

# Chapter 6

## Hydroponics

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- ▶ Hydroponics is the art of gardening without soil.
- ▶ Hydroponics is a Latin word meaning “working water.” In the absence of soil, water goes to work providing nutrients, hydration, and oxygen to plant life.
- ▶ From watermelons to tomato plants the careful regimen of hydroponics.
- ▶ Using minimal space, 90% less water than traditional agriculture, and ingenious design, hydroponic gardens grow beautiful fruits and flowers in half the time.

- ▶ **What is hydroponics?**
- ▶ Hydroponics is the cultivation of plants without using soil.
- ▶ Hydroponic flowers, herbs, and vegetables are planted in inert growing **media and supplied with nutrient-rich solutions, oxygen, and water.**
- ▶ This system fosters rapid growth, stronger yields, and superior quality. When a plant is grown in soil, its roots are perpetually searching for the necessary nutrition to support the plant. If a plant's root system is exposed directly to water and nutrition, the plant does not have to exert any energy in sustaining itself.
- ▶ The energy the roots would have expended acquiring food and water can be redirected into the plant's maturation.
- ▶ As a result, leaf growth flourishes as does the blooming of fruits and flowers.

- ▶ Plants do not need soil to photosynthesize. They need the soil to supply them with **water and nutrients**.
- ▶ When nutrients are dissolved in water they can be applied directly to the plant's root system by flooding, misting, or immersion.
- ▶ Hydroponic innovations have proven direct exposure to nutrient-filled water can be a more effective and versatile method of growth than traditional irrigation.

## How does hydroponics work?

- ▶ Hydroponic systems work by allowing minute control over environmental conditions like temperature and pH balance and maximized exposure to nutrients and water.
- ▶ Hydroponics operates under a very simple principle: provide plants exactly what they need when they need it.
- ▶ They allow you to control exactly how much light the plants receive and for how long.
- ▶ pH levels can be monitored and adjusted. In a highly customized and controlled environment, plant growth accelerates.
- ▶ By controlling the environment of the plant, many risk factors are reduced. Plants grown in gardens and fields are introduced to a host of variables that negatively impact their health and growth. Fungus in the soil can spread diseases to plants.
- ▶ Without the mechanical resistance of the soil, seedlings can mature much faster. By eliminating pesticides, hydroponics produce much healthier and high-quality fruits and vegetables. Without obstacles, plants are free to grow vigorously and rapidly.

## What are the components of a hydroponic system?

To maintain a flourishing hydroponic system, you will need to become acquainted with a few components that make hydroponics run efficiently.

### ► Growing media

Hydroponic plants are often grown in inert media that support the plant's weight and anchor its root structure. Growing media is the substitute for soil, however, it does not provide any independent nutrition to the plant. Instead, this porous media retains moisture and nutrients from the nutrient solution which it then delivers to the plant.

Many growing media are also pH-neutral, so they will not upset the balance of your nutrient solution. There are a host of different media to choose from, and the specific plant and hydroponic system will dictate which media best suits your endeavor. Hydroponic growing media is widely available both online and at local nurseries and gardening stores.

## ► Air stones and air pumps

Plants that are submerged in water can quickly drown if the water is not sufficiently aerated. [Air stones](#) disperse tiny bubbles of dissolved oxygen throughout your nutrient solution reservoir. These bubbles also help evenly distribute the dissolved nutrients in the solution. Air stones do not generate oxygen on their own. They need to be attached to an external [air pump](#) via opaque food grade plastic tubing (the opacity will prevent algae growth from setting in). Air stones and air pumps are popular aquarium components and can be purchased easily at pet stores.

## ► Net pots

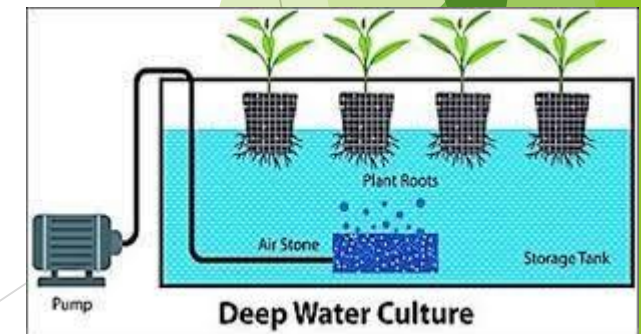
[Net pots](#) are mesh planters that hold hydroponic plants. The latticed material allows roots to grow out of the sides and bottom of the pot, giving greater exposure to oxygen and nutrients. Net pots also provide superior drainage compared to traditional clay or plastic pots.



