An Introduction to Synthetic Biology

"Hacking DNA for Fun and Profit"


Hello
World

1. what?
2. applications
3. the tech
4. free and safe
5. go hack

1. what?
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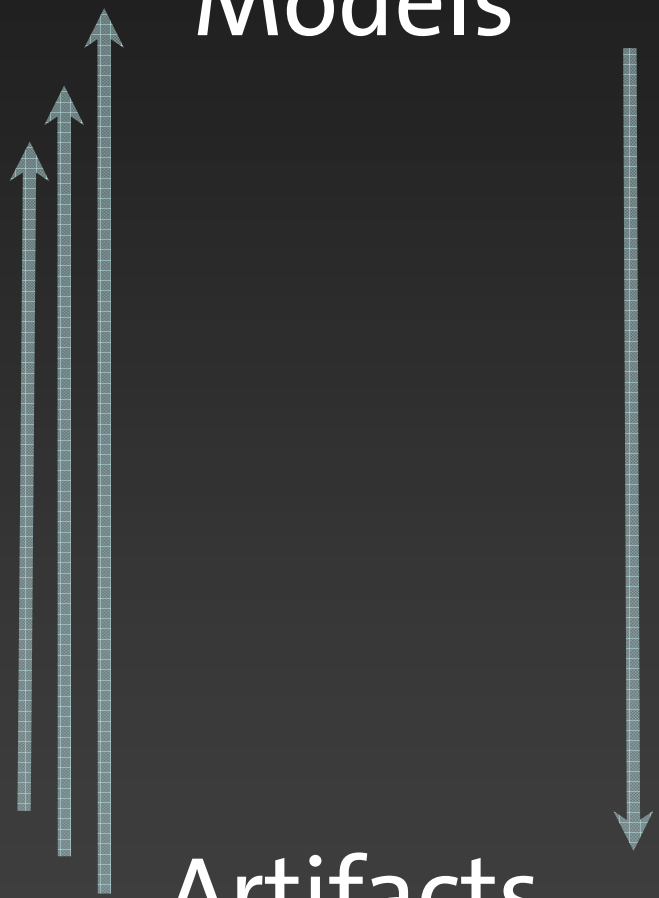
Engineering vs Science

Understanding,
Models



Science

Engineering

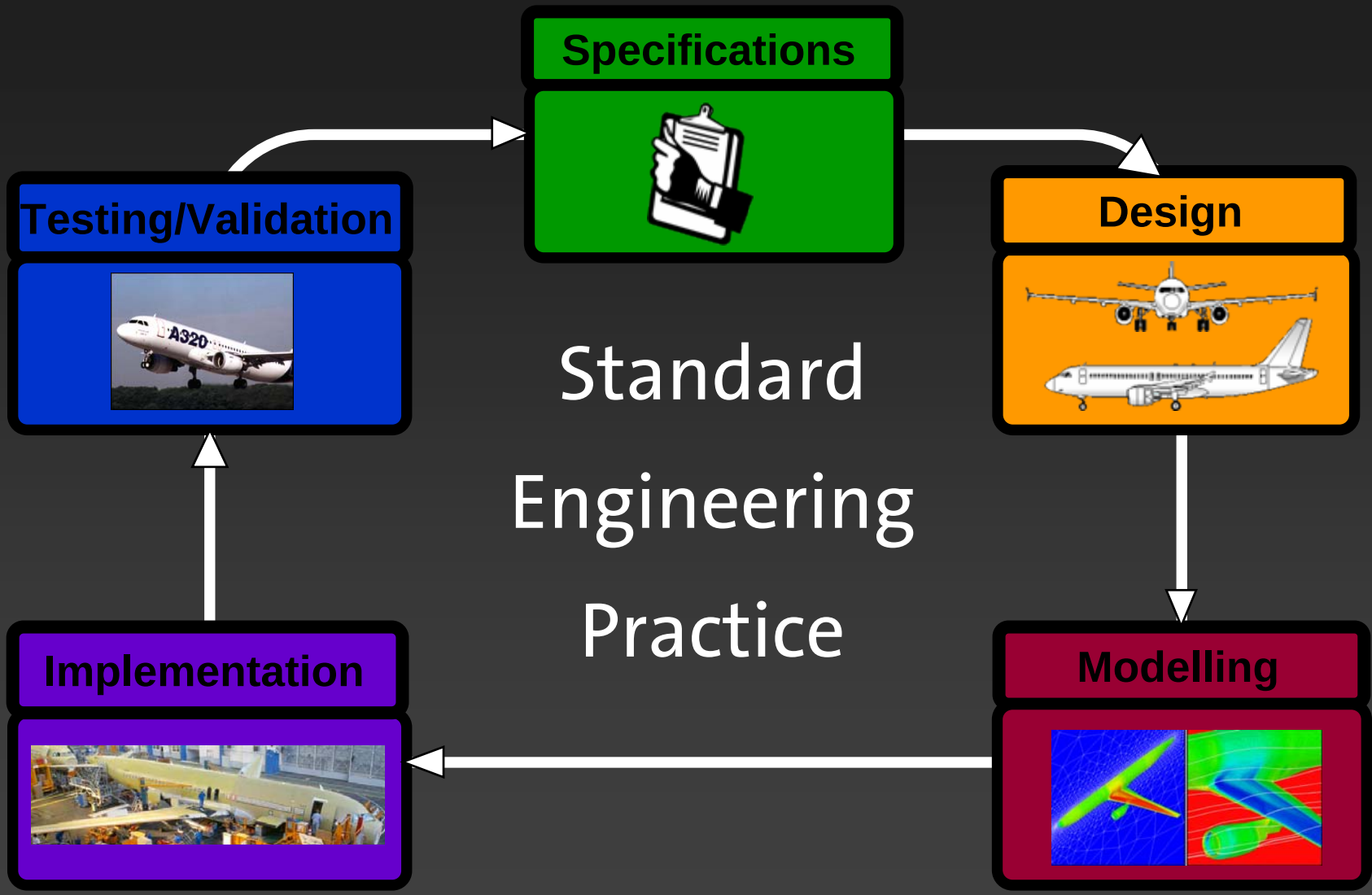
Artifacts
(cells)

