PLANTS

LESSON 8: PH & PLANTS

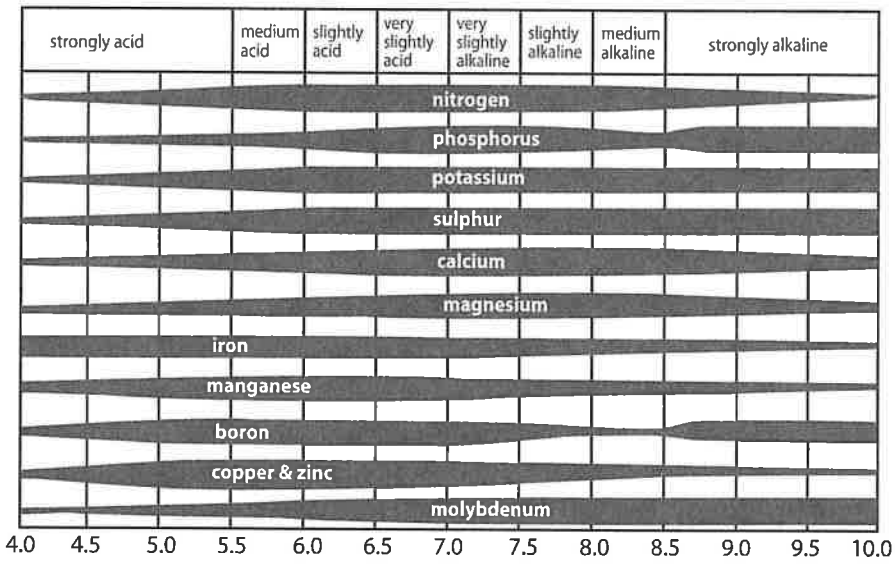
TEACHER GUIDE

BACKGROUND INFORMATION

- pH is defined as the negative logarithm of the hydrogen ion activity in a solution. An easier to understand notion is that it measures the acidity or basicity of a solution on a scale of 0 to 14, with a pH of 7 being neutral. Pure water is said to have a pH of 7, while a pH of less than 7 is acidic and a pH that is greater than 7 is basic. The scale is logarithmic, which means that each unit change equals a ten-times increase or decrease of acidity. Therefore 6 is 10-times as acidic as 7, and 5 is 100-times more acidic than 7. Small changes in pH actually result in large changes in acidity.

- Just like with temperature, most living things have a very specific pH range in which they can survive, and an even narrower range in which they thrive. In aquaponics, there are four living things co-habiting the same eco-system so you want the pH of your water in a range that is compatible with all four: your fish, your plants, the worms and the bacteria. For fish, this is optimally a pH of around 6.5 to 8.0. For plants, this is a pH of around 5.0 to 7.0. For red worms and for bacteria it is a pH of 6.0 to 8.0. Aquaponic systems are a compromise of the pH requirements of all four components. Thus, optimal pH is around 6.8 to 7.0.

- The range for plants exists because plants can only take up certain nutrients within certain pH ranges. The ideal range for plants allows the plants to best take-up all of the essential nutrients. The chart below illustrates this concept.



- The thickness of the bar in the chart above represents the amount of nutrient that is available at that pH level. Look at how much of each of the nutrients is available at the recommended pH level of 6.8 – 7.0, vs. a pH level of 6.0 or 8.0. As an example, let's consider iron. Notice how the amount of iron that is available quickly decreases as pH increases above 7.0. This is called "nutrient lock-out."

LESSON OBJECTIVES

- To have a basic understanding of what the pH scale represents.
- To understand that the relative acidity and basicity change amongst substances.
- To realize the pH of an environment can affect the living conditions of living things, namely plants.
- To practice reading charts and plotting data.
- To be able to measure and read pH, and to understand the results.

