PROTOZOAN ECOLOGY: DIVERSITY AND INTERDEPENDENCE

By: Ann Marie Wellhouse

Science Content Standards for High School Biology

National Standards

A: Understanding about Scientific Inquiry

- Scientists inquire about how physical, living, or designed systems function.
- Scientists rely on technology to enhance the gathering and manipulation of data.

C: Life Science the Interdependence of Organisms

- Organisms both cooperate and compete in ecosystems. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years.
- Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite. This fundamental tension has profound effects on the interactions between organisms.
- Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption.

Louisiana Standards

SI-H-A1 identifying questions and concepts that guide scientific investigations; (2, 4)
SI-H-A3 using technology to improve investigations and communications;
SE-H-A4 understanding that change is a fundamental characteristic of every ecosystem and that ecosystems have varying capacities for change and recovery; (1, 2, 3, 4, 5)
SI-H-B2 communicating that scientists conduct investigations for a variety of reasons, such as exploration of new areas, discovery of new aspects of the natural world, confirmation of prior investigations, evaluation of current theories, and comparison of models and theories; (1, 3, 4)
SI-H-B3 communicating that scientists rely on technology to enhance the gathering and manipulation of data; (1, 3)
LS-H-C4 classifying organisms; (1, 2, 3, 4)
LS-H-C5 distinguishing among the kingdoms; (1, 3, 4)
LS-H-D2 describing trophic levels and energy flows; (1, 3, 4, 5)
LS-H-D4 exploring how humans have impacted ecosystems and the need for societies to plan for the future; (1, 2, 4, 5)

Prerequisites

Knowledge:	Skills:
Ecology Trophic Levels	Use of the Scope-On-A-Rope

This work is supported in part by a grant to Louisiana State University from the Howard Hughes Medical Institute through the Precollege and Undergraduate Science Education Program.

Materials

1. Scope-On-A-Rope
2. Eyedroppers, standard slide, cover slips, depression slide
3. TV and/or computer with adaptor
4. Aquarium, pond, stream, and/or lake water – bottom scum

Objectives

One of the most exciting activities that biology students do is also one of the simplest. Dip into an overgrown pond or dirty aquarium for a water sample. Plug in the microscopes and watch the drama of microscopic life unfold. Extraordinary little creatures spin, twist, whirl and chomp their way around in that tiny ecosystem. This lesson introduces students to the microscopic world of protists and micro animals, and teaches skills necessary to prepare their own slides and identify what they find.

Background

Protists Are Not Plants, Animals or Fungi

The Domain Eukarya includes all living things that have membrane-bound organelles inside their cells such as a nucleus, mitochondria and chloroplasts. Even very young children are able to tell plants from animals. Mostly one is green and held to something else such as soil with roots. The other moves more freely. Some of the marine anemones clinging to rocks on the ocean floor might look more like plants but they have a gut to digest food and other characteristics that put them firmly in the animal kingdom. Once only those two kingdoms were used to describe all organisms. The only distinction that seemed to matter was eating habits. Animals take in food to provide themselves with energy that was produced by something else: They are heterotrophs. Plants take in raw materials from the soil and air and some even ambush insects, but they are able to harness the energy they need from the sun through photosynthesis: They are autotrophs. One problem with having just two kingdoms of eukaryotes is that fungi are very different. The fungi, including mushrooms, once classified with plants have very interesting eating habits. They digest their food outside of their filamentous bodies.

And then there is everything else. The Kingdom Protista contains so many different life-styles and body plans that it looks as if all of the eukaryotes that were left on the lab table, after the fungi, plants and animals were carefully classified, were just scraped off into the fourth container and labeled “Protista.” In the future this widely diverse kingdom may be itself divided.

