MARINE PRODUCERS

This activity introduces oceanic organisms that photosynthesize and support food webs.

Objectives for Exam #1:
1. Discuss characteristics used to classify organisms, including producers.
2. Using satellite data, describe primary productivity in marine ecosystems, including the impact of upwelling during El Niño and La Niña events.
3. Provide examples of phytoplankton, and food webs based on phytoplankton.
4. List characteristics of macroscopic marine algae and the importance of pigments.

Objective for Portfolio #1:
Synthesize information on marine organisms from different parts of the course.

Part I: Activity Manual Notes *(Your GTA will point out key parts of the course syllabus and appendices in the activity manual, you can write any notes here)*

Part II: Producer Taxonomy *(*Do these *Thought Questions* with classmates at the round tables or before class*)*

1. Match the following eight terms in the table to the definitions below. Only use each term once:

prokaryotic	unicellular	autotrophic	sessile
eukaryotic	multicellular	heterotrophic	motile

_____ A. capable of locomotion.
_____ B. incapable of locomotion.
_____ C. composed of only one cell.
_____ D. composed of more than one cell.
_____ E. must ingest organic materials from its environment (feeds on "others").
_____ F. can synthesize organic materials like sugars from its environment, includes organisms that can photosynthesize (feeds "self").
_____ G. a cell that does not have a membrane-bound nucleus (ancestors arose "before" those organisms that have nuclei).
_____ H. a cell that has a nucleus.

Use the Domain/Kingdom characteristic table on the next page for the next two questions:

2. What two Domains contain prokaryotic organisms? _____ and_____

3. Another name for autotroph is **producer**. Producers are organisms that produce energy-rich sugars, usually through the process of photosynthesis. In marine biomes, producers are typically not plants (except some species in estuaries), instead they are primarily photosynthetic bacteria, archaea, and algae. Marine algae are classified in *Domain* _____ and *Kingdom* _____.

Domain/Kingdom	Key Characteristics	Examples
Domain *Bacteria* "True Bacteria"	Prokaryotic Unicellular (some form colonies) Autotrophic or Heterotrophic Sessile or Motile Different in genetic material than *Archaea*	*Escherischia coli* Bacteria *Salmonella* Bacteria *Nitrobacter* Bacteria Blue-green "algae" (Cyanobacteria)
Domain *Archaea* "Archaebacteria"	Prokaryotic Unicellular (some form colonies) Autotrophic or Heterotrophic Sessile or Motile Different in genetic material than *Bacteria*	Halobacteria (salt tolerant) Methanogens
Domain *Eukaryota* Kingdoms of Protists	Eukaryotic Unicellular (some form colonies) Autotrophic or Heterotrophic Sessile or Motile	Algae *Amoeba* *Paramecium* *Euglena*
Domain *Eukaryota* Kingdom *Fungi*	Eukaryotic Mostly Multicellular Heterotrophic Sessile	Mushrooms Molds Mildews Yeast (unicellular)
Domain *Eukaryota* Kingdom *Plantae*	Eukaryotic Multicellular Mostly Autotrophic Sessile	Moss Ferns Flowering Plants Trees
Domain *Eukaryota* Kingdom *Animalia*	Eukaryotic Multicellular Heterotrophic Motile	Jellyfish Insects Fish Birds

Part III: Marine Producer Stations

Station A: Marine Primary Productivity *(all of these are Thought Questions)*

Photosynthesis uses the energy in sunlight to convert carbon dioxide (CO_2) into organic material. Aquatic and terrestrial photosynthetic producers use some of their newly formed carbon products immediately for energy and maintenance. The remaining photosynthetic products are available for producer growth or consumption by all of the organisms that need to eat other organisms to survive (the consumers). The "leftover" photosynthetic products produced are often referred to collectively as **primary productivity**, and microscopic marine organisms are responsible for about half of the primary productivity on earth. Primary productivity is commonly measured as the amount ("biomass") of photosynthesizing organisms (**producers**).

