iGEM

International Genetically Engineered Machine Competition

U.S. National Academies,
OECD, & The Royal Society

7/10/2009

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igem.org

Synthetic Biology Question

Can simple biological systems be built from standard, interchangeable parts and operated in living cells?

Or, is biology so complex that each case is unique?

What is iGEM?

- An international design competition for undergraduate teams
- Synthetic Biology based on Standard Parts
- Goal: Design and build a project that will impress us
- Have fun

Long term outcomes:

1. Help develop Synthetic Biology
2. Train its students and instructors
3. Establish a positive and cooperating community

iGEM Philosophy

iGEM Philosophy: Get and Give

Teams are expected to use the parts, ideas, and experience of teams in previous years.

Teams are expected to contribute their parts, ideas, and experiences.

iGEM Growth and Scale

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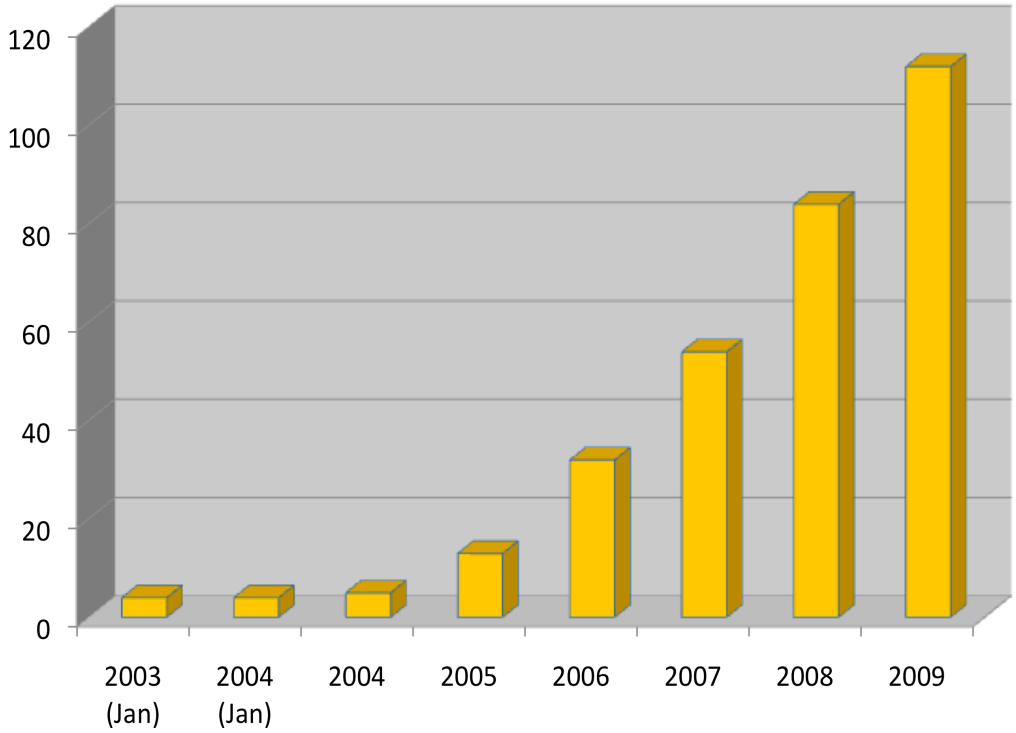
Teams



iGEM Scale and Growth

Year	Teams	Jamboree	Total
IAP	4	20	20
2004	5	70	70
2005	13	120	150
2006	32	360	400
2007	54	570	750
2008	84	825	1180
2009	112	1100	1650
2010	180	1800	2700
2011	270	2700	4000

Or Not !

iGEM 2009 – Europe and USA

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Europe (33)

Aberdeen Scotland	Amsterdam	BCCS Bristol	BIOTEC Dresden	Bologna
Cambridge	DTU Denmark	Edinburgh	EPF Lausanne	ESBS Strasbourg
Freiburg bioware	Freiburg software	Groningen	Heidelberg	Imperial London
KU Leuven	Newcastle	Paris	SDU Denmark	Sheffield
Slovenia	Southhampton	SupBiotech Paris	Sweden	TU Delft
Turkey	UAB Barcelona	UCL London	ULB Brussels	UNIPV Pavia
Uppsala Sweden	Valencia	Warsaw		

USA (36)

Bay_Area_RSI	Berkeley_Software	Berkeley_Wetlab	Brown	Brown Too
City College SF	Cornell	Duke	Gaston Day School	Harvard
Illinois	Illinois Tools	Indiana	Johns Hopkins	Johns Hopkins BAG
Michigan	Minnesota	Missouri Miners	MissouriW–Davidson	MIT
Nevada	Purdue	Rice	Stanford	U Chicago
UCSF	UC Davis	UNC Chapel Hill	Utah State	Virginia
VA Commonwealth	Washington	Washington Software	Wash U	Wisconsin Madison
Yeshiva NYC				

iGEM 2009 – Asia, Canada, Latin America

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Asia (27)

Bangalore	CBNU Korea	Chiba	HKU-HKBU	HKUST
IBB Pune	IGIB Delhi	IIT Bombay	IIT Madras	KU Seoul
Kyoto	NCTU Formosa	NTU Singapore	NYMU Taipei	Osaka
PKU Beijing	Queensland	SJTU Shanghai	Tianjin	Todai Tokyo
Tokyo Nokogen	Tokyo Tech	Tsinhua	TzuChiU Formosa	USTC
USTC Software	Victoria			

Canada (10)

Alberta	British Columbia	Calgary	Lethbridge	McGill
Queens Ontario	Toronto	U Ottowa	Victoria BC	Waterloo

Latin America (5)

IPN UNAM Mexico	IPOC1 Colombia	IPOC2 Colombia	LCG UNAM Mexico	UNICAMP Brazil

iGEM Schedule: Assemble Teams

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Nov.	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	May	Jun.	Jul.	Aug.	Oct.	Nov.	Beyond

iGEM Schedule: Raise Money

Small sample of team budgets

$20K	8
$30K	8
$40K	1
$50K	4
>$50K	2

Nov.	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	May	Jun.	Jul.	Aug.	Oct.	Nov.	Beyond

Teachers Workshops - Tianjin 2007

igem.org

Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	**May**	**Jun.**	Jul.	Aug.	Oct.	Nov.	Beyond