The Kingdom Protista includes:

- **Algae** such as multi-cellular kelp and unicellular dinoflagellates and diatoms;
- **Protozoans** such as the amoebas, many parasites, and the ciliates;
- **Slime Molds**

These organisms are primarily aquatic. Some protists prefer oxygen, making use of aerobic respiration to breakdown sugars for energy, and some do not and those live in anaerobic conditions (oxygen free). All of the protists are eukaryotes and so have membrane bound organelles including

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mitochondria. Many protists are single celled. Some form colonies and a few are multi-cellular but very simple. Many protists are heterotrophs and eat food such as bacteria or other protists or bits of debris that are floating in their watery-world. Some are autotrophs, acquiring energy through the process of photosynthesis, such as kelp and other photosynthetic algae. Some protozoa are photosynthetic, such as members of the genus Euglena who will move rapidly around the slide using their flagella for locomotion. They are mobile like animals and photosynthetic like plants. Some scientists think they are mobile heterotrophs that engulfed a single-celled photosynthetic organism to eat it but failed to digest it and it went on to become a symbiont and live inside of the mobile organism to the benefit of both. This is a similar relationship to the bacteria that live in our digestive system and help us digest our food.

The freshwater pond protists that we will look at in the lab are microscopic. There may also be microscopic animals, plants and fungi as well as bacteria on the slides.

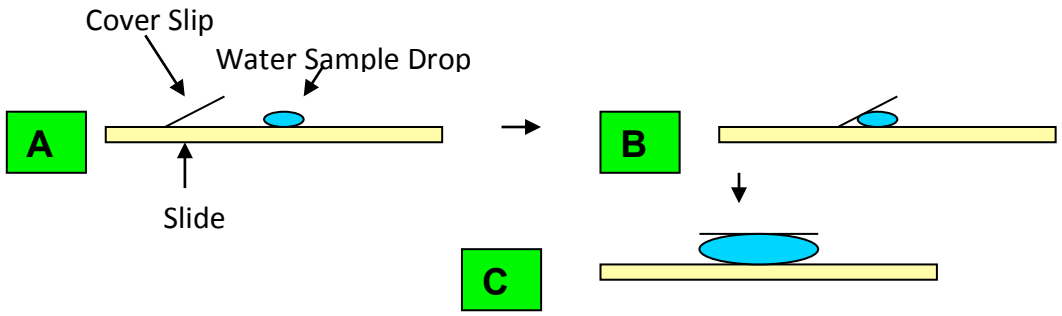
Micro Lab

1. Go to:
   http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/wimsmall/smal1.html
   Click on each type of organism listed to see some representative groups.

2. Write out a one-sentence definition for each group, which includes their distinguishing characteristics. Your teacher will help with this.

Slide Preparation Labs

3. **Learn to make wet-mount slides**. Use an eyedropper or disposable pipette to collect the water samples. They should be as grungy as possible. Bottom scum is good.



A Put 1-2 drops of the water sample in the center of the slide. Drag a cover slip along slide. The drop should not look clear.

B Drop will adhere to the base of the cover slip.

C Let the cover slip drop over the liquid.

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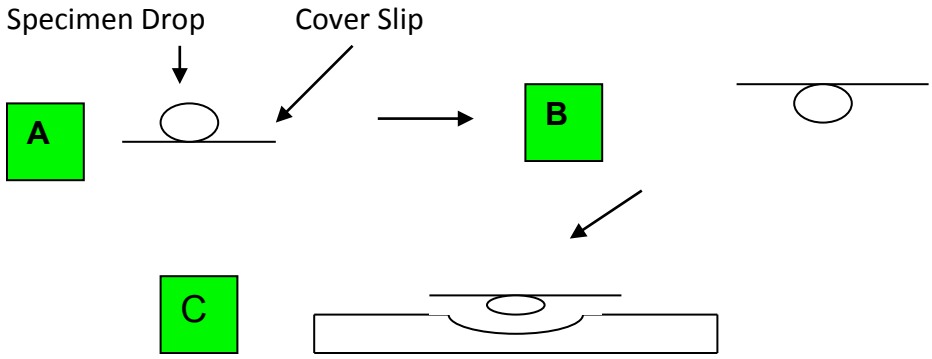
4. Make several slides from the following sources using the wet-mount procedure.
   Make sure the water sample is totally gross. Clear samples have too few organisms.
   - Aquarium glass or algae clump
   - Pond bottom
   - Stream bottom

5. Set up the SOAR mounted on the stand so that it will look at a slide placed below it.
6. Begin with the 1X lens and then the 30X lens. Use the 200X lens to take your pictures.
7. Make sure the picture is clearly focused.

