

Vision and Change Introductory Biology Lecture and Lab

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Biology Department and **GCAT**

DAVIDSON


ASM Eastern PA
March 23, 2015

Outline of Presentation

Why change my intro bio course now?

How is *ICB* different?

Hands-on activity #1 - constructing your own knowledge

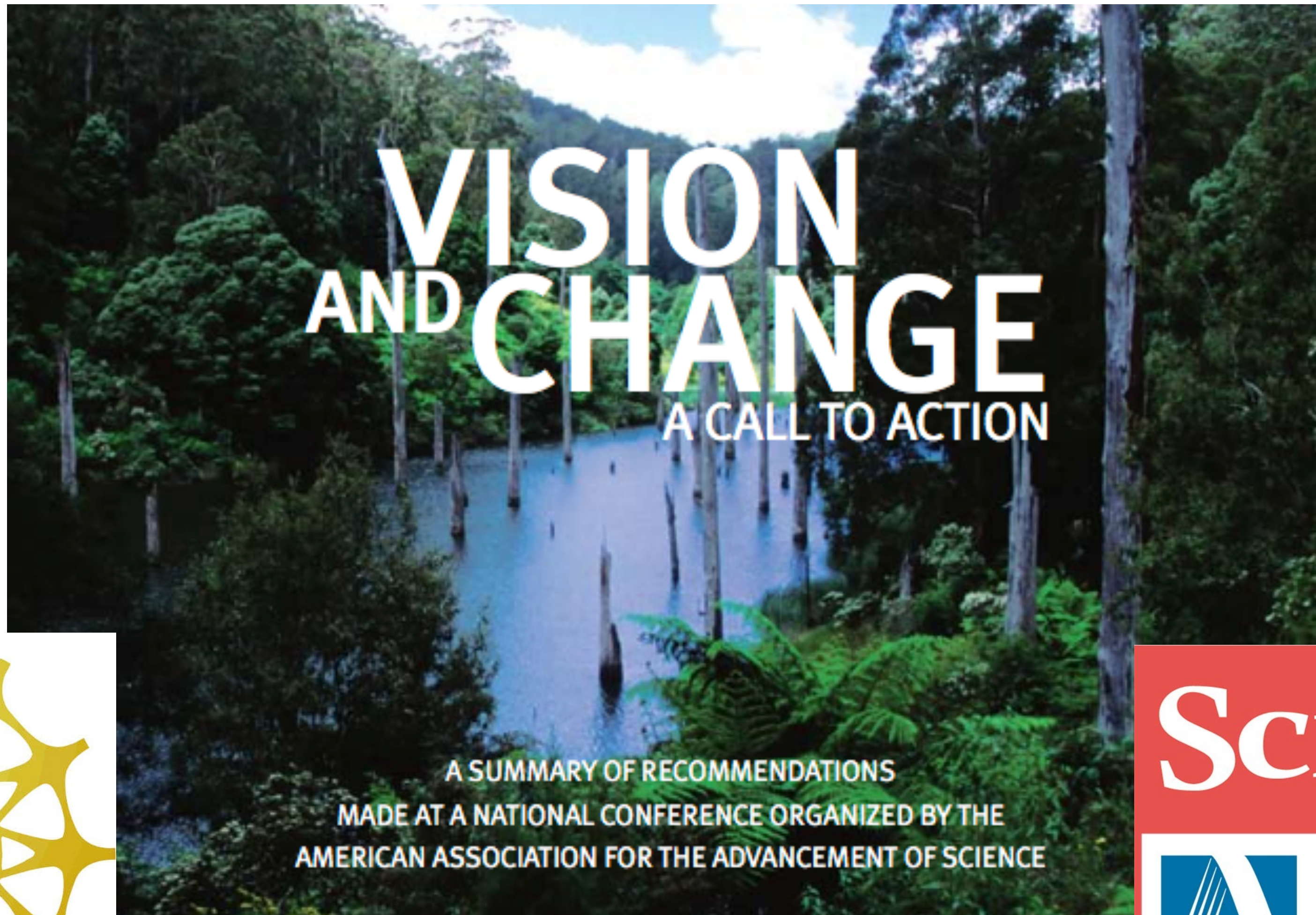
Did students meet learning objectives (content and attitude)?

Can intro labs be more authentic? Hands-on activity #2

pClone: real research by first year students

Closing remarks

National Recognition of Need to Change

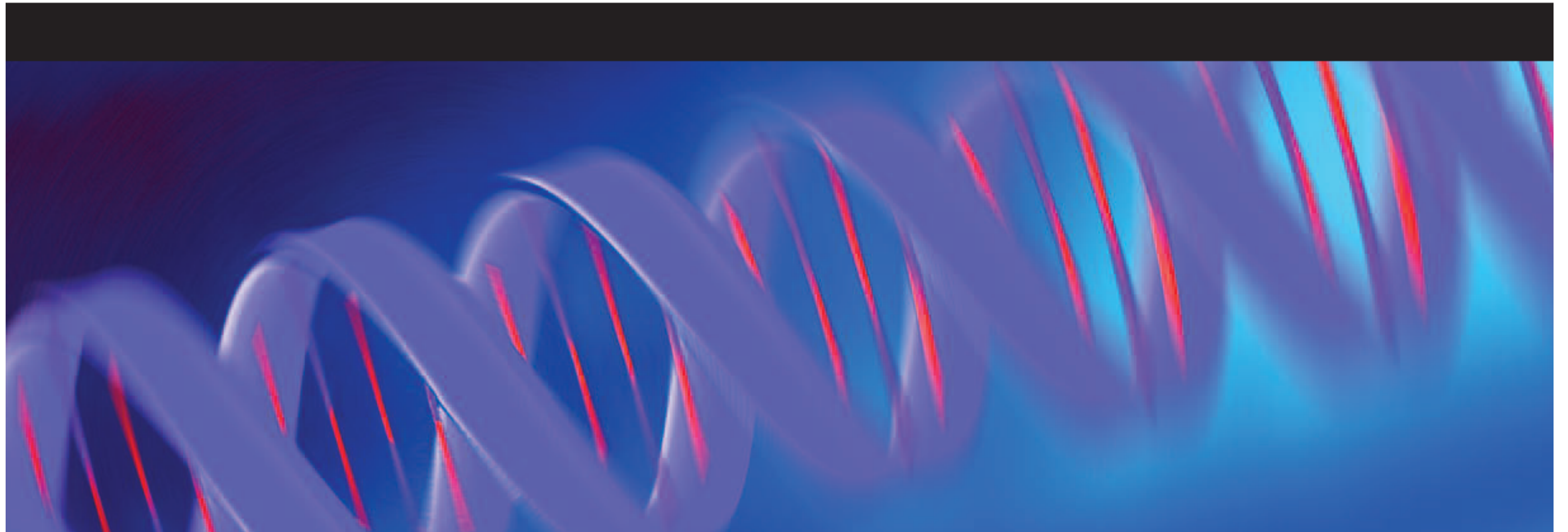


AP Biology Redesign in Third year

 AP[®] BIOLOGY

Curriculum Framework

2012–2013



GRE General Test

Verbal Reasoning: measures your ability to understand what you read and how you apply your reasoning skills.

Quantitative Reasoning: measures your ability to

- understand quantitative information
- interpret and analyze quantitative information
- solve problems using mathematical models
- apply basic mathematical skills and elementary mathematical concepts of arithmetic, algebra, geometry and data interpretation
- includes real-life scenarios

Analytical Writing: provide focused responses to prompts so you can demonstrate your ability to directly respond.

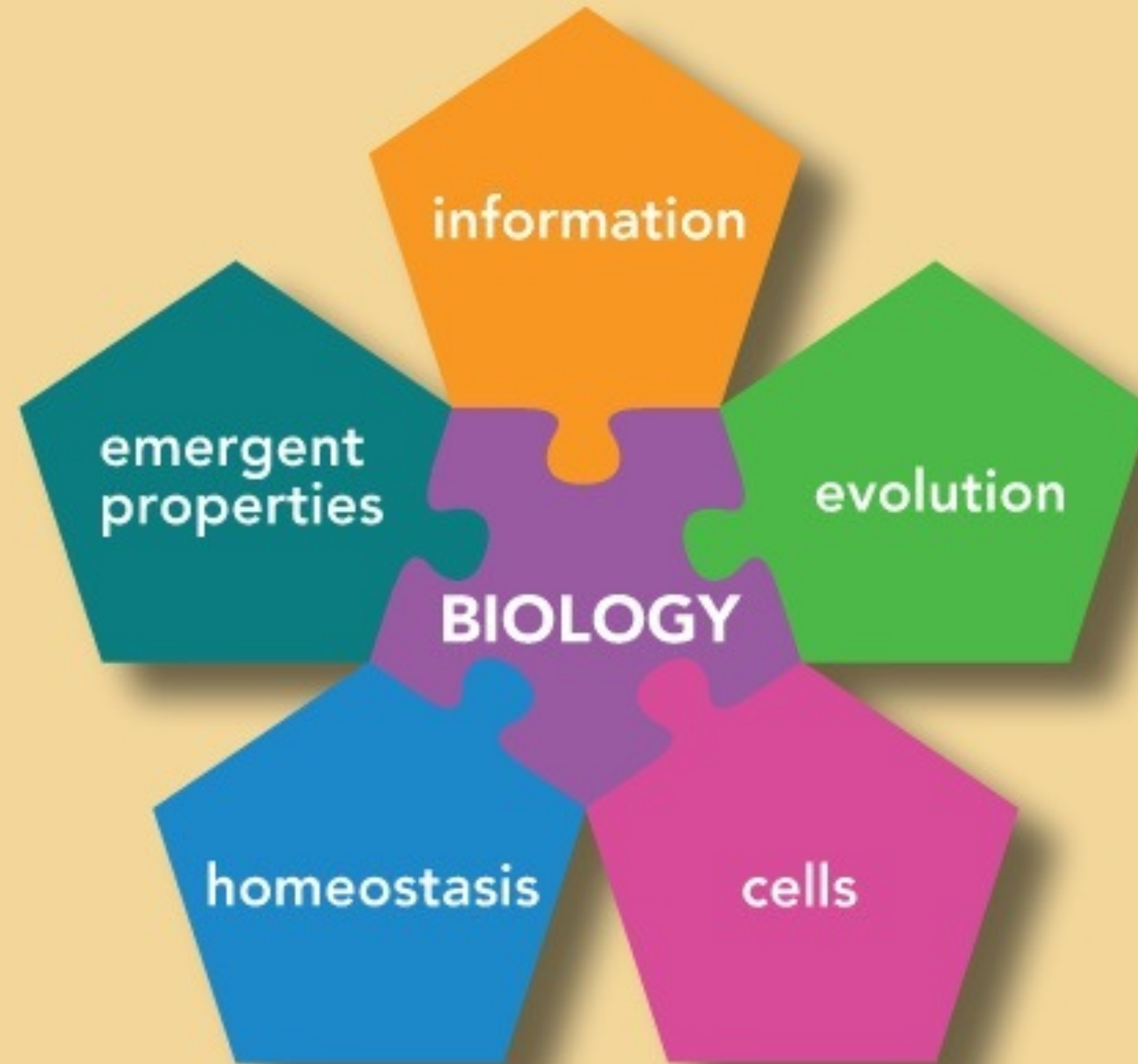
MCAT Redesigned Test

Critical Analysis and Reasoning Skills: analyze, evaluate, and apply information provided in passages

Natural Sciences: combine knowledge of natural science concepts with their scientific inquiry and reasoning skills to solve problems that demonstrate their readiness for medical school.

Psychological, Social, and Biological Foundations of Behavior

INTEGRATING CONCEPTS IN BIOLOGY

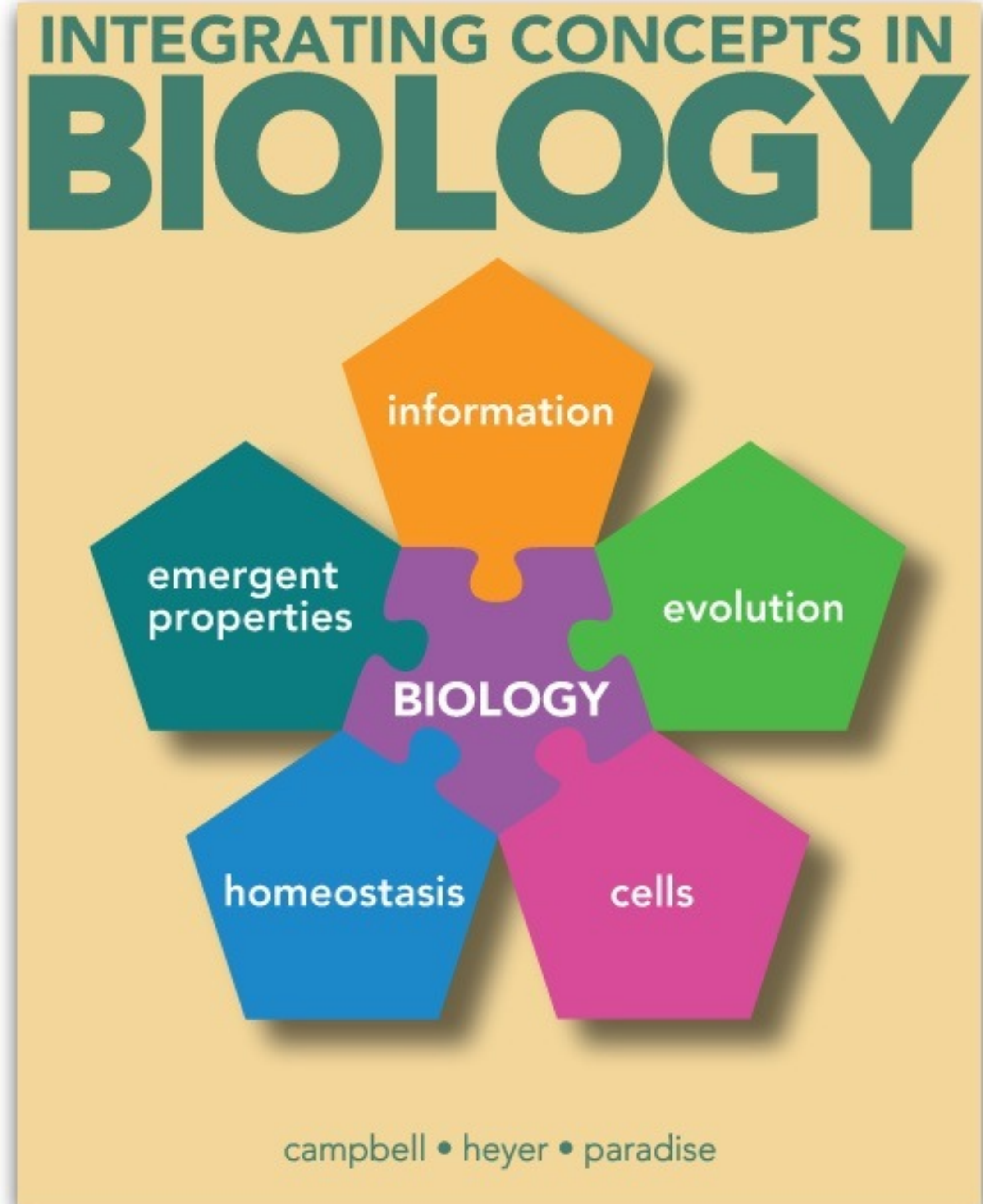


campbell • heyer • paradise

full disclosure

ICB is a
commercial
product

- 3 years to write, 4 years to publish
- traditional publishers rejected
- eBook hosted by Trunity
- David Botstein gift funded book
- Bruce Alberts wrote Foreword
- demonstrated learning gains
- adopt only chapters you use
- <http://goo.gl/nRA0Od>



Core Concepts = Big Ideas

Vision & Change

Evolution

Structure and Function

Information

Energy and Matter

Systems Biology

AP Biology

Evolution

Information

Homeostasis

Emergent Properties

ICB

Evolution

Cells

Information

Homeostasis

Emergent Properties

V&C Core Competencies

- Apply the process of science
- Use quantitative reasoning
- Use modeling and simulations
- Integrate different disciplines
- Communicate & collaborate
- Connect science & society

V&C Core Competencies (*ICB*)

- Apply the process of science (experimental design)
- Use quantitative reasoning (interpret raw data)
- Use modeling and simulations (work with models)
- Integrate different disciplines (chemistry, math, some physics)
- Communicate & collaborate (small group discussions, lab)
- Connect science & society (ELSI boxes)

What's Wrong with Biology Education Now?

- Vocabulary is emphasized (800-1000 vs 1400)

- Experimental approaches are minimized

- Math is absent

- Memorization is rewarded

- Critical thinking is discouraged

- Information is irrelevant to students

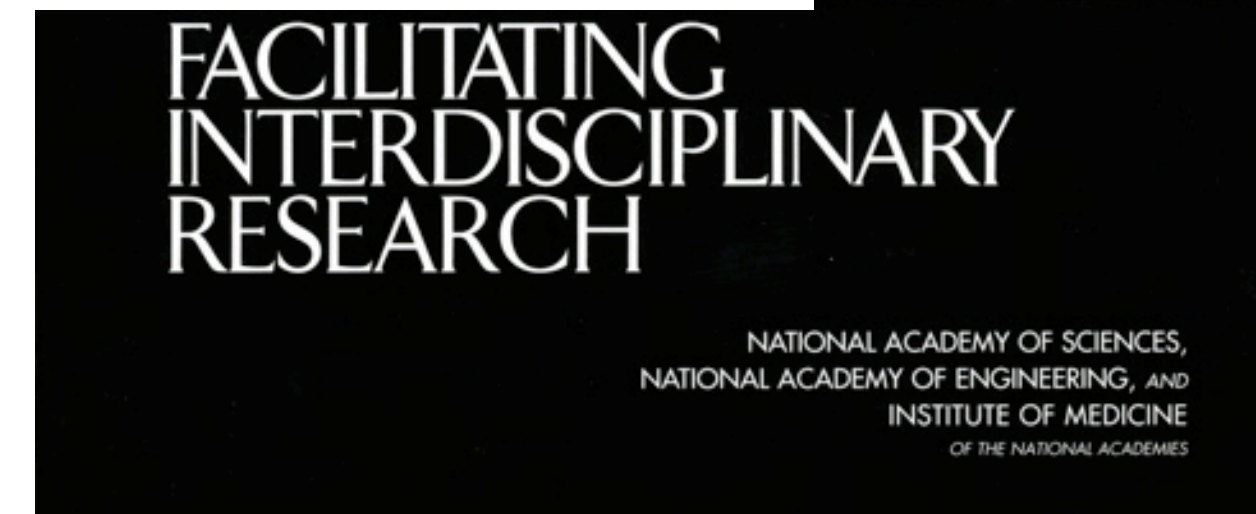
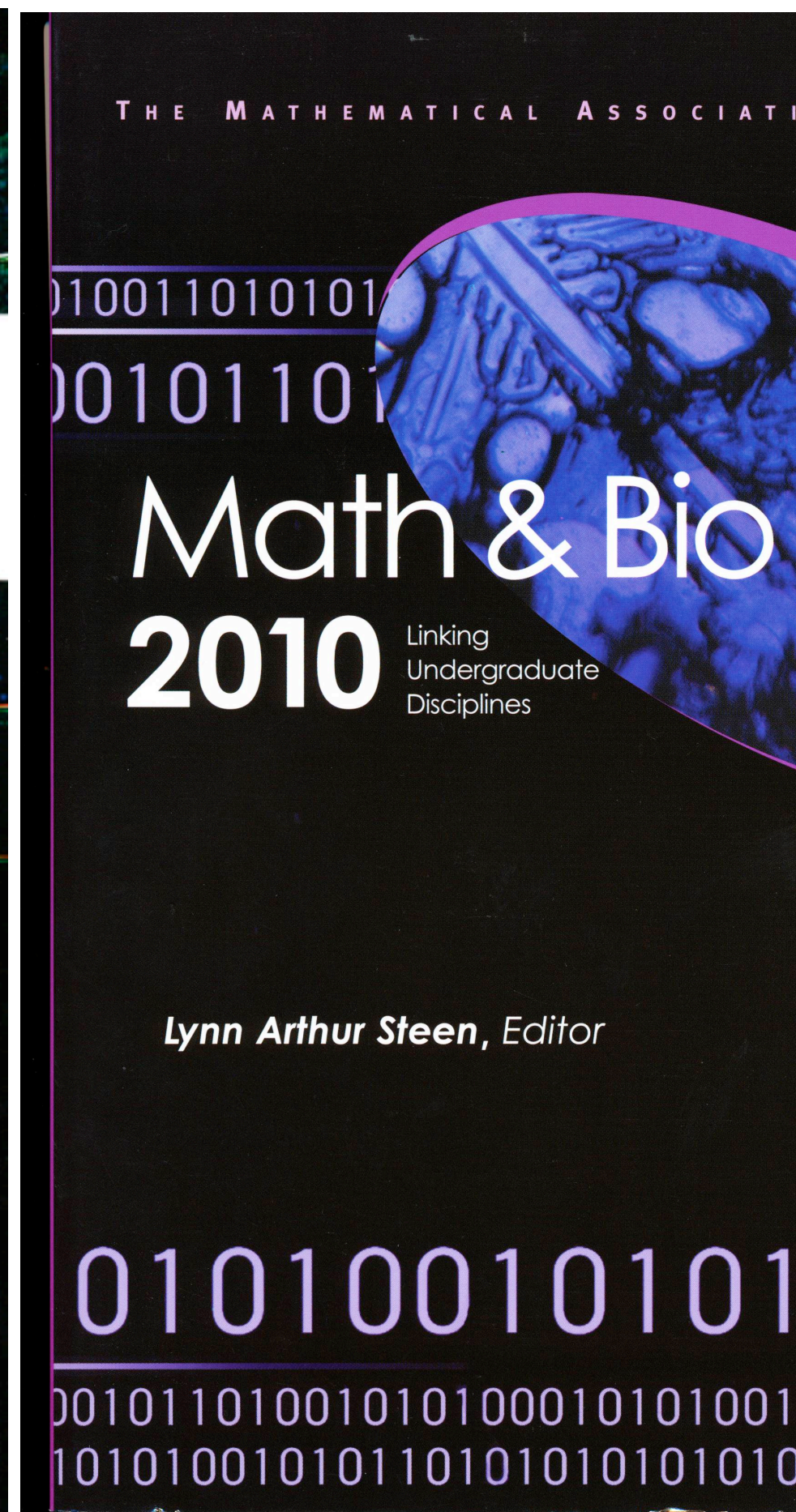
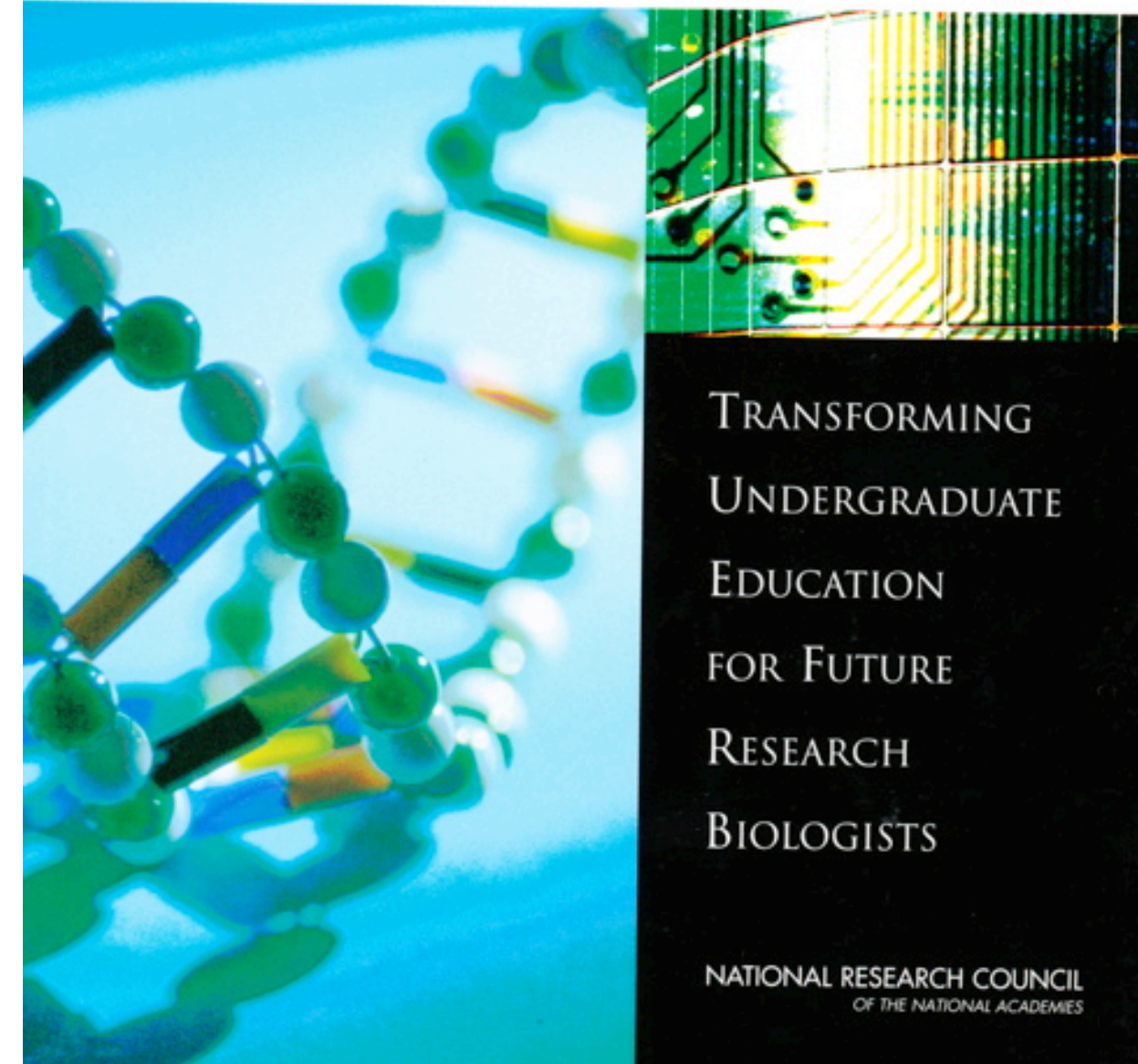
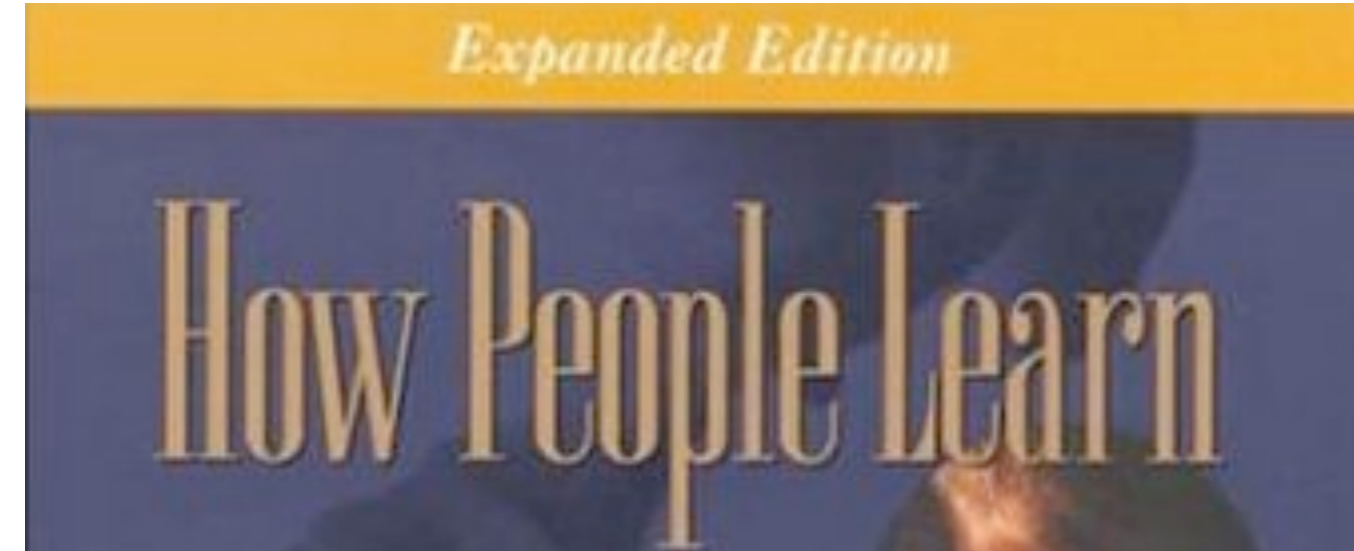
Present information and data...



