

Bootcamp Microbiology Labs: An Approach to Deliver Essential Labs in Online Programs

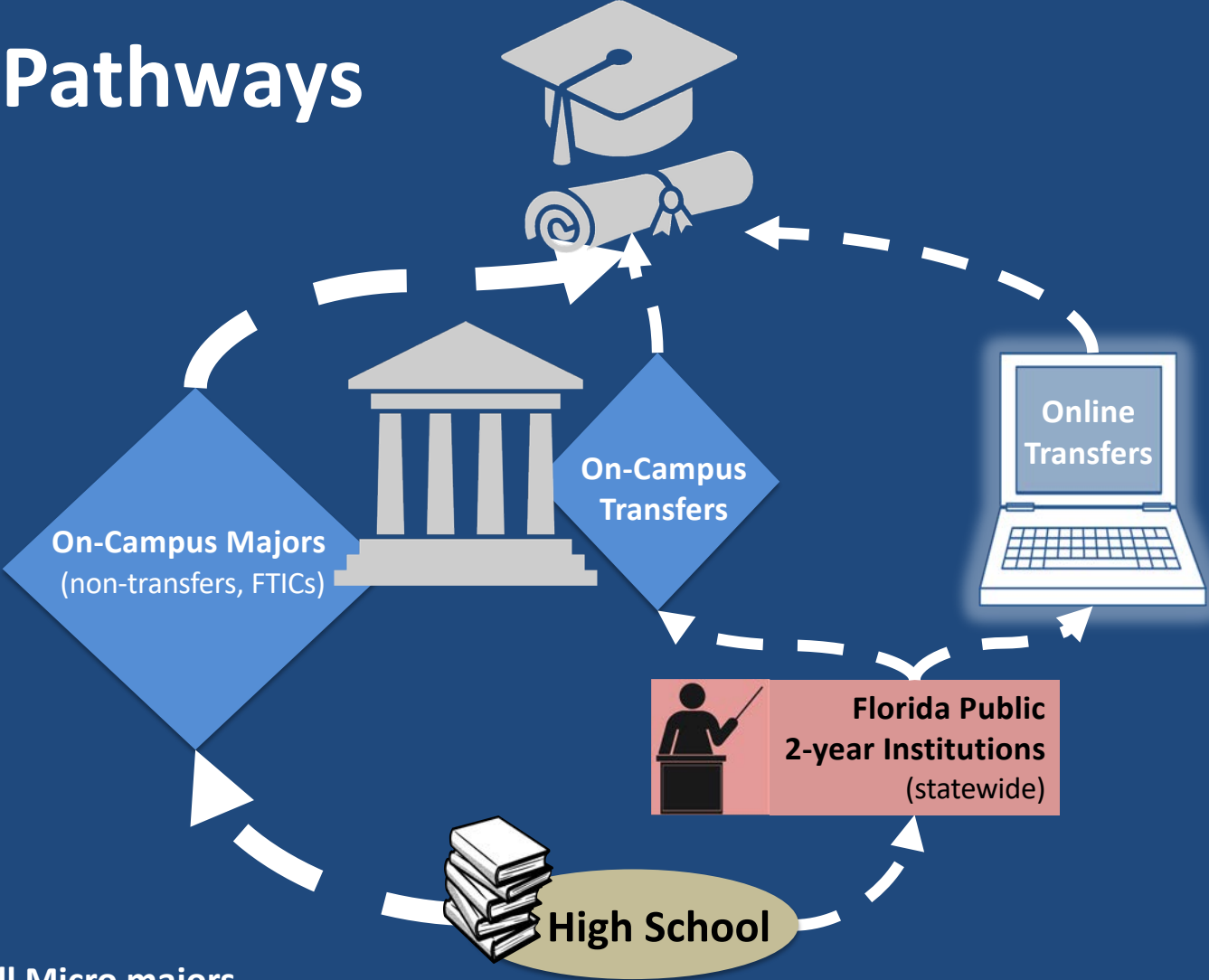
Jennifer C. Drew, Alexandria Ardisson, Monika Oli, Kelly Rice, Sebastian Galindo-Gonzalez, Macarena Urrets, Allen Wysocki, Eric Triplett

Introduction

- Overview of Microbiology 2+2 hybrid online program
- Bootcamp Lab Model for STEM education – Comparison of bootcamp lab to 16-week lab

OVERVIEW OF HYBRID ONLINE 2+2 PROGRAM

3 Main Pathways



Captures 86% of all Micro majors

2+2 in STEM

- 40% with a STEM B.S. have attended a community college
- Community colleges serve the most diverse student populations in the country
- *2-year to 4-year transition is challenging to analyze*
- Transfer gap is wider for underrepresented minority (URM) students:
 - > 50% of Latino 2-yr students are interested in 4-yr degree, but only 6% earn complete within 6 years

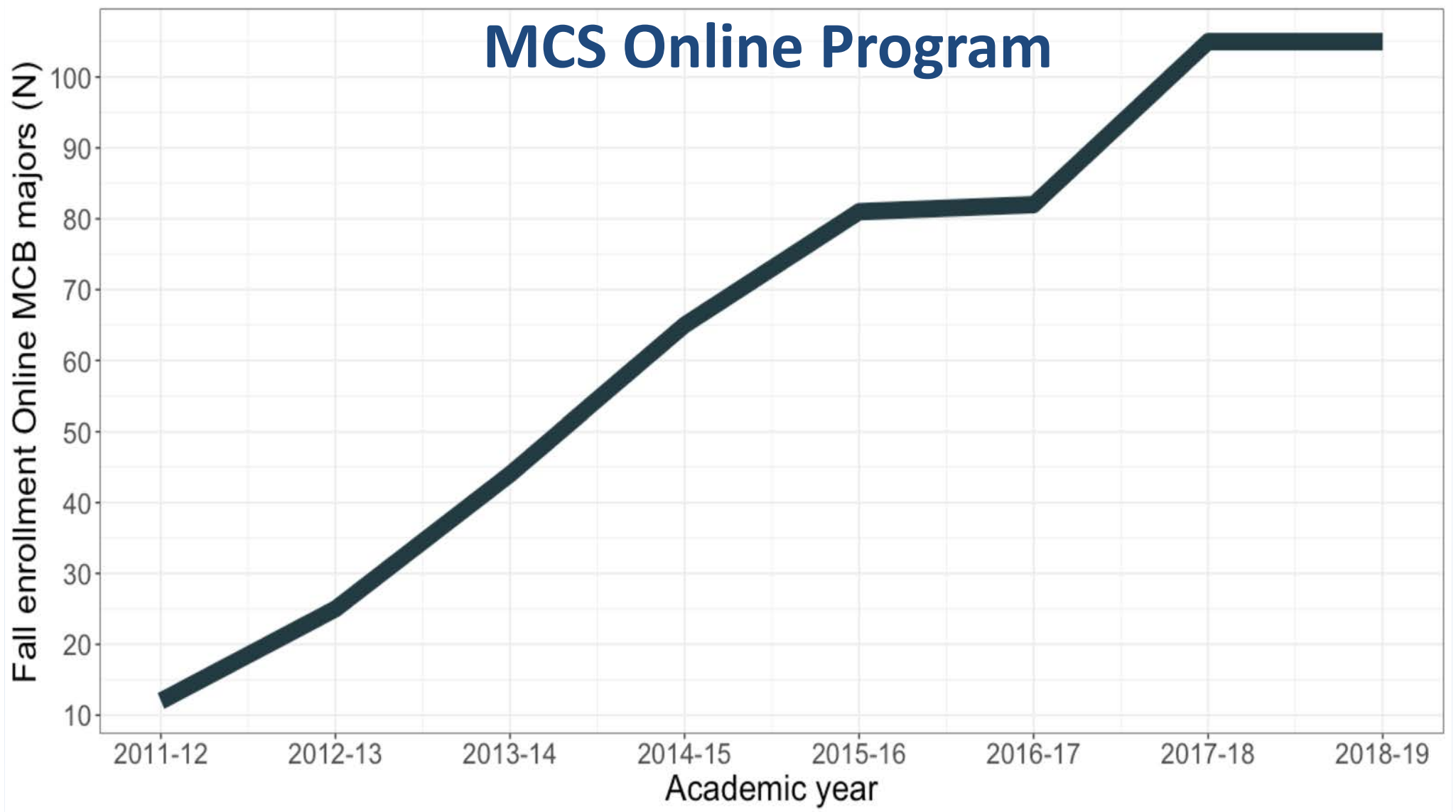


Think
big

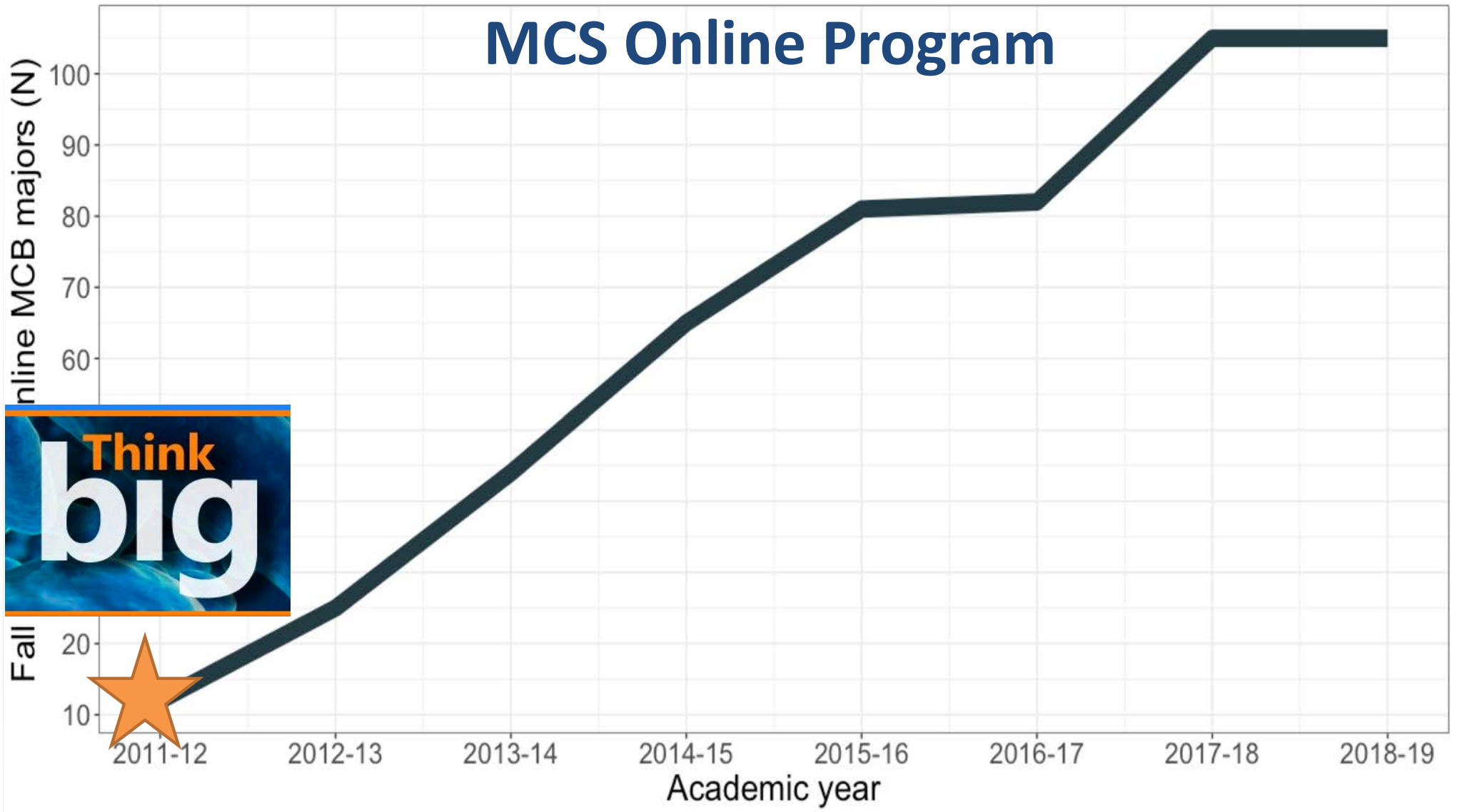
Online Bachelor of Science in
Microbiology & Cell Science

- 1st hybrid online STEM degree offered by a land-grant institution
- 2-yr students transfer into 4-yr program without relocating
- Courses, curriculum, and instructors are the same as on-campus program
- Began with Miami Dade College, largest minority-serving institution in the country and expanded statewide
- All lecture courses are online
- **ALL LAB COURSES ARE FACE-TO-FACE**

