What we will cover:
- History and Motivation
- Android app (Ecolight)
- Results
- Systems Cloned
Light As A Tool For Gene Induction

Why Light?
- Eliminates inducing chemicals
- Tunable
- It’s everywhere

Levskaya et al., *Nature* 2005
Current Standards for Conducting Light Experiments Are Inadequate

- Problem:
  - Expensive
  - Modification to existing equipment
  - Complicated
Building On Our Project From 2012

- App developed by UW iGEM 2012
- App largely untested
  - Non-reproducible data
  - Non-standard cell line
- We had a lot to learn
Samsung Galaxy 7.7 Tablet Has An OLED Display

OLED = Organic Light Emitting Diode
Samsung Galaxy Tab 7.7 Emits Photons At Discrete Peaks

[Diagram showing a graph with wavelength on the x-axis and normalized intensity (RFU) on the y-axis, with an arrow pointing to a region labeled 'Dark Emission']
Samsung Galaxy Tab 7.7 Emits Photons At Discrete Peaks

Flavin mononucleotide

Phycocyanobilin

Dark Emission
Running An Experiment!

Step 1:

- Download and Launch free Ecolight App!
Step 2: Select Well Configuration
Step 3:
Enter Duration and Intensity
Step 4: Review And Run Experiment!
Each Well In A 96 Well Plate Can Be Individually Configured

Red
- Red Wait (Milliseconds): 250
- Red Intensity (%): 100

Green
- Green Wait (Milliseconds): 150
- Green Intensity (%): 75

Blue
- Blue Wait (Milliseconds): 100
- Blue Intensity (%): 100

Black
- Black Wait (Milliseconds): 150
- Black Intensity (%): 100

Set Values
- Back
- Set Values
- Start Test

Set Values
Ecolight Has Been Designed For Light Experiments

What we have covered so far:

● Motivation
● How light experiments are currently conducted
● Ecolight app features:
  ○ Accessibility
  ○ OLED display
  ○ 3 different plate configurations
  ○ Control of intensity, temperature, wavelength and cycle duration
Mechanism of Induction by Light

- Light source
- Photoreceptor
- Inactive response regulator
- Activated response regulator
- Promoter
- Output gene
- Product
Does Ecolight work?
Plates Do Not Facilitate GFP Quantification

Darkness

Green Light
Growing Liquid Cultures on *Ecolight* Required Optimization

- Culture Vessel
Our Setup for Light Inducible Experiments Using *Ecolight*
This Setup Made Cultures Too Hot For Growth

Culture temperature: 44°C
Solutions to Reduce Overheating

- Spacer plate petri dish
- Petri dish with M9 + culture
- Tablet
8 Hours is Optimal to Measure Differential GFP expression
Green Light Activated System responds with our App!

Normalized Mean Fluorescence

![Bar chart showing fluorescence levels under different light conditions: Green Light, Dark, Red Light. The green light condition has the highest normalized mean fluorescence, followed by red light, and then dark.](chart.png)
Scaling Up to a 96 Well Plate
There is Diffusion of Light in Adjacent Wells
Will Light Intensity affect GFP Expression?
The Sensitive Range of this System is Below 40% Intensity
Blinking Green Light Linearly Modulates GFP Expression.

- **Always Green**: Green Light 600 ms, Darkness 400 ms
- **125 ms Green Light**: 875 ms Darkness
- **25 ms Green Light**: 975 ms Darkness
- **5 ms Green Light**: 995 ms Darkness
- **Always Dark**
Lab on a Tablet!

• Can the tablet provide all the necessary features for light experiments?

- Light Source
- Incubator
- Shaker

![Graph showing OD600 over time for different conditions: Tablet Turned On, Incubator, Tablet Turned On, Foiled, Tablet Turned Off, Not Foiled at 37°C, 28°C, and 21°C.](image)
Are biobricks parts characterized?
Few biobricks are sequenced and none are characterized

- Phytochrome: 10 (No sequence), 5 (Sequenced)
- Other light parts: 34
- Light Sensor: 18
- ccaR: 1 (No sequence), 1 (Sequenced)
- ccaS: 6 (Sequenced)
- ccaR+ccaS: 2
- cph8: 9
- pcyA+Ho1+etc.: 1

74% Not Sequenced
90% Sequenced
Biobricked light sensor plasmid

Light Sensor Plasmid

Submission/Testing

pSB1C3

Similar origin of replication
Biobricked phytochrome plasmid

Phytochrome plasmid

- Plac/ara
- ho1
- specR
- pcyA
- p15A origin of replication

Submission

pSB1C3

Testing

tetR

pSB3T5

Similar origin of replication
Biobrick parts work!

Native System vs Cloned Biobrick System Time Course

- Orange line with diamonds: Native System in Green
- Red line with diamonds: Native System in Dark
- Grey dashed line with circles: Biobrick System in Green
- Purple dashed line with circles: Biobrick System in Dark

Normalized Fluorescence

Time (h)
Educating Our Future Scientists

Engineering Discovery Days!
Cloning for Kids

START!

Linearized DNA

Digestion:

Transformation:

Ligation:

FINISHED!
Biobricks: Quality over Quantity

- Sequence Verified
- Portable incubator
- Characterization data
- 3 different plate configurations
- Control of intensity, temperature, wavelength, and cycle duration

Native System vs Cloned Biobrick System Time Course

- Native System in Green
- Native System in Dark
- Biobrick System in Green
- Biobrick System in Dark
Our Team and Sponsors

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Sponsors
THANK YOU!!

As Well As
Jeff Tabor

Jeff Tabor
Tablet Operating Systems on the market

**1Q13 Tablet OS Market Share**

<table>
<thead>
<tr>
<th>Operating System</th>
<th>% Total Market Share</th>
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<tr>
<td>Android</td>
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<tr>
<td>iOS</td>
<td>40</td>
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