DNA Distribution

igem.org

Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	**May**	Jun.	Jul.	Aug.	Oct.	Nov.	Beyond

iGEM Work At Your School

igem.org

Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	**Jun.**	**Jul.**	**Aug.**	**Oct.**	**Nov.**	Beyond

iGEM Jamboree

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Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Oct.	**Nov.**	Beyond

iGEM Jamboree

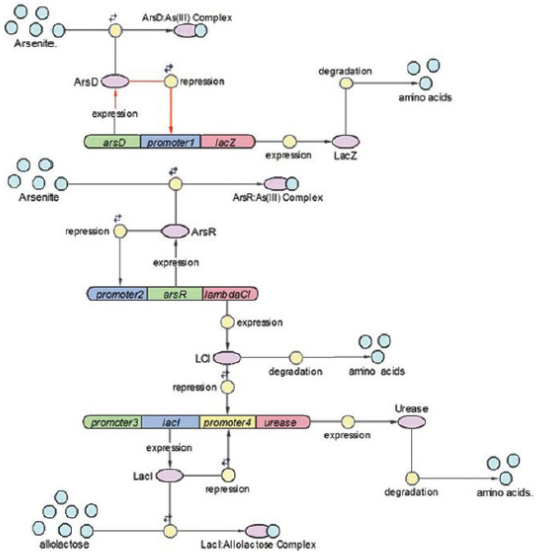
igem.org

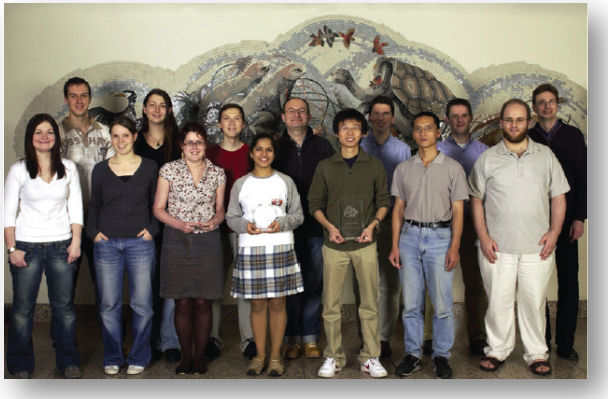
Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Oct.	**Nov.**	Beyond

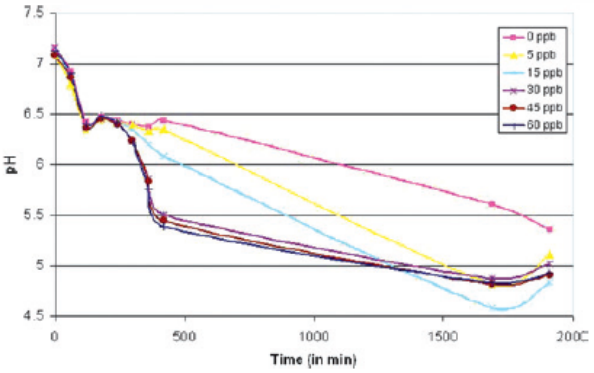
After iGEM – PublishYour Work

Development of a novel biosensor for the detection of arsenic in drinking water

J. Aleksic, F. Bizzari, Y. Cai, B. Davidson, K. de Mora, S. Ivakhno, S.L. Seshasayee, J. Nicholson, J. Wilson, A. Elfick, C. French, L. Kozma-Bognar, H. Ma and A. Millar







Is iGEM Safe?

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page discussion edit history move watch teams

Safety

For iGEM 2009 teams are asked to detail how they approached any issues of biological safety associated with their projects.

Specifically, teams should consider the following four questions:

1. Would any of your project ideas raise safety issues in terms of:
   - researcher safety,
   - public safety, or
   - environmental safety?
2. Is there a local biosafety group, committee, or review board at your institution?
3. What does your local biosafety group think about your project?
4. Do any of the new BioBrick parts that you made this year raise any safety issues?
   - If yes, did you document these issues in the Registry?

Teams, please document any answers to these (or other) safety questions in your presentation, wiki presentation, or poster.

Judges will be asked to evaluate your project, in part, on the basis of if and how you considered and addressed issues of biological safety.

If any questions arise regarding iGEM and biological safety please send an email to safety AT igem.org.

Impact of iGEM

- Students
  - Training future synthetic biologists
  - Teaching entrepreneurial competition
- Instructors
  - Opportunities for junior faculty
  - New programs - new ideas
- Schools
  - Synthetic biology entering curriculum
  - Energize research programs
- Synthetic Biology
  - Examples, parts, successes, testimonials
  - Academic research projects – SynBERC
- A task worth the effort

iGEM 2008 Projects

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- RNA Logic, Biological Memory,
- Turing Patterns, Voltage Output,
- Magnetic Bacteria,
- Polutants
- GFP Modification, Biomacromolecule
- Fuel, bio-removal
- Betacarotine production
- Quorum sensing
- Counter in yeast
- Game of life
- GM Symbiots
- Cyanobacteria
- Slot machine
- 'Stress kit', transcription factors
- Yeast biosensor
- Bioprinter
- Starch-producing E.coli
- Yeast sex detector
- Bacterial drug delivery system
- Ligase independent cloning
- Counter, time bomb
- Ligain peroxide degrading
- Biogurt
- Repressilator
- "Bug Busters"
- Kill bad E.coli O157:H7
- Bacter O'Clock
- Hormone biosensor
- Bacterial UV sensor
- "Redhawk: Search and destroy"
- Viral amplification
- Biobeer
- Chemotaxis
- Thermometer
- Lysophonix - sound sensitive bacteria
- Clotho (biocad)
- Multiplexor/Demultiplexor
- Singing bacteria

And 40 more . . .