# Types

## 1. Deep water culture systems

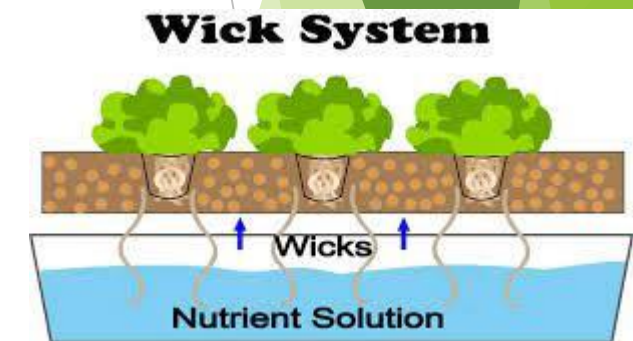
- ▶ Deep water culture hydroponics are simply plants suspended in aerated water.
- ▶ Deep water culture systems, also known as a DWC system.
- ▶ A DWC system dangles net pots holding plants over a deep reservoir of oxygen-rich nutrient solution.
- ▶ The plant's roots are submerged in the solution, providing it with perpetual access to nutrition, water, and oxygen.
- ▶ Deep water culture is considered by some to be the purest form of hydroponics.
- ▶ Since the root system is suspended in water at all times, proper water oxygenation is vital to the plant's survival.
- ▶ Add an air stone connected to an air pump at the bottom of the reservoir to supply oxygenation to the entire system. The bubbles from the air stone will also help circulate the nutrient solution.
- ▶ Plants in DWC systems should only have their roots submerged in the solution. No part of the stem or vegetation should be underwater.





## 2. Wick systems

- ▶ In a wick system, plants are nestled in growing media on a tray that sits on top of a reservoir. This reservoir houses a water solution with dissolved nutrients.
- ▶ Wicks travel from the reservoir to the growing tray. Water and nutrients flow up the wick and saturate the growing media around the root systems of the plants.
- ▶ These wicks can be made of material as simple as rope, string, or felt.
- ▶ Wick systems are by far the most simple form of hydroponics. Wick systems are passive hydroponics - meaning they **don't require mechanical parts like pumps to function**. This makes it ideal for situations where electricity is either unreliable or unavailable.
- ▶ Wicks systems work by a process called capillary action. The wick absorbs the water it's immersed in like a sponge, and when it comes in contact with the porous growing media, it transfers the nutrient solution.
- ▶ Wick system hydroponics only work if accompanied by growing media that is able to facilitate nutrient and water transference.
- ▶ Coco coir (fibers from the outer husks of coconuts) have excellent moisture retention and the added benefit of being pH neutral.
- ▶ Perlite is also pH neutral and extremely porous, making it ideal for wicking systems. Vermiculite is also very porous, and also possesses a high cation-exchange capacity.
- ▶ Wick systems work quite slowly compared to other hydroponic systems, which does limit what is practical to grow with them.



### 3. Nutrient film technique systems

- ▶ Nutrient film technique (NFT) systems suspend plants above a stream of continuously flowing nutrient solution that washes over the ends of the plant's root systems.
- ▶ The channels holding the plants are tilted, allowing water to run down the length of the grow tray before draining into the reservoir below.
- ▶ The water in the reservoir is then aerated via air stone.
- ▶ A submersible pump then pumps the nutrient-rich water out of the reservoir and back to the top of the channel.
- ▶ The nutrient film technique is a recirculating hydroponic system.
- ▶ Unlike with deep water culture hydroponics, the roots of the plants in an NFT system are not immersed in water. Instead, the stream (or “film”) only flows over the ends of their roots. The roots' tips will wick the moisture up into the plant, while the exposed root system is given plenty of access to oxygen. The bottoms of the channels are grooved, so the shallow film can pass over the root tips with ease. This also prevents water from pooling or damming up against the root systems.

