From Podcasts to Primary Literature: Engaging students in OER design and use

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Why?

- Spring/Summer 2020 saw the loss of many “in person” internship opportunities due to COVID-19 restrictions
- Disconnect between what students think scientists do and what we actually do; Scientists read, write, present, and use primary literature
- Primary literature has a steep learning curve

Why Science Literacy?

- ASM, GSA, and AAAS's Vision and Change for biology education and focus on both content knowledge and core competencies.
- Overlap with CURE best practices:
  - Experimental design
  - Data analysis
  - Communication of results (in multiple contexts)
  - Quantitative reasoning
  - Ethical Considerations

Part 2: Competencies and Skills

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.

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  - Data analysis
  - Communication of results (in multiple contexts)
  - Quantitative reasoning
  - Ethical Considerations

Core Competencies

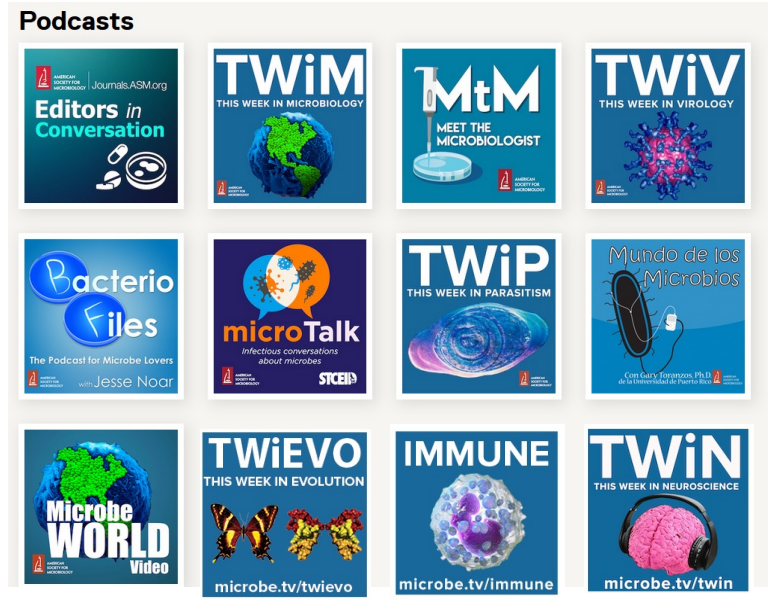
Additionally, all GSA PREP and related resources promote proficiency in at least one core competency listed below (see Vision and Change).

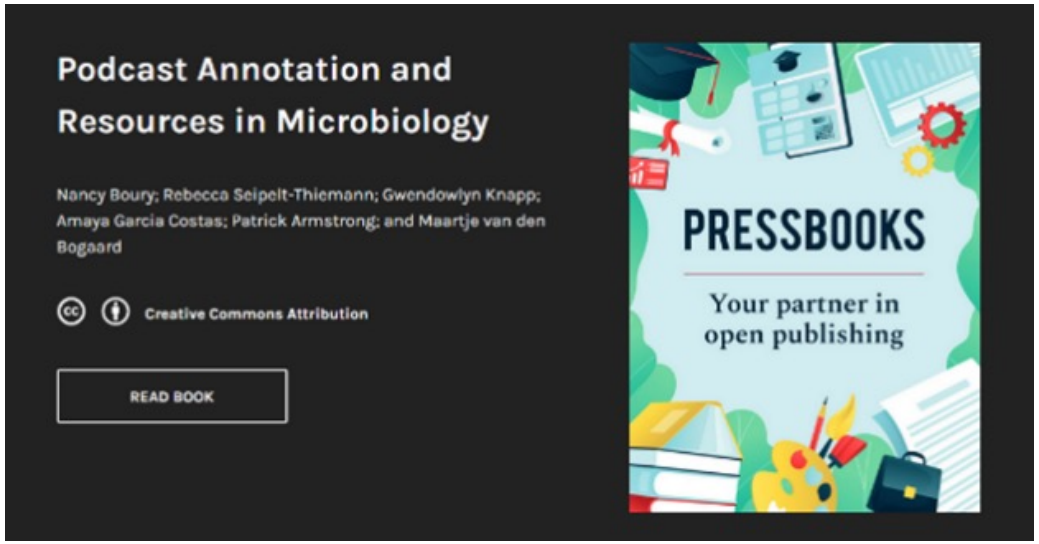
Students should be able to:

- Locate, read, and comprehend primary literature research papers on genetics topics;
- Implement observational strategies to formulate a question;
- Generate testable hypotheses;
- Design an experiment using appropriate controls and appropriate sample sizes;
- Gather and evaluate experimental evidence, including qualitative and quantitative data;
- Apply statistical methods when analyzing their data, and use patterns to construct a model;
- Generate and interpret graphs displaying experimental results;
- Critique large data sets and use bioinformatics to assess genetics data;
- Communicate experimental results effectively, including writing research papers and giving presentations;
- Effectively explain genetics concepts to different audiences;
- Tap into the interdisciplinary nature of science;
- Identify and critique scientific issues relating to society or ethics.

What?

- Utilize scientific podcasts for a digital science literacy internship
  - Students are involved two-fold; faculty lead the team
- Goals of DOING Annotation –
  - interns gain a deeper and applied understanding of their coursework and
  - produce a resource that faculty can use in their classes
- Goals of USING Annotations –
  - students hear scientists talk about science and
  - engage in reading figures and primary literature



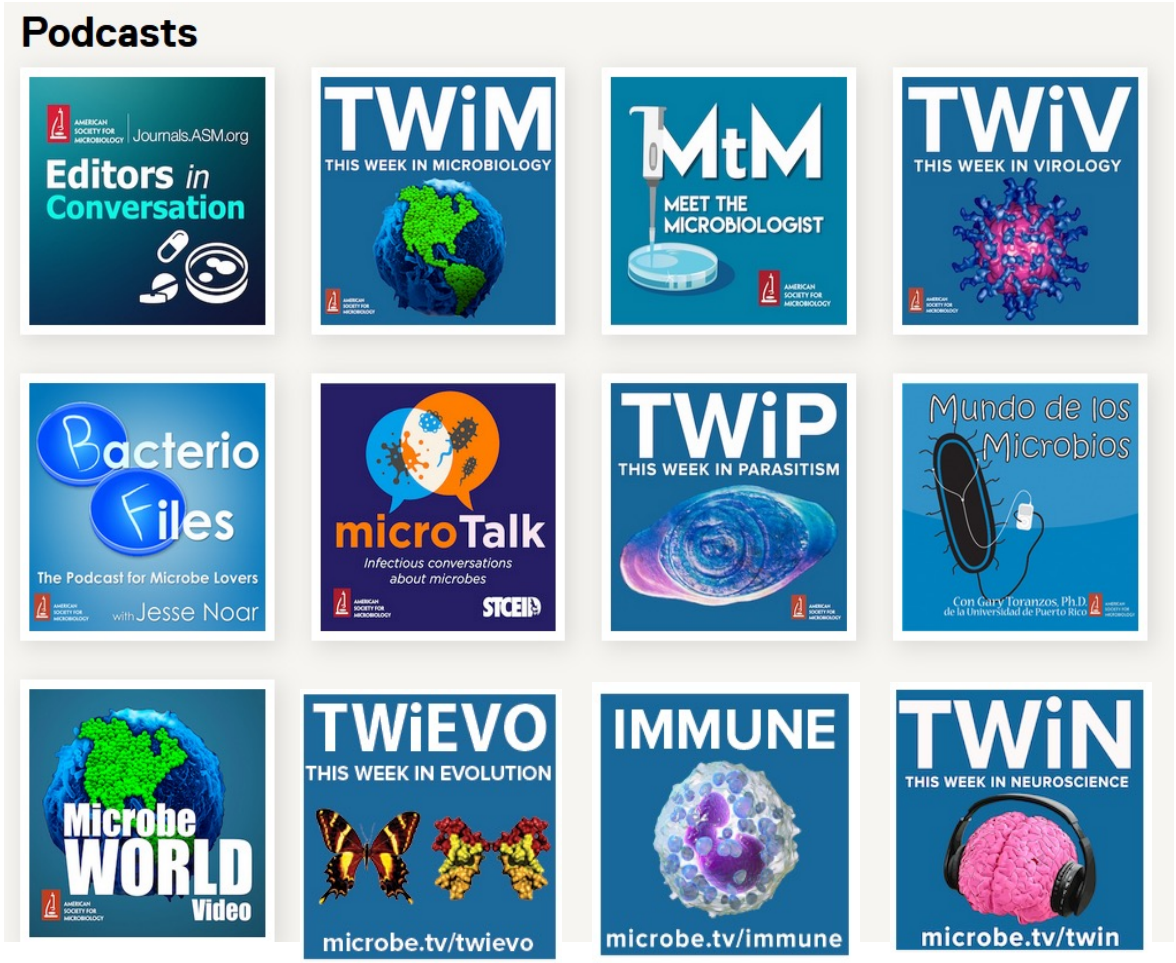


PSSSST: We have a new grant to train faculty in this project! Stay tuned!!!

Why start with TWiM/TWiX?

- https://www.microbe.tv/

- Freely available podcast; Figures from open-access; Open Educational Resource (equity)
- Hundreds of episodes, many have audio and written transcripts (accessibility)
- Topics are current and based in peer-reviewed scientific literature
- Discussion panel includes a rotation of practicing scientists (diversity)