... in the context of the big picture.



Start with the literature...

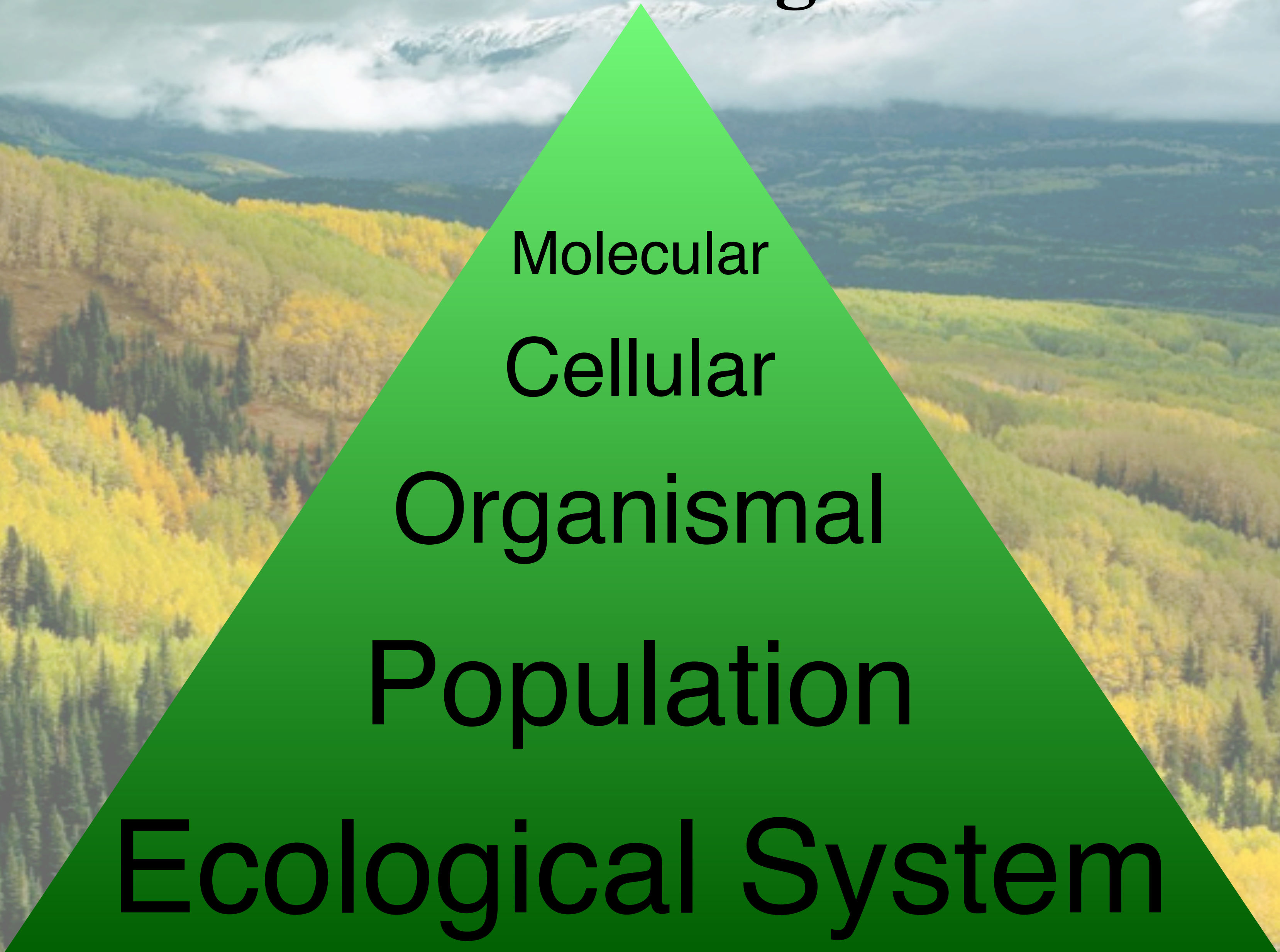


Artificial Divide within Biology

Small Biology

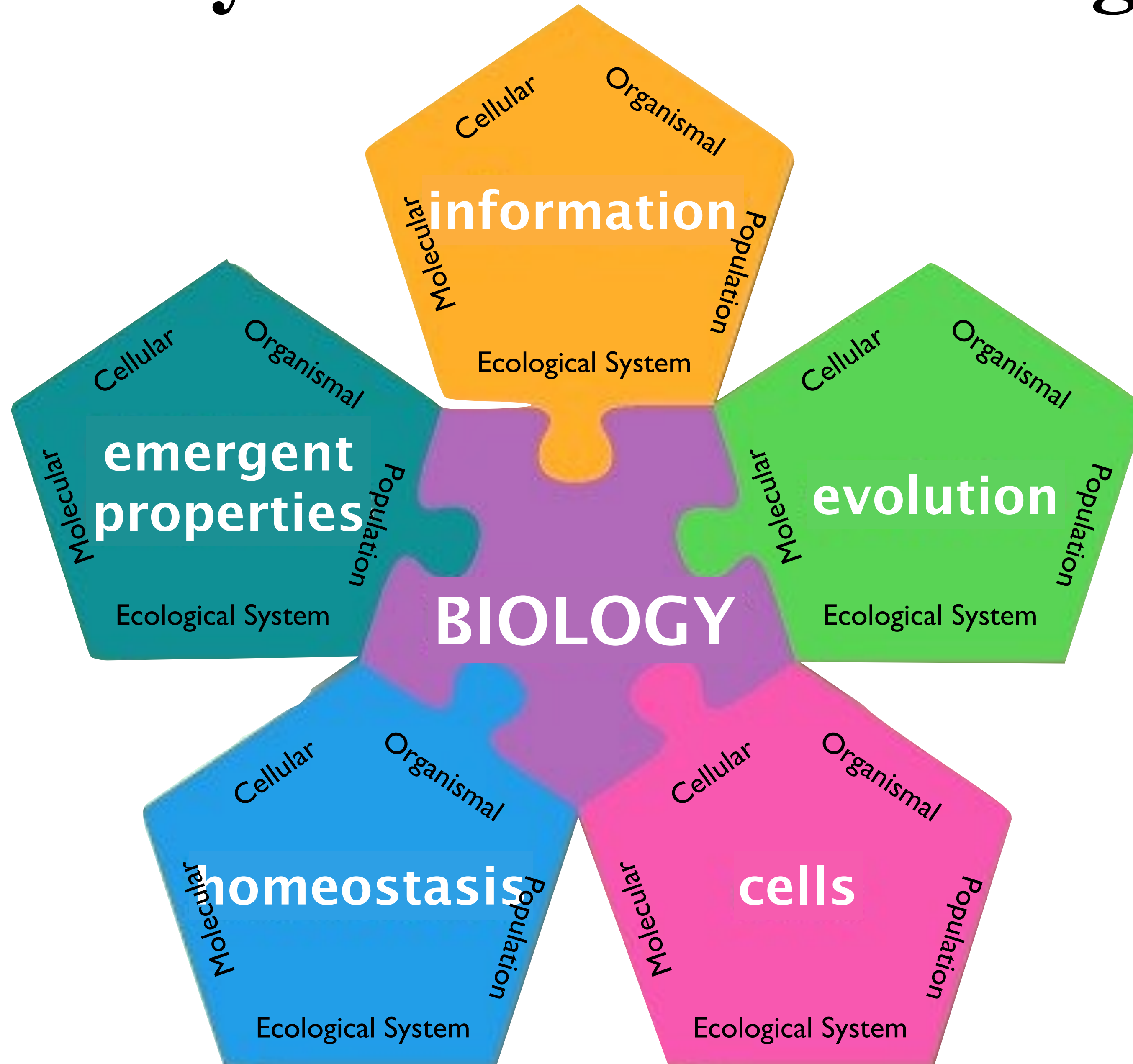
Big Biology

Five Levels of Organization



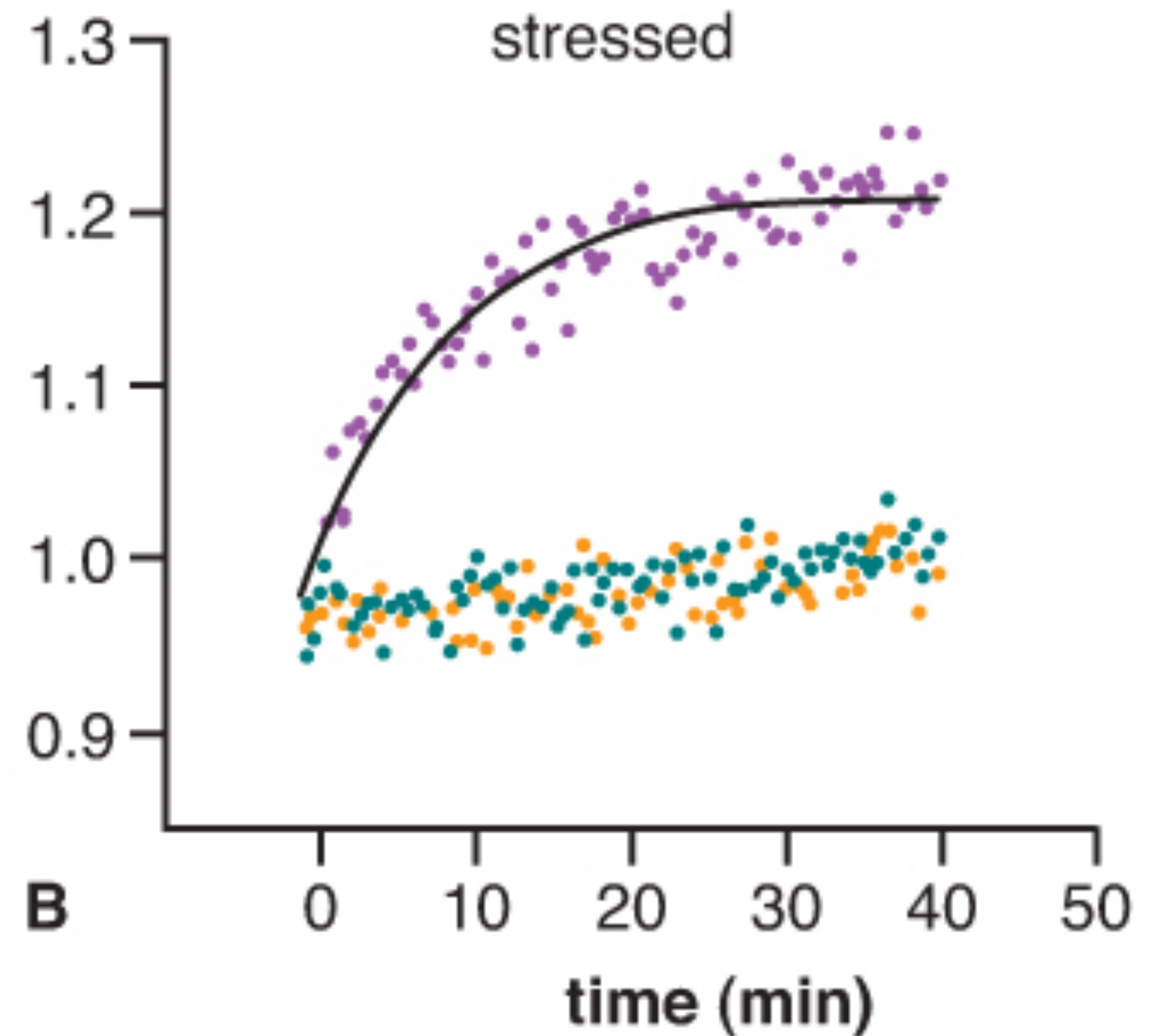
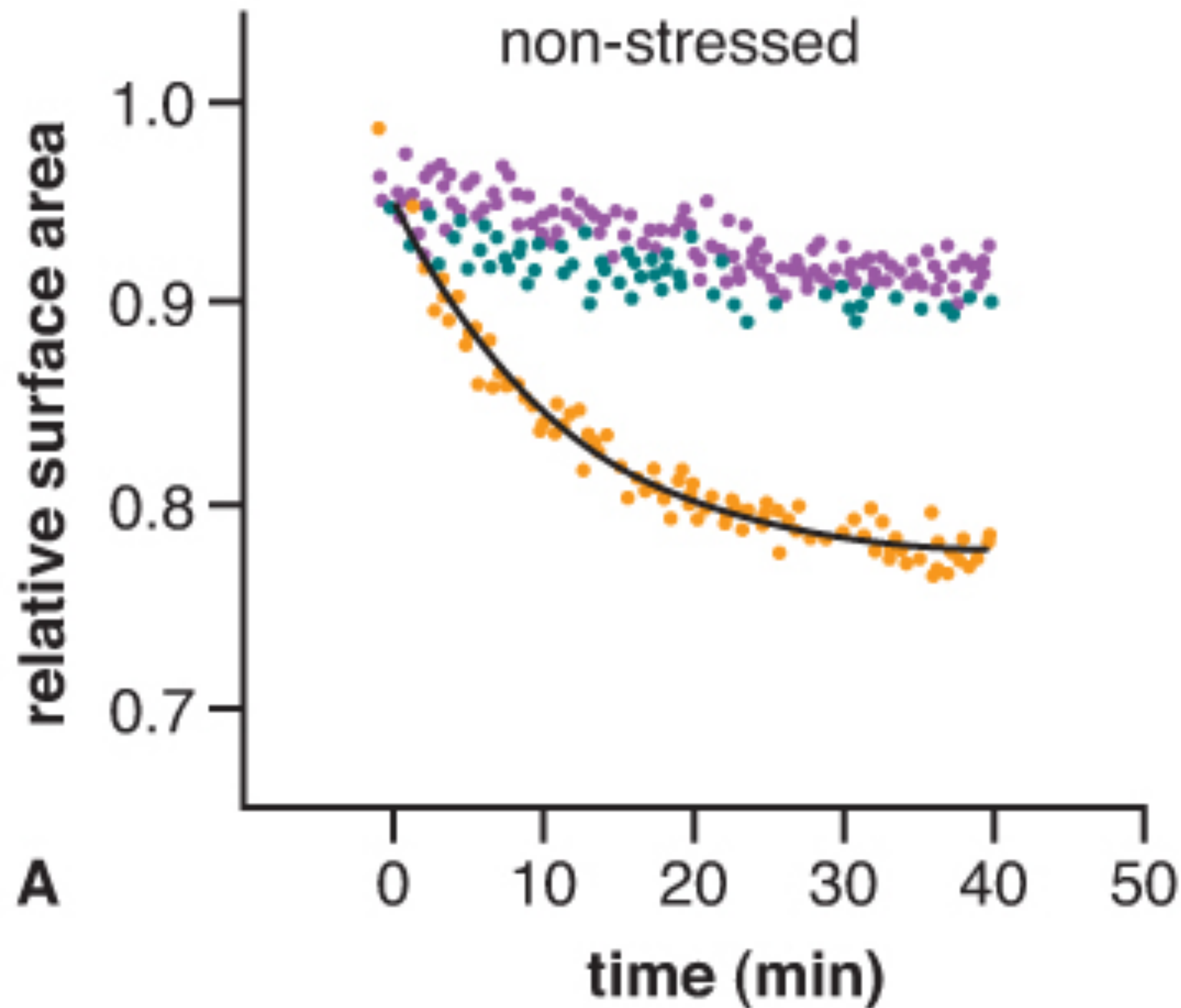
Molecular
Cellular
Organismal
Population
Ecological System

Five by Five Matrix of Biology



BioMath Exploration 4.2 (BME)

How fast is the vesicle size changing?

