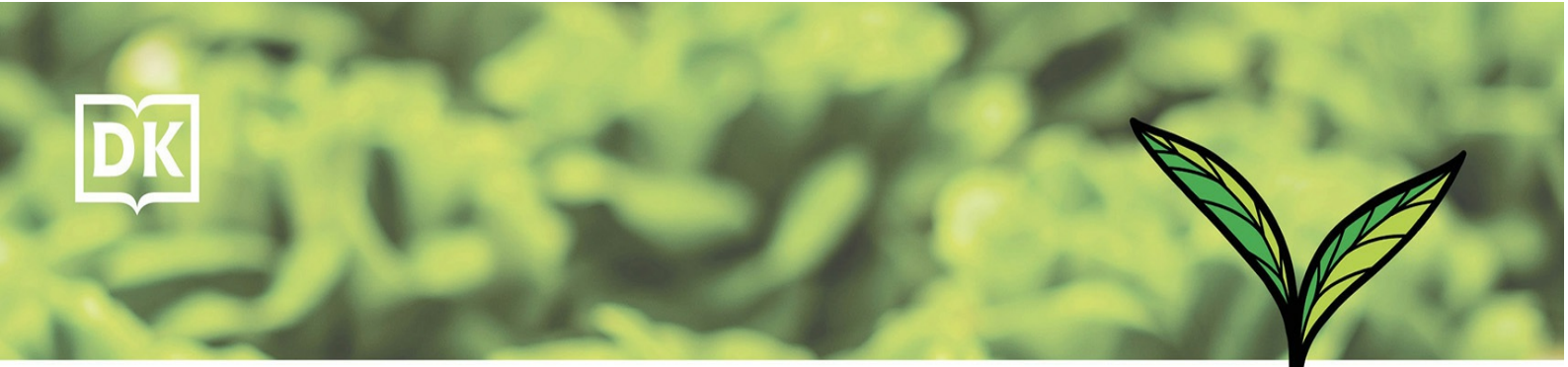


HYDROPONICS

for beginners

Your complete guide to growing food without soil

JEREE HARMS

HYDROPONICS

for beginners

JEREE HARMS

DK

CONTENTS

4: Growing Vegetables

5: Growing Fruits

6: Growing Houseplants

7: Maintenance

8: Troubleshooting

◄ CONTENTS

How to use this eBook

Preferred application settings
For the best reading experience, the following application settings are recommended:

- Orientation: ***Portrait***
- Color theme: ***White background***
- Scrolling view: ***[OFF]***
- Text alignment: ***Auto-justification [OFF]*** *(if the eBook reader has this feature)*
- Auto-hyphenation: ***[OFF]*** *(if the eBook reader has this feature)*
- Font style: ***Publisher default setting [ON]*** *(if the eBook reader has this feature)*
- In Settings, change the font size to a size you are most comfortable with.

◂ CONTENTS

INTRODUCTION

Are you ready for a new way to grow your own food?

Hi! I'm Jeree Harms—the Hydro Guy. I was introduced to hydroponics more than 30 years ago. After experimenting with this new way of growing, I was completely sold on the idea of growing plants without soil. I wrote Hydroponics for Beginners to share my excitement about growing everything from herbs and vegetables to orchids and houseplants hydroponically.

The definition of hydroponics is growing plants without soil. There are many ways to do this—and this book describes all the most popular methods. You'll see how easy it is to start a simple garden and how to plan for bigger projects as your imagination grows.

There's a certain thrill watching the first leaves of a plant emerge from tiny seeds. And nothing matches the satisfaction of seeing those little seedlings grow into mature plants. But for many people, the anticipation of newly planted seeds turns into disappointment as they watch them spring from the container and then die or get infested with insects or diseases. I want to change that and I believe hydroponics can make the difference between success and failure.

Hydroponic growing isn't complicated and doesn't need to cost a lot of money. You don't need a garden that fills your basement or garage to experience the benefits of growing with hydroponics. A simple tray of microgreens or a small container of herbs on your countertop or windowsill can be a satisfying garden.

Step-by-step instructions show you how to hydroponically grow everything from sprouts and microgreens to peppers and

tomatoes. Even if you've never gardened before, you'll be growing like a pro in no time. Imagine having a garden at your fingertips that can provide healthy, homegrown produce year-round. The satisfaction of saying "I grew that" never loses its appeal.