iGEM 2008 Activity and Success

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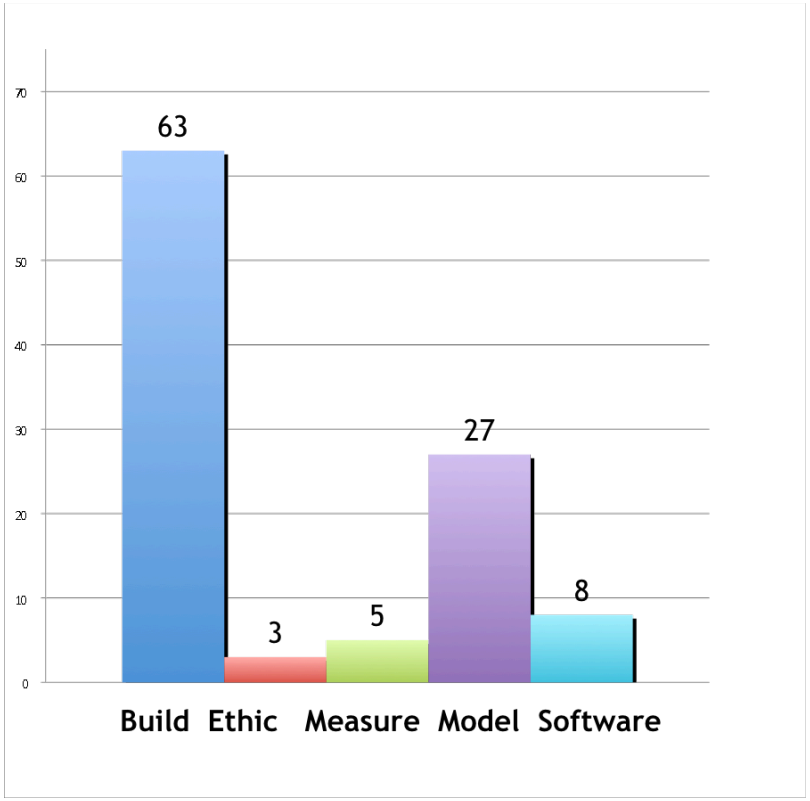
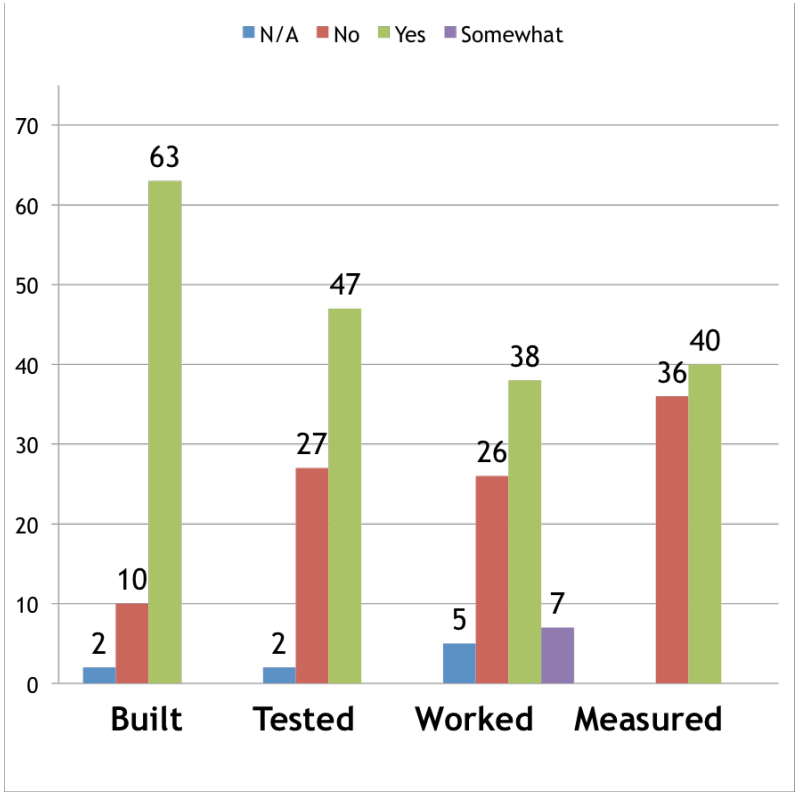
Activities



Successes



iGEM 2008

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The Registry of Standard Biological Parts

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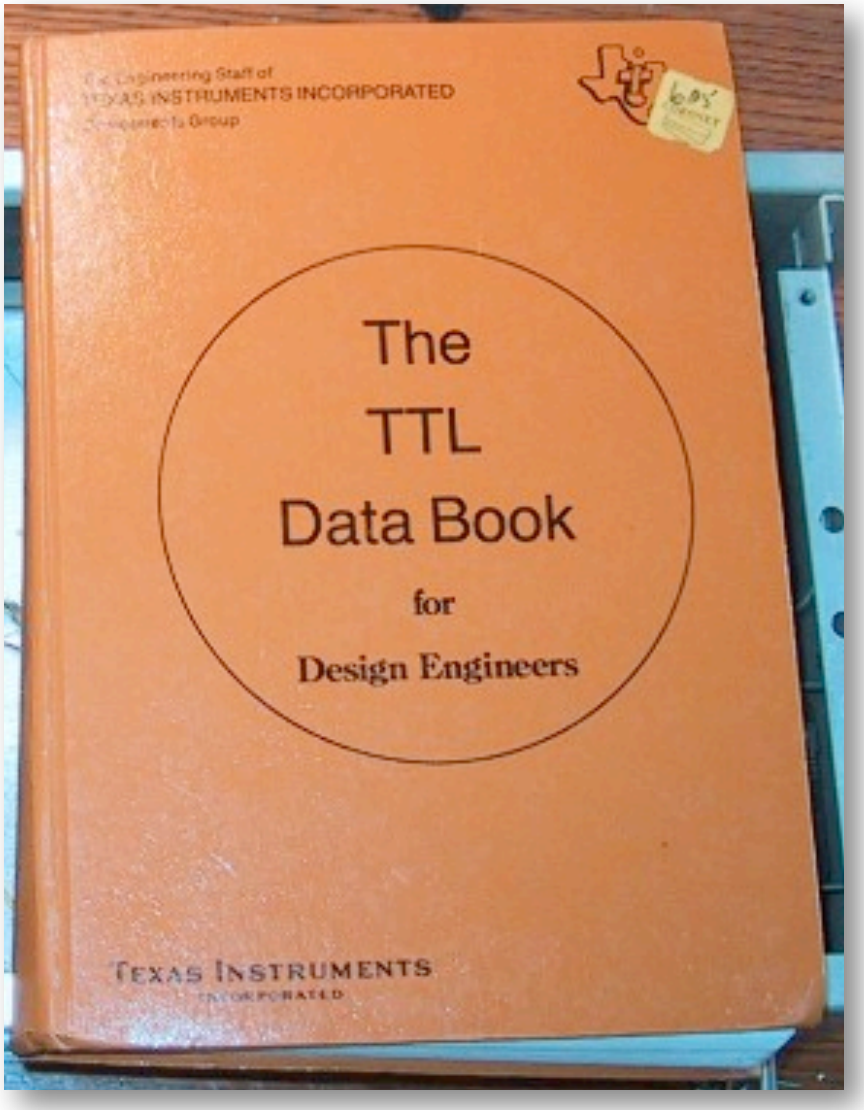


SN74LS14

Schmitt Triggers
Dual Gate/Hex Inverter

The SN74LS14 contains logic gates/inverters which accept standard TTL input signals and provide standard TTL output levels. They are capable of transforming slowly changing input signals into sharply defined, jitter-free output signals. Additionally, they have greater noise margin than conventional inverters.