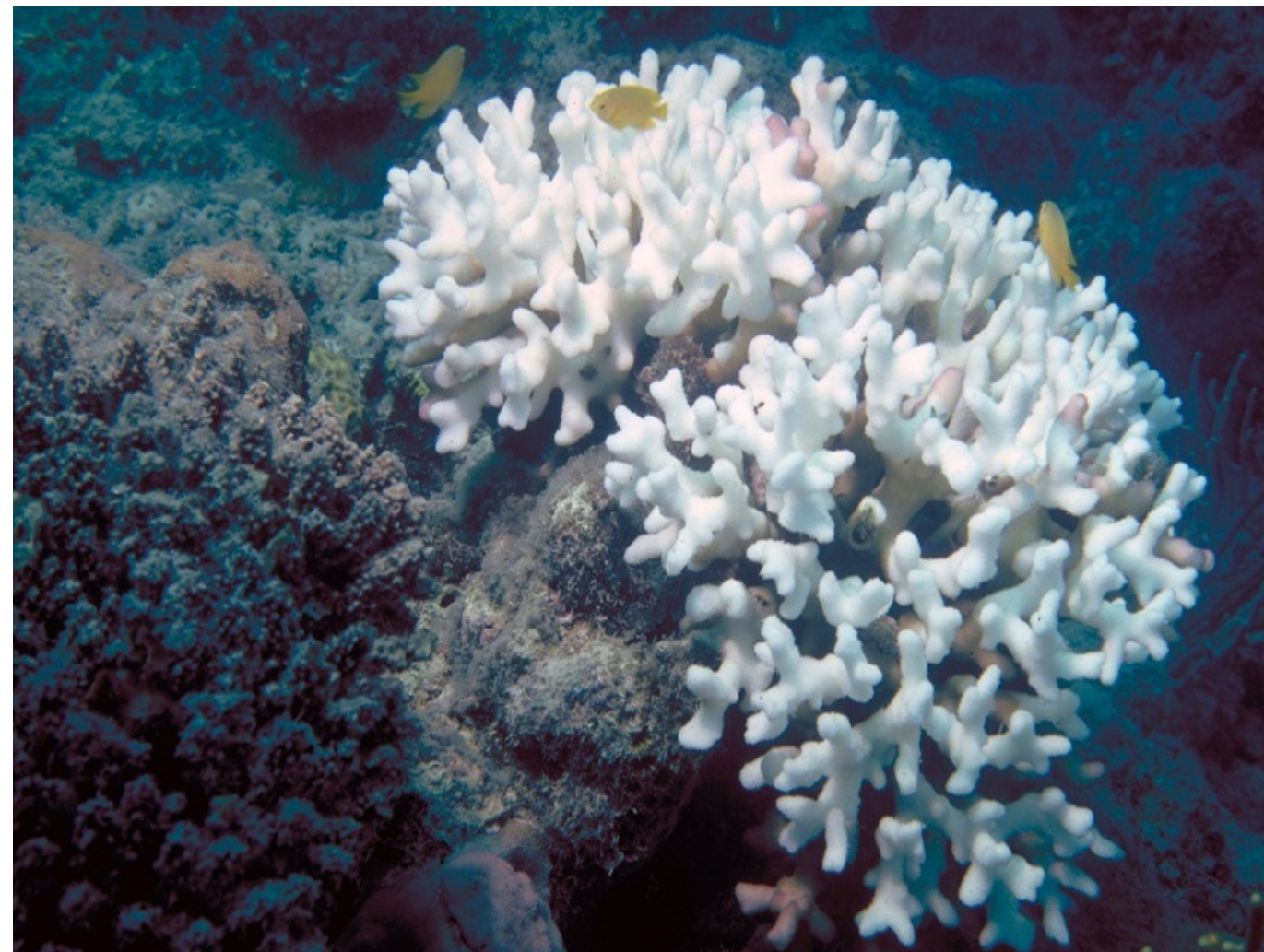


Ethical, Legal and Social Implications (ELSI)



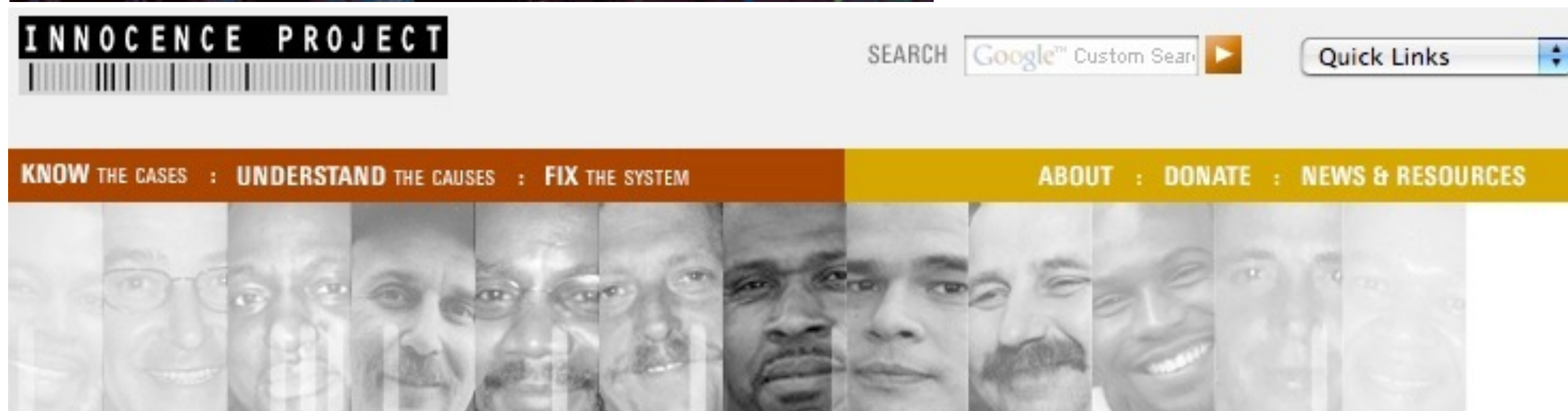
Are religion and evolution compatible?

Is science possible if you are uncertain about what is true?



Does basic biology have any impact on the real world?

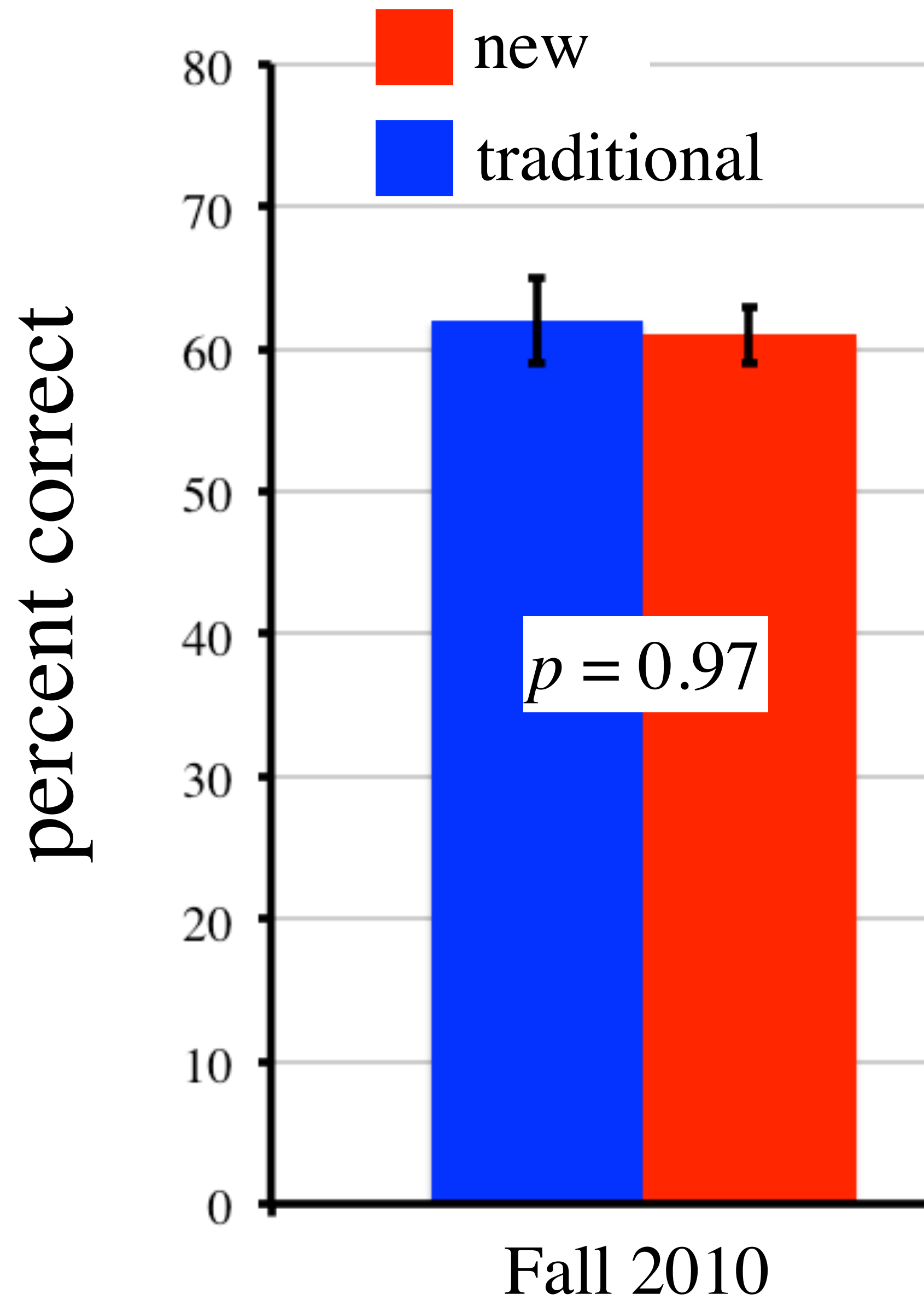
Who owns your DNA?



Hands-on Activity #1

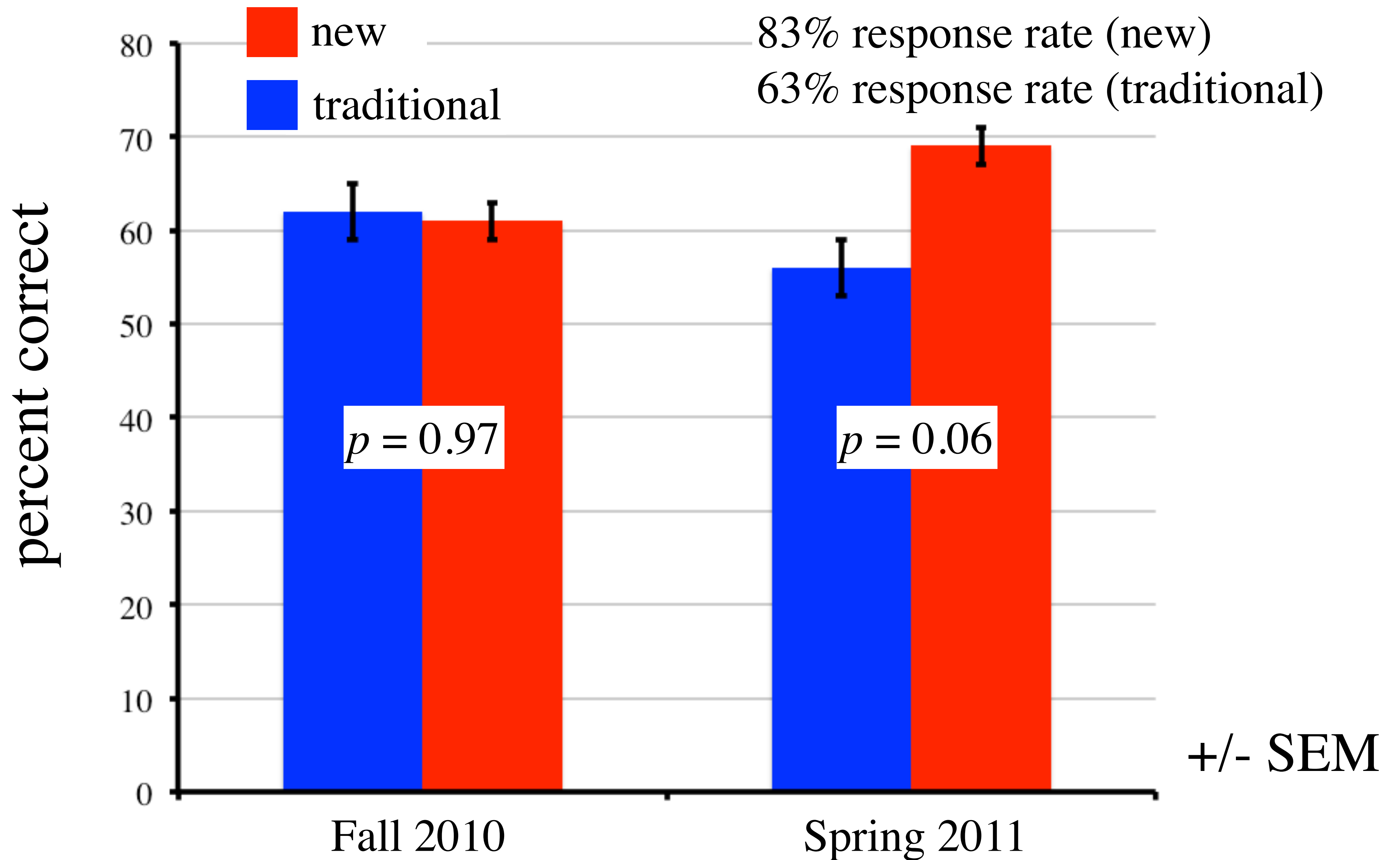
Did my students “learn less” content?

Core Concepts Assessment



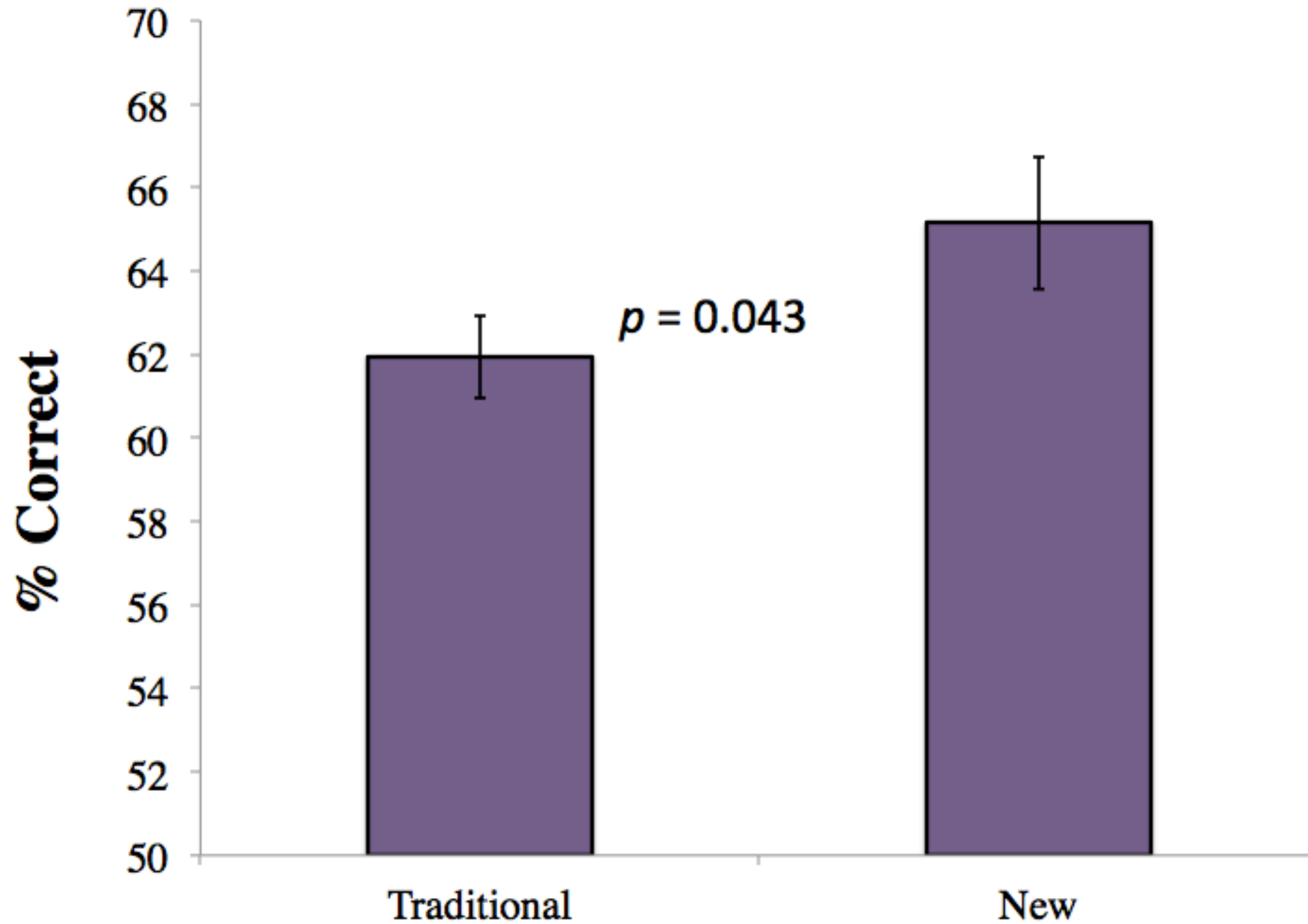
+/- SEM

Core Concepts Assessment

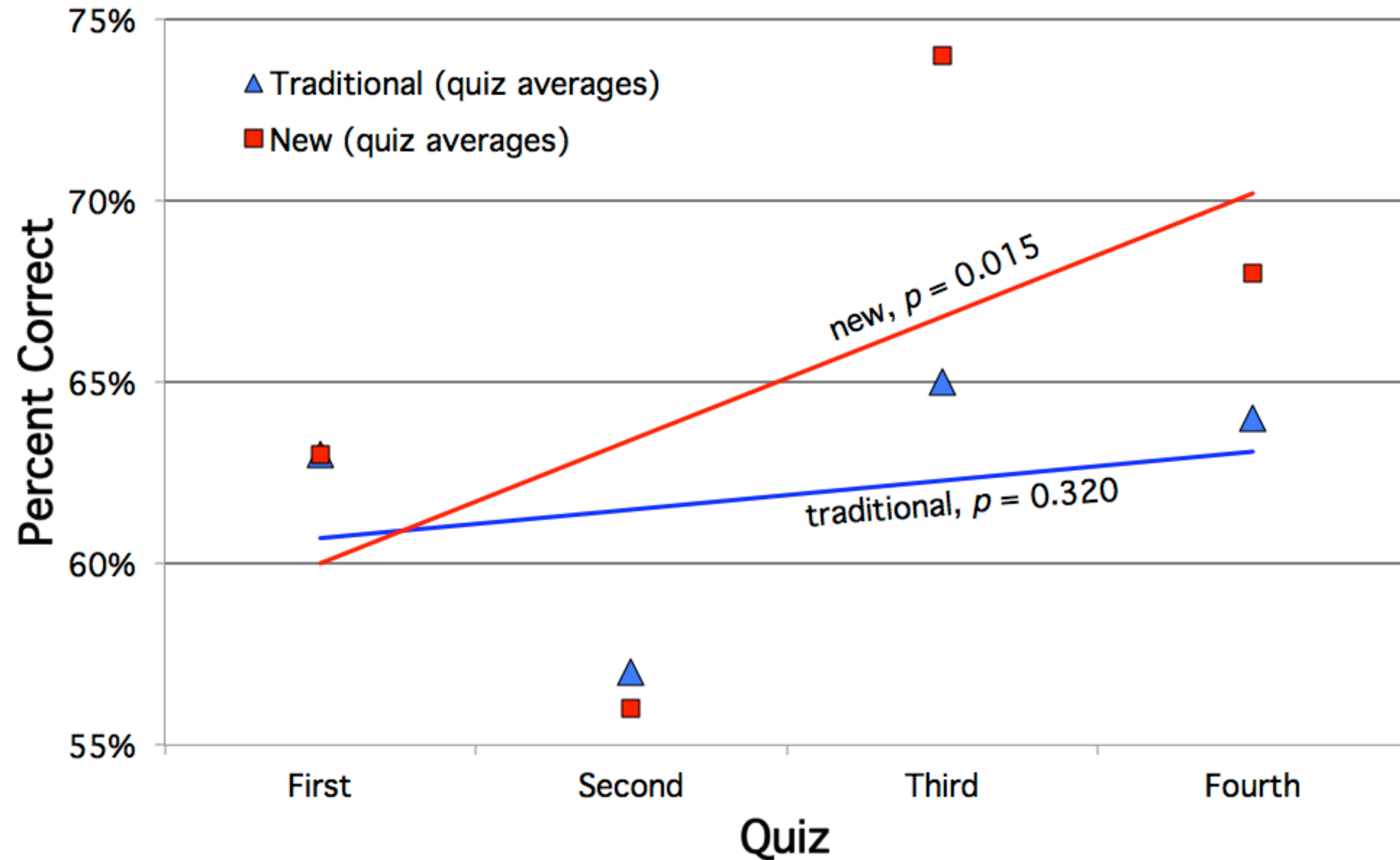


Can my students analyze data better?

Core Competency Assessment



Core Competency Assessment



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

no

* 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	
	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	yes!			
memorization	3.96	3.64	-1.48***	-0.08

* 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	yes!
big questions of biology already answered	1.71	1.50	-0.32*	+0.22	-0.33^	0.00	yes?
big/small division of biology describes nature	3.15	3.02	-1.08***	-0.06	-0.75**	-0.10	yes!
1-5 scale 5 = extremely important							yes!
memorization	3.96	3.64	-1.48***	-0.08	-1.27***	+0.23	

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

Hands-on Activity #2

Can introductory biology labs be more authentic?

A common criticism I had gotten for 16 years was the lecture and lab were “disconnected” or were “unrelated.”

When you do research in lab:

1. Has someone prepared data collection tables for you?
2. Does someone hand you all the controls you will need for the day?
3. Does someone else do all the creative thinking for you and you merely pipet?
4. Do you only work on one project until it is completed?
5. Is your research completed in 3 hours?

My educational goals for Intro Bio Lab

1. Employ a **scientific approach** to answering biological questions and test hypotheses.
2. **Design experiments** to test hypotheses, answer questions.
3. **Analyze experimental data** and reach logical conclusions.
4. Organize an **oral presentation** for sharing scientific information with peers.
5. Prepare a **written summary** of experiments designed, performed and analyzed personally.
6. Work on three overlapping labs: **discover new promoter**, **why mammals evolved bitter taste receptors**, and **evolution of antibiotic resistant bacteria**.

Major Changes I Made to Intro Bio Lab

1. Minimal lab manual

A. Malcolm Campbell

Bio 113 Labs

Bio113 Week 4

Before you come to lab

1) At 5:30 pm on the Wednesday before your lab, one person from each lab group MUST COME TO Dr. C's research lab (Dana room 221). Make sure to bring your protocol from last week of how to prepare the **oligos** for boiling.

3) Answer each of these four questions in two sentences or less.

A) How will you ligate your new promoter into a plasmid for testing?

B) What will the plasmid need to contain if you want to determine if your promoter is working?

C) How is fluorescence of red fluorescent protein (RFP) measured?

D) How is a spectrophotometer used to measure cell density in a population of *E. coli*?

NOTE: At 5:30 pm on the Wednesday before your lab, one person from each lab group MUST COME TO Dr. C's research lab (Dana room 221). Please be on time. We need to boil the **oligos** so we can ligate them tomorrow. See page 2 for details.

A. Malcolm Campbell

Bio 113 Labs

Week 4

Before you come to lab

1) The afternoon before lab, one person has already boiled **oligos** and let cool slowly overnight.

Information: Design and Build a New Promoter (an 8 week project)

In Lab: (Start lab at this point)

2) Do appropriate dilution ([step 9 of this protocol](#)) of boiled and cooled **oligos**. You will ligate your promoter into receiving plasmid J119137.

3) You have been provided two tubes of a master mix for GGA. It already contains the receiving plasmid J119137, the **BsaI** and the ligase. The volume is 9 μ L in each tube. You need one tube for your promoter (P) and one for a negative control (-). Add 1 μ L of your freshly diluted promoter to the P tube and 1 μ L water to the "-" tube. Label your tubes. Put them in the **thermocycler**. GGA is program name.

4) Transform cells (zippy competent JM109) with 3 different DNAs:

a) experimental ligation DNA (with your promoter **oligos** added = P)

b) ligation negative control DNA (water added, not promoter = -)

c) transformation positive control DNA(+ tube; [pLac promoter+RBS+RFP](#))

5) Plate each transformation on its own **LB+amp** plate.

6) Discuss as a group how to assay your promoter. How will test your promoter to know if it works the way you thought it would?

7) One person from each group will need to start the cells growing 4 pm next Wednesday the day before lab. Come to Dr. C's research lab on time.