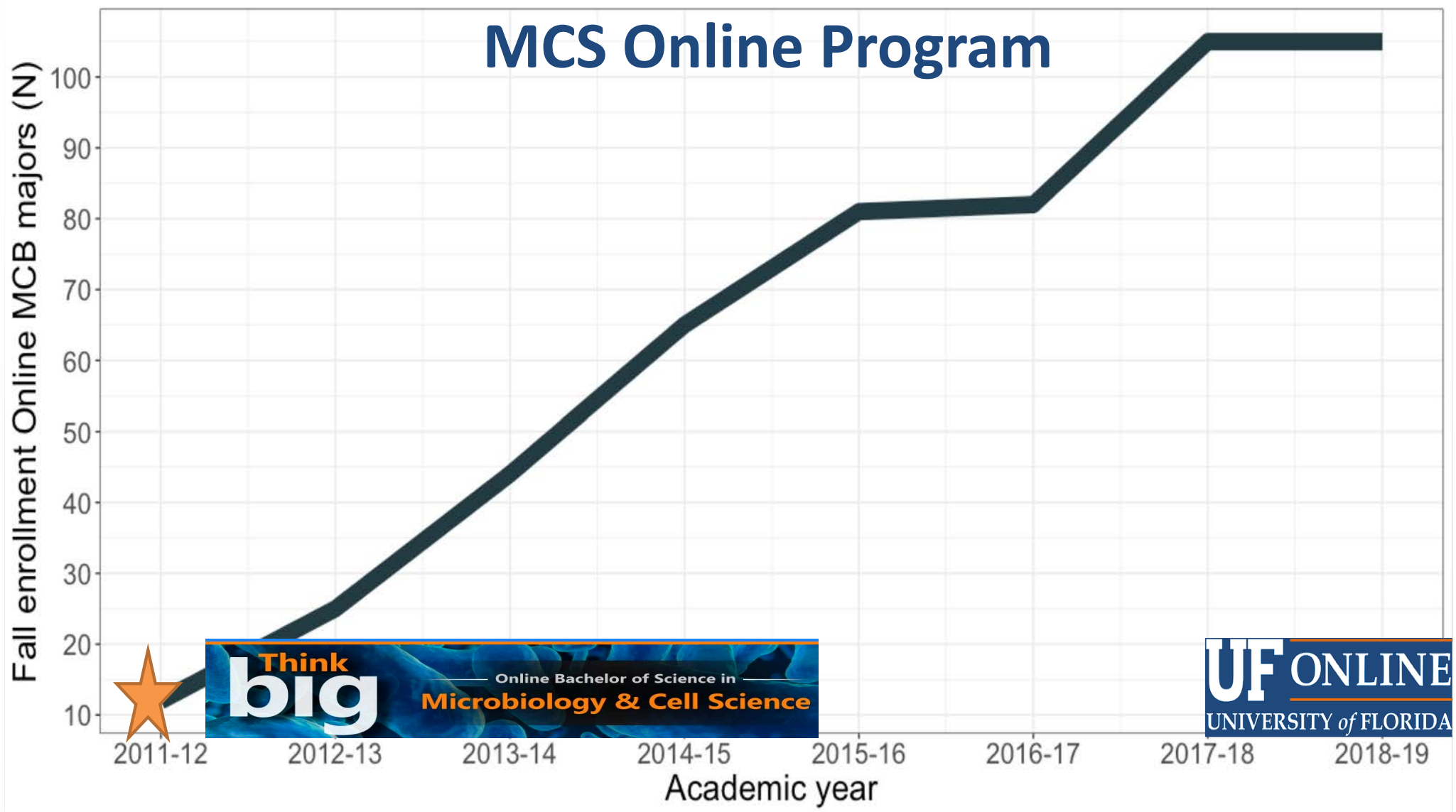
MCS Online Program



MCS Online Program



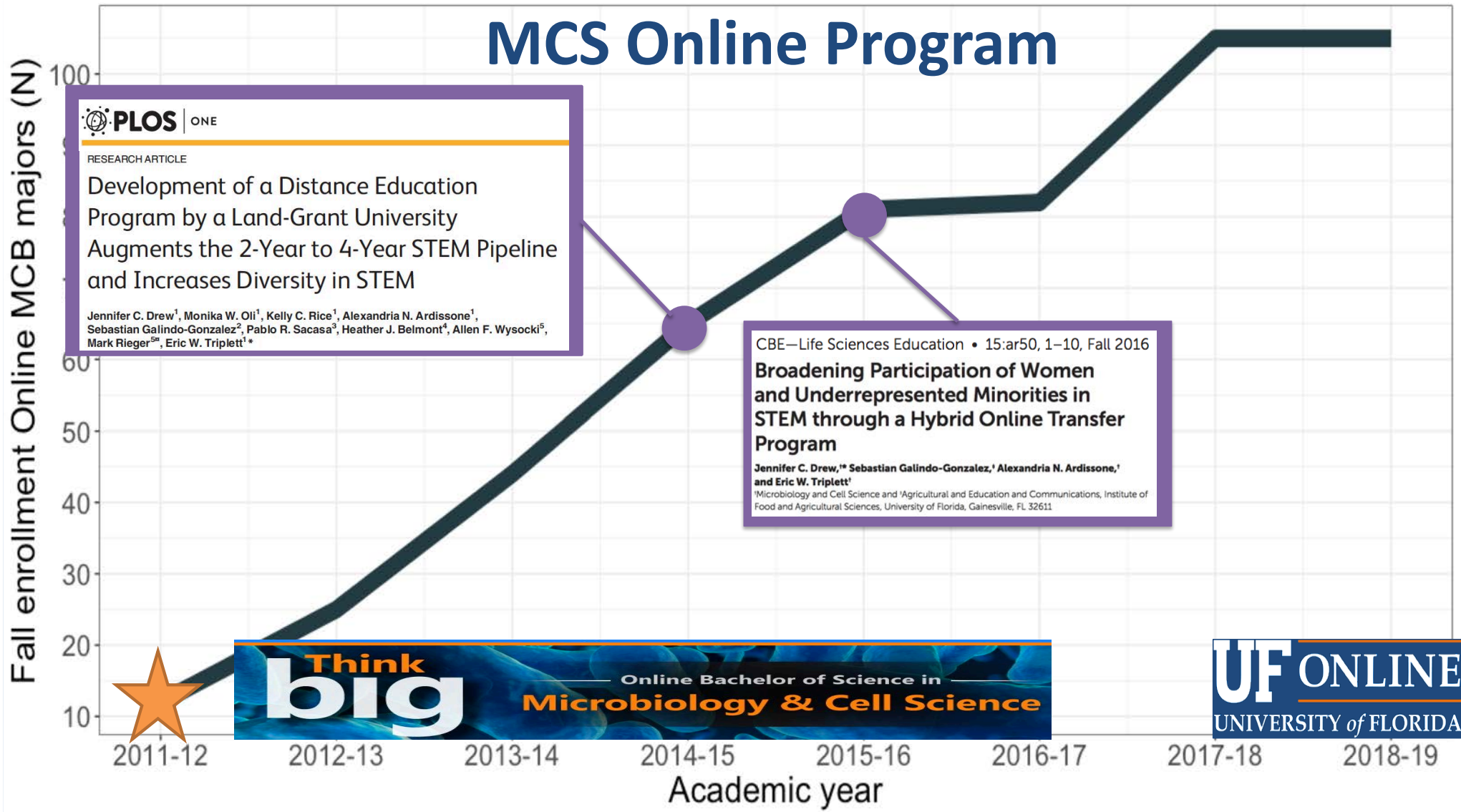
MCS Online Program



Think big
Online Bachelor of Science in
Microbiology & Cell Science

UF ONLINE
UNIVERSITY of FLORIDA

MCS Online Program



MCS Online Program

Fall enrollment Online MCB majors (N)

2011-12

2012-13

2013-14

2014-15

2015-16

2016-17

2017-18

2018-19

Academic year



A STEP up for the life sciences
#1161177



RESEARCH ARTICLE

Development of a Distance Education Program by a Land-Grant University Augments the 2-Year to 4-Year STEM Pipeline and Increases Diversity in STEM

Jennifer C. Drew¹, Monika W. Oll¹, Kelly C. Rice¹, Alexandria N. Ardissone¹, Sebastian Galindo-Gonzalez², Pablo R. Sacasa², Heather J. Belmont², Allen F. Wysocki², Mark Rieger^{2*}, Eric W. Triplett^{1*}

CBE—Life Sciences Education • 15:ar50, 1–10, Fall 2016

Broadening Participation of Women and Underrepresented Minorities in STEM through a Hybrid Online Transfer Program

Jennifer C. Drew,^{1*} Sebastian Galindo-Gonzalez,¹ Alexandria N. Ardissone,¹ and Eric W. Triplett¹

¹Microbiology and Cell Science and ²Agricultural and Education and Communications, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL 32611



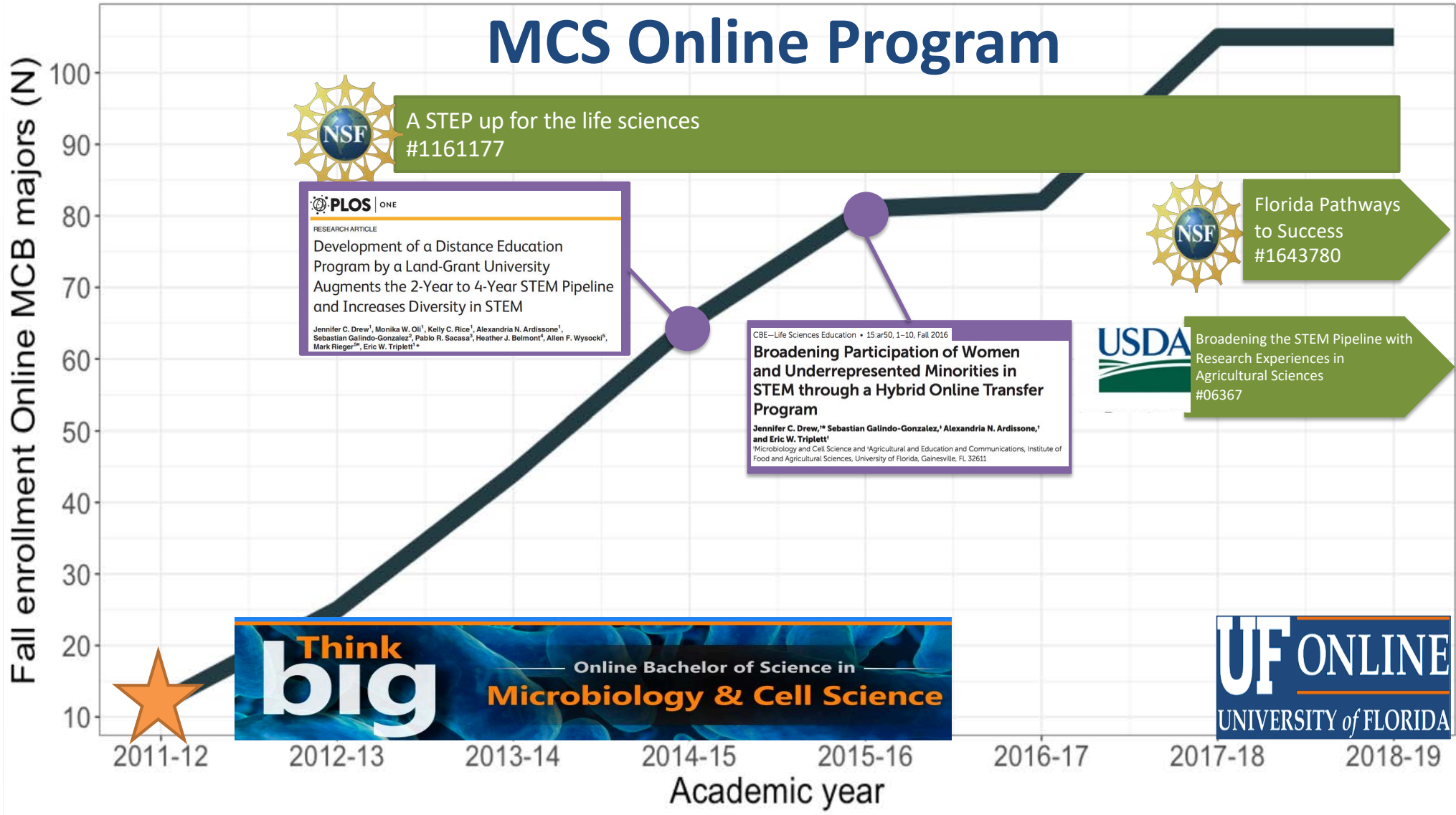
Florida Pathways to Success
#1643780



Broadening the STEM Pipeline with Research Experiences in Agricultural Sciences
#06367

