

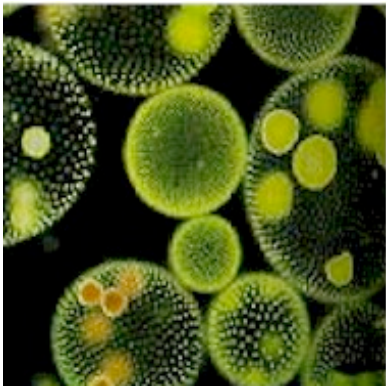
Name _____ Period _____

Chemistry Connection Worksheet

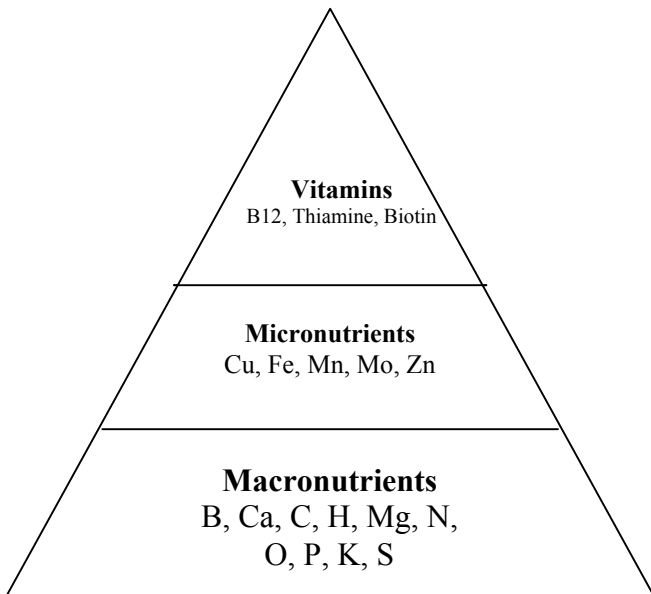
Nutrients

Every living organism needs to eat to stay alive, what they eat and how they eat it is going to vary a lot though! I'm sure that all of your parents have encouraged you to eat more fruits, veggies, and "healthy" food instead of eating junk food like candy and desserts. You are also probably familiar with the food pyramid, describing how many servings of each food group you should eat every day. Algae have their own food pyramid, and while they aren't eating sandwiches and fruit, they do have their own nutrition requirements. Food for algae falls into two major categories: macronutrients and micronutrients. Macronutrients are the "food" that the algae need a lot of while they tend to need less of the micronutrients.

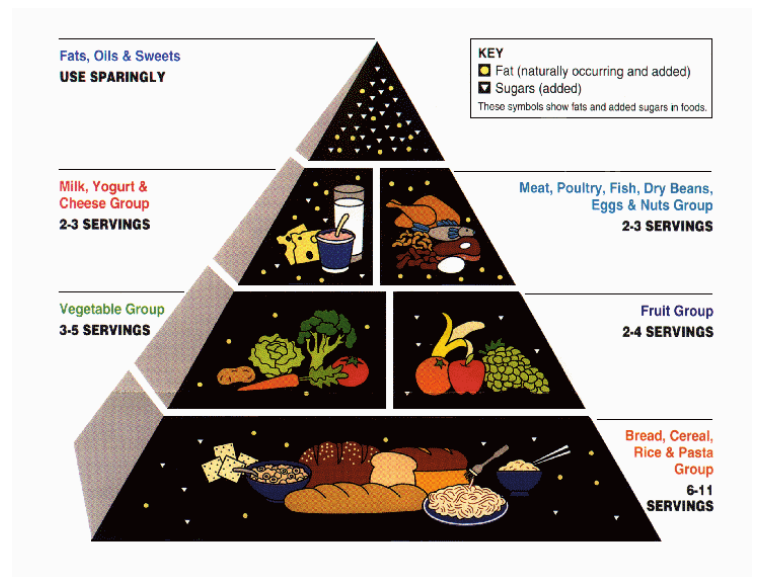
Algae Nutrients



Macronutrients	Micronutrients
Boron (B)	Copper (Cu)
Calcium (Ca)	Iron (Fe)
Carbon (C)	Manganese (Mn)
Hydrogen (H)	Molybdenum (Mo)
Nitrogen (N)	
Oxygen (O)	Vitamins
Phosphorus (P)	B12
Potassium (K)	Thiamine
Sulfur (S)	Biotin



