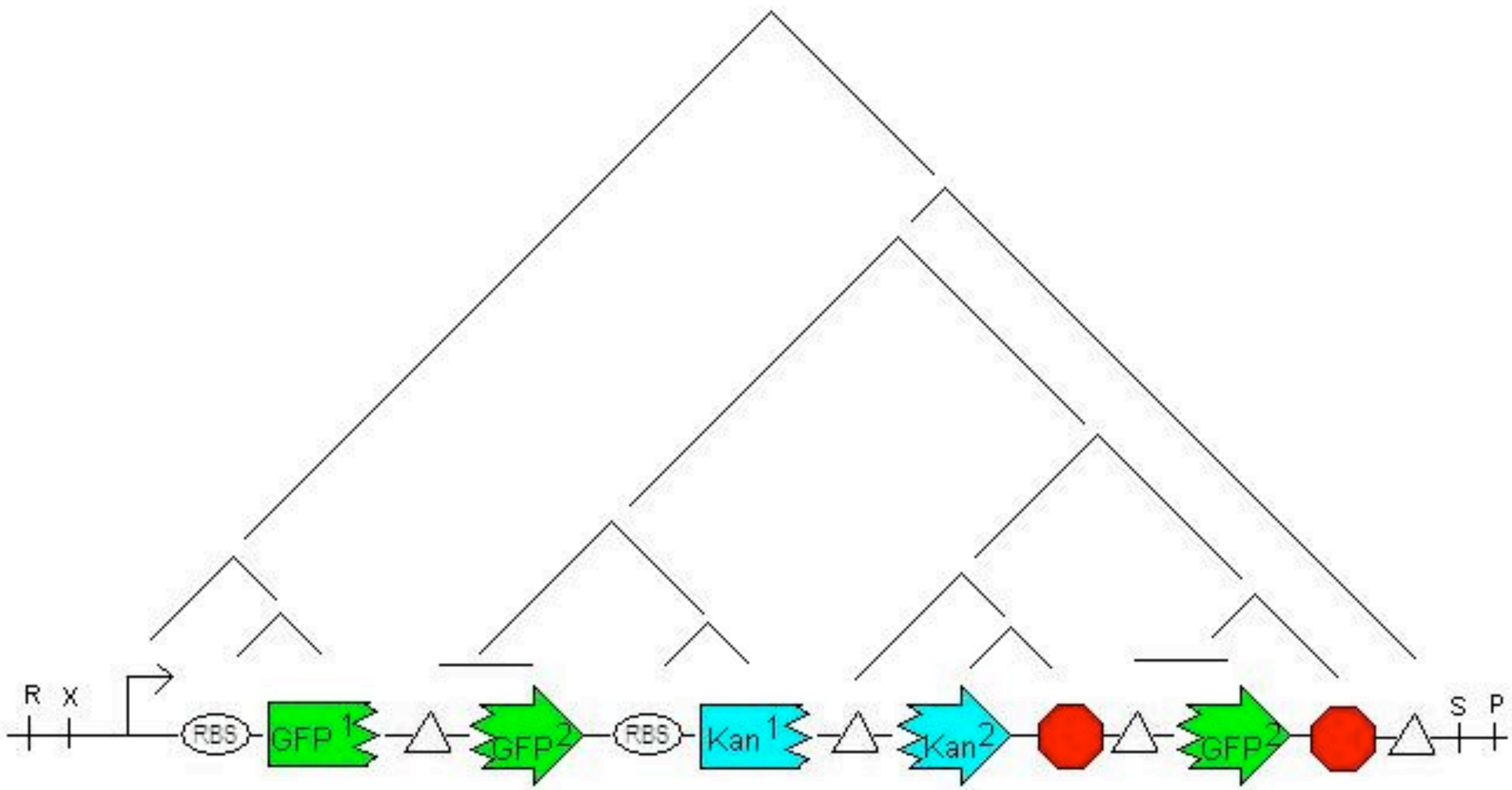
Writing Computer Code

Matlab scripts for multi-parameter sensitivity analysis

```
sbioloadproject Biosensor %change the project name to replace “Biosensor” here
m1
m1.Species
m1.Reactions
csObj = getconfigset(m1);
% change stop time to the time you want the simulation to run for in the line below
set(csObj, 'StopTime', 500);
csObj
csObj.RunTimeOptions.StatesToLog
% in line below change urease for the output you want to monitor
csObj.RunTimeOptions.StatesToLog = sbioselect... (m1, 'type', 'species', 'Where', 'Name', '==', 'Urease');
csObj.RunTimeOptions.StatesToLog
```

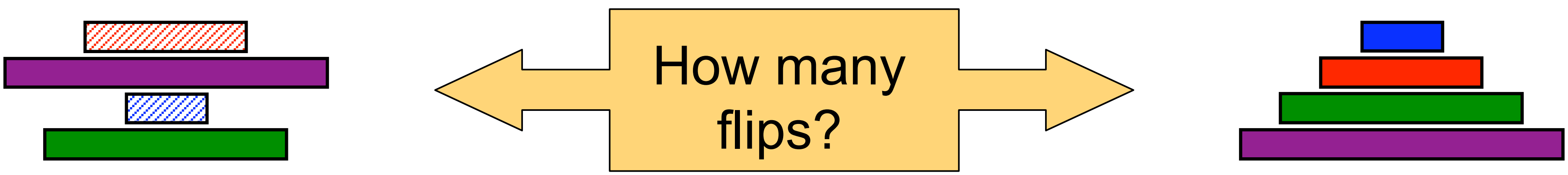
Building an Efficient Plan:

Fewest steps (some simultaneous) with constraints



The Burnt Pancake Problem

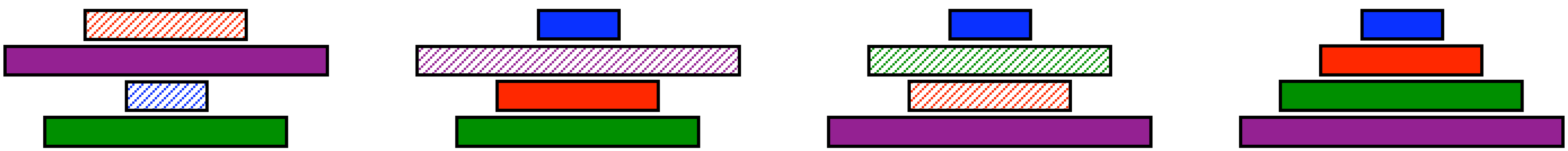
Using two spatulas, sort from smallest to largest, burnt side down



-2	1
4	2
-1	3
3	4

The Burnt Pancake Problem

Solution



-2	1	1	1
4	-4	-3	2
-1	2	-2	3
3	3	4	4

Computing *in vivo*