Active Learning is Lecture^{-1}

A. Malcolm Campbell

DAVIDSON

10 October, 2017
Hunter College

Key Points for Today

- teaching *vs*. learning
- what would a scientist do?
- three extracts to sample readings
- change labs to model real science
- assess your teaching to know what works

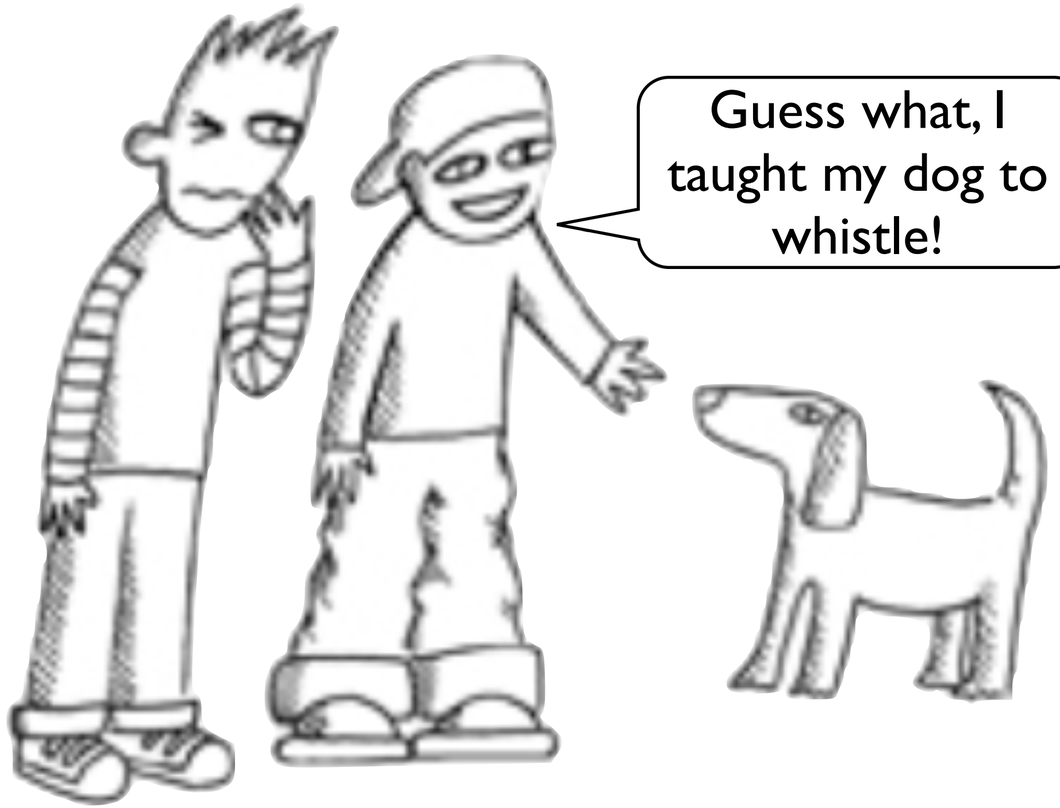
Introductions

name
department and courses
workshop focus course

Malcolm Campbell
Biology and Genomics (24 years)

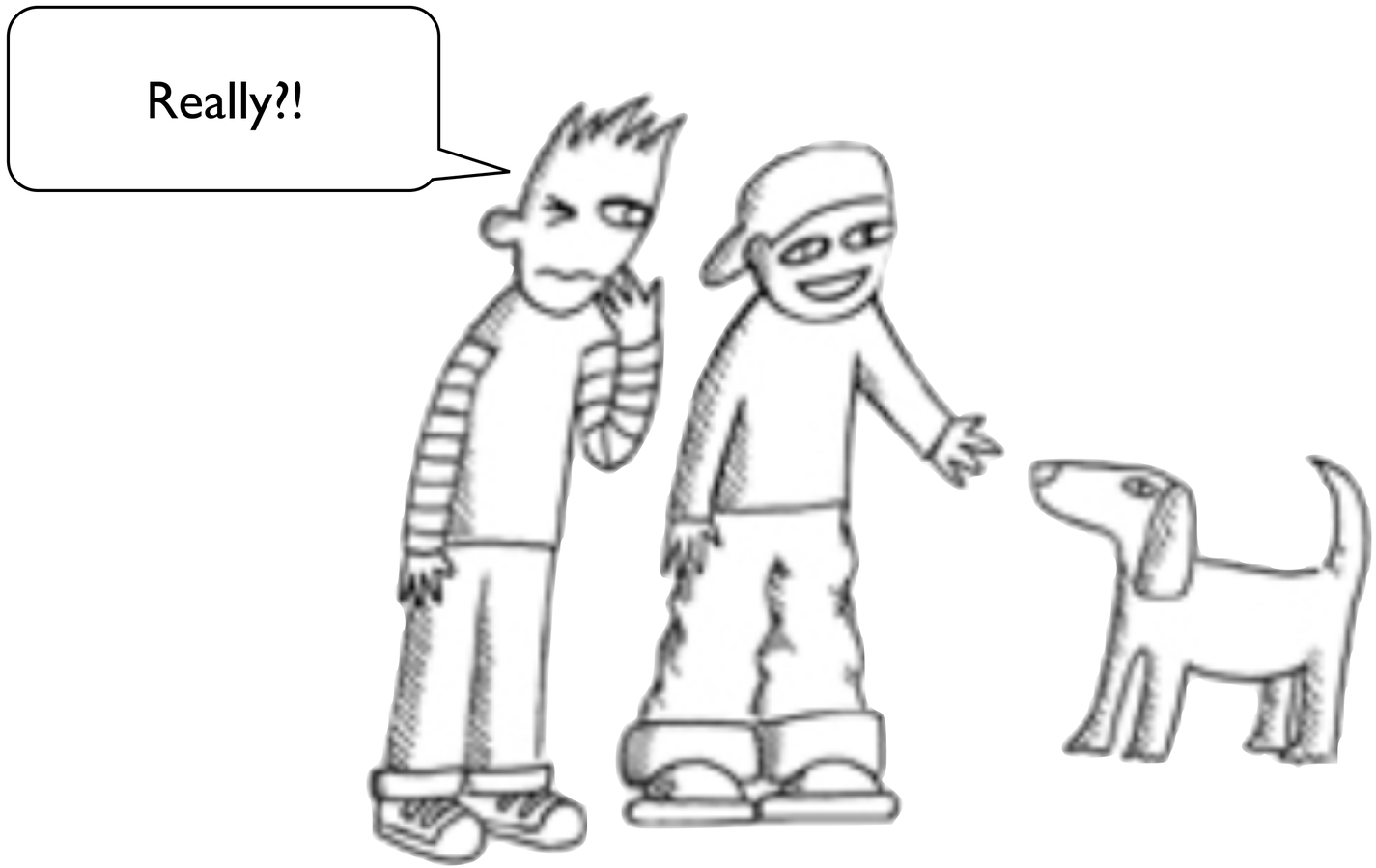
- Introductory Biology
- Genomics
- Lab Method in Genomics

Teaching *vs* Learning

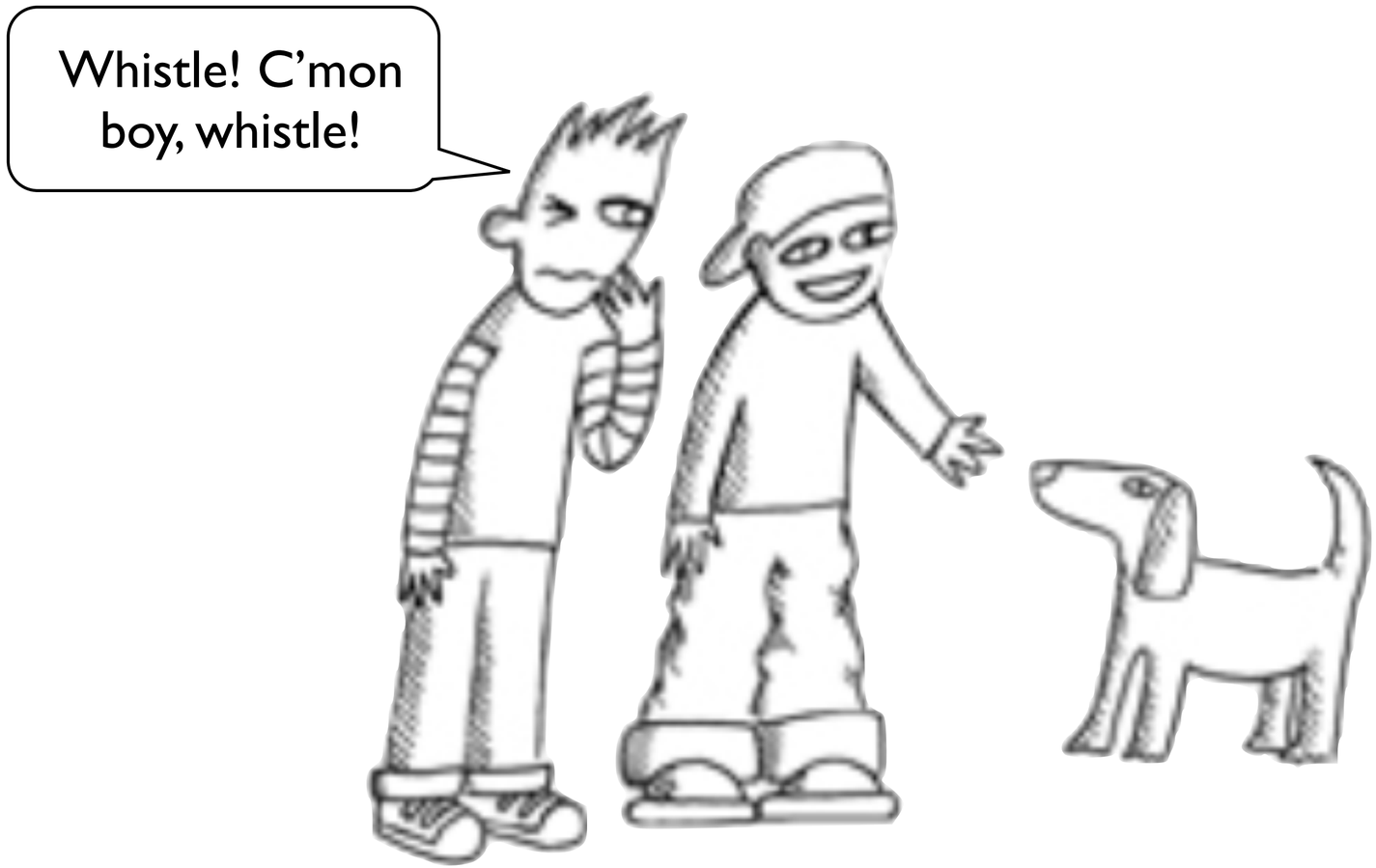


http://thegoodpeople.se/blog/?p=208

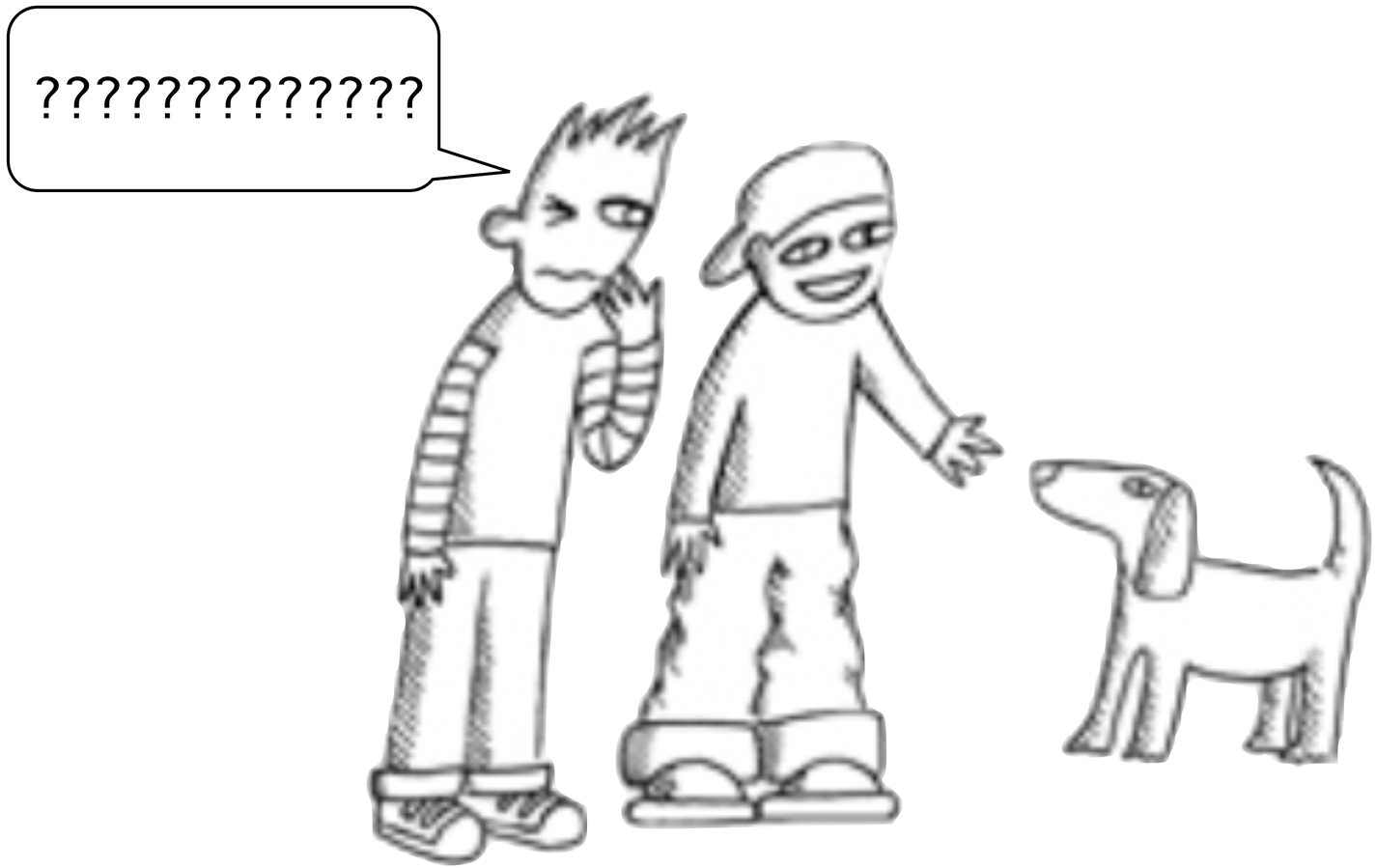
Teaching *vs* Learning



Teaching *vs* Learning



Teaching *vs* Learning



Teaching *vs* Learning

Teaching *vs* Learning

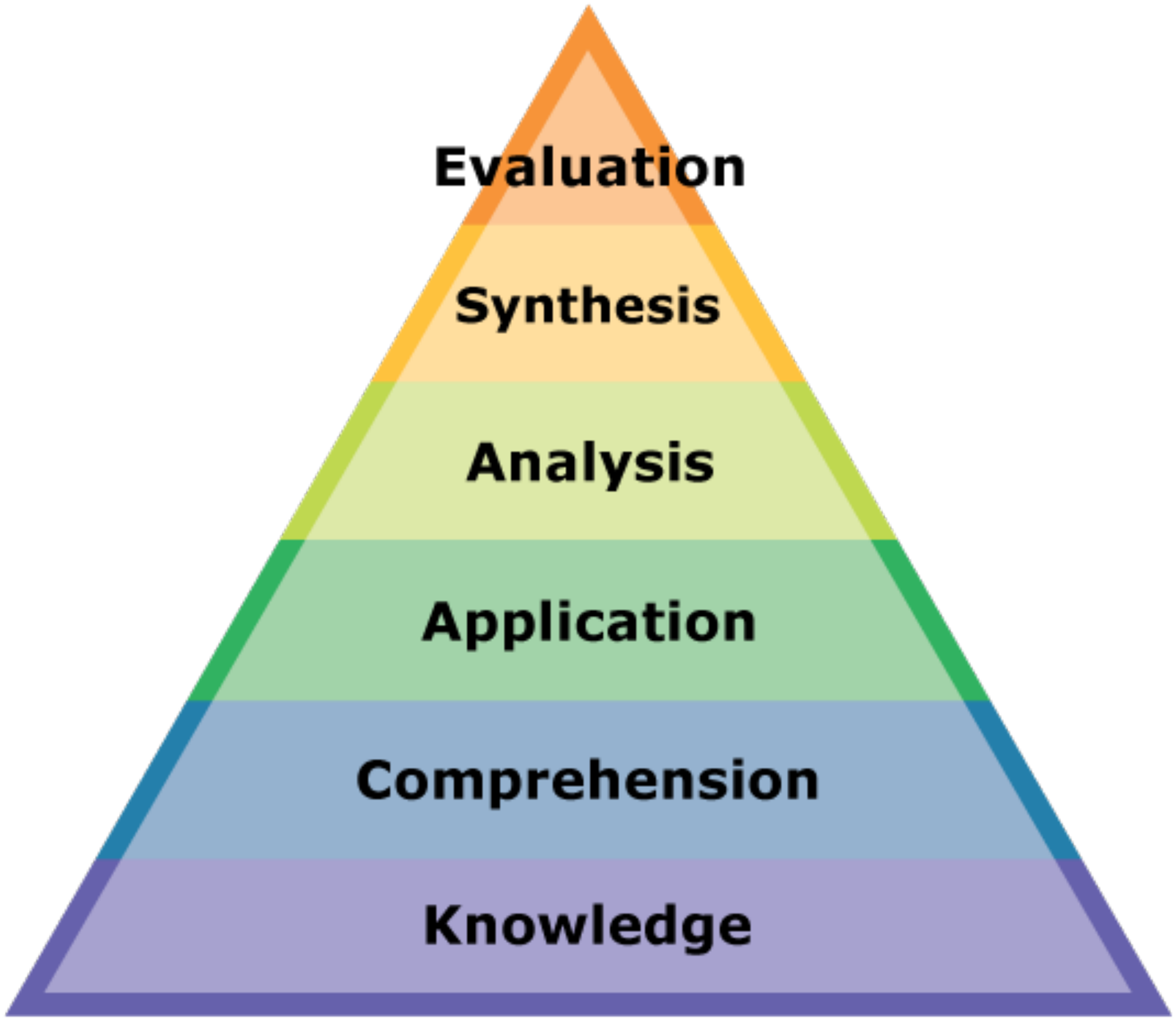
Backwards Design of Curriculum

1. What will your students be able to do after this lesson/activity/course? (learning objectives)

2. How will you know if they can do this?

3. What will your students do to gain this ability?

Bloom's Taxonomy of Learning



http://www.learnnc.org/lp/media/misc/2008/blooms_old.png

handout

Your Turn

Think of one class to focus on today.

Look at Bloom’s taxonomy & pick the level to target.

Write one learning objective using Bloom’s verbs.