Synthetic Biology

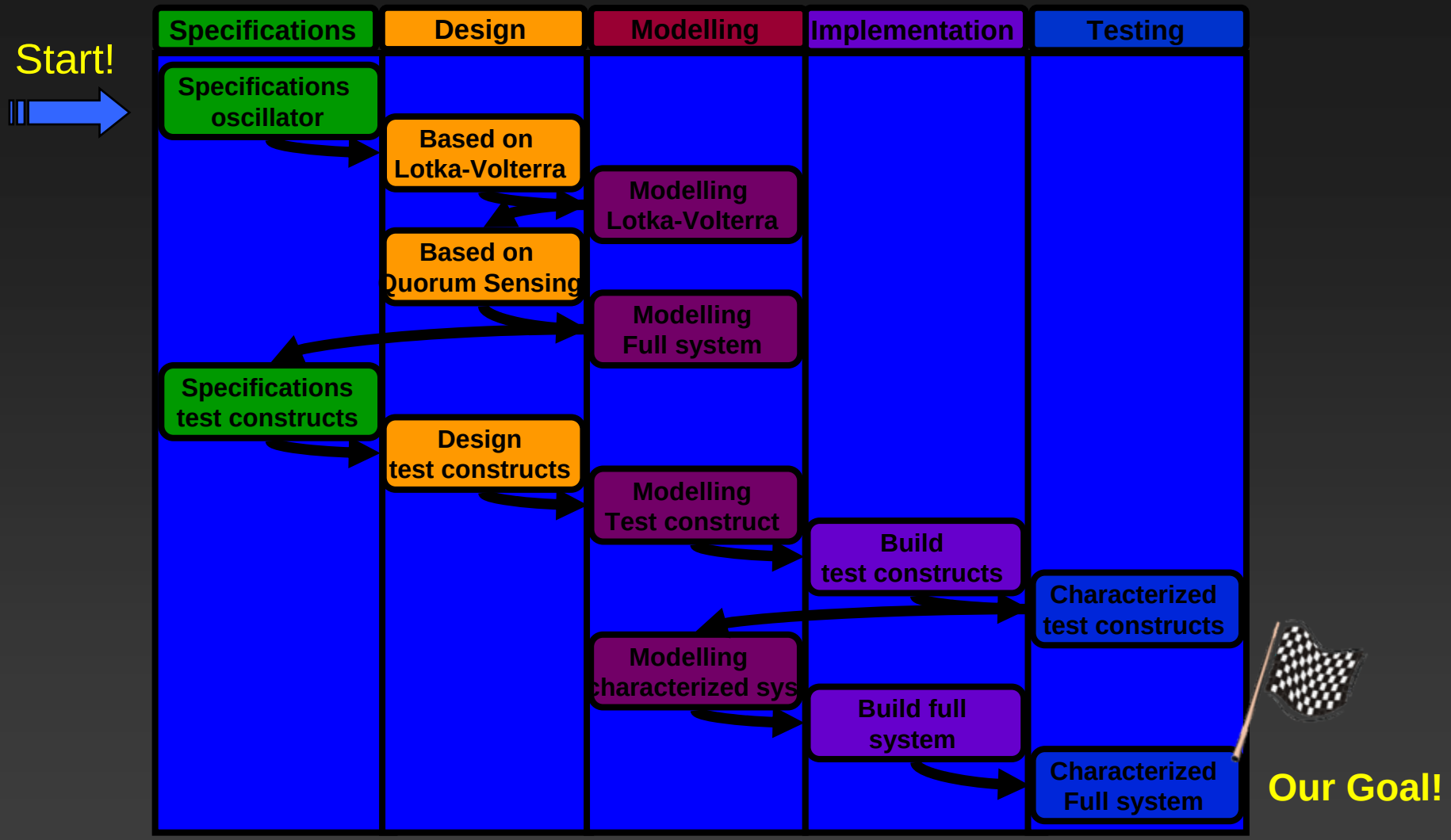
Synthetic Biology
=
GeneticEngineering++

