Hydroponics

Growing Food Without Soil

Grades 4-8

Master Gardeners

The University of California Cooperative Extension (UCCE) Master Gardener Program (MGP) is an educational program designed to teach and effectively extend information to address home gardening and non-commercial horticulture needs in California.

UCCE is the outreach arm of UC's division of Agriculture and Natural Resources (ANR). Master Gardener volunteers (MG volunteers) promote the application of basic environmentally appropriate horticultural practices through UCCE-organized educational programs that transfer research-based knowledge and information.

University of California
Agriculture and Natural Resources
UCCE Master Gardener Program

Why Is This Important?

- Hydroponics is a gardening system that has many advantages, notably a decrease in water usage for growing plants.
- Since hydroponics uses much less water to grow produce, it is a water-conserving growing system for both home and school gardens.

Learning Goals

Student gardeners will learn

- the basic components of a hydroponics system;
- ongoing maintenance of a hydroponics system;
- and the edible plants that grow best in this system.

What Is Hydroponics?

- Hydroponics is the science of growing plants in a nutrient-rich solution instead of soil.
- Instead of soil, the water does the “work” of delivering nutrients to the plant’s roots.
- Because the roots are bathed in a nutrient solution, there is constant nourishment for the plants.

What Are the Advantages of Hydroponics?

- Plants can be grown anywhere year-round.
- Provides greater control over growing conditions.
- Provides a faster growing time.
- No weeding is required.
- Uses less water than outdoor, in-soil gardening.
- Plants can be spaced close together and stacked vertically.
- Materials can be reused.

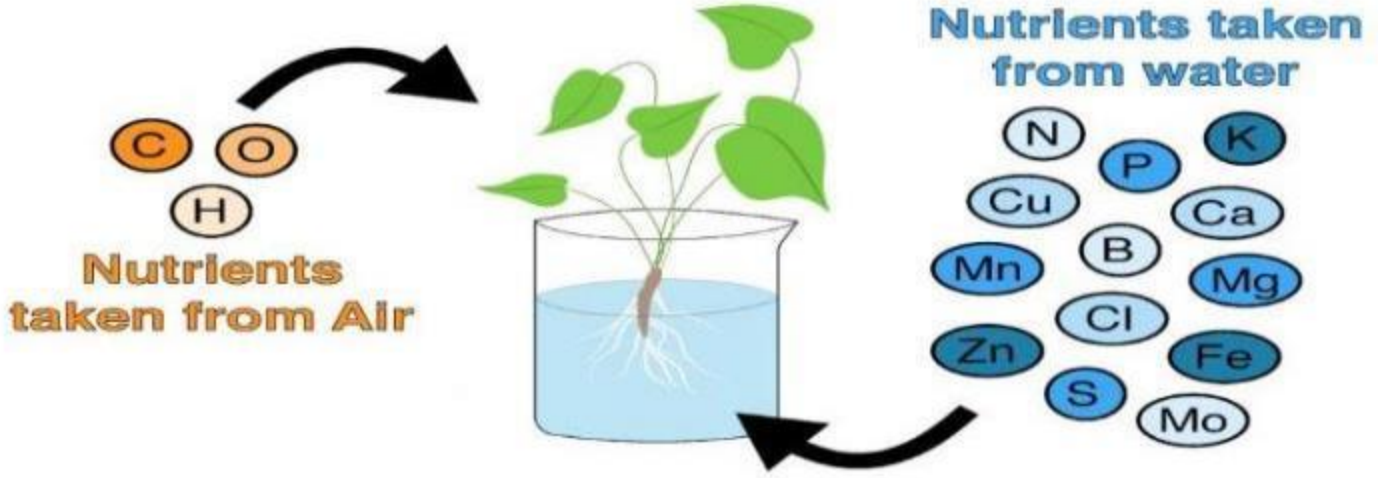
-- College of Agriculture, Biotechnology, and Nature Resources University of Nevada. Reno

What Are the Disadvantages of Hydronics?

- Higher start-up costs compared to soil growing systems.
- Requires the use of electricity to power the growing system and provide sufficient lighting for plant growth if growing indoors.
- Requires some basic skills and knowledge to maintain the system.
- Diseases, when present, can spread easily.

