BACK BAY SCIENCE CENTER

Harmful Algal Blooms

ACTIVITY : ALGAE ATTACK!

TIME: 50 minutes
GRADE LEVEL: 8th-12th
GROUP SIZE: 10-15 students

Activity at a Glance: Students will collect, analyze, and identify phytoplankton then assess if there are any toxic organisms in their sample. Through scenario situations they will discover how harmful blooms of algae can affect the ocean food web and human health.

NEXT GENERATION SCIENCE STANDARDS

PERFORMANCE EXPECTATIONS

MS-LS2-2 Ecosystems: Interactions, Energy, and Dynamics
Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
MS-LS2-4 Ecosystems: Interactions, Energy, and Dynamics
Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
MS-ESS3-2 Earth and Human Activity
Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
HS-LS2-6. Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions • Apply scientific principles to design an object, tool, process, or system (MS-ESS3-3) **Engaging in Argument from Evidence** • Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments (HS-LS2-6) Connections to Nature of Science --- **Scientific Knowledge is Open to Revision in Light of New Evidence** • Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence	**ETS1.B: Developing Possible Solutions** • A solution needs to be tested, and then modified on the basis of the test results, in order to improve it (MS-ETS1-4) • Models of all kinds are important for testing solutions (MS-ETS1-4) **ETS1.C: Optimizing the Design Solution** • The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution (MS-ETS1-4) **ESS3.C: Human Impacts on Earth Systems** • Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things (MS-ESS3-3) • Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth, unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3) **LS2.C: Ecosystem Dynamics, Functioning, and Resilience**	**Cause and Effect** • Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation (MS-ESS3-3) **Stability and Change** • Much of science deals with constructing explanations of how things change and how they remain stable (HS-LS2-6)

that may result in revision of an explanation (HS-LS2-6)	• A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e. the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability (HS-LS2-6)	

Ocean Literacy Principle 5: The ocean supports a great diversity of life and ecosystems

A- Ocean life ranges in size from the smallest living things, microbes, to the largest animal on Earth, blue whales.

B- Most of the organisms and biomass in the ocean are microbes, which are the basis of all ocean food webs. Microbes are the most important primary producers in the ocean. They have extremely fast growth rates and life cycles, and produce a huge amount of the carbon and oxygen on Earth.

Ocean Literacy Principle 6: The ocean and humans are inextricably interconnected.

C- Humans effect the ocean in a variety of ways. Laws, regulations, and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (point source, non-point source, and noise pollution), changes to ocean chemistry (changes to the beaches, shores, and rivers). In addition, humans have removed most of the large vertebrates from the ocean.

BACKGROUND INFORMATION

The term plankton is derived from the Greek word planktos, meaning "wanderer" or "drifter" and is used to describe any organism that drifts with the ocean's currents. There are many varieties of plankton which are uniquely important to the environment.

Plant plankton, known as phytoplankton, form the base of the food chain through their cellular respiration. They are responsible for a supreme amount of the atmospheric oxygen with estimates as high as 80%. This is due to the presence of chloroplasts in their cells that allow them to photosynthesize. Unlike other types of plankton all phytoplankton are holoplankton – they remain planktonic through their whole life cycle.

Animal plankton, known as zooplankton, are the next level in the food chain. They are the primary consumers of phytoplankton and bacteria and they vary greatly in morphology and characteristics. It is in this group that you start to see species of meroplankton – the type of animals that are only plankton at various stages in their life cycle.

As a whole, phytoplankton are ecologically important but potentially dangerous. They produce most of the oxygen we breathe and serve as an important carbon sink trapping dangerous carbon emissions. They are also the base of the food chain, which means that disruptions at that trophic level have far reaching implications further up the chain. Some species of phytoplankton can be hazardous if conditions allow for algal blooms. During these times of population explosions, they not only can cause the oxygen in the water to drop, creating anoxic conditions, but some species release toxins into the water that are bio-magnified up the food chain.

Harmful algal blooms, or HABs, occur when colonies of toxic phytoplankton grow out of control and produce harmful effects for people, fish, shellfish, marine mammals and birds. The human illnesses caused by HABs, though rare, can be debilitating or even fatal.

Bioaccumulation occurs when an organism absorbs a substance at a rate faster than that at which the substance is lost by catabolism and excretion. **Biomagnification** is the process in which toxins are concentrated in an organism as larger animals continue to eat smaller animals. This process moves toxins exponentially up the food chain to larger organisms and is of particular concern with regards to concentrating dangerous toxins in larger species.

