Gardening Basics: Hydroponics

Hydroponics, in its simplest form, is growing plants by supplying all necessary nutrients in the plants' water supply rather than through the soil. Growing plants hydroponically helps gardeners and farmers grow more food more rapidly in smaller areas (greenhouses, living rooms, classrooms, and rooftops, for instance) and to produce food in parts of the world where space, good soil, and/or water are limited.

Plants, like all living things, have certain requirements that need to be met for them to grow and thrive. These include water, nutrients, light, air, and structural support for the roots. In traditional gardening, plants get root support, nutrients, water, and oxygen from the soil. Hydroponic growers don't use soil and instead provide water and the right balance of nutrients directly to the plants' roots, enabling the plants to concentrate their energy on producing leaves and fruits rather than forming extensive root systems to search for water and nutrients. Hydroponic growers use a variety of systems to provide water and nutrients. The systems must also provide roots with the oxygen they need and offer a way for the roots to anchor the plants in place.

Passive vs. Active Systems

There are two main types of hydroponic systems: active and passive.

Passive systems: These systems use no energy to move nutrients and water. Passive systems often use a "wicking" material to draw up the liquid nutrients for the roots to access, or they simply suspend the plants in the solution with an air space around some of the root zone.

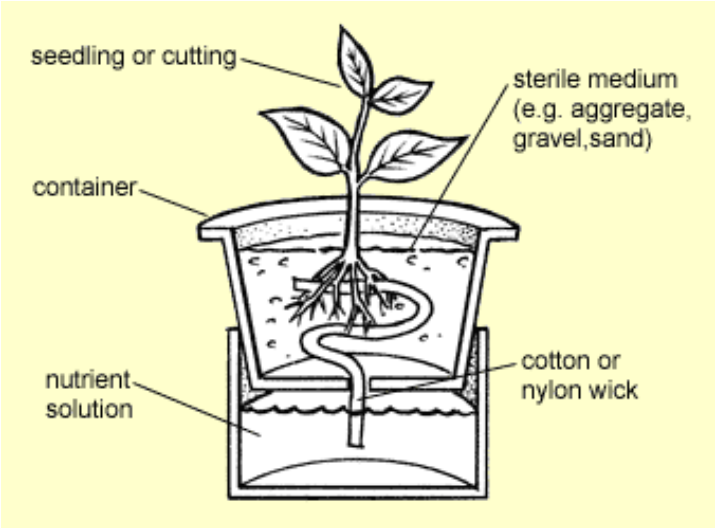

Figure 1: Basic wick system

Active systems: A hydroponic system is active if it relies on some type of energy (usually electricity via a pump) to move the nutrients in and out of the root zone area and to provide aeration. Systems

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with pumps to aerate the nutrient solution and deliver more oxygen to roots tend to produce healthier plants more quickly than do passive systems.

Media-Based and Water-Based Systems

Passive and active systems can either be media-based or rely solely on water. Media-based systems use some kind of material, such as gravel, perlite, or rockwool to support the plants and the roots in the nutrient solution. Water-based systems do not use any medium other than water, so they require a support material such as wire mesh to keep the plants from drowning. These systems rely on regular contact between plant roots and the nutrient solution. Leafy crops like lettuce and herbs tend to do better in water culture than do fruiting crops like tomatoes, cucumbers, or peppers.

Nutrients

In soil, nutrients come from rock and mineral leaching and organic matter decomposition. They are "held" by the soil particles and dissolved in the surrounding water. In hydroponics, the liquid solution is taken in directly by the roots and the nutrients are transported throughout the plant via the stem. These nutrients or minerals are not actual food, but elements vital to helping the plant utilize the sugars (the real food) that it produces during photosynthesis.

The easiest way to supply these nutrients is to purchase prepared hydroponic nutrients in dried or liquid form. Most are concentrated and must be mixed with water. Water between 65 and 75 degrees F makes nutrients most available to plants. Tap water may contain significant concentrations of chlorine, which can adversely affect plant growth. If your water has a lot of chlorine, you can use distilled water or simply let water stand uncovered for a couple of days before using it. Your students might want to explore this themselves by comparing plants grown in nutrient solutions made with distilled water versus those made with tap water.

When mixing nutrient solutions, always dilute them to the concentration recommended by the manufacturer. The amount of nutrients you use will depend on the type of system you have, temperature, light and type of plants you are growing.

Maintaining Nutrients - You'll have to periodically replace the nutrient solution.
The frequency will depend on the type of system. Nutrient concentrations, for example, 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, you may also want to top off the solution with more water to avoid building up concentrations of mineral salts. These solutions can be recycled for watering other classroom or outdoor plants.

Nutrient Disposal Caution -Take care where you dispose of nutrient solutions.
Houseplants, indoor plants, and container gardens are fine places to recycle the liquid. However, aquatic ecosystems are quite sensitive and the balance of minerals is very delicate. If there is a stream, lake, or other water source nearby, do not dispose of liquid nutrients on the ground.

pH - The pH of the nutrient solution is an important factor in hydroponics. It is a measure of the acidity and alkalinity on a scale from 1 to 14, with 1 being very acidic, 7 being neutral, and 14 being very alkaline. Most of the plants in your classroom hydroponics projects grow best when the pH of the nutrient mix is between 5.8 and 6.5. At pH readings above or below this range, certain nutrients become unavailable to plant roots. The range that allows the plant to use the dissolved minerals most effectively is just slightly acidic. pH levels vary in different nutrient mixes and water sources.

Oxygen

It is sometimes difficult for students to realize that even roots buried in soil must have oxygen for the plant to survive. Plants respire by taking in oxygen, which triggers plant cells to release and use the energy manufactured during photosynthesis, while also releasing carbon dioxide and water.

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Plant roots typically take in oxygen that's available in the small spaces between soil particles.

In short-term passive systems, there are other means of getting oxygen to the roots. In some setups, water and nutrients reach the roots via a wick made of absorbent material, and part of the roots are continually exposed to air. A porous medium like rockwool has a tremendous capacity for retaining oxygen while also absorbing nutrient solution. In some otherwise passive systems, like the KidsGardening Simple Straw Aeration Activity, human bubbles do the aerating! Many activity hydroponic systems use a pump to infuse oxygen into the water. For small setups, aquarium pumps do the trick.

You can find the KidsGardening Simple Straw Aeration Activity at:
https://kidsgardening.org/garden-activities-hydroponic-system/

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