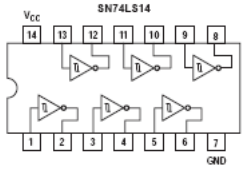
Each circuit contains a Schmitt trigger followed by a Darlington level shifter and a phase splitter driving a TTL totem pole output. The Schmitt trigger uses positive feedback to effectively speed-up slow input transitions, and provide different input threshold voltages for positive and negative-going transitions. This hysteresis between the positive-going and negative-going input thresholds (typically 800 mV) is determined internally by resistor ratios and is essentially insensitive to temperature and supply voltage variations.

ON Semiconductor
Formerly a Division of Motorola
http://onsemi.com

LOW
POWER
SCHOTTKY

LOGIC AND CONNECTION DIAGRAMS

SN74LS14



PLASTIC
N SUFFIX
CASE 646

SOIC
D SUFFIX
CASE 751A

GUARANTEED OPERATING RANGES

Symbol	Parameter	Min	Typ	Max	Unit
V_{CC}	Supply Voltage	4.75	5.0	5.25	V
T_A	Operating Ambient Temperature Range	0	25	70	°C
I_{OH}	Output Current – High			−0.4	mA
I_{OL}	Output Current – Low			8.0	mA

ORDERING INFORMATION

Device	Package	Shipping
SN74LS14N	14 Pin DIP	2000 Units/Box
SN74LS14D	14 Pin	2500/Tape & Reel

December, 1999 – Rev. 0

Publication Order Number:
SN74LS14/D

Registry of Standard Biological Parts

Go Search

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The Registry of Standard Biological Parts has moved from parts.mit.edu to partsregistry.org.
References to the Registry at parts.mit.edu will be automatically redirected to the new site.

- Browse Parts by Type

Featured Parts

Help & Documentation

Users & Groups

Apply here for a Registry account

Registry News

- We are considering releasing the Registry's DNA Repository and Library system to the Registry labs and IGEM teams. This is the system we use to keep track of parts in our freezer boxes and plates. Please check it out and let us know what you think. - June 2, 2008
- A bug that kept Internet Explorer users from seeing the Part menu on Part pages has been fixed. Now, if you go to a part, you will see menu choices for hard information and physical location. - June 2, 2008
- The sequence and features for all parts are available through DAS, the Distributed Annotation System. Learn more here - May 26, 2008
- Changes to the Registry software are underway. Check it out!
- We have a new tutorial for starting teams in the Help section
- We are starting an editorial board for promoting well-defined and useful parts to BioBrick™ part status. To join this effort check the BioBrick™ Part Program
- There is a problem with using primers VR and VF2 to PCR parts containing B0015 or B0010.
- News archive...

Report any bugs here | Request new features here | See new features here | See old bugs,requests, and features here

Registry Tools

- Add a part
- Search Parts
- More...
- Measurement
- DNA Repositories
- Sequence Analysis
- Send Parts to the Registry

Parts From Groups

- 2008 iGEM Teams
- 2007 iGEM Teams
- 2006 iGEM Teams
- 2005 iGEM Teams
- Parts by Lab

Registry Community

Frequently Asked Questions

Recent changes What links here Related changes Upload file Special pages My preferences
Recent part changes Printable version Permanent link Privacy policy Disclaimers

partsregistry.org

Example Part

igem.org

Registry of Standard Biological Parts

Part:BBa_I13600

DNA Available
Experience: Works

Designed by Christopher Batten, Victoria Chou, Kenneth Nesmith

Entered: 2004-07-16

From partsregistry.org

Tet with CFP reporter (without LVA tag)

The part glows (rather weakly) with a cyan colored flourescent protein. In the absence of the tetR protein, CFP expression is constitutive. tetR represses CFP production; this repression can be relieved by the addition of tetracycline or one of its analogs (ie. aTc) (http://openwetware.org/wiki/ATc) .

Sequence and Features

Format: Subparts | Ruler | SS | DS Search: Length: 940 bp Context: Part only Get selected sequence

p(tetR) . ECFP . .
R0040 B0034 E0020 B0010 B0012

Pictures

BBa_I13600 visualized under non-UV lightbox

BBa_I13600 visualized under 254nm wavelength UV

Retrieved from "http://partsregistry.org/Part:BBa_I13600"

- Recent changes
- What links here
- Related changes
- Upload file

Plasmids/Assembly

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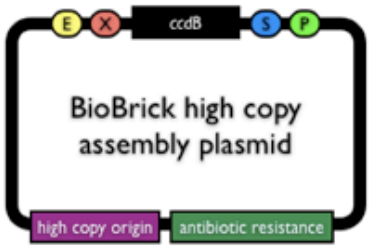
High copy number assembly plasmid backbones

The most common set of plasmid backbones that people use to assemble BioBrick® standard biological parts together are high copy BioBrick plasmid backbones. High copy plasmid DNA is easily purified in high yield from cultures, so it makes obtaining enough DNA for assembly easy.



The high copy plasmid backbones listed below have a common set of features.

1. A complete BioBrick® cloning site for easy cloning and assembly of BioBrick parts.
2. Terminators flanking the BioBrick® cloning site to insulate the vector from read-through transcription originating in the cloned BioBrick® part, device or system.
3. Primer binding sites for the standard BioBrick® verification primers VF2 (BBa_G00100) and VR (BBa_G00101). These primers are located for convenient sequencing and screening by colony PCR of cloned BioBrick® parts, devices, and systems.

Plasmid backbones are distributed by the Registry with a default insert. There are just a handful of default plasmid inserts used in the Registry. Many the available plasmid backbones have the *ccdB* positive selection marker (BBa_P1010) as the default plasmid insert within the BioBrick® cloning site. The *ccdB* gene ensures that when assembling two BioBrick® parts together, the uncut plasmid is not transformed. However, inclusion of the *ccdB* gene means that these vectors must be propagated in a *ccdB* tolerant strain, such as *E. coli* strain DB3.1 (BBa_V1005).

Finally, to make assembly of BioBrick® parts easier, these BioBrick® assembly plasmid backbones are available with three different antibiotic resistance markers, so that you can use 3 antibiotic assembly methods to assemble BioBrick® parts.

