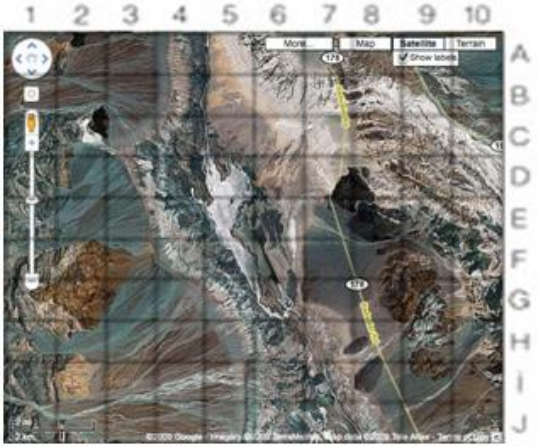
Curriculum Supplement Series

Observing Beyond our Senses: Inquiry Drives Technology

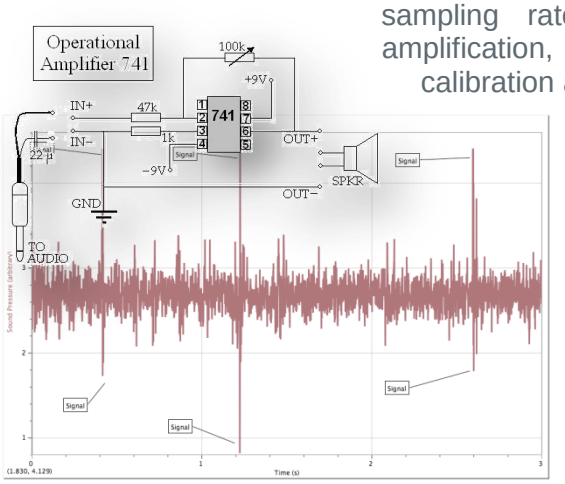
ISB Systems Education Experiences

In this high school curriculum module, students in physics, integrated science, biotechnology, and STEM courses are confronted with the same challenges scientists and engineers are when the technology they need to answer questions is not available. Lessons may be taught separately or together as a 3 week module.

In this module, students focus on the role of physics and engineering in the increasingly interdisciplinary field of systems biology where investigations in biological networks are advanced through improving technologies. Centered on a case study requiring instrumentation for field research, the driving question is **"How do scientists measure what they cannot directly observe with their senses?"**



The complexities of proxy variables, the limitations of inferences, and the interpretation of quantitative data are examined. Tradeoffs in instrumentation design related to precision, accuracy, resolution, sampling rate, samples size, signal amplification, signal noise, and calibration are explored. This series of inquiry based activities utilizes the graphing visualization capabilities of excel, real time data collection probeware such as Vernier of Pasco, student built proto-board circuits, and custom instruments provided in the kit. The culminating project is a case study involving a high saline environment impacted by mine tailings. Exploration of instrumentation design is driven by the need to count the indicator microbial populations invisible to the naked eye. Students develop an iterative sampling strategy based on limited resources to map the microbial population with the kit provided handheld spectrophotometer and infer point pollution and freshwater sources. Their findings and recommendations are presented as a water management plan.



Observing Beyond Our Senses: Inquiry Drives Technology		
Name of Lesson	**Main Question Explored**	**# of 50 min. Class Periods**
1. Intro to Saline Environments and Halophiles	How can we count halophilic microbes?	1
2. Design Process: Measuring Wind Speed	How do scientists and engineers design and evaluate solutions to measuring problems?	2
3. Inferences from Proxy Variables: Mock Atomic Force Microscope	How do we count or measure things we cannot observe directly?	2-3
4. Resolution and Noise: Operational Amplifiers	What are the trade-offs and benefits to amplifying a signal?	2
5. Calibration and Inferring Properties from Light Behavior	How can we use light as a quantifiable proxy variable and how do we make our light measurements meaningful for population density?	2
6. Case Study: Mapping Death Valley	How can we make inferences from microbe populations to develop a water management plan?	2-4

Funded by NSF 0640950 *with leveraged dissemination by* ***NIH/NIGMS.***
Please see the Module pages at http://see.isbscience.org for more information.

Observing Beyond our Senses: Inquiry Drives Technology

Principal Investigator	Program Manager	
Nitin S. Baliga, ISB	Claudia Ludwig, ISB	
2008 Development Team	**2009 Development Team**	
Ryan Gunhold, City University, Seattle	**David Bruncke**, Aberdeen HS	**Brad Moore,** Seattle Public Schools
Jessica Hale, ISB Intern, Ballard HS	**V. Pramod Chavali**, Intern, Redmond HS	**Eric Muhs**, Ballard HS, Seattle
Dr. Christopher Lausted, ISB	**D. Knickerbocker**, International School	**Dr. W. Lee Pang**, ISB
Brad Moore, International School, Bellevue	**Mari Knutson Herbert**, Lynden HS	**Kim Sciarrone**, Ingraham HS
Dr. W. Lee Pang, ISB	**Dr. Christopher Lausted**, ISB	**Neelofer Vahora**, Intern, Evergreen HS
Sue Yi, ISB Intern, Lakeside School, Seattle	**B Lippitt**, ISB	
2010 Development Team	**2011 Development Team**	
Mari Knutson Herbert, Lynden HS	**Kevin Baker**, ISB Intern, Chief Sealth HS	**Eric Muhs**, Ballard HS, Seattle
Dr. Christopher Lausted, ISB	**Mari Knutson Herbert,** Lynden HS	**Olachi Oleru**, ISB Intern, Garfield HS
Aisha McKee, Intern, International School	**Jocelyn Lee**, ISB Intern, Garfield HS	**Jia Hao Xu,** ISB Intern, Eastside Prep
Dr. Danielle Miller, ISB		
Brad Moore, Seattle Public Schools		
Eric Muhs, Ballard HS, Seattle		
Danny Thomson, ISB Intern, Ballard HS		
2008 - 2011 Field Test Teachers		
Amanda Cope, Monroe SD, L. in Learning	**Mari Knutson Herbert,** Lynden HS	**Brad Moore**, International School, Bellevue
Eric Muhs, Ballard, HS, Seattle	**Kim Sciarrone**, Ingraham HS, Seattle	**Brad Moore**, ACS Cobham, England

ISB Systems Education Experiences

Funded through the National Science Foundation (NSF 0640950)

NSF