1. Recombinant DNA
2. PCR
3. Automated sequencing

1. Recombinant DNA
2. PCR
3. Automated sequencing
4. Automated construction
5. Standardization
6. Abstraction



The Imperial College of London, iGEM 2006



The Imperial College of London, iGEM 2006

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Biofuels

Bioremediation

Medicine

Space ISRU

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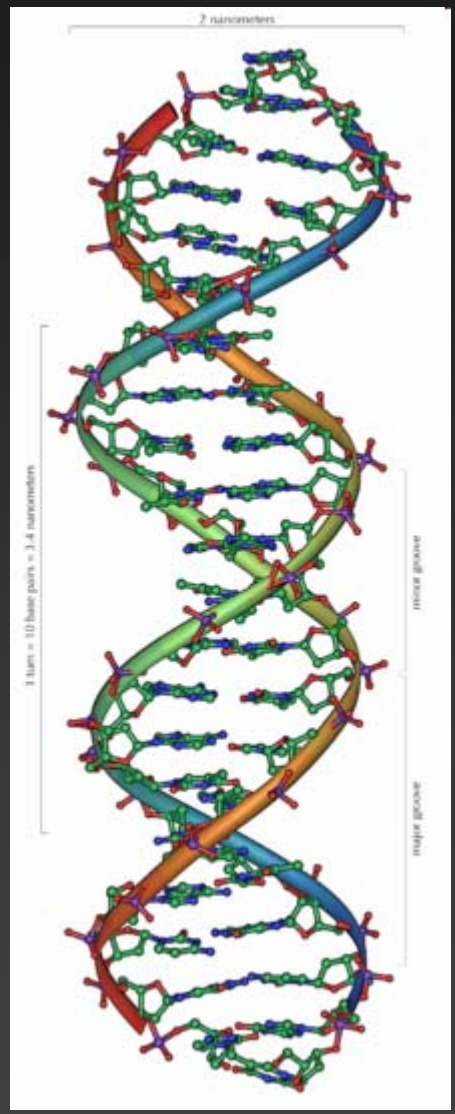
EPSON
EPSON STYLUS C45