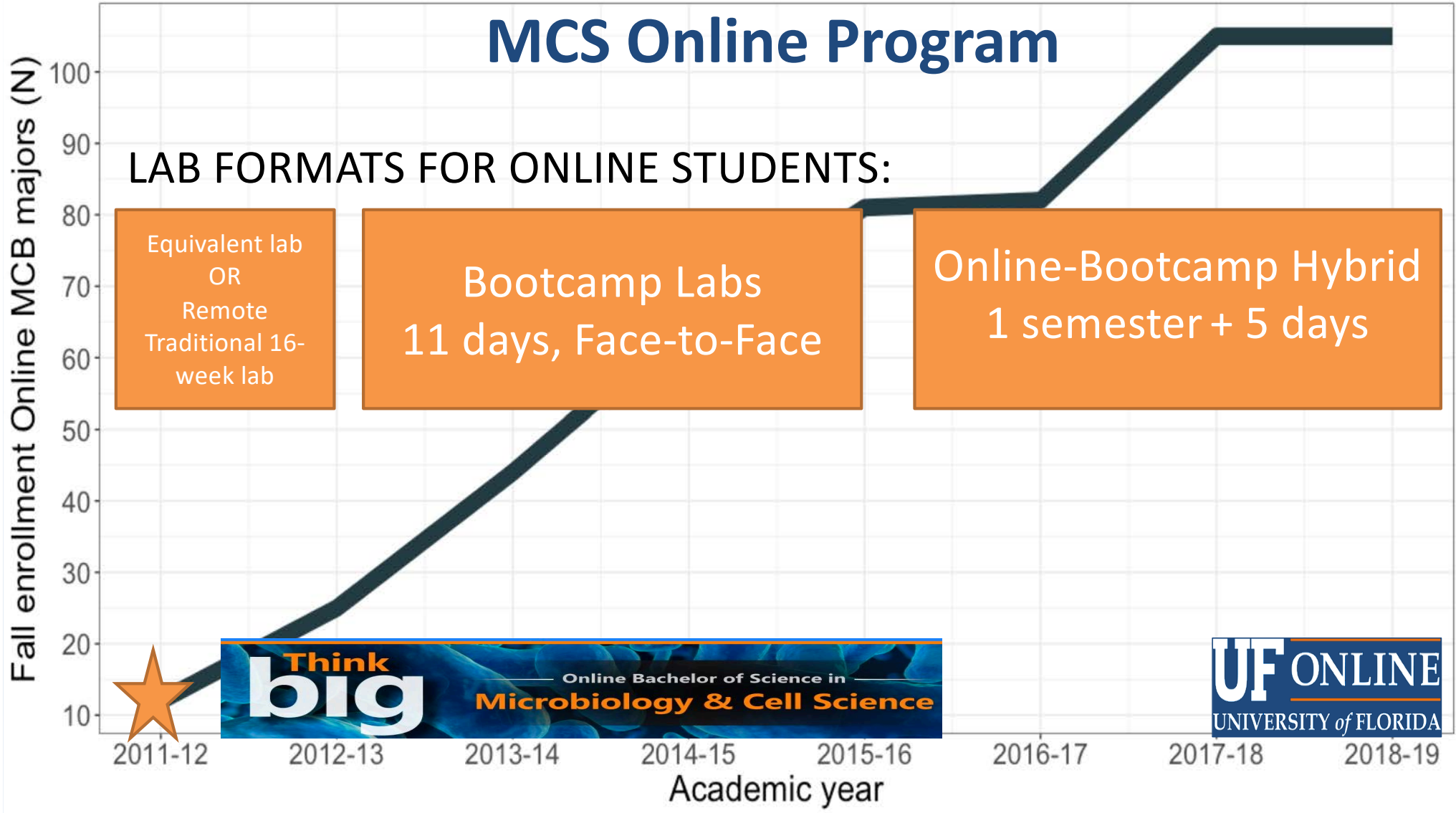
Think big Online Bachelor of Science in **Microbiology & Cell Science**

UF ONLINE
UNIVERSITY of FLORIDA

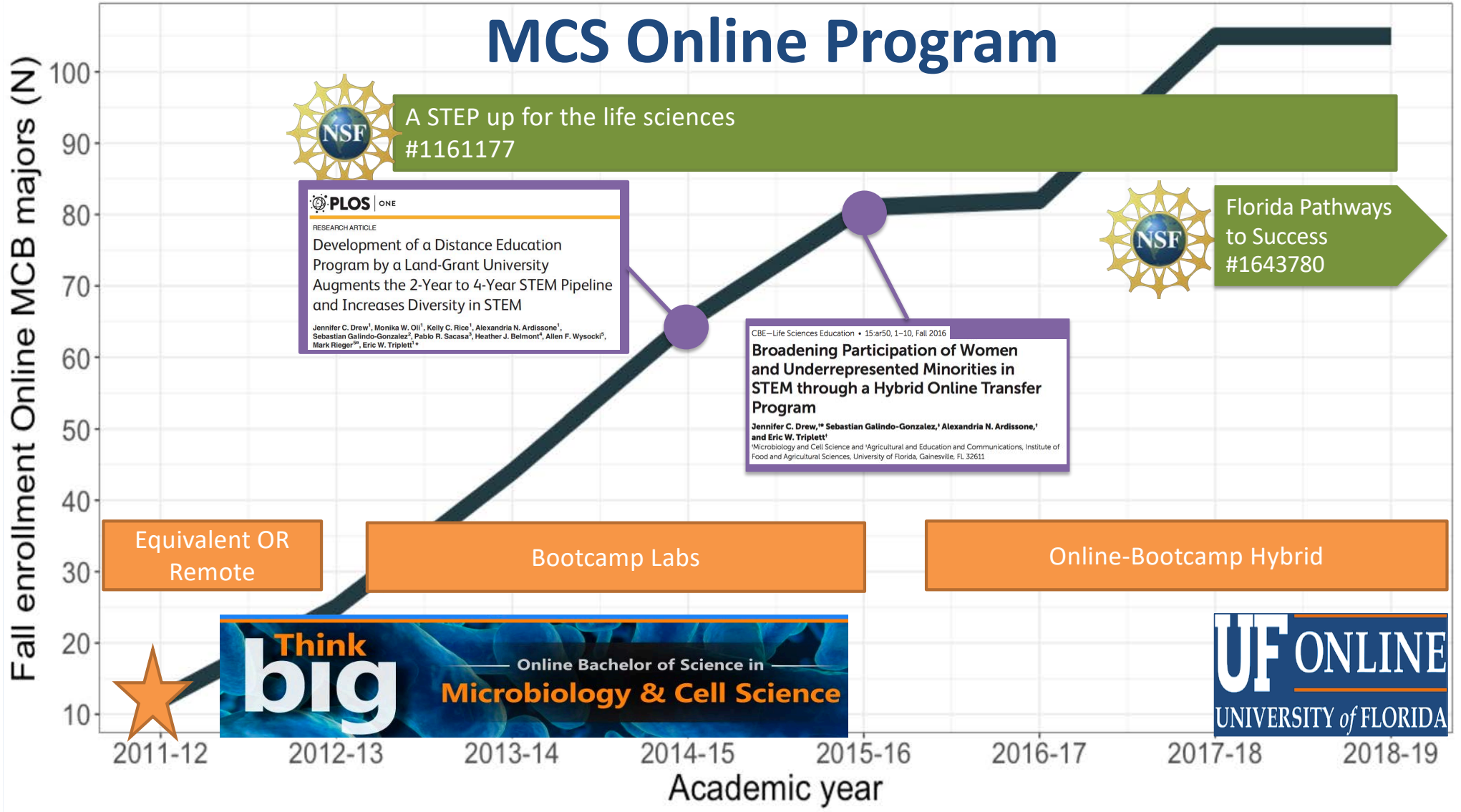


WHAT ABOUT THE LABS?

MCS Online Program



MCS Online Program



A STEP up for the life sciences
#1161177

PLOS ONE
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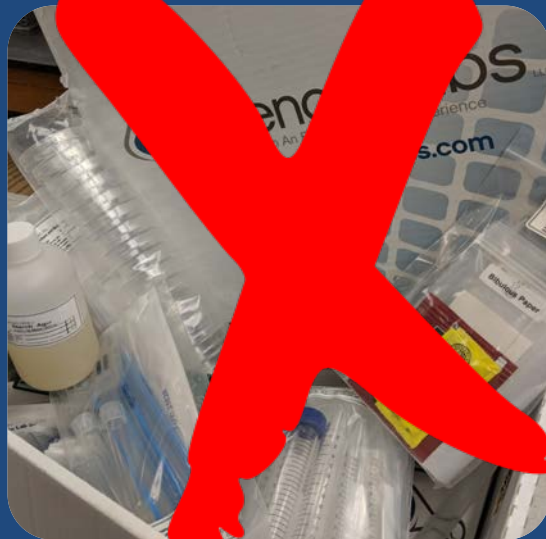
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Think big Online Bachelor of Science in **Microbiology & Cell Science**

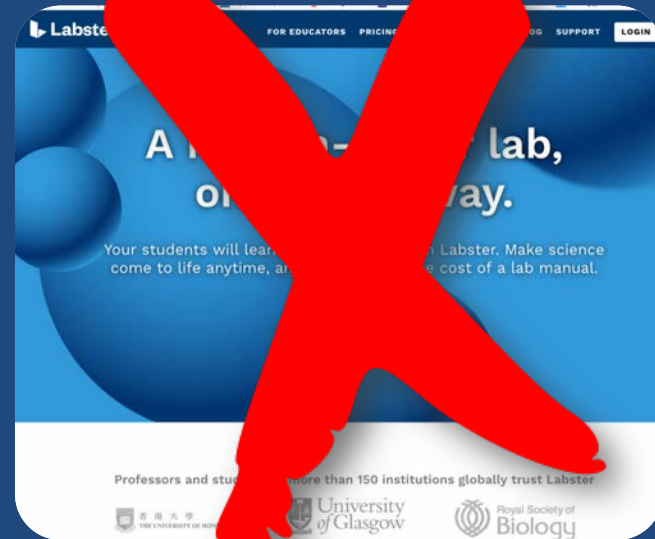


CAN YOU TEACH THE LABS ONLINE?

Lab in a Box



Virtual/Augmented reality



Benefits of face-to-face labs for online students

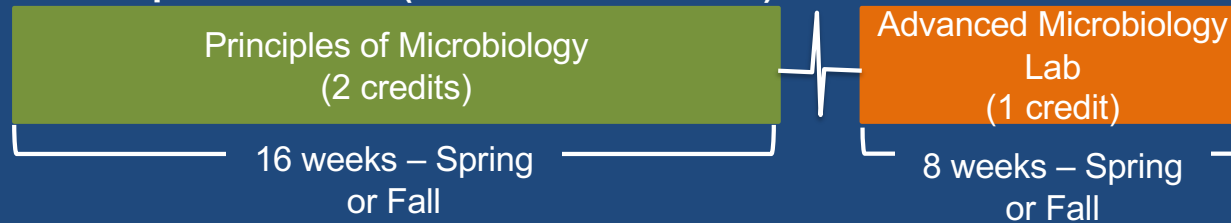
- Admission to professional/graduate schools
- Developed in collaboration with UF Medical Admissions
- Data indicates that virtual labs and alternatives are successful primarily as *supplements*
- No studies indicate online labs as effective as F2F replacement
- Employers require hands-on lab
- Experience with state-of-the-art equipment
- Meet other online students
- Meet faculty and advisors
- Fieldtrips



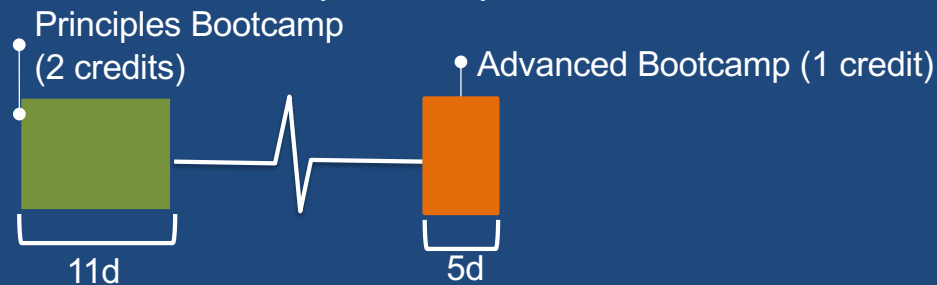
Face-to-Face Paradigms

- Equivalent course accepted
- 16-week lab taught at another site
- **Bootcamp or "compressed" lab**