Major Changes I Made to Intro Bio Lab

1. Minimal lab manual
2. Overlapping lab modules

9 weeks on promoters

8 weeks on taste receptor

7 weeks on antibiotic^R

Major Changes I Made to Intro Bio Lab

1. Minimal lab manual
2. Overlapping lab modules
3. CATME tool (CATME.org)



CATME
SMARTER Teamwork

Summary—Malcolm Campbell

Question Manager

Add New Class

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Show 10 entries

Search:

Class	Activity (Section)	Start	End	% Comp.	
Bio113	Week 15 Lab	2014-12-04	Released	<div style="width: 87%;"><div style="background-color: green; height: 10px;"></div></div> 87%	View Results
Bio113	Week 15 Lab (A)	2014-12-04	Released	<div style="width: 81%;"><div style="background-color: green; height: 10px;"></div></div> 81%	View Results
Bio113	Week 15 Lab (B)	2014-12-04	Released	<div style="width: 93%;"><div style="background-color: green; height: 10px;"></div></div> 93%	View Results
Bio113	Week 13 Lab	2014-11-20	Released	<div style="width: 71%;"><div style="background-color: green; height: 10px;"></div></div> 71%	View Results
Bio113	Week 13 Lab (A)	2014-11-20	Released	<div style="width: 75%;"><div style="background-color: green; height: 10px;"></div></div> 75%	View Results
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Bio113	Week 12 Lab (A)	2014-11-13	Released	<div style="width: 93%;"><div style="background-color: green; height: 10px;"></div></div> 93%	View Results
Bio113	Week 12 Lab (B)	2014-11-13	Released	<div style="width: 100%;"><div style="background-color: green; height: 10px;"></div></div> 100%	View Results
Bio113	Week 11 Lab	2014-11-06	Released	<div style="width: 93%;"><div style="background-color: green; height: 10px;"></div></div> 93%	View Results

Showing 1 to 10 of 49 entries

◀ Previous Next ▶

Promoter Research Using Golden Gate Assembly

Todd Eckdahl
MWSU



Eco RI

GAATTC

CTTAAG

palindrome

type II

Bsa I

GAGACC

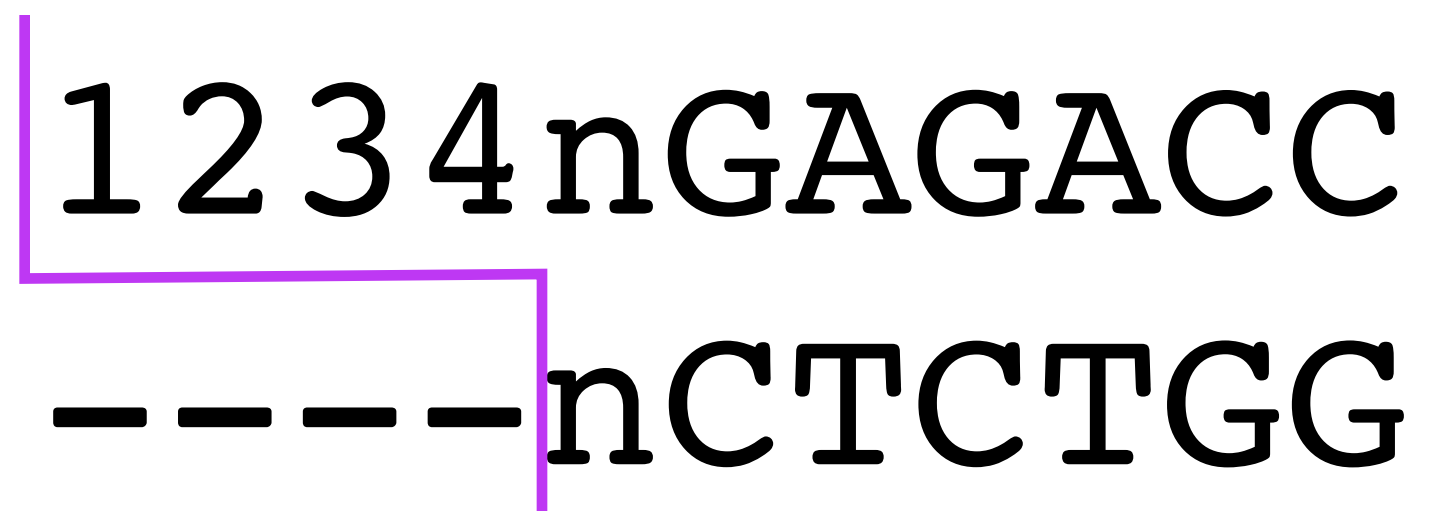
CTCTGG

not a
palindrome

type II

Bsa I

1 2 3 4 n G A G A C C
- - - - n C T C T G G

A diagram showing the recognition sequence for the Bsa I restriction enzyme. The top strand is 5'-1 2 3 4 n G A G A C C-3' and the bottom strand is 3'-- - - - n C T C T G G-5'. A purple line highlights the recognition sequence: a vertical line at position 1, a horizontal line from position 1 to 4, and a vertical line at position 4. The 'n' represents a variable number of nucleotides between the two recognition sites.

type II

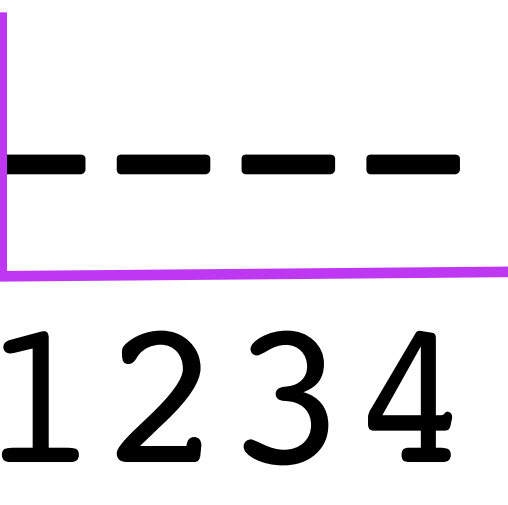
Bsa I

1 2 3 4 n G A G A C C
n C T C T G G

type II

Bsa I

GGTCTCn-----
CCAGAGn1234

A diagram showing the recognition sequence for Bsa I. The top strand is GGTCTCn----- and the bottom strand is CCAGAGn1234. A purple L-shaped line connects the end of the top strand to the start of the bottom strand, indicating a staggered cut. The cut on the top strand is between the 'n' and the first dash, and the cut on the bottom strand is between the 'n' and the '1'.

type II

Bsa I

GGTCTCn

CCAGAGn1234

type II

Bsa I

cuts
left

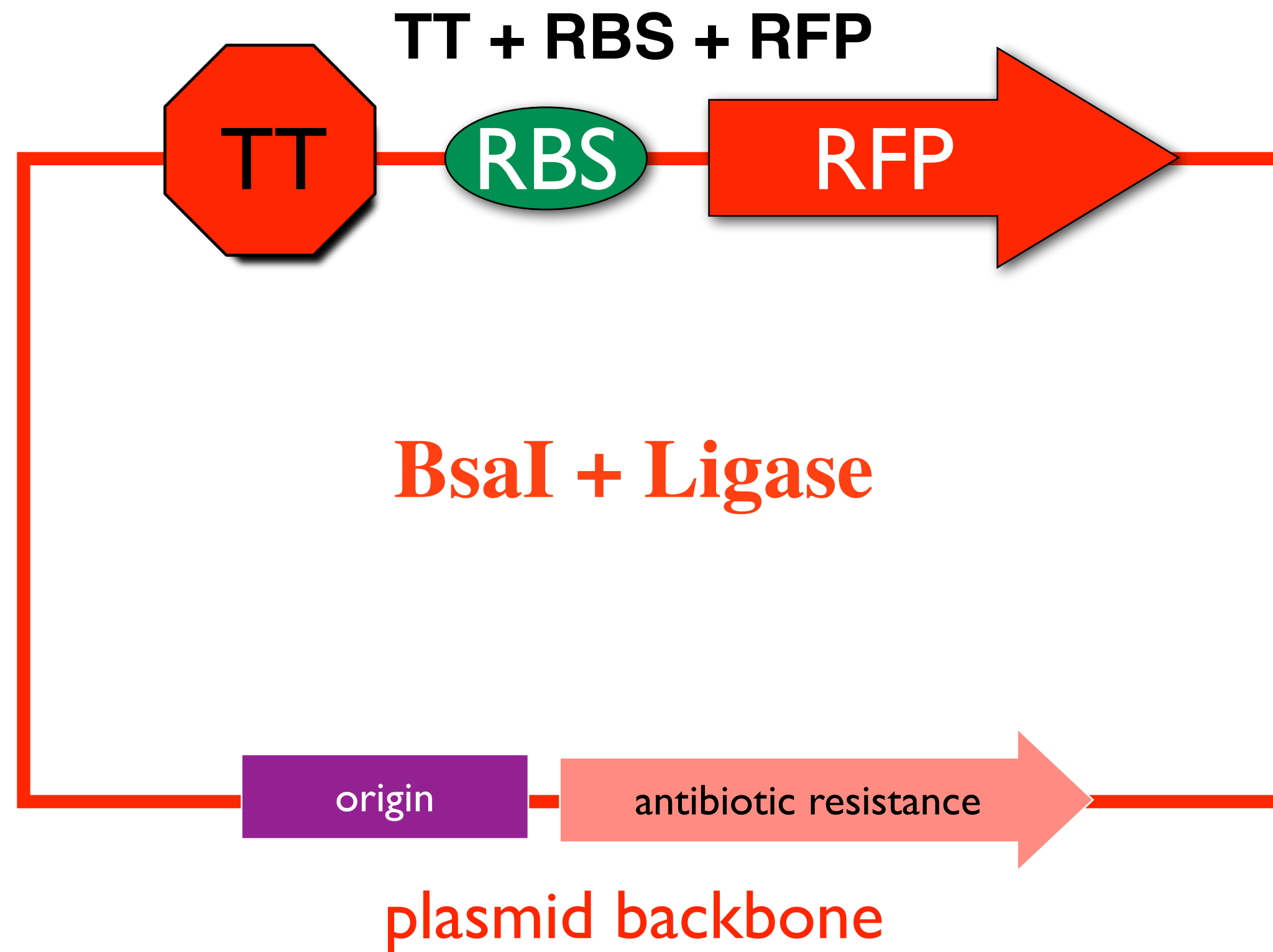
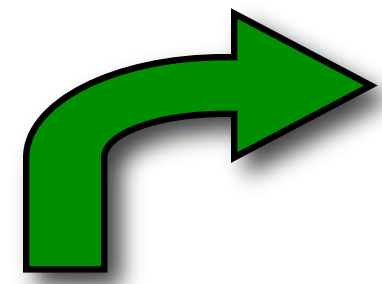
1 2 3 4 n GAGACC
-----n CTCTGG

GGTCTCn-----

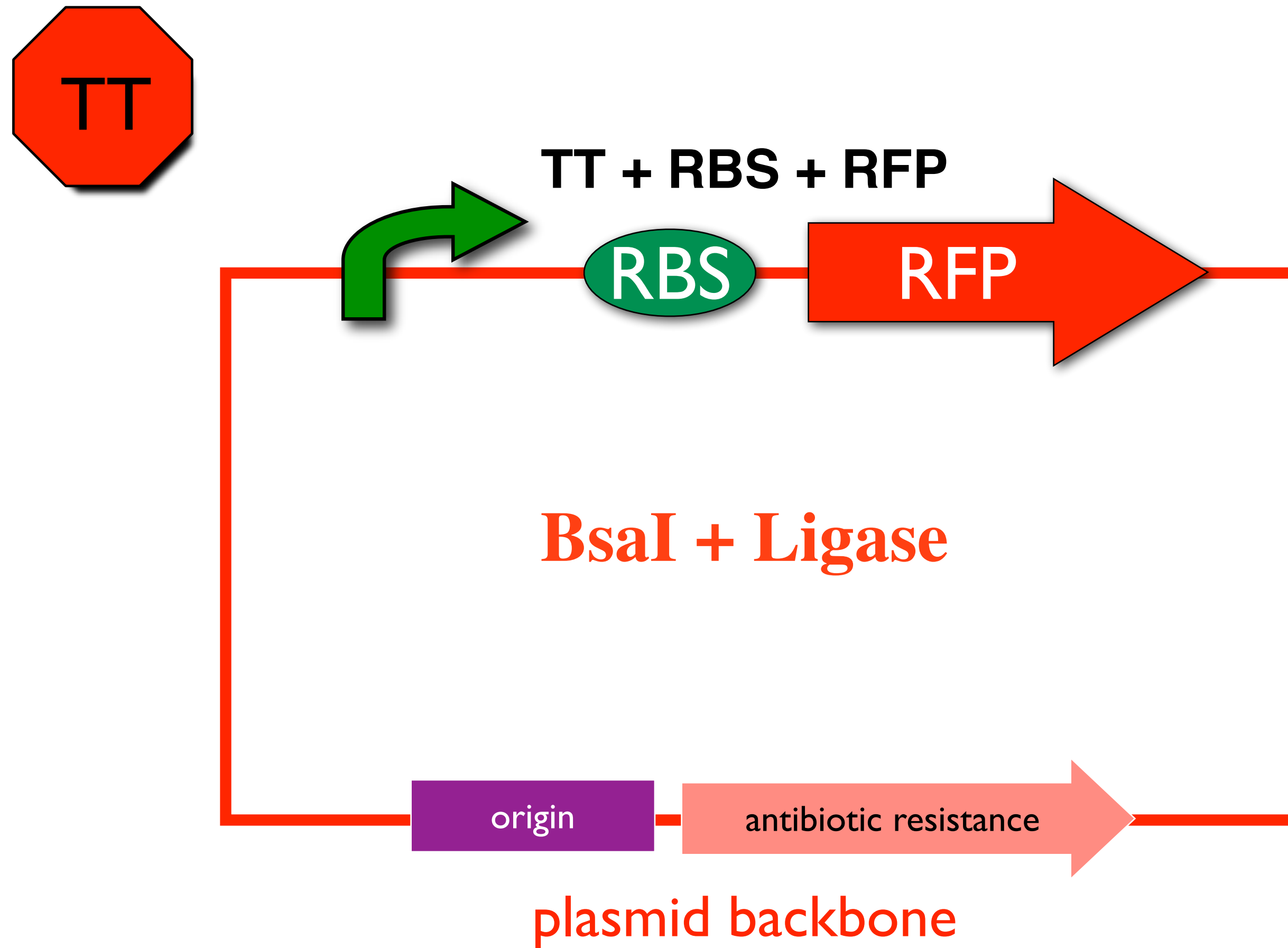
CCAGAGn 1 2 3 4

cuts
right

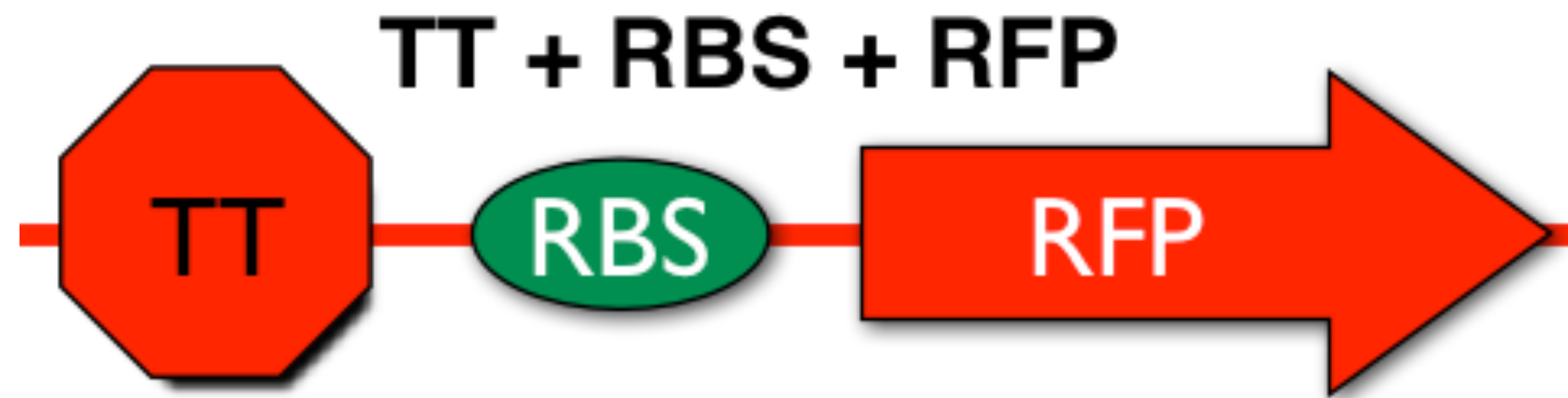
GGA Ligation Method - one step, one tube



GGA Ligation Method - one step, one tube

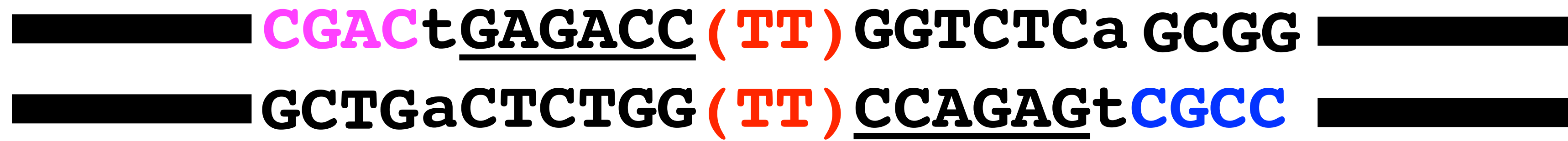


GGA Ligation Method - one step, one tube



GGA Ligation Method - one step, one tube

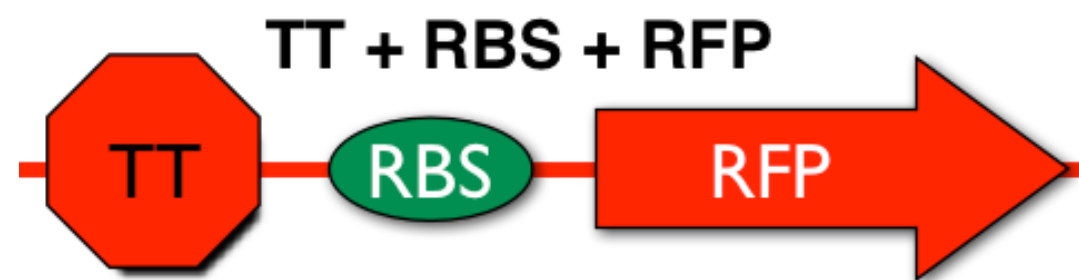
Bsa I



Bsa I

ligase

ligase



CGACtGAGACC (**TT**) GGTCTCa
aCTCTGG (**TT**) CCAGAGt**CGCC**

██████████
██████████ **GCTG**

ligase

GCGG ██████████
██████████

ligase



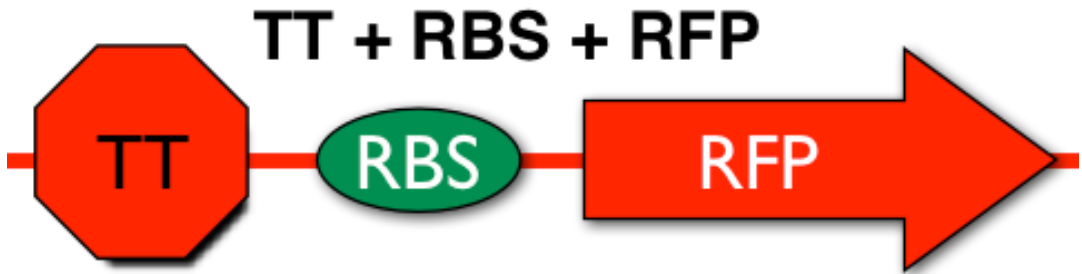
Bsa I

██████████ **CGAC** **t****GAGACC** **(TT)** **GGTCTCa** **GCGG** ██████████

██████████ **GCTGa****CTCTGG** **(TT)** **CCAGAG****t** **CGCC** ██████████

ligase

Bsa I ligase



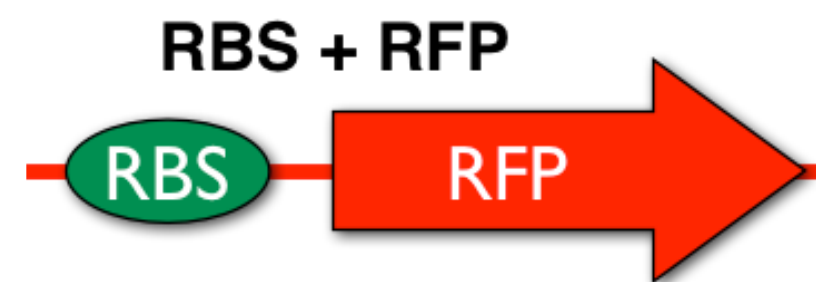
CGACtGAGACC (**TT**) GGTCTCa
aCTCTGG (**TT**) CCAGAGt**CGCC**

██████████
██████████ **GCTG**

ligase

GCGG ██████████
██████████

ligase



CGAC

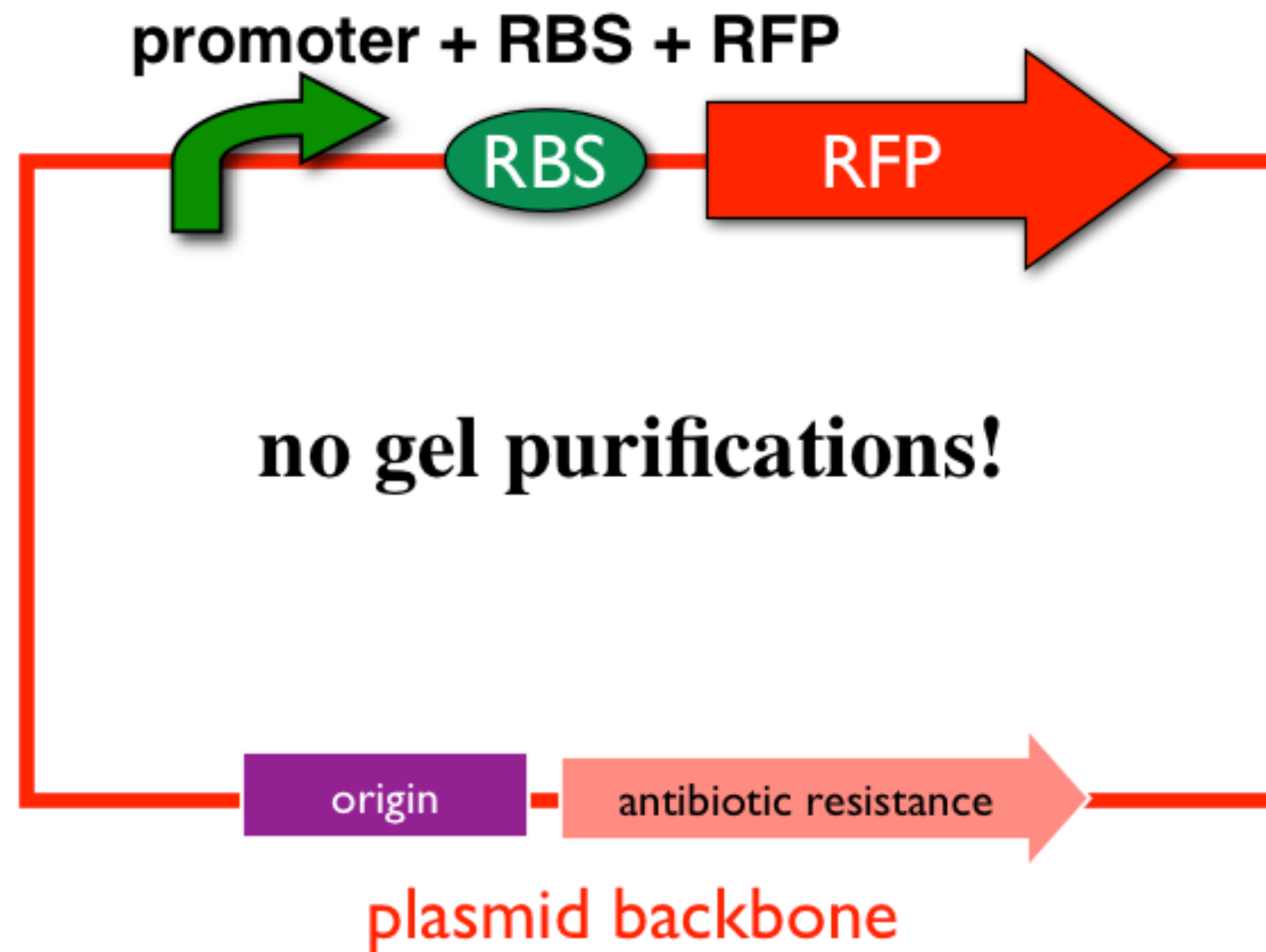
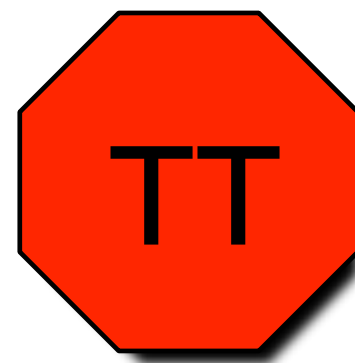
CGAC