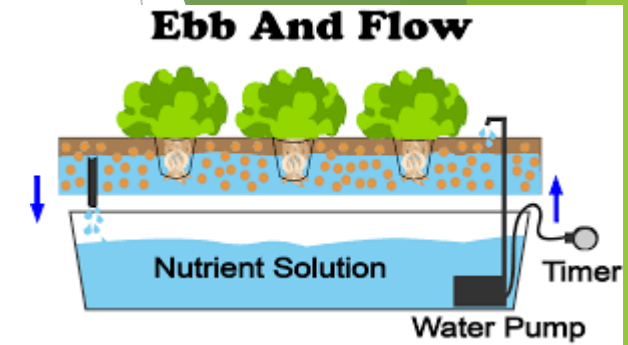


- ▶ Even though nutrient film technique systems are constantly recycling water, it is wise to drain the reservoir and replenish the nutrient solution every week or so. This ensures your plants are being delivered ample nutrition.
- ▶ NFT channels must be angled at a gradual slope. If it's too steep, the water will rush down the channel without properly nourishing the plants. If too much water is being pumped through the channel, the system will overflow and the plants can drown.
- ▶ NFT hydroponics are popular commercial systems, as they can support several plants per channel and can easily be mass-produced. Nutrient film technique systems are best suited for lightweight plants, like mustard greens, kale, lettuce, spinach as well as fruits like strawberries.
- ▶ Heavier fruiting plants like tomatoes and cucumbers will require trellises to support the excess weight.



## 4. Ebb and flow systems

- ▶ Ebb and flow hydroponics work by flooding a grow bed with a nutrient solution from a reservoir below.
- ▶ The submersible pump in the reservoir is equipped with a timer. When the timer starts, the pump fills the grow bed with the water and nutrients. When the timer stops, gravity slowly drains the water out of the grow bed and flushes it back into the reservoir.
- ▶ The system is equipped with an overflow tube to ensure flooding doesn't surpass a certain level and damage the stalks and fruits of the plants. Unlike the previous systems mentioned, the plants in an ebb and flow system are not constantly exposed to water.
- ▶ While the grow bed is flooded, the plants drink up the nutrient solution through their root systems. When the water ebbs and the grow bed empties, the roots dry out. The dry roots then oxygenate in the interval before the next flood. The length of time between floods is dictated by the size of your grow bed and the size of your plants.
- ▶ Ebb and flow systems (also called flood and drain systems) are one of the most popular hydroponic growing methods.
- ▶ The abundance of oxygen and nutrition the plants are supplied with encourages quick and vigorous growth. The ebb and flow system is easily customizable and versatile.



- ▶ The grow bed can be filled with an assortment of net pots and a variety of fruits and vegetables. Perhaps more than any other hydroponic system, the ebb and flow system allows you to experiment with your plants and media.
- ▶ Ebb and flow systems can accommodate almost any type of vegetation. Your primary limitation is the size and depth of your grow tray.
- ▶ Root vegetables will require a much deeper bed than lettuce or strawberries. Tomatoes, peas, beans, cucumbers, carrots, and peppers are all popular ebb and flow crops. In fact, you can even attach trellises directly to the grow bed. “Grow rocks” and expanded clay pebbles (hydroton) are some of the most popular growing media in ebb and flow hydroponics.
- ▶ These are cleanable and reusable, lightweight, and while they do retain moisture they will also drain. This is an important quality in ebb and flow systems.

## Aeroponics

- ▶ Aeroponics systems suspend plants in the air and expose the naked roots to a nutrient-filled mist.
- ▶ Aeroponics systems are enclosed frameworks, like cubes or towers, that can hold a multitude of plants at once. Water and nutrients are stored in a reservoir, and then pumped to a nozzle that atomizes the solution and distributes it as a fine mist. The mist is usually released from the top of the tower, allowing it to cascade down the chamber.
- ▶ Some aeroponics continuously mist the plant's roots, much like NFT systems expose the roots to the nutrient film at all times.
- ▶ Others function more like the ebb and flow system, spraying the roots with mist in intervals. Aeroponics do not need substrate media to survive.
- ▶ The root's constant exposure to air allows them to drink in oxygen and grow at an accelerated rate.



The systems use less water than any other form of hydroponics. In fact, it takes 95% less water to grow a crop aeroponically than in an irrigated field. Their vertical structure is designed to take up minimal room and allows for numerous towers to be housed in a single location.

With aeroponics, great yields can be produced even in confined spaces. Furthermore, because of their maximized exposure to oxygen, aeroponic plants grow faster than other hydroponically grown plants.

- ▶ Aeroponics allow for simple harvesting year-round. Vine plants and nightshades like tomatoes, bell peppers, and eggplants all perform well in an aeroponic environment. Lettuce, baby greens, herbs, watermelons, strawberries, and ginger all also flourish.
- ▶ However, fruiting trees are too large and heavy to be grown aeroponically, and underground plants with extensive root systems like carrots and potatoes cannot be grown.

Thank you

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