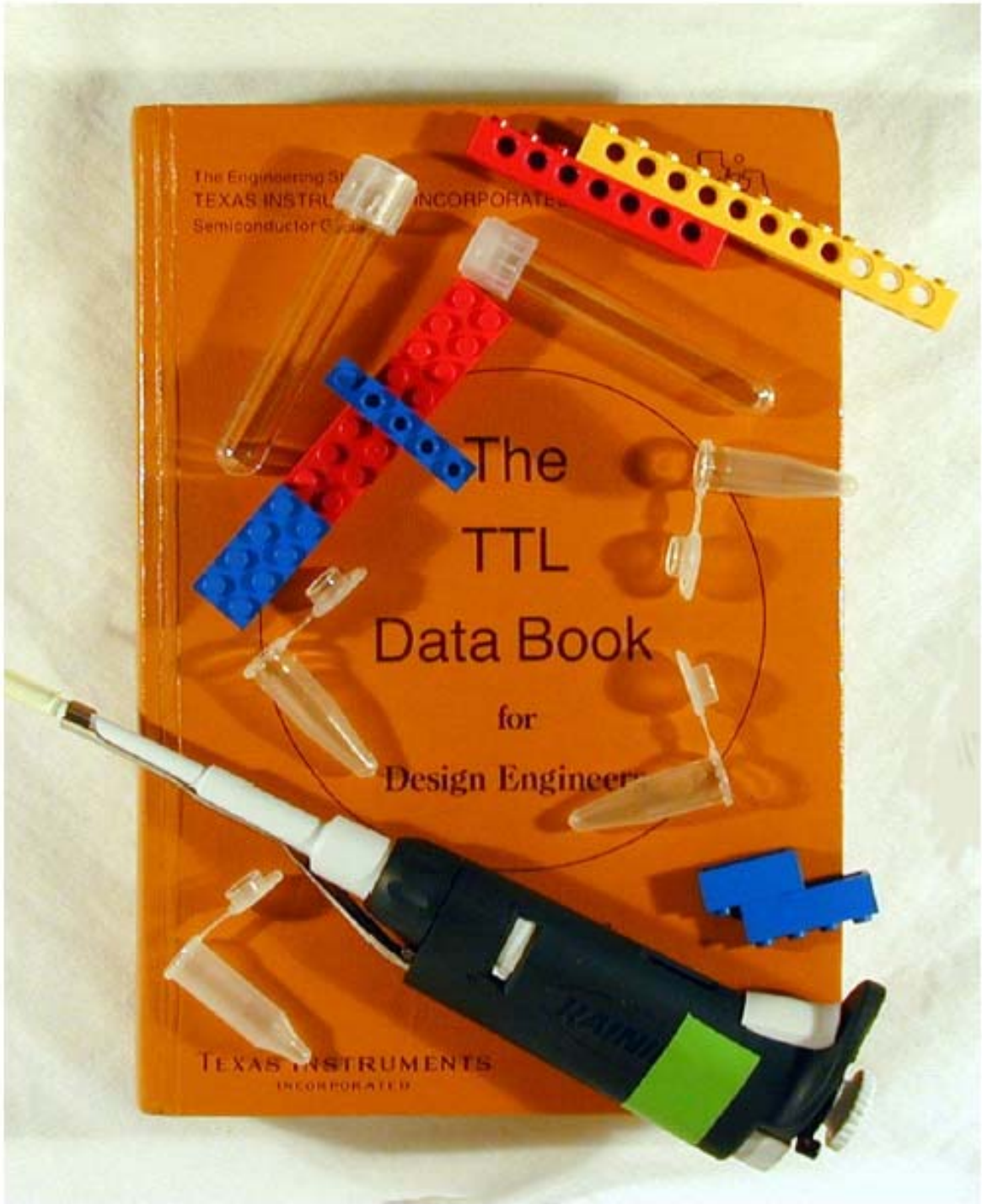

2 nanometers
1 turn = 10 base pairs = 3.4 nanometers
minor groove
major groove

$1/bp, 4wk

e. coli: 4k

you and me: 3gbp

Standardzied Assembly


The
TTL
Data Book
for
Design Engineers
TEXAS INSTRUMENTS
INCORPORATED

Common Signal Carrier


WHEN THE INPUT RATE IS HIGH, THE REPRESSOR PROTEIN GETS MADE, IT SHOOTS UP AND LANDS ON THE OPERATOR SITE, AND THUS THE OUTPUT RATE IS LOW-
-WHEN THE INPUT RATE IS LOW, NO REPRESSOR GETS MADE, SO THE OUTPUT IS HIGH!
HIGH
LOW
DEVICE
VERY GOOD! BUT WHAT EXACTLY IS THE RATE?
RATE OF GENE EXPRESSION.
WHAT DO YOU MEAN EXACTLY?
RATE OF GENE EXPRESSION IS THE NUMBER OF RNA POLY-MERASE MOLECULES THAT TRUNDLE PAST YOU EACH SECOND.
LET'S CALL THIS POLYMERASE PER SECOND OR POPS!**
AH, THE STUDENT BECOMES THE MASTER.
PRETEND YOU ARE STANDING ON THE DNA WHERE THE INPUT SIGNAL ARRIVES.
GOOD. NOW WHAT?
EXCELLENT!
POPS IS THE "FLOW" OF RNA POLYMERASE ALONG MY DNA WIRE.
KINDA LIKE ELECTRICAL CURRENT!
YES!!

Polymerase Operations per Second


Kellogg's
CORN
POPS
BIG YELLOW TASTE...
SWEET PUFFED CRUNCH!
FREE
MOVIE
POPCORN!
IN THEATERS

Characterization

BBa_F2620

3OC$_6$HSL → PoPS Receiver

http://parts.mit.edu/registry/index.php/Part:BBa_F2620

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Last Update: 15 January 2007

Description

A transcription factor (LuxR, BBa_C0062) that is active in the presence of cell-cell signaling molecule 3OC$_6$HSL is controlled by a TetR-regulated operator (BBa_R0040). Device input is 3OC$_6$HSL. Device output is PoPS from a LuxR-regulated operator. If used in a cell containing TetR then a second input signal such as aTc can be used to produce a Boolean AND function.

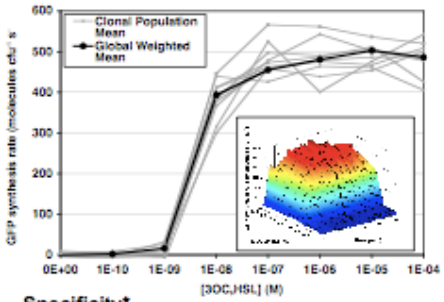
Characteristics

Input Swing: **1E-9 to 1E-6** M 3OC$_6$HSL, exogenous
Output Swing: **0±1 to 503±1** GFP molecules cfu^{-1} s^{-1}
Switch Point: **7±1 nM** 3OC$_6$HSL, exogenous
LH Response: **9 min** ($t_{50\%}$), **27 min** ($t_{90\%}$)