The Algae Food Pyramid



The Human Food Pyramid

Limiting Nutrients

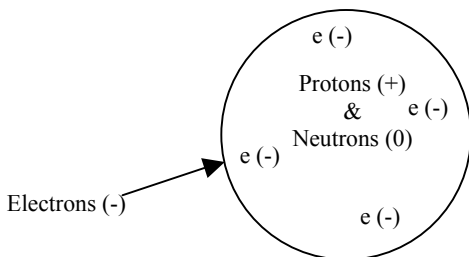
Do you remember when we talked about limiting factors? We defined limiting factors as any abiotic or biotic factor that restricts the number of individuals in a population. An example is houses. If there are no more houses for sale and no land to build more houses on in a town; the population of that town cannot increase. In this case, housing would be a limiting factor. Nutrients can be a limiting factor as well. If you didn't have food to eat, you wouldn't be able to grow- in fact it could lead to death. In this case, nutrients would be the limiting factor, limiting your growth.

Algae frequently face a problem of having limited nutrients. Nitrogen (N), phosphorus (P), iron (Fe), copper (Cu), zinc (Zn), manganese (Mn), and carbon (C) have all been shown to limit algae growth in different situations. The first two nutrients, nitrogen and phosphorus, limit algae growth most regularly.

Do you remember any products that might put these nutrients (nitrogen and phosphorus) into the aquatic environment? Write your answer below:

Algae food isn't quite like human food....

You may have noticed that the type of food algae eats is really different than what we eat. Instead of eating a nice slice of pizza, algae enjoy some yummy nitrogen! The favorite foods of algae, such as nitrogen and phosphorus, are all elements that you might be familiar with from the periodic table of elements. Each element on the periodic table is made up of three parts: protons, neutrons and electrons. Protons have a positive charge, neutrons have no charge and electrons have a negative charge. Protons and neutrons make up the core of the element and are surrounded by the electrons. Usually the number of electrons is equal to the number of protons so the element has no charge. Sometimes though, an element may either lose or gain electrons and this will give it a charge. When an element has a charge, it is called an ion. It can gain a positive charge, which makes it a cation, or it can gain a negative charge, making it an anion.



Ions

6 protons (+) & 6 electrons (-) = no charge

6 protons (+) & 5 electrons (-) = +1 charge (cation)

6 protons (+) & 7 electrons (-) = -1 charge (anion)

Practice Questions:

1. Nitrogen (N) normally has 7 protons and 7 electrons. It loses 1 electron, calculate its charge and indicate if it is negative or positive:

2. Phosphorus (P) normally has 15 protons and 15 electrons. It gains 1 electron, calculate its charge and indicate if it is positive or negative:

How do Algae “Eat” their Nutrients?

When you need some nutrients, you might make a sandwich or go to the store and get something that is already made. You take bites of it, digest it, and voila: your body gets nutrients! All of the nutrients that algae need are found in the water around them, but how do they “eat” them? How do they get the nutrients from the water into their cells?

There are 4 ways that algae take nutrients into their cells:

1. Adsorption
2. Passive Transport
3. Facilitated Diffusion
4. Active Transport

Activity: You and your group will visit 4 lab stations, at each one there will be an activity and some questions that you need to answer. You will rotate through each station and learn about the 4 ways that algae take nutrients into their cells.

Station 1: Adsorption

Have you ever heard the phrase “opposites attract”? Well that is basically what is happening in the case of adsorption. There are certain negatively charged molecules (such as proteins with sulfate, carboxyl, and phosphate groups) which are found in the cell wall of algae. When a cation (a positively charged ion) tries to enter the cell, it gets trapped by these negatively charged molecules because the negative charge and the positive charges attract one another. One cation that algae needs is the sodium ion (Na^+), it has a charge of +1 and the negatively charged molecules in the cell wall are going to try and grab it and use it to neutralize their charge (+1 and -1 = 0 charge). Most things want to be neutral if they can, that is their most comfortable condition.

Question 1: Do you think 2 positive charges would attract or repel? How about 2 negative charges? Answer below

Activity: See for yourself! Magnets have a positively charged end and a negatively charged end. Using the magnets at your station, what happens when you try to put 2 positively charged ends together? (Please be gentle with the magnets, they break easily!)

What happens when you try to put 2 negatively charged ends together?

What happens when you put 1 positively charged end with 1 negatively charged end?

Which of these 3 set-ups (2 positive charges, 2 negative charges or 1 positive and 1 negative charge) is most like adsorption? Circle your answer.

Question 2: If you had a sodium ion (Na^+), which of the following would it probably want to combine with?

