# Biodiversity Laboratory:
# Does Biodiversity Vary Between Habitats?

The species you will encounter this semester--small and large, simple and complex--are the working cogs of the living machine that is our biosphere and our only home. Each is important to the workings of its ecosystem. Even though we humans have not yet fathomed the ecological roles of most non-human species, we must learn to recognize them as we search for their importance to us and to the biosphere.

As you recall from your first semester of biology, the most ancient living organisms, in the Domain Archaea and Domain Bacteria, are sometimes referred to as **prokaryotes**. Prokaryotic organisms lack membrane bounded organelles, and their DNA consists of a single, circular chromosome of double stranded DNA organized in what is known as the **nucleoid region** of the cell.

More recently derived, **eukaryotes** (Domain Eukarya) are believed to share a most recent common ancestor with the Archaea. Eukaryotes may have evolved from ancient prokaryotes that formed symbiotic relationships with one another (The Endosymbiont Model) and/or who underwent inpocketing of their external plasma membranes to form an internal membrane network (The Autogenous Model). It is quite probable that both phenomena were involved in the evolution of eukaryotes.

Let's meet some of the results of these millennia of evolution.

## I. Inquiry-Based Exercise: Species Diversity Variation in Two Local Ecosystems

### A. Introduction

The responsibility and rush of every day life sometimes distracts us from the natural world around us. The diversity of non-human species is immense, and yet most people rarely stop to consider it. Today, we hope to change that for you.

Located to the west of the Cox Science Building is the Gifford Arboretum Native Biome. Nestled in its center is a small pond, complete with plants, animals, fungi, protists and bacteria of many species. A little bit farther off, towards the center of campus, lies Lake Osceola. What might we have in store for you? Hint: You never know just what you'll find in a bit of pond sludge.

All species of living organisms have different tolerance limits for various environmental factors, including temperature, light, humidity, nutrients, etc. Because different ecosystems have different levels of each of these factors, the species in each ecosystem will differ accordingly. The **abiotic** (non-living) components of any given habitat determine the composition and abundance of the **biotic** (living) components of that habitat, and the biotic components, in turn, affect each other's abundance and diversity.

Consider that a freshwater habitat presents more of an osmotic (water/salt balance) challenge to living cells than a saltwater or brackish environment. Also consider that different habitats not only have natural variables when it comes to abiotic factors, but that in an urban/suburban environment, they also are subjected to differing levels of human disturbance from things like pesticide and fertilizer runoff, physical disturbance, sanitation/clearing efforts, etc.

In today's exercise, you will compare the species diversity in two different local habitats on the University of Miami campus. Your TA will provide you with collection materials and send you, in teams of two, to collect samples of bottom sludge from either:

1. The Gifford Arboretum Native Biome pond, a eutrophic, freshwater pond habitat that is isolated from other bodies of water
2. Lake Osceola, a eutrophic, brackish lake habitat that is contiguous with Coral Gables canals, and ultimately, connected to the Atlantic ocean.

You will work in pairs to locate, identify and catalog as many different species as you can in bottom sludge samples from each of the two ecosystems. An identification list and tally sheet are provided on the following pages.

## B. Asking A Scientific Question

Before your TA turns your team loose to collect samples, you need to have a plan. As a class, you will consider the differences between the two habitats to be sampled. In teams of four, discuss and ask five questions about the relative biodiversity of each habitat that you might be able to answer by taking samples from the two habitats. List those questions here:

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

Once all teams are finished posing questions, each group will announce their questions to the class, and your TA will write them on the board. As a class, you will vote on the question you will address as a single research team consisting of all students in your lab section. And the winning question is:

______________________________

______________________________

**Your Null Hypothesis**:

______________________________

______________________________

**Your Alternative Hypothesis:**

______________________________

______________________________

**Type of Data you will be collecting (see Appendix IV):**

______________________________

**Type of statistical test you will use the analyze the data (see Appendix IV):**

______________________________

## C. Collecting Data from Your Samples.

Each pair of students should go to the assigned locality and collect 20 ml of wet bottom sludge from the edge of the body of water. Place your sample in the labeled cup provided and return to the laboratory as quickly as possible.

Once all teams have returned to the laboratory, samples should be placed on the front desk where teams can easily sample them. Each team member should obtain one cc (= one milliliter) of substrate sample from one of the two habitats. For best results, take your sample from the bottom of the cup. Place your samples, still in their syringes, in properly labeled beakers, and take to your station.