Literature-focused Genetics Podcasts

- Genetics in Your World (GSA, 5ep)
  - https://shows.acast.com/632def7c8ad88f001368cc47
- Heredity Podcast (Genetics Society, Nature, 145ep)
  - https://shows.acast.com/heredity-podcast-naturecom-science-feeds
- The Genetics Podcast (Sano Genetics, 103ep)
  - https://podcasts.apple.com/us/podcast/the-genetics-podcast/id1462418412
- GenePod (Genetics in Medicine, 45ep)
  - https://www.gimjournal.org/multimedia/audio

Heredity
PODCAST

Genetics in Medicine
GENEPOD

Initial Project Structure

Initial meeting

Faculty introduced the podcast, ASM guidelines, and project

Draft team annotation

Interns independently annotated the same podcast, then met to discuss their annotation and reach a consensus for the final draft annotation.

Peer review

Interns present their annotations for 2 podcasts per week (one in draft form, one near final) and peer review the other group.

Refinement

Faculty refined microbiology topics for students, edited learning objectives for clarity and alignment, and developed multiple choice assessments with selected figures

How is the annotation done?

We’re going to move quickly through the annotation template
– focus on the colors and the “big picture”

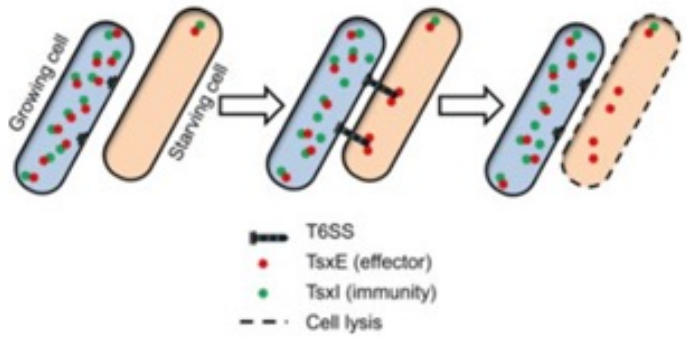
template	**example**

TWiM
THIS WEEK IN MICROBIOLOGY

Contribute Shop TWiM Archive

TWiM 177: Microbial sibling conflict

June 1, 2018



The TWiM team discuss bacteriophage evolution in a dairy plant, and killing of less fit cells among social microbes.

Hosts: Vincent Racaniello, Michael Schmidt, Elio Schaechter and Michele Swanson

Right click to download TWiM#177 (26 MB .mp3, 55 minutes)

Subscribe to TWiM (free) on iTunes, Stitcher, Android, RSS, or by email. You can also listen on your mobile device with the Microbeworld app.

Become a Patron of TWiM!