LESSON MATERIALS

- pH testing strips – these are very affordable and can likely be found at your local pharmacy (the API Fresh Water Master Test Kit has a limited range, for the experiment idea included in this curriculum, you will have to acquire materials, such as litmus paper, with a broader range)
- A variety of substances on which to test pH. Here are some ideas:
    - The water from your aquaponics system
    - Regular tap water
    - Milk

- Baking soda solution
- Soap solution
- Lemon or lime juice
- Tomato juice
- Vinegar
- Pond water

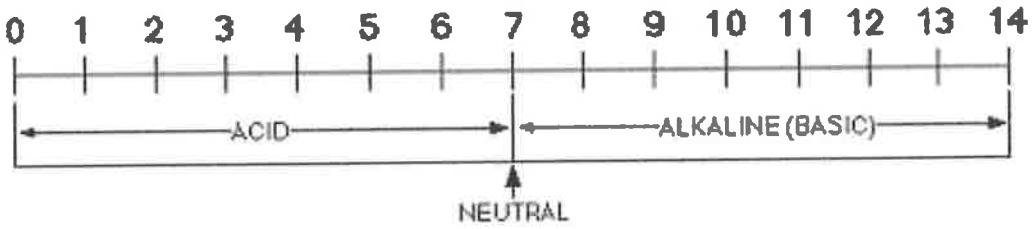
- Blank pH charts (copy the page below)
- Copies of the assessment

Assessment Answer Key

1) A substance with a pH of 1.0 would be acidic (A)
2) If the pH were 9.5, iron would be hard to get (C)

This range is healthy for the fish. This range is healthy for the plants; it allows them to get their necessary nutrients. This range is a good compromise for the fish and the plants.

3)



VOCABULARY

pH – the measure of how acidic or basic a substance is. A substance with a 1.0 rating is extremely acidic. A substance with a 14.0 rating is extremely basic. A substance with a 7.0 rating is called neutral.

Acid – a substance below 7.0 on the pH scale. It usually has a sour taste.

Base – a substance above 7.0 on the pH scale. It usually has a bitter taste and may feel slippery.

Neutral – a substance that is in between acid and base (water for instance)

Nutrients – food for plants.

LECTURE AND DISCUSSION

- Lemon juice is an acidic substance. Soap is a basic substance. Water is a neutral substance.
    - Ask the students: what other acidic substances can you think of? (common acids include citruses, milk and vinegar)
    - Ask the students: what other basic substances can you think of? (common bases include substances that are slimy, such as cleaning supplies and eggs)

- Show the diagram of a pH scale with a lemon on the acidic end, and soap on the basic end. (in power point)
    - Ask the students: would you want to live in lemon juice or soap?
    - Ask the students: where on the scale do you think you would be comfortable living?
- Plants are similar to people, they do not want to live in very acidic, or very basic conditions. They prefer to be closer to 7.0, or a neutral pH. (power point)
- pH is not only important for the plants' survival (remember they would die in lemon juice or soap), but for their ability to consume the nutrients necessary for their survival.
    - Ask the students: what do you need to eat? (Looking for answers such as bread, meat, vegetables and fruit)
- Plants are very similar to people; they need a variety of nutrients, like iron and calcium.
- Different pH levels in the water allow for different nutrients to be consumed by the plants.
    - Use the chart to show this phenomenon (power point)
- The larger the bar, the easier it is for the plants to eat the nutrient
    - Show the students how to follow the big parts of the bar down to the associated pH level.
- It is as if the thickness of the bar is the plant's mouth. The wider the mouth is open, the easier it will be to eat a lot of the nutrient.
    - Ask the students: which pH lines up with the greatest number of wide bars? (the answer should be 6.5-7.0) (power point)
- This is a good pH for the plants, so they can be as healthy as possible.
- The fish want a slightly higher pH, so to compromise, the perfect pH range for an aquaponics system is from 6.8-7.0.

ACTIVITY

Allow the students to test the pH of several substances and plot the values they find on an empty pH scale.

Possible substances to test include:

- The water from your aquaponics system
- Regular tap water
- Milk
- Baking soda solution
- Soap solution
- Lemon or lime juice
- Tomato juice
- Vinegar
- Pond water

CONCLUSION

- Various substances have different levels of pH.
- Plants want to live in a pH of around 6.5 to not only survive, but to absorb all of the necessary nutrients.
- Go over the results of the activity to ensure that every student understands roughly where a few substances lie on the pH scale.

EXTENSION

Math – if the students are unfamiliar with decimals, the pH scale provides a good example of decimals in use. Additionally, an advance student could us the pH scale as an introduction to logarithms.

Name_____ Date_____

ASSESSMENT 8 – PH & PLANTS

1) A substance with a pH of 1.0 would be (circle one):

   A. Acidic

   B. Basic

   C. Neutral

2) Using the picture - if the pH were 9.5, which nutrient would be hard for the plants to get? (circle one)

   A. Phosphorus

   B. Sulfur

   C. Iron

3) Short Answer: list a few reasons why we should keep the pH of the Aquabundance system at 6.8-7.0?