How People Learn Best

- construct our own knowledge
- connect to previous knowledge
- guided enquiry effective
- lecturing is coverage, not learning

How People Learn Best

- construct our own knowledge
- connect to previous knowledge
- guided enquiry effective
- lecturing is coverage, not learning

http://gocoderz.com/wp-content/uploads/2015/01/110115-229.jpg

Biology Has Become A Religion

https://salemnet.vo.llnwd.net/media/cms/CCOM/13346-preacher_bible_church630x315.630w.tn.jpg

Biology Has Become A Religion

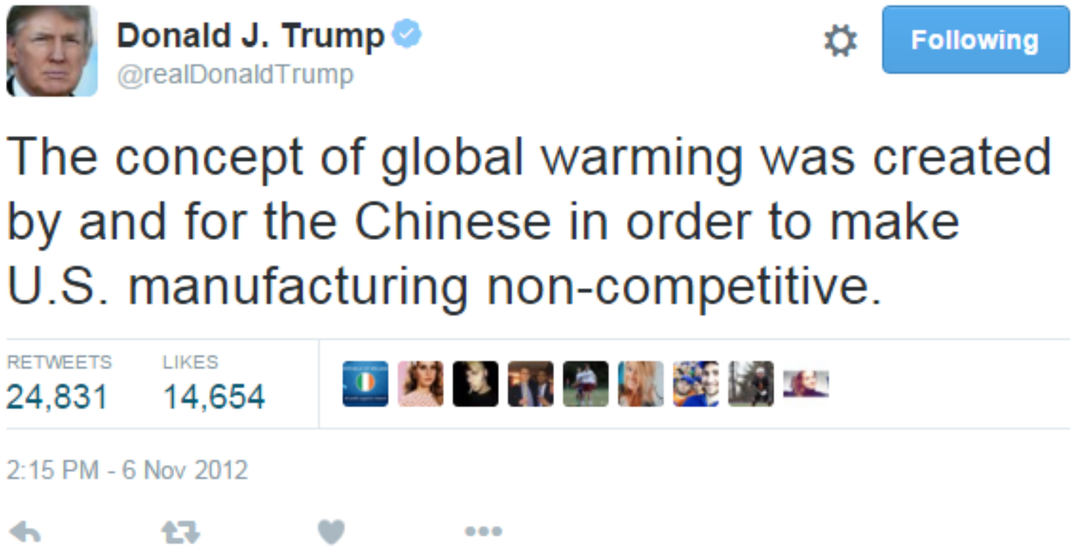
- no data
- accept on faith
- repeat what told
- too much detail
- not science

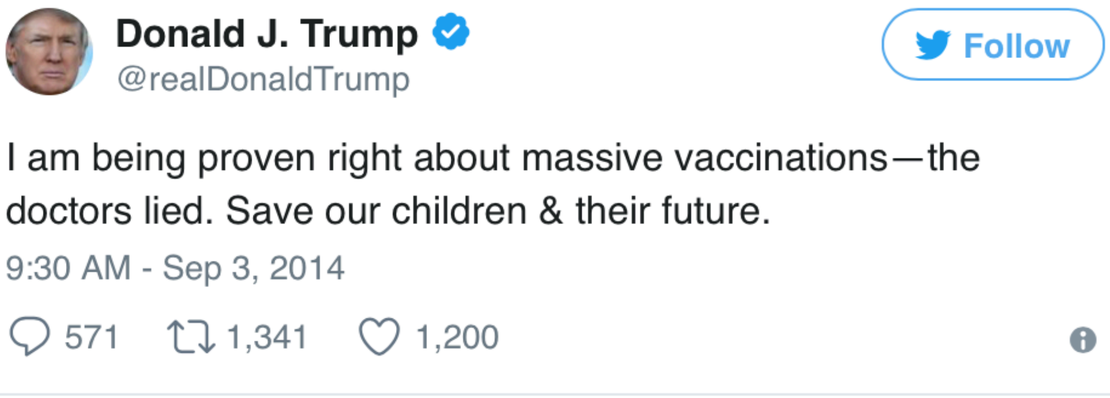
https://salemnet.vo.llnwd.net/media/cms/CCOM/13346-preacher_bible_church630x315.630w.tn.jpg

http://media.salemwebnetwork.com/cms/blog/2467849/boring-preacher/bored-in-church1.jpg

WWSD?

I want my students to think like scientists,
but not necessarily stay in science.





http://www.fair.org/wp-content/uploads/2013/02/Powell-UN.jpg

WWSD?

I want my students to think like scientists,
but not necessarily stay in science.

http://media.graytvinc.com/images/810*455/Three+Hurricanes+at+the+same+time.jpg

Extracted Text: data interpretation

Students need to practice:

interpreting data

constructing knowledge

making connections.

Chapter 13.2 Emergent Property at Molecular Level

you are here		Big Ideas of biology				
		Information	Evolution	Cells	Homeostasis	Emergent Properties
levels of the biological hierarchy	molecules	1	4	7	10	13
	cells	2	5	8	11	14
	organisms I	3	6	9	12	15
	organisms II	16	19	22	28	25
	populations	17	20	23	29	26
	ecological systems	18	21	24	30	27

handout

Extracted Text: data interpretation

formative assessment and class activity
hemoglobin handout

synthesize the data and information
to complete the tables on the new handout

handout

Extracted Text: ELSI

Students need to connect new knowledge to existing:

draw on life experience

remember past interactions

provide practical advice

ELSI 4.1 Are evolution and religion compatible?

you are here		Big Ideas of biology				
		Information	Evolution	Cells	Homeostasis	Emergent Properties
levels of the biological hierarchy	molecules	1	4	7	10	13
	cells	2	5	8	11	14
	organisms I	3	6	9	12	15
	organisms II	16	19	22	28	25
	populations	17	20	23	29	26
	ecological systems	18	21	24	30	27

handout

Extracted Text: ELSI

think-pair-share

What do you do when a student tells you they *believe* the Bible literally?

Interactive: BioMath Exploration

Students need to practice:

interpreting mathematical model

connect model to real world experience

apply math to gain biological insights

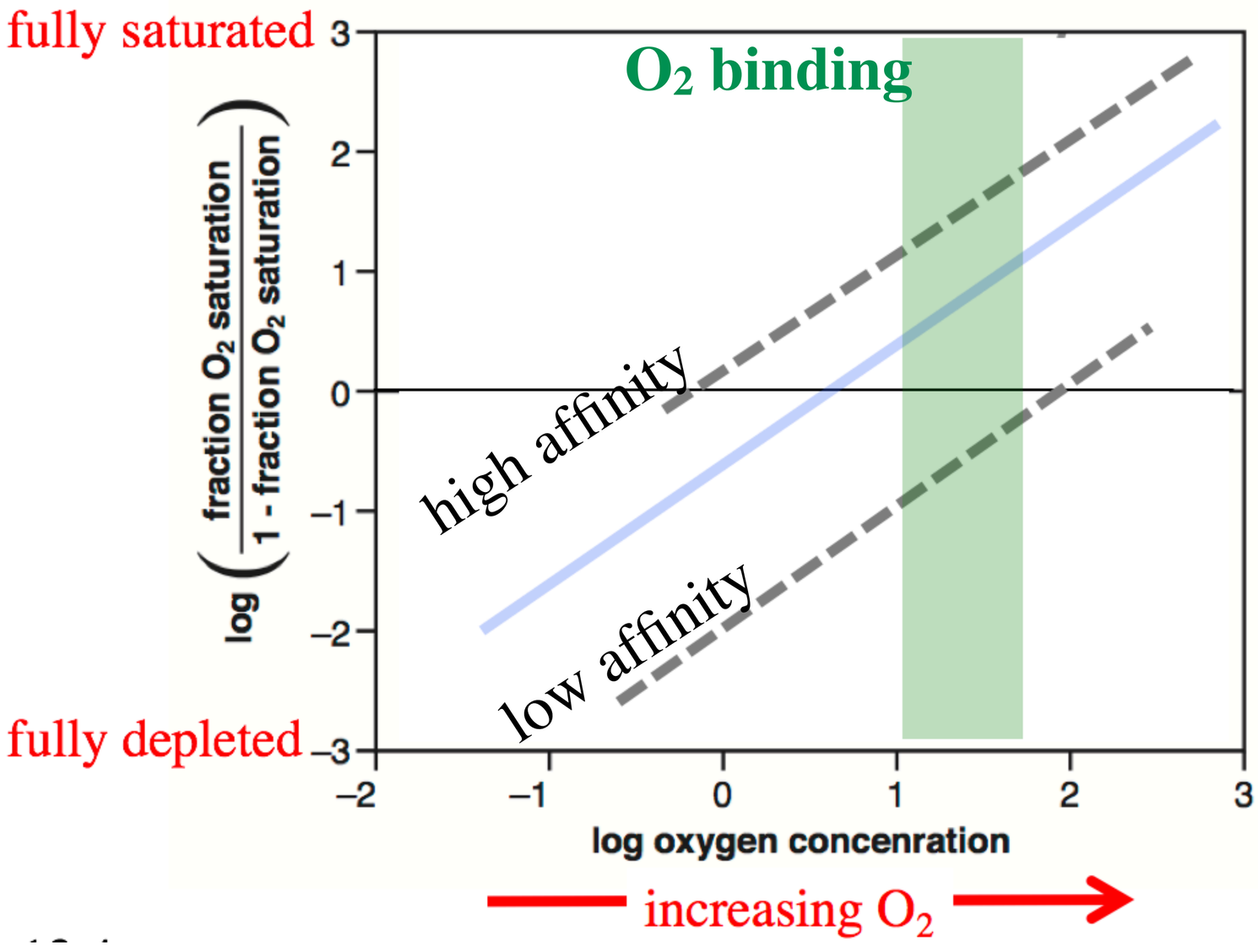
BME 13.1 How can you quantify cooperativity?

you are here		Big Ideas of biology				
		Information	Evolution	Cells	Homeostasis	Emergent Properties
levels of the biological hierarchy	molecules	1	4	7	10	13
	cells	2	5	8	11	14
	organisms I	3	6	9	12	15
	organisms II	16	19	22	28	25
	populations	17	20	23	29	26
	ecological systems	18	21	24	30	27

handout

Interactive: BioMath Exploration

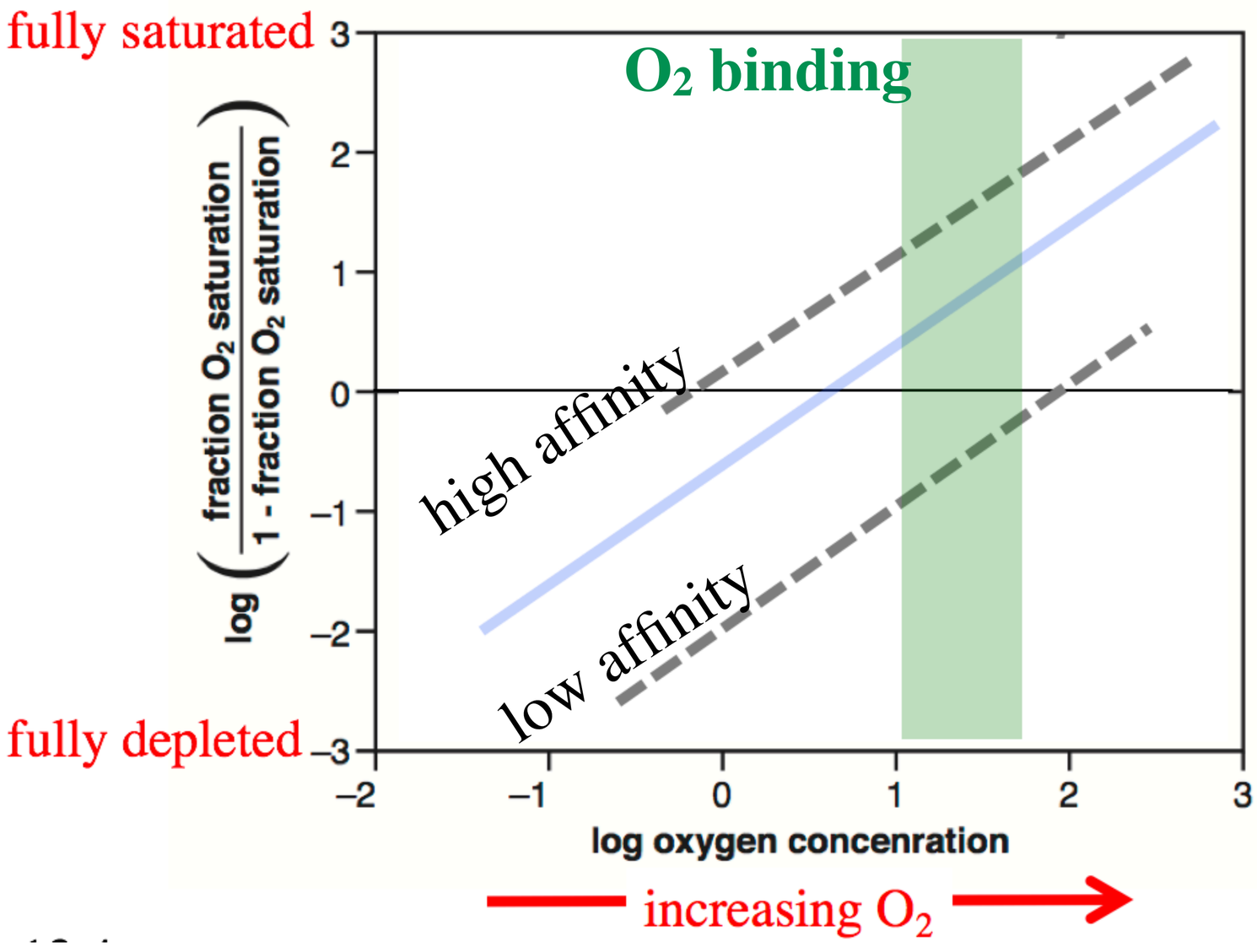
graph hemoglobin's affinity



slope = __

Interactive: BioMath Exploration

graph hemoglobin's affinity



slope = <u>2.8</u>

Do *ICB* students see biology differently?

1-5 scale 5 = extremely accurate	Average at Start Fall	
	ICB	**Traditional**
biology is definitions & processes	2.86	2.61
big questions of biology already answered	1.71	1.50
big/small division of biology describes nature	3.15	3.02
1-5 scale 5 = extremely important		
memorization	3.96	3.64

* p<0.05, ** p<0.01, *** p<0.001, ^ p= 0.06

no

Do *ICB* students see biology differently?

1-5 scale 5 = extremely accurate	Average at Start Fall		Δ in Average End of Fall	
	ICB	Traditional	ICB	Traditional
biology is definitions & processes	2.86	2.61	-0.58***	+0.50
big questions of biology already answered	1.71	1.50	-0.32*	+0.22
big/small division of biology describes nature	3.15	3.02	-1.08***	-0.06
1-5 scale 5 = extremely important				
memorization	3.96	3.64	-1.48***	-0.08

yes!

yes!

yes!

yes!

* p<0.05, ** p<0.01, *** p<0.001, ^ p= 0.06

Do *ICB* students see biology differently?

1-5 scale 5 = extremely accurate	Average at Start Fall		Δ in Average End of Fall		Δ in Average End of Spring	
	ICB	Traditional	ICB	Traditional	ICB	Traditional
biology is definitions & processes	2.86	2.61	-0.58***	+0.50	-0.46***	+0.45
big questions of biology already answered	1.71	1.50	-0.32*	+0.22	-0.33^	0.00
big/small division of biology describes nature	3.15	3.02	-1.08***	-0.06	-0.75**	-0.10
1-5 scale 5 = extremely important						
memorization	3.96	3.64	-1.48***	-0.08	-1.27***	+0.23

yes!

yes?

yes!

yes!

* p<0.05, ** p<0.01, *** p<0.001, ^ p= 0.06

Your Turn

Map out active learning module for your course.

https://www.ibiology.org/scientific-teaching/active-learning.html

End of Semester Course Evaluations

traditional textbook + traditional lab

"Lecture and lab are not integrated."

End of Semester Course Evaluations

traditional textbook + traditional lab

"Lecture and lab are not integrated."

ICB textbook + traditional labs

"I love how lecture and lab are so integrated!"

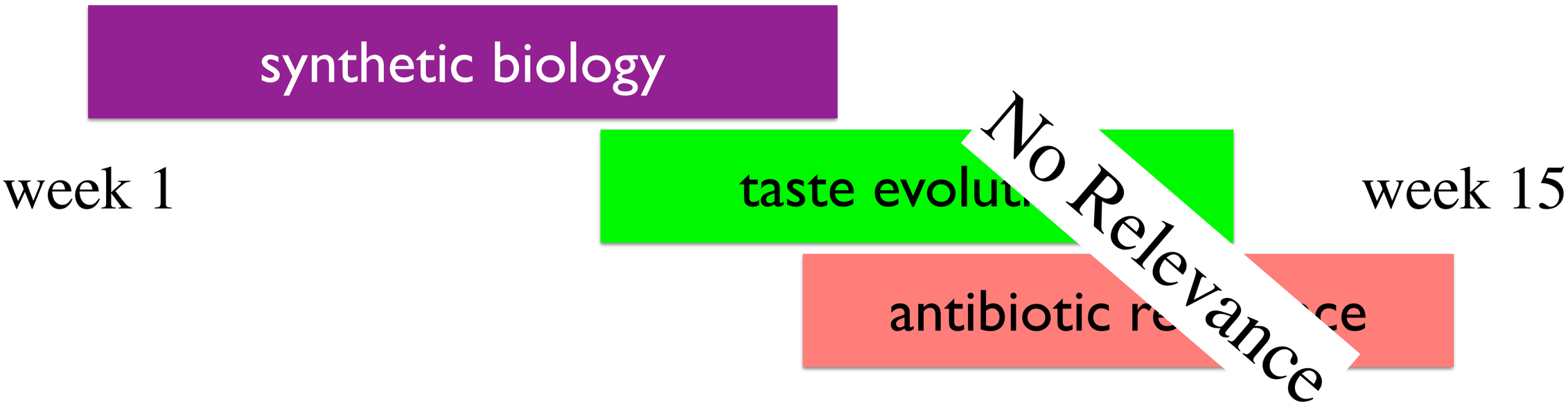
handout

What's lacking in Lab?

Trait	Inquiry Lab	CURE	SURE
scientific practice	yes	yes	yes
discovery	yes	yes	yes
relevance	rarely	yes	yes
collaboration	yes	yes	yes
iteration	no	yes	yes

CBE LSE Vol. 13, 29–40, Spring 2014

What's lacking in Lab?



What's lacking in Lab?

WWSD?

What Would a Scientist Do?