Links for this episode

- A decade of phage evolution (Appl Env Micr)
- Animation of phage infection (Vimeo)
- Double agar assay for phage (Dairy Science)
- Sibling conflict among social bacteria (mBio)
- Image credit
- Transcript of this episode (html or pdf)

Music used on TWiM is composed and performed by Ronald Jenkees and used with permission.

Send your microbiology questions and comments to twim@microbe.tv

Annotation

- **Title & Number (link to podcast)**
- **Annotated By**
- **Snippet Paper (ASM Format) (TimeStamp)**
- **Main Paper (ASM Format) (TimeStamp)**
- **Vision and Change Core Concepts**

Evolution, Structure/Function, Metabolic Pathways, Information Flow (genetics), Microbial Systems, Impact of Microbes

Title & Number TWiM #177: Microbial Sibling Conflict
Annotated by: **Leonardo Baumgartner, Martin Leyhe, Triston Walsh, Nancy Boury**
Snippet Paper Starts at: 5:11
Lavelle K, Murphy J, Fitzgerald B, Lugli GA, Zomer A, Neve H, Ventura M, Franz CM, Cambillau C,Sinderen DV, Mahony J. 2018. A Decade of *Streptococcus thermophilus* Phage Evolution in an Irish Dairy Plant. Appl Environ Microbiol. DOI: 10.1128/AEM.02855-17
Main Paper Starts at 25:29 - 48: 30
Troselj V, Treuner-Lange A, Søgaard-Andersen L, Wall D. 2018. Physiological Heterogeneity Triggers Sibling Conflict Mediated by the Type VI Secretion System in an Aggregative Multicellular Bacterium. mBio. DOI: 10.1128/mBio.01645-17
Vision and Change Core Concepts
Snippet: Microbial Systems, Impact of Microorganisms **Main**: Cell Structure and Function, Metabolic Pathways

- **ASM Fundamental Statements (from list)**

2-3 for Snippet and Main

- **Potential Learning Objectives from this TWiM Episode**

Look over the "Fundamental Statements with LOs" document for examples of higher order and lower order learning objectives (LOs) that are related to this podcast.

Students should be able to___. (do a measurable thing once they have listened to the podcast and read the paper(s))

ASM Fundamental Statements
Snippet: [example]
Fundamental Statement 4: The traditional concept of species is not readily applicable to microbes due to asexual reproduction and the frequent occurrence of horizontal gene transfer
Main: [example]
Fundamental Statement 8: Bacteria and Archaea have specialized structures (e.g., flagella, endospores, and pili) that often confer critical capabilities.

Potential Learning Objectives from this TWiM Episode
Snippet:
Lower Order:[example]
Differentiate between lytic and lysogenic phage replication cycles.
Main:
Higher Order: [example]
Explain why auxotroph's were used in this experiment and predict the results of co-culture experiments.
Speculate as to why prokaryotes did not develop true multicellularity

- **Techniques Described (include time stamps)**

List the techniques mentioned throughout the podcast.

- **Links to General Microbiology Processes/Concepts (include time stamps) 1) Mentions 2) Discussed Topics**

What ideas from general microbiology coursework did the podcast hosts discuss or mention? This can be short definitions (mentions) or a lengthier explanation in the context of the research article and podcast (for topics discussed)

Techniques Described
Snippet: [example] **-Counting Methods** (14:30-15:20): Double agar plaque assay was used to isolate phage **Main**: **Selective Media** (38:27 – 39:15): Use of selective media and auxotrophs to test how the wild type bacteria would interact with physiologically distinct bacteria
Links to General Microbiology Processes/Concepts
Snippet: Mentioned: [example] **CRISPR** (11:20 – 11:40, 21:30) first characterized -**Diversity and application of fermentation** (7:15 – 8:00): *Streptococcus thermophilus* ferments milk to make cheese and whey **Main: Discussed*:* [example]** **Cell-Cell Recognition** (36:40 – 37:30): *Myxococcus xanthus* are capable of cell-cell recognition through exchange of outer membrane

- **Most Interesting thing (from student perspective)** Write a 1-2 sentence "Take Home Message" or Headline for Snippet and Main)

- **Figures from Episode:** Link to 1-2 key figures described in the podcast (Student Teams), include data analysis questions with each figure. (Faculty – may pick different figures depending on focus of activity)

Most Interesting thing

Snippet:
Phage are ubiquitous and are often neglected in microbial ecology.