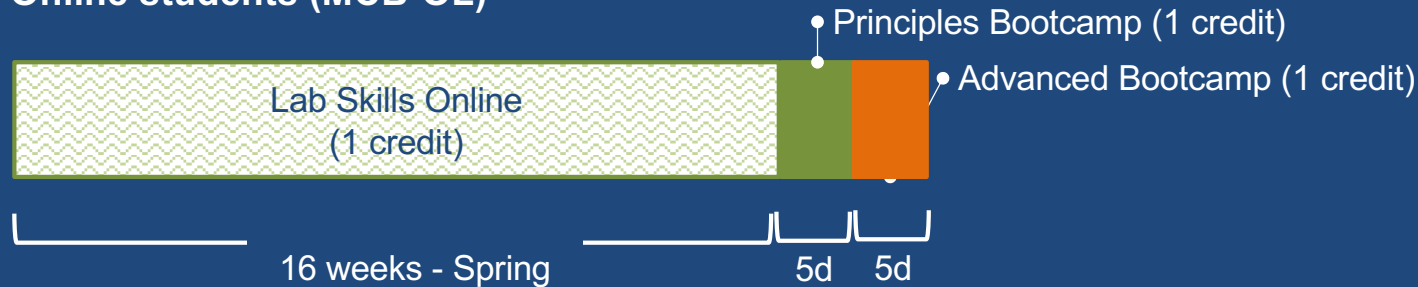
**A Traditional Delivery of Microbiology and Cell Science Laboratory Requirements
On-campus students (MCB-UF & MCB-TR)**



**B 2013-2015 Bootcamp Delivery of Microbiology and Cell Science Laboratory Requirements
Online students (MCB-OL)**



**C 2016-2018 Online-Bootcamp Hybrid Delivery of Microbiology and Cell Science Laboratory Requirements
Online students (MCB-OL)**



Competencies & Skills

Traditional	Hybrid delivery	
	Online Module	5-day Lab

Scientific Thinking

28. Ability to apply the process of science

- a. Demonstrate an ability to formulate hypotheses and design experiments based on the scientific method.
- b. Analyze and interpret results from a variety of microbiological methods and apply these methods to analogous situations.

29. Ability to use quantitative reasoning

- a. Use mathematical reasoning and graphing skills to solve problems in microbiology.

30. Ability to communicate and collaborate with other disciplines

- a. Effectively communicate fundamental concepts of microbiology in written and oral format.
- b. Identify credible scientific sources and interpret and evaluate the information therein.

31. Ability to understand the relationship between science and society

- a. Identify and discuss ethical issues in microbiology.

Microbiology Laboratory Skills

32. Properly prepare and view specimens for examination using microscopy (bright field and, if possible, phase contrast)

33. Use pure culture and selective techniques to enrich for and isolate microorganisms

34. Use appropriate methods to identify microorganisms (media-based, molecular and serological).

35. Estimate the number of microorganisms in a sample (using, for example, direct count, viable plate count, and spectrophotometric methods).

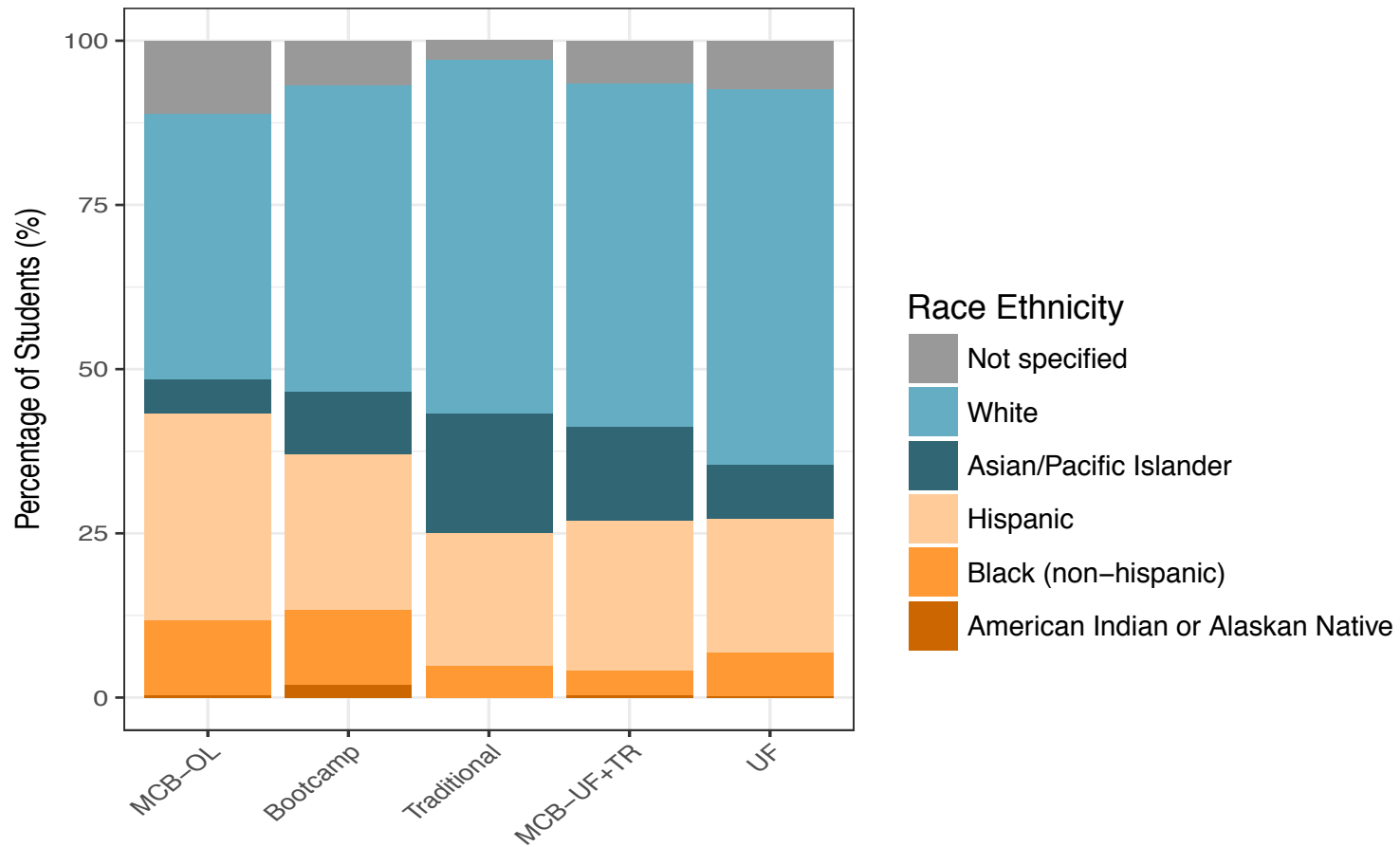
36. Use appropriate microbiological and molecular lab equipment and methods.

37. Practice safe microbiology, using appropriate protective and emergency procedures.

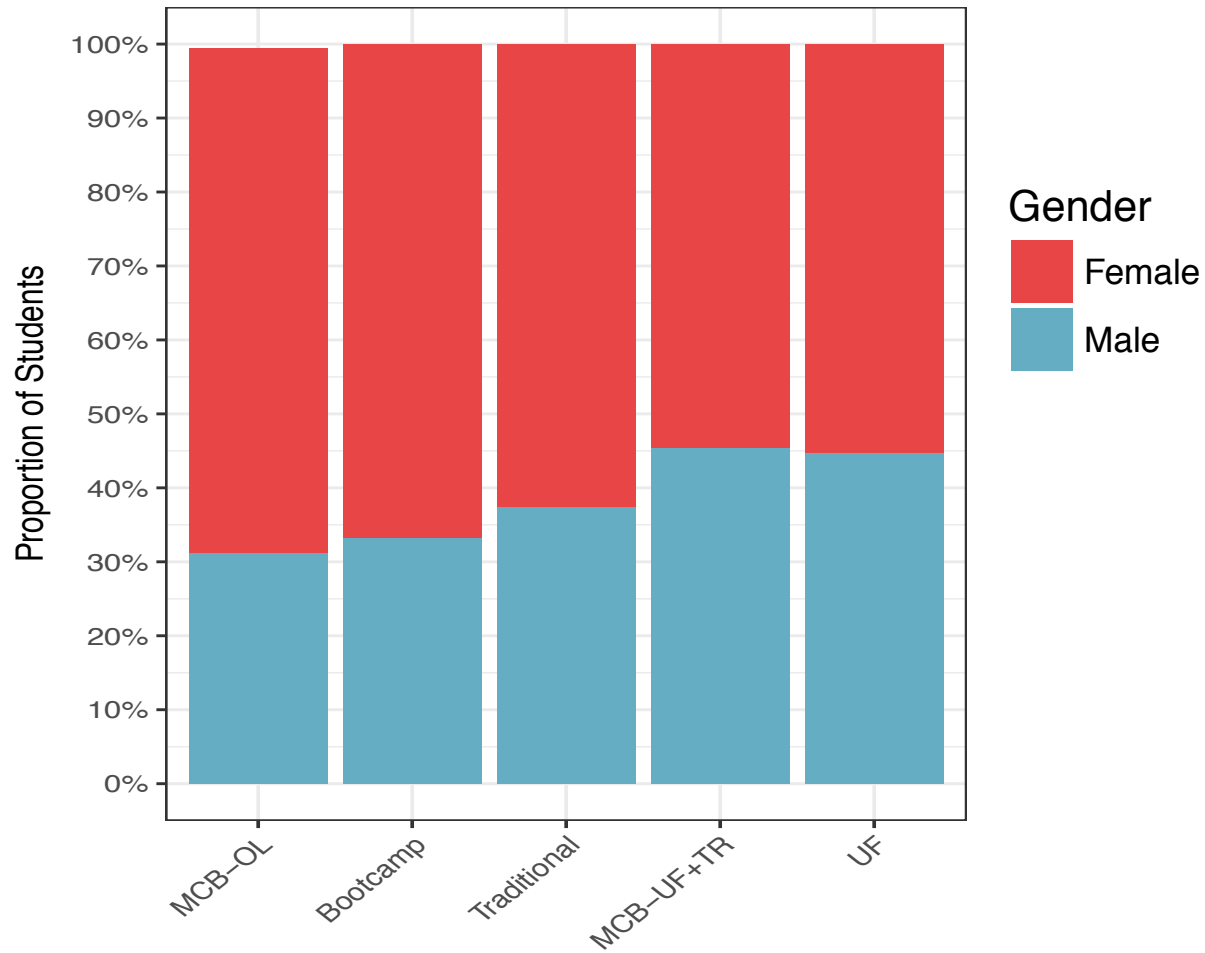
38. Document and report on experimental protocols, results and conclusions.

