

## Lab 2--Resource Acquisition

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Carbon. Nitrogen. Carbon fixation. Photosynthesis. Photosynthetic pigments. Heterotrophy. Autotrophy. A lot of new terms and concepts to know, but you still want to think about how the information given in this lab still relates to the ecology and evolution of organisms.

Life is basically about surviving and reproducing, and organisms survive and reproduce in many different ways. The intent of this lab was to give you an idea as to what are the basic needs of some of the major groups of organisms and how do they go about fulfilling those needs. Upper division courses will go into a lot more detail about the physiology of these groups. We are just introducing you to the very basics in this lab.

Plants, animals, micro-organisms, and fungi can be split into two basic groups—autotrophs and heterotrophs. The lab itself is basically split into these two parts, too. Stations A-F dealt primarily with autotrophs, and pretty much the rest of the lab dealt with heterotrophs (the exception being station I).

**NOTE: One quick note on terms. Biology is a terminology heavy science, and in the intro series we will be introducing you to the language of biology. Understanding the origin of the words will go a long way in helping you master this language. The reason for complex terminology is that, believe it or not, it facilitates unambiguous communication. For those who are med school bound, you definitely want to begin getting comfortable with this language as there is a long, complicated name for every part in the human body.**

The word “troph” is from the Greek for food or nourishment, and so you know that we are then dealing with two basic types of nutrient acquisition. The prefix “auto” in autotroph means self. Autotrophic organisms basically produce their own food, typically through photosynthesis (think plant). You definitely want to understand what photosynthesis is, what fuels photosynthesis, and what are the products of photosynthesis. See your pre-lab and lecture notes for further details.

Heterotrophs, on the other hand, must get their nutrients and energy from a different source (hetero=different). They feed on other organisms, be it another heterotroph or an autotroph. All animals are heterotrophs as are many micro-organisms. When we get to trophic interactions later in the quarter you will see the significance of the interactions of these two types of organisms.

Below is a quick synopsis of each station. Your lab manual has all the details.

### **Station A.**

Photosynthesis is the primary means most photoautotrophs obtain their energy. In order for photosynthesis to happen, organisms need a way to capture sunlight and transform that energy into a form the cell can use. Light harvesting pigments do this job. Different pigments capture light at different wavelengths, allowing the organism to take advantage of much of the visible spectrum (you will learn about wavelengths in your physics classes). Questions to think about: Which pigment do most plants possess? What advantage is there to having other pigments (think about the amount of light found in different habitats)?

### **Station B**

This was your homework: Observing photosynthesis. Recall you were asked to place a photosynthetic organism (the single celled *Euglena* packed into balls of alginate) at different distances from the light source. Sometimes the reaction took longer than anticipated, but you should see a change in pH in the vials with *Euglena*. The change is a result of the removal of CO<sub>2</sub> from the solution (why would the removal of CO<sub>2</sub> suggest photosynthesis is occurring?) Review the photosynthesis equation again: what happens to that CO<sub>2</sub> in a plant?

### **Station C**

In BIS2C you will go over this topic in much more detail, but the basic idea here is the evolution of organisms from a rather simple form to much more complex forms. The simplest organisms are made of just one cell. Things get a bit more complex when these cells form colonies. You saw that with the *Volvox* and *Spirogyra* colonies. These colonies, however, do not have any specialized tissues and they are only 2-dimensional in nature (grow only in the X-Y plane, if you will). The next step in the evolution of more complex organisms is for a colony to be able to grow in the vertical plane (the Z-axis), and the development of cells becoming specialized for a particular function. This led you to the plants at this station. Plants have three basic parts: leaves, stems, and roots. At its most basic, each is specialized for a particular function. For example, roots take in nutrients from the soil. I'll let you think about the primary function of the stem and leaves. The tomato plant at this station showed you these basic parts nicely. Internally you start seeing more complex structures, too. For example, the xylem and phloem make up the transport system of the plants (we use blood vessels for transport). Also, you see modifications of these basic plant structures. Root hairs on plants increase surface area to increase the plants ability for water and nutrient uptake. In the cactus the leaves were reduced to spines. This

provides two functions: 1) protection from predators and 2) reduce surface area for living in very dry environments. The orchids and other plants also deviated from the basic tomato pattern. How might natural selection have led to these changes (after lab 4 you should be able to answer this question)?