8. **Learn to make hanging drop slides.**



A — Place a very tiny drop on cover slip that is resting on the lab table. The drop should look mucky not clear.

B — Quickly invert the cover slip with the drop now hanging underneath.

C — Carefully place the cover slip with the drop underneath on the depression slide as shown in the diagram. Cover slip should be flat on the slide with the drop hanging freely underneath.
If the drop smears it was too large so make a new slide with a smaller drop.

9. Make several slides from the following sources using the wet-mount procedure.
   - Aquarium Glass or algae clump
   - Pond Bottom
   - Stream Bottom

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10. Follow steps 6-8 above.

11. Complete the Protist and Micro-Animals Data Sheet (on following page)
    - Draw and describe at least one protist from each location and slide preparation type.
    - Draw and describe all of the micro-animals that you find.

Organism Identification

12. After you have made your slide and drawings and are ready to identify organisms go to: http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/wimsmall/smal1.html

    Scroll down to the clickable list of organisms.

Look closely at your organism.

Does it have a long tail called a Flagellum?. . . . . .Click Flagellated Protozoa

Does it have tiny hairs all around the outside?. . . . . .Click Ciliates

Does it look like a tiny clear jelly on a short stem
and you can see its internal organs? . . . . . Click Rotifers

Does it have a geometric shape and move slowly
and it is **not** green? . . . . . .Click Diatoms

Does it look like a worm?. . . . . .Click Worms

Does it look green and not move and seem to
be a group of cells forming stems?. . . . . Click Green Algae

Does it look green and have a spectacular
geometric shape? . . . . . .Click Desmids

Does it look like it has internal organs and eyes?. . . .Click Crustaceans

Does it look like a giant sun or a huge blob
that changes shape?. . . . . Click Sun Animalcules and Amoebas

13. Answer the questions on the Lab Reflection Sheet.

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Protists and Micro-Animals Data Sheet

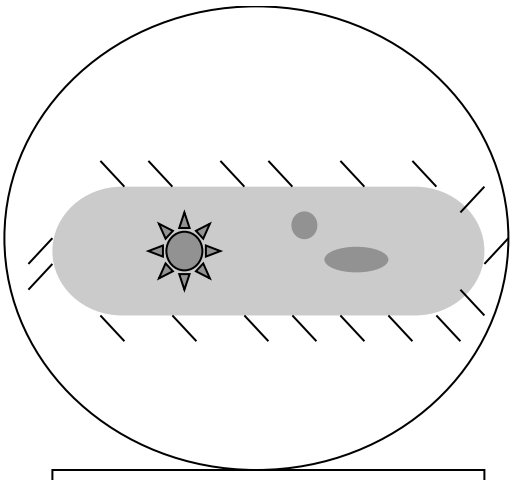
First record a picture of a slide you made of pond water organisms using the SOAR and then draw from the picture.

Try to draw them as large as the circle. **Record where each organism came from.**

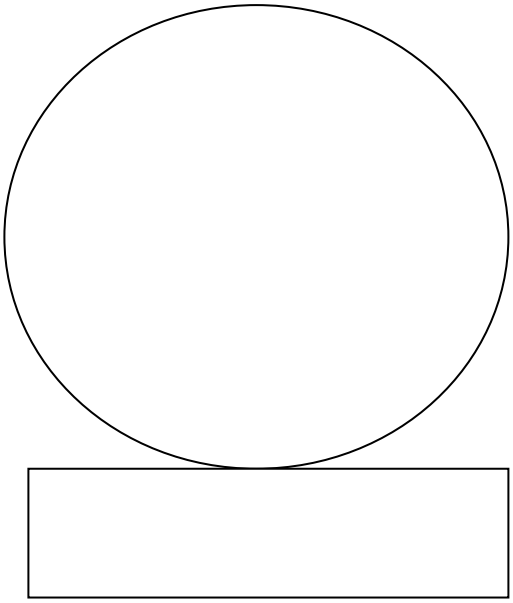
Drawing organisms that you are viewing under a microscope is an art form that gets better with practice. Make sure you are looking at one organism and not a clump of stuff. Ask your teacher for help with identification.