**HOW DO BOOTCAMP FORMATS COMPARE TO
TRADITIONAL LABS?**

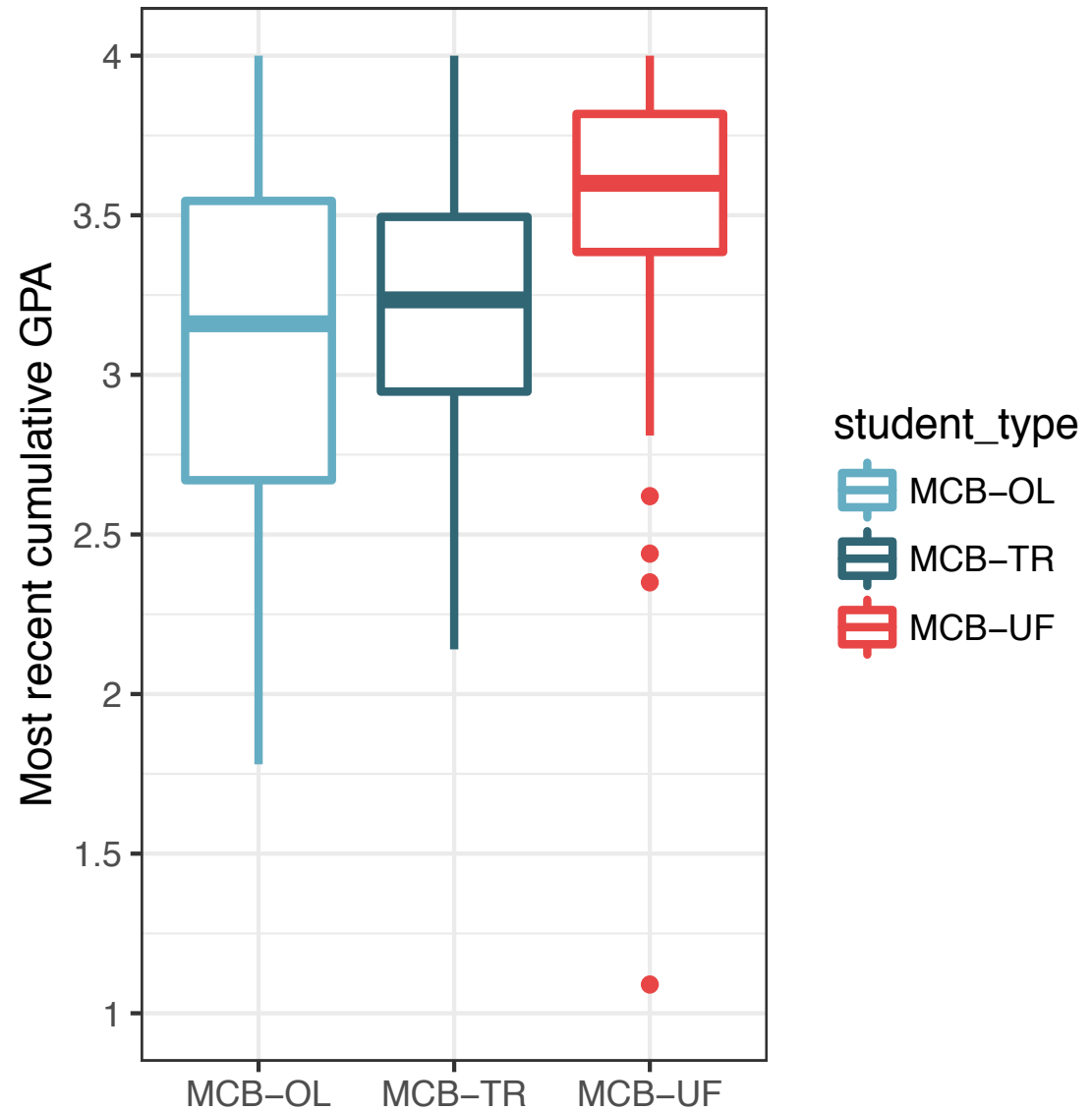
Bootcamp labs have higher enrollment of URM students than 16-week lab



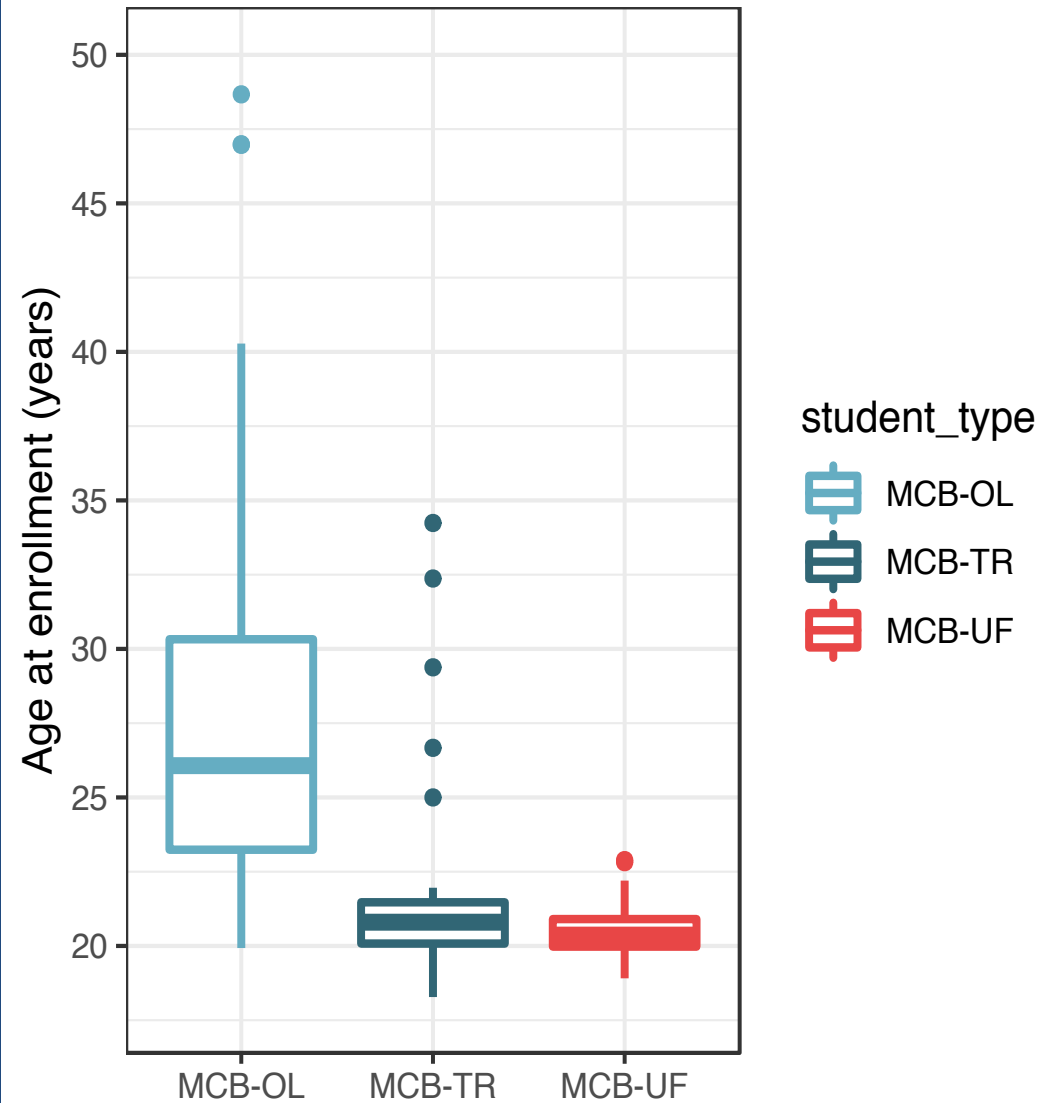
Two-thirds of Bootcamp students are female



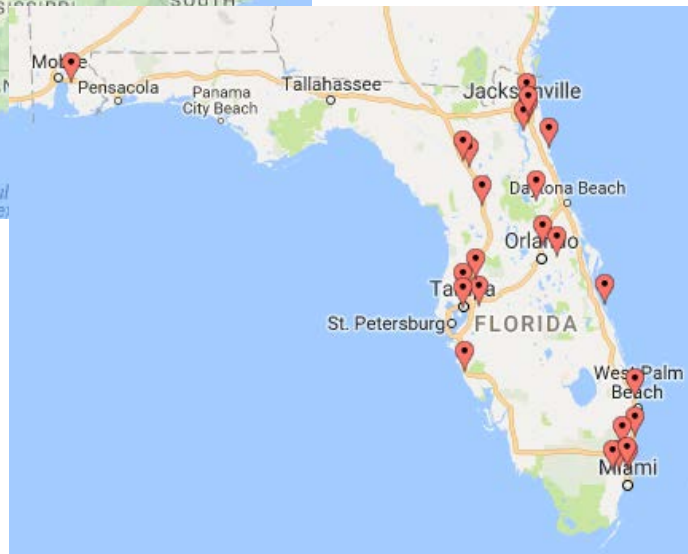
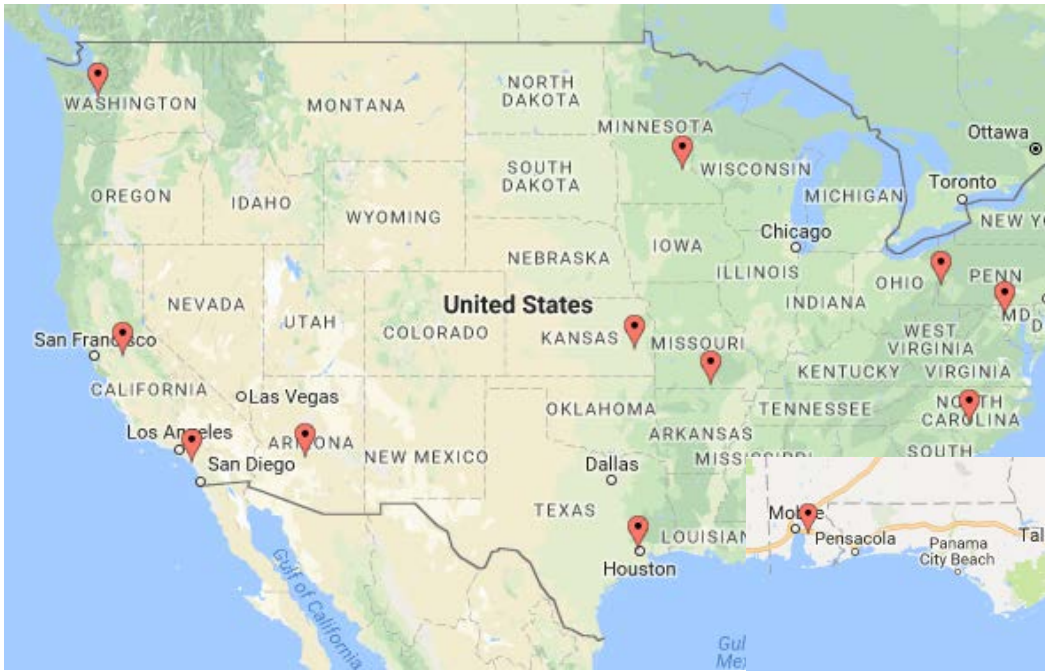
**On-campus,
non-transfer
students have
higher GPA**



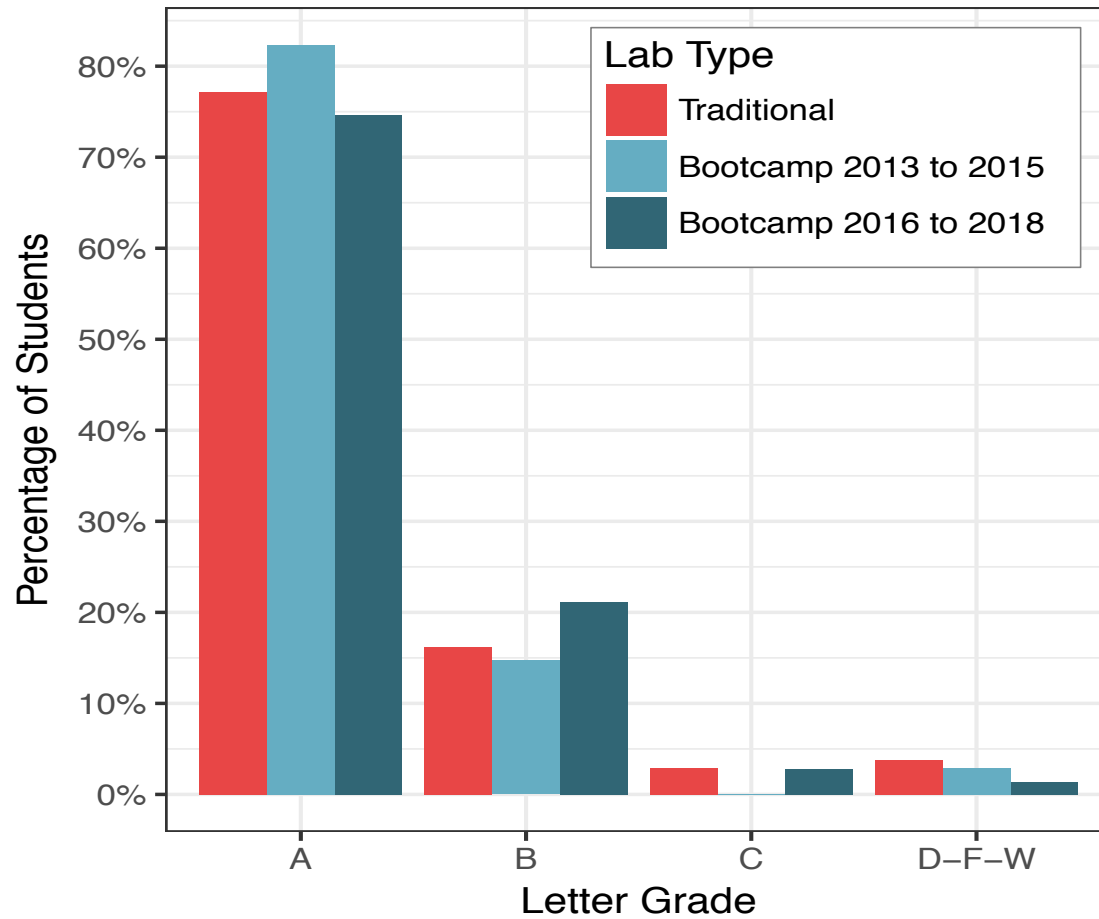
Online students are older than on-campus students



