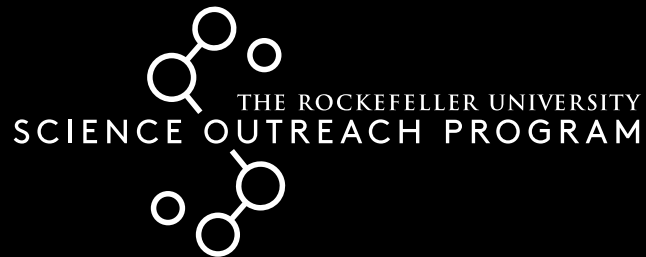


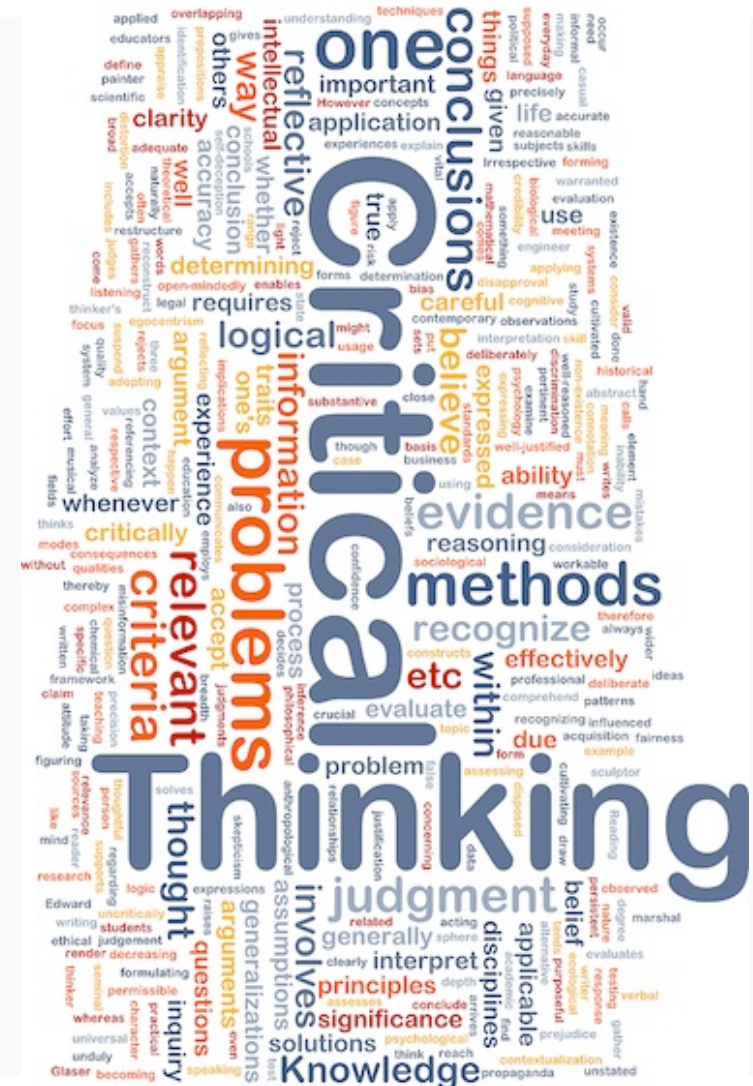
To Swab Is To Teach



Jeanne Garbarino, PhD
@JeanneGarb
@Rockedu_
#Rockedu

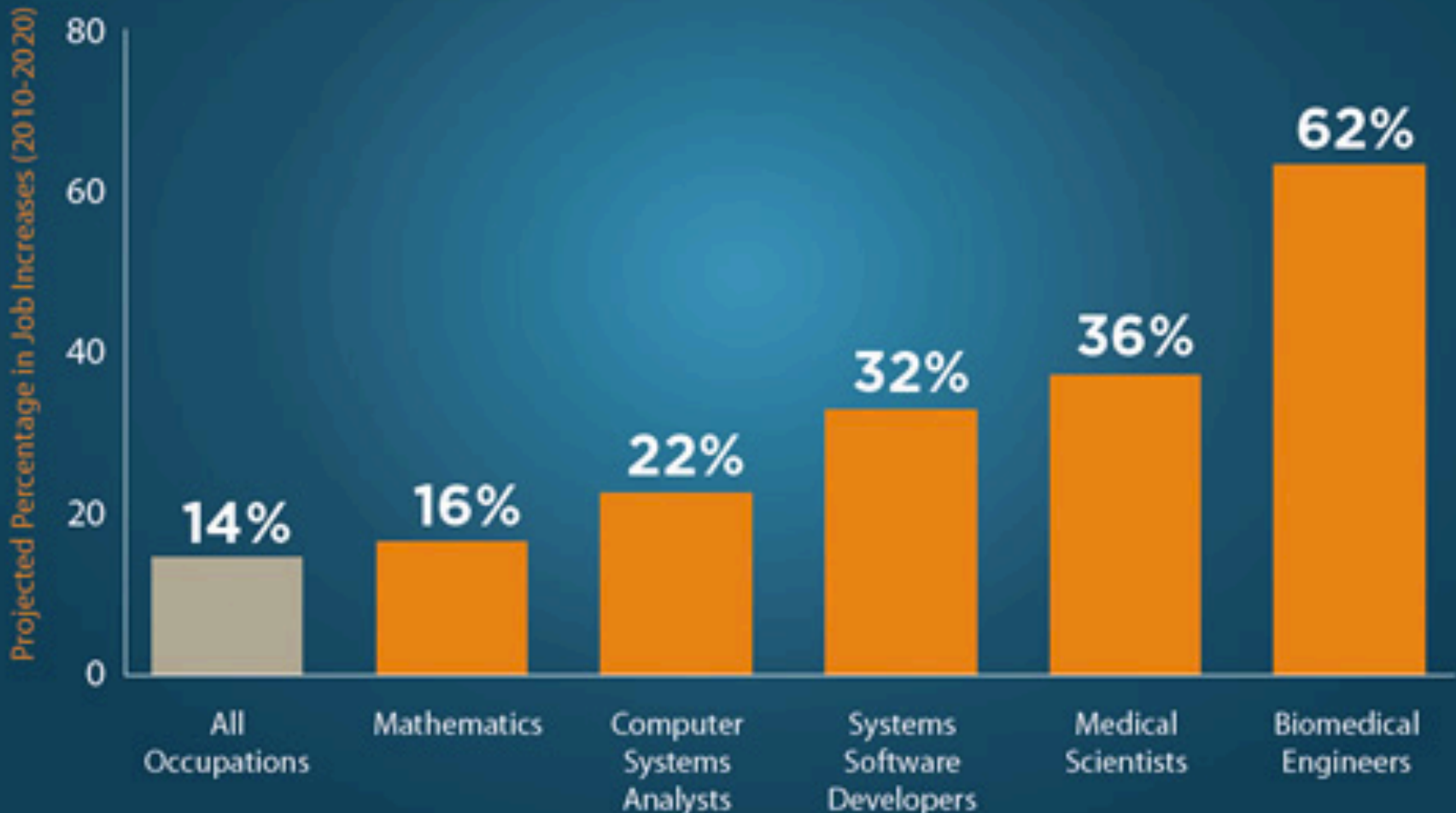
We All Agree: STEM Education is Important

- Inherent to STEM training is the development of critical thinking skills
- This is important for both STEM and non-STEM careers
- STEM education correlated with higher paying jobs
 - Potential to decrease wage gap, particularly for socioeconomically disadvantaged