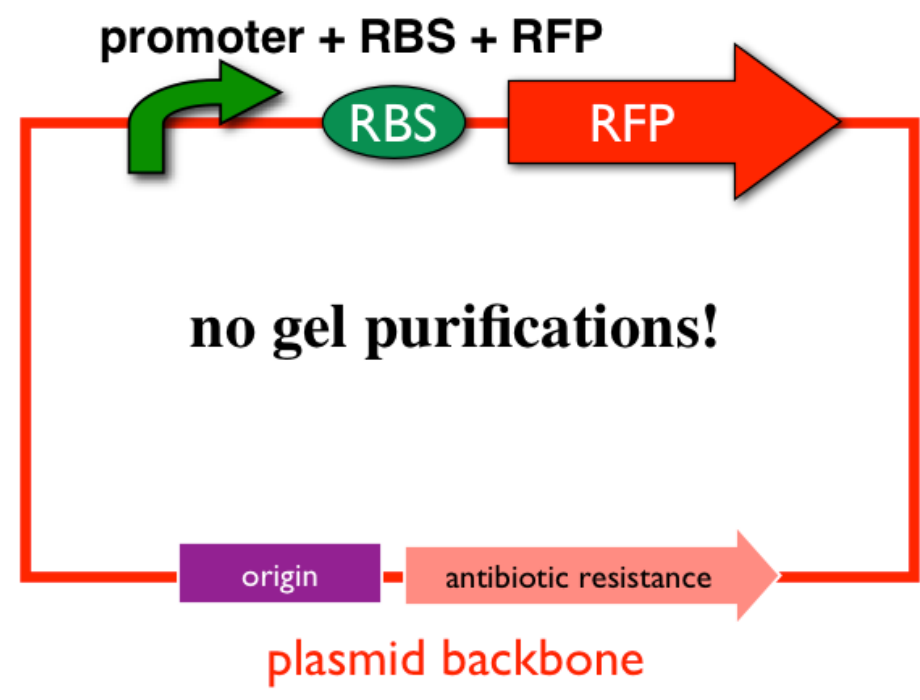


promoter + RBS + RFP

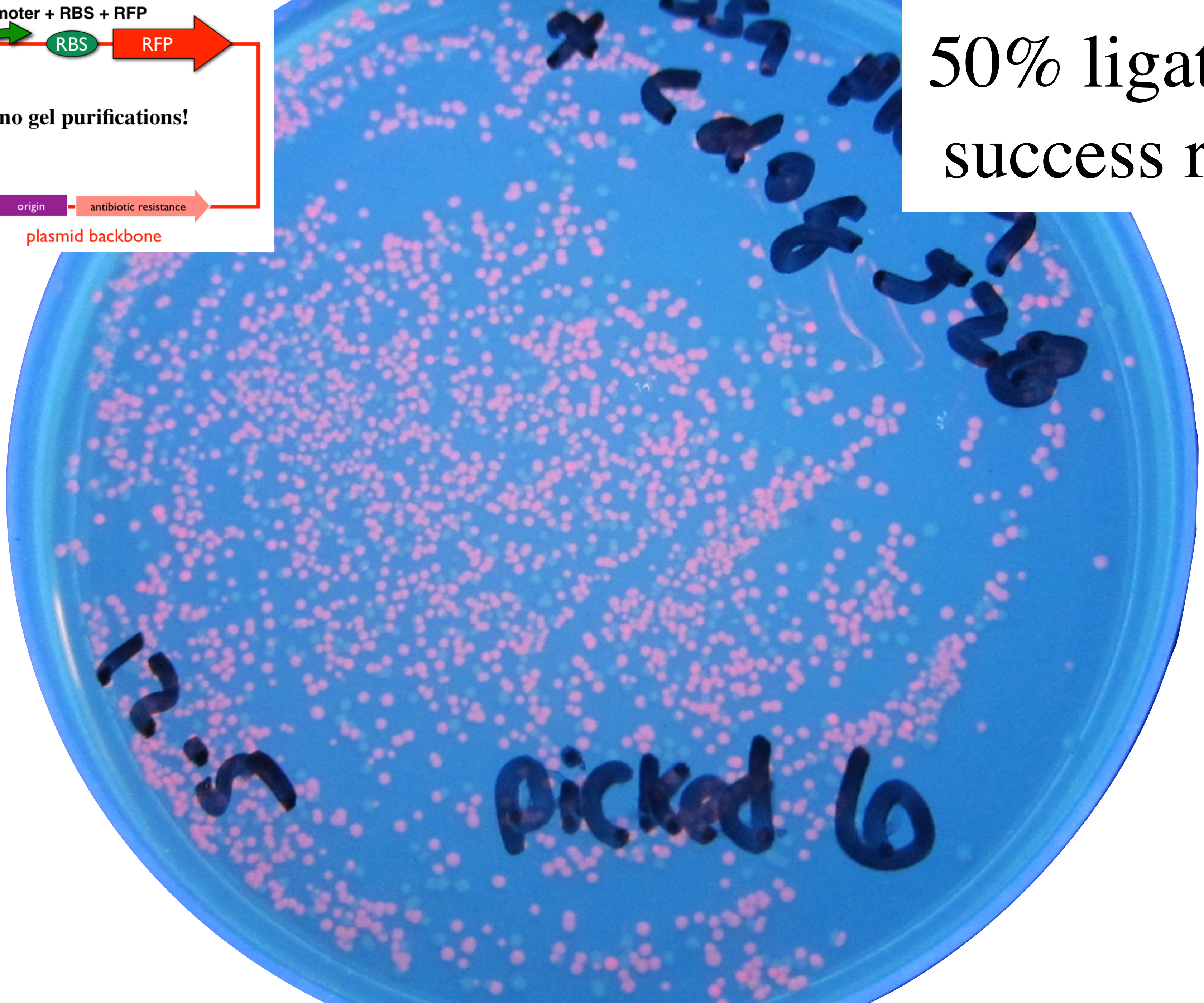


GGA Ligation Method - one step, one tube

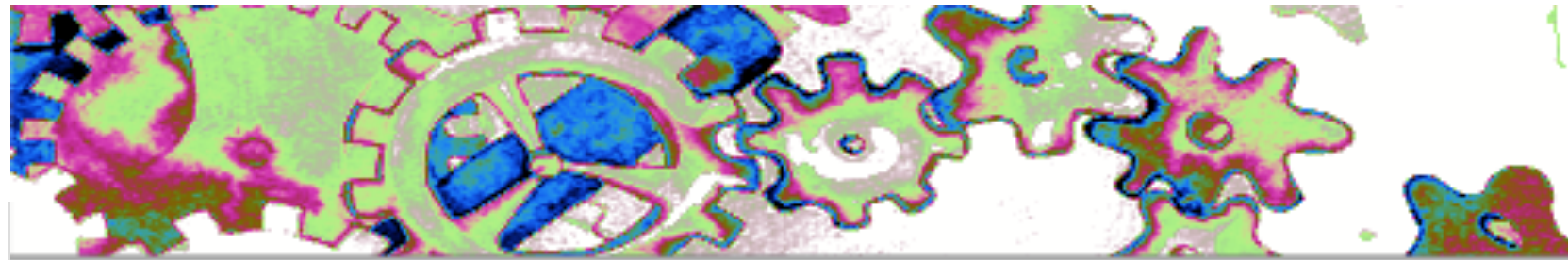




50% ligation
success rate




Student Sample, September 2012



Registry of Standard Biological Parts

	BBa_J100067	Regulatory	fadB promoter (long sequence)	Meredith Nakano	85
	BBa_J100068	Regulatory	fadB promoter (short sequence)	Meredith Nakano	61
	BBa_J100069	Reporter	Superfolder GFP	Rebecca Evans	770
	BBa_J100070	Coding	Superfolder GFP	Rebecca Evans	720
	BBa_J100071	Regulatory	cadA promoter	Ben Clarkson	334
	BBa_J100072	Regulatory	LcpxP promoter--Long cpxP promoter	Ben Clarkson	392
	BBa_J100073	Regulatory	ScpxP--Short cpxP promoter	Ben Clarkson	94
	BBa_J100074	Regulatory	Long pLux Promoter	Betsy Gammon	197
	BBa_J100075	Regulatory	CydAP1 Long Promoter	Betsy Gammon	158
	BBa_J100076	Regulatory	CydAP1 Short Promoter	Betsy Gammon	151
	BBa_J100077	Composite	J10068:K0903005	Meredith Nakano	793
	BBa_J100078	Composite	J100067:K0903005	Meredith Nakano	817
	BBa_J100079	Device	Riboswitch and GFP	Rebecca Evans	879
	BBa_J100080	Device	Riboswitch and GFP	Rebecca Evans	882
	BBa_J100081	Reporter	J100071+E0240	Ben Clarkson	334
	BBa_J100082	Reporter	J100072+E0240	Ben Clarkson	1276
	BBa_J100083	Composite	LuxI Long + RBS + GFP	Betsy Gammon	1081
	BBa_J100084	Composite	CydAP Long + RBS + GFP	Betsy Gammon	1042
	BBa_J100085	RNA	short CRISPR sequence with GFP target spacer	Caroline Vrana	240
	BBa_J100086	Composite	CydAP Short Promoter + RBS + GFP	Betsy Gammon	1035
	BBa_J100087	Reporter	J100073+E0240	Ben Clarkson	978
	BBa_J100088	Generator	J100071+J10063	Ben Clarkson	2965
	BBa_J100089	Generator	J100072+J10063 (LcpxP+LRE, Luciferase)	Ben Clarkson	3023
	BBa_J100090	Regulatory	CRISPR sequence with GFP and AmpR targets	Caroline Vrana	412
W	BBa_J100092	Regulatory	Constitutive promoter for M1-162	Natalie Spach	50
?	BBa_J100093	Regulatory	rrnB P1 promoter	Kayla McAvoy	60
?	BBa_J100094	Regulatory	Lac promoter E. Coli	Cameron Bard	44
?	BBa_J100095	Regulatory	malE1 Maltose induced promoter.	Pooja Potharaju	65
	BBa_J100096	Regulatory	PBAD Promoter from araE Gene	Elizabeth Brunner	27
W	BBa_J100097	Regulatory	Anhydrotetracycline inducible promoter with BsaI sticky ends	Sarah Kim	55
	BBa_J100098	DNA	Promoter for the argF gene	Erin Nieuwma	44
W	BBa_J100099	Regulatory	A promoter (CydAB) activated by the FNR enzyme	Phoebe Parrish	64

Student Sample, September 2012



Registry of Standard Biological Parts


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[BBa J100099 Main Page](#) [Part Design](#) [Physical DNA](#) [Hard Information](#) [Experience](#) [Tools](#)

Part:BBa_J100099

Designed by Phoebe Parrish Group: Campbell_M_Lab (2012-09-13)

 [DNA Planning](#)
[Experience: Works](#)
[Get This Part](#)

A promoter (CydAB) activated by the FNR enzyme

The promoter, CydAB, was found to be activated by the FNR enzyme, which is induced by the presence of $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2$ and ascorbate. The oligo includes both CydAB, the FNR binding site, and the sticky ends needed for the Golden Gate Assembly method.

Sequence and Features

Format:	Subparts	Ruler	SS	DS	Search:	Length: 64 bp	Context: Part only	Get selected sequence	
1	11	21	31	41	51	61	71	81	91
1	ggaattgata tttatcaatg tataagtctt ggaaatgggc atcaaaaaga gataaattgt tctc								
	FNR binding			-35		-10			

Assembly Compatibility: [10](#) [12](#) [21](#) [23](#) [25](#)

Jeffrey Green. 1993. "Activation of FNR-dependent transcription by iron: An in vitro switch for FNR." FEMS Microbiology Letters 113 (1993) 219-222

[\[edit\]](#)

Student Sample, September 2012

Part:BBa_J100099:Experience

Designed by Phoebe Parrish Group: Campbell_M_Lab (2012-09-13)



DNA Planning

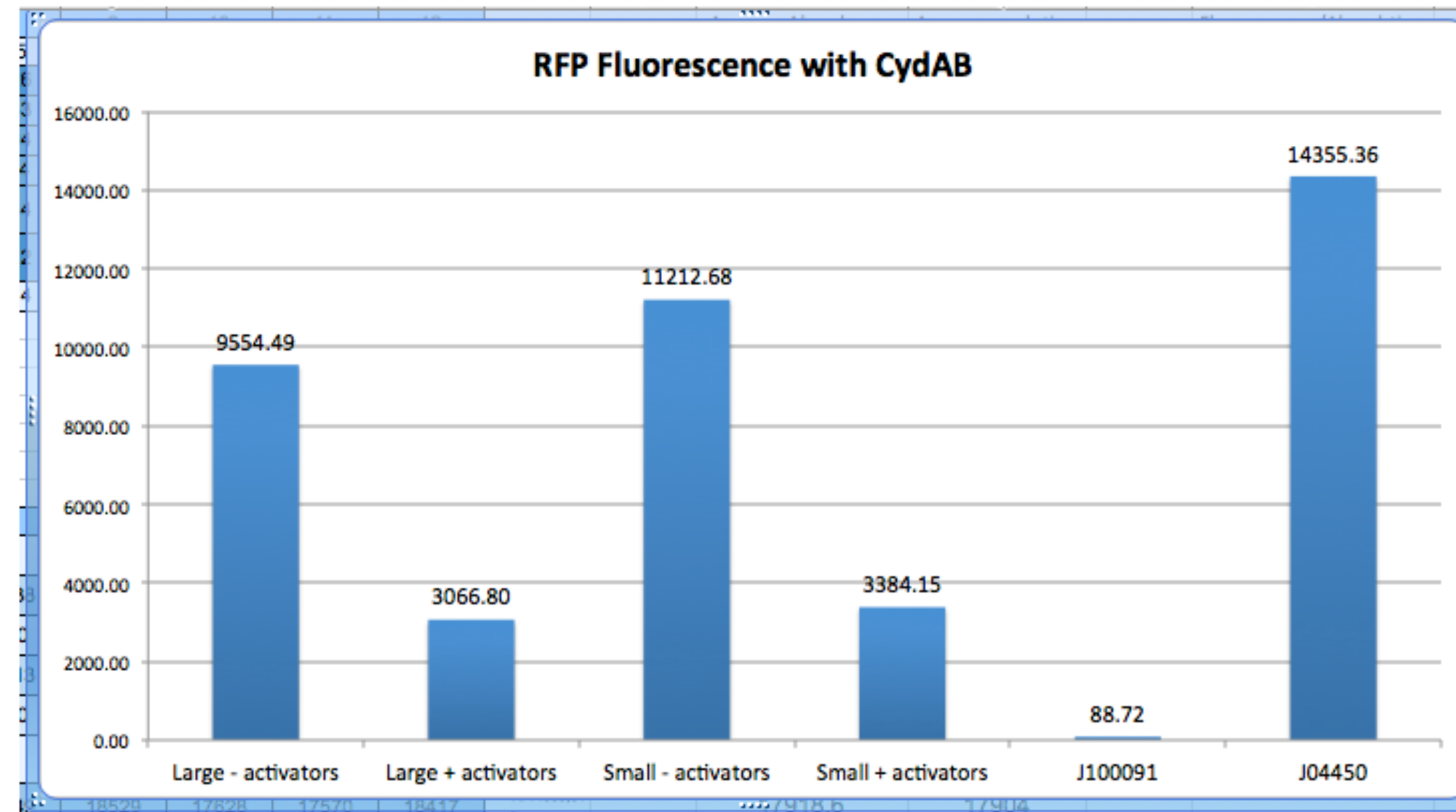
Experience: Works

[Get This Part](#)

This experience page is provided so that any user may enter their experience using this part. Please enter how you used this part and how it worked out.

Applications of BBa_J100099

We pipetted 200 microliters of one solution containing E coli cells from a small colony and the activators, one with cells from a small colony and no activators, one containing cells from a large colony and the activators, and one containing cells from a large colony and no activators. We also did a positive control with E coli cells containing a known promoter that causes red florescence (J04450) and a negative control with cells containing a the transcriptional terminator that does not cause red florescence (J100091). We tested both fluorescence of our samples using a fluorometer and the light absorbance using a spectrophotometer. We measured the fluorescence and absorbance of five samples of each solution, including a control solution that just contained the growth medium. We averaged the values for each solution and subtracted the average fluorescence/absorbance of the control. We then divided the average fluorescence by the average absorbance for each solution. These values are displayed on the accompanying graph.



Registry of Functional Promoters (RFP)

Registry of Functional Promoters (v1.0)

Welcome to the Registry of Functional Promoters

This Registry of Functional Promoters was developed by Bill Hatfield, Laurie J. Heyer, A. Malcolm Campbell at Davidson College and Todd Eckdahl of Missouri Western State University, through the support of HHMI grant 52006292 ([GCAT main page](#)) and is freely available for others to use though no support other than the user manual is available.

If you are already a Registered User of GCAT-alog, you do not need to Reregister

[LOGIN](#) [REGISTER AS NEW USER](#)

- For comments or questions about this website contact, [Malcolm Campbell](#)

gcat.davidson.edu/RFP/

Registry of Functional Promoters (RFP)

Registry of Functional Promoters (v1.0)

SEARCH

Search by Entry Number

Entry Number Use ", " for multiple entries, "-" for range

Search Criteria

OR AND Promoter Name

OR AND Part Number

OR AND Sequence

OR AND Length

OR AND Criterion

OR AND Species of Origin:

OR AND Constitutive Regulated

OR AND RBS Used for Testing:

OR AND ORF Used for Testing:

OR AND Plasmid Used for Testing:

OR AND *E.coli* Used for Testing:

OR AND Media Used for Testing:

OR AND Comparison Construct:

OR AND Comparison Plasmid:

OR AND *E.coli* Used for Comparison Construct:

OR AND Media Used for Comparison Construct:

OR AND Fold Difference From Comparison:

OR AND Comment

OR AND Direction: Forward Reverse

OR AND Status: Works Not Working Iffy

gcat.davidson.edu/RFP/

Registry of Functional Promoters (RFP)

Registry of Functional Promoters (v1.0)
SEARCH PROMOTER RESULTS

Entry No.	Promoter Name	Part Number	Sequence	Length	Citation	Species of Interest	Constitutive/Regulated	Inducible/Repressible	Regulator	RBS Used for Testing	ORF Used for Testing	Plasmid Used for Testing
1	TetR Repressible Promoter	R0040	tcctatcagtgatagagattgacatccctatcagtgatagagatactgagcac	54			Regulated	Repressible	TetR			pSI
2	56 bp LacI Promoter	K091110	cgttgacaccatcgaatggcgcaaaaccttccggtatggcatgatagcgccgg	56			Constitutive					
3	200 bp LacI Promoter	R0010	caatacgcaaacgcctctccccgcgcttgccgattcattaatgcagctggcac gacaggttcccactggaaagcgggcagtgagcgcaacgcaattaatgtgagtt agctcactcattaggcaccagggtttacactttatgcttccggctcgtatgtgtg ggaattgtgagcggataacaattcacaca	200			Constitutive					
4	LuxR & HSL Regulated Lux promoter	R0062	acctgtaggatcgtacaggttacgcaagaaaatggtttgatagtcgaataaa	55			Regulated	Repressible				
5	Backwards 200 LacI Promoter (right to left)	J31013	tgtgtgaattgtatccgctcacaattccacacaacatacagccggaagcataaa gtgtaaagcctggggtgcctaataatgagtgagctaacacattaattgcgttgcgctc actgcccgttccagtcggaaacctgctgtgccagctgcattaatgaatcgcca acgcgccccggagaggcggtttgcgtattg	200			Regulated	Repressible				
6	OmpC Promoter	K199017	tttacatttgaacatctatagcgataaatgaacatcttaaaagttttagtatcatattc gtgttgattattctgcattttgggagaatggact	99			Constitutive					
7	23K series very strong constitutive Promoter	J23100	ttgacggctagctcagtcctaggtacagtgctagc	35			Constitutive					

To Edit an Entry, Enter the Entry # and press "Edit Entry"

To Delete an Entry, Enter the Entry # and press "Delete Entry"

[Search Again](#)

Testing Known Promoters: Ptac



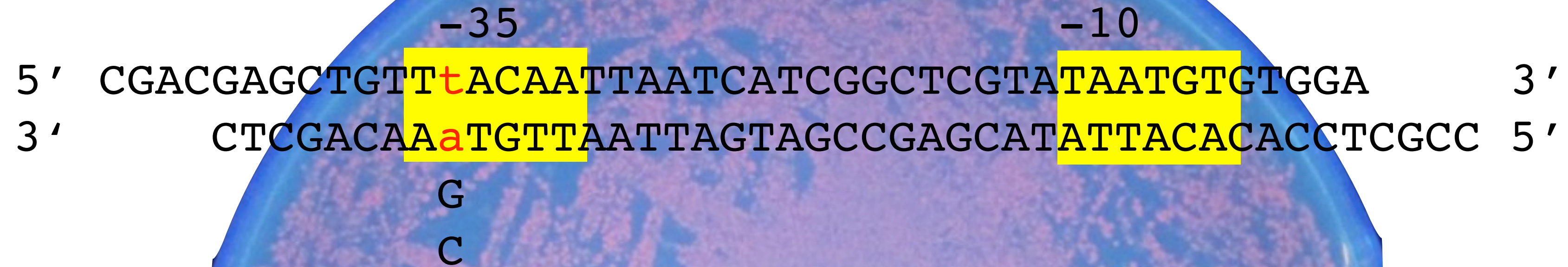
A petri dish containing a bacterial culture on a blue agar surface. The surface shows a central zone of dense growth and several smaller, irregular colonies scattered around it. Handwritten in blue ink on the agar are the words "EB amp oligos Ptac" at the top, "20 cyes" on the right, and "P100" on the left. The numbers "-35" and "-10" are printed above the DNA sequence.