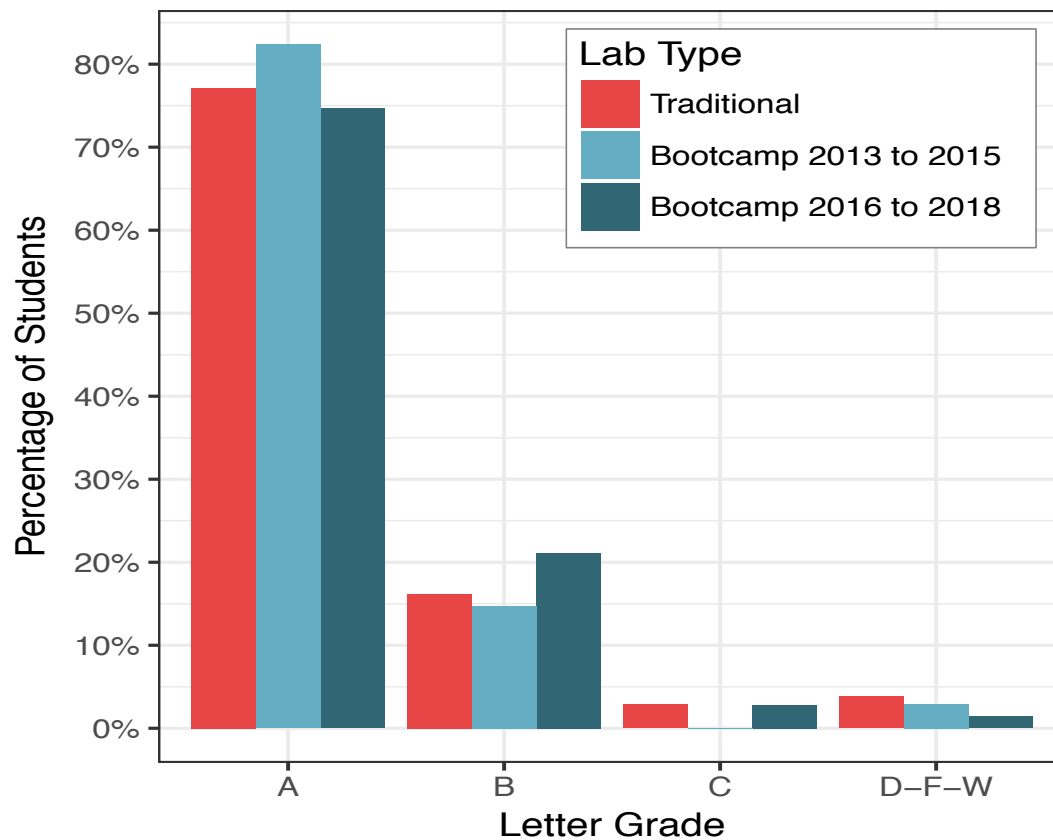
2018 Bootcamp Students



Comparable Grade Outcomes between Traditional and 11-day and 5-day Bootcamp Labs



Comparable Grade Outcomes between Traditional and 11-day and 5-day Bootcamp Labs



Predictors of Course Grade?