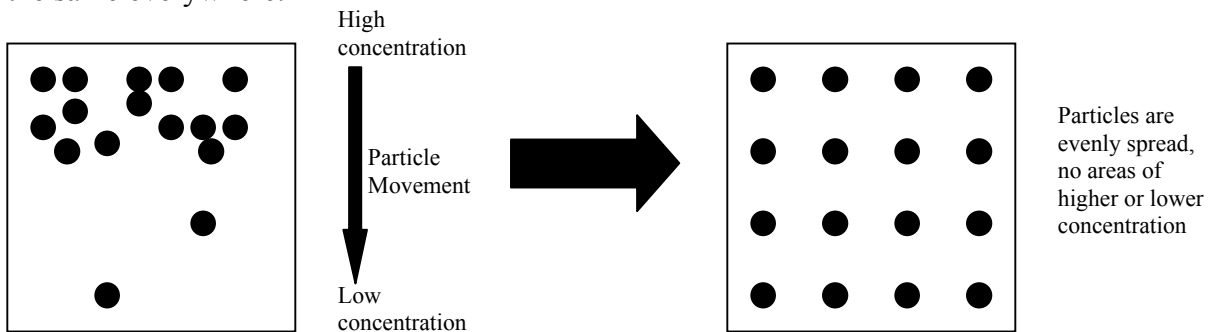
- a) Carbon (C, charge = 0)
- b) Chlorine (Cl^- , charge = -1)
- c) Oxygen (O, charge = 0)

Question 3: Lead (Pb) is often added to aquatic environments as a result of pollution (burning fossil fuels releases lead into the air and it reaches the earth when it rains). Lead is a positively charged metal and is adsorbed by algae cells. Lead can poison humans, what do you think its affect on algae is? Adsorption usually happens quickly, would fast uptake of lead be bad for algae?

Station 2: Passive Transport

Have you ever heard the word diffusion before? Diffusion is the tendency for chemicals or elements to spread out from areas of high concentration so that concentration becomes equal over a given area. Chemicals diffuse, so do people! Think about a crowded beach during the summer. A lot of people arrive at the beach at one small area (where there is a parking lot or where a path leads down to the beach); do they all stay clumped together right at the entrance? Not usually, normally they spread out. People want to leave the area where it is really crowded and go to an area where there are less people.

The trend that you see with people and with particles is the same; you see movement from areas of high concentration to areas of low concentration until the concentration is the same everywhere.



Activity: Your group is going to carefully add 5 drops of food coloring to your container of water, make sure to put them all in at the same place. Watch what happens after you add the food coloring and write down any observations.

Question 1: Where is the concentration of the food coloring the highest when you first added the drops?

Question 2: Does the food coloring stay where you first added it to the water? If not, where does it go?

What you saw happening was diffusion. Nutrients can diffuse into a cell if the concentration of that nutrient is lower inside of the cell than it is outside of the cell (remember, the nutrients don't like to be crowded!). Waste products from the cell can also diffuse out of the cell.

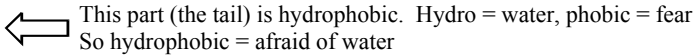
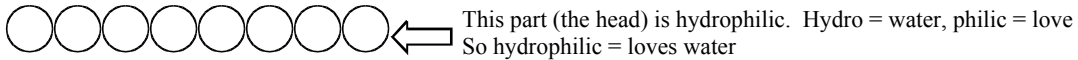
Question 3: Do you think it would be easier for a particle with a neutral charge or a particle with a positive or negative charge to diffuse in or out of a cell? Why?

Station 3: Facilitated Diffusion

This is the same idea as the diffusion that we just talked about, the main difference is that facilitated diffusion is faster than the diffusion we talked about at Station 2.

Fill in the blanks: Diffusion is movement from areas of _____ concentrations to areas of _____ concentration.

Sometimes nutrients need a little help to diffuse into the cell, when they get this help it is called facilitated diffusion. The cell membranes of algae cells are made up of a lipid bilayer (lipid= fat, bilayer= 2 layers).



The hydrophobic part of this membrane is a barrier for charged nutrients (ions), so how do they get through the membrane and into the cell? They need some help!

Activity 1:

Question 1: Can you think of anything that is hydrophobic (afraid of water)? If you can write you answer here: _____

Question 2: How do you know it is “afraid” of water? What does it do that shows you that? _____

Pour a small amount of oil into your container of water.