-?-		Name	Description	Resistance	Replicon	Copy number	Chassis	Length
A	W	pSB1A3	High copy BioBrick assembly plasmid	A	pMB1	100-300		2157
A	W	pSB1A7	Transcriptionally insulated high copy BioBrick plasmid	A	pMB1	100-300		2431
A	W	pSB1AC3	High copy BioBrick assembly plasmid	AC	pMB1	100-300		3055
A	W	pSB1AK3	High copy BioBrick assembly plasmid	AK	pMB1	100-300		3189
A	W	pSB1AT3	High copy BioBrick assembly plasmid	AT	pMB1	100-300		3446
	W	pSB1C3	High copy BioBrick assembly plasmid					2072
	W	pSB1K3	High copy BioBrick assembly plasmid					2206
	W	pSB1T3	High copy BioBrick assembly plasmid					2463

Karmella Haynes, an instructor of the 2006 Davidson College iGEM team, designed and constructed the plasmid backbone pSB1A7). You can read more about the 2006 Davidson project in their open-access paper Engineering bacteria to solve the Burnt Pancake Problem published in the *Journal of Biological Engineering*.

Robbie Bryant constructed the plasmid backbone pSB1AC3 in Tom Knight's lab.

Parameters, Categories, . . .

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Biological Parts

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BBa E0840 Main Page Part Design Physical DNA Hard Information Experience Tools

Part:BBa_E0840

Designed by Jennifer Braff Group: Endy Lab, Registry (2004-10-18)

Reporter
GFP genera

DNA Available
1 Registry Star
Get This Part

GFP generator

BBa_E0840 takes as input a transcriptional signal (PoPS) and produce as output the fluorescent protein GFP.

Usage and Biology

- See BBa_E0040 for additional details.
- BBa_E0840 is often used to quantify the behavior of transcriptional control devices such as promoters.
- BBa_E0840 has a strong ribosome binding site.

Sequence and Features

Format: Subparts | Ruler | SS | DS Search: Length: 878 bp Context: Part only Get selected sequence

Assembly Compatibility: 10 21 23 25

[edit]

Parameters

emission	Green
excitation	
tag	None

Twins

BBa_I741026 Deleted
BBa_I751310 Building
BBa_S04013 Planning

Reviews

1 Registry Star
Group Favorite
Experience: Works

Categories

//classic/reporter/ret
//iGEM2006/MIT/favorites

Part Libraries

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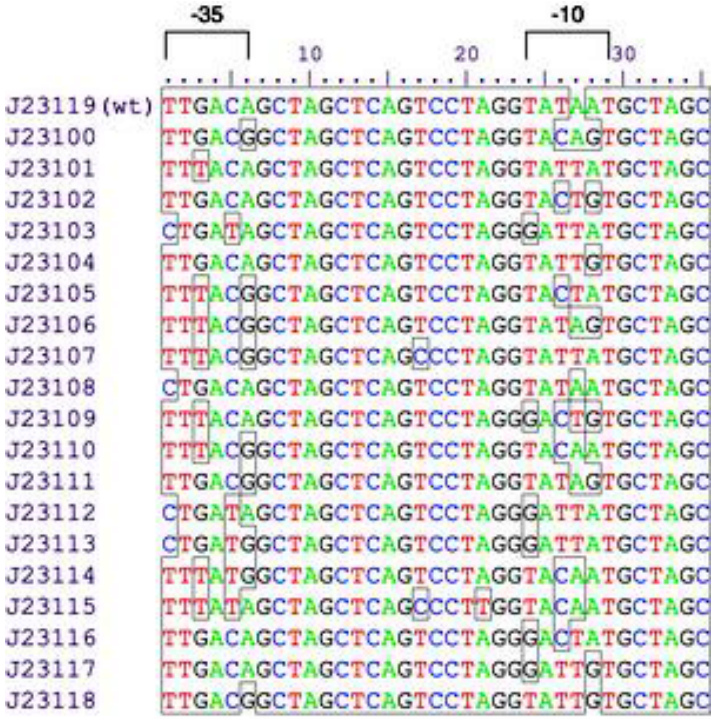
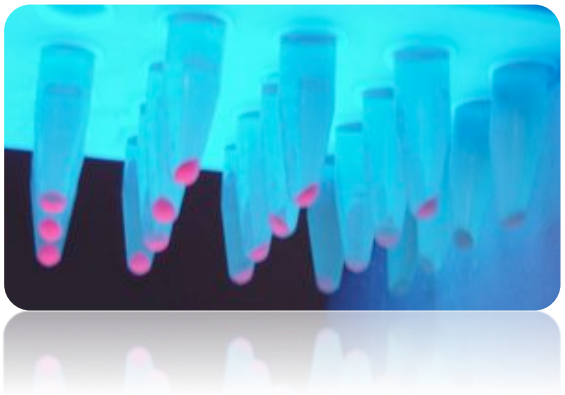
Chris Anderson's Constitutive Promoters



Variant	RFP (au)
J23112	1
J23103	17
J23113	21
J23109	106
J23117	162
J23114	256
J23115	387
J23116	396
J23105	623
J23110	844
J23107	908
J23106	1185
J23108	1303
J23118	1429
J23111	1487
J23101	1791
J23104	1831
J23102	2179
J23100	2547



Registry Contents 1/2009

3500 Parts Available as DNA

(Includes 1300 from iGEM 2008)