-35 -10

5' CGACGAGCTGTTGACAATTAATCATCGGCTCGTATAATGTGTGGA 3'

3' CTCGACAACCTGTTAATTAGTAGCCGAGCATATTACACACCTCGCC 5'

Student Sample, November 2012



Student Sample, November 2012

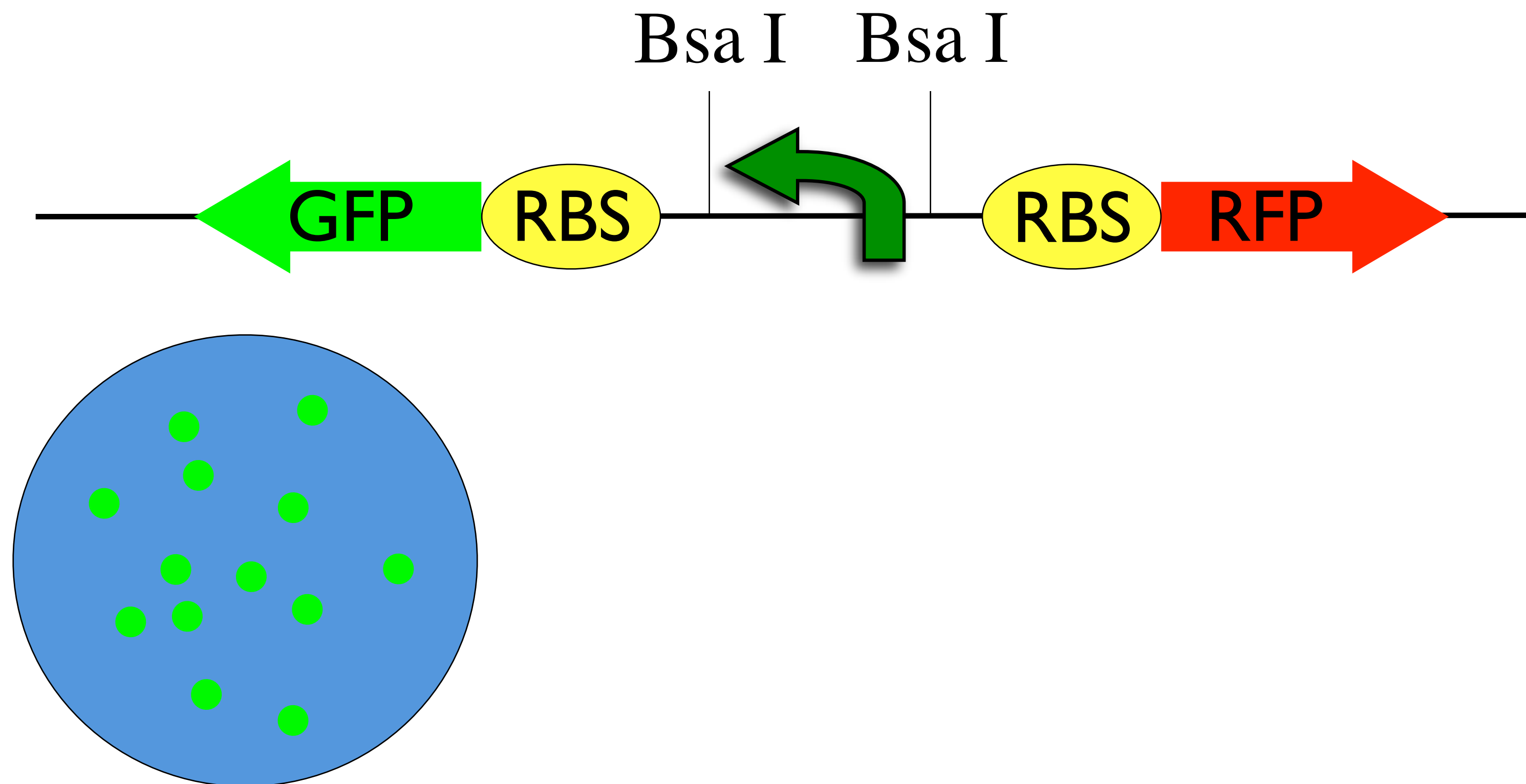
TBA

-35 ATAA (deleted) -10

5' CGACGAGCTGTTGACA-----ATCATCGGCTCGTATAATGTGTGGA 3'
3' CTCGACAACTGT-----TAGTAGCCGAGCATATTACACACCTCGCC 5'

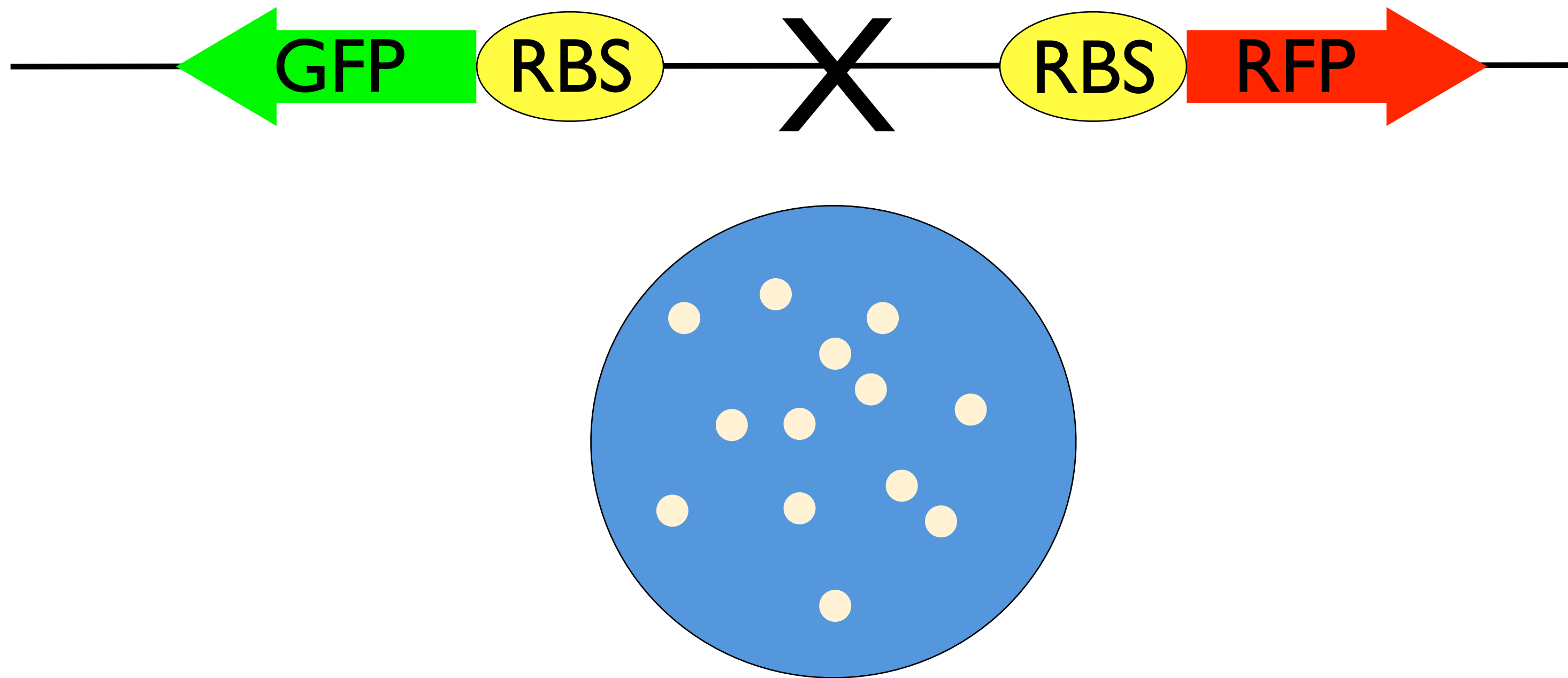
11-7-12

pClone Red J119137



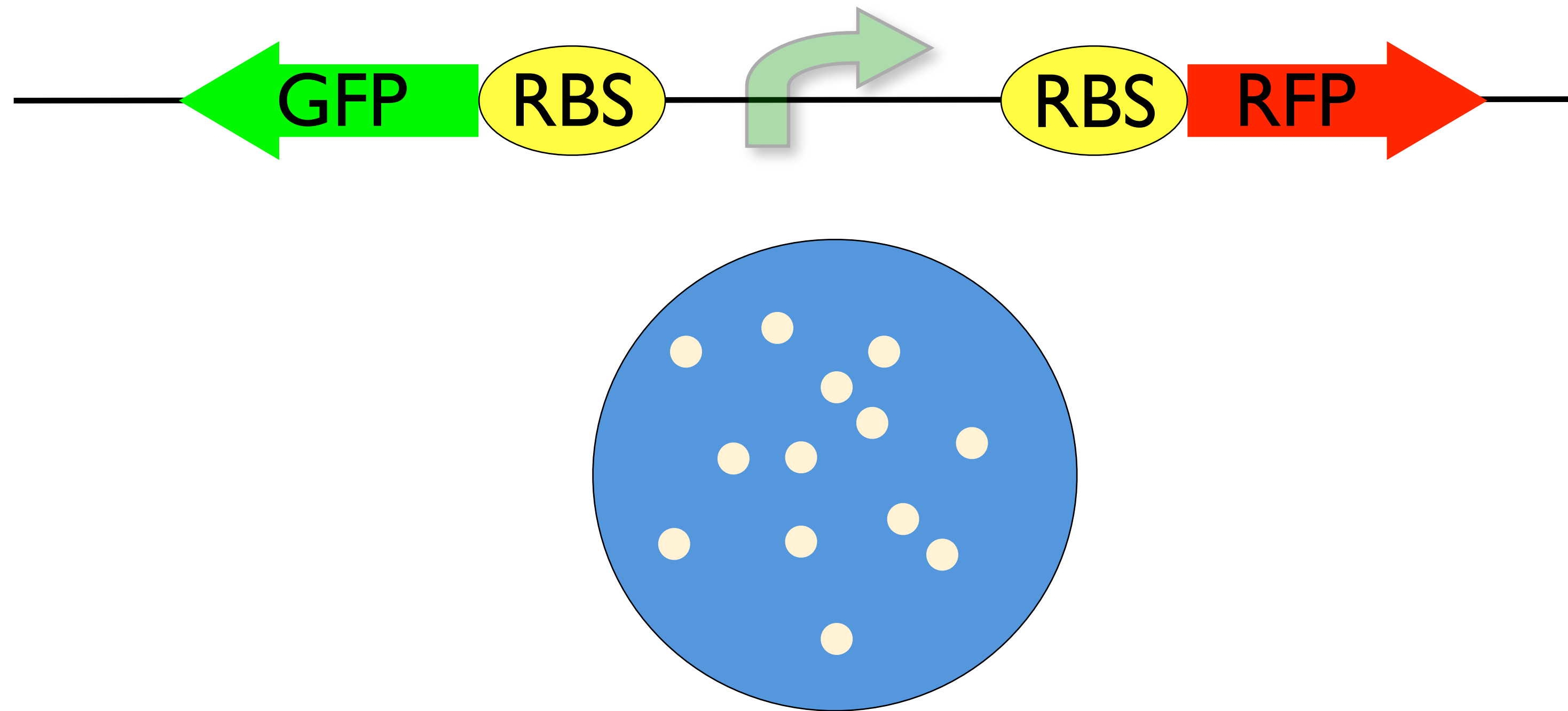
Remove Initial Promoter

J119137



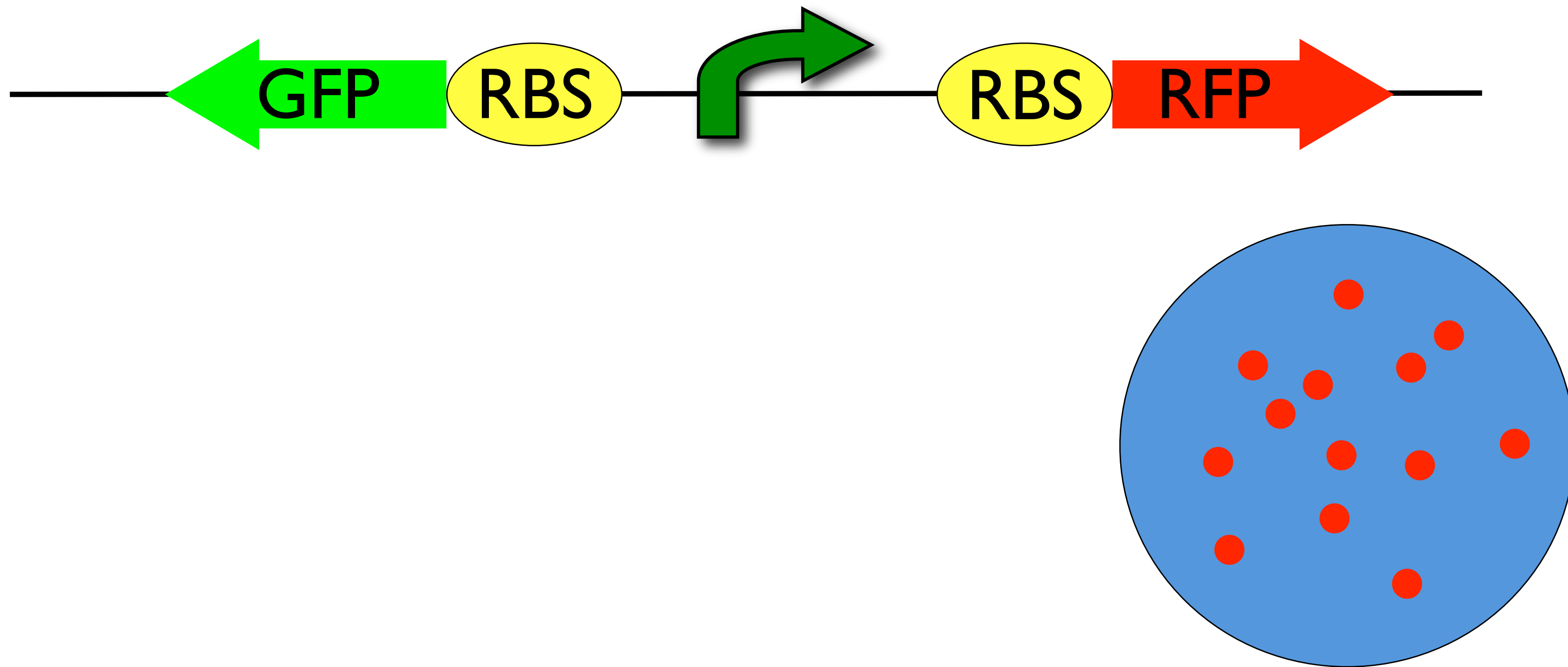
Insert Non-functional Promoter

J119137

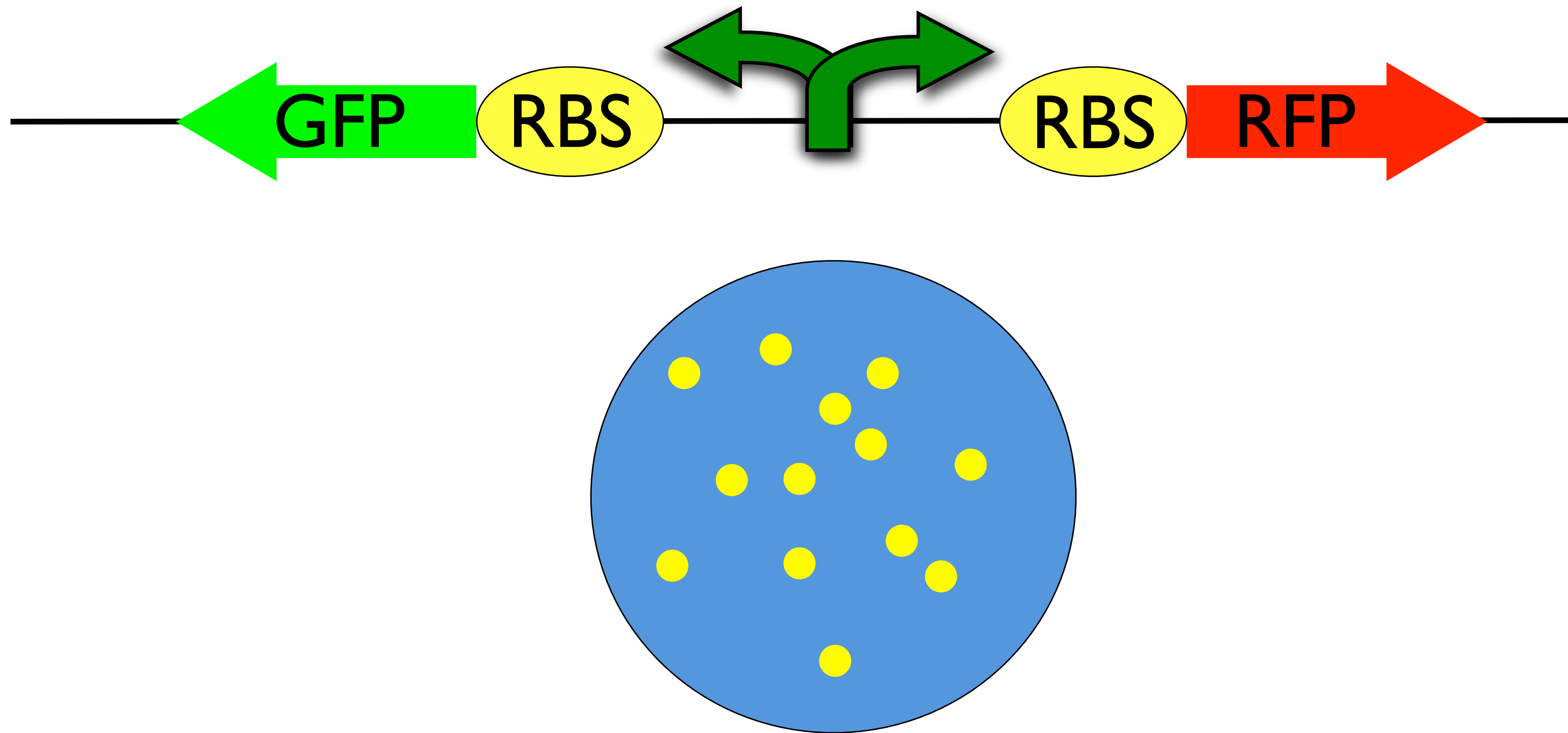


Insert Forward Promoter

J119137



Insert Bi-directional Promoter J119137



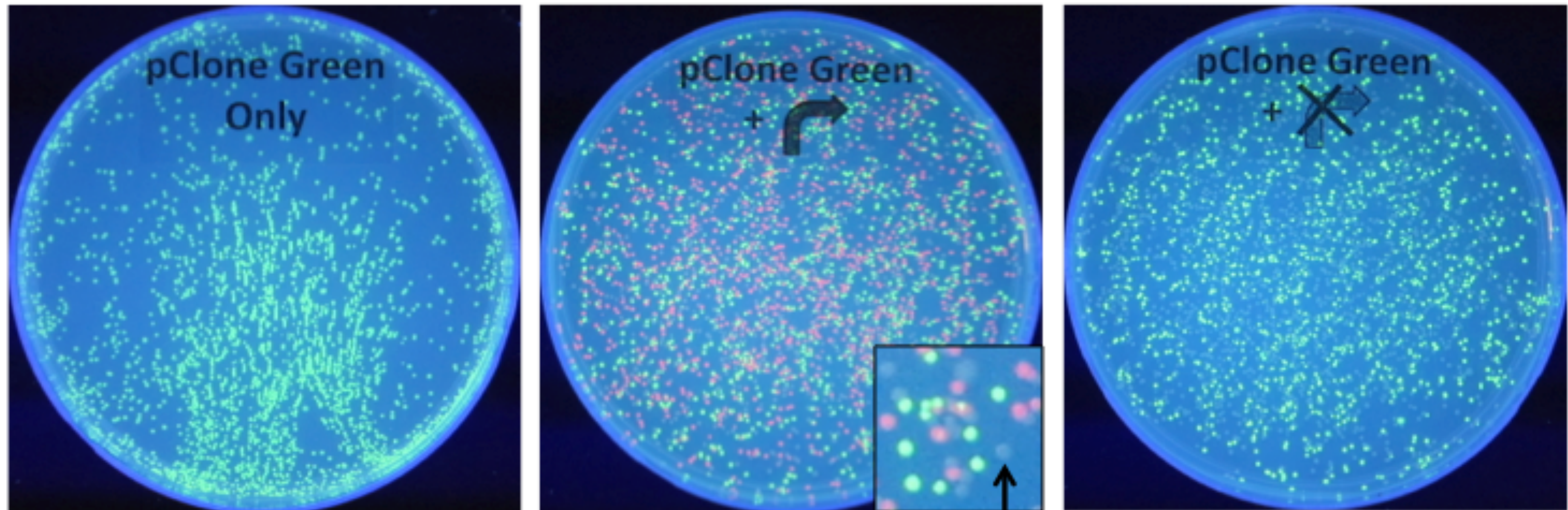
pClone Red J119137

A

pClone Red

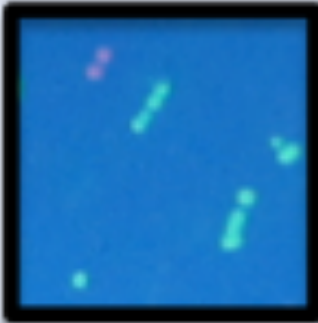
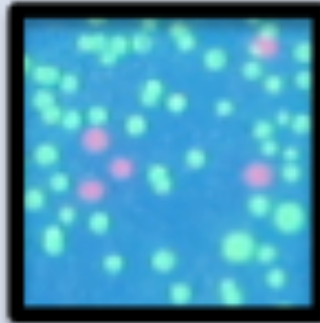
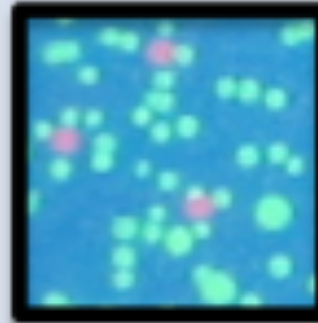
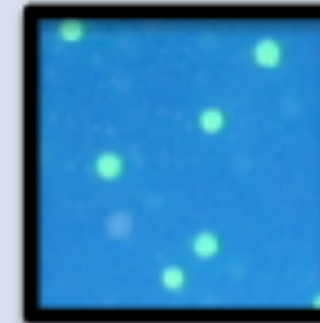
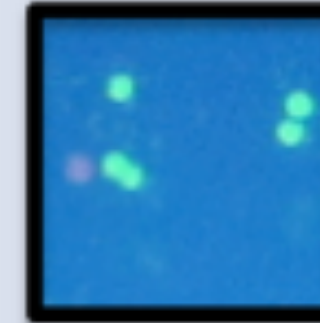
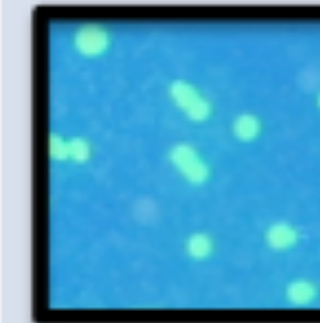

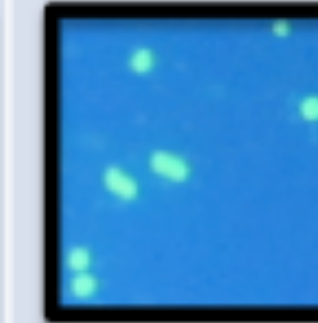










B



Quantify with Phone and ImageJ

J119137

Mutant	J119319	J119320	J119321	J119322	J119323	J119324	J119325	J119326
pClone Green plate								
Isolated clones								
Expression Ratio	4.09	3.94	3.84	2.04	1.54	1.34	3.52	1.00