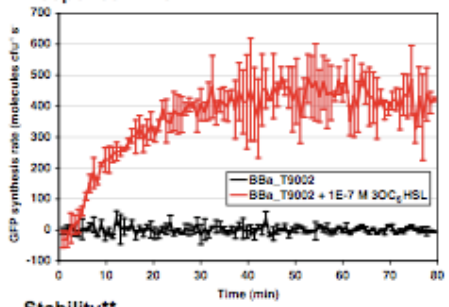
Key Parts

BBa_R0040: TetR-regulated operator
BBa_C0062: luxR ORF
BBa_R0062: LuxR-regulated operator

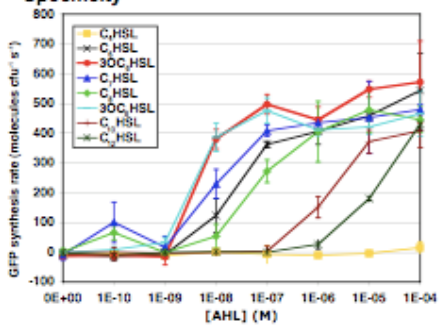
Transfer Function*



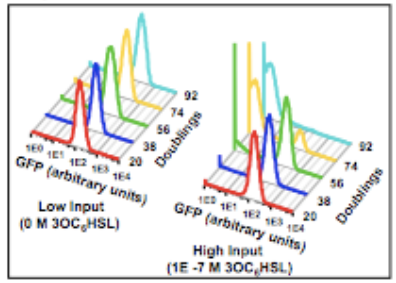
Response Time*



Specificity*



Stability**



Demand (low/high input)

Translational: **256/8048** ribosomes cfu^{-1}
3.8E3/1.2E5 charged tRNA cfu^{-1} s^{-1}

Stability (low/high input)

Genetic: **>92/74** replication events**
Performance: **>92/74** replication events**

Compatibility

Chassis: Compatible with *MC4100*, *MG1655*, and *DH5α*
Plasmids: Compatible with *pSB3K3* and *pSB1A2*
Devices: Compatible with *E0240*, *E0430* and *E0434*
Crosstalk with systems containing *TetR (C0040)*
Signaling: Crosstalk with input molecules similar to 3OC$_6$HSL

Conditions (abridged)

Output: Indirect via *BBa_E0240*
Vector: pSB3K3
Chassis: MG1655
Culture: Supplemented M9, 37°C
**Equipment:* PE Victor3 plate reader
***Equipment:* BD FACScan cytometer

Signaling Devices

Composition & Abstraction

Part:BBa_R0011

DNA Available
Experience: Works

Designed by Neelaksh Varshney, Grace Kenney, Daniel Shen, Samantha Sutton

Entered: Antiquity

Promoter (lacI regulated, lambda pL hybrid)

Inverting regulatory region controlled by LacI (BBa_C0010 , BBa_C0012 , etc.) The PLlac 0-1 promoter is a hybrid regulatory region consisting of the promoter P(L) of phage lambda with the cI binding sites replaced with lacO1. The hybrid design allows for strong promotion that can nevertheless be:

- repressed by LacI, the Lac inhibitor (i.e. repressor) (BBa_C0012) ([LUTZ97]).
- induced by IPTG in E.Coli DH5-alpha-Z1 (same paper reference) over a >600-fold range

Usage and Biology

[edit]

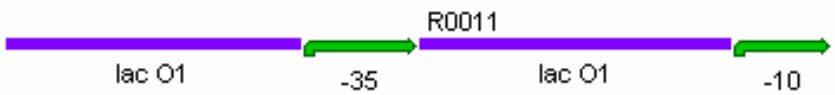
Strong promoter. [jb, 5/24/04]

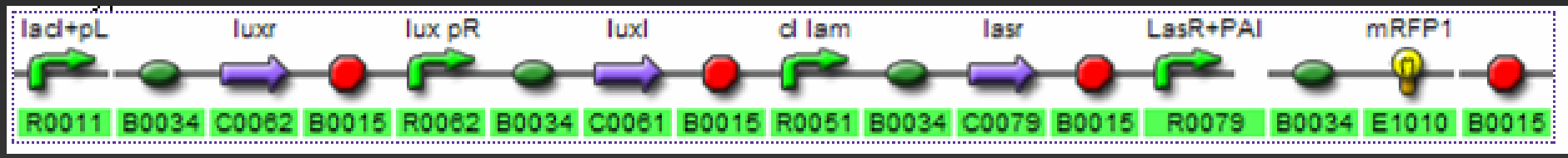
R0011 will be on in strains without lacI, off in strains that are laclq (ie. Part:BBa_V1003) and medium in strains that are lacI