✓ GPA

Traditional/Bootcamp lab format type

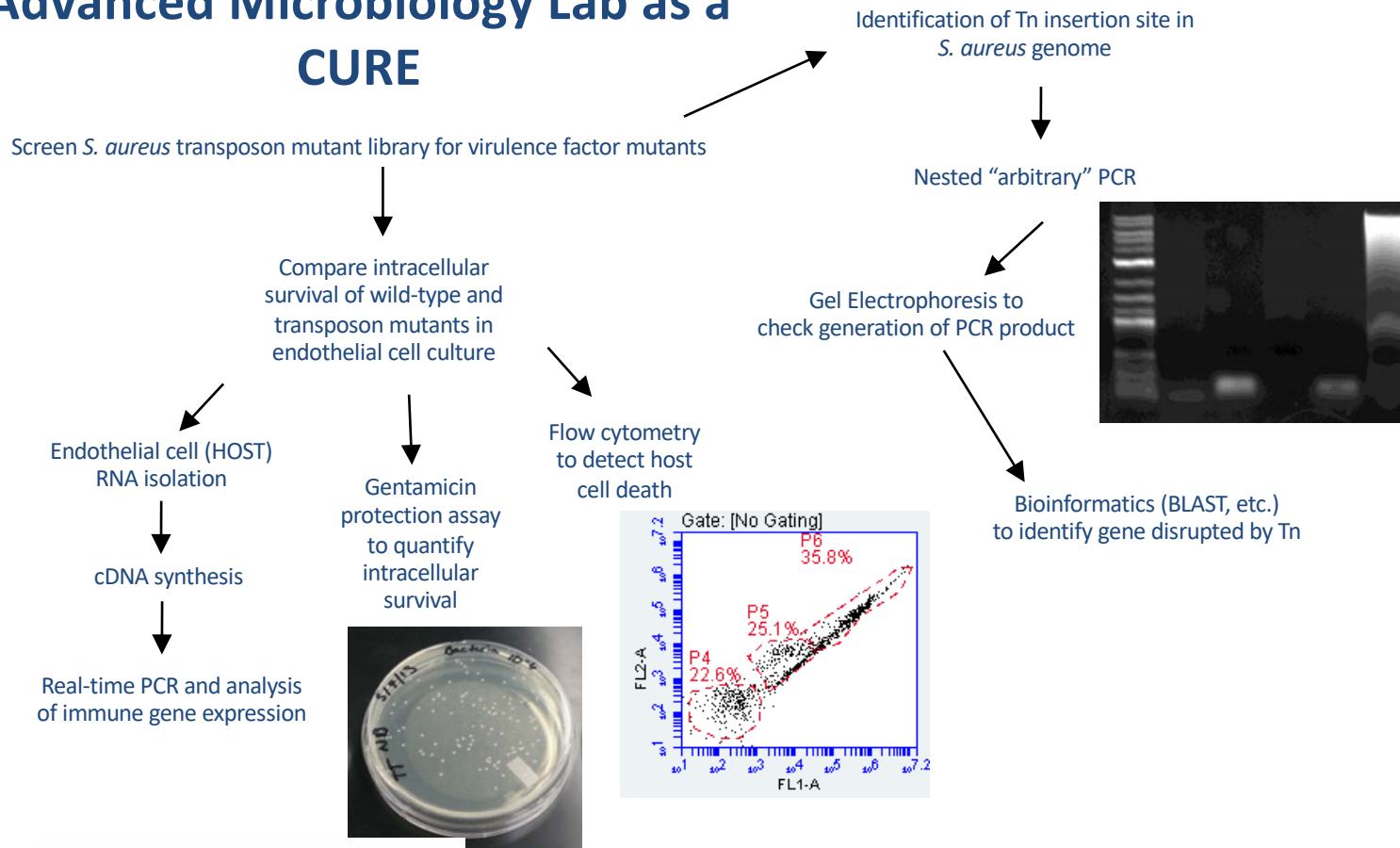
Type of student: on-campus/online

Sex

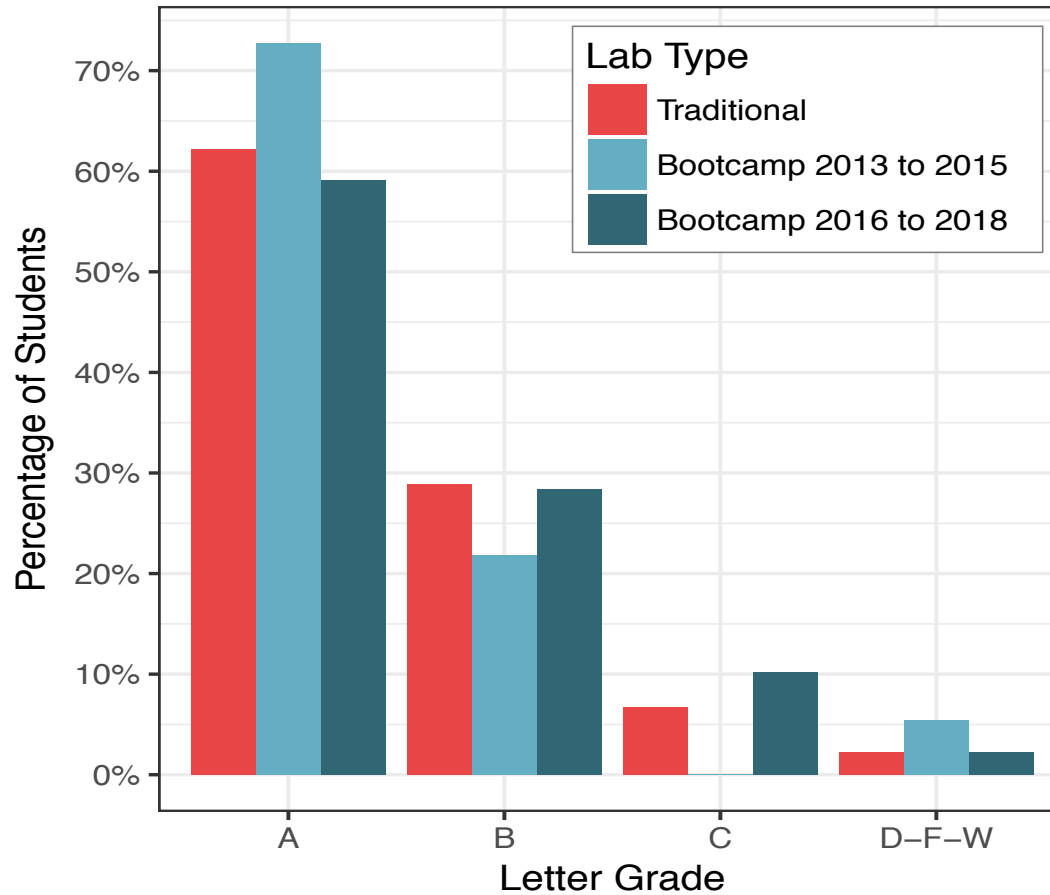
URM/non-URM

Higher GPA 9x more likely to receive an increased letter grade

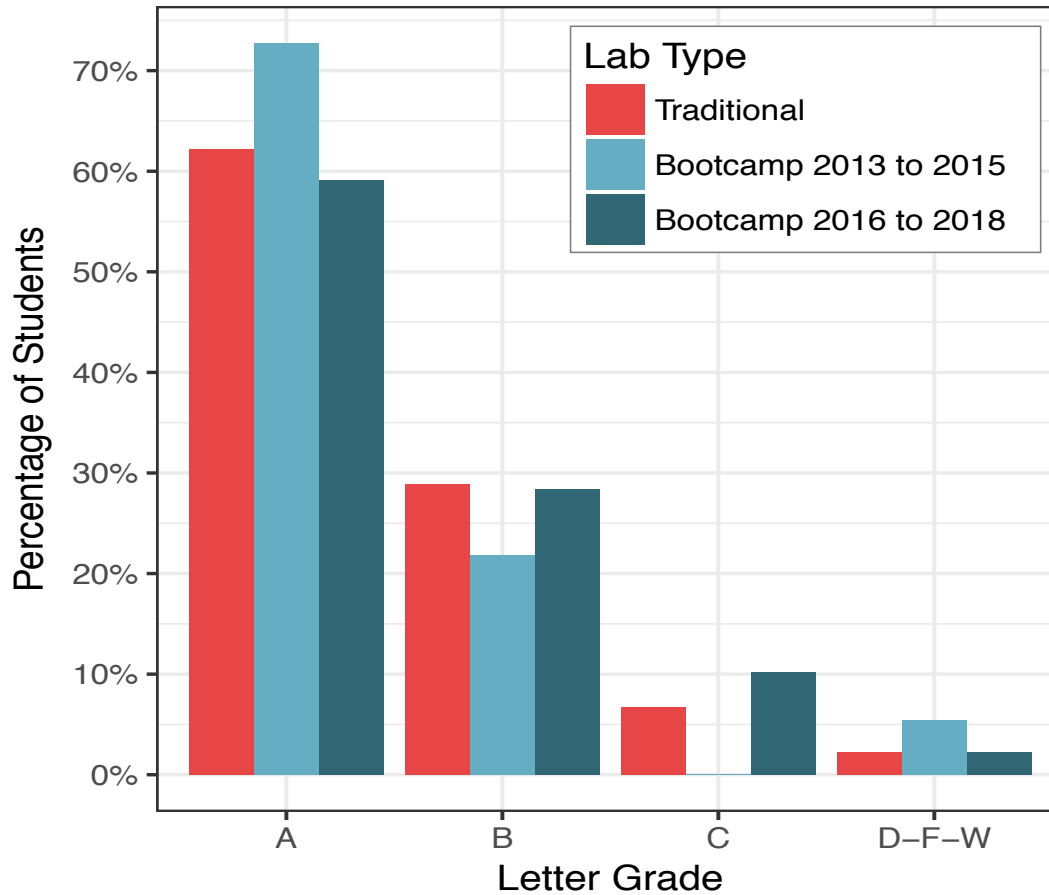
Advanced Microbiology Lab as a CURE



No difference in letter grade frequency between Traditional and Bootcamp Lab

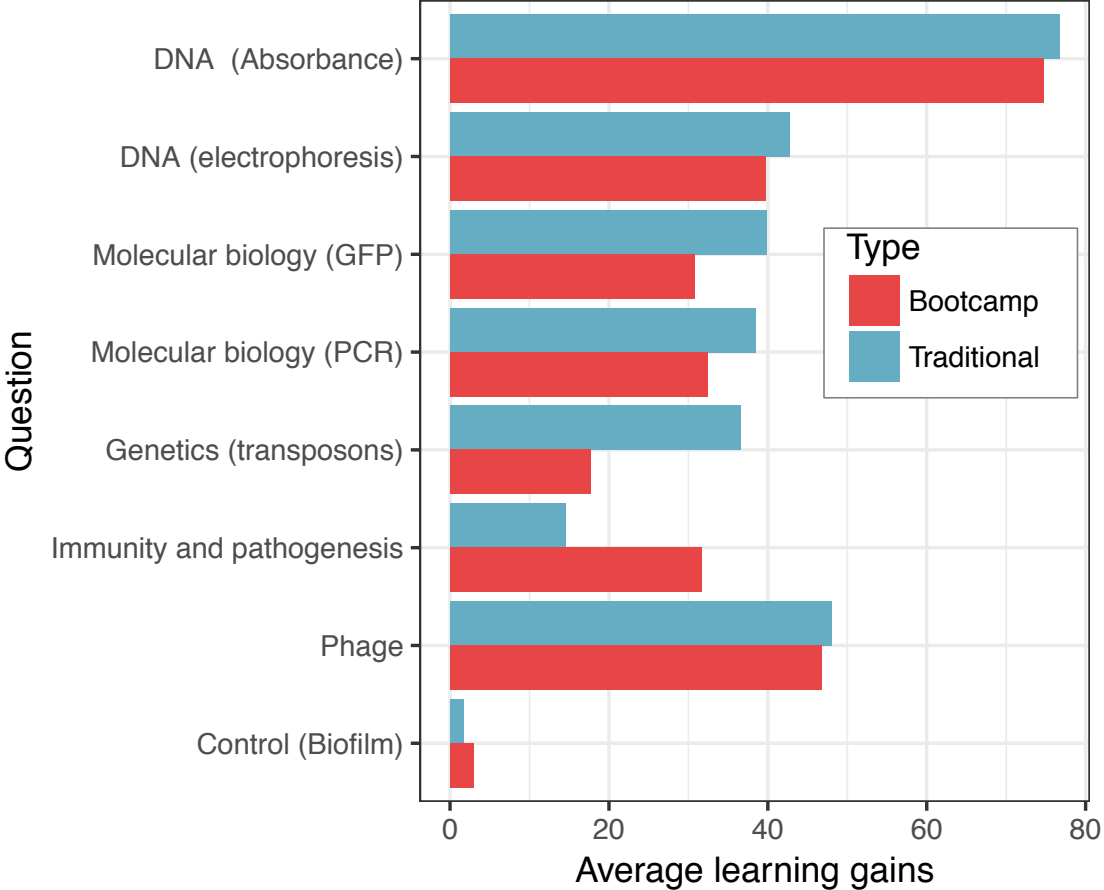


No difference in letter grade frequency between Traditional and Bootcamp Lab



GPA is still the best predictor of letter grade outcome in the labs.

Similar learning gains for Advanced Micro Lab



Key Findings

QUALITATIVE ANALYSIS

Focus groups

- 2016 & 2018 Bootcamp students (Principles & Advanced lab)
- 9 interview sessions, 48 students (37 online students)

Vital to the learning experience and to instill confidence

“hands-on is just extremely important. especially if you are going to go to a field that the whole point of learning is having those practical skills. if you are not in a lab, how are you going to learn those practical skills that you are going to need?” (Principles, 2016)

“I feel like I’ve got enough skills now that I can go and try to take up a position in the summer in some sort of lab. I feel confident enough to do that” (Principles, 2018)

Online course preparation facilitates success in bootcamp

“A lot of that stuff I did remember from just previously getting in there, taking the online boot camp. So, I did not feel confused at all. I think it benefit me quite a lot having gone straight from the [online] boot camp to the lab.” (Principles, 2018)

“How does a compressed format compare to other 16-week lab courses you have taken?”

Challenging but enhances the educational experience

Easier to maintain interest and motivation from start to finish.

Work in a “real-life” scenario, as if they were working on a lab, instead of going to class. All the interviewed agreed that this format was a better preparation for life, and for finding a job afterward.

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“It’s almost like conducting actual research lab in which you would be working on.”

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“It’s almost like conducting actual research lab in which you would be working on.”

“I’ve actually learned better with it being so condensed”.

Could a compressed format be a better way to learn than a 16-week format?

Conclusions and Broader Impacts

Bootcamps are a model of STEM education that:

Are comparable to semester labs in grade outcomes, learning gains

Can increase access and diversity

Can enhance the learning process

Manuscript is accepted

Suggests compressed labs may be *more effective* than semester labs

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Bootcamps are a model of STEM education that:

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Suggests compressed labs may be *more effective* than semester labs

Online 2+2 program has led to unexpected ways to improve STEM education overall

Acknowledgements

Monika Oli

Eric Triplett

Lexi Ardisson

Kelly Rice

Sebastian Galindo-Gonzalez

Macarena Urrets-Zavalía

Jonathan Orsini

Microbiology & Cell Science Team

Al Wysocki

Elaine Turner

UF Online

Marie Zeglen

Institutional Planning and Research

Miami Dade College



Supplemental Slides

Student/Instructor feedback drive the evolution

- ✓ Online module prep + 5-day bootcamp is preferred by students
- ✓ Providing visuals, tutorials, and lab modules prior to lab (24/7 access)
- ✓ Providing 1-day break between Principles and Advance Micro labs (5 days + 5 days)
- ✓ Student motivations vary and for many, bootcamp is the only option
- ✓ Hands on lab experience is appreciated by student body

Instructor perspective

Challenging, exhausting, need to be able to gauge students progress, improvise and be flexible

How do you persuade instructors to do this? (hint: It's more challenging to have GTAs teach the bootcamps)

Benefit: teach in 5-7 days vs. 16 weeks

"I would rather switch my semester lab for a bootcamp lab anytime" (Monika Oli, 2018)

Logistics and Challenges

Student Cost to travel/stay in Gainesville

Student availability - taking PTO or leave without pay

UF Housing coordination

Lab timing/scheduling, teaching lab space

Need weekend lab prep staff

Exhausted and overwhelmed students (*especially if they are used to work at their own pace online*)

Uniqueness of our program

2+2 transfer program and 1+1 hybrid bootcamp lab

Access to online tools before, during, and after → our own tools (lab skills video, virtual field trips), subscription resources (Gideon, Excel) and publicly available tools (Bioinformatics)

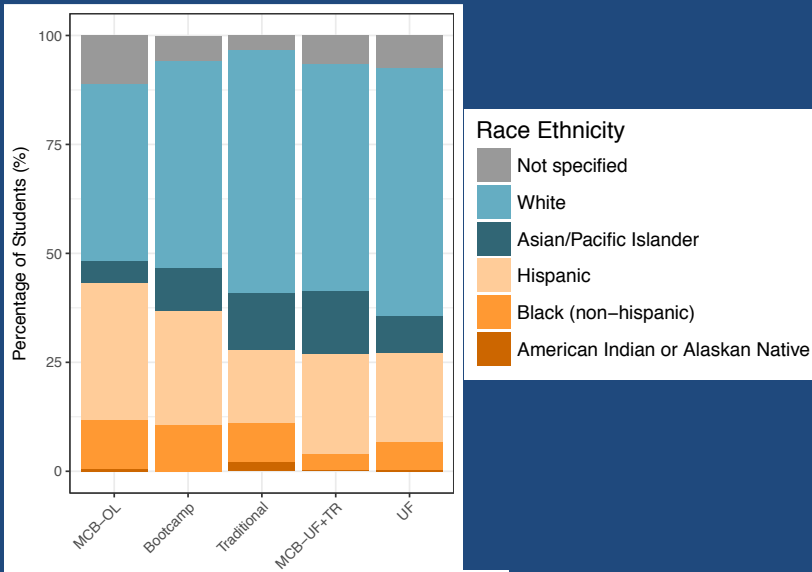
Expectation is to use resources, tools, critical thinking, quantitative and analytical skills, presentations

Opportunity for interaction, teamwork, networking with students and faculty

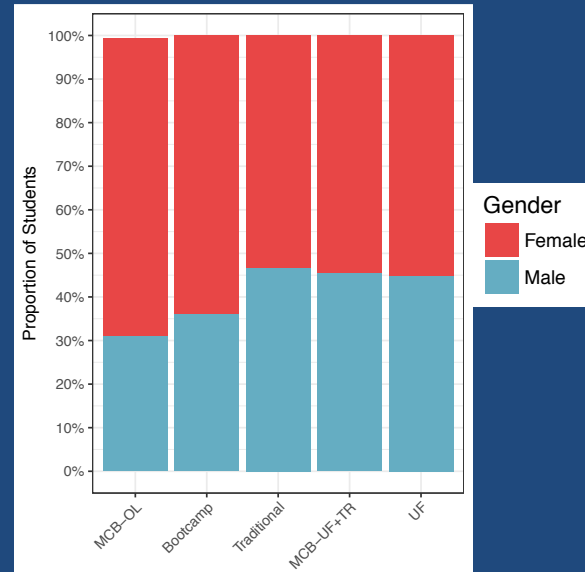
Table 2. Enrollment in traditional and bootcamp formats of Principles of Microbiology Lab and Advanced Microbiology Lab for Microbiology and Cell Science majors in the College of Agricultural and Life Sciences. Student type within each lab course and format is indicated. Lab course totals (N) represents enrollment observations, not unique student counts.

Course	Type	2011	2012	2013	2014	2015	2016	2017	2018
Principles of Microbiology (N=210)	Traditional (UF:TR:OL)	-	-	10 (8:2:0)	17 (8:9:0)	19 (12:7:0)	22 (9:13:0)	25 (18:7:0)	12 (9:3:0)
	Bootcamp (UF:TR:OL)	-	-	4 (0:0:4)	15 (0:0:15)	15 (1:2:12)	20 (2:0:8)	21 (0:1:20)	30 (0:0:30)
Advanced Microbiology (N=233)	Traditional (UF:TR:OL)	17 (13:4:0)	41 (25:16:0)	32 (22:10:0)	-	-	-	-	-
	Bootcamp (UF:TR:OL)	-	-	10 (2:3:5)	16 (7:7:2)	29 (6:7:16)	29 (1:2:26)	26 (0:0:26)	33 (0:0:33)

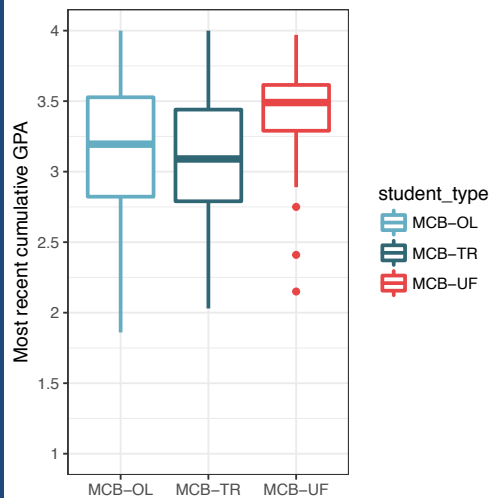
A



B



C



Supplemental. Demographics and GPA for Advanced Microbiology Lab students is comparable to Principles of Microbiology Lab.