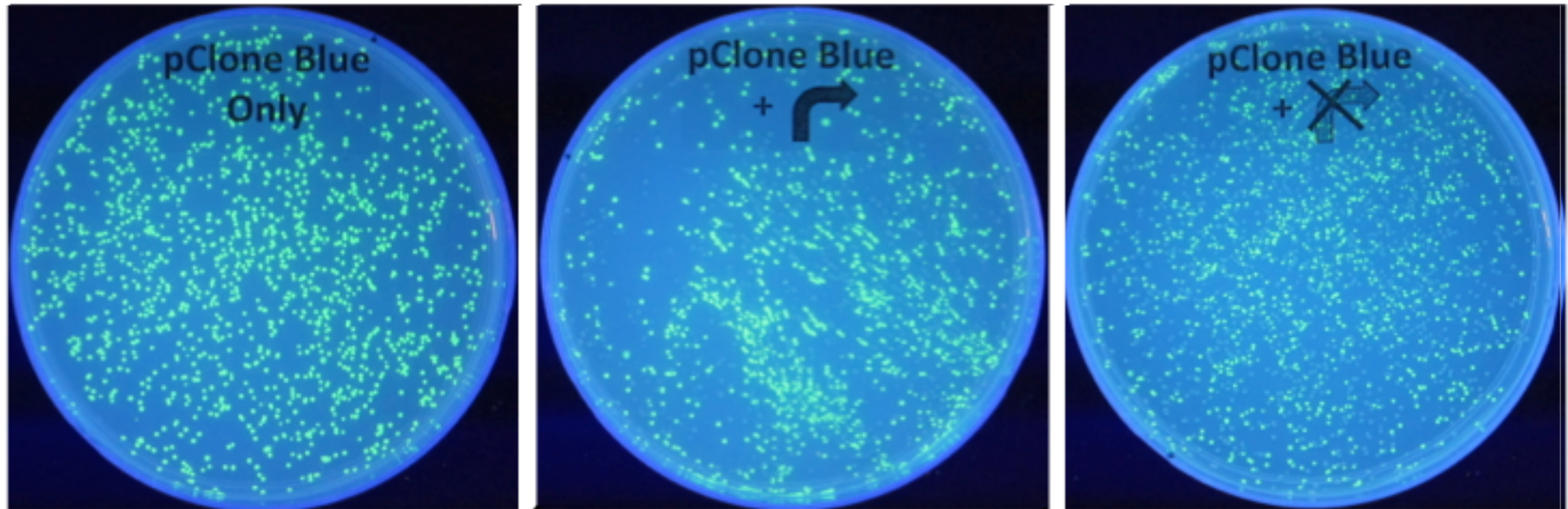
pClone Blue J119313

A

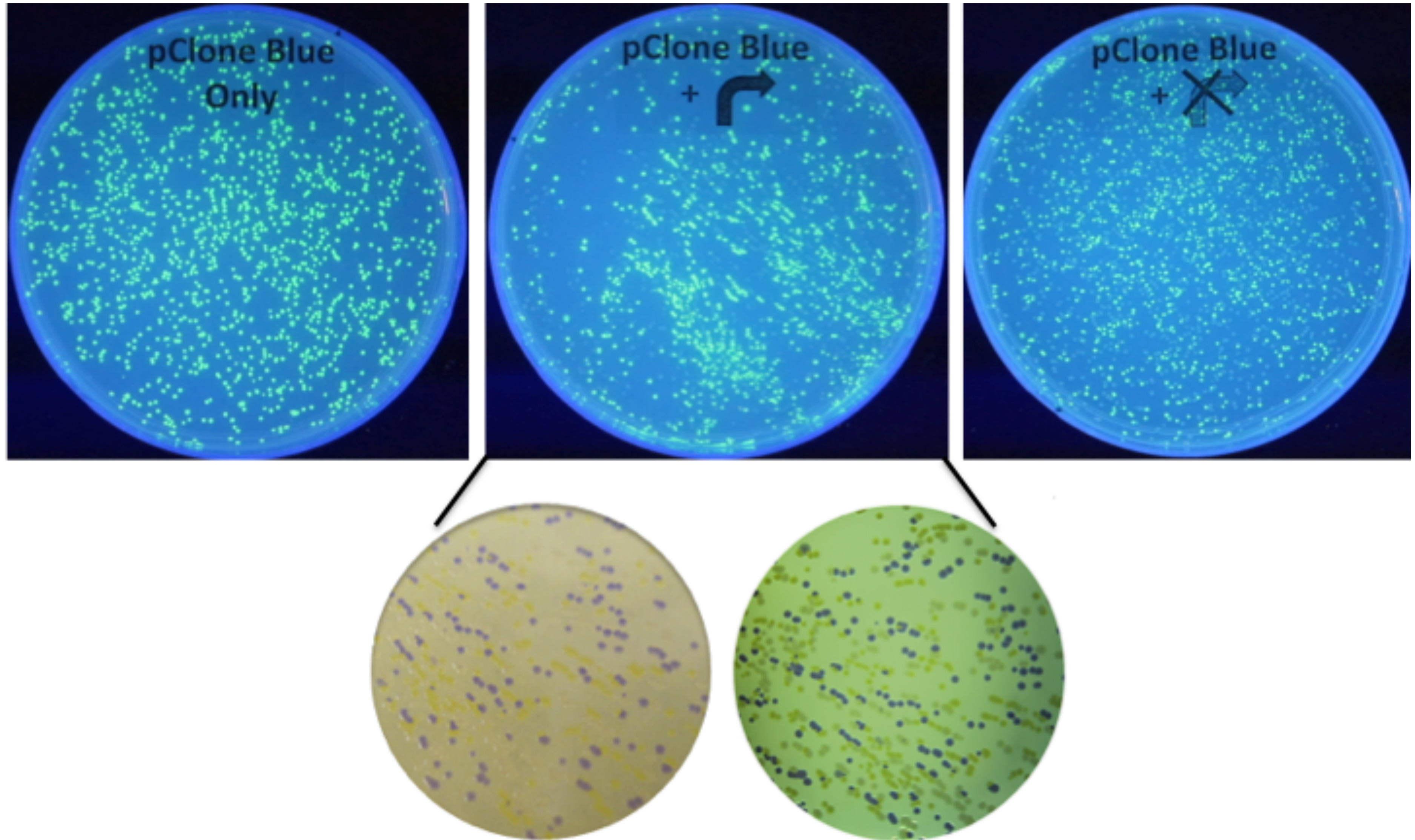
pClone Blue



B



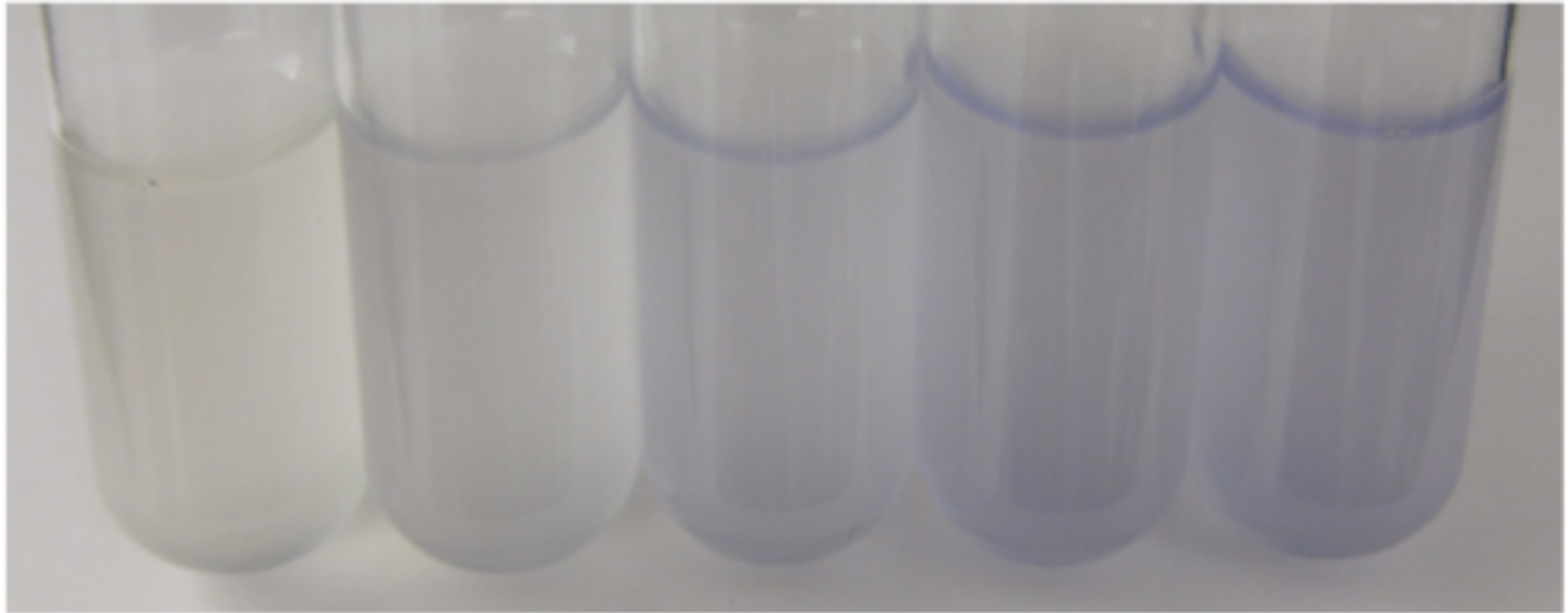
pClone Blue



Measure Promoter Qualitatively

J119313

A



0% Blue

40% Blue

70% Blue

90% Blue

100% Blue

Assessment Davidson Intro Bio

	Learning objective	Pretest experimental	Posttest experimental	Comparison course	$F(2,88)$	Effect size (η^2)	Conclusion
1	Function of promoter	43%	87% ^a	48%	8.008, $p = 0.001$	0.154	Large effect
2	Repressor diagram	23%	53% ^a	13%	7.206, $p = 0.001$	0.141	Large effect
3	Activator diagram	0%	41% ^a	0%	7.250, $p = 0.001$	0.167	Large effect
4	Experiment overview	0%	13% ^a	0%	4.538, $p = 0.013$	0.103	Moderate effect
5	Transformation method	0%	20% ^a	0%	7.374, $p = 0.001$	0.143	Large effect
6	Verify promoter cloned	50%	40%	48%	0.34, $p = 0.713$	0.008	No effect
7	Test promoter strength	43%	60%	39%	1.525, $p = 0.223$	0.034	No effect
8	Type IIs restriction enzymes	7%	50%	6%	1.873, $p = 0.16$	0.041	No effect
9	GGA method	10%	63% ^a	0%	31.929, $p < 0.001$	0.421	Large effect

^aSignificant improvement between pre- and posttest.

Assessment MWSU Genetics (soph)

	Learning objective	Pretest experimental	Posttest experimental	Control course (ecology)	$F(2252)$	Effect size (η^2)	Conclusion
1	Function of promoter	36%	59% ^a	20%	13.527, $p < 0.001$	0.097	Moderate effect
2	-10 and -35 sites	3%	70% ^a	0%	145.374, $p < 0.001$	0.536	Large effect
3	Mutational analysis	30%	75% ^a	33%	28.773, $p < 0.001$	0.186	Large effect
4	Student-designed mutation	0%	0%	0%	0, $p > 0.05$	0.000	No effect
5	Transformation method	11%	51% ^a	12%	30.731, $p < 0.001$	0.196	Large effect
6	Verify promoter cloned	19%	44% ^a	18%	10.264, $p < 0.001$	0.075	Moderate effect
7	Test promoter strength	17%	33% ^a	18%	4.421, $p = 0.013$	0.034	Moderate effect
8	Type IIs restriction enzymes	2%	29% ^a	4%	21.661, $p < 0.001$	0.147	Large effect
9	GGA method	14%	22%	14%	1.56, $p = 0.212$	0.012	No effect

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Assessment Davidson Intro Bio

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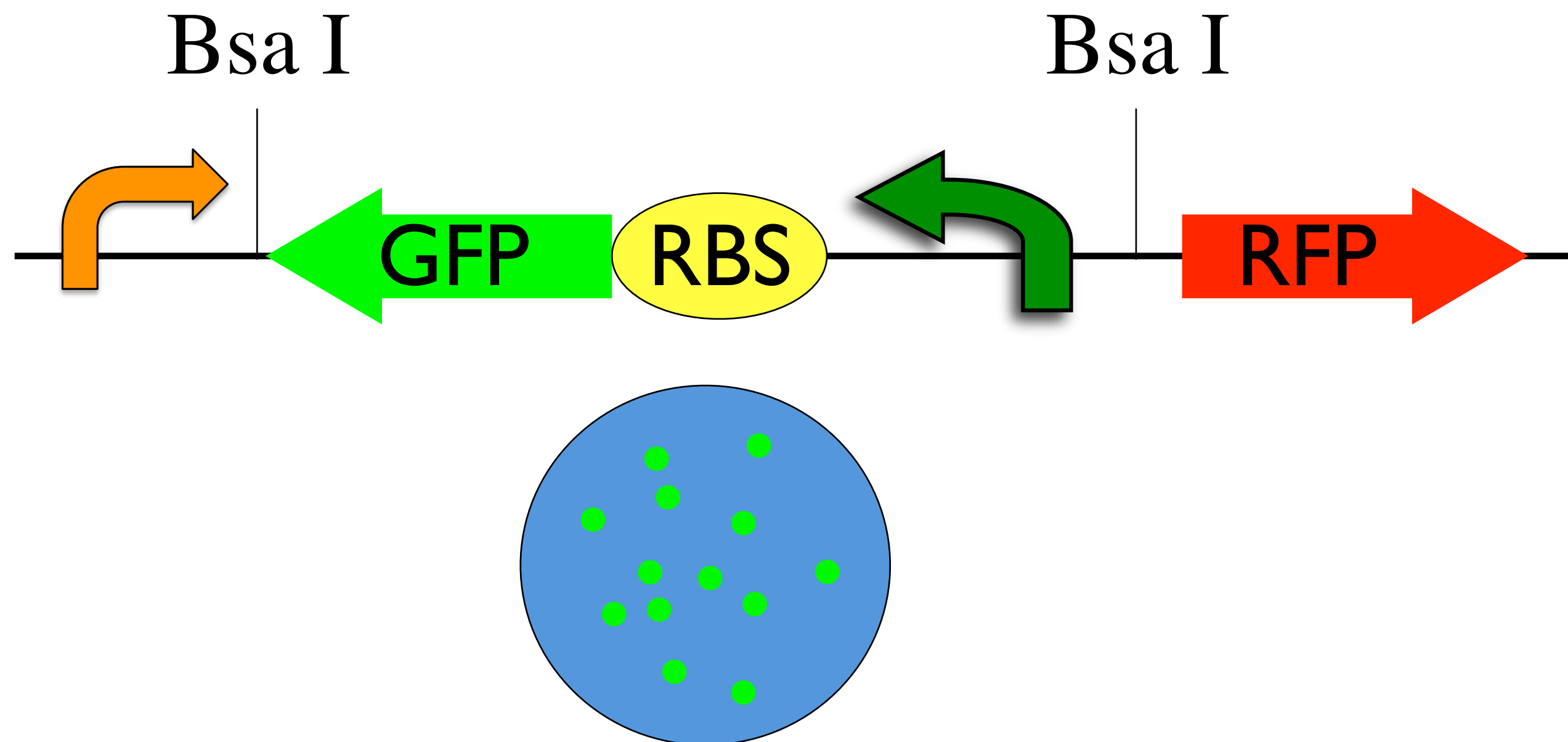
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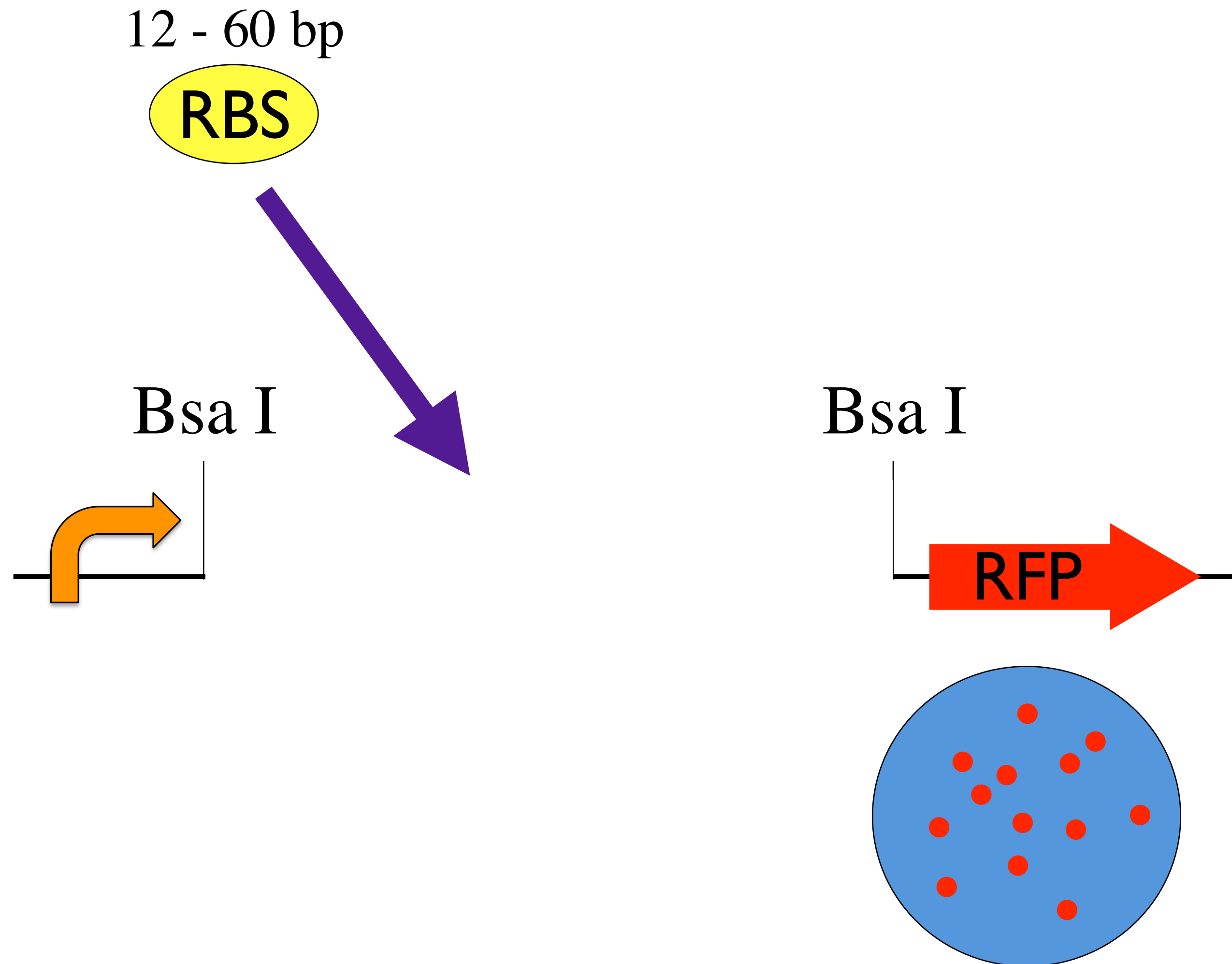
rClone Red

J119###



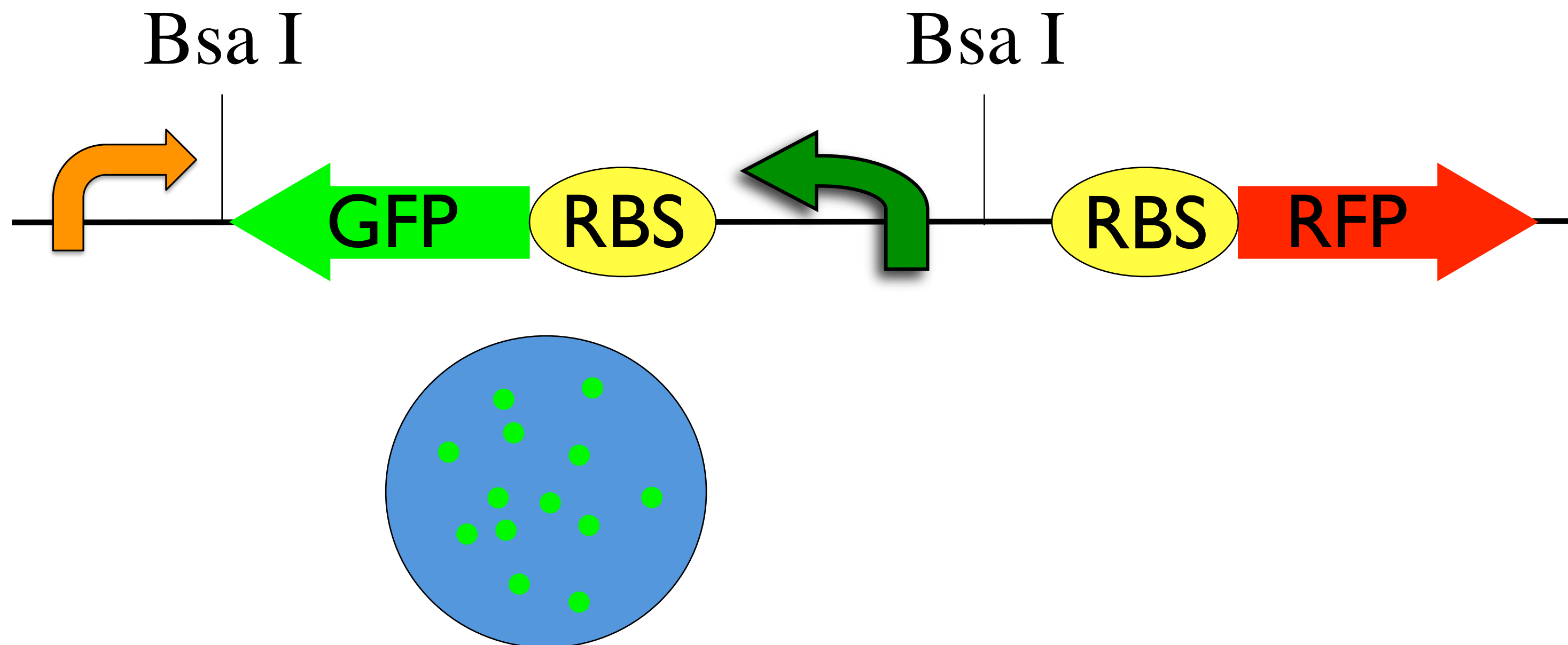
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J119###