Main:
Myxobacteria exhibit higher forms of differentiation than other bacteria.
Myxococcus xanthus use type 6 secretion systems to inject toxin into their less productive brethren

Figures from Episode

Snippet: 10.1128/AEM.02855-17

Figure 1 There are 4 distinct groups of phage from the 11 year study. These groupings are based on genomic sequence data of 17 isolates. All of the phage sequenced are more similar to cos phage (DT1) than the representative pac phage (TP-J34, 5093, and 9871). The phage from factories were in groups L1 and L2(black text), while phage from whey samples were in groups L1-4 (in green)

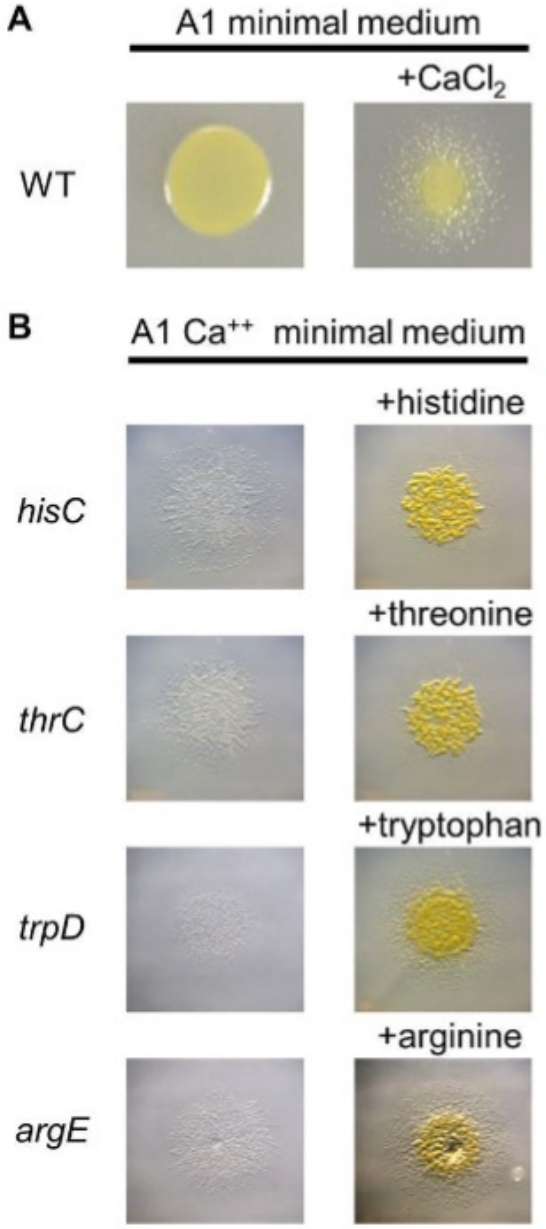
Main 10.1128/mBio.01645-17

Fig. 7 Model for how "sibling conflict" of prototroph vs auxotroph cells causes the prototroph to kill its low-functioning colleague/sibling.

How are the finished annotations used?

Figure Reading Activity with MC Questions

Figure Reading Exercise:



Myxococcus xanthus is a social bacteria that forms "hunting parties" to surround other soil bacteria and secrete digestive enzymes. They also form a multicellular fruiting body when starved. The researchers focused on the population dynamics within *Myxococcus xanthus* populations during starvation. To mimic starvation, they grew the *Myxococcus xanthus* bacteria on A1 minimal media. Figure 1 shows the phenotypic properties of strains on minimal medium. Round colonies are made up of bacteria that do not move (are non-motile). **Figure 1** (A) Cell motility in DK1622 (WT) is blocked on A1 and is restored by addition of 2 mM $CaCl_2$ to A1 (A1 Ca^{2+}). (B) Gene disruptions were made in ORFs predicted to be involved in amino acid biosynthesis, and the resulting mutants were assessed on A1 Ca^{2+} minimal medium agar (left) and A1 Ca^{2+} supplemented with 100 mg/liter of the indicated amino acids (right). Stereoscope micrographs were taken after a 96-hours of incubation.