Sequence and Features

Format: Subparts | Ruler | SS | DS Search: Length: 55 bp Context: Part only Get selected sequence

```
     1          11         21         31         41         51         61         71         81         91
1    aattgtgagc ggataacaat tgacattgtg agcggataac aagatactga gcaca
     ttaacactcg cctattgtta actgtaacac tcgcctattg ttctatgact cgtgt
```





http://www.ccbi.cam.ac.uk/iGEM2006/index.php/Description

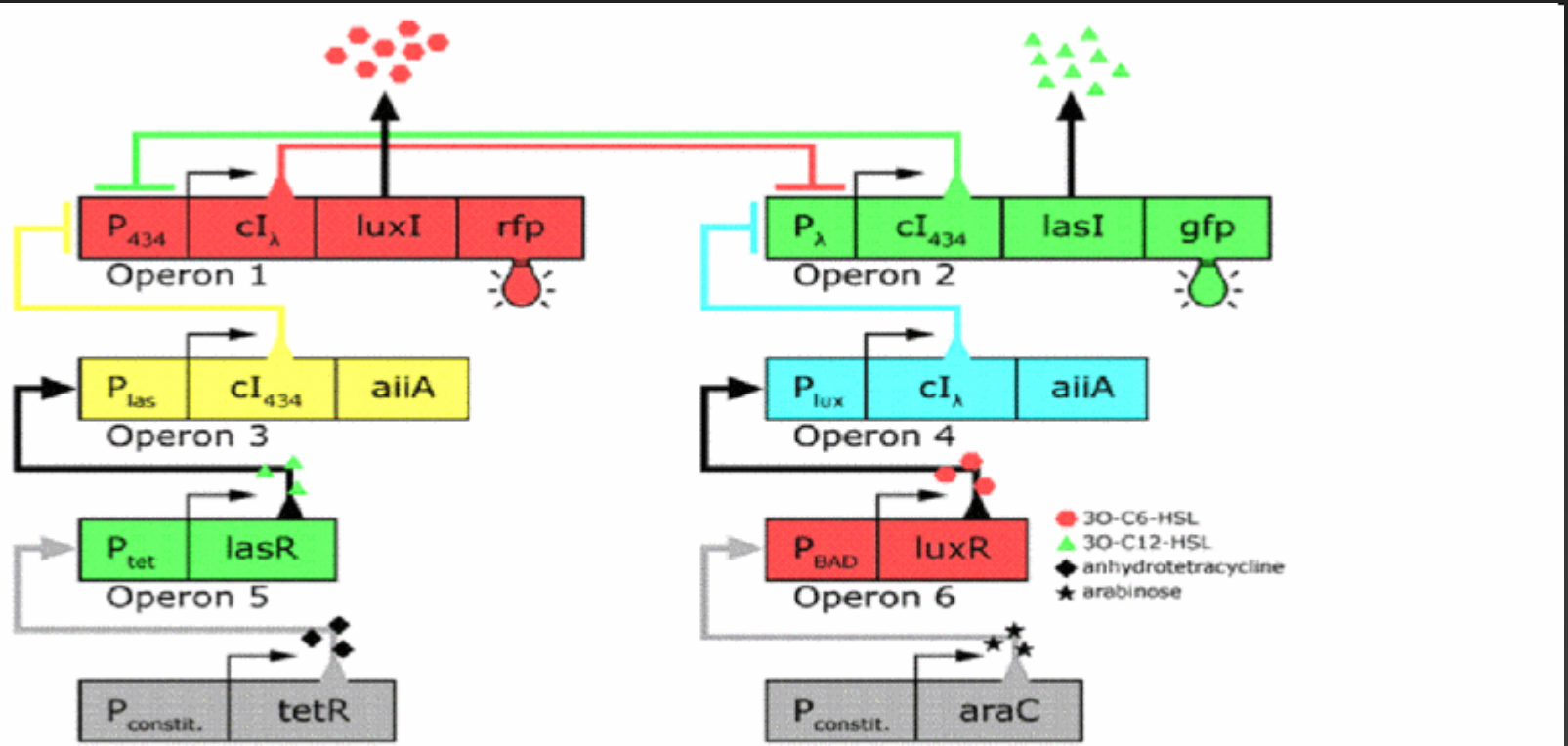


Figure 5.1. Diagram of genetic circuitry of the proposed bi-stable switch system

http://www.ccbi.cam.ac.uk/iGEM2006/index.php/Description

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Legal Frameworks

Human Factors

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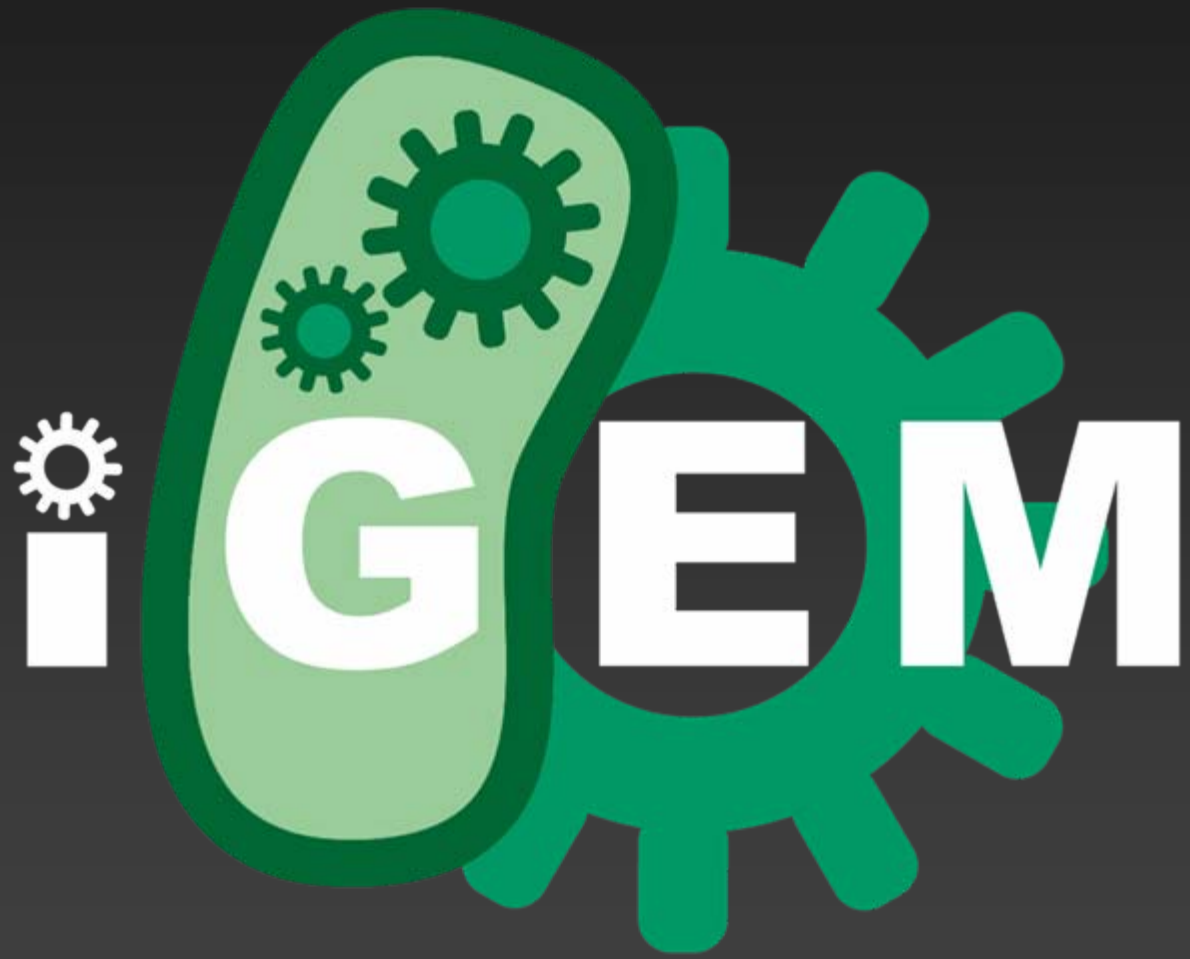
iGEM

http://www.igem.org

iGEM 2007 Wiki

International Genetically Engineered Machine Competition

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teams jamboree participate help about registry

iGEM Boogie

A mass of anxious iGEMMERS join a spontaneous dance on stage while waiting for the final Grand Prize decision from the Judges.

Publish Your Project

IBE's Journal of Biological Engineering
abstracts due Dec. 21!!!

Find more info on the Publish page

iGEM 2007 has officially concluded

And it was a great success! 54 teams from around the world spent their summer engineering novel biological machines using and creating BioBrick standard biological parts, then gathered

iGEM?

Hundreds of undergraduates all over the world spend their summer making Synthetic Biology a reality by participating in the annual International Genetically Engineered Machine competition.

