**Plankton Phenomenon Pre and Post-Program Activities**

**Grade Level: 6 - 12**

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**Next Generation Sunshine State Standards**
- SC.912.L.17.16
- SC.912.L.17.20
- SC.912.N.1.6

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**Program Overview**
Discover the importance of plankton as we examine the different classifications and their roles in the marine ecosystem. We will bring the lab into the classroom to study algae that cause harmful blooms and investigate why these water quality issues could be prevalent in southwest Florida. Use microscopes with water samples to determine human impact problems and potential solutions.

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**Learning Objectives** Students will be able to:
1. Explain the importance of plankton in relation to the marine ecosystem, the ocean food chain, and global economy.
2. Classify different types of plankton and their life stages.
3. Define harmful algal blooms and describe their effects on the environment.
4. Identify plankton species under a microscope.
5. Infer potential environmental impacts based upon acquired water samples using laboratory equipment.
6. Discuss large-scale impacts resulting from human activity, how human lifestyles affect sustainability, and describe actions to reduce these impacts.
Pre-Program Activity 1: Plankton BioSheet

Duration of Activity: approx. 30-45 minutes

Materials:
Plankton ID guide, paper and pencils, computers for research

Background:
What first comes to mind when you think of plankton? Maybe the infamous villain of SpongeBob, or their role in harmful algal blooms (HABs) along the coasts of Florida. Their importance to life on Earth, however, far outweighs the significance of these examples. Plankton form the base of the food chain in all aquatic ecosystems, and are responsible for producing 50% of the world’s oxygen to boot. Plankton, from the Greek word *planktos* for wanderer or drifter, are classified by their inability to swim against a current rather than by size and taxonomy. A dinner plate-sized moon jelly is just as much of a plankton as are the diatoms invisible to the naked eye.

Yet most plankton cannot be seen without the aid of a microscope. Watch “The Secret Life of Plankton” in class to introduce students to the incredible diversity of plankton and unique forms and function of their kind. Click the link (6 minute video): [https://ed.ted.com/lessons/the-secret-life-of-plankton](https://ed.ted.com/lessons/the-secret-life-of-plankton)

In this activity, students will begin a preliminary study of plankton by sketching an example species and researching its taxonomy, anatomy, and adaptations.

Directions:
Break students into groups of 2-3. Each group chooses one plankton from the plankton ID guide below. Students may use computers and/or other resources to research their chosen plankton and create a “Plankton BioSheet.” This biosheet must include:

1. A large sketch of the chosen plankton
2. At least 3 anatomical structures labeled
3. The Domain, Kingdom, and Phylum of the plankton (N/A if not applicable)
4. Preferred diet and possible predators
5. The plankton’s role in the marine/freshwater food web
6. At least 3 adaptations used for mobility, feeding, defense, mating, etc.

Groups can then present a short overview of their species to the class, no more than 5 minutes.

OPTIONAL: Ask groups to arrange their plankton biosheets on a chalkboard or wall based upon different ecological classifications. Some examples include: Phytoplankton vs. Zooplankton, holoplankton vs. meroplankton, similar feeding strategies, similar adaptations, etc.

References:
- Palmer Station Antarctica LTER: “Plankton & the Antarctic Ecosystem: What are plankton? Are all plankton the same?” (pg.7). [https://pal.lternet.edu/sites/default/files/files/Plankton%20Identification%20%26%20Antarctica%20Ecosystem%20FINAL%20ver._1.pdf](https://pal.lternet.edu/sites/default/files/files/Plankton%20Identification%20%26%20Antarctica%20Ecosystem%20FINAL%20ver._1.pdf)
**PHYTOPLANKTON**

**DINOFLAGELLATES**
- Ceratium
- Noctiluca
- Peridinium
- Gonyaulux
- Protoperidinium
- Alexandrium

**DIATOMS**
- Chaetoceros
- Asterionella
- Licmophora (epibiotic diatom)
- Pseudonitzschia
- Nitzschia
- Coscinodiscus

**ZOOPLANKTON**

**PERMANENT**
- Ciliate (unidentified)
- Tintinnid
- Rotifer
- Radiolarians
- Salp (doliolium)
- Larvacean (oikopleura)
- Ctenophore
- Flatworm
- Chaetognath (arrow worm)
- Jelly medusa
- Isopod
- Cladocera (male)
- Cladocera (female with eggs)
- Amphipod
- Copepod
- Copepod larva

**TEMPORARY**
- Sea star larva
- Bivalve larva
- Bryozoa larva
- Polychaete worm
- Snail veliger larva
- Barnacle nauplius larva
- Barnacle cypris larva
- Crustacean nauplius larva
- Crab megalops larva
- Crab zoea larva
- Fish egg
- Fish larva
Pre-Program Activity 2: It’s all NPP to Me

Duration of Activity: approx. 1 hour

Materials:
“It’s all NPP to Me” worksheet, paper and pencils, computers for research

NOTE:
An understanding of the balanced equation of photosynthesis (\(6\text{CO}_2 + 12\text{H}_2\text{O} = \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{H}_2\text{O} + 6\text{O}_2\)) is an important prerequisite for the rest of this lesson.