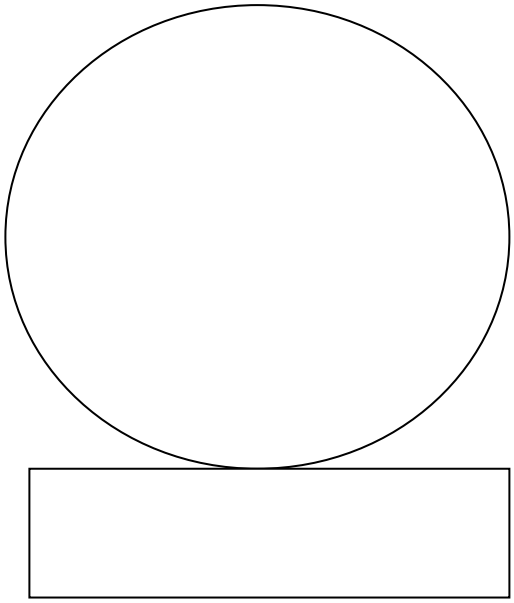
After you have drawn an organism then go to the website in #13 above to **identify it.** If you identify it first you will draw from that picture and it may be the wrong organism!

EXAMPLE



Paramecium
Aquarium Scum





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Micro Lab Reflection Sheet

- Each answer should be a long paragraph or more.
- The words in green refer to the science content standards.
- You may go to the following websites for more information:
  http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/wimsmall/smal1.html
  http://www.explorebiodiversity.com/

1. What is an ecosystem? Go to:
   http://www.teachersdomain.org/9-12/sci/life/eco/index.html

   Click Ecosystems
   Click on "Ancient Farmers of the Amazon" and watch the video.

   Refer to the ecosystem described in the video and the data you collected from your micro-ecosystems in your answer.

2. How would you describe the bio-diversity of the ecosystems that you sampled?

   "Biodiversity is the sum total of different kinds of organisms."

   Were there more organisms than you expected? Fewer?

   Were there more types of organisms than you expected? Fewer?

   Be sure to include each ecosystem (aquarium, pond, stream, etc.) in your answer.

   Read and include information from:
   http://explorebiodiversity.com/Mexico/Pages/Habitats/Biodiversity.htm

3. What kinds of changes in the habitat might affect these organisms?

   Think about and refer to the following when answering this question:
   - Climate
   - Human activity
   - Introduction of nonnative species (new food or new predators)
   - Changes in population size

   Include information from the Quick Time Video "Biological Invaders" at:
   http://www.teachersdomain.org/9-12/sci/life/eco/bioinvaders/index.html

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4. What might cause the size of the populations of these microorganisms to change?

   Think about and refer to the following when answering this question:
   - Initial population size
   - Rates of birth
   - Immigration
   - Emigration
   - Death
   - How humans impact ecosystems

5. How do the organisms that you drew fit into their ecosystem? Include each one.

   Think about and refer to the following when answering this question:
   - Producers – photosynthetic and chemosynthetic organisms
   - Consumers – organisms that do not make their own food
   - Decomposers- organisms that break down decaying matter for food
   - Describe trophic levels and energy flows (Refer to Energy diagram below)

   Go to the following website, watch the Quick Time video "Decomposers" and include information from it in your answer:
   http://www.teachersdomain.org/3-5/sci/life/oate/decompose/index.html

   Go to the following website, watch the Quick Time video "Producers" and include information from it in your answer:
   http://www.teachersdomain.org/3-5/sci/life/oate/deepseavents/index.html

6. Explain what you think the following statements mean:

   Stability in an ecosystem is a balance between competing effects.
   Organisms both cooperate and compete in ecosystems.
   Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite.
   Change is a fundamental characteristic of every ecosystem and ecosystems have varying capacities for change and recovery

   Refer to your data, and the information you have gathered in questions 1-5.
   This answer should be longer than the others.

