Controlling Plant Pathogens using Bacteria
Controlling Plant Pathogens using Bacteria
100% Colombian Coffee
Hand picked to become, “the richest coffee in the world.”

Café de Colombia
Majors

- Microbiology: 8
- Physics: 7
- Biology: 6
- Mathematics: 3
- Chemical Engineering: 2

Sunday, October 9, 11
The Problem:
The Problem: The Effects of fungicides

Rust control requires, at least, 6 different types of fungicides!

Farmers and workers use fungicides without any protection
The Idea: *Bacteria that can aid in the control of plant pathogens*
How did we do it?
How can Cropspirin detect Plant pathogens?

Chitin
How can Cropspirin detect Plant pathogens?
How can Cropspirin detect Plant pathogens?
The Chitin Detection system: New Bricks

- **chiS**
  - BBa_K669000

- **chiP**
  - BBa_K669001

- **CBP**
  - BBa_K669002

- **CBP Promoter**
  - BBa_K669003

- **CBP Promoter + CBP**
  - BBa_K669005

Chitin
The Chitin Detection system: New Bricks

Chitin
Our NEW Bricks

ChiP (Chitoporin)

CBP (Chitin Binding Protein)

ChiS (Chitin Sensor)

HK
RR
HPT
Our NEW Bricks
Our NEW Bricks

Oligomers
Our NEW Bricks
Our NEW Bricks

Sunday, October 9, 11
Our NEW Bricks
Our NEW Bricks

Sunday, October 9, 11
Our NEW Bricks

Sunday, October 9, 11
Our NEW Bricks
P1: HK RR HPT SENSOR CBP Chitoporin

15 - 21 - 17 - 21 - 16
How do the two Cropspirin bacteria communicate?
P2a: Pci PChitoporin RBS CI RBS LuxR

P2b: PLuxBox Pchitoporin RBS CHI-A RBS Lux1
P2a: Pci \(\rightarrow\) PChitoporin \(\rightarrow\) RBS \(\rightarrow\) CI \(\rightarrow\) RBS \(\rightarrow\) LuxR

P2b: PLuxBox \(\rightarrow\) PChitoporin \(\rightarrow\) RBS \(\rightarrow\) CHI-A \(\rightarrow\) RBS \(\rightarrow\) Lux1
P2a: 
Pci  PChitoporin  RBS  CI  RBS  LuxR

P2b: 
PLuxBox  PChitoporin  RBS  CHI-A  RBS  Lux1
P2a: Pci pChitoporin RBS CI RBS LuxR
P2b: PLuxBox pChitoporin RBS CHI-A RBS Lux1
P2a:

P2b:
Pci PChitoporin RBS CI RBS LuxR

PLuxBox Pchitoporin RBS CHI-A RBS Lux1
P2a: Pci PChitoporin RBS CI RBS LuxR

P2b: PLuxBox Pchitoporin RBS CHI-A RBS Lux1
P2a: Pci PChitoporin RBS CI RBS LuxR

P2b: PLuxBox RBS CHI-A Pchitoporin RBS Lux1

Sunday, October 9, 11
P2a: Pci PChitoporin RBS CI RBS LuxR

P2b: PLuxBox Pchitoporin RBS CHI-A RBS Lux1

Sunday, October 9, 11
PLuxBox RBS CHI-A pchitoporin RBS Lux1

P2b:

Pci PChitoporin RBS CI LuxR RBS

P2a:

SENSOR CBP Chitoporin

P1:

Pcat RBS LuxR PLuxBox Lactonase LuxBox Acetil-Salicilic Acid

P3:

Pcat RBS LuxR PLuxBox Lactonase LuxBox Acetil-Salicilic Acid

Sunday, October 9, 11
PLuxBox
RBS
CHI-A
Pchitoporin
RBS
Lux1

P2b:
Pci
PChitoporin
RBS
CI
LuxR

P2a:
SENSOR
CBP
Chitoporin

P1:
SENSOR
CBP
Chitoporin

P2a:
PLuxBox
Pchitoporin
RBS
CHI-A
RBS
Lux1

P3:
Pcat
RBS
LuxR
PLuxBox
Lactonase
LuxBox
Acetil-Salicilic
Acid

2
-       12     -         6            -    21    -         1        -          5          -        1       -            41
PLuxBox RBS CHI-APchitoporin RBS Lux1

Pci PChitoporin RBS CI LuxR RBS

SENSOR CBP Chitoporin

Pcat RBS LuxR PLuxBox Lactonase LuxBox Acetil-Salicilic Acid
PLuxBox RBS CHI-A Pchitoporin RBS Lux1

P2a:

SENSOR CBP Chitoporin

P2b:

Pci PChitoporin RBS CI LuxR RBS

P1:

PCat RBS LuxR PLuxBox Lactonase LuxBox

Acetil-Salicilic Acid

2     -       12     -         6            -    21    -         1        -          5          -        1       -            41