Provide Iteration, Sustain Relevance

synthetic biology I

synthetic biology II

week 1

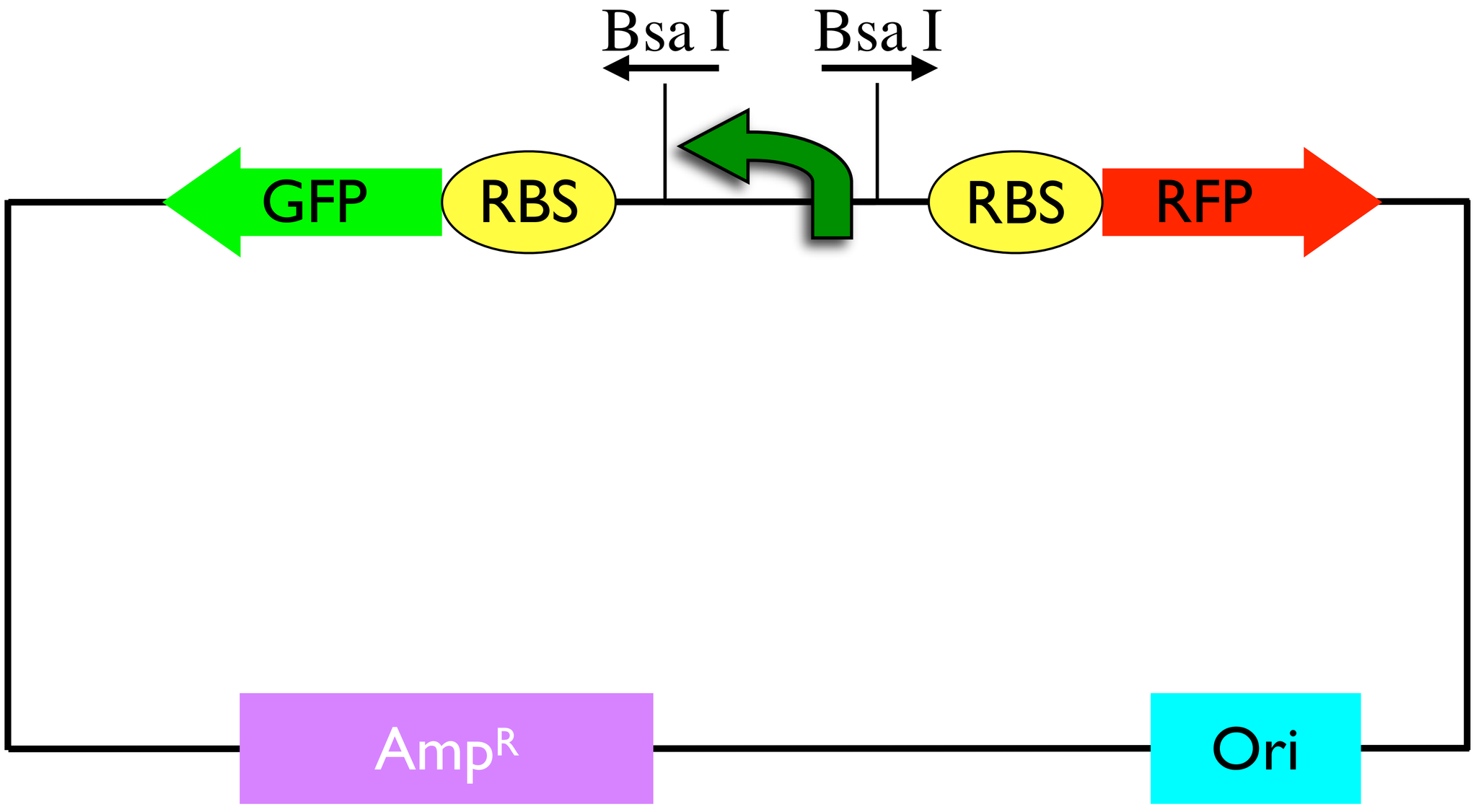
taste evolution

week 15

antibiotic resistance

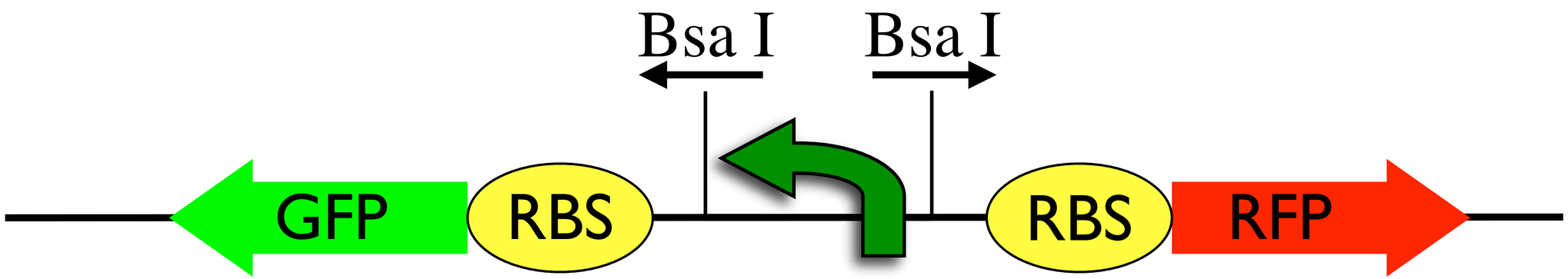
pClone Red

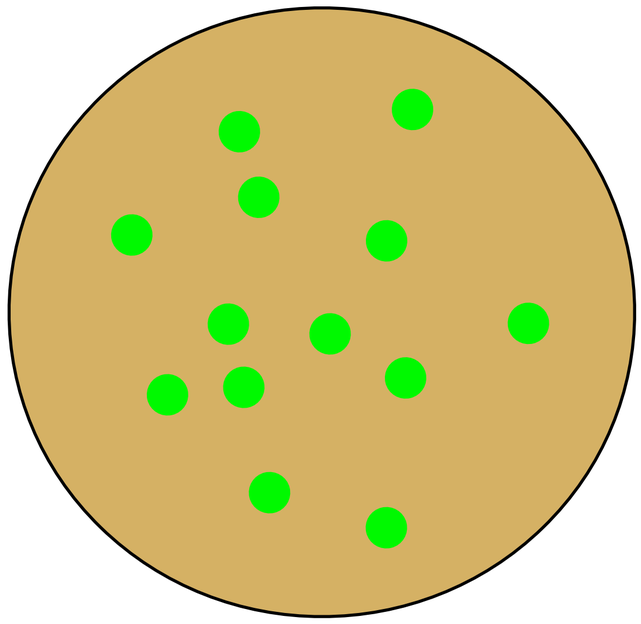
J119137



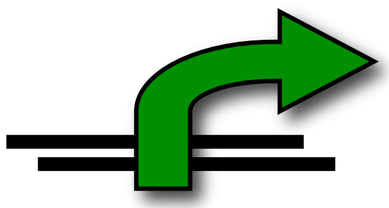
pClone Red

all colonies green

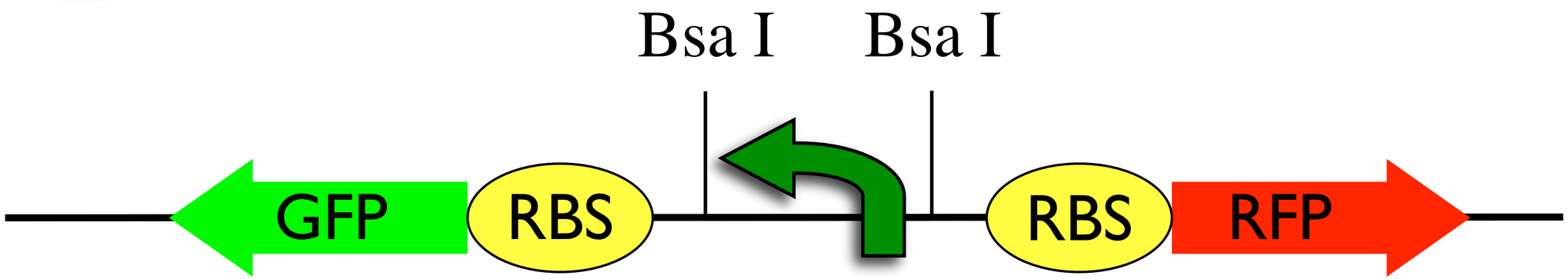


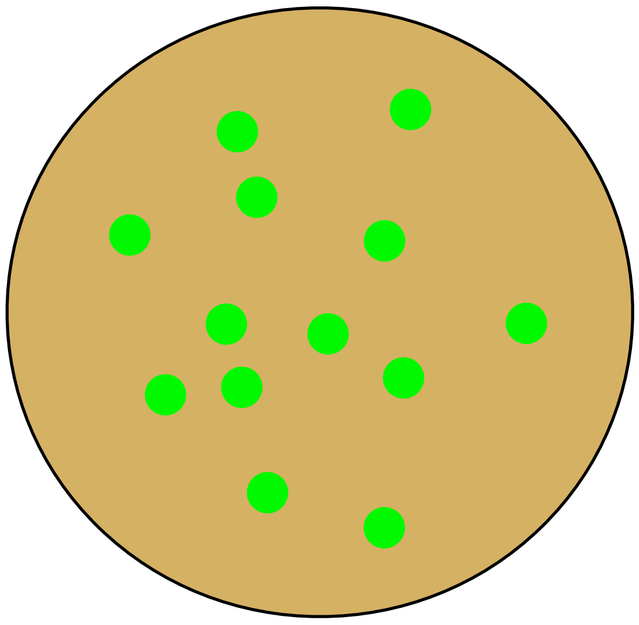


Golden Gate Assembly Method

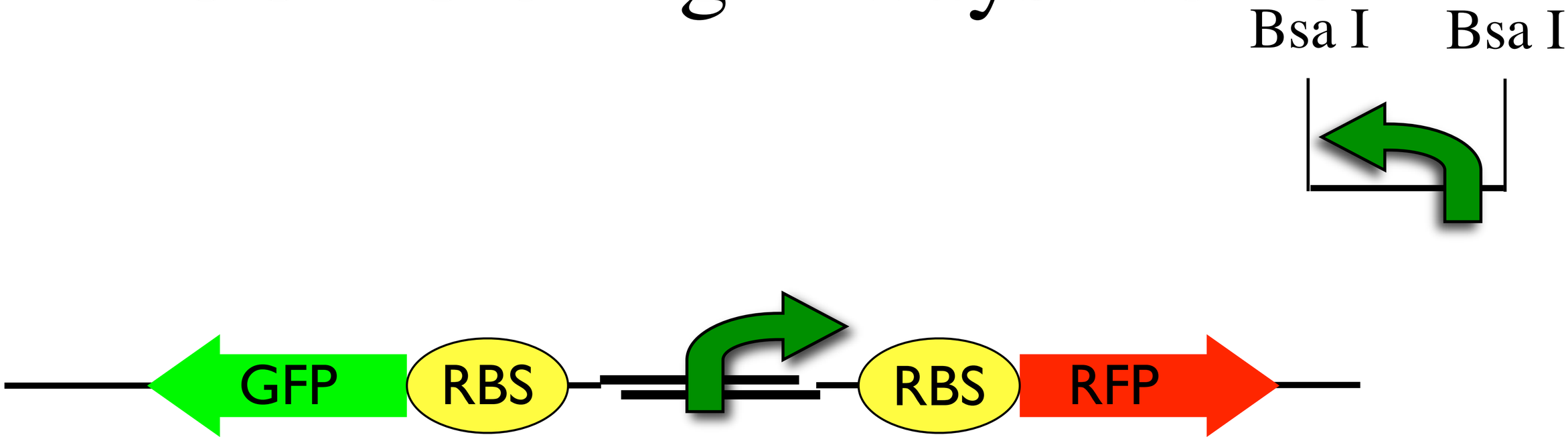


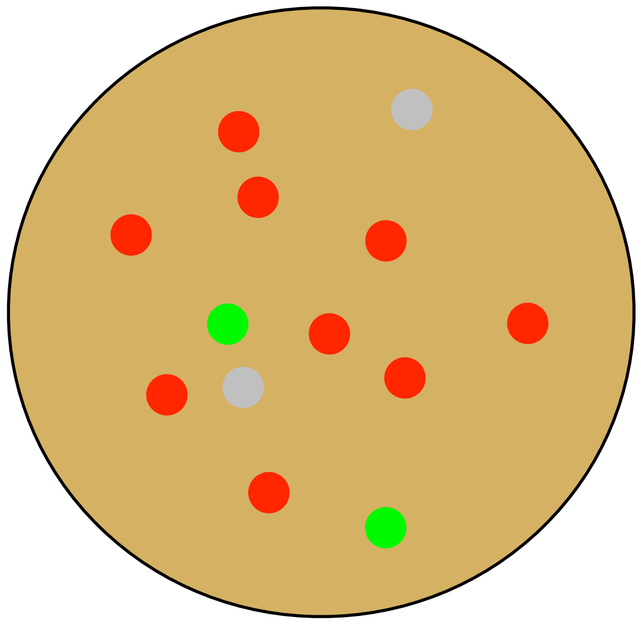
Bsa I + ligase





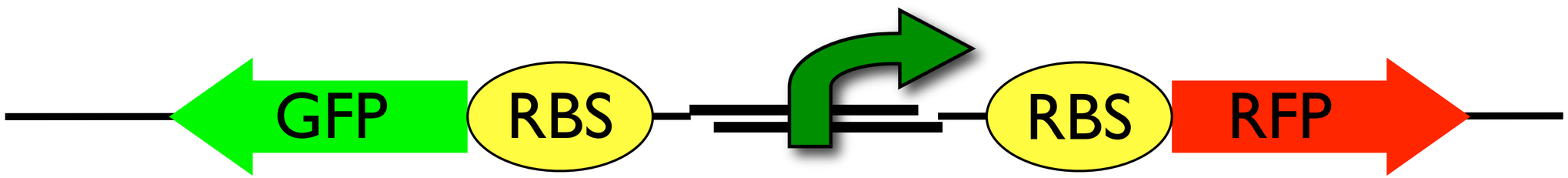
GGA Cloning Always Works

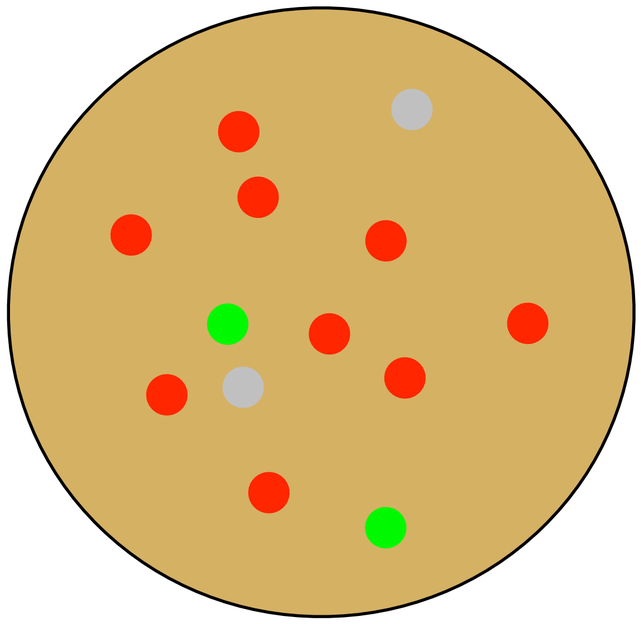




First Year Students in 3 Hour Lab

no gel purifications!



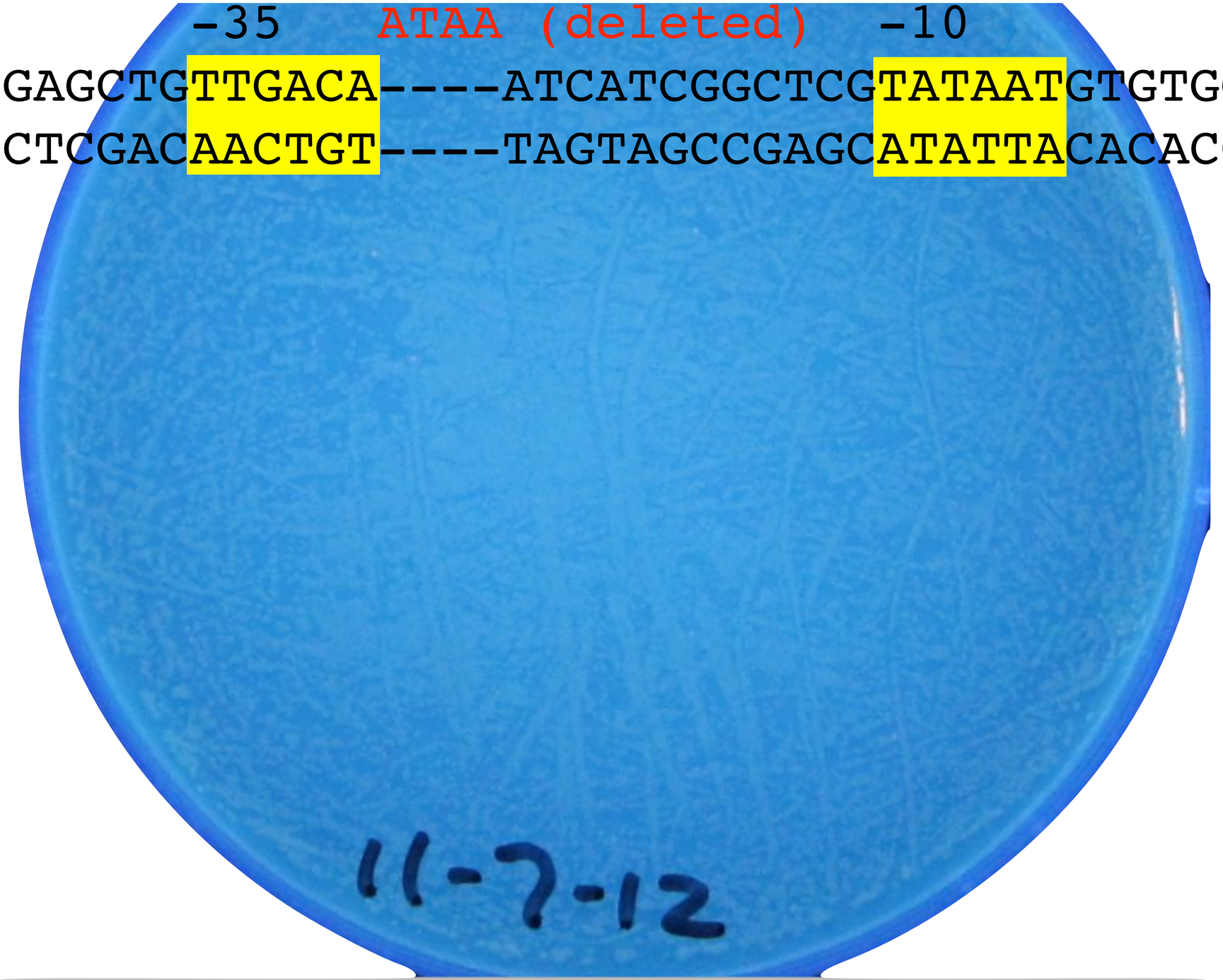


Student Sample, November 2012

-35 ATAA (deleted) -10

5′ CGACGAGCTGTTGACA----ATCATCGGCTCGTATAATGTGTGGA 3′

3′ CTCGACAACTGT----TAGTAGCCGAGCATATTACACACCTCGCC 5′



Student Research, October 2016

Registry of Standard Biological Parts

Registry News

- Registry Release
- Registry 6.0
- Report Bugs
- Request Features
- News Archive
- Feature Box Archive

Other

- Registry API
- Safety
- Videos

Catalog

The iGEM Registry has over 20,000 documented parts. The Catalog organizes many of these parts by part type, chassis, function, and more. Browse for parts through the Registry Catalog or use the search menu.

2016 DNA Distribution

The iGEM 2016 DNA Distribution is shipping to registered teams and labs. We've added some new material this year, so be sure to read through the 2016 Distribution Handbook before using your kit.

Collections [updated!]

We've **updated** the Registry part collections. There are part collections for reporter proteins, plant chassis, cellulose-related parts, and more. Users can discover new parts and collections and build upon what previous iGEM teams and labs have achieved.

- Plant Chassis [UPDATED!]
- *Bacillus subtilis* [UPDATED!]

Registry Help

Protocols

First Year Promoters in Registry

		BBa_J100282	Reporter	rClone Red Version 2 with RBS: Device for GGA Cloning and Testing RBS elements and Riboswitches	Rachel Neal	738
		BBa_J100283	Reporter	rClone Red with RBS: Device for GGA Cloning and Testing RBS elements and Riboswitches	Rachel Neal	738
		BBa_J100284	Plasmid	JC184d5 with Mutagenesis Cassette Removed	Zachary Shaver	3760
		BBa_J100285	Plasmid	SPT7specific with Riboswitch C	Dylan Maghini	8875
		BBa_J100286	Composite	tetA+sacB with RBS	Hartlee Johnston	
		BBa_J100287	Plasmid	J100265 (pJC173b) with GFP replacing LuxAB	Owen Koucky	4981
		BBa_J100288	Plasmid	pJC173b with gIII neg	Hartlee Johnston	6178
		BBa_J100289	Measurement	Pnar7 Nitrate Biosensor	Shuk Hang Li	1803
		BBa_J100290	Measurement	O Biosensor + NarX	Shuk Hang Li	3194
		BBa_J100291	Measurement	L Biosensor + NarX	Shuk Hang Li	3194
		BBa_J100292	Measurement	R Biosensor + NarX	Shuk Hang Li	3195
		BBa_J100293	Measurement	B Biosensor + NarX	Shuk Hang Li	3195
		BBa_J100294	Measurement	DL Biosensor + NarX	Shuk Hang Li	3036
		BBa_J100295	Measurement	DB Biosensor + NarX	Shuk Hang Li	
		BBa_J100296	RBS	rClone Red Version 2 with RBS 2.0: Device for GGA Cloning and Testing RBS elements and Riboswitches	Shuk Hang Li	
		BBa_J100297	RBS	rClone Red Version 1.5 with RBS 2.0: Device for GGA Cloning and Testing RBS elements and Riboswitche	Shuk Hang Li	
		BBa_J100298	Regulatory	deoP2--> cAMP --> E. coli	Shannon Blee	54
		BBa_J100299	Regulatory	lysine regulated promoter	Lydia Soifer	47
		BBa_J100300	Regulatory	PprpB	Jose David Hernandez	50
		BBa_J100301	Regulatory	ompW Promoter	Hannah Sinks	56
		BBa_J100302	Regulatory	asr promoter (trimmed version of K1231000)	Jackson Miller	56
		BBa_J100303	Regulatory	PmanP	Emilie Uffman	50
		BBa_J100304	Regulatory	NPT-II	India Little	51
		BBa_J100305	Regulatory	upp Promoter	Sabrina Shepherd	56
		BBa_J100306	Other	repClone Red (J100205) with wt TetR promoter (R0040)	Monica Prudencio	2339
		BBa_J100307	Composite	Variant of repClone Red (J100205)	Monica Prudencio	2414
		BBa_J100308	Other	Variant of repClone Red(J100205) w/ wt TetR promoter (R0040)	Monica Prudencio	2339
		BBa_J100309	Reporter	actClone Red with wt full OmpR promoter	Monica Prudencio	1683

One Lab Group's Promoter, *upp*

iGEM wiki tools search toc macampbell

Registry of Standard Biological Parts

iGEM tools catalog repository assembly protocols help search BBa_

main page design experience information part tools edit

Part:BBa_J100305

Designed by: Sabrina Shepherd Group: Campbell_M_Lab (2016-09-08)

Regulatory

Not Released
Sample Not in stock
No Results
-1 Uses

Get This Part

upp Promoter

This promoter is UTP sensitive and begins the transcription process of the upp gene in E. coli. We are going to test with a 600 µM solution of UTP.

Sequence and Features

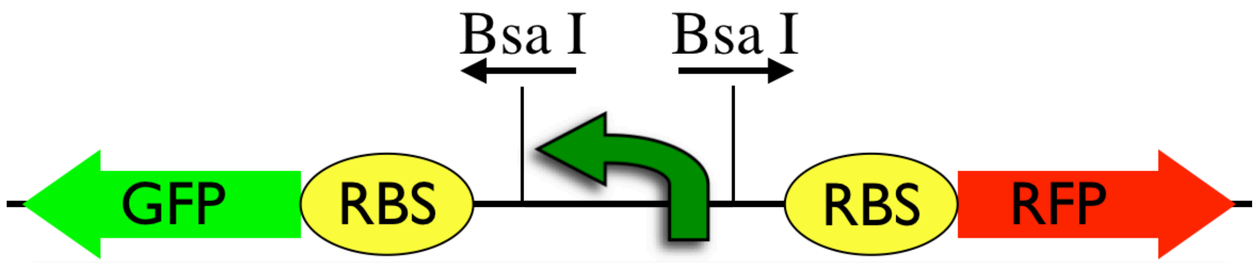
Subparts | Ruler | SS | **DS** **Length: 56 bp** View plasmid Get part sequence.