Bioaccumulation and Biomagnification can have major impacts on food chains and ecosystems, as well as on human health. Shellfish are well known to bioaccumulate toxins making them an especially dangerous part of the food web for predators, including human consumers.

There are four recognized forms of shellfish poisoning; **Diarrhetic, Amnesic, Paralytic, and Neurotoxic.**

Dinophysis species of plankton produces toxins called okadiac acid and dinophysis toxins. These toxins cause **Diarrhetic Shellfish Poisoning** (DSP), which is a gastrointestinal illness. DSP

symptoms usually occur within 30 minutes to a few hours after consumption of contaminated shellfish. Symptoms include diarrhea, nausea, vomiting and abdominal pain. Shellfish containing toxic levels of Diarrhetic Shellfish Poison don't look or taste any different from shellfish that are safe to eat. Laboratory testing of shellfish meat is the only known method of detecting Diarrhetic Shellfish Poison.

Amnesic shellfish poisoning is an illness caused by consumption of a marine biotoxin called domoic acid, produced by a marine diatom called Psuedo-nitzschia. Symptoms include vomiting, nausea, diarrhea, and abdominal cramps within 24 hours of ingestion. In more severe cases, neurological symptoms develop within 48 hours and include headache, dizziness, confusion, disorientation, short-term memory loss, motor weakness, seizures, profuse respiratory secretions, cardiac arrhythmias, coma, and possible death. Short term memory loss can be permanent. Razor clams are most commonly affected by Amnesic Shellfish Poison.

Paralytic shellfish poisoning is caused by an accumulation of neurotoxins, such as Saxitoxin. Saxitoxin is a neurotoxin produced by some dinoflagellate, diatoms, and cyanobacteria. Alexandrium are the most numerous and widespread dinoflagellates to produce saxitoxins. PSP can be fatal in extreme cases, particularly in immunocompromised individuals. Children are more susceptible. Early symptoms include tingling of the lips and tongue, which may begin within minutes of eating toxic shellfish or may take an hour or two to develop. Symptoms may progress to tingling of fingers and toes and then loss of control of arms and legs, followed by difficulty in breathing. Some people feel nauseous or experience a sense of floating. If a person consumes enough toxin, muscles of the chest and abdomen become paralyzed, including muscles used for breathing, and the victim can suffocate. Death from Paralytic Shellfish Poison has occurred in less than 30 minutes.

Neurotoxic shellfish poisoning is caused by the consumption of shellfish contaminated with brevetoxins, primarily by the dinoflagellate, *Karenia brevis.* Symptoms can occur 15 minutes to 18 hours after consumption. In humans they include vertigo, convulsions, vomiting, diarrhea and nausea and a variety of neurological symptoms such as slurred speech and the reversal of hot and cold sensations. No fatalities have been reported but there are a number of cases which led to hospitalization.

****The Back Bay Science Center participates in collecting plankton for the California Department of Public Health's monthly Marine Biotoxin Monitoring Reports. This report provides a monthly summary of toxin concentrations and threats to public health, related to harmful algal blooms.*

TEACHER GUIDE – HARMFUL ALGAL BLOOMS

ACTIVITY: Algae Attack!

OBJECTIVES:

Students will be able to:

1. Utilize scientific equipment to sample and be able to generate data on counting and identifying plankton
2. Use mathematical representations to explain how the presence and abundance of plankton can affect entire ecosystems

MATERIALS:

Plankton net with detachable containers
Sample jar/container to transfer sample into
Microscope slides and covers
Pipette
Compound microscopes
Plankton ID sheets
Plankton Sampling Observation Sheets
Plankton Sampling Analysis Question Sheets
Pencils
HABs illness diagnostic cards

KEY TERMS:

Algal Bloom Anoxic Biomagnification Bioaccumulation Cellular Respiration Chloroplast Flagella Holoplankton Meroplankton Morphology Organism Phytoplankton Photosynthetic Plankton Primary Producer Thermocline Trophic Level Water Column Zooplankton Productivity Harmful algal blooms Diarrhetic Shellfish Poisoning Amnesic Shellfish Poisoning Nuertoxic Shellfish Poisoning Paralytic Shellfish Poisoning