Background:
If you are a living organism, chances are you need to eat. Or, from a biochemical perspective, you need energy. Life cannot exist without it. The production of this energy begins at the base of the food chain via the primary producers. These essential life forms are autotrophic, meaning they convert energy from light (photosynthesis) or energy from inorganic compounds (chemosynthesis) to stored, usable energy for growth and consumption up the food chain. As the chemosynthesizers account for a very small portion of energy available on a global scale, we will only consider the process of photosynthesis in this lesson.

Scientists can measure the production of energy from these primary producers at an extremely large scale as a [unit of] carbon-mass produced per [unit of] area per [unit of] time. This is known as gross primary production, GPP, and is commonly expressed as gCm\(^{-2}\)y\(^{-1}\). While GPP can tell us the rate at which energy is stored as biomass, not all of these sugar molecules are available for a hungry consumer. The primary producers take some of their own energy for cellular respiration and growth, and so an additional measurement, net primary production, is necessary. Calculated as (NPP = GPP – respiration), the net primary productivity gives us a more practical rate at which energy is stored as biomass and available to the consumers.

In marine ecosystems, phytoplankton (plant-like plankton) are the photosynthesizing autotrophs responsible for NPP. In fact, phytoplankton match their title as the producers of half of the world’s oxygen by accounting for half of the world’s NPP too! In this lesson, students will use the Gulf of Mexico as an example ecosystem to understand the limiting factors of NPP. Students will also use real-time data maps to interpret regional variances in NPP.

Directions:
Give each student a worksheet. Allow group work if desired. Students will need computers and/or phones to access real time data on a NOAA website.

References:
- NOAA Ocean Explorer: “Section 6: Ocean Primary Production” (pgs. 111-114).
- Margareth Kyewalyanga, UNEP: “Phytoplankton Primary Production” (pgs. 207-225).


Additional Resources:

Lesson Plans from NOAA Ocean Explorer: “Section 6: Ocean Primary Production.”
  o Lesson Plan 15: Being Productive in the Arctic Ocean (pgs. 115-125).
  o Lesson Plan 16: Chemosynthesis for the Classroom (pgs. 126-129).
  o Lesson Plan 17: Biochemical Detectives (pgs. 130-135).
It’s All NPP to Me

Use the graph below to answer the following questions:

NOTE: Open = Open Ocean/Central Gulf; TX = Texas, N Central = North Central Gulf; WFS = West Florida Coast; MX = Mexico

<table>
<thead>
<tr>
<th>Region</th>
<th>Daily PP gC m² d⁻¹</th>
<th>Annual PP gC m² y⁻¹</th>
<th>Area km²</th>
<th>Regional PP Gt C y⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
<td>0.28</td>
<td>102.2</td>
<td>9.89E+05</td>
<td>0.101</td>
</tr>
<tr>
<td>TX</td>
<td>0.33</td>
<td>120.45</td>
<td>8.68E+04</td>
<td>0.010</td>
</tr>
<tr>
<td>N Central</td>
<td>1.1</td>
<td>401.5</td>
<td>1.47E+05</td>
<td>0.059</td>
</tr>
<tr>
<td>WFS</td>
<td>1.3</td>
<td>474.5</td>
<td>1.47E+05</td>
<td>0.070</td>
</tr>
<tr>
<td>MX</td>
<td>0.23</td>
<td>83.95</td>
<td>1.83E+05</td>
<td>0.015</td>
</tr>
</tbody>
</table>

1. The regions listed in the graph above are all different sections of the Gulf of Mexico. Which areas show the highest annual PP? The lowest?

2. What might explain the wide margin between the primary production measurements? Are there major geographical differences between the regions? Use a map to help.

3. Scientists can determine primary productivity by measuring the amount of chlorophyll-a (the green pigment responsible for most phytoplankton photosynthesis) in the ocean. Go to this NOAA website [https://www.ospo.noaa.gov/Products/ocean/color/swir_chla_daily.html](https://www.ospo.noaa.gov/Products/ocean/color/swir_chla_daily.html) and click on the most recent Gulf of Mexico (GM) projections. Where are chlorophyll concentrations the highest and lowest? What can you infer about the concentration of phytoplankton in the Gulf from this data?