iGEM through the years

- 2008
- 2007
- 2006

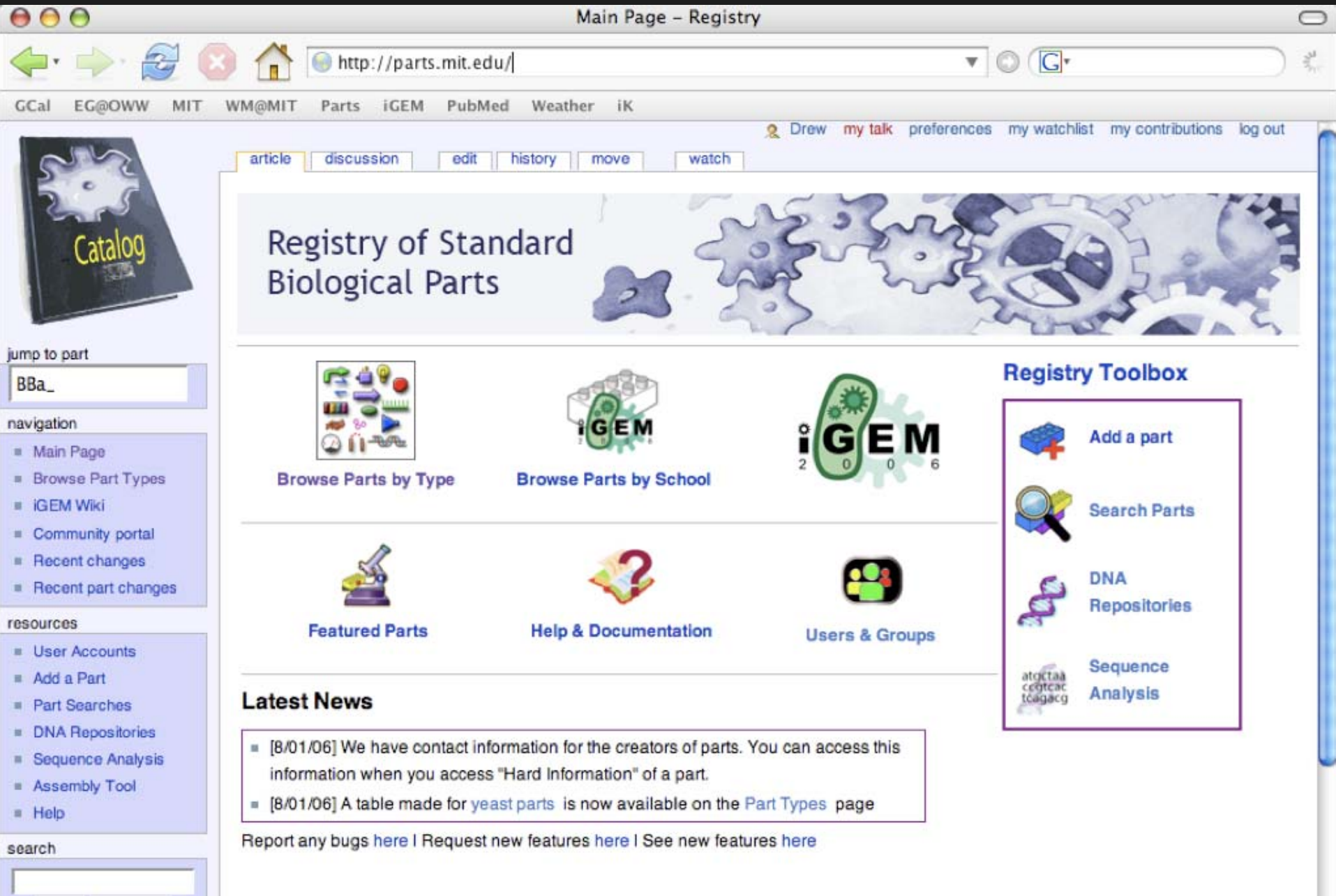
Learn More

iGEM in the News

Here are some recent publications about iGEM teams:

- **Slate:** Students from around the world synthesize new forms of life at the iGEM Jamboree
- **NY Times:** English, Algebra, Phys Ed ... and Biotech
- **San Francisco Chronicle:** High

http://parts.mit.edu



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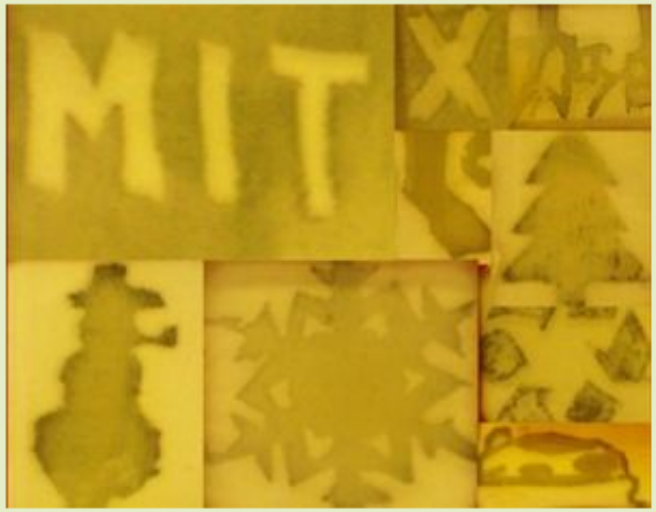

OWW News

OpenWetWare Announces ROD: ?Research on Demand?
2008-04-01 13:30:17 EDT[OpenWetWare]

OWW is pleased to announce a new addition to our system: ROD: "Research on Demand". ROD enables the creation of research results that meet the demands of your publication and graduation schedules. By design, ROD is never 100% correct, and includes errors as subtle or as blatant as you

Questions!

diybio.org
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