Questions:

1) If the researchers had used rich media instead of minimal media, they would have likely ___.

A. Seen more swarming of the bacteria
B. Seen less growth of the auxotrophs supplemented with amino acids
C. Seen less swarming of the bacteria
D. Had less round colonies
E. The media used would not influence the growth of these bacteria

2) If the researchers had supplemented the *argE* auxotroph with tryptophan, you would expect to see ___ of the bacteria.

A. More growth
B. Less growth
C. No growth
D. Less swarming

3) Why was calcium added to the A1 minimal media?

A. To mimic starvation
B. The bacteria need it to swarm
C. To induce mutations
D. The bacteria use it to divide

The modules

- Access?
  - https://iastate.app.box.com/folder/129625831481
- Annotated episodes reflect 25/27 fundamental statements and all 6 Vision and Change Categories

ASM Fundamental Statements	TWiM episodes
Evolution	
#1: Cells, organelles (e.g., mitochondria and chloroplasts) and all major metabolic pathways evolved from early prokaryotic cells.	188 Turducken Antibiotics
#2: Mutations and horizontal gene transfer, with the immense variety of microenvironments, have selected for a huge diversity of microorganisms.	166 Dark Fermentation
#3: Human impact on the environment influences the evolution of microorganisms (e.g., emerging diseases and the selection of antibiotic resistance).	163 Saliva and sptR/S 170 Rats, Lice, and Nanoparticles 182 A micro story with macro implications
#4: The traditional concept of species is not readily applicable to microbes due to asexual reproduction and the frequent occurrence of horizontal gene transfer	177 Microbial Sibling Conflict
#5: The evolutionary relatedness of organisms is best reflected in phylogenetic trees	173 Gee Whiz in Style 188 Turducken Antibiotics
Cell Structure and Function	
#6: The structure and function of microorganisms have been revealed by the use of microscopy (including bright field, phase contrast, fluorescent, and electron)	182 A micro story with macro implications
#7: Bacteria have unique cell structures that can be targets for antibiotics, immunity and phage infection.	174 A Gathering Typhoid Storm 175 Neomycin is antiviral 188 Turducken Antibiotics
#8: Bacteria and Archaea have specialized structures (e.g., flagella, endospores, and pili) that often confer critical capabilities.	177 Microbial Sibling Conflict 182 A micro story with macro implications 188 Turducken Antibiotics
#9: While microscopic eukaryotes (for example, fungi, protozoa and algae) carry out some of the same processes as bacteria, many of the cellular properties are fundamentally different.	173 Gee Whiz in Style 177 Microbial Sibling Conflict 188 Turducken Antibiotics
#10: The replication cycles of viruses (lytic and lysogenic) differ among viruses and are determined by their unique structures and genomes.	170 Rats, Lice, and Nanoparticles

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- Coming soon: an OER pressbook