1. What is an organism that can be classified as a **producer** in terrestrial (land) ecosystems? _____

2. What are two examples of producers that can be found in marine ecosystems? _____ and _____

3. List at least three factors that you think can limit primary productivity in oceans (*hint*: think about some of the factors that can limit houseplant growth).

4. Based on your answer to the previous question, where in the ocean do you expect to find conditions for high levels of primary productivity? _____

Station B: Marine Productivity Satellite Images

1. Looking at the satellite image (upper left), what colors indicate high primary productivity (high amounts of producers)? _____ (as measured by chlorophyll concentration, a green photosynthetic pigment). In the top right photos, where in the earth's oceans do you see the greatest amount of primary productivity? Provide general locations.

2. **Upwelling** is water currents bringing nutrient-rich waters up along coasts. Thinking about what producers need to survive and grow, does upwelling increase or decrease primary productivity? _____ Looking at the upwelling charts on the bottom right of the poster, where does upwelling primarily occur? _____ Refer to the food web in the middle of the chart. Nutrients and light are taken in by _____ which are eaten by _____, including the shrimp-like _____ animals. What eats the krill? _____

3. Explain how upwelling can have an impact on whale populations.

Station C: El Niño/La Niña

1. During El Niño years, winds over the equatorial Pacific Ocean change, and upwelling of cool nutrient-rich bottom water decreases off of the Peruvian coast, and other coastal regions. How can this impact fish populations traditionally found close to the Peruvian coast?

2. In La Niña years, the opposite occurs off the Peruvian Coast, upwelling actually increases. Fish populations often increase dramatically in size within months. Why?

3. The Pacific coast of North America is also impacted in El Niño and La Niña years. During which of these events would you expect Pacific Northwest salmon species to have a decrease in available food? _____

Station D: Phytoplankton Marine Producers

Plankton includes organisms that are carried around by water currents. This includes the **phytoplankton** (algae and bacteria that are producers), **zooplankton** (organisms that consume the phytoplankton, including protists and animals), and **bacterioplankton** (the bacteria and archaea that decompose dead organisms and wastes). Phytoplankton includes four major groups: cyanobacteria, diatoms, dinoflagellates, and coccolithophores. Cyanobacteria were introduced in last week's *Lichens* activity, and will be in lab again later this term.

Diatoms

1. Diatoms are a group of algae that make up the bulk of eukaryotes in phytoplankton, there are an estimated 100,000 species of diatoms globally. Marine diatoms are typically greenish-brown single-celled organisms. Different species are classified by their distinctive shapes and patterns. Examine the marine diatom slide under the microscope, and sketch at least three different shapes of diatoms (representing different species).

2. The diatom's symmetrical shapes are reinforced by silica shells that can remain after the diatoms have died. **Diatomaceous earth** is a sedimentary rock that is crumbled and used as a filter material and for products like kitty litter and insulation material. Look at the sample of diatomaceous earth under the microscope. The rock is actually made up of fossilized _____.

3. Diatoms have been collected, organized, and made into microscopic art work on glass slides. Some of this work has been magnified and painted by one of the most famous of the biological artists (1834-1919), _____.

Dinoflagellates

4. The next largest group of organisms making up marine phytoplankton are the **dinoflagellate** algae. "Dino-" for two, and "-flagella" for whip. These whip-like structures can be used for movement. Most dinoflagellates are producers, but some are also parasites and predators. Dinoflagellates and diatoms sometimes **bloom** in large numbers, meaning the organisms are reproducing and producing large numbers of individuals in their population. These blooms can feed consumers and support migrating animals. However, we typically hear about the blooms close to shore that are potentially harmful to fish and other animals. These blooms are often called "**red tides**." From the display, why are these blooms called red tide? _____ Why is this a misleading name? _____ What can cause red tides? _____ How can red tides harm fish and other animals?