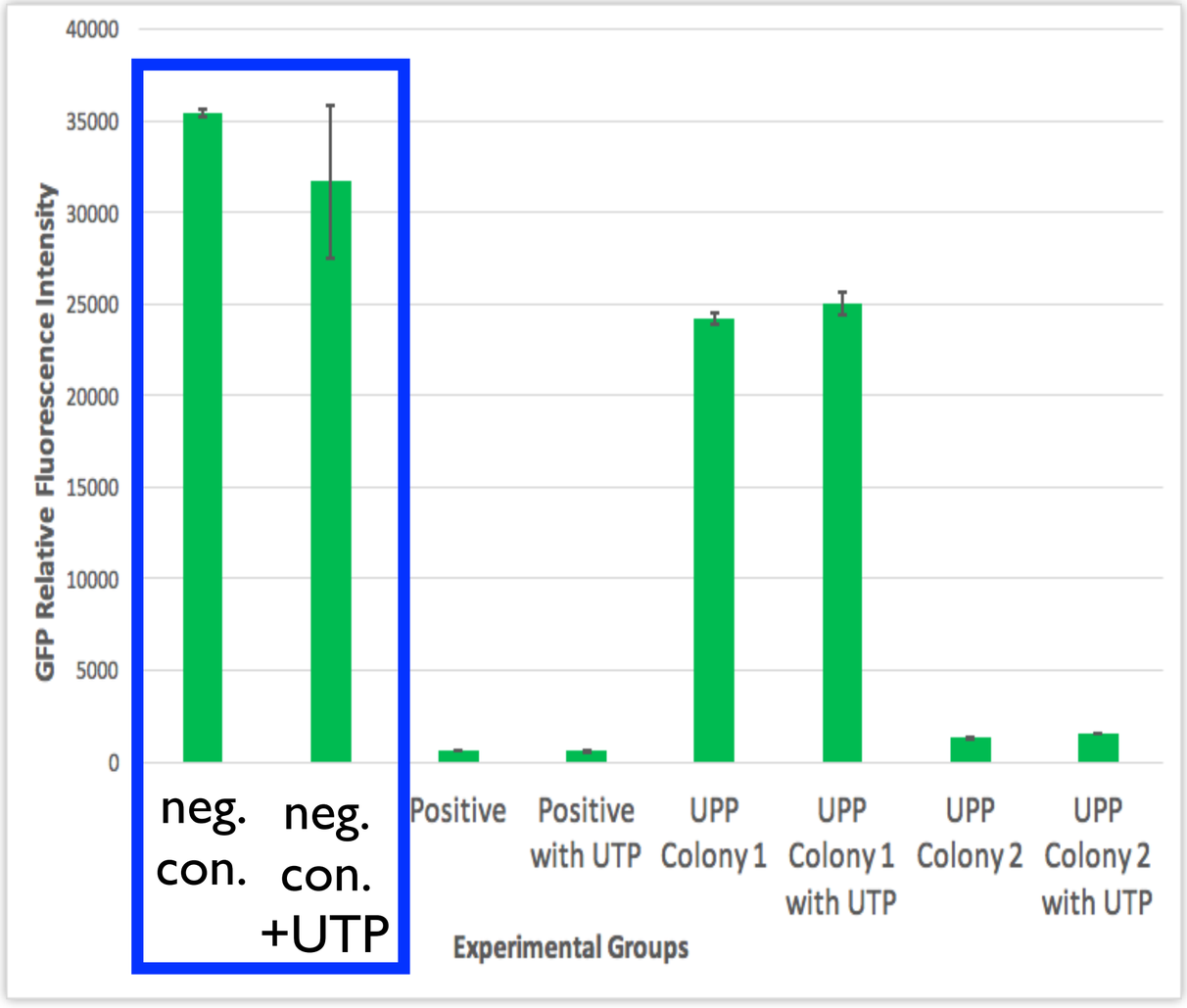
```
     1          11         21         31         41         51         61         71         81         91
1    gactaaagtc aacgaaaaga atattgccgc cttgaagaaa ggaggtataa tccgtc
     ctgatttcag ttgcttttct tataacggcg gaacttcttt cctccatatt aggcag
                            -35 box                -10 box
```

Assembly Compatibility: 10 12 21 23 25 1000

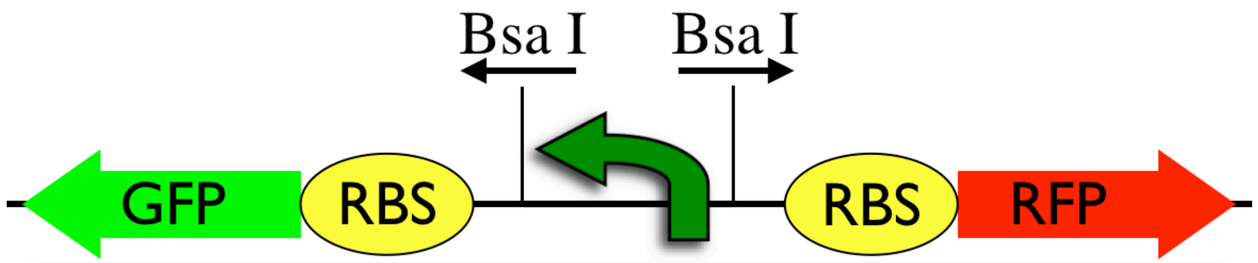
[edit]

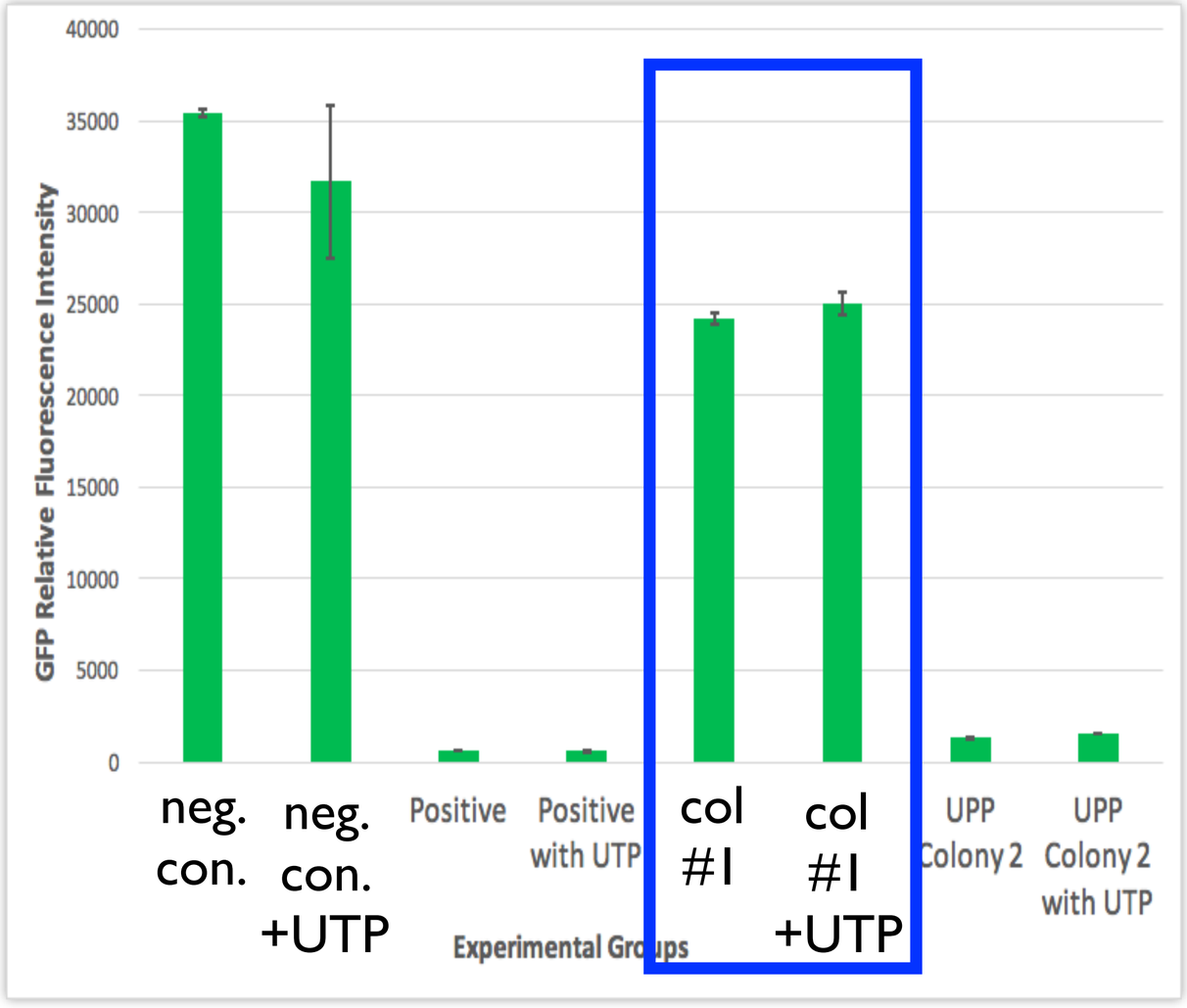
Negative Control *vs* Colony #1



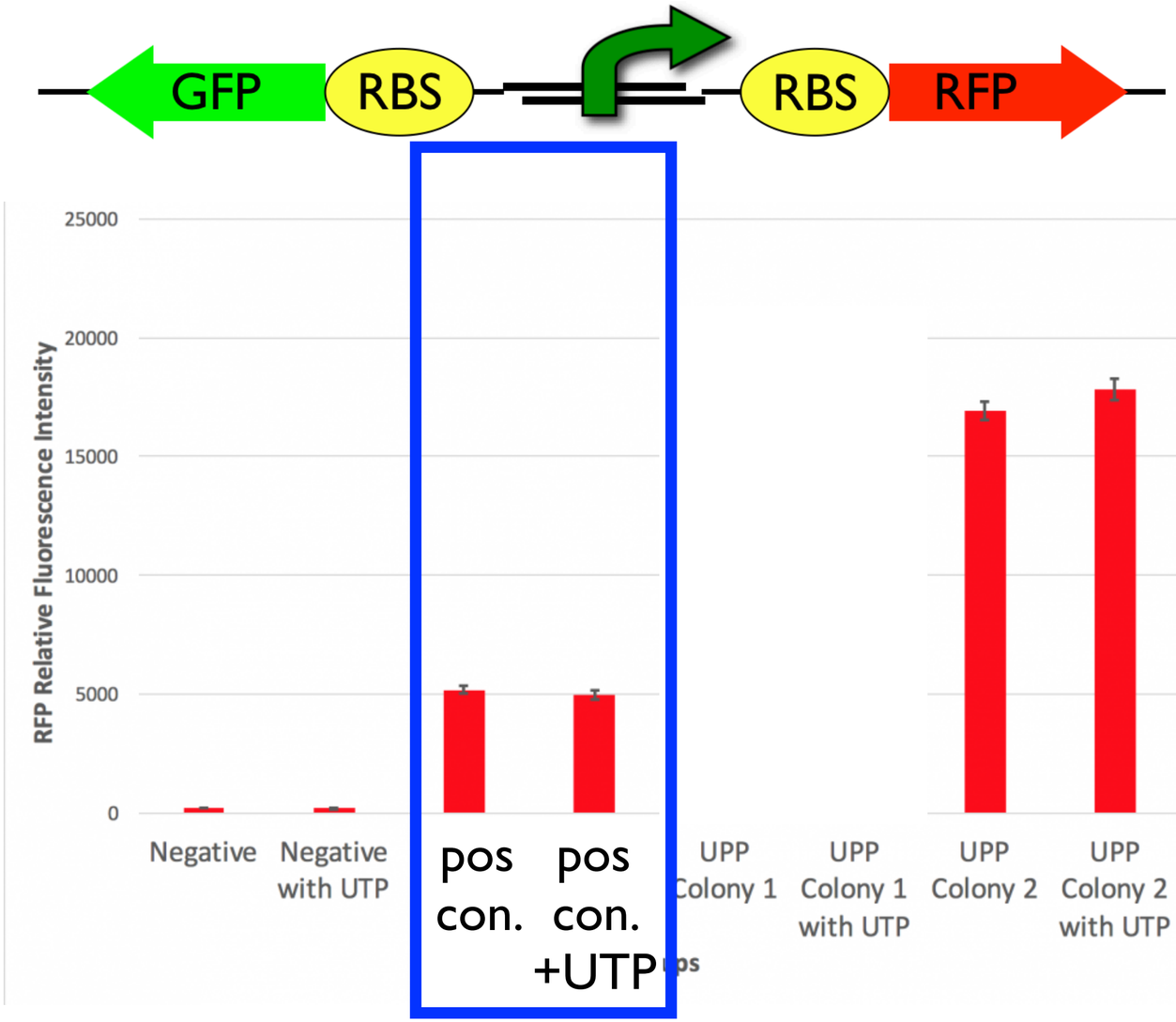


Negative Control *vs* Colony #1

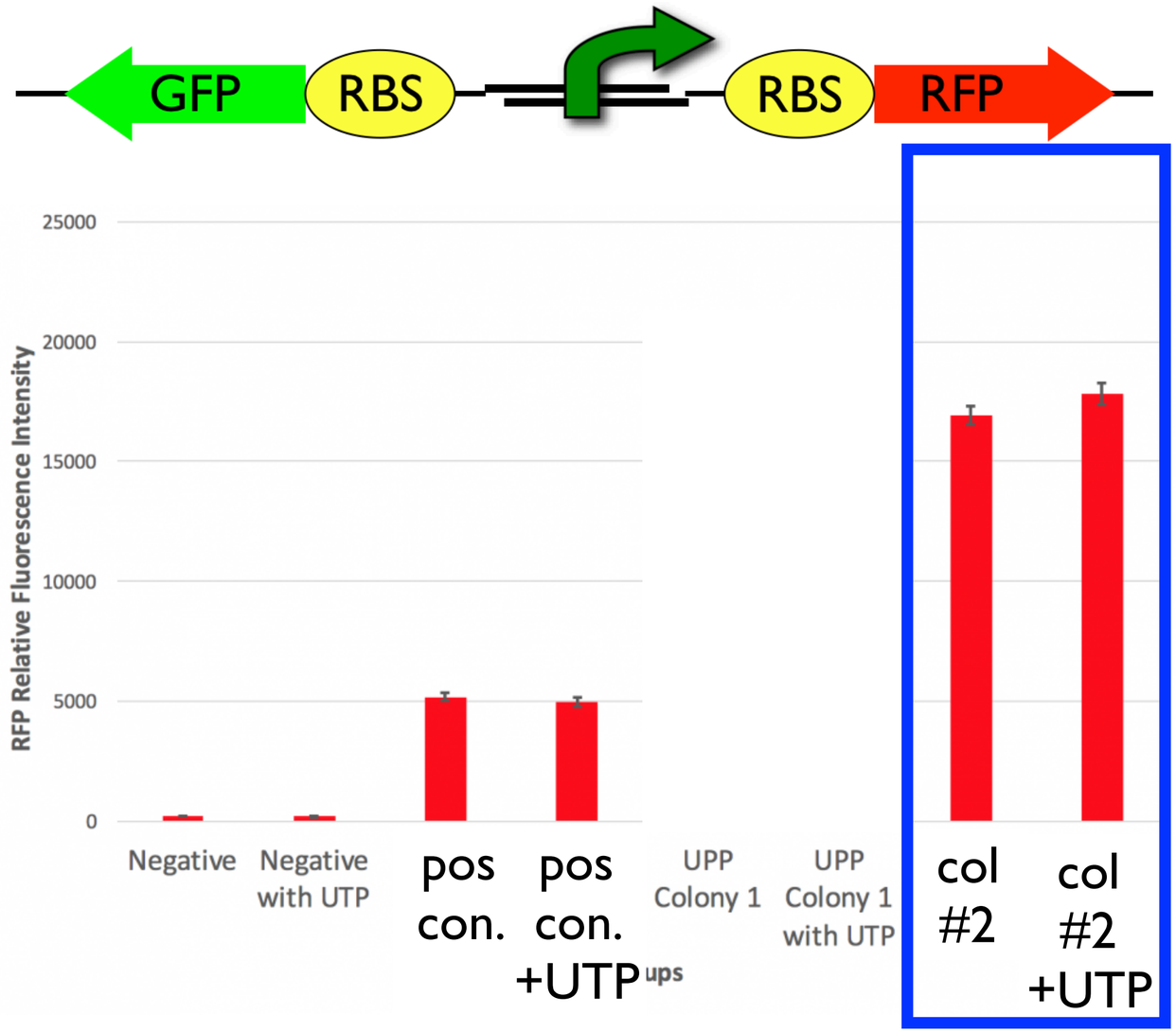




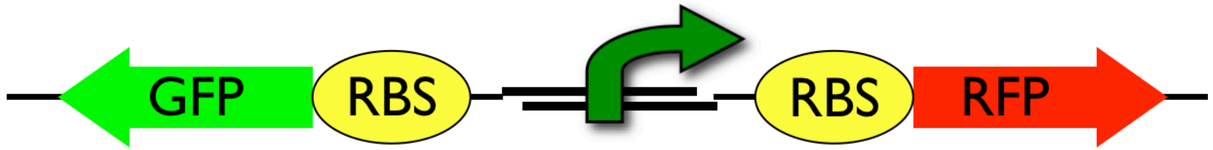
Positive Control *vs* Colony #2



Positive Control *vs* Colony #2



Students Discovered Strong Promoter



iGEM wiki tools search toc macampbell

Registry of Standard Biological Parts

tools catalog repository assembly protocols help search BBa_

main page design experience information part tools edit

Part:BBa_J100305

Designed by: Sabrina Shepherd Group: Campbell_M_Lab (2016-09-08)

Regulatory

Not Released
Sample Not in stock
No Results
-1 Uses
Get This Part

upp Promoter

This promoter is UTP sensitive and begins the transcription process of the upp gene in E. coli. We are going to test with a 600 µM solution of UTP.

Sequence and Features

Subparts | Ruler | SS | **DS** **Length: 56 bp** View plasmid Get part sequence.