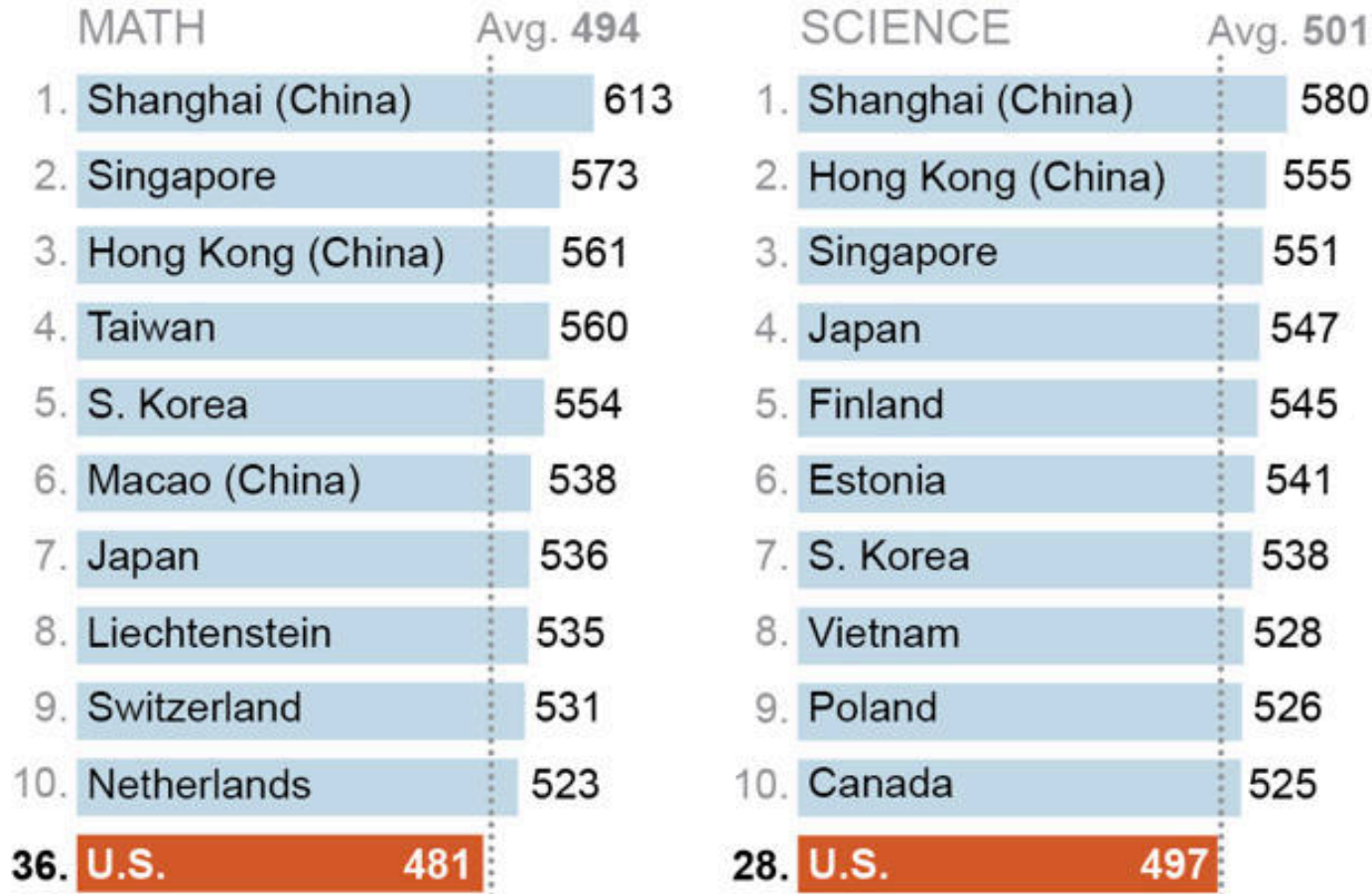


Recent and Projected Growth in Employment in the United States (2010 – 2020)

<http://www.ed.gov/stem>



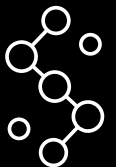
International Rankings for Science and Math (2012)



Programme for International Student Assessment (PISA)

This is a global standardized test given to 15 year old students.

The purpose is to gauge educational success and creativity.