#### **Station D**

This station harkens back to the nutrient requirements of plants discussed in the pre-lab. The tomato plants were grown here without certain nutrients are not healthy when deprived of their “daily nutritional requirements”, so to speak. How might this affect a plant’s overall ability to compete (and ultimately its relative fitness—after lab 4 you should be able to answer this question)?

This station also introduced you to mutualistic relationships of the plants with other organisms, be they fungus or bacteria. These relationships help the plant do better. Your lab manual goes into detail on these.

#### **Station E**

Just like us, plants have the ability to store nutrients and energy (we use fat to store energy). This station showed you how the plant does this by modifying its roots, stems, or leaves. Different types of vegetables are present at this station showing you how we have taken advantage of these modifications for our own purposes. We are heterotrophs and so must eat other organisms to survive. We just happen to like potatoes, ginger, celery, carrots, etc.

This plant also talked about flowers and fruits—which are involved in reproduction, not nutrient or energy storage. Recall flowers possess the reproductive structure of the plant while fruits aid in seed dispersal [animals eat fruits, which have seeds (the presence of seeds generally indicates it’s a fruit) and then will poo the seeds out somewhere else, effectively dispersing the seed for the plant].

#### **Station F**

It is important to understand the difference between adaptation and acclimation. An adaptation involves an evolutionary change that happens over generations. Acclimation occurs within a single organism’s life time. For example, we acclimate our bodies to running 26 miles by going out and running longer and longer distances—our bodies respond to that stress and acclimate. In order for there to be an adaptation to running 26 miles, running 26 miles should increase our relative fitness, and the ability to run 26 miles should be passed to our offspring, and then they pass that trait on to their offspring. We see the change in the species over time, not the individual. Understand?

This station deals with the ability of plants to acclimate to environmental stimuli. Plants respond to light by turning their leaves to

the light (note: big hint on a function of leaves). You also saw the stem of a plant growing in the opposite direction of gravity. What might happen in space where there is no gravity? Plants do respond to the environment in ways that benefit them. Here's a harder question: how might the ability to acclimate be an adaptation?

### **Station G**

This is the first station dealing with heterotrophs (specifically animals, in this case). Recall heterotrophs feed on other organism and so must process that food in some way.

The digestive system of animals converts food into forms that can be used by the body for growth and metabolic requirements. Digestive systems come in different form, though. The simplest is essentially a sac. There is only one entrance. Food and waster enter and exit this one opening. These are called incomplete or two-way or blind guts. Most animals have two opening to their gut—a mouth and an anus. Guts of this type are called complete or one way (since food moves in only one direction). With food moving in one direction you start seeing specialized regions of the gut that was not found in animals with just a simple sac-like gut. For example, a gizzard may be present, which is used for grinding food into smaller pieces. The intestine is specialized for nutrient absorption.

With guts you also see how surface area has been increased to aid in nutrient absorption. This is discussed in the lab manual, but think about your small intestine. It is very long but coiled inside your body. Also, there are many finger-like projections that increase the surface area. This helps in nutrient absorption.

### **Station H**

There are different types of heterotrophs. For example, those that feed only on plants (herbivores), those that feed only on animals (carnivores). Your lab manual talks about other types of heterotrophs.

This station showed you that heterotrophs can also include micro-organisms. Some will swim around and engulf other micro-organisms through the process of phagocytosis (basically ingestion by a cell of some food or other particle—cell biology classes will go into detail on this process).

### **Station I**

A preview of lab 4.

### **Station J**

Before digestion can occur (see station G), an animal must have some way of grabbing and ingesting its food. This station goes into some detail on this. Hopefully the pre-dental types out there will appreciate this station.

One can tell what kind of food a mammal eats by looking at their teeth. Carnivores, the meat eaters, have sharp, pointy teeth to help them grab their prey and rip meat. Herbivore teeth tend to be flatter. This helps them grind plant material. Omnivores split the difference. They have both sharp teeth and flattened teeth since they eat pretty much anything. If you take a mammology class you will spend a lot of time on teeth.