- Promoters

- Protein Coding

- Reporters

- RNA

- Terminators

- Signaling

- Many project parts

Quality Control

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Sequence Verification

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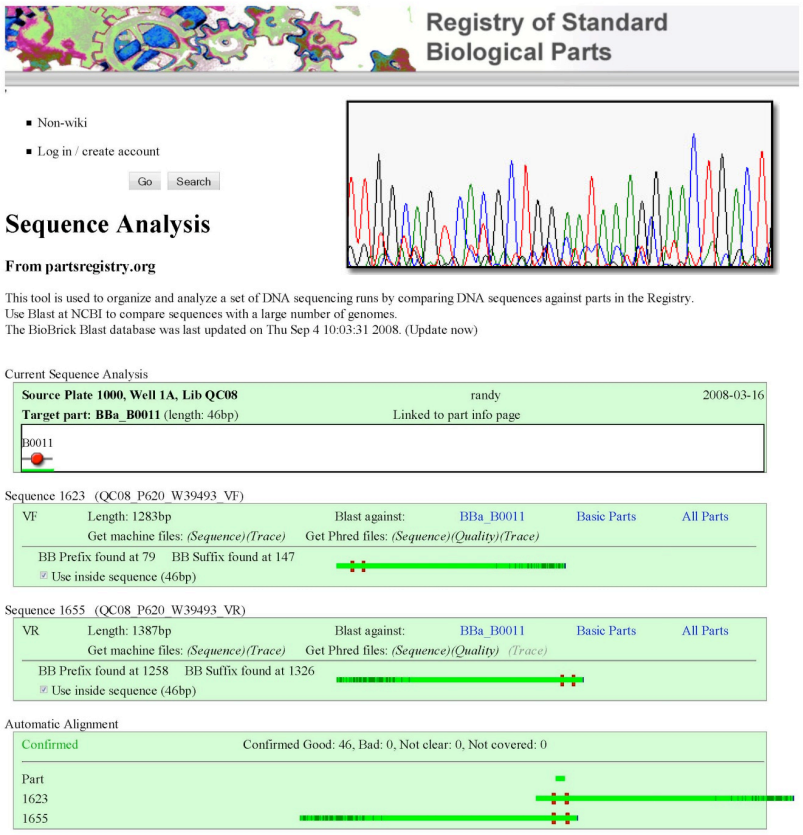
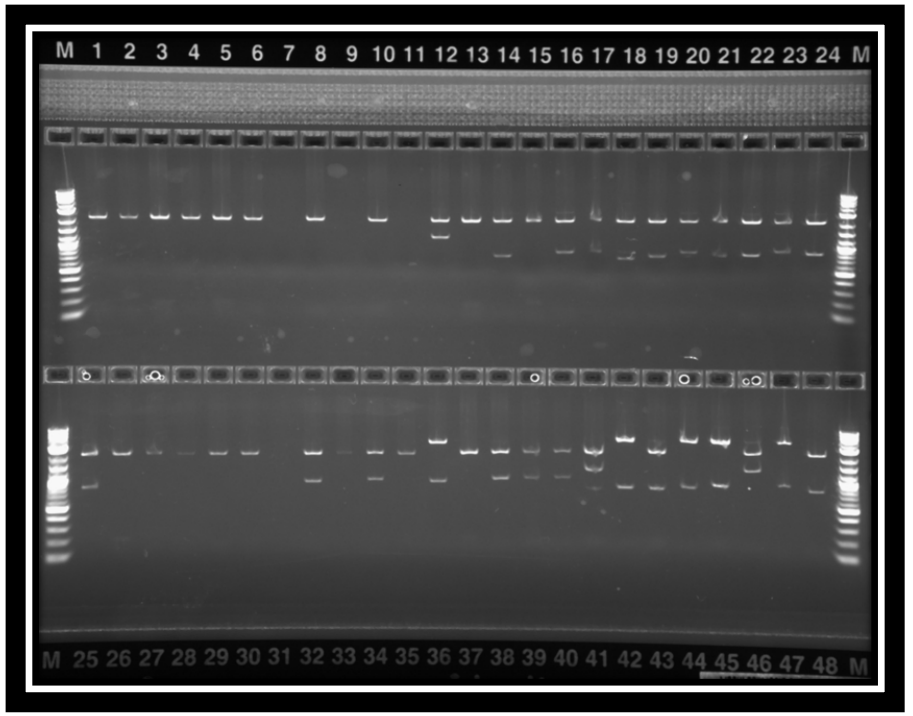
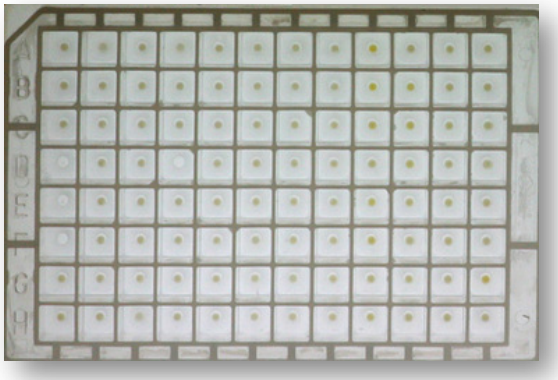
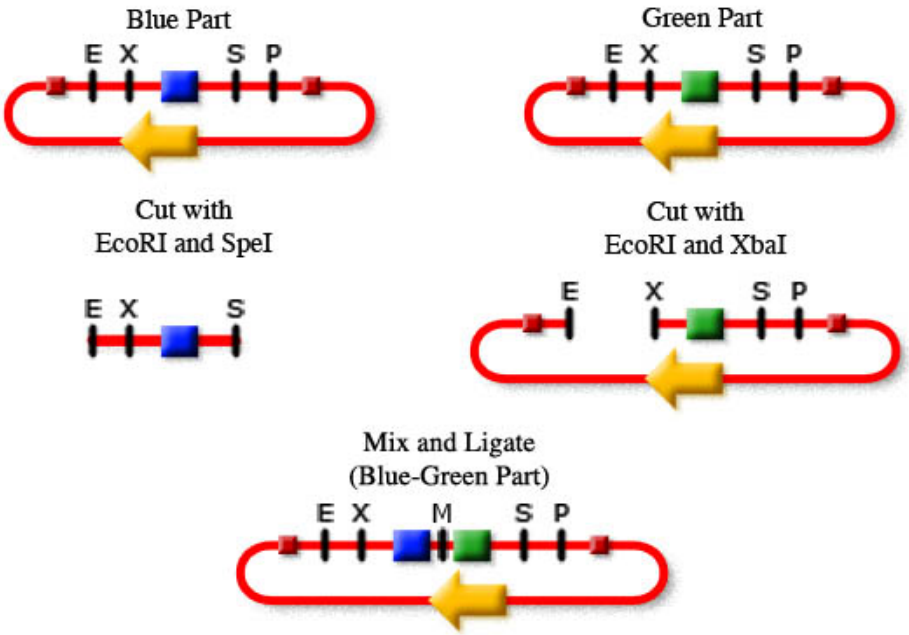