1. Place two drops of your sample on a microscope slide
2. Drop a coverslip onto the drops
3. Place one drop of methyl cellulose at the edge of the coverslip, and allow to diffuse under the coverslip. (This will slow down the rapidly swimming microorganisms)
4. STARTING ON LOW POWER, observe your sample under the microscope.
5. Begin at one corner of the coverslip, and gradually work your way across and down, in a zig-zag fashion.
6. Whenever you find a motile organism (protist or animal), stop and identify it as completely as you can by using the Identification Guide following this section as well as your Photo Atlas. If you're stumped, call your TA for help.
7. Record your results on the appropriate tally sheet (Lake Osceola or Gifford Pond) provided on the following pages.
8. Do three replications of this procedure.
9. When you have finished, notify the instructor, who will tally all groups' results on the board.

## D. Organism Identification Guide

Since this is your first introduction to some of the vast diversity of the Kingdoms of Life, we don't expect you to be able to identify with any great resolution the many organisms we hope you will see. However, this guide should help you narrow down the identification of the living organisms in your sample, and help you fill your species diversity tally sheet. Refer to your Laboratory Photo Atlas or the online field guide (**www.bio.miami.edu/dana/161/fieldguide.html**) for more detail, once you have narrowed your organism down to one of the major groups listed below. Note that we have omitted the “Kingdom” and “Phylum” designations for the major taxonomic groups you will likely find in your habitats. This is because the rank of these taxa occasionally changes. What’s more important than knowing that “Animalia” is a kingdom and “Arthropoda” is a phylum is knowing that the taxon Arthropoda is a subtaxon within Animalia.

The phyla listed here are arranged from most primitive to most derived. **If you find something you can't identify, call your instructor over for help!**

### 1. Protists

These are the simplest of the eukaryotic organisms, and they are a very diverse assemblage now assigned to several different candidate kingdoms once subsumed under the defunct name "Kingdom Protista." The types you are likely to see today will be very small and usually highly motile. To see them well, you'll probably have to use methyl cellulose to slow them down. Most common in daytime samples will be diatoms and small flagellates. But the occasional amoeba will show up.

For a nice overview of diatom appearance and biology, visit:

**http://arch.ced.berkeley.edu/kap2/php/Hidden_Ecologies/?page_id=197**

**2. Animalia, Porifera - The Sponges**

The sponges are the simplest of animals, and they are found in both freshwater and marine habitats. They are characterized by an amorphous body shape with no distinguishable head or tail end. Lacking true tissues, these animals have an array of diversified cell types, each of which performs a specific function.

**3. Animalia, Cnidaria - The Radially Symmetrical Animals**

Found in both freshwater and marine habitats, these animals are radially symmetrical (i.e., the body is divisible into identical "pie shaped" wedges) and have two true tissue layers (endoderm and ectoderm).

**4. Animalia, Platyhelminthes - The Flatworms**

If the body is dorsoventrally flattened (i.e., flattened from "top" to "bottom") and there is a distinct head end that guides the animal's movements, there's a good chance you're looking at a flatworm. (If you're not sure, call the instructor for a positive I.D.) These animals have three true tissue layers (endoderm, ectoderm and mesodermal mesenchyme) and simple organ systems.

**5. Animalia, Rotifera - The Wheel Animalcules**

These tiny animals are no bigger than a large protist, yet they have three true tissue layers and complex organ systems. They feed by means of a cephalic (head end) corona of cilia which beats food particles from the water into the mouth. They also use the corona for swimming; it pulls the animal through the water like a little propeller when it decides to weigh anchor (pull up its sticky pedal disk) and move.

**6. Animalia, Nematoda - The Roundworms**

These worms are very thin, symmetrical, and tapered at both ends. There is no evidence of body segmentation, and they move with a characteristic sinusoidal wave motion unique to this phylum. This is because the body wall has only longitudinal muscles, another characteristic unique to this phylum.

**7. Animalia, Annelida - The Segmented Worms**

The familiar earthworm is a member of this large, diverse phylum. You can identify a segmented worm by the ringlike markings on its body, which delineate the body segments. Internally and externally segmented, the body design and function is based on this characteristic metamerism, which is found in many other more derived (i.e., not primitive) animal taxa.

**8. Animalia, Mollusca - The Mollusks**

Closely related to the Annelids, the mollusks have secondarily lost their body segmentation, though it is present in the larval forms which you might see in your sample today. Mollusks can usually be identified by the presence of a distinct head and a muscular foot, though if you happen to find a bivalve, these features will be hidden inside the two shells.

