



Curriculum Units by Fellows of the Yale-New Haven Teachers Institute  
2013 Volume IV: Asking Questions in Biology: Discovery versus Knowledge

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## Introduction

Many teachers observe a trend in their classrooms where students are increasingly reluctant to ask questions. Apparently, students fear that asking questions would reveal their limited knowledge, or would cause them to appear less intelligent than their peers. This trend is especially troubling when biology and other sciences are taught in the classroom, because it signals that students are stifling their inherent curiosity about the natural world. This seminar examined why it is important to encourage students to ask questions in the classroom, particularly in biology. It emphasized that asking questions is crucial for making scientific discoveries, which are essentially questions (hypotheses) that are either supported or refuted through direct tests. We learned that, over time, this iterative process of discovery-making translates directly into the collection of facts that we call "scientific knowledge." We discussed why biologists and other scientists generally consider their careers rewarding, even though their discoveries are often overturned, or proven incorrect. In addition, we learned that many famous scientific discoveries occurred through sheer accident, which emphasizes that science is mainly about asking questions and pursuing unknowns, and less about posing ideas that are absolutely correct. We examined the biological underpinnings of question-asking, and learned that our strong curiosity prompts humans to ask questions, whereas our close primate relatives such as chimpanzees do not. We considered how philosophical approaches to asking questions have changed through history, but that certain approaches such as Socrates' Scientific Method have remained influential and persisted over time. We discussed scientific ethics and the public perception of science, to better understand why some scientists act irrationally in the name of career advancement, and how their actions can violate public trust of science and medicine.

Throughout the seminar we related discussions of these topics to the fundamental human fear of being perceived as "wrong," and how this creates a reluctance to ask questions in the classroom. Importantly, we worked together to discuss and design curriculum units which may be used to address this problem, especially by convincing students that discovery and knowledge in biology can only occur through willingness to ask questions. The seminar included discussions of reading assignments on asking questions, active-learning exercises, and a tour of the collections at the Yale Peabody Museum of Natural History to learn how these holdings are used to test hypotheses in biology research. The seminar was especially intended for teachers of biology, but at all grade levels.

The resulting units were diverse, reflecting the varied interests and backgrounds of the Fellows. Terry Bella developed a unit on enzymes targeted for high-school students, which uses question-generating activities to emphasize that knowledge of enzyme function is crucial for human applications, such as bioremediation. Laura Carroll-Koch's unit takes students on a journey to understand the biodiversity of Long Island Sound, and to question how organisms have adapted to the many habitats of the Sound and how they function together in

this rich ecosystem. Lindsey Flanick focuses on the amazing scientific discoveries achieved through using HeLa cells, ranging from polio vaccines to cancer therapy, and the ethical controversies that come from harnessing these cells originally isolated from Henrietta Lacks, an unfortunate victim of cervical cancer. Shaunquetta Johnson's unit emphasizes student exploration of everyday body function, bravely using flatulence as a focus for asking questions on how our bodies work, even when we are embarrassed by their sounds and smells! Waltrina Kirkland-Mullins' unit uses fiction and nonfiction readings on insects and their adaptive traits, to motivate elementary students to ask questions on why organisms differ; the activities in this unit stimulate youngsters to harness their innate curiosity and to empower them to think like scientists. Similarly, Laura Namnoum's unit is designed for young learners, emphasizing question-asking about plant life cycles, with a goal to using this acquired knowledge to hypothesize how and why animal life cycles differ according to their specific environments. Victoria Raucci's unit engages students to compare and contrast differences between human eyes and dog eyes, with the goal of better understanding these familiar organisms while creating a "judgment-free" classroom environment where students are allowed to openly question how traits work. Kathleen Rooney's unit looks at classroom instruction in mathematics and statistics in the age of easy Internet accessibility to facts, emphasizing that it is still vital to ask questions in the classroom, even in subjects where students perceive there can only be one correct answer. Larissa Spreng's unit looks at Long Island Sound, with the understanding that students are often unfamiliar with natural areas located in their own backyards, and uses field trips to encourage students to better appreciate and ask questions about their natural surroundings.

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