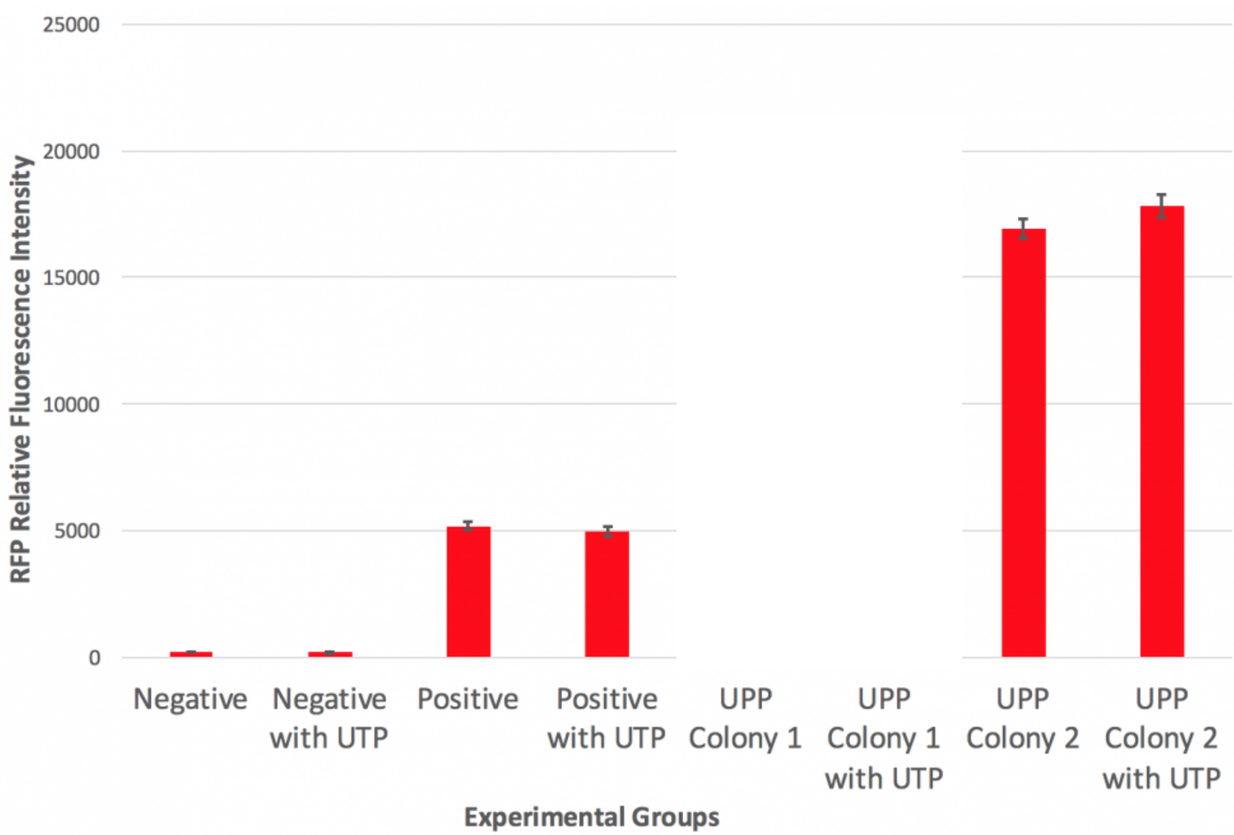
```
     1          11         21         31         41         51         61         71         81         91
1    gactaaagtc aacgaaaaga atattgccgc cttgaagaaa ggaggtataa tccgtc
     ctgatttcag ttgcttttct tataacggcg gaacttcttt cctccatatt aggcag
                           -35 box                -10 box
```

Assembly Compatibility: 10 12 21 23 25 1000

[edit]

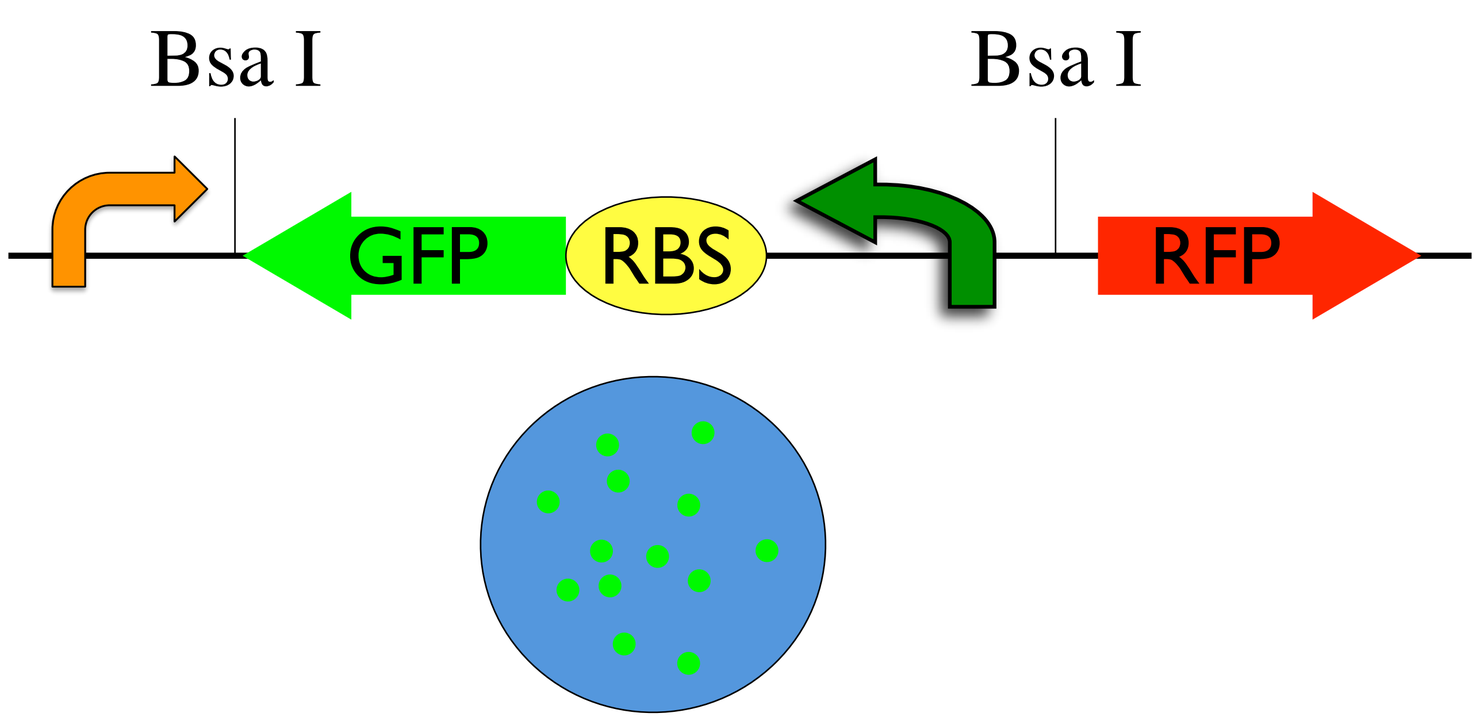
Parameters: None

Categories



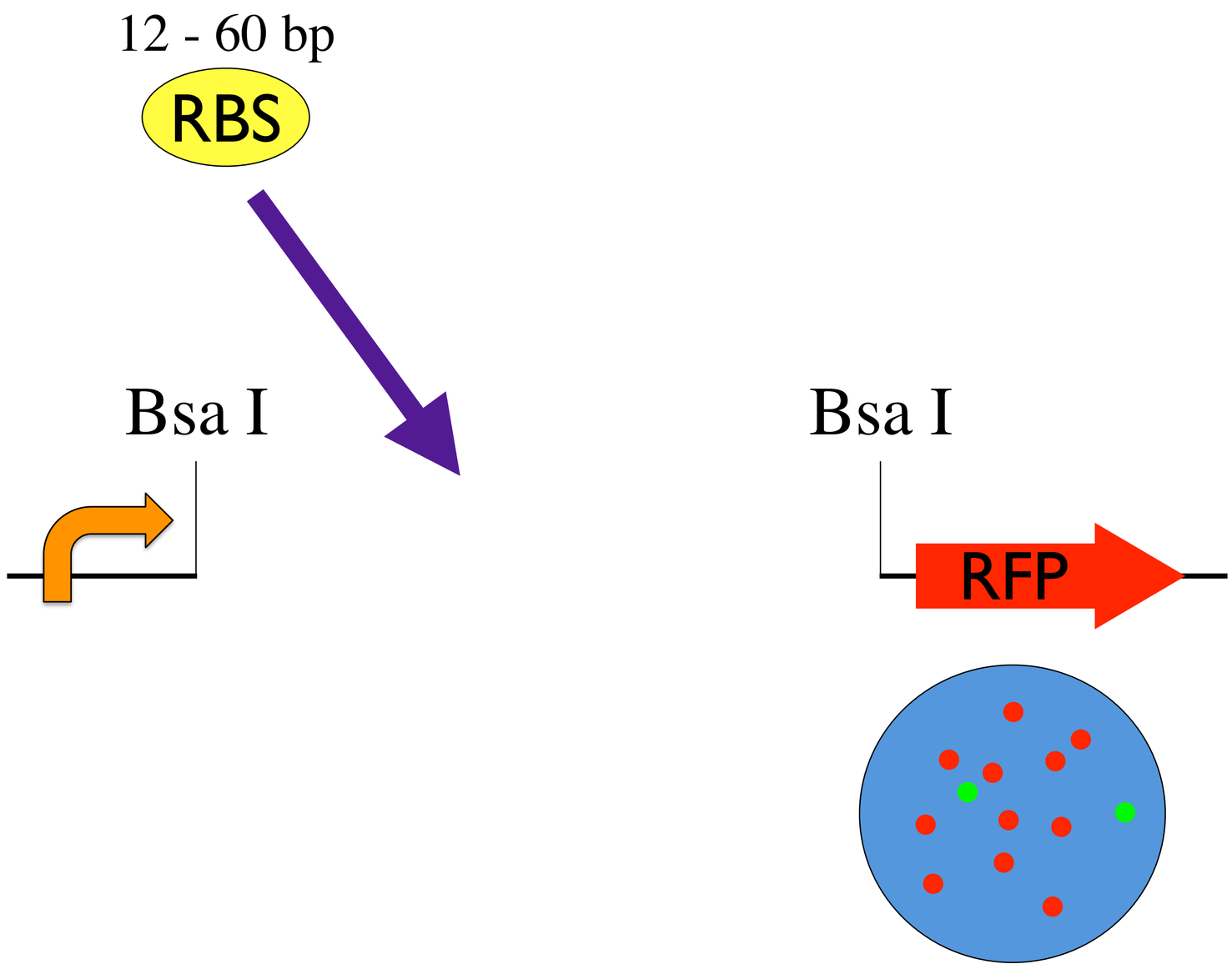
rClone Red (ribosome research)

J119384

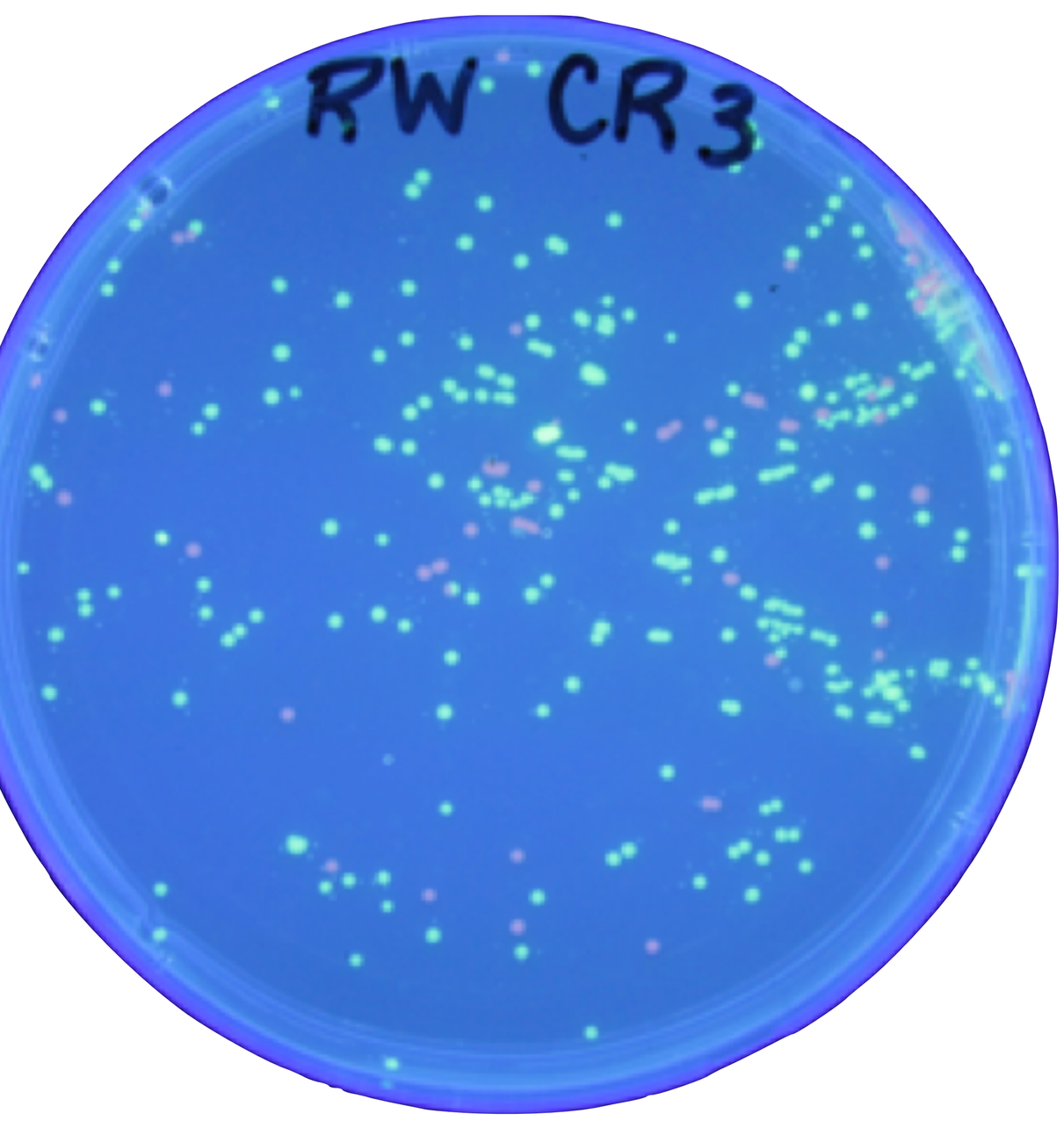


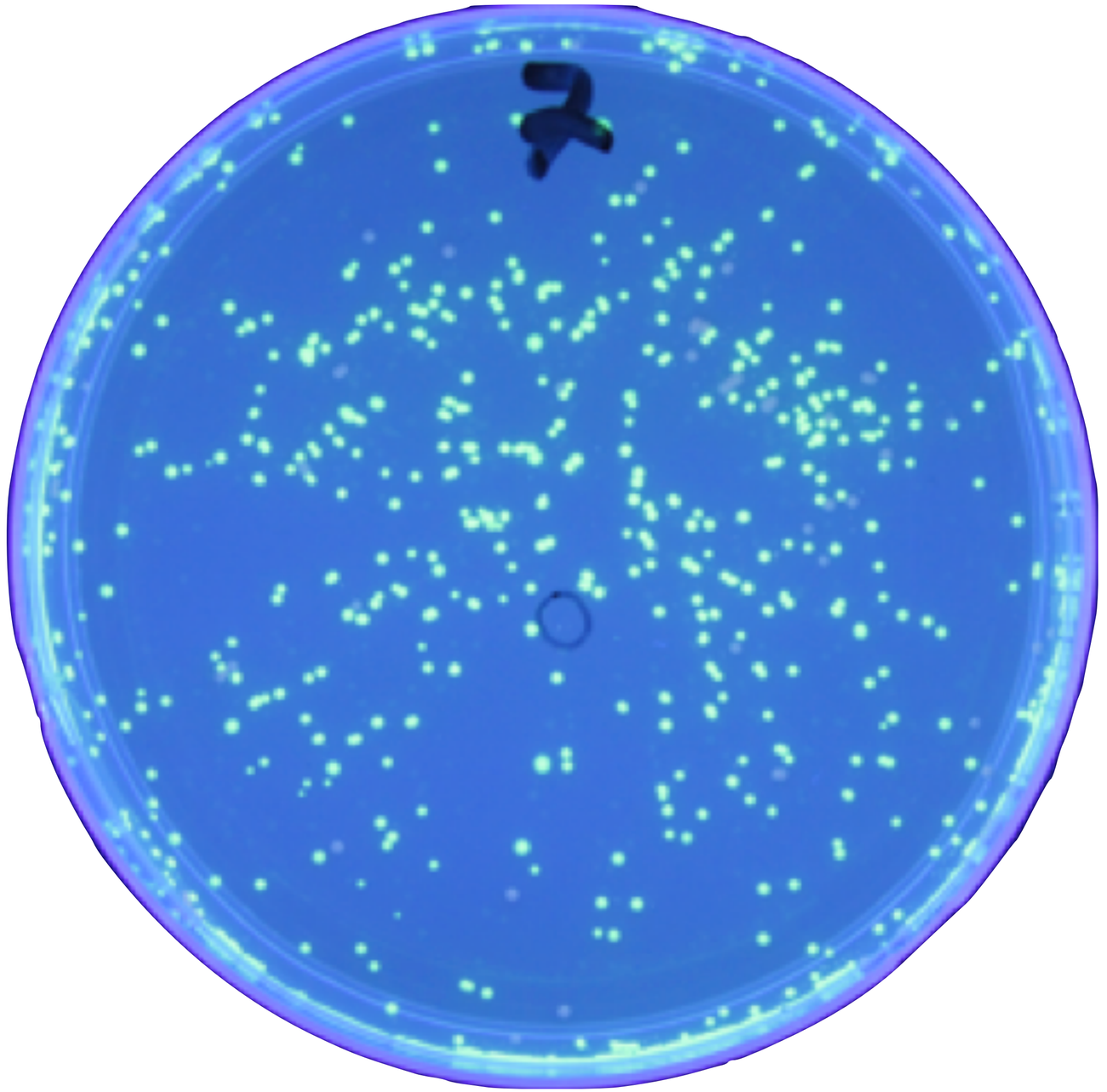
rClone Red (ribosome research)

J119384



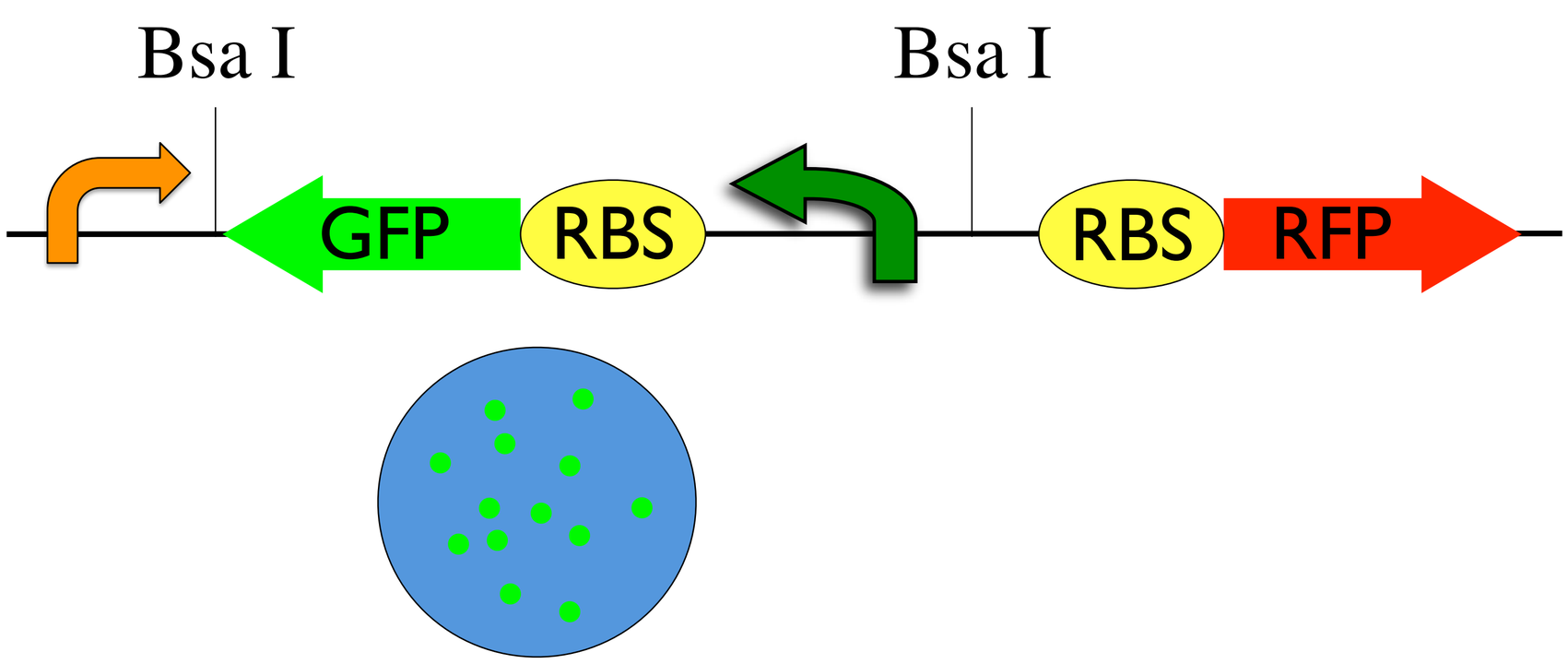
rClone Red (student-designed RBS)





tClone Red (terminator research)

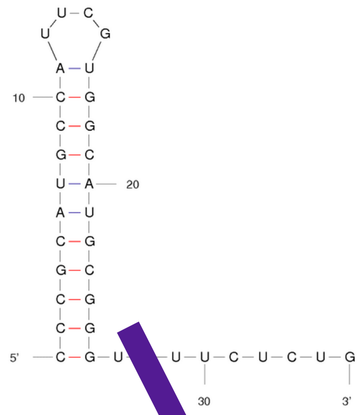
J119361



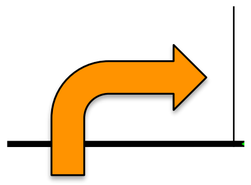
tClone Red (terminator research)