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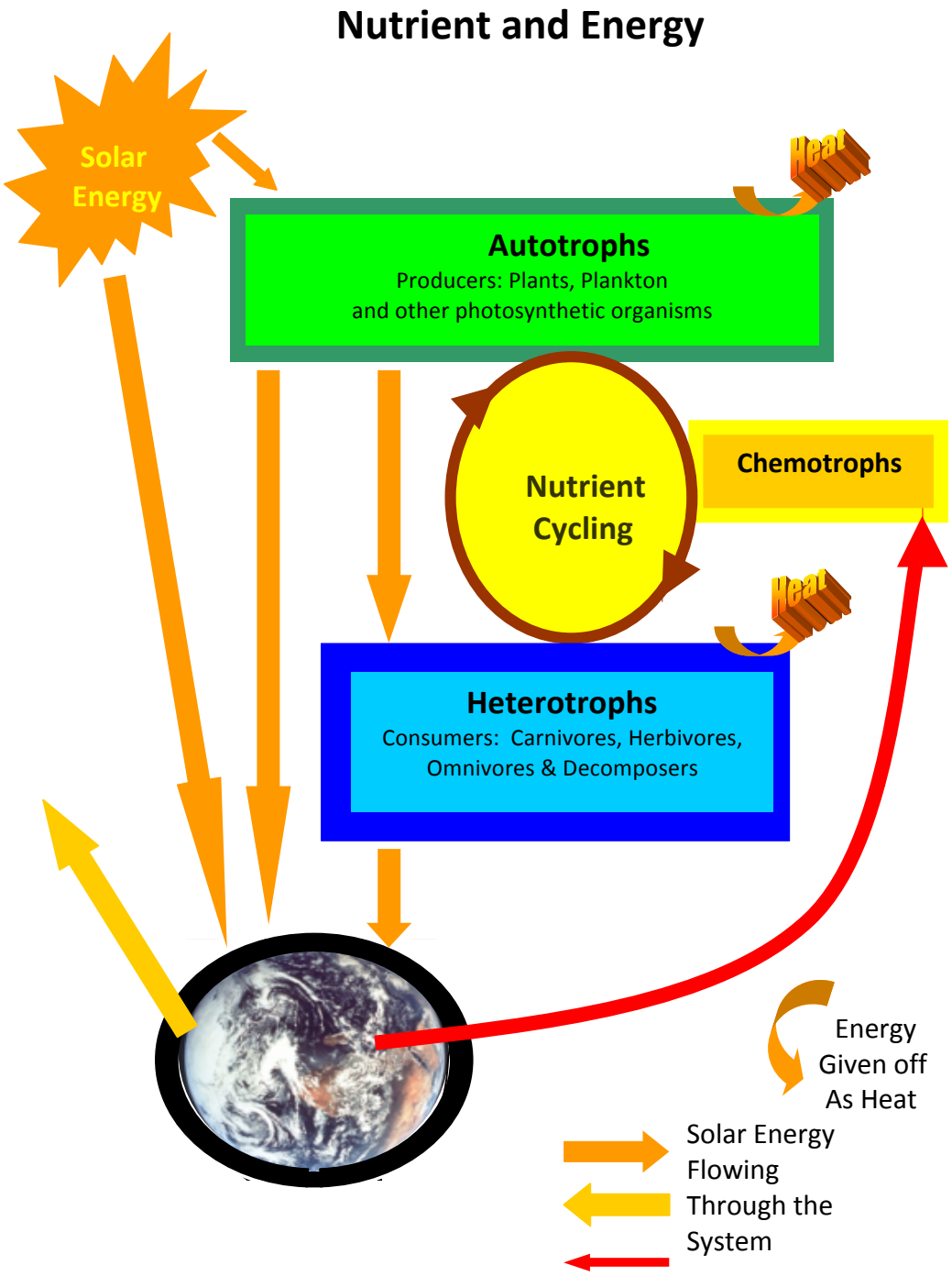
Additional Resources

Lesson Plan: Populations and invasive species
http://www.teachersdomain.org/9-12/sci/life/eco/lp_popgrowth/index.html



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Student Evaluation Form

Item		Great	Good	Needs Work
Background Pre-Reading	**Understandable?**			
	Useful?			
Micro-Lab	**Computer Research**			
	Wet Mount			
	Hanging Drop			
Organism Identification	**Useful**			
	Understandable			
Data Sheet	**Understandable**			
	Useful			
Reflection Sheet	**Understandable**			
	Useful			
Comments				

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