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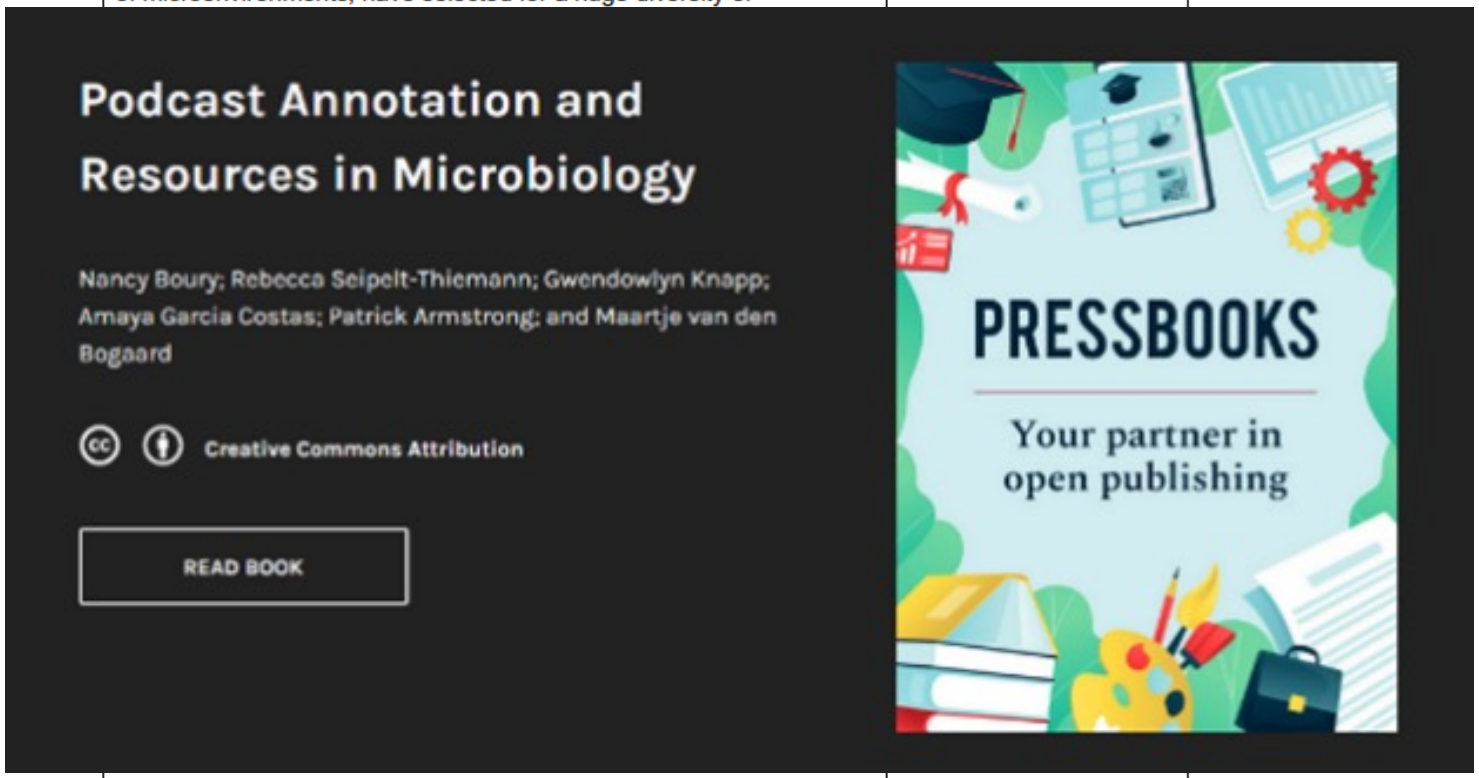
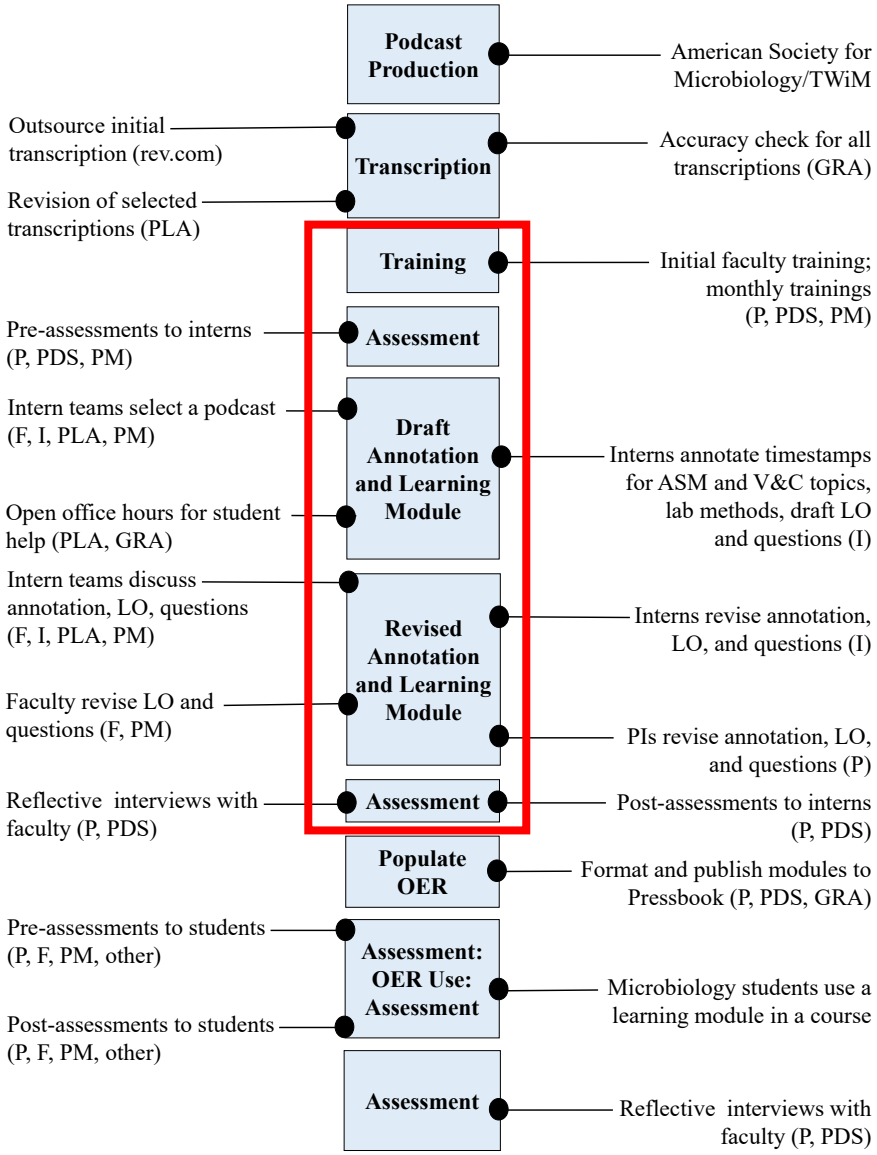