J119361

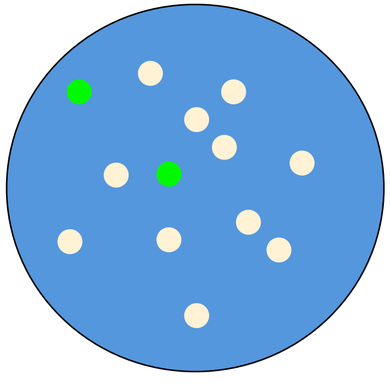
60 - 230 bp



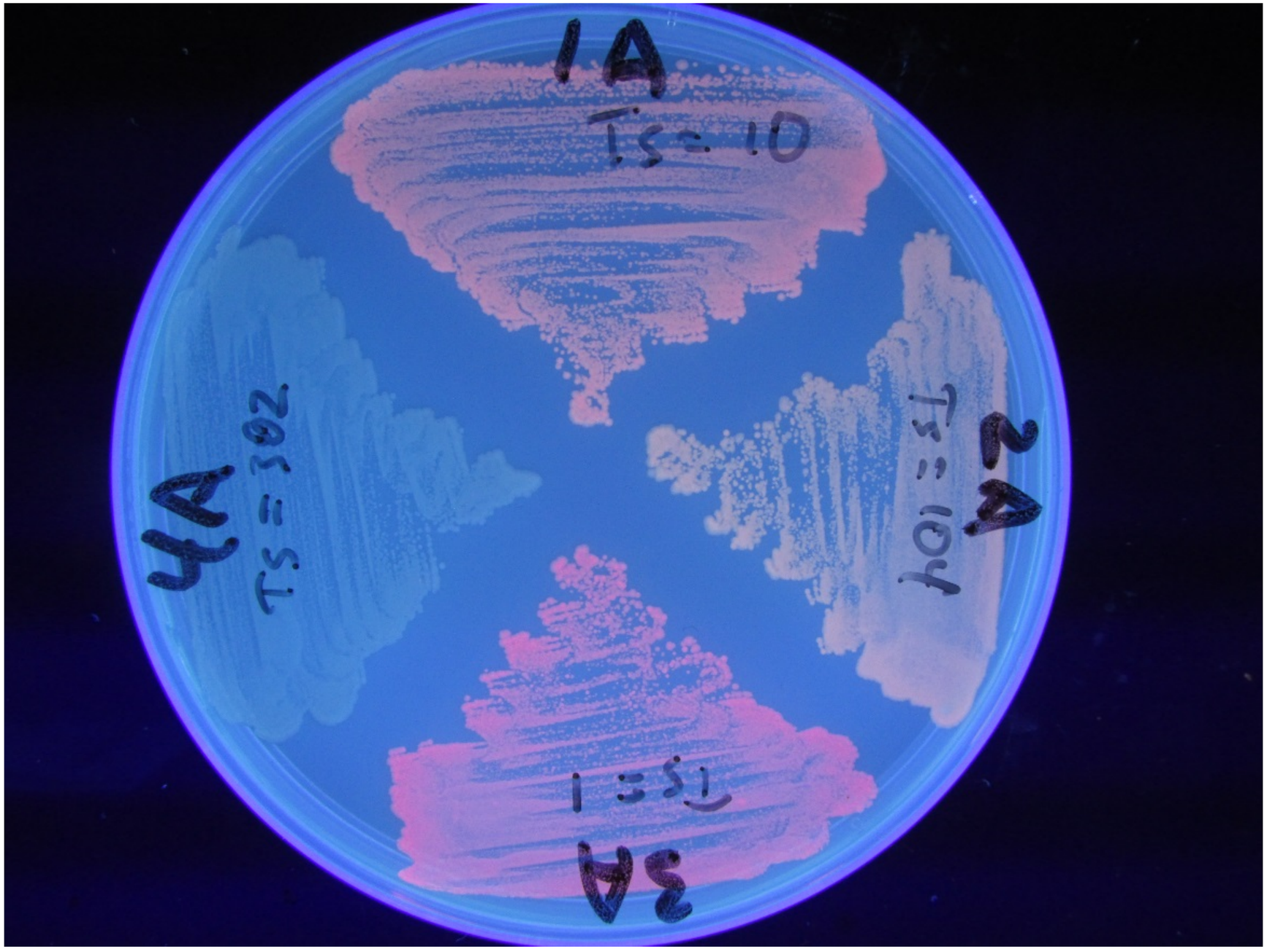
Bsa I



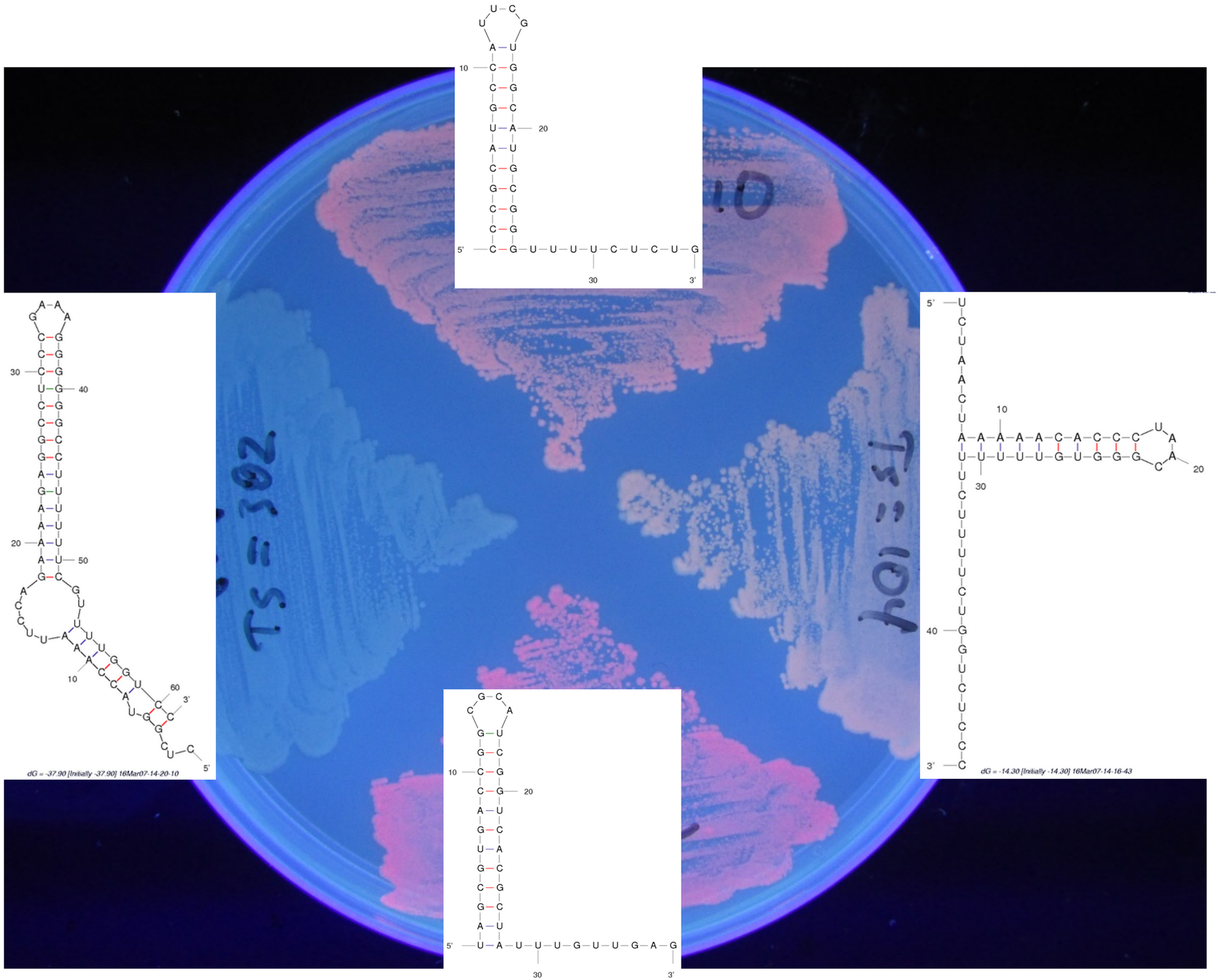
Bsa I



tClone Red (student-designed terminators)

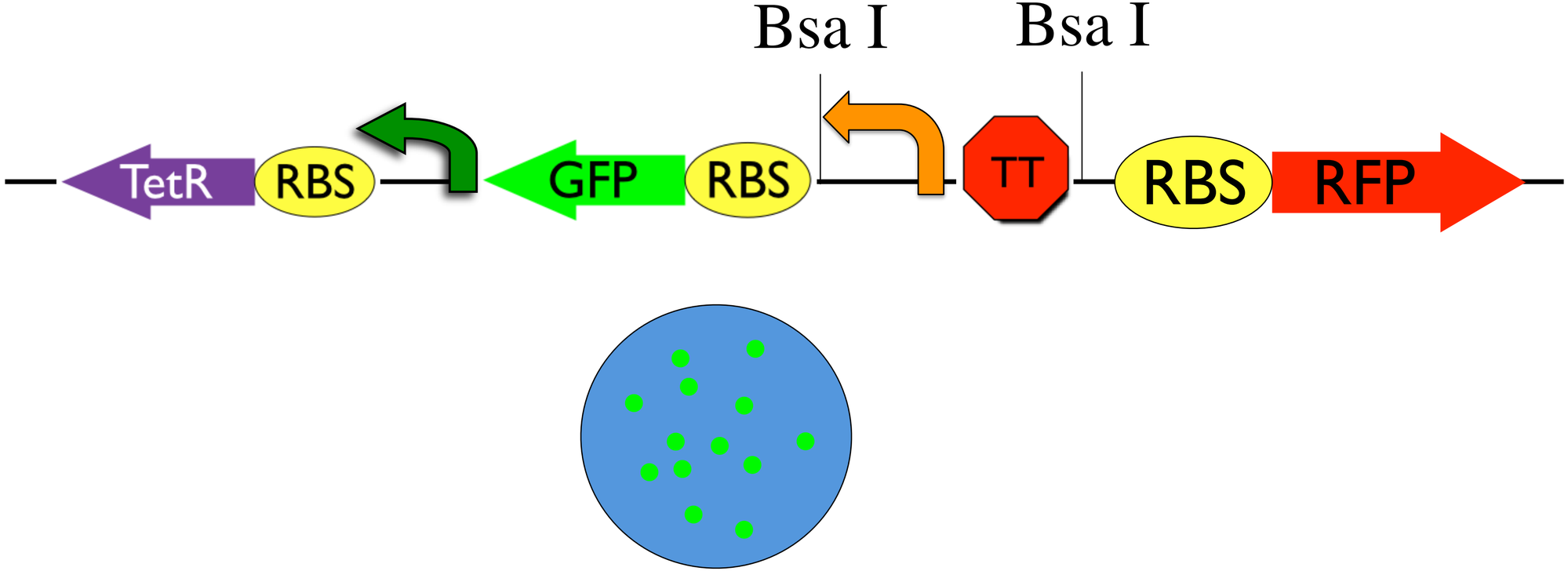


tClone Red (student-designed terminators)