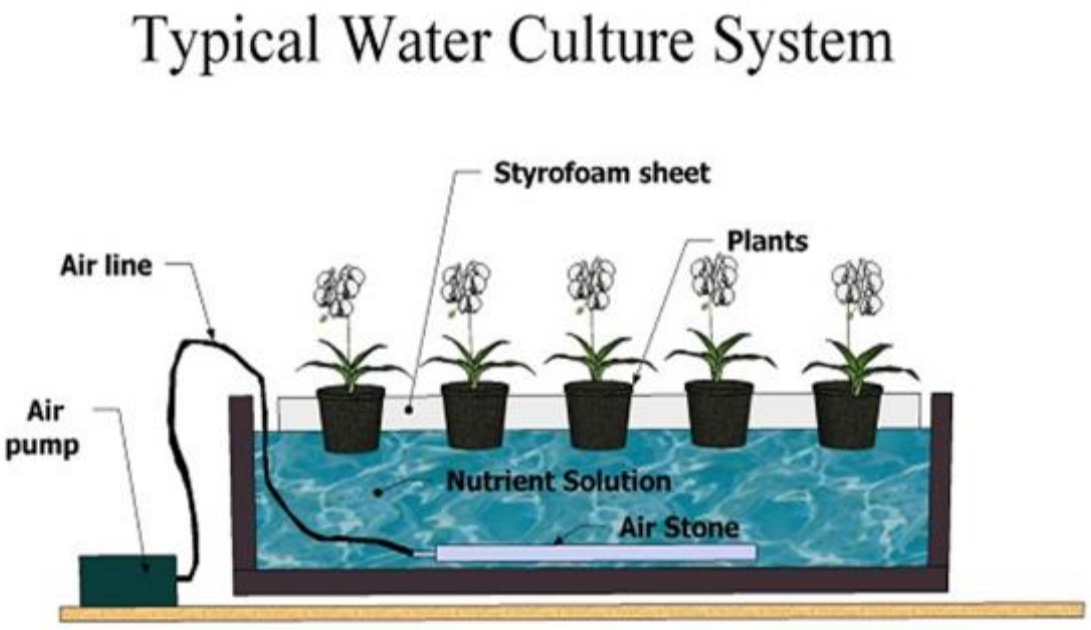
Hydroponics Basics

- Plants are exposed to light to allow for the process of photosynthesis, and plant roots are exposed to air allowing the roots to capture oxygen that they need to grow.
- Nutrients mixed into water feed plant growth and include nitrogen, phosphorous, potassium, and calcium.

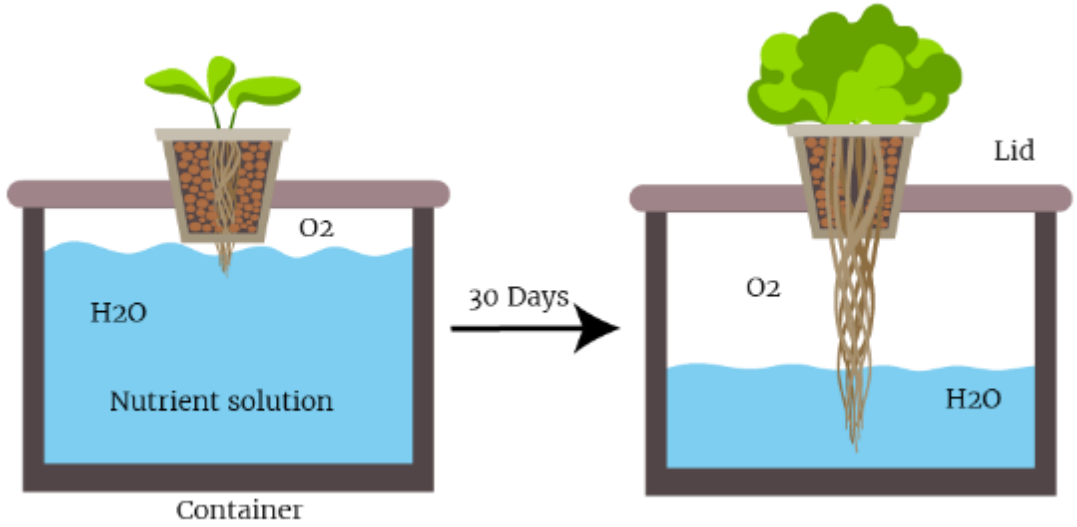


Two Categories of Hydroponics Systems

- **Dynamic** or active systems, which use pumps that oxygenate the water.



- **Passive** or inactive systems which do not pump water. Plants are set in a non-soil growing material and part of their roots sit in a nutrient solution.