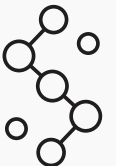
US Schools: Expensive and Unchanging

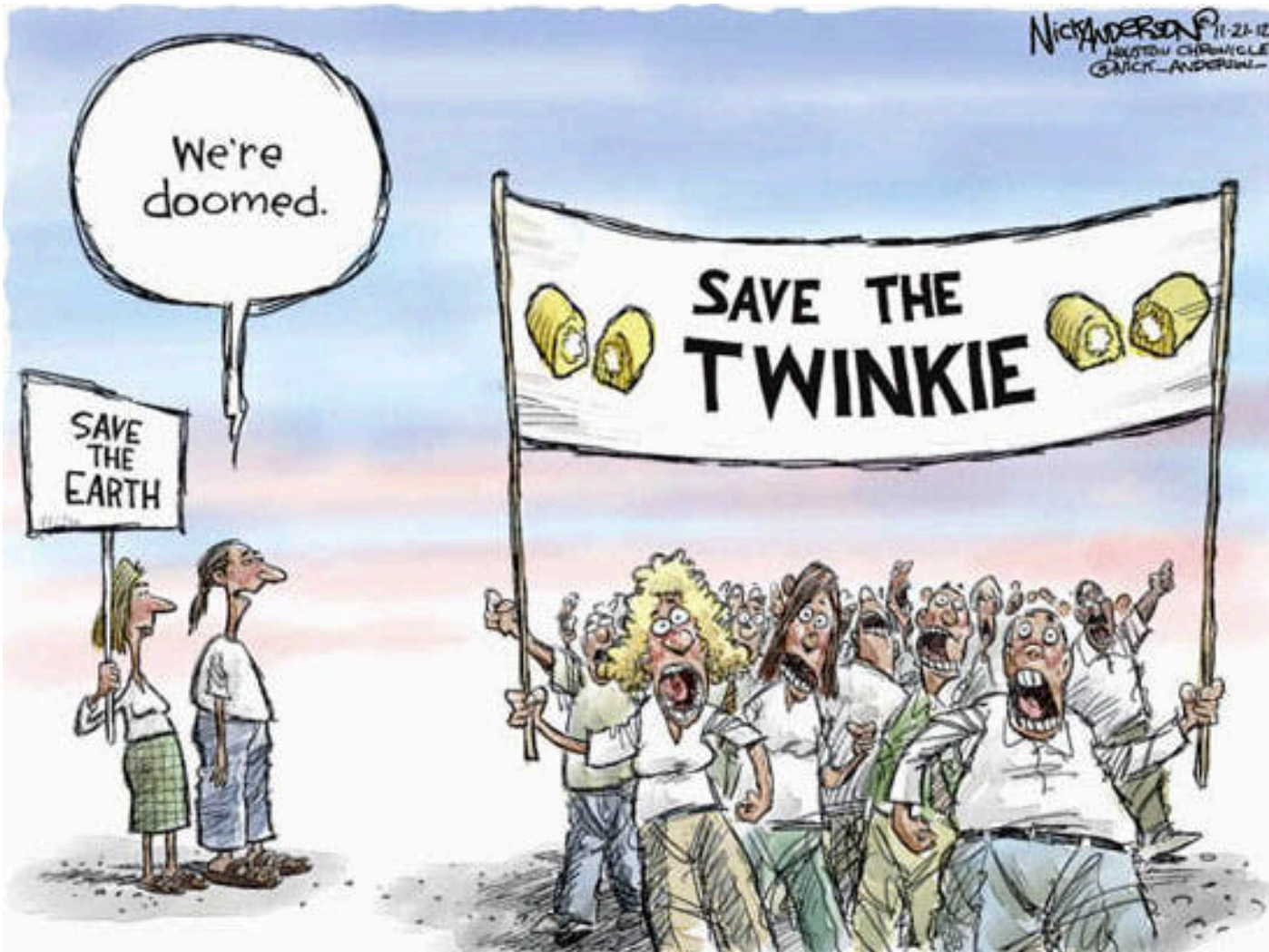
- The US spends approximately \$12,000 per full-time K-12 student.
 - This is 35% higher than other nations in the OECD Convention*
 - Despite the amount we spend, performance has not improved in years

Hyper-Testing. Teacher Sanctioning. Lack of Resources.
This all leads to compartmentalized, surface level science instruction.