repClone Red

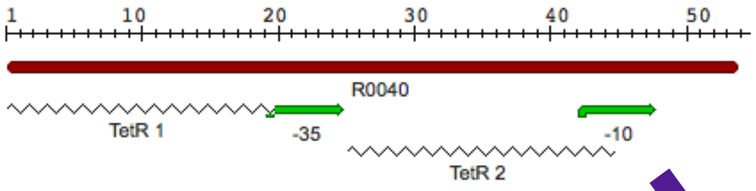
J100205



repClone Red

J100205

Ptet



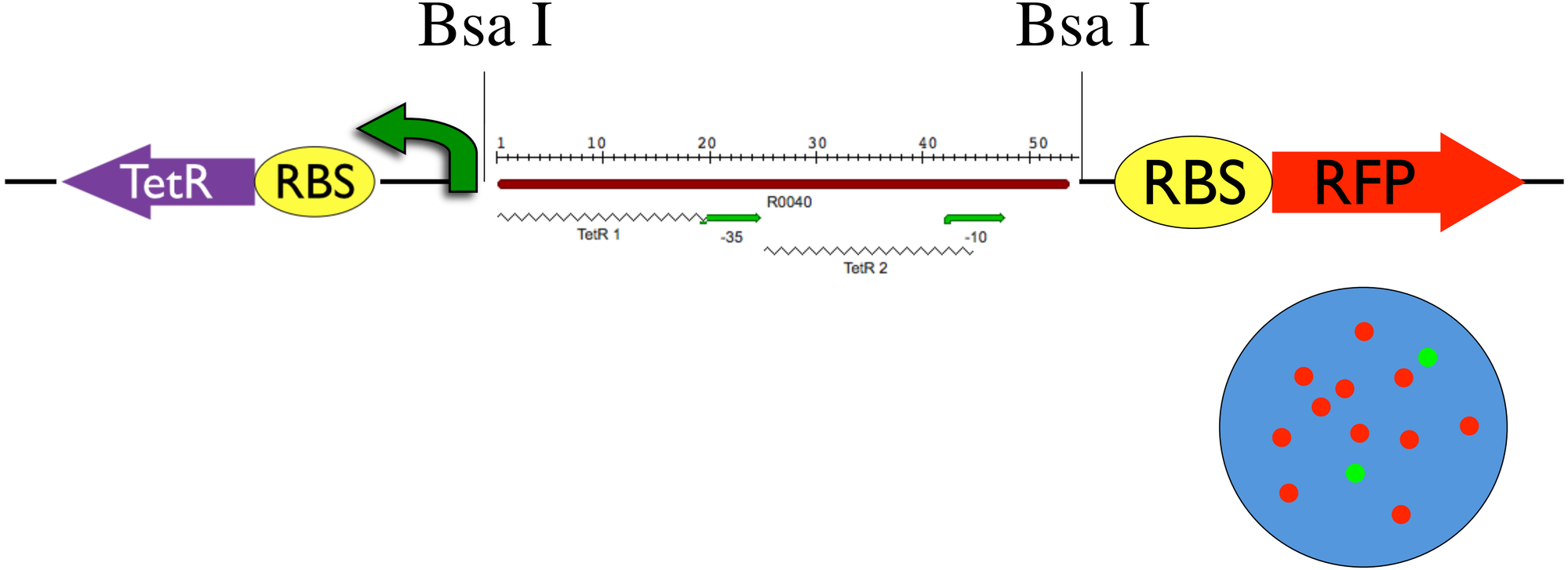
54 bp

Bsa I

Bsa I

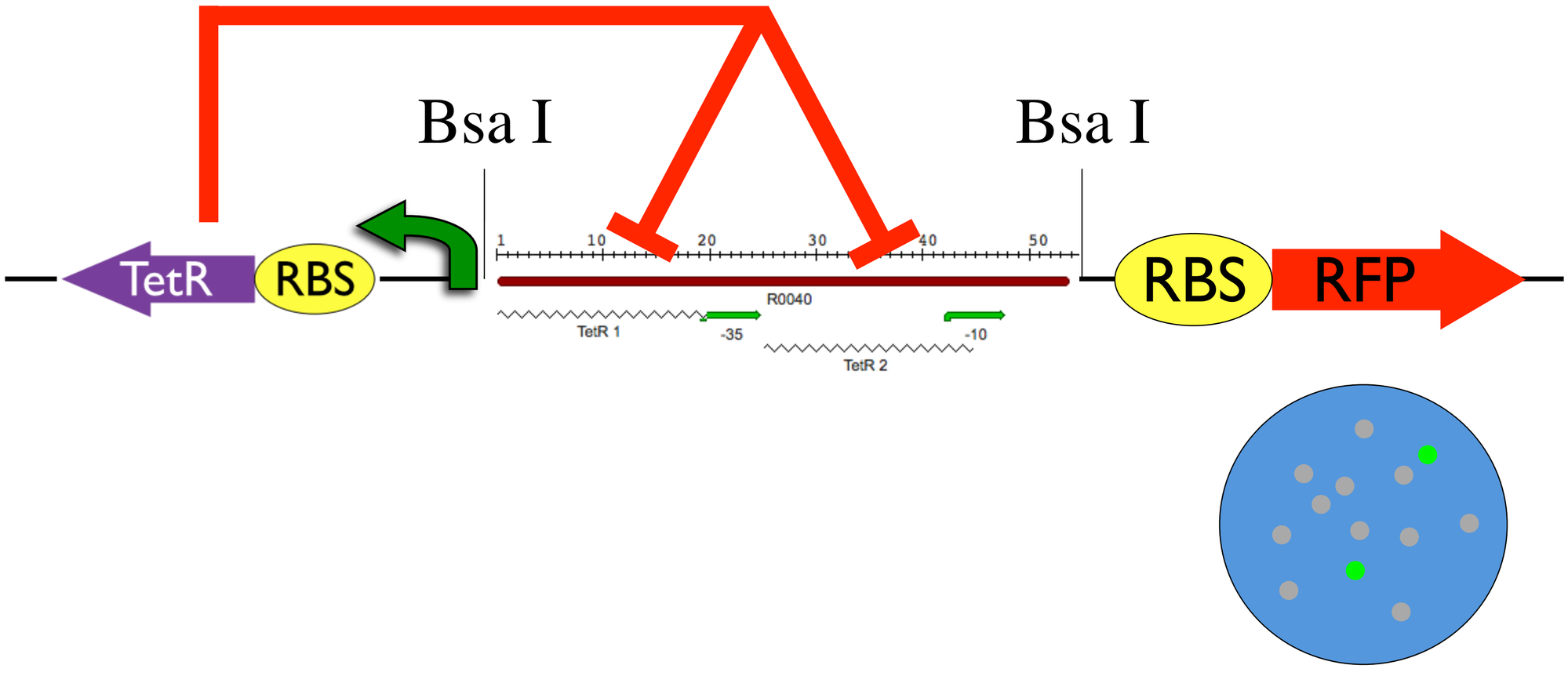
repClone Red

J100306



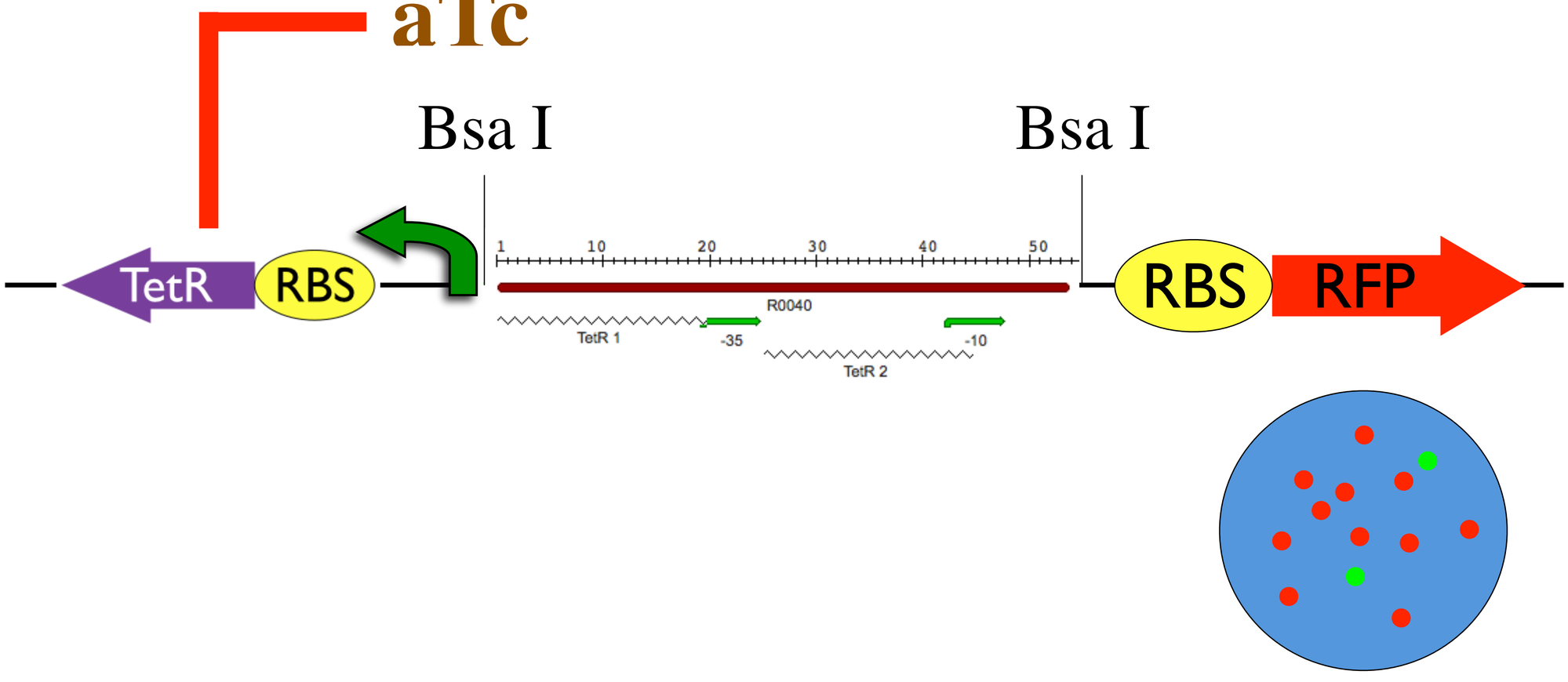
repClone Red

J100306

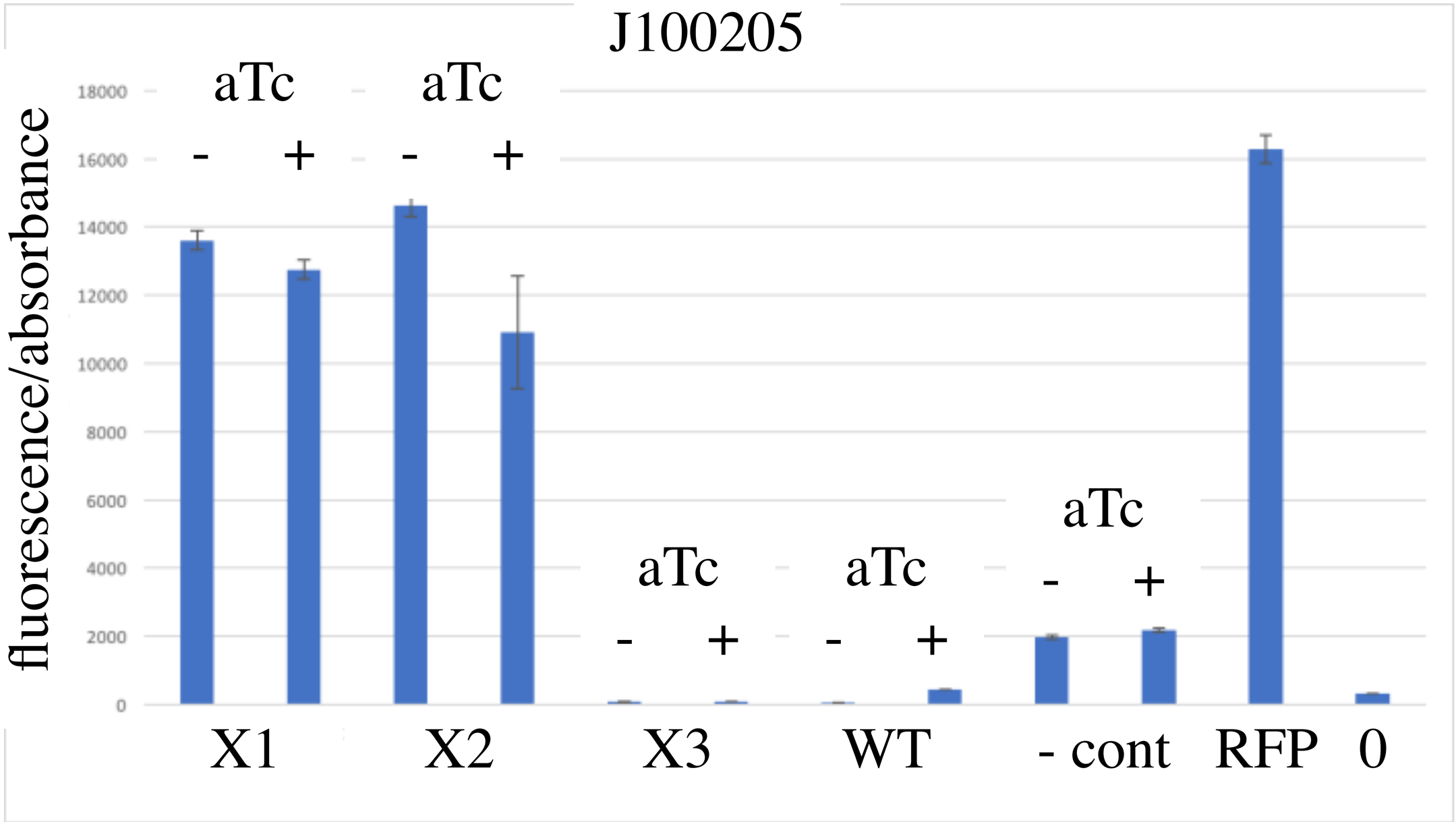


repClone Red

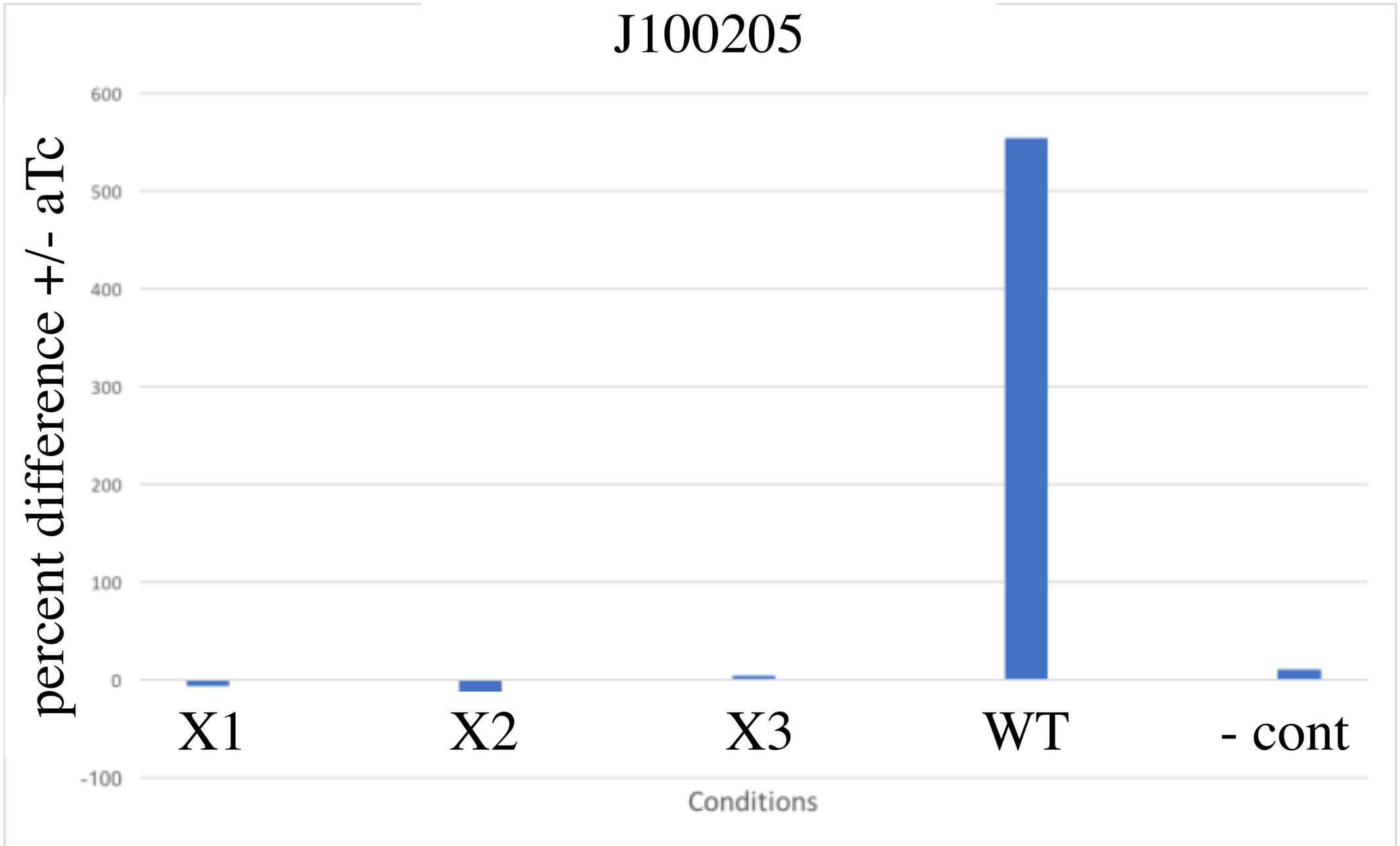
J100306



Student Results repClone Red F2017

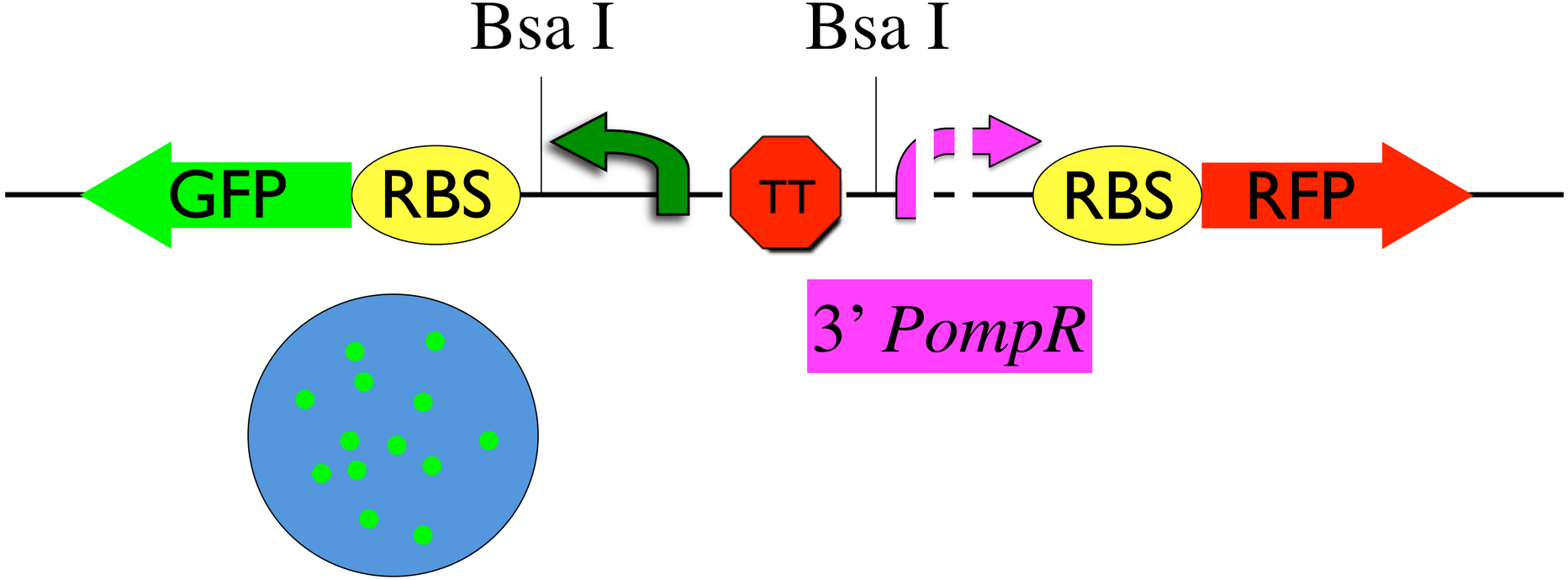


Student Results repClone Red F2017



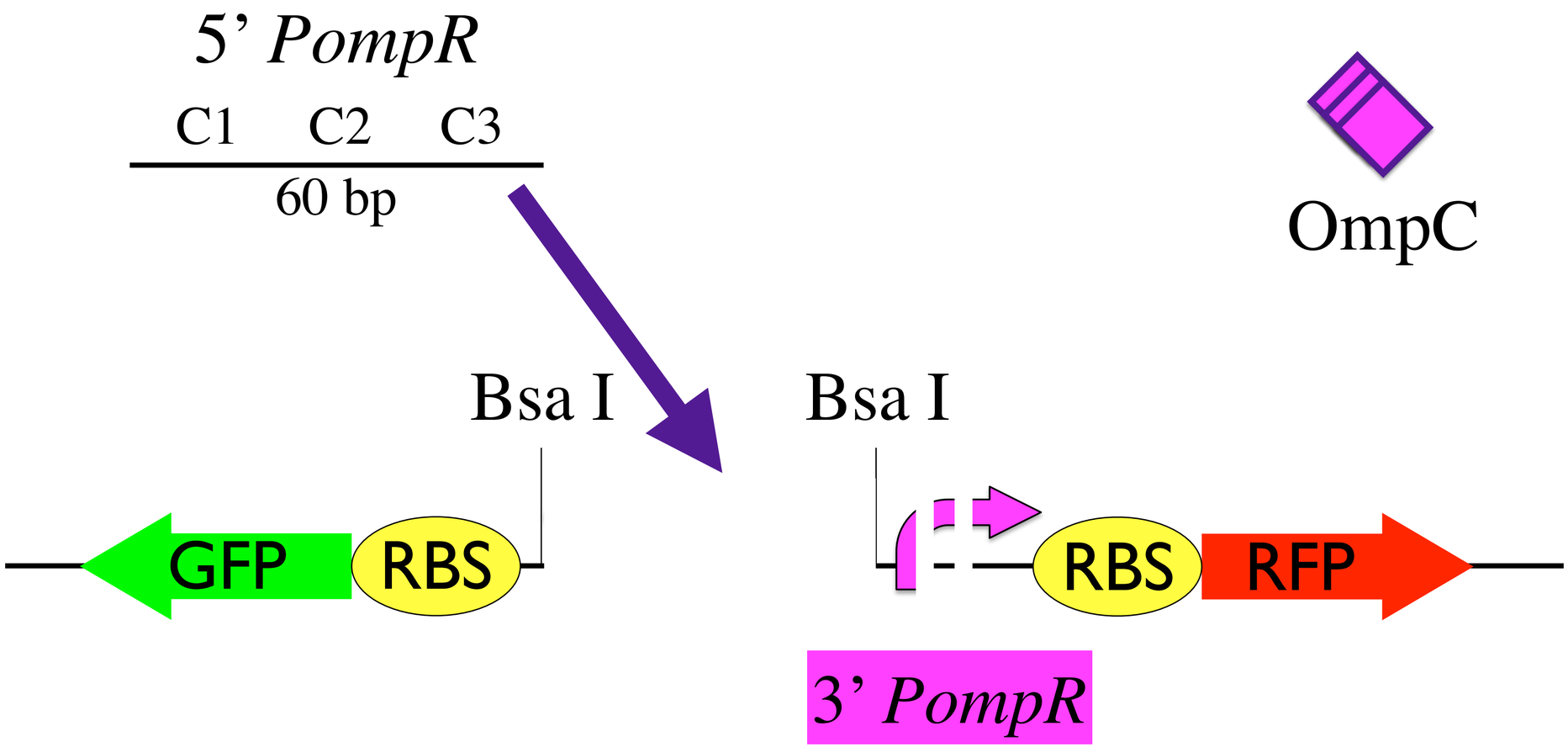
actClone Red

J100204



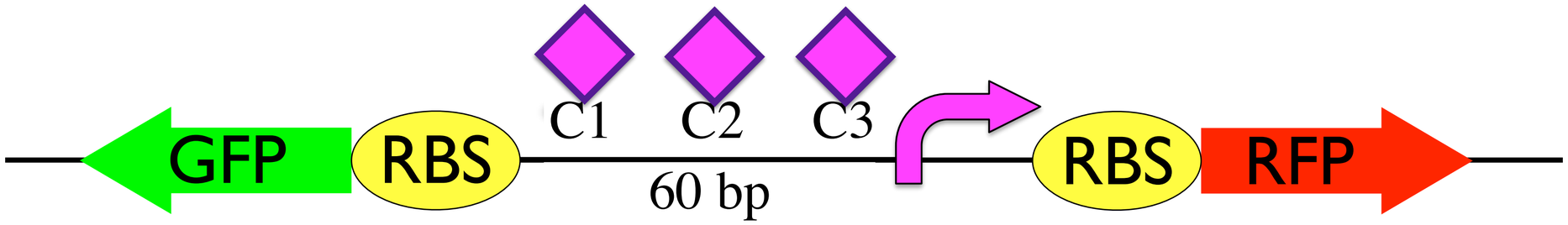
actClone Red

J100204

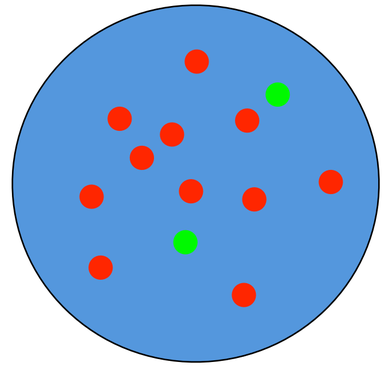


actClone Red

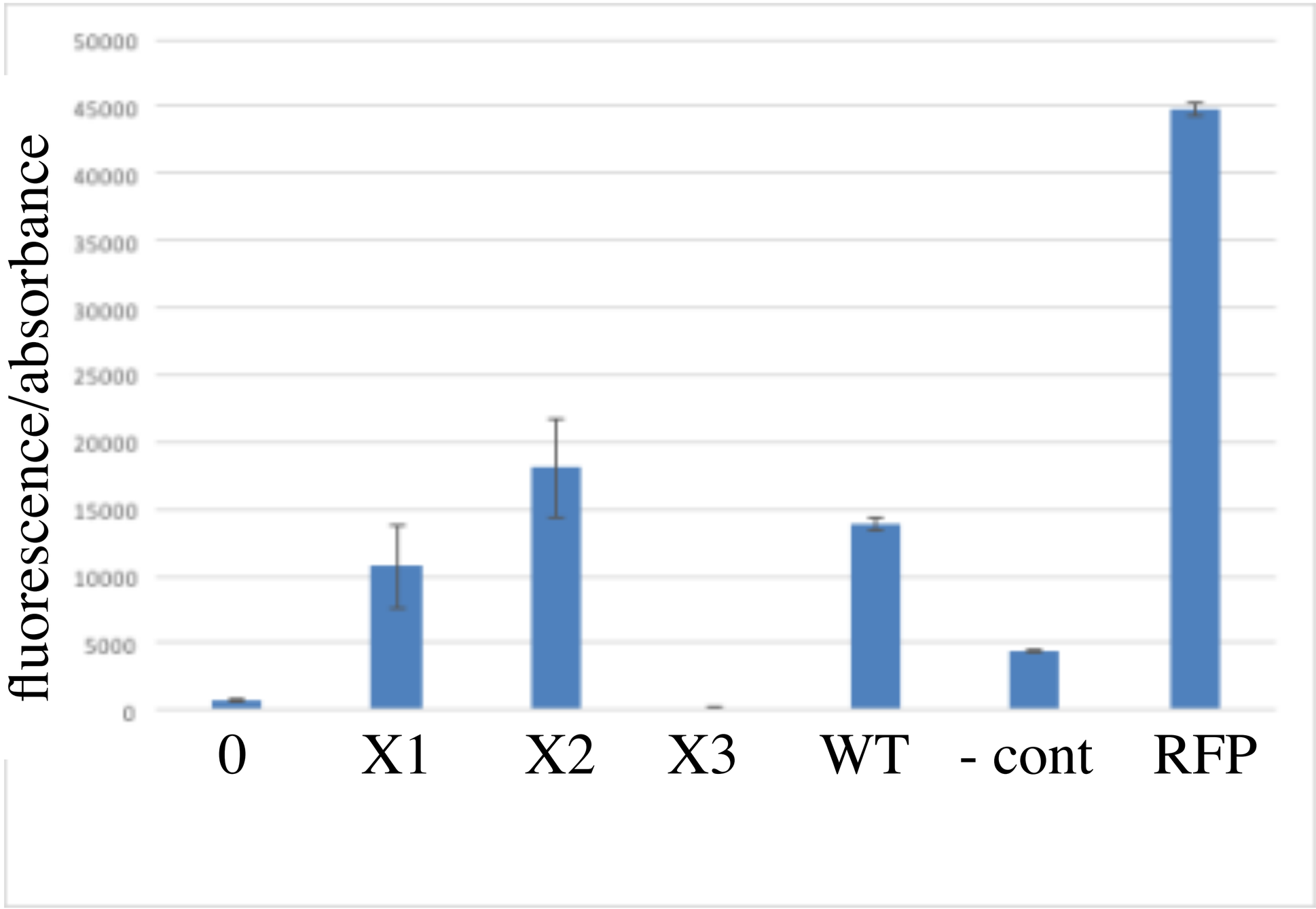
J100309 = WT



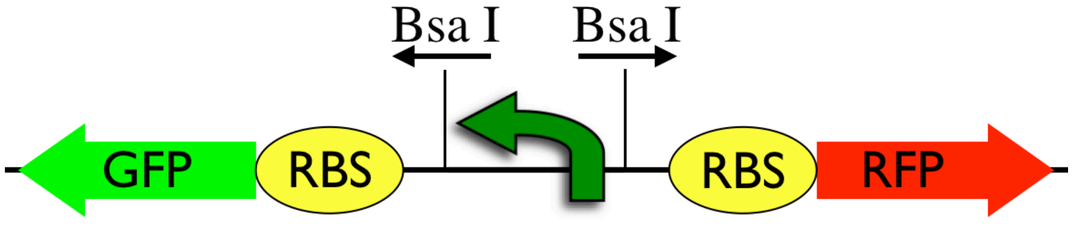
all of *PompR*



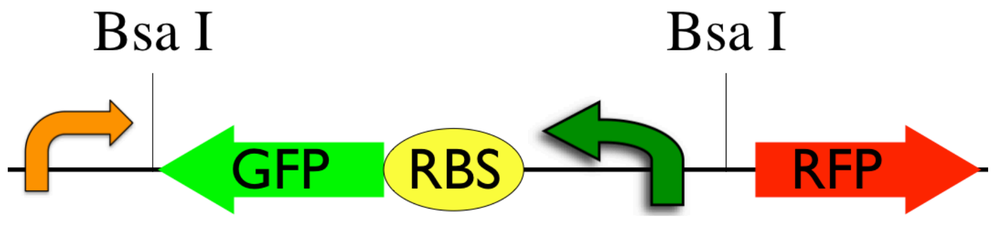
Student Results actClone Red F2017



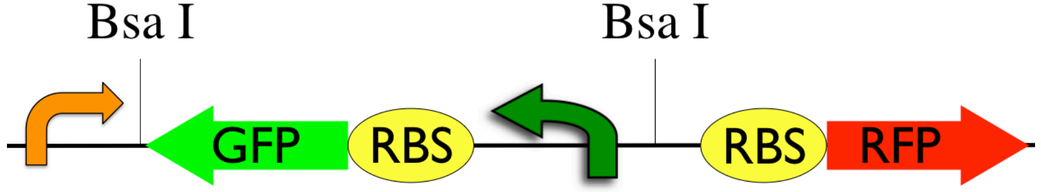
Genuine Introductory Student Research



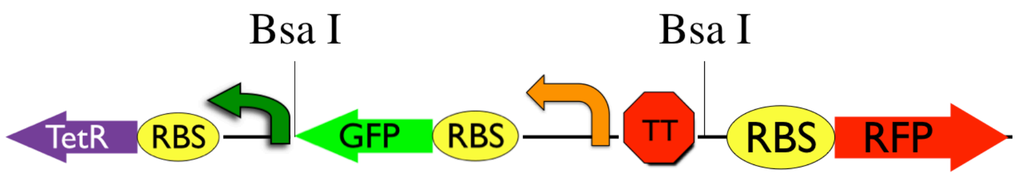