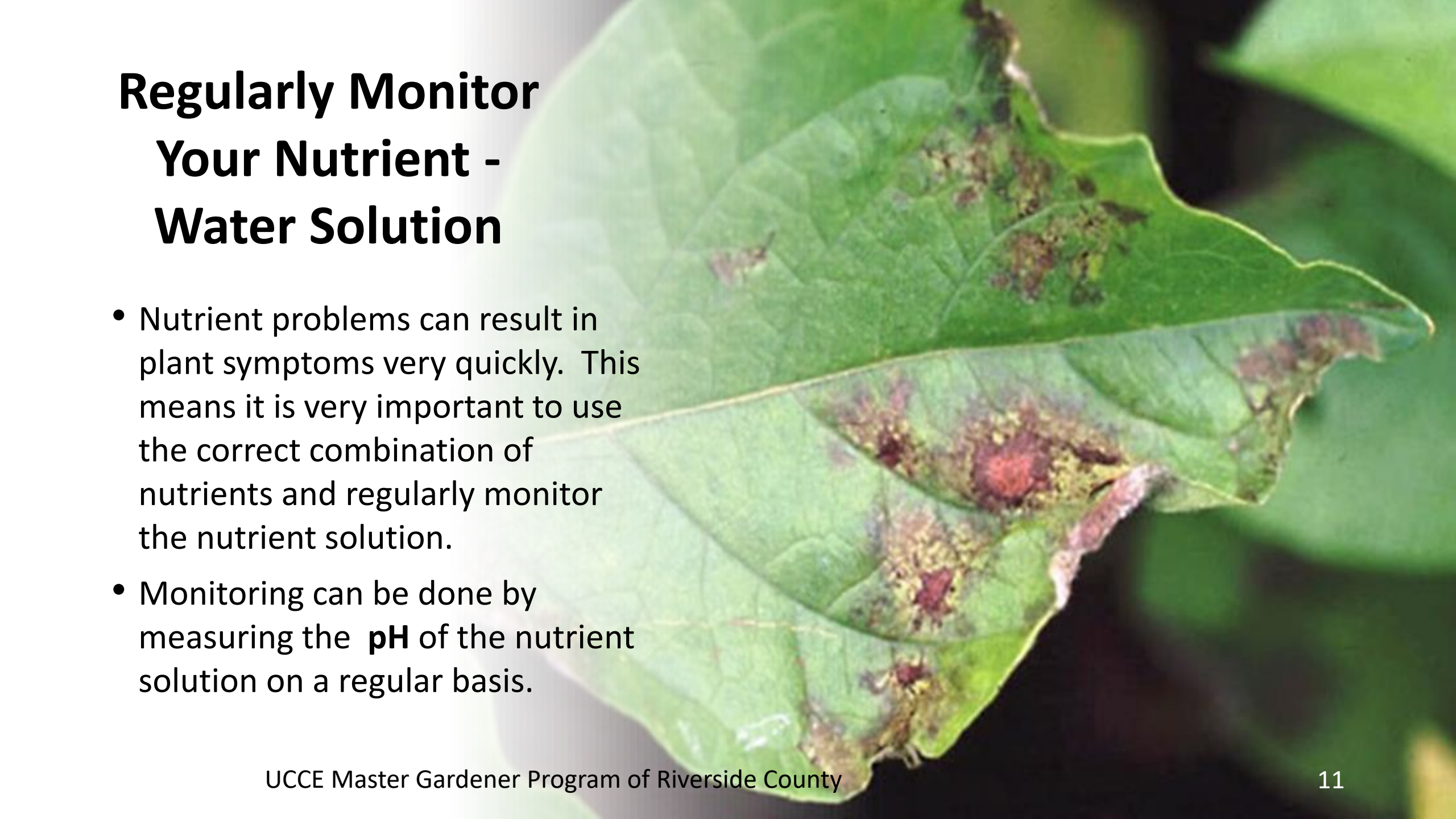


Maintaining a Hydroponics System

Both active and passive systems require that nutrients be added to the water.

- In soil, nutrients come from rocks, minerals and organic matter. They are “held” by the soil particles and dissolved in the surrounding water before being absorbed the roots.
- In hydroponics, gardeners add nutrients to the water. The easiest way to supply these nutrients is to purchase prepared nutrients in dried or liquid form.
- Most are concentrated and must be mixed with water.