**9. Animalia, Arthropoda - The Arthropods**

This is the most diverse of all animal phyla, with hundreds of thousands of species (The beetles alone comprise more than 350,000 described species!). Arthropoda includes the familiar insects, crustaceans, and spiders, as well as other less familiar forms. Like the annelids to which they are closely related, the arthropods show distinct body segmentation. And if it has distinctly jointed appendages, it's an arthropod.

**10. Animalia, Echinodermata - The Spiny-Skinned Animals**

Our closest invertebrate relatives that you're likely to see today are the starfish and their relatives, though you'll probably see only ciliated larval forms. Adults are pentaradially symmetrical. These animals are strictly marine, and may not be present in either of your samples.

**11. Animalia, Chordata - The Chordates**

This familiar group includes the sea squirts (subphylum Urochordata), the lancelets (subphylum Cephalochordata) and the vertebrates (subphylum Vertebrata). All are united by the presence of a cartilaginous skeletal support rod (the notochord) present at some time during development, a muscular, post-anal tail, segmentally arranged muscle bundles (at least in development) and pharyngeal gill slits. The only kinds you're likely to see today are fish and amphibians, but we are not likely to see any chordates. We just thought you'd like to know they're there.

Using the general identification guide above along with your Photo Atlas, try to locate and differentiate as many different species within the listed taxonomic groups as you can. Simply use hashmarks to keep count of the number in each category, and enter these on the tally sheets provided for each of the two habitats sampled.

## E. Analyzing your Data

When all teams have finished their survey and reported them to the TA, subject your data to statistical analysis in the way you deem most appropriate. Do this as a class, referring to Appendix IV if you need to review. (HINT: The contents of each 1cc sample can be considered one data set, and so a mean number of species can be calculated for each of the two habitats. Are these paired or independent samples? Beware of false replicates! You be the judge.) Use the space below for your calculations.

**Your statistic value:** ________________________

**P-value:** _________ > P > _______

Do you accept or reject your null hypothesis? _____________________________

Return to your groups of four, and now discuss the significance of your hypothesis testing. To the best of your ability, try to explain your results, and list reasons for your results here:

______________________________________________________________________

______________________________________________________________________

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After about 10 minutes of discussion in your teams, the class should confer as a group, and each team offer its explanations for the results. If an explanation is offered that your team didn't think up, write it here if you think it's a worthy explanation.

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**Species Diversity Tally Sheet: Lake Osceola**

| Taxonomic Group | species 1 | species 2 | species 3 | species 4 | species 5 | species 6 | Total # |
|---|---|---|---|---|---|---|---|
| **Protist** (diatom) | | | | | | | |
| **Protist** (flagellate) | | | | | | | |
| **Protist** (amoeboid) | | | | | | | |
| **Protist** (ciliate) | | | | | | | |
| **Porifera** (sponge) | | | | | | | |
| **Cnidaria** (cnidarians) | | | | | | | |
| **Platyhelminthes** (flatworm) | | | | | | | |
| **Rotifera** (wheel animalcules) | | | | | | | |
| **Nematoda** (roundworm) | | | | | | | |
| **Annelida** (segmented worms) | | | | | | | |
| **Mollusca** (mollusks) | | | | | | | |
| **Arthropoda** (arthropods) | | | | | | | |
| **Chordata** | | | | | | | |
| **Other** | | | | | | | |

**Total number of different species:** ______________________________

**Time of day sample was collected:** ______________________________

**Notes:** ______________________________________________

## Species Diversity Tally Sheet: Gifford Arboretum Pond

| Taxonomic Group | species 1 | species 2 | species 3 | species 4 | species 5 | species 6 | Total # |
|---|---|---|---|---|---|---|---|
| **Protist** (diatom) | | | | | | | |
| **Protist** (flagellate) | | | | | | | |
| **Protist** (amoeboid) | | | | | | | |
| **Protist** (ciliate) | | | | | | | |
| **Porifera** (sponge) | | | | | | | |
| **Cnidaria** (cnidarians) | | | | | | | |
| **Platyhelminthes** (flatworm) | | | | | | | |
| **Rotifera** (wheel animalcules) | | | | | | | |
| **Nematoda** (roundworm) | | | | | | | |
| **Annelida** (segmented worms) | | | | | | | |
| **Mollusca** (mollusks) | | | | | | | |
| **Arthropoda** (arthropods) | | | | | | | |
| **Chordata** | | | | | | | |
| **Other** | | | | | | | |

**Total number of different species:** ______________________________

**Time of day sample was collected:** ______________________________

**Notes:** ______________________________________________