pClone Red



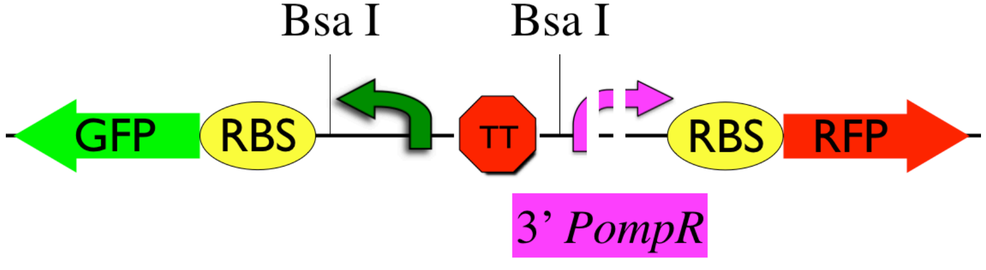
rClone Red



tClone Red



repClone Red



actClone Red

Critical Aspects in CURE Experiences

present work outside class

work collaboratively with peers

select or design all or part of data collection methods

collect novel data

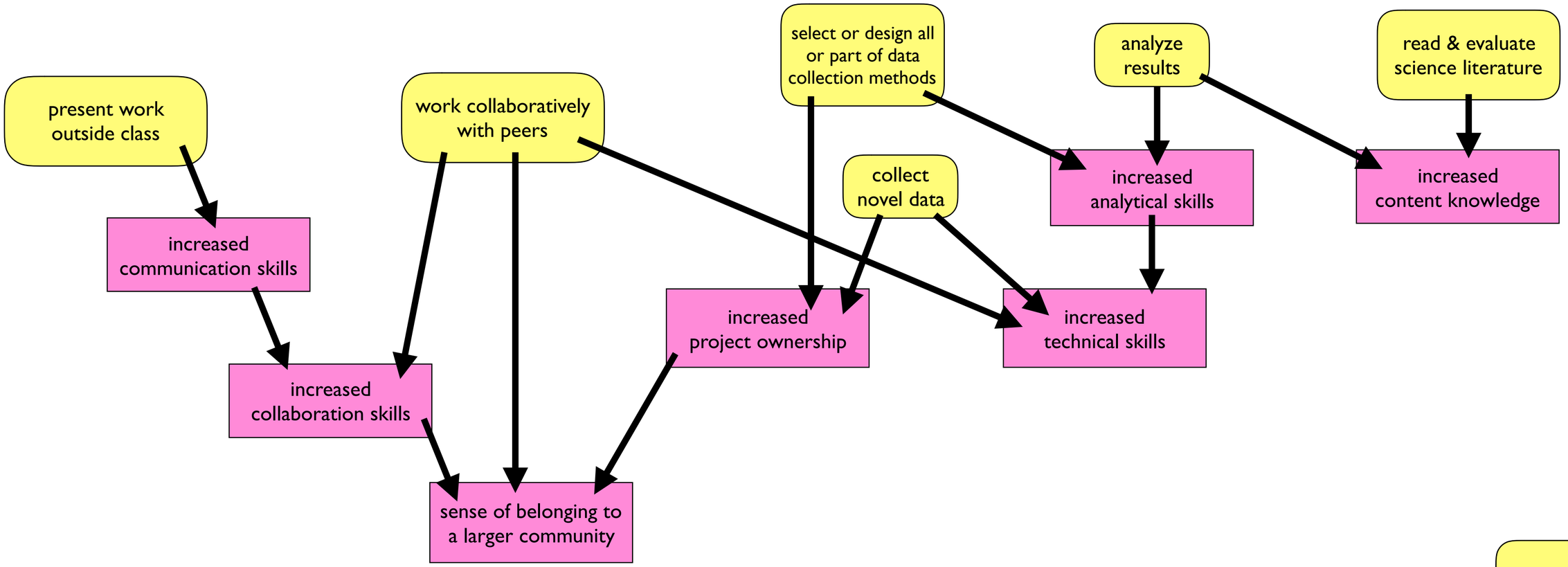
analyze results

read & evaluate science literature

activities

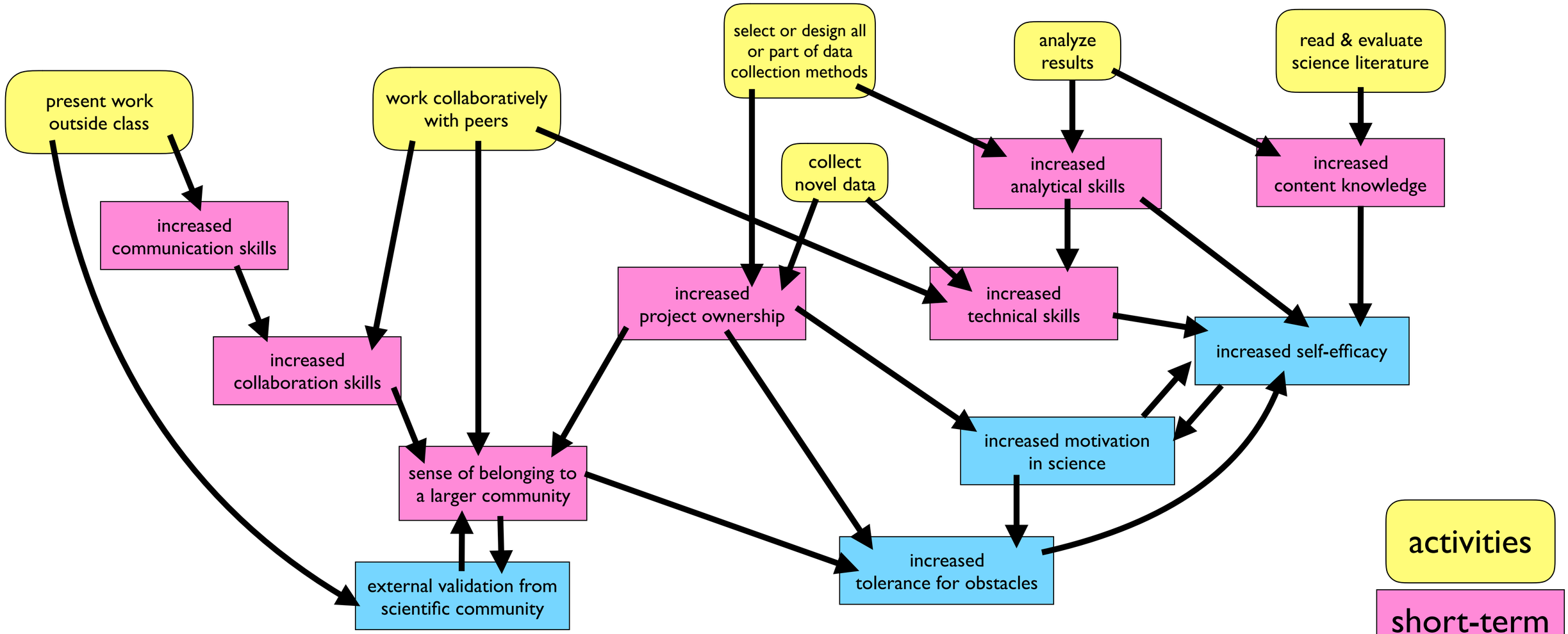
CBE LSE Vol. 14, 1 - 13, Spring 2015

Critical Aspects in CURE Experiences



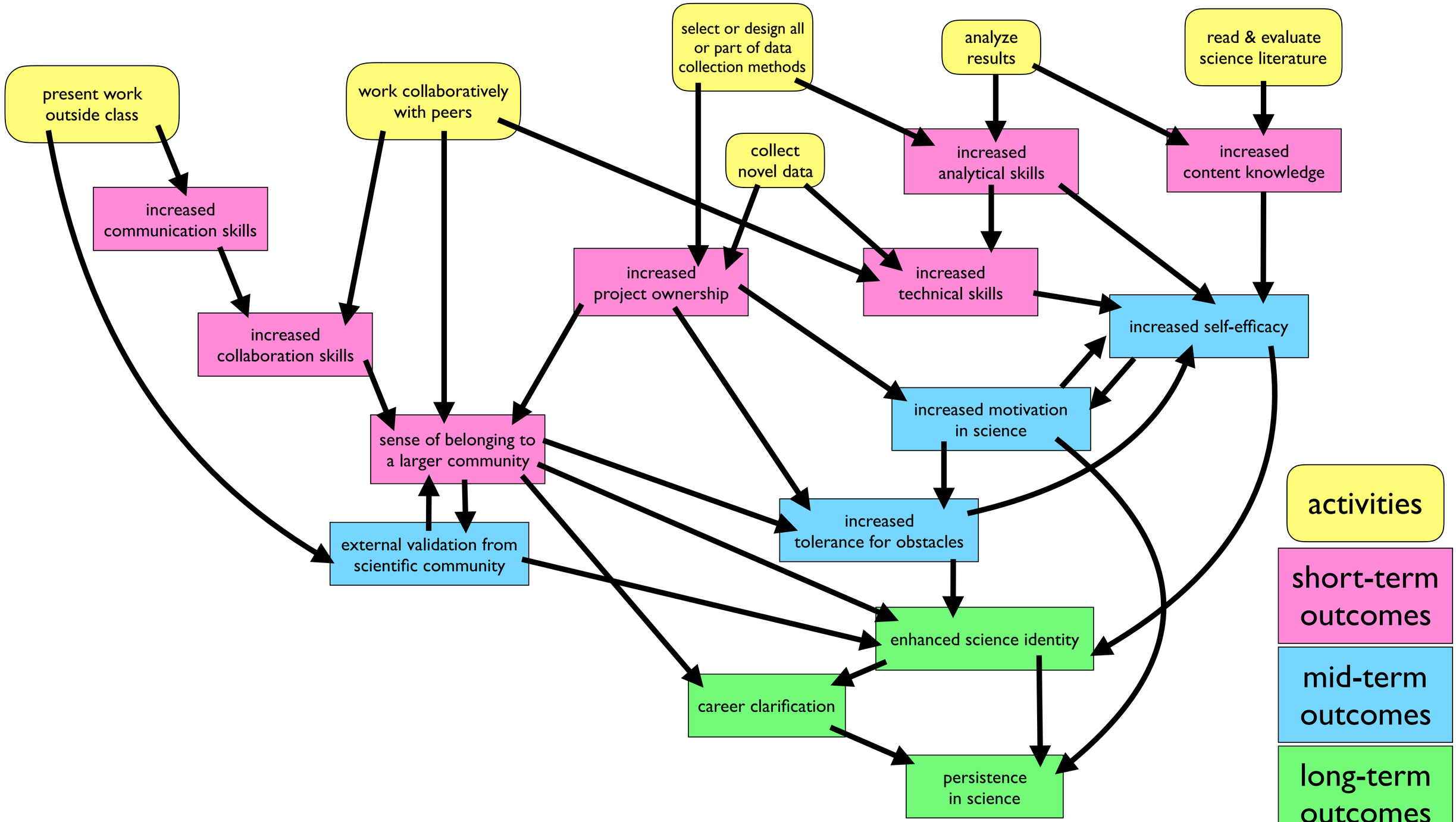
CBE LSE Vol. 14, 1 - 13, Spring 2015

Critical Aspects in CURE Experiences



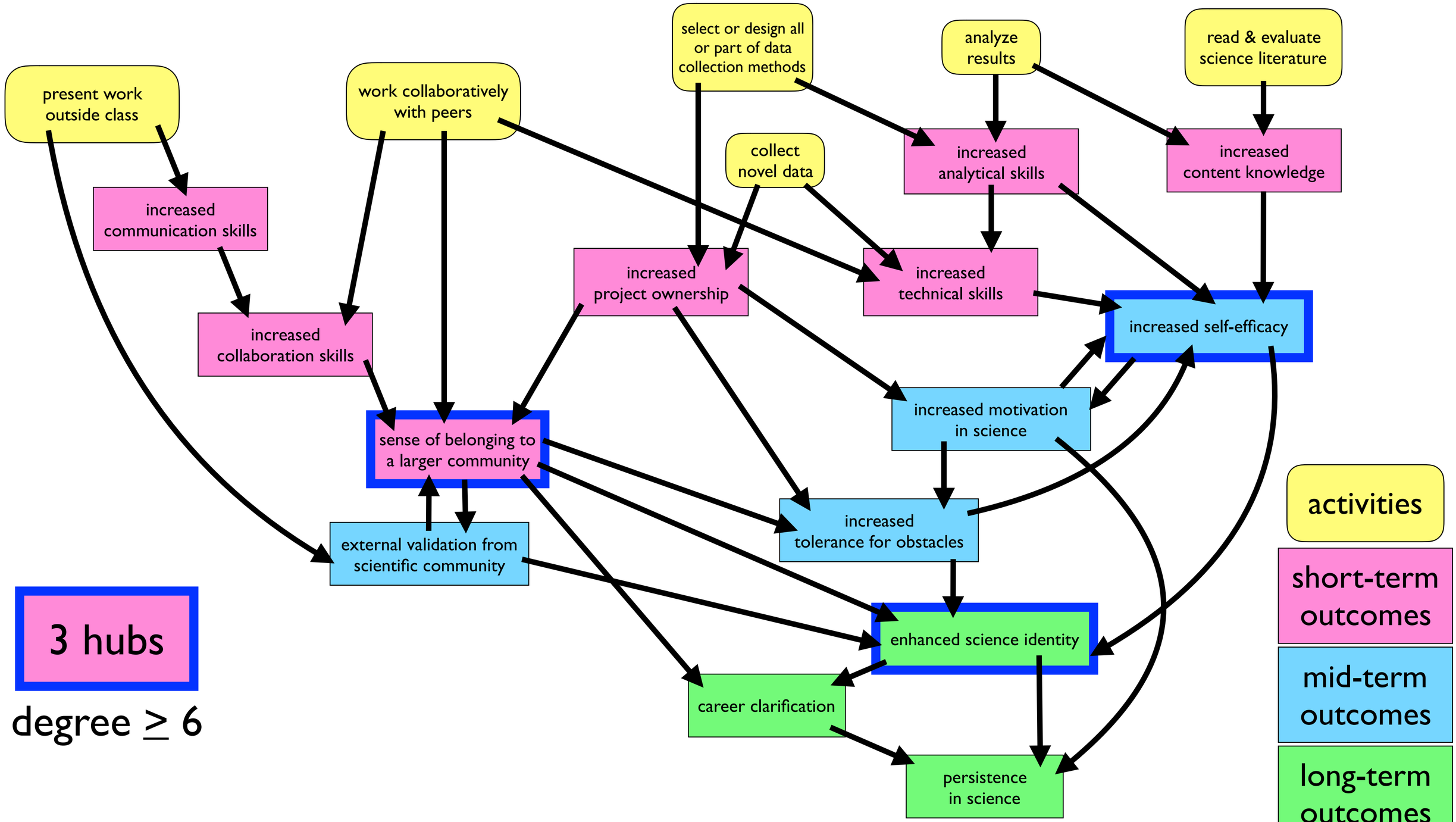
CBE LSE Vol. 14, 1 - 13, Spring 2015

Critical Aspects in CURE Experiences



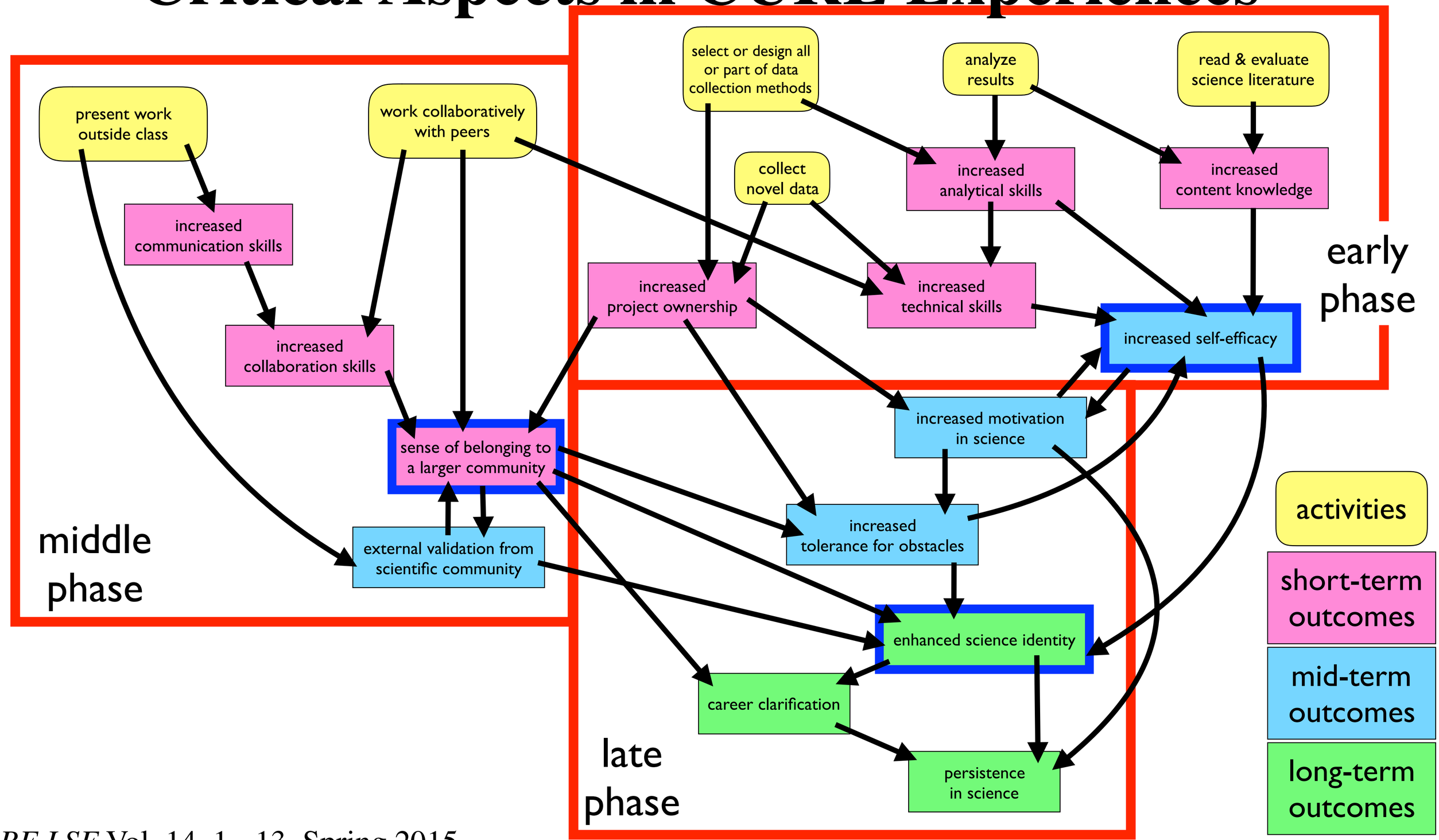
CBE LSE Vol. 14, 1 - 13, Spring 2015

Critical Aspects in CURE Experiences



CBE LSE Vol. 14, 1 - 13, Spring 2015

Critical Aspects in CURE Experiences



CBE LSE Vol. 14, 1 - 13, Spring 2015

Teaching Should Be Fun!