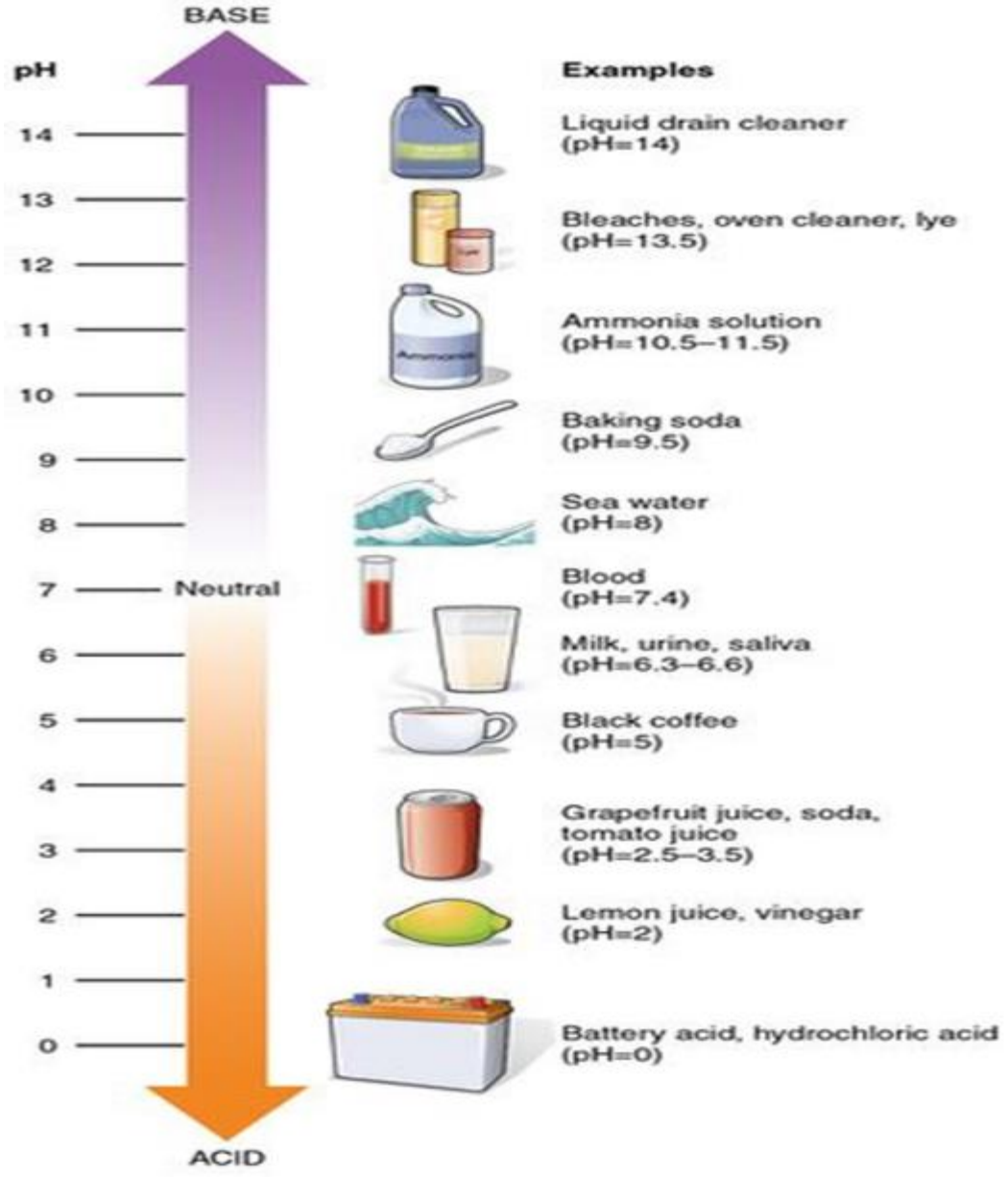
Regularly Monitor Your Nutrient - Water Solution



- Nutrient problems can result in plant symptoms very quickly. This means it is very important to use the correct combination of nutrients and regularly monitor the nutrient solution.
- Monitoring can be done by measuring the **pH** of the nutrient solution on a regular basis.

What Is pH?

- pH is a measure of the level of acidity and alkalinity on a scale from 1 to 14, with 1 being very acidic, 7 being neutral, and 14 being very alkaline, also called base.
- **Most of the plants in a hydroponics system grow best when the pH of the nutrient solution is between 5.8 and 6.5.**
- At pH readings above or below this range, certain nutrients become unavailable to plant roots.



Tools for Measuring pH

- Two of the easiest ways to obtain an accurate pH reading are to use specially designed pH test papers or a pH meter.