- (A) Bootcamp labs tend to host more URM students than the traditional lab format, though not significant (p -value = 0.148, Fisher's exact test). This is represented at the program level, where MCB-OL students are more diverse than MCB-UF+TR students; the latter being comparable to university-level (UF) demographics.
- (B) Bootcamp and traditional lab formats host a comparable ratio of female:male students (p -value=0.131, Fisher's exact test). There tends to be increased representation of female students in the Bootcamp lab and MCB-OL compared to the traditional lab, MCB-UF+TR, and university-wide (UF).
- (C) MCB-UF students enrolled in Advanced Microbiology lab have increased cumulative GPA (p -value<0.001, ANOVA) compared to MCB-OL and MCB-TR students.

Figure 2 Statistical Test Results (Advanced Lab)

Fisher's Exact Test results for Race:

Groups	d f	p-value
All groups	4	0.1554

Groups	OR	95% CI	p-value
URM vs. non-URM	0.629	0.335:1.163	0.1481

	Non-URM	URM
Bootcamp	81 (60.9%)	52 (39.1%)
Traditional	62 (71.3%)	25 (28.7%)

Fisher's Exact test results for Gender

Groups	OR	95% CI	p-value
F vs. M	1.54	0.869:2.74	0.1308

	Female	Male
Bootcamp	90 (63.8%)	51 (36.2%)
Traditional	48 (53.3%)	42 (46.7%)

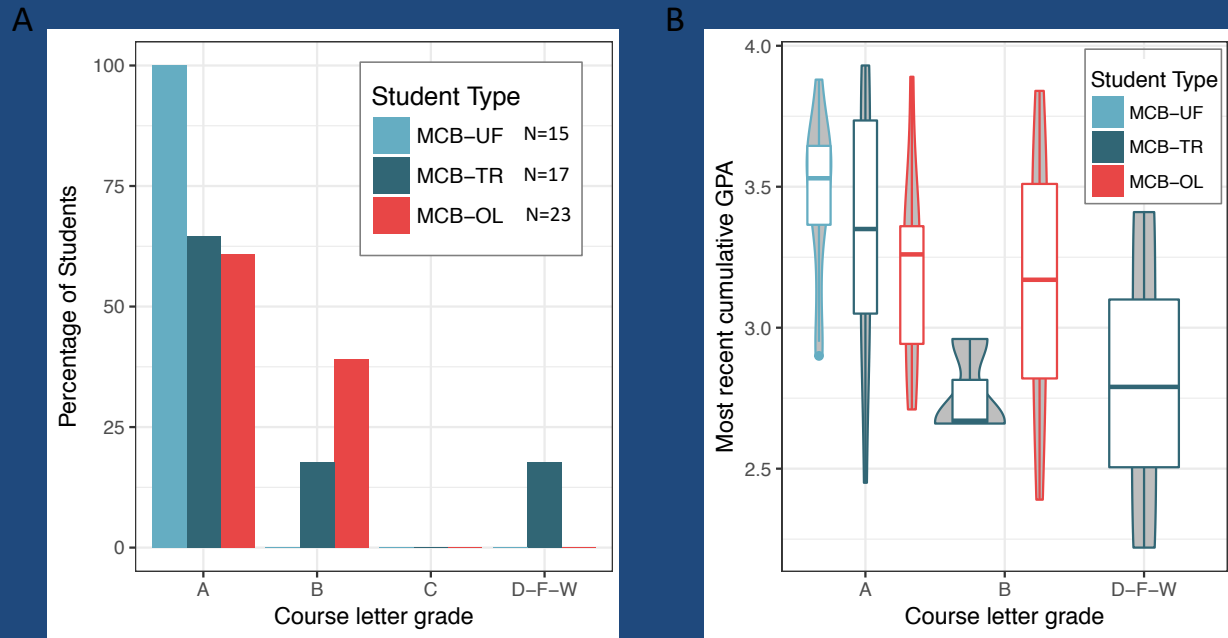
GPA: ANOVA with Tukey correction for pairwise comparisons:

Student type	Mean	SD
MCB-UF	3.42	±0.33
MCB-TR	3.11	±0.47
MCB-OL	3.14	±0.50

Comparison	Difference	95% CI	p-value
MCB-UF vs MCB-TR	0.314	0.12:0.51	4.72e-4
MCB-UF vs MCB-OL	0.283	0.12:0.44	1.06e-4
MCB-TR vs MCB-OL	-0.031	-0.21:0.15	0.915

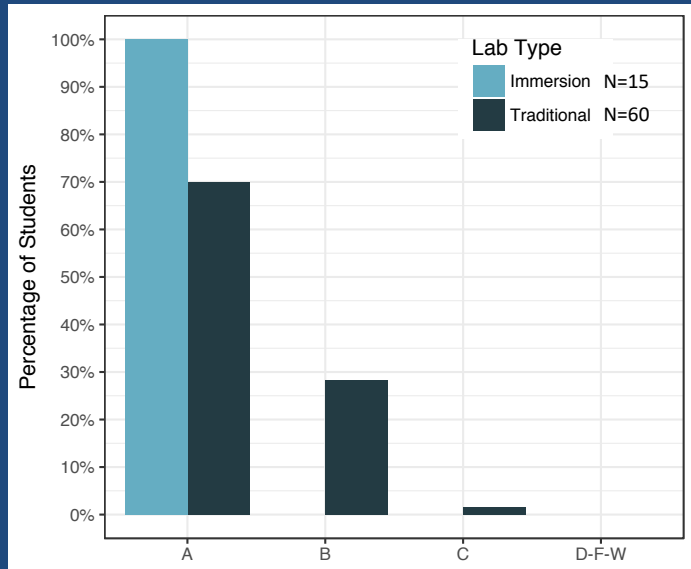
Supplemental Table. Race and ethnicity demographics by lab format for Principles of Microbiology and Advanced Microbiology labs.

Race/Ethnicity	Principles of Microbiology Lab (N=209)		Advanced Microbiology Lab (N=231)	
	Bootcamp (2013-2018)	Traditional (2013-2018)	Bootcamp (2013-2018)	Traditional (2011-2013)
White	49 (46.7%)	56 (53.8%)	67 (47.5%)	50 (55.6%)
Hispanic	25 (23.8%)	21 (20.2%)	37 (26.2%)	15 (16.7%)
Asian/Pacific Islander	10 (9.5%)	19 (18.3%)	14 (9.9%)	12 (13.3%)
Black (non-Hispanic)	12 (11.4%)	5 (4.8%)	15 (10.6%)	8 (8.9%)
Not specified	7 (6.7%)	3 (2.9%)	8 (5.7%)	3 (3.3%)
American Indian/Alaskan Native	2 (1.9%)	0 (0%)	0 (0%)	2 (2.2%)
Total	105	104	141	90

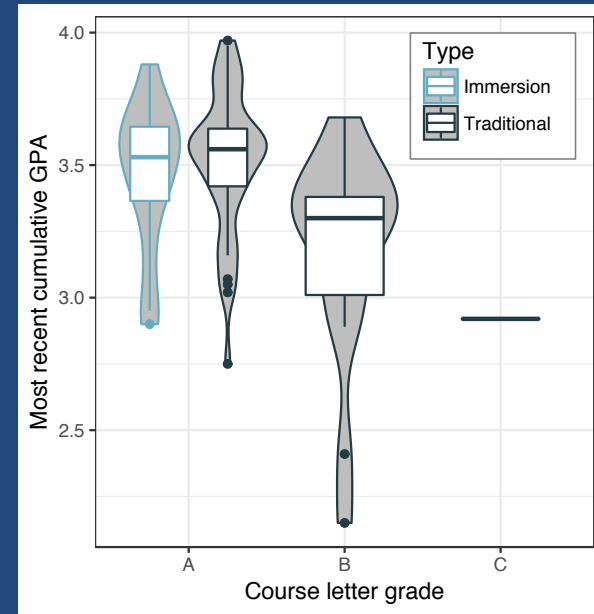


Supplemental. Advanced Microbiology Bootcamp Labs from 2013 to 2015 enrolled all 3 students types, MCB-UF, MCB-TR, and MCB-OL, thus permitting comparison of the course outcomes between these groups of students. (A) All MCB-UF students enrolled in the Advanced Microbiology Bootcamp labs between 2013 and 2015 received As, leading to a significant difference in course grade frequency between student type (Fisher's Exact test, p -value=0.003). However, (B) course grade and cumulative GPA is highly correlated, and students receiving As in the lab, regardless of students type, also have higher GPAs. Therefore, and difference in course grade outcome between student type is better explained by overall student performance as indicated by GPA. This was observed in ordinal regression results (Table 4), which showed that there was no difference in course grade outcome between student types when controlling for GPA.

A

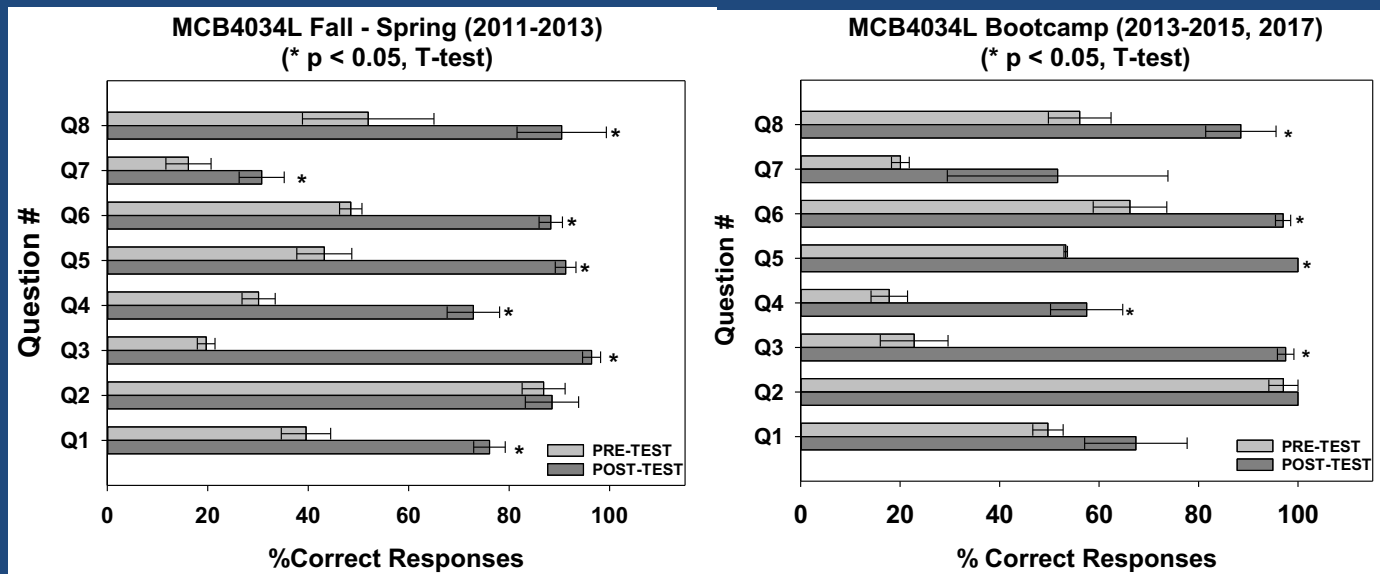


B



Supplemental. (A) When comparing course grade frequency, MCB-UF students taking Advanced Microbiology Bootcamp Labs from 2013 to 2015 have improved course outcomes compared to their counterparts taking the traditional format of Advanced Lab (Fisher's Exact test, p -value = 0.028). However, (B) MCB-UF students taking Advanced Bootcamp lab also had higher cumulative GPA. Therefore, controlling for GPA, MCB-UF students similarly in the Bootcamp compared to the traditional formats of Advanced Microbiology lab.

Supplemental



GPA is the best predictor of letter grade outcome in the labs. Lab format did not affect performance

Predictor	OR (CI)	p-value
GPA	9.333 (4.52:20.8)	<0.001 (7.25e-9)
Lab format	1.855 (0.144:63.5)	0.689
Student type: MCB-TR	1.217 (0.435:3.46)	0.708
MCB-OL	1.272 (0.038:18.4)	0.877
Sex - Male	0.460 (0.215:0.97)	0.042
Race/Ethnicity - URM	0.685 (0.319:1.49)	0.333

...what about Advanced lab?