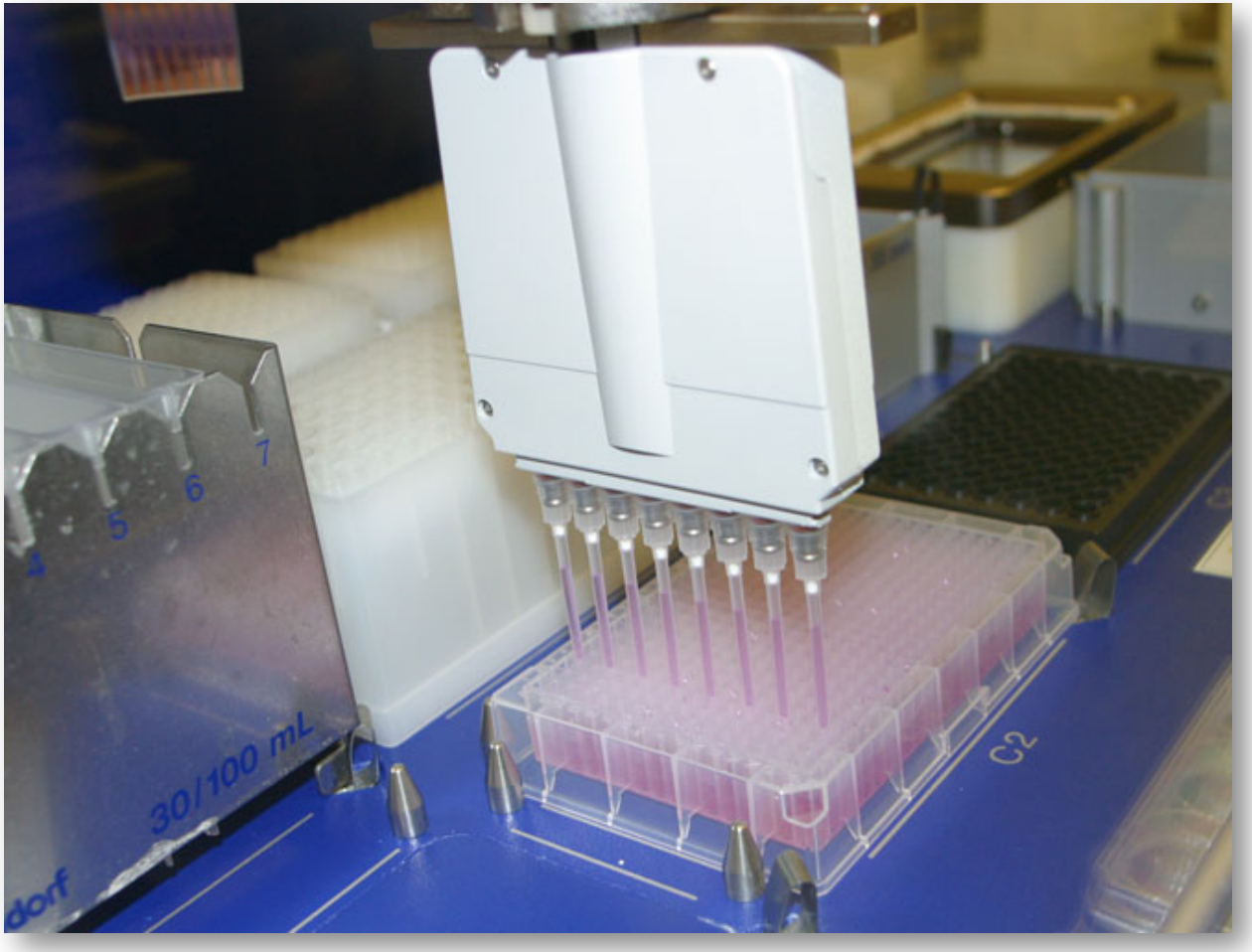
Source Plate 1000 Image Antibiotic A



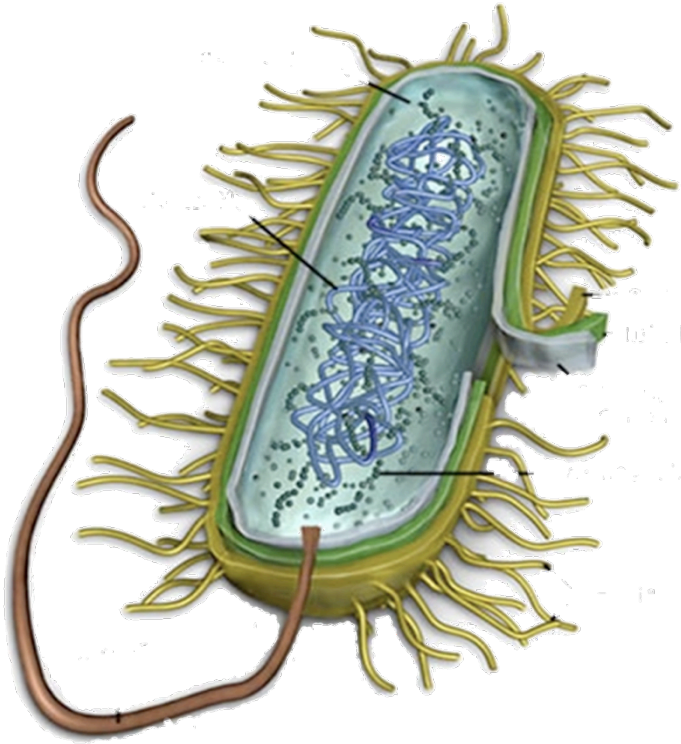
BioBrick Standard Assembly

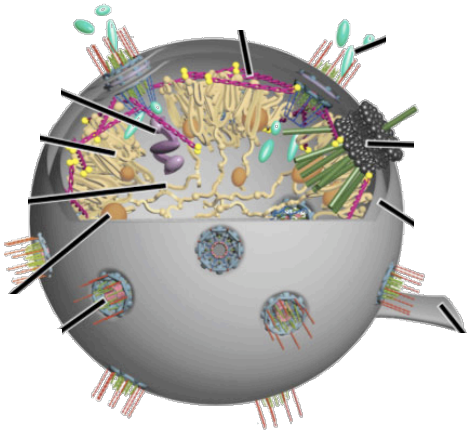


Robotic Assembly

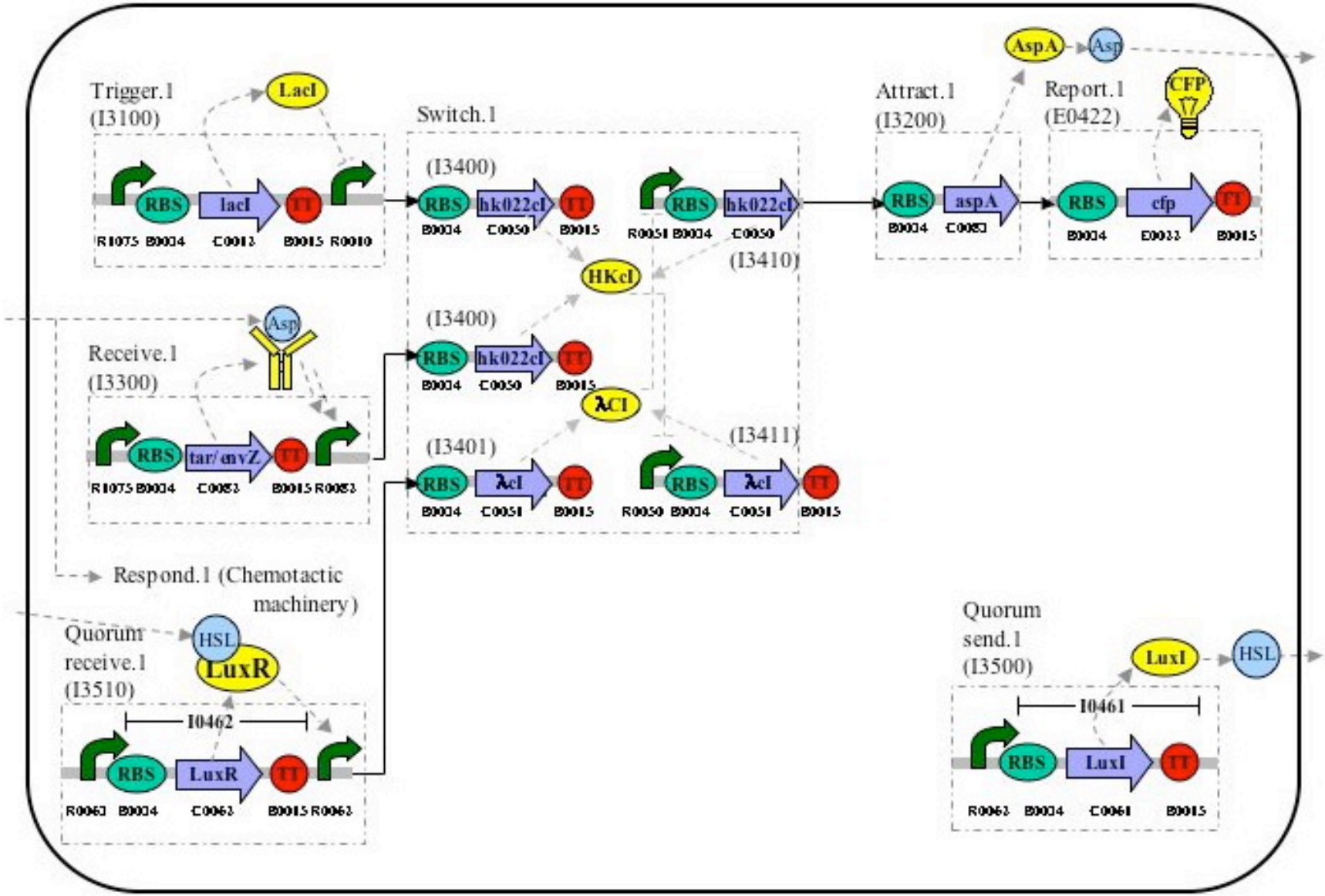


Different Chassis





iGEM CAD and System Design



Commercial Applications

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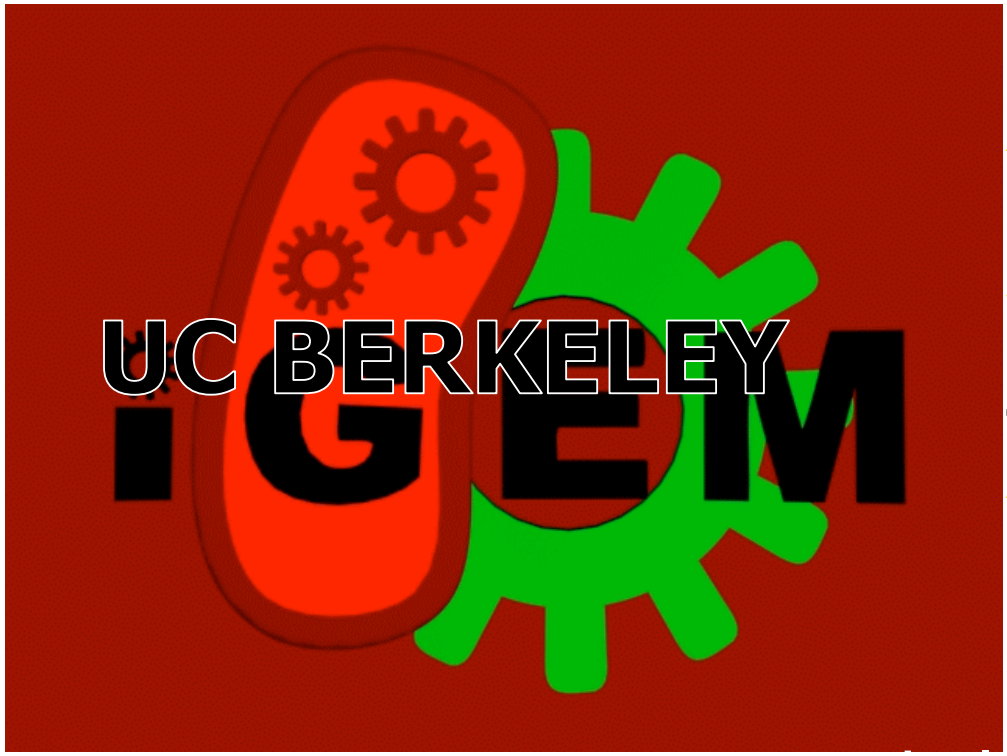
BACTOBLOOD



Researchers

Arthur Yu • Austin Day • David Tulga • Hannah Cole • Kristin Doan • Kristin Fuller • Nhu Nguyen • Samantha Liang • Vaibhavi Umesh • Vincent Parker

Teaching Assistants

Amin Hajimorad • Farnaz Nowroozi • Rickey Bonds

Advisors

John Dueber • Christopher Anderson • Adam Arkin • Jay Keasling

Save the World - Arsenic Detector

A test tube could contain all the necessary components: Freeze dried bacteria, growth medium, indicator powder, Ampicillin salt, etc…

- These tubes could then be given to local villagers to monitor their own water quality themselves
- A good alternative to the widely used Gutzeit method

iGEM and Registry Needs

- Open Access
  - Visas, Iran
- Patents
  - Is there a de facto research or education exemption?
  - Does it work for iGEM?
- Organization
  - Not for profit vs NCBI vs other
- Policy and Education
  - What should we teach the 1700 participants this year?
- Funding for iGEM Headquarters and the Registry
- Funding for teams
- Better parts
- Better tools

Sponsors

- NSF / SynBERC
- MIT
- Microsoft (2005-2006)
- MathWorks
- GeneArt