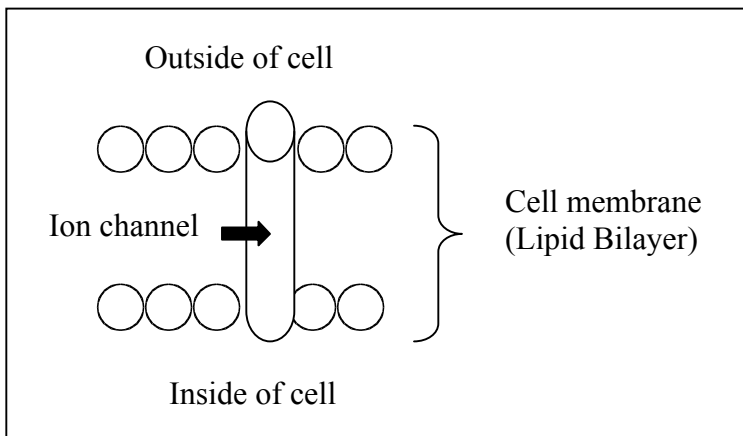
Question 3: What does it do? If you stir the container can you get the oil to mix with the water? Describe what happens: _____

It would be difficult to get your oil to stay at the bottom of the water:

Water
Oil

How would you do this? If you think of the top of the container as the surface of an algae cell, and the bottom of the container as the middle of the algae cell (where it wants to get nutrients), you see the problem the algae face. So how do they do it?

They can get charged molecules (ions) into their cells two different ways which are both considered facilitated diffusion, the two ways may work together (scientists are trying to figure it out). The first way is by having a carrier. The carrier grabs the ion at the cell membrane and helps it to get inside the cell. This would be like trying to get into a very exclusive club and knowing a member who can help you get in. The second way is through something called an ion channel. An ion channel is a protein that goes through the cell membrane (see picture).



Ion channels will allow charged nutrients to get inside of the cell without being stopped by the lipid bilayer. The nutrients are still diffusing into the cell because their concentration is greater outside of the cell than it is inside of the cell—so they are still moving from areas of high concentration to areas of low concentration. A carrier and an ion channel can work together (the carrier would take the charged molecule through the ion channel).

Activity 2: Carefully pour a little of the colored water on top of the oil. Does it mix with the water below the oil or stay on top of the oil? (Circle your answer).

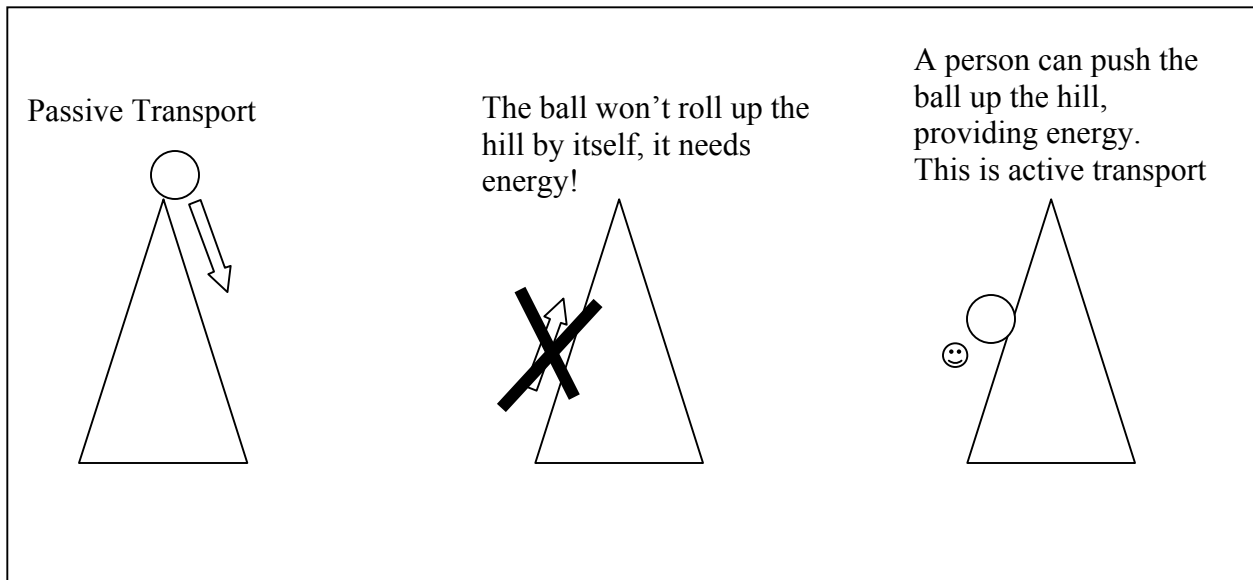
Now, place your straw so that it goes through the layer of oil and into the water below. Pour a small amount of colored water through the straw. Does it get trapped above the oil like before, or does it reach the water? (Circle your answer)

The straw is just like the ion channels, allowing charged nutrients to make it through the membrane and into the cell!