4. Hypothesize the factors that might limit and encourage the growth of phytoplankton in the Gulf.
5. Do the maps and data table above support your hypothesis? Explain.

6. What impacts will the concentration of phytoplankton, and thus NPP, have on a marine ecosystem’s food web? Compare and contrast impacts in areas of extremely high and extremely low NPP in the Gulf of Mexico.

Use the graph below to answer the following questions:

1. Why do you think estuaries have a far higher annual average NPP than oceans and freshwater ecosystems?

2. Are there any similarities between high-producing terrestrial ecosystems and estuaries that may explain this disparity? Are there similarities between low-producing terrestrial ecosystems and the open ocean?
Post-Program Activity 1: Plankton Connections

Duration of Activity: approx. 30 minutes

Materials:
“Plankton Connections” worksheet, paper and pencils, computers for research

Background:
Every ecosystem on the planet is a tapestry of interwoven reactions, and aquatic ecosystems are no different. From predator-prey relationships to the effects of water temperature on dissolved oxygen, ecosystem connections abound. In this activity, students will determine relationships between plankton and a selection of abiotic and biotic factors. These factors are mostly close in proximity, but some are not! Students will also hypothesize the significance of these connections.

Directions:
Each student gets a connections worksheet.
1. Draw at least 4 lines from plankton to one of the surrounding biotic or abiotic factors of aquatic ecosystems.
2. Label each line 1 – 4, and match to the corresponding connections cards below.
3. Allow students time to research the ways in which plankton are connected to their chosen factors, as well as the significance of this connection for the health of the system.
4. Write a concise sentence or two describing the plankton/other factor relationship in each connections box.
5. Write an additional sentence that posits the importance of this connection.

OPTIONAL: Students can draw additional lines that connect the non-plankton factors to each other to determine further ecosystem relationships.

References: N/A
Plankton Connections

- Oyster Reefs
- Turbidity
- Carbon Dioxide
- Solar Radiation
- Oxygen
- Amazon Basin
- Marine Megafauna
- Primary Productivity

1

2

3

4
Post-Program Activity 2: Investigating HABs in Southwest Florida

Duration of Activity: approx. 30 minutes – 1 hour

Materials:
- Paper and pencils, computers for research

Background:
Harmful algal blooms hit the state of Florida hard in 2018, when both red tide and cyanobacteria blooms overwhelmed the state’s fresh and saltwater ecosystems. The blooms were so severe that Florida’s water crisis became the subject of national news and propelled its impacts onto the forefront of state politics. In this lesson, students will investigate both red tide and blue-green algae blooms in southwest Florida using FWC reports and mainstream media sources. Students will use critical thinking skills to assess the credibility of sources when discussing HAB phenomena.

Directions:
1. Begin this lesson by checking the status of red tide in Florida. Use this FWC daily sampling map:
   Are there any blooms in your area? In other parts of coastal Florida?
2. Direct students to go to the following websites to research red tide and blue-green algae blooms in southwest Florida:
   a. https://myfwc.com/research/redtide/general/
   b. https://myfwc.com/research/redtide/general/cyanobacteria/
3. Ask students to search for at least 3 news articles pertaining to HABs in Florida from the past 2 years. Encourage distinct media sources for each article – i.e., local news vs. national news, scientific magazine vs. fishing magazine, etc.
4. Ask students to consider any bias in news articles. Are the write-ups accurate to what is stated by the FWC? Are there discrepancies? What personal interests might motivate the authors of the articles chosen?
OPTIONAL:
Split students into six groups. Each group will choose from one of the following media interest groups:

1. Environmental Blog
2. Local SW FL newspaper
3. National news source
4. FL Hunting and Fishing magazine
5. “Coastal Living” magazine
6. Science Journal

Students will write a short (2-3 paragraph) opinion piece on HABs in Florida. Ask them to consider the motivations of the author and the audience of the articles in writing their pieces! Students can then present their articles to the class. Discuss the differences and/or similarities found in each piece.

References:
- Florida Fish and Wildlife Conservation Commission: “Red Tide”
  [https://myfwc.com/research/redtide/](https://myfwc.com/research/redtide/)

Additional Resources:
- NOAA Ocean Service Education, “Bad Algae!”
  [https://oceanservice.noaa.gov/education/lessons/bad_algae.html](https://oceanservice.noaa.gov/education/lessons/bad_algae.html)
- Project Oceanography: “Unit III: Red Tide and Harmful Algal Blooms” (pgs. 36-45).
  [https://www.marine.usf.edu/pjocean/packets/sp01/sp01u3p2.pdf](https://www.marine.usf.edu/pjocean/packets/sp01/sp01u3p2.pdf)
  - Activity: Growing Algae (pgs. 39-40)
  - Activity: Algal Explosion (pgs. 41-42).