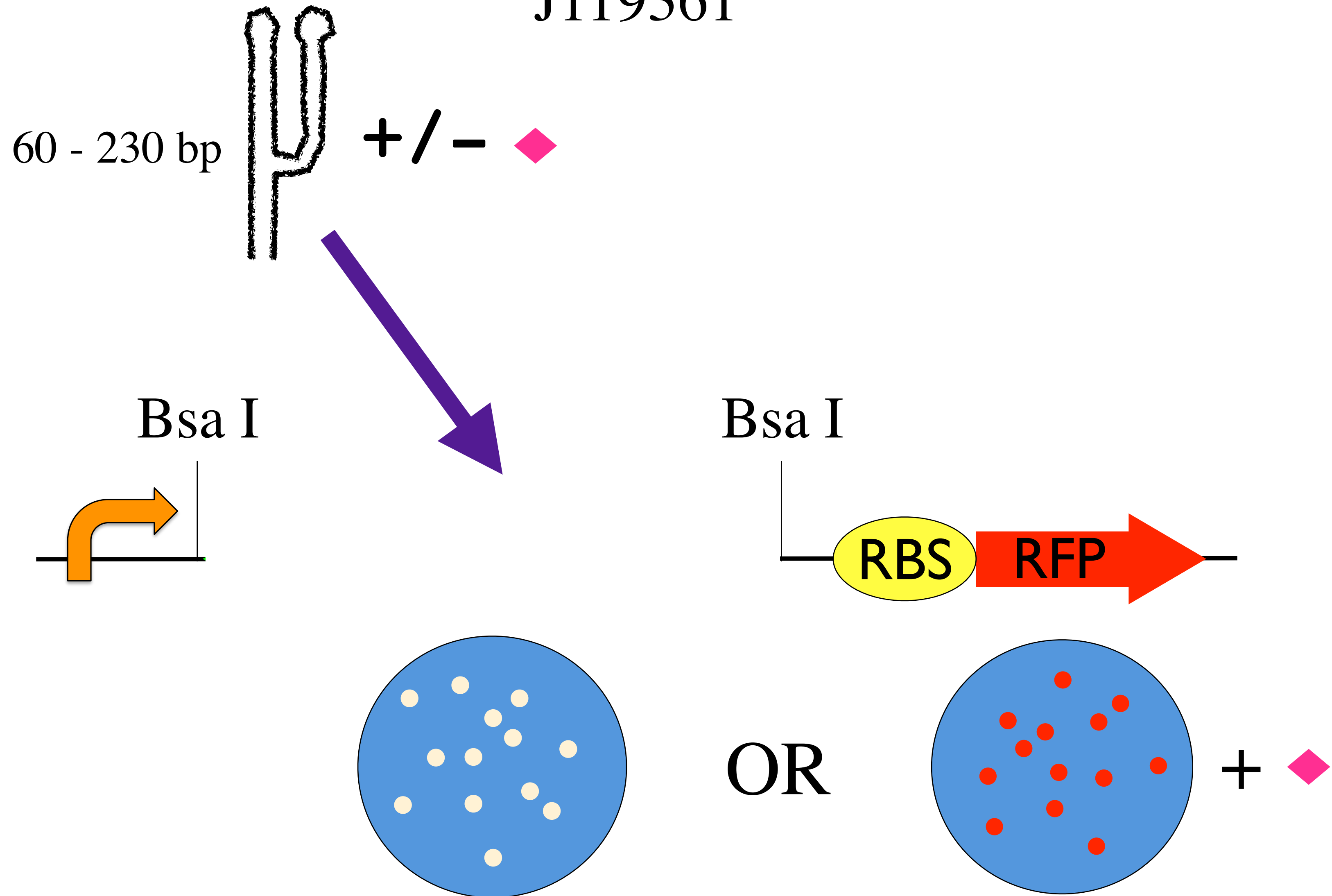
tClone Red

J119361



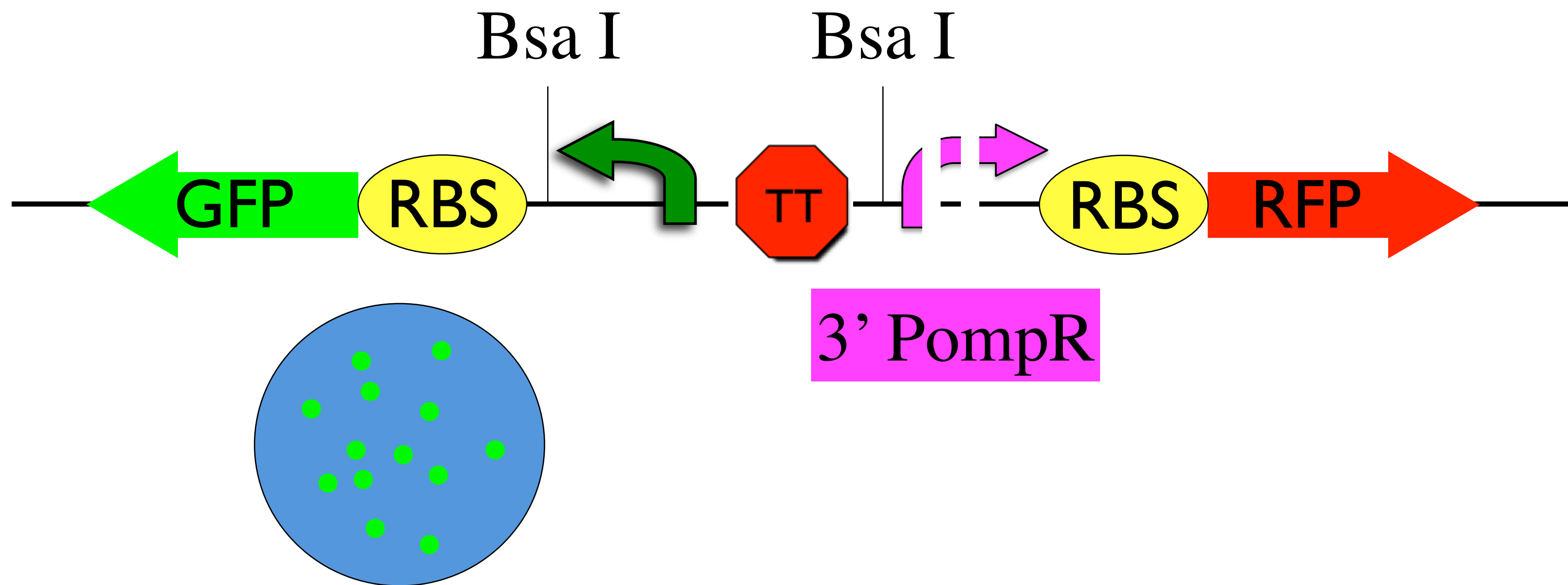
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J119361



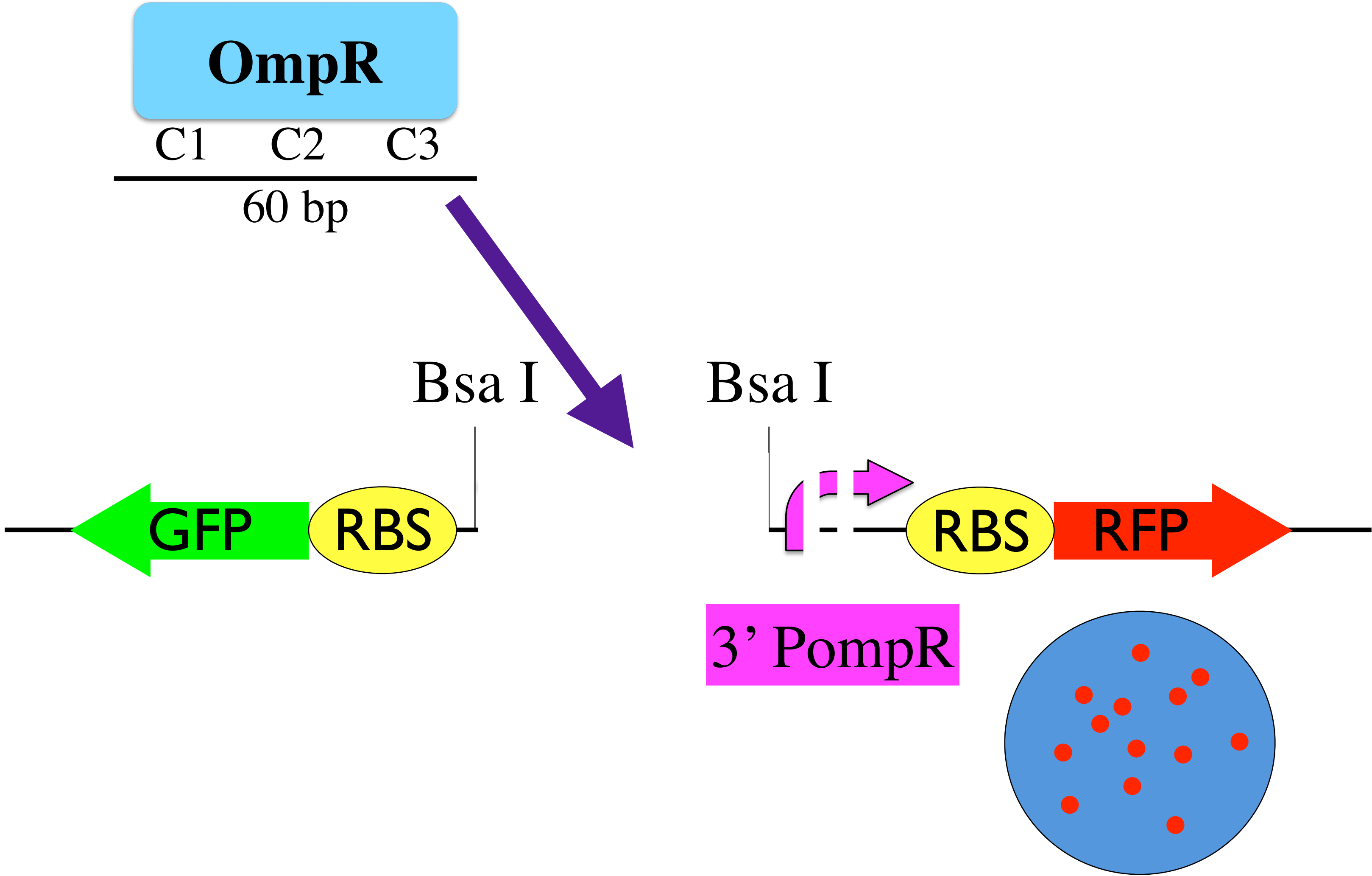
actClone Red

J100204



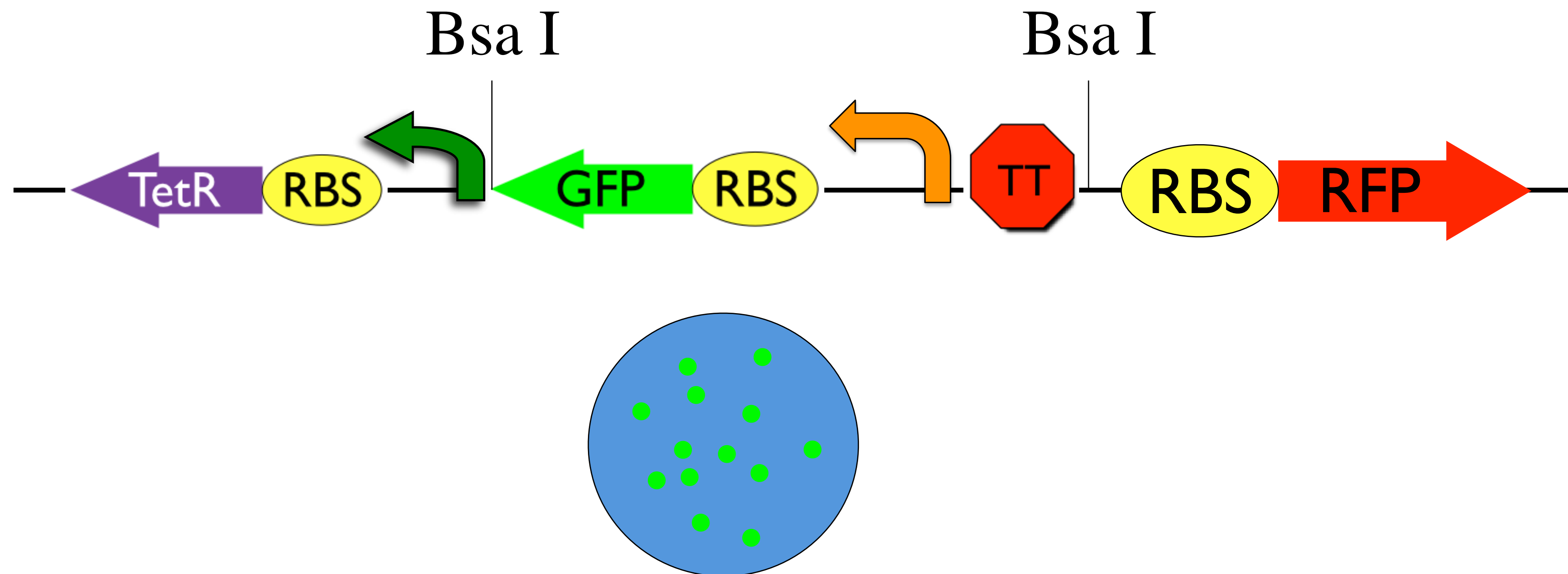
actClone Red

J100204



repClone Red

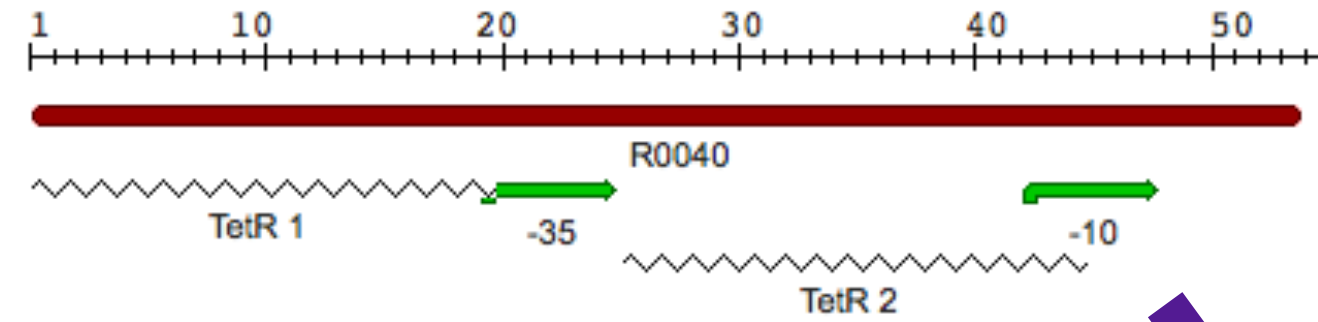
J100205



repClone Red

J100205

Ptet

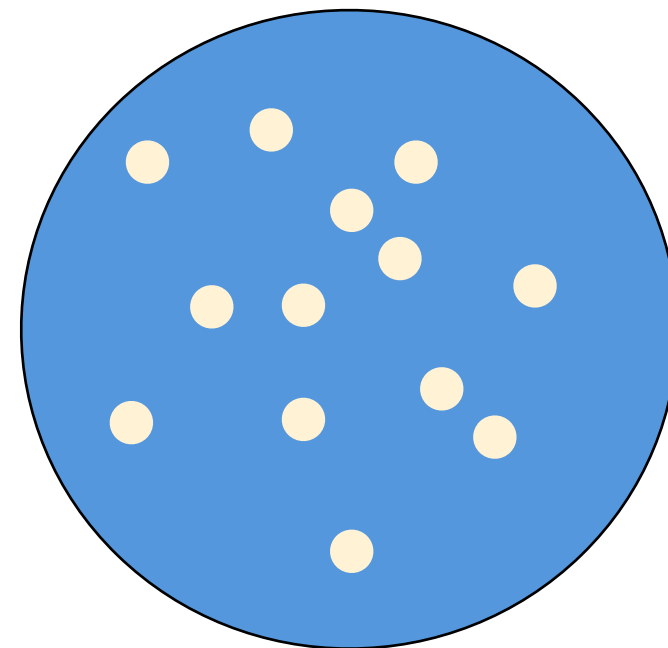


54 bp

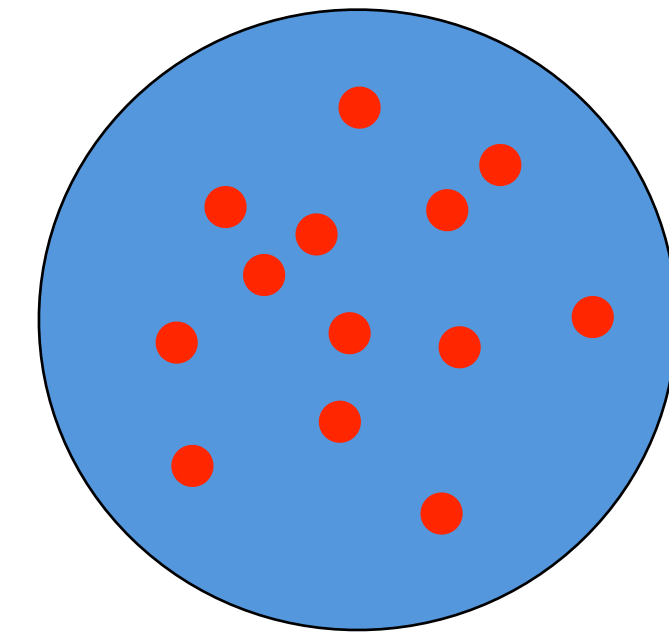
Bsa I



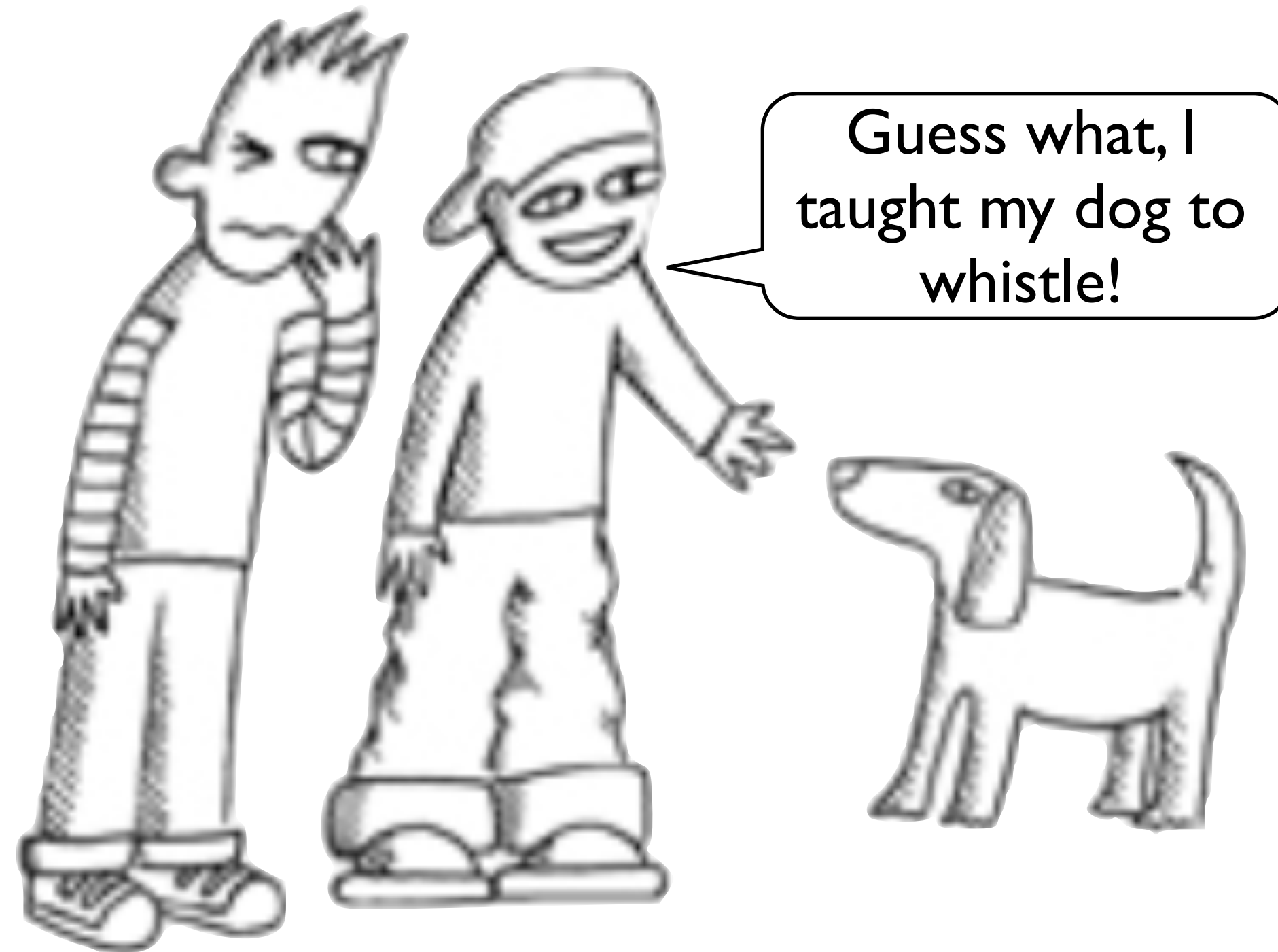
Bsa I



OR



Teaching vs Learning



Teaching vs Learning

Really?!

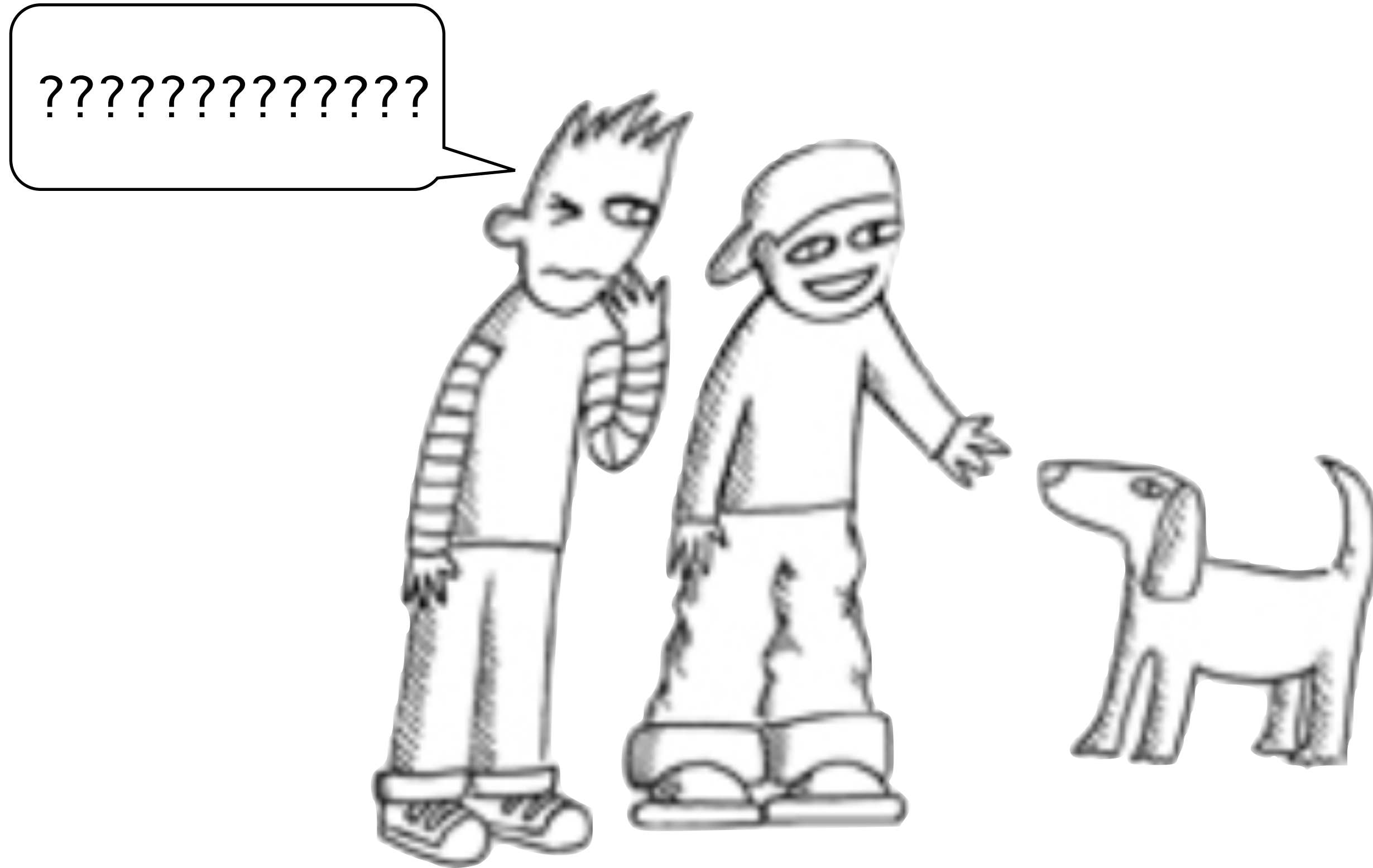


Teaching vs Learning

Whistle! C'mon
boy, whistle!



Teaching vs Learning



Teaching vs Learning

I thought you said
you taught your
dog to whistle.



Teaching vs Learning



Acknowledgements

Lecture: A. Malcolm Campbell Laurie Heyer, Chris Paradise

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Genome Consortium for Active Teaching (GCAT)

Davidson College James G. Martin Genomics Program

MWSU SGA, Foundation & Summer Research Institute



Remember, teaching is supposed to be fun!