**THE LEARNING OF SCIENCE RESEMBLES
NOTHING OF THE PRACTICE OF SCIENCE.**

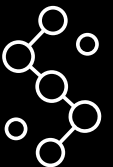
* Convention on the Organization of Economic Cooperation and Development includes 34 nations





The Repercussions are Real.

- Vaccinations
- Climate change
- GMOs
- Hyped media
- Act out of fear, not fact
- General apathy



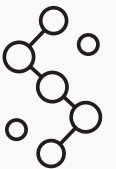
New Standards for Science Education

Next Generation Science Standards (NGSS)

- Organized by the National Academy of Sciences
- Based on the intersection of knowledge and application
- Emphasis on cross-cutting principles to integrate *all* science and engineering disciplines

Overarching goals:

- Instill general appreciation
- Public engagement on issues related to science
- Develop critical thinking
- Empower students to find the career of their choosing.



Science and Engineering Principles

- Asking questions, defining problems
- Planning and executing investigations
- Analyzing data, mathematical modeling
- Using evidence to construct arguments

Emphasis on the Human Built World

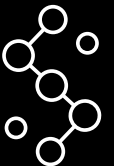
- How does the natural world interact with human infrastructure?
- How do the life sciences integrate with engineering principles?

Relevant Entry Points and Big pictures

- How does [enter scientific concept] this relate to the students?
- Why should students care?

NGSS Framework

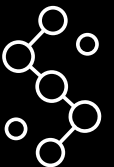
From *A
Framework for
K-12 Science
Education*,
National
Academies
Press, 2011.



Microbiome Research:

A perfect platform for integrating *relevant and accessible* knowledge and application for students, while providing a wide breadth of scientific experience

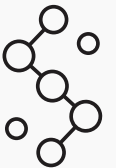
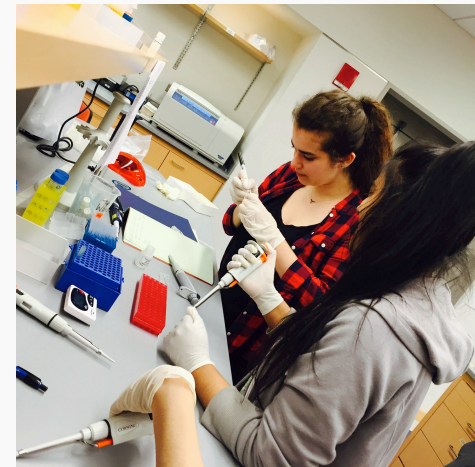
Addresses the goals of the NGSS, particularly regarding the nexus of the built and natural environment