Question 4: What do you think would happen to an alga cell that doesn't have any ion channels? Would it still be able to get the nutrients it needs or would it starve?

Station 4: Active Transport

Active transport is different from the other three methods of nutrient transport because it requires energy in order to get the nutrients into the cell. It forces nutrients from areas of low concentration into areas of high concentration (and remember; nutrients don't like to be crowded!). The other three methods of nutrient transport can be thought of as downhill processes: a ball balancing at the top of a hill is naturally going to roll down the hill, but a ball at the bottom of a hill definitely won't roll up the hill by itself! In this example, active transport is the process of pushing the ball up the hill; it takes energy.



Activity: Your group has several balloons at your station.

Question 1: Do you think the concentration of air is greater inside of the balloon, outside of the balloon or is it equal inside and outside of the balloon? Circle your answer.

Question 2: If you were to blow up the balloon, you would be increasing the concentration of air inside of it. Would this take energy? Yes or No (circle your answer)

Question 3: Does a balloon ever spontaneously fill up with air? Why or why not?

Question 4: If you blow up a balloon and you do not tie the end, does the air want to stay inside of the balloon or does it want to come out? Why?

Everyone in your group should take a balloon and blow it up.

Question 5: Is it easier to blow it up when you first start, or when the balloon starts to get very full? Why do you think that is the case? _____

Carefully (please don't let your balloon go zooming out of control!), let a little air out of the balloon.

Question 6: Is it easier to get the air out of the balloon than it was to put the air into the balloon? Yes or No (circle)

Does it take energy? Yes or No (circle)

Question 7: Which of the 4 transport methods (adsorption, passive transport, facilitated diffusion or active transport) brings the air out of the balloon? Circle your answer.

Question 8: Draw the concentration of air particles (just draw them as dots, lots of dots for high concentration and just a few dots for low concentration) you think are in the balloon and outside of the balloon in each situation below:

Empty Balloon	Inflated Balloon	Balloon Losing Air

Question 9: Zinc (Zn) is a metal and a micronutrient that algae need to survive, however algae only need low concentrations of zinc and if the concentrations get too high, zinc can actually become toxic to the algae and poison them! Zinc is brought into algae cells by active transport. Why do you think algae would continue to bring zinc into their cells when the concentration of it gets high enough to be toxic? Can they control it?

Conclusion: Hopefully you have learned something about how another type of organism “eats” their food. Even though algae don't go to the fridge and make a sandwich, they still have to get nutrients everyday just like us! So, the next time you are eating lunch, think about all of the algae “munching” on nitrogen, phosphorus, carbon and all of the other macro and micro nutrients they like so much.

Vocabulary List

Active Transport: the transport of a substance against a concentration gradient (from an area of low concentration to an area of high concentration – the opposite of diffusion). Active transport requires energy.

Adsorption: the binding of a particle (nutrient) to the surface of a solid (cell membrane).

Alga (plural algae): Any one of a wide diversity of protists. Most live in the water, where they are the dominant autotrophs; most are unicellular, but a minority are multicellular.

Anion: a negatively charged ion (an atom that gained electrons).

Atom: the smallest unit of a chemical element. Consists of a nucleus and one or more electrons.

Cation: a positively charged ion (an atom that lost electrons).

Diffusion: movement of molecules or other particles from areas of high concentrations to areas of low concentrations, resulting in even distribution of the particles.

Electron: a fundamental part of an atom, it has a charge of -1 and surrounds the nucleus of an atom.

Facilitated Diffusion: something that helps diffusion happen and usually speeds it up. Two possible facilitators are carriers and ion channels.

Hydrophilic: love for water.

Hydrophobic: afraid of water.

Ion: an atom or group of atoms with electrons added or removed, giving it a negative or positive electrical charge.

Ion Channel: a membrane protein that can let ions pass across the cell membrane.

Limiting Factors: any abiotic (non-living) or biotic (living) factor that restricts the number of individuals in a population.

Lipid Bilayer: the cell membrane of a cell, made up of 2 layers of hydrophobic tails and hydrophilic heads.

Neutron: a fundamental part of an atom, it has no charge and is found in the nucleus of an atom.

Passive Transport: doesn't require energy, see "Diffusion" definition.

Proton: a fundamental part of an atom, it has a charge of +1 and is found in the nucleus of an atom.