Curriculum Supplement Series
Our Invisible Forest:
What's in a Drop of Seawater?

Portland State
UNIVERSITY

ISB Systems
Education
Experiences

> *In this high school curriculum module, students in marine science, environmental science, physics, chemistry, biology, integrated science, biotechnology, or STEAM courses use real-world, big data to investigate how our "invisible forest" influences ocean and Earth systems. Students build an art project to represent their new understanding and share this with the broader community.*

The Baliga Lab at the Institute for Systems Biology has been translating their research into user-friendly curriculum modules since 2004 through the program, Systems Education Experiences (SEE). By forming collaborative teams comprised of scientists, educators, and students, today's research and methods have become hands-on, accessible activities for students. These activities provide authentic science investigations that engage students and build higher-level, interdisciplinary thinking skills while bridging the distance between the professional lab and the classroom.
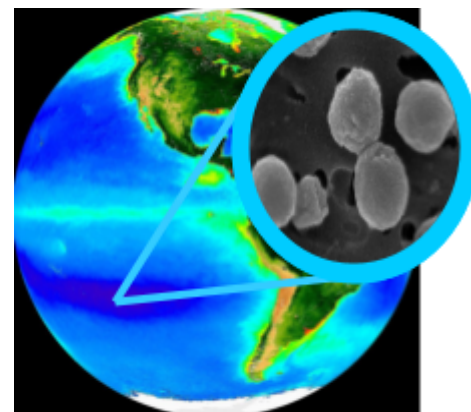
This curriculum module is based on the oceanographic research of Dr. Anne Thompson of Portland State University in Oregon, which focuses on the abundant ocean phytoplankton *Prochlorococcus*. These interdisciplinary STEAM lessons were inspired by Dr. Thompson's lab and fieldwork as well as many beautiful visualizations of *Prochlorococcus*, the ocean, and Earth. Students learn about the impact and importance of *Prochlorococcus* as the smallest and most abundant photosynthetic organism on our planet. Through the lessons, students act as both scientists and artists as they explore where breathable oxygen comes from and consider how to communicate the importance of tiny cells to human survival.

This module is written as a phenomenon-based, Next Generation Science Standards (NGSS) three-dimensional learning unit. Each of the lessons below also has an integrated, optional Project-Based Learning (PBL) component that guides students as they complete the PBL process. Students learn to model a system and also design and evaluate questions to investigate phenomena. Students ultimately learn what is in a drop of ocean water and showcase how their drop contributes to our health and the stability and dynamics of global systems.

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Name of Lesson	**Main Question(s) Explored**	**# of 50 min. Class Periods**
PBL Introduction & Pre-assessment	In a world without land, would we always have enough oxygen? What does the ocean give us?	1
1. Breath of Oxygen	From where do living systems acquire their breathable Oxygen?	2-3
2. Who's Who in the Photosynthetic World	How do we know who photosynthesizes? How small can a living cell be and still carry out all the functions of life?	2-3
3. Tools of the Trade Exploratorium, including a Microscope and Spectrophotometry Lab	How can we measure what we cannot see in our vast ocean? How do we know what we know?	2-5
4. Linking Cells in a Drop of Water to Global Patterns	Why do different types of photosynthesizers have different distributions? What are the limitations and strengths of current models for understanding global ocean patterns, diversity and dynamics?	2
5. Using Data to Understand the Nature of Science and Oceanographic Processes	How can we accurately and effectively represent data trends and patterns?	1-4
Revisiting PBL Lessons, Action Plan & Post-assessment	How do we make this invisible forest visible to others and why might that be important?	2

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