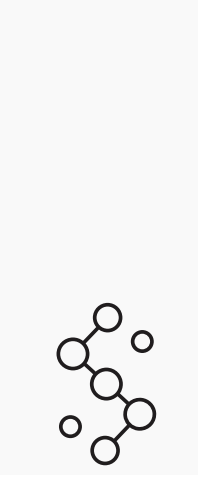
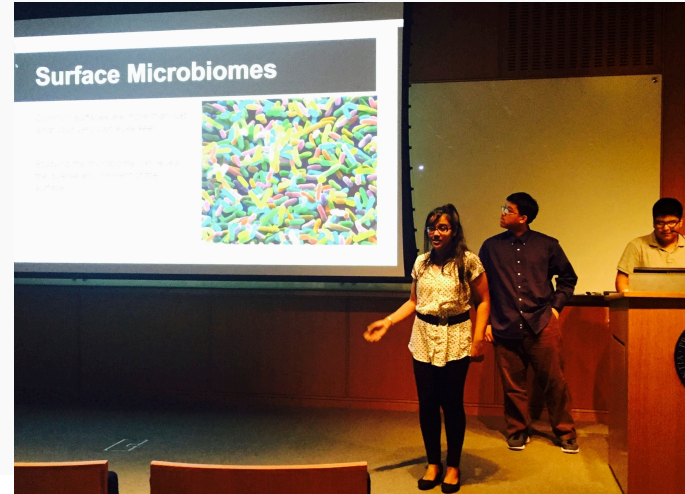
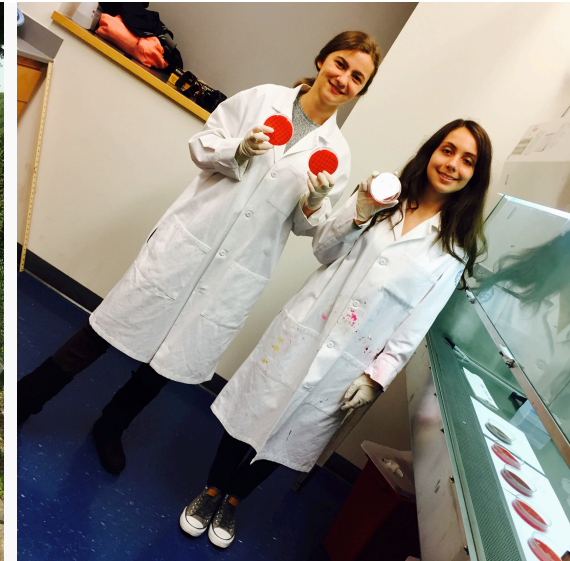
Connecting HS Students to Microbiome Research

Learning At the Bench (LAB) Initiative:

- Provides students an opportunity to learn by discovery
- Encourages students to come up with their own research question – explore what interests them!
- Puts the investigative power into their hands – empowers students and creates buy-in
- Connects Students to scientists – breaks stereotypes



The Pen Swab is Mightier Than the Sword!



Students as Investigators

The Microbiomes of Central Park Water Fountains

Will Lounsbury-Scaife, Elias Pineda, Nell Kirchberger, Anya Auerbach, Anya Dunaif, Jonathan Schneiderman PhD, Elizabeth Waters PhD, Jeanne Garbarino PhD
Science Outreach Teaching Laboratory, Rockefeller University

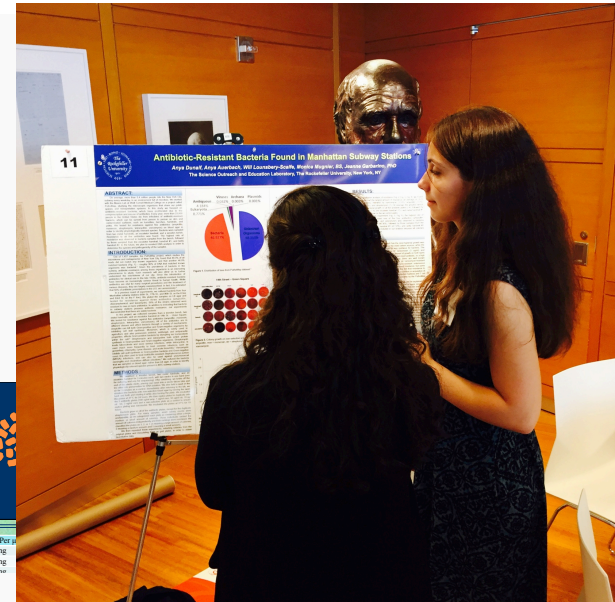
SUMMARY

Hundreds of thousands of people use Central Parks' drinking fountains every day. Previous reports have shown disease outbreaks caused by drinking from public fountains, so we wanted to test the cleanliness of the ones in Central Park. To test



MATERIALS & METHODS

Moving from the Northern tip of the park downwards, we sampled the selected fountains for three minutes each with two synthetic swabs—one on the bowl and one on the spout. Back in the lab, we used



Microbial Accumulation On Surfaces With Frequent Skin Contact

Anya Auerbach, Jonathan Schneiderman PhD, Elizabeth Waters PhD, Jeanne Garbarino PhD
The Science Outreach and Education Lab, The Rockefeller University, New York, NY