Organisms that are not mammals feed in an analogous manner. Snails have a structure known as a radula. The radula scrapes algae from rocks (you don't need to know what a radula). The silk worms have what are known as molars. These are basically insect mouthparts designed for biting. The scorpion we have will grab its prey with its claws than feed using what are known as chelicerae (in a spider these are the fangs). Don't worry, you don't need to know the term chelicerae.

### **Station K**

Fungi, believe it or not, are heterotrophs. They must feed on other organisms. Basically they typically feed on dead, decaying organic matter. There are exceptions (athlete's foot or baking yeasts, for example), but in general they are saprotrophs (sapro=rotten or putrid—they feed on rotten organic matter). Your lab manual discusses how they feed, but basically they feed by digesting the food before taking it into their cells. Several animals also do this. Spiders inject digestive enzymes into their prey, and then suck the fluids out. Sea stars insert their stomach between the two shells of a mussel, digesting the mussel inside its own shell before ingesting it. Other examples of this type of feeding were given at this station and discussed in the lab manual.

### **Station L**

The idea of surface area came up frequently in this lab. This station gives more detail on surface area. Surface area plays a critical role in a lot of biological functions, and at this station, it is discussed relative to respiration. Animals need oxygen (so do plants and all other organisms that use O<sub>2</sub> for mitochondrial respiration). They must take it into their bodies in some manner, and this is done via diffusion. Diffusion occurs across the body wall or it can happen in specialized areas (gills or lungs, for example). Structure specialized for respiration have a lot of surface area. Think about fish gills. There are many folds in the structure of their gills. One of the reasons fish die when pulled out of the water is the gills collapse, reducing the surface area available for gas exchange, thus suffocating the fish.

Once oxygen is obtained, it must be transported to all the cells of the body. This is why animals have a circulatory system. In general, the circulatory system is the primary conduit of O<sub>2</sub> (there are exceptions—namely insects which use a series of tubes rather than blood vessels, but that is beyond the scope of this course). If an animal has a lot of surface

area relative to its volume, O<sub>2</sub> might be able to diffuse to all cells without the aid of the circulatory system. This is not true for most animals, and so the circulatory system helps in this regard.

Do you recall plants also have vascular system?

1. What is a photoautotroph? What is a heterotroph?
2. Give an example of each.
3. What are some chemical elements generally all organisms require?
4. What are the products of photosynthesis? How do heterotrophs benefit from these products?
5. What is one reason water is so important to organisms?
6. What are the products of respiration? How might autotrophs benefit from these products?
7. What are the basic functions of a root, stem, and leaf?
8. How do plants increase their ability to take in nutrients from the soil?
9. Would you expect a plant living in a very dry environment (desert) to have leaves with a high surface area to volume ratio or a low surface area to volume ratio? To retain heat would an organisms more likely have a high surface area to volume ratio or a low surface area to volume ratio? How about for respiration?
10. Why are *Rhizobium* bacteria critical for the survival of plants (and even us)?
11. Herbivores eat primary producers. What is a primary producer and why are they called primary producers?
12. What do omnivores eat? Carnivores? What is an example of a carnivore?
13. Natural selections produces organisms that seem very well adapted to their particular situation. What is an adaptation? How does this differ from an acclimation? Can an acclimation be an adaptation?
14. What is gravitropism? Is it found in an animal or a plant? How does it allow a plant to acclimate to the environment?

15. Describe the difference between a blind gut and a 2-way gut. Which one has specialized structures to aid in digestion?
16. Why might a digestive system have a high surface area to volume ratio?
17. Define herbivore, carnivore, omnivore, detritivore, and scavenger. In what category does a cat fit? How do the teeth of a carnivore differ from an herbivore? Give an example of an animal and non-animal example of a detritivore.
18. What is mixotroph?
19. Describe the differences between a deposit feeder and a suspension feeder. Into which category does a humpback whale fit?
20. What is a function of a trichome? Is this an adaptation or acclimation?
21. How does a fungus feed on other organisms?
22. What are hyphae and where are they found?
23. How does a parasite differ from a saprotroph?
24. Do respiratory structures, in general, have a high or low surface area to volume ratio? What could be a disadvantage for having a high surface area to volume ratio as a body form?