I wouldn't be a scientist doing what I love without the dedication of teachers and mentors that have guided me throughout my career. I may never be able to repay them adequately, but I can pass on their kindness and devotion to new students. My Ph.D. advisor and mentor, Professor Harold May, inspired me to pursue a career in research and teaching by challenging me daily and giving me *independence to discover*. Most importantly, in addition to the intellectual challenges he was patient and kind. My teaching philosophy echoes these sentiments and I think it is imperative to **teach critical thinking skills and inspire independent learning**. My strategy to achieve these goals of independent learning and critical thinking are through active engagement, team learning-team teaching, and research-based learning. Each of these strategies I will discuss below are methods of implementing active learning, defined as student engagement through discussion or hands-on tasks that emphasizes higher-order thinking. Active learning is an experimentally proven teaching technique that results in increased student performance in STEM fields.[1]

Active engagement I am focused on encouraging student curiosity about a subject; specifically, I am interested in developing an integrated teaching program that allows interdisciplinary engagement across microbiology, biotechnology, and environmental science. More importantly, I want the students to relate to the science, to discovery, and to the impact these areas have on their daily lives. Relating learning to experience, for example through topical news stories and presentations, leads to a more thorough learning focus, enabling students to pursue learning independently. I have found that students are naturally inclined to find connections with the source material and that it is just a matter of making that connection with the student to incite engagement. For example, I increased the engagement of art majors in my non-biology majors class by developing a project to grow microbial colonies on agar plates with different colors and patterns – visualizing the beauty of the unseen. The students quickly learned about microbial growth characteristics and metabolic interactions between species for the sake of art.

Team learning-team teaching An effective way to teach critical thinking and independent learning is to create group activities and discussions where students can freely exchange ideas and develop testable hypotheses. My research is multidisciplinary, bridging microbial physiology, ecology, bioinformatics, and engineering so I recognize the importance of building diverse groups with varying perspectives. Furthermore, an important lesson I have learned is that everyone has individual experiences that affect their ability to learn, accomplish tasks, and cooperate with others. My teaching strategy is to build upon these individualities and promote diversity in the classroom and the laboratory. This is no different from what happens in the workplace when students graduate, therefore it is important to incorporate diversity and differing perspectives in all aspects of education. Additionally, this strategy of team exercises and discussion emphasizes the importance of effectively communicating knowledge and research.

Research-based learning Research is conducted largely through iterative hypothesis testing, and I believe both teaching and learning should be accomplished in the same manner. Students should be able to develop testable hypotheses just like we do as scientists and learn the invaluable skill of troubleshooting when things don't go according to plan. Teaching can also work in this manner. Not everything I try in the classroom and with students will be a success, but student feedback is always encouraged to help refine what isn't as effective. In my classroom, informal student feedback and reviews are given at least twice during each course, in addition to formal semester end reviews. This enables me to develop a dynamic curriculum that supports the development of each student, and provides ample opportunity for me to refine the message and focus of my delivery.

My experience as an instructor and student mentor has taught me to allow students to select the paths that best suited their interests. This is essential if the student is going to relate to the material, think independently about microbiology related topics, and be actively engaged.

To do this in my general microbiology laboratory, I required students to work in groups and use primary literature to present on topics they were interested in as a part of my team learning-team teaching strategy. In one example, I asked students to cook or buy a shareable snack that involved a microbiological process (*e.g.* sauerkraut fermentation). The class would all eat the snack while the presenters would describe the process and microbial physiology that resulted in the consumable end product. This was a fun way to inspire the students to present science while sharing a little bit of their culture and background through the foods and microbes they selected (nothing brings people together like good food!).

As a mentor to graduate and undergraduate student researchers, I have worked hard to develop projects that excited them. This excitement was key to overcome the inherent challenges of research that might discourage students from pursuing a career in science. One student I mentored was interested in civil engineering, specifically the economic cost of microbial corrosion of our decaying plumbing infrastructure, but she had very little experience in microbiology. While corrosion was not at all my focus, we developed a project together that incorporated her interests and my microbial physiology and bioelectrochemical expertise. Since her interests spurred this project, she was more likely to take the lead in overcoming obstacles and troubleshooting - vital lessons for undergraduates. These skills have benefited the students that I have mentored when they moved on to graduate or medical schools. In one of my proudest moments as a mentor, my most recent undergraduate mentee was awarded the prestigious NSF graduate research fellowship and is now attending Virginia Tech for a PhD program in engineering.

In the last 3 years, I have had the opportunity to teach “The Microbiome in Health and Biotechnology” to non-major undergraduate students at the University of Chicago, teach graduate and undergraduate students “Applied and Environmental Microbiology” at Duquesne University, as well as give lectures to the graduate program on bioinformatics, microbiomes, and microbial physiology at the University of Pittsburgh. The non-majors class especially was tremendously exciting as it provided me with the opportunity to develop novel ways of engaging with economics, art, English language, theology, and medical students on a topic that is far outside of their normal interest. I found ways to communicate science to this broad audience and developed with Jack Gilbert an exciting curriculum based on microbiology in the modern age. These experiences have strengthened my resolve to develop and employ novel pedagogical techniques.

Looking forward – My future as an educator will involve university classrooms, the laboratory, K-12 classrooms, and the general public. One of the most rewarding programs I participated in as a graduate student was Graduates Reaching Out With Science (GROWS). In this program, a small group of graduate students attended middle school classrooms and gave a demonstration on a topic like ‘Germs’. This was followed by questions and answers with the classroom that were always lively and fun. I would like to continue and expand this kind of outreach to local schools and public libraries. As a framework for this, I have helped develop the EvolvingSTEM curriculum that Vaughn Cooper has developed and deployed in area high schools (http://www.evolvingstem.org/).

My passion for teaching and multidisciplinary training translates to several courses that I would like to teach. The possibilities include general microbiology, microbial physiology, microbiome and health, environmental chemistry, environmental microbiology, anaerobic microbiology, microbial ecology, environmental science, biotechnology, and genomics. In addition to formal undergraduate and graduate level courses, I think journal clubs are an essential aspect of graduate education and I will continue to facilitate student-led microbiome journal clubs.

1. Freeman, S. *et al.* Active learning increases student performance in science, engineering, and mathematics. *Proc. Natl. Acad. Sci.* **111,** 8410–8415 (2014).