Sunday, October 9, 11
That's how Cropspirin communicates with the plant.
The Plant’s response to Infection
Signaling control
Signaling control

Detection -> Activation
Signaling control

Detection → Activation → Loss of plant resources
Signaling control

Detection -> Activaction

Loss of plant resources

Detection -> Regulation

Regulation -> Activaction

No Activation
Regulation Requirements

- Graduated to ON/OFF
- Time integration
- Smooth Switching
Positive feedback dynamics

• PFS shows theoretically and experimentally a bistable response.
• PFS also has the ability to delay the protein synthesis kinetics.
• Promoter Prm and protein CI are well studied, and show delay times of 70 minutes.
Hysteretic dynamics of positive feedback

• The path of the system dynamics depends on its history.
• This property is useful for keeping plant signaling system active after phytopatogen is attacked.
Modelling of the detection signaling analysis system

Double promoter control: Hill functions.

\[
\frac{dx}{dt} = f(x, y) - g(x)
\]

\[f(x, y): Pr_1 \text{ and } Pr_2 \text{ terms.}\]

\[Pr_1: \frac{\beta_1}{1 + \left(\frac{K_1}{x}\right)^n} \quad Pr_2: \frac{\beta_2}{1 + \left(\frac{K_2}{y}\right)^m}\]

\[f(x, y) = \frac{\beta_1 + \beta_2}{\left[1 + \left(\frac{K_1}{x}\right)^n\right] \left[1 + \left(\frac{K_2}{y}\right)^m\right]} \approx \frac{\beta}{1 + \left(\frac{K_1}{x}\right)^n + \left(\frac{K_2}{y}\right)^m}\]
Plasmid 1

Sunday, October 9, 11
Plasmid 2

P2a: Pci PChitoporin RBS CI RBS LuxR

P2b: PLuxBox Pchitoporin RBS CHI-A RBS Lux1
Plasmid 3

- Pcat
- RBS
- LuxR
- PLuxBox
- Lactonase
- LuxBox
- Acetil-Salicilic Acid

Sunday, October 9, 11
Human Practices

Issues we identified

Perception
Desertion
classical → molecular → synthetic

cell → systems
new biology

classical

molecular

synthetic

cell

systems

Sunday, October 9, 11
"new biology"

classical
cell
molecular
systems
synthetic
new biology
"new biology"

classical → molecular → synthetic

cell → systems
DNA is an editable recipe for proteins!
“new biology”

classical
molecular
cell
systems
synthetic
“new biology”

classical → molecular → systems → synthetic

cell
"new biology"

classical → molecular → systems → synthetic

cell

Sunday, October 9, 11
Biology is **NOT** just for biologists!
“new biology”

classical → molecular → systems → synthetic

cell
“new biology”

classical → molecular → systems → synthetic

cell
"new biology"

classical cell

molecular systems

synthetic
new biology

classical → molecular → synthetic

cell → systems
"new biology"

classical → molecular → synthetic

cell → systems

Bacteria are NOT EVIL!
“new biology”

classical → molecular → systems → synthetic

cell
classical cell molecular systems synthetic
How is DNA extracted?
How is DNA extracted?

How to CUT and PASTE DNA?
How is DNA extracted?

Why use E. coli?

How to CUT and PASTE DNA?
How is DNA extracted?

Why use E. coli?

Will Cropspirin affect the coffee plant?

How to CUT and PASTE DNA?
How is DNA extracted?

Why use *E. coli*?

Will Cropspirin affect the coffee plant?

How to CUT and PASTE DNA?

Is there an iGEM high school division?
How is DNA extracted?

May we contact you in the future?

Have you been to Tokyo?

What's your Facebook?

Why use E. coli?

Will Cropspirin affect the coffee plant?

What about the E. coli problem in Germany?

Are there an iGEM high school division?

And many many more!
How is DNA extracted?

Why use *E. coli*?

Will Cropspirin affect the coffee plant?

Are there an iGEM high school division?

And many many more!
• More Parts & Plasmids!
• More Parts & Plasmids!

SENSOR  CBP  Chitoporin
TO DO’s

• More Parts & Plasmids!
  SENSOR                              CBP
  Chitoporin

• Plants in vivo testing!
TO DO’s

- More Parts & Plasmids!

- Plants in vivo testing!
TO DO’s

- More Parts & Plasmids!
  SENSOR
  CBP
  Chitoporin

- Plants *in vivo* testing!
TO DO’s

- More Parts & Plasmids!
- Plants *in vivo* testing!
- Model experimental validation and tuning
- Stochastic modeling
TO DO’s

- More Parts & Plasmids!
- Plants \textit{in vivo} testing!
- Model experimental validation and tuning
- Stochastic modeling
TO DO's

- Divulgation as a duty
TO DO’s

- Divulgation as a duty
TO DO’s

- Divulgation as a duty
Thanks to:

Acknowledgements

Nelson

David

Adriana
Thanks!