Coccololithophores

5. **Coccololithophores** are also a group of algae, but unlike diatoms and dinoflagellates, they are only found in marine environments and not in fresh water habitats. Coccololithophores are covered in calcium carbonate plates and are also called coccloliths, for "round plates." The function of these plates is still unknown. From the display, what are fossilized coccoliths used for? _____

Phytoplankton and Food webs

6. Phytoplankton are consumed by zooplankton. Krill are well-known shrimp-like animal zooplankton that are eaten by many larger animal species in marine food webs. Arrange the marine food web playing cards. What eats phytoplankton? _____ What eats the zooplankton (including the krill)? _____ _____ The role of the decomposers is to break down the detritus (remains of organisms) so the nutrients can be recycled back to the _____.

Station E: Macroalgae "Seaweed" Marine Producers

The **macroalgae**, also called **seaweed**, flourish in shallow water, close to shore.

Macroalgae Colors

1. The *Algae Types* display shows that macroscopic marine algae are typically grouped by three colors (red, brown, and green) and are classified as *Phyla* (or *Divisions*): _____ (red), _____ (brown), and _____ (green).

2. The different colors of macroalgae are from different pigments (chemicals) within the algae, each playing a role in capturing light for photosynthesis. A **pigment** is a material that selectively absorbs different wavelengths, reflecting other wavelengths. From the display, the most common group of pigments is the **chlorophylls**, found in green algae and plants. The "green" chlorophyll pigments absorb _____ light for photosynthesis and reflect _____ light back to our eyes.

3. Even though they may appear only green, plants and algae can have smaller quantities of other color pigments. Spinach leaves have been ground up in a solvent and allowed to dry on a piece of absorbent paper. In addition to the green pigments, what other colors can you see?
   _____

Macroalgae Structure

4. Although superficially they look like plants because they are multi-cellular and photosynthesize, macroalgae are simpler in internal structure. Hold a leaf from a plant and a "blade" (algae equivalent to a leaf) from kelp up to light. What appears different?

5. Sketch a kelp plant and label: Blade(s), Stipe (equivalent to a plant stem), Holdfast (equivalent to root, holds kelp to rocks), and Float (gas-filled bladder that keeps fronds up by light):

6. The dried specimen of seaweed was washed ashore on a Pacific Coast beach with high tide. Using the *Seashore of the Pacific Northwest* guide, tentatively identify the species:
   _____

Human Uses

7. From the display, seaweeds are not just used as food, humans also use them for:

Other Marine Producers

8. In addition to microscopic phytoplankton and macroalgae, near shore there are some marine plants, primarily the **sea grasses**. Compare the microscopic view of the sea grass sample to the microscopic view of a macroalgae. How do they appear different in structure?

Part IV: Marine Organism Synthesis (for portfolio #1)

Skill: Synthesize information on marine organisms from different parts of the course.

Assignment: Marine organisms are covered in lecture, lab, recitation, and the on-line readings this week. In this assignment, you will be bringing together this information and writing three paragraphs that summarize characteristics and provide examples of marine organisms. Write your paragraphs clearly and concisely, as if you are explaining the information to a fellow student. In the first paragraph, describe what a producer is and provide two examples of organisms that are marine producers (from this recitation and Tuesday's lecture). In the second paragraph, describe what a consumer is, provide examples of both invertebrate and vertebrate phyla (from this week's lab). In the third paragraph, describe what zooplankton and nudibranchs are (from this week's readings).

Assessment: This portfolio assignment is worth 4.0 points: 1.5 point for the producer paragraph (0.5 point for producer description, 0.5 point each for the two example producers); 1.5 points for the consumer paragraph (0.5 point for consumer description, 0.5 point for example of an invertebrate phylum, 0.5 point for example of vertebrate phylum); and 1.0 point for the third paragraph (0.5 point for zooplankton, 0.5 point for nudibranchs).