Replacing and Disposing of Nutrient Solutions

Nutrient solutions need to be replaced periodically. How often depends on the type of system as well as other factors. For example:

- Nutrient concentrations will vary as nutrients are taken up by the plant, and as water evaporates and transpires from plant leaves.
- As the water in your system evaporates and transpires through plants, you may top off the solution with more water to avoid building up concentrations of mineral salts.
- When replacing used water solutions, recycle this solution by watering other classroom or outdoor plants with it.

Selecting Edible Plants To Grow

Edible plants consistently recommended for growing in a hydroponic system either self-pollinate or do not need to be pollinated to produce their edible leaves.

- Kale
- Lettuce
- Spinach
- Beans (Green Beans, Pole Beans}
- Cucumber
- Peppers
- Tomatoes
- Strawberries
- White Radish
- Basil

Increasing Your Vegetable and Fruit Production

- If your hydroponics system is indoors, bees and other insects will not be able to cross-pollinate your plants.
- You can assist with the pollination process to increase your yield of beans, cucumbers, strawberries, and tomatoes.
- Watch this brief video on how you can pollinate indoor plants.

Hand-pollination of strawberry plants

Check For Understanding

- Describe one advantage of hydroponics gardening.
- Describe one disadvantage of hydroponics gardening.
- What is the difference between an active versus a passive hydroponics system?
- Explain why nutrients must be added to the water.
- Why is measuring the pH of the water important?
- Name two edible plants that grow well in a hydroponics system.
- How can you increase the yield of some edible plants?

Application Activities

Practice Hand-Pollinating Plants

Follow the process demonstrated in the video. This can be done with plants grown outdoors or in a hydroponics system.

- Use a small, clean pain brush.
- Gently brush the anther of one flower to collect pollen.
- Then gently brush the stamen of another flower of the same kind of plant.

Practice Measuring pH

Use a meter and/or strips to test the pH of a variety of liquids:

- Water from the faucet
- Bottled Water
- Soda
- Coffee
- Lemon Juice

Next Generation Science Standards

Grades 4-5

4th Grade

- 4-LS1 From Molecules to Organisms: Structures and Processes 4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

5th Grade

- 5-ESS3 Earth and Human Activity 5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
- 5-LS1 From Molecules to Organisms: Structures and Processes 5-LS1-1. Support an argument that plants get the materials they need for growth chiefly from air and water.

Next Generation Science Standards

Grades 4-5

Science and Engineering Practice:

Engaging in Argument from Evidence ▪ Engaging in argument from evidence in 3–5 builds on K– 2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). Construct an argument with evidence, data, and/or a model. (4-LS1-1) Support an argument with evidence, data, or a model. (5-LS1-1)

Crosscutting Concepts:

Systems and System Models ▪ A system can be described in terms of its components and their interactions. (4- LS1-1),(4-LS1-2); 5-LS2- 1)

Energy and Matter ▪ Matter is transported into, out of, and within systems. (5-LS1-1)

Influence of Engineering, Technology, and Science on Society and the Natural World ▪ People's needs and wants change over time, as do their demands for new and improved technologies. (3-5-ETS1-1) ▪ Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. (3-5-ETS1-2)

Next Generation Science Standards

Grades 6-8

MSLS2.A: Interdependent Relationships in Ecosystems

- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2- 1)
- Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)

Next Generation Science Standards

Grades 6-8

Science and Engineering Practice:

- Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2)

Crosscutting Concepts:

- Cause and Effect ▪ Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1)
- Influence of Science, Engineering, and Technology on Society and the Natural World ▪ The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus, technology use varies from region to region and over time. (MS-LS2-5)

Resources

- Green Our Planet: Why School Hydroponics?
- Hydroponics: A Brief Guide to Growing Food Without Soil; Treftz, C., Kratsch, H., and Omaye, S. 2015, | University of Nevada, Reno, Fact Sheet FS-15-08
- KidsGardening.Org: Exploring Hydroponics
- National Park Service: Hydroponics: A Better Way to Grow Food
- Penn State Extension: Hydroponic Systems and Principles of Plant Nutrition
- University of Florida: Hydroponic Gardening Publications
- University of Minnesota Extension: Small Scale Hydroponics
- Video: Ellen Rotheray (You Tube)
- Images: Creative Commons; harvard.edu; Stock

Gardening Questions?

- Email or Call the UCCE Master Gardeners of Riverside County
- Email Helpline
  - anrmgriverside@ucanr.edu
- Riverside Master Gardeners Website

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