SUMMARY

Microbes are found all around us, interacting

Although the Mason Lab's study tells us about bacterial

Trials One and Two:

- The first six samples collected from just the ticket

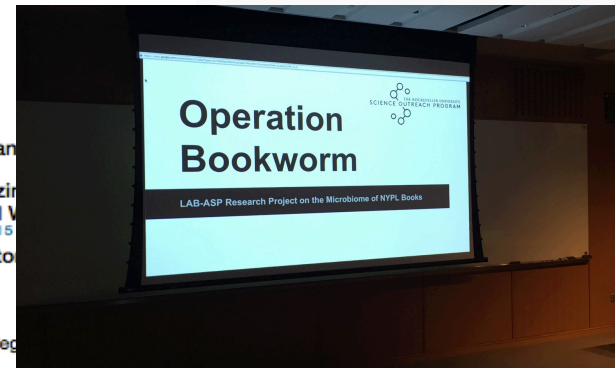
Sample #	# of handles	Tween Y/N	Yield Per
18	3	Y	< 0.5 ng
19	3	N	< 0.5 ng
20	3	N	< 0.5 ng

Geospatial Resolution of Human and Bacterial Diversity with City-Scale Metagenomics

Ebrahim Afshinnekoo,^{1,2,3,21} Cem Meydan,^{1,2,21} Shanin Chowdhury,^{1,2,4} Dyala Jaroudi,^{1,2} Collin Boyer,^{1,2} Nick Bernstein,^{1,2} Julia M. Maritz,⁵ Darryl Reeves,^{1,2,6} Jorge Gandara,^{1,2} Sagar Chhangawala,^{1,2} Sofia Ahsan Amber Simmons,^{1,2} Timothy Nease,⁸ Bharath Sundaresh,⁸ Elizabeth Pereira,⁸ Ellen Jorgensen,⁹ Sergios-Orestis Kolokotronis,¹⁰ Nell Kirchberger,^{1,2} Isaac Garcia,^{1,2} David Gandara,^{1,2} Sean Dhanraj,⁷ Tanzir Yogesh Saletore,^{1,2,6} Noah Alexander,^{1,2} Praveena Vijayaraj,¹¹ Elizabeth M. Hénaff,^{1,2} Paul Zumbo,^{1,2} Michael V. Gregory D. O'Mullan,³ Scott Tighe,¹² Joel T. Dudley,³ Anya Dunaif,¹⁴ Sean Ennis,^{15,16} Eoghan O'Halloran,¹⁵ Tiago R. Magalhaes,^{15,16} Braden Boone,¹⁷ Angela L. Jones,¹⁷ Theodore R. Muth,⁷ Katie Schneider Paolanto Elizabeth Alter,¹⁸ Eric E. Schadt,¹³ Jeanne Garbarino,¹⁴ Robert J. Prill,¹⁹ Jane M. Carlton,⁵ Shawn Levy,¹⁷ and Christopher E. Mason^{1,2,20,*}

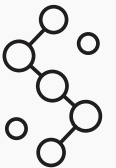
¹Department of Physiology and Biophysics, Weill Cornell Medical College, New York, NY 10065, USA

²The HRH Prince Alwaleed Bin Talal Bin Abdulaziz Alsaud Institute for Computational Biomedicine, Weill Cornell Medical College, New York, NY 10065, USA



Benefits to Scientists

- Human Power!
 - Data collection often requires an army
 - DNA extractions are straightforward – students can easily follow MoBio protocols
 - Students are inherently computer savvy and can work with data output
 - Keeps mentoring skills sharpened
 - Broader Impacts!!
- You get to learn what words like “fleek” and “brick” mean.

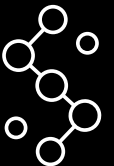




**KEEP
CALM
AND
SWAB
ON**

For
Science!

And Science
Education!



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The Rockefeller University

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Paul Zumbo

The Pinkerton Foundation

Brooke Astor One Year Fund

Dreyfus Foundation

Barnard

Krista McGuire

NAC

Clara Pregitzer