Join us???

- NSF-funding will start Oct 23
- Teams start Jan 2024 (Email me!)

Potential Internship Semester Schedule (12 weeks)	
1	pre-assessments
2	introduce resources and goals, students pick podcast episodes
3	initial draft with timestamps of topics and discuss how to make a better annotation, students set up a consensus meeting for themselves
4	discuss consensus annotation
5	discuss learning objective phrasing with students drafting them for next week
6	discuss LO as a team and students revise
7	discuss how to write good questions and students select figures from papers
8	discuss the selected figures with students to ensure they understand them, students then construct questions
9	students evaluate each other's questions and discuss as a group whether they align LO, students revise
10	intern team takes a final look at the revised final learning module
11	students turn in final learning module
12	post-assessments



F = Faculty Fellow
GRA = Graduate Research Assistant
I = Student Intern
P = PI
PDS = Post-doctoral Scholar
PLA = Peer Learning Assistant
PM = Faculty Peer Mentor (yr2 only)

Thanks!

TWiM and Hosts

About

As a science Professor at Columbia University, Vincent Racaniello has spent his academic career directing a research laboratory focused on viruses. His enthusiasm for teaching inspired him to reach beyond the classroom using new media. TWiM is for everyone who wants to learn about the science of microbiology in a casual way.

TWiM co-hosts include Elio Schaechter, Michael Schmidt, and Michele Swanson.

Interns

Lauren Ballar
Leonardo Baumgartner
Madonna Ghobrial
Martin Leyhe
Benjamin Walsh
Triston Walsh
Kaitlyn Wesselink

Project Support

Teaching in a Time of Crisis
DOI: https://doi.org/10.1128/jmbe.v22i1.2433
JMBE Journal of Microbiology & Biology Education

Teaching in the Time of COVID-19: Creation of a Digital Internship to Develop Scientific Thinking Skills and Create Science Literacy Exercises for Use in Remote Classrooms†

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USDA United States Department of Agriculture
National Institute of Food and Agriculture

NSF National Science Foundation