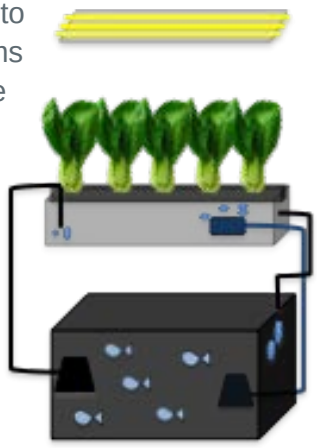
Curriculum Supplement Series

Modeling Sustainable Food Systems

ISB Systems Education Experiences

In this curriculum module, students in high school biology and environmental science courses learn how to use scientific inquiry, systems thinking, mathematical modeling, and engineering approaches to understand a global issue: environmentally sustainable global food security. Students construct, monitor and optimize an aquaponic system as a model system.



The Baliga Lab at the Institute for Systems Biology has been translating their research into user-friendly curriculum modules since 2004. Through forming collaborative teams comprised of scientists, educators, and students, today's research and methods have become hands-on, accessible activities for students.

In this curriculum module, students take an interdisciplinary approach to understanding a global issue. The driving question is, "**Is there a way to produce and consume food resources that will be environmentally sustainable and sufficient for global needs?**" Students learn that systems thinking is helpful in identifying influences and interactions within the food security system. Next, students use mathematical modeling to analyze whether current agricultural practices will be sustainable and sufficient for a growing global population, and then they specify criteria for new solutions for viable sustainable agriculture practice. To critically evaluate one possible solution, students build an aquaponic system (growing fish and plants) and take an engineering approach to evaluate the potential of scaling up aquaponics as a food production system (NGSS Standards HS-ESS3: Earth and Human Activity and HS-ETS1: Engineering Design). The aquaponic system can also serve as a platform for numerous lessons and units throughout the academic year across a variety of classes.

Modeling Sustainable Food Systems	
Core Module Lesson	*Main question explored*
Food security and stakeholder introduction	What is food security? What groups of people and environmental factors are related to food production?
Network building	How are all of the players in food production and consumption connected as a system?
Food origins and transport	What resources does it take to get food to us?
Environmental trade-offs to food production	Why can't we just grow more food to feed more people?
Engineering a solution	How can we design and evaluate possible solutions?
Year-long use of aquaponic systems for NGSS standards	*Example question explored*
HS-LS1: From Molecules to Organisms: Structures and Processes	What are the inputs and outputs of cellular metabolism in the plants, bacteria, and fish?
HS-LS2: Ecosystems: Interactions, Energy and Dynamics	Do changing water or light conditions lead to changes in organism number?
HS-LS3: Heredity: Inheritance and Variation of Traits	How can probability help explain the distribution of Mendelian traits in the plants?
HS-LS4: Biological Evolution: Unity and Diversity	How can we simulate adverse effects of human impact on biodiversity?
HS-PS3: Energy	How does energy transfer between lights, plants, bacteria, & fish?

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