My hope is that this book will encourage you to start growing with hydroponics. Whether you're a true beginner or have some experience, hydroponics will make you a better gardener.

JEREE HARMS
Venice, Florida

◂ CONTENTS

A BRIEF HISTORY OF HYDROPONICS

The history of hydroponics began at least more than 2,500 years ago. From then to modern day, soilless gardening has had a long history.

600 BCE: The Hanging Gardens of Babylon

From references in ancient literature, we believe these gardens were built with an elaborate system where fresh water rich in oxygen and nutrients passed through the plants' exposed roots.

1150–1350 CE: Chinampas

The Aztecs established the "Floating Gardens of the Aztecs": islands of reed mats, called "chinampas," in shallow lakes. Plants were anchored to the mats with twigs and branches.

1648: Jan Baptista van Helmont's Willow Tree Experiment

Helmont of Belgium planted a five-pound willow tree in a bucket. For five years, he added only rainwater to the bucket. He concluded that the 169-pound tree's roots were nourished by water, not soil.

1860s: Sachs and Knop: Fathers of Hydroponics

German agricultural chemists Ferdinand Gustav Julius von Sachs and Johann August Ludwig Wilhelm Knop created nutrient-solution formulas for waterculture and conducted several experiments, developing the foundational elements for modern hydroponics. They called it "nutriculture."

1940: *The Complete Guide to Soilless Gardening*

published

William Gericke, of the University of California, wrote this landmark book, establishing the modern practice of hydroponics. Gericke conducted experiments throughout the 1930s in plant nutrition at large-scale commercial productions using just water and nutrients to grow tomato vines, with some growing 25 feet (7.62 meters) tall!

HYDROPONICS DURING WWII

Troops on Pacific Ocean islands used hydroponics to grow food. Most islands were either barren or made of coral, so growing food was impossible. Shipping food to troops also wasn't practical. They distilled fresh water from seawater and flushed it through the plant roots. They could grow 30 pounds of tomatoes, 20 pounds of string beans, 40 pounds of corn, and 20 heads of lettuce weekly. Troops at Ascension Island reported one monthly harvest of 1,910 pounds of cucumbers, 768 pounds of tomatoes, 990 pounds of lettuce, 109 pounds of peppers, and 955 pounds of radishes.

1940s–1960s: Plastics, growing mediums, and new technologies

• 1948: The invention of polyethylene (a plastic). Hydroponic systems for food production could now be made from plastics or PVC.

• 1950s: A clay substrate called LECA (lightweight expanded clay aggregate) began to be used for growing plants because the pebbles are porous and have a wicking ability.

• 1965: Nutrient film technique (NFT) and drip irrigation become popular.

1976: General Hydroponics sells first commercial systems

The company was one of the first to make hydroponic systems out of PVC and other plastic materials. This would be the start of hydroponics for food production on a commercial level.

1982: Disney's EPCOT opens

Disney's EPCOT Center opened its pavilion—"The Land"—with a focus on the future of farming and food. Several greenhouses use the latest in hydroponic technology and visitors could tour the exhibit by boat. It was considered the first large-scale introduction of hydroponics to the general public.

Hydroponics in the 21st Century

Commercial growers use automation for growing and harvesting plants. They use digital sensors for watering. Robots assist during harvesting—even judging the ripeness of a strawberry before picking it. Our current system for producing food is being reinvented. Consumers want to understand how and where their food is grown. The traditional concept of growing food on rural farms and shipping it across the country is gradually becoming outdated.

Using hydroponic technology, indoor vertical farms in urban areas are gaining popularity. Growing food where it's consumed makes more sense than shipping it thousands of miles across the country to consumers.

Such terms as "waterculture," "nutriponics," "container agriculture," and "hydroponics" mean essentially the same thing. These terms are often used interchangeably.

◂ CONTENTS

THE FUTURE OF HYDROPONICS

Hydroponics might become the future of gardening, but what might the future of hydroponics look like? Here are some present-day methods that might help foretell how hydroponics will evolve.

WHY HYDROPONICS WILL SURVIVE

When it comes to the future of growing food, hydroponics has some advantages over traditional growing methods:

- **It saves water:** There's no water waste because nutrients and water are absorbed directly by the plant. Water loss is only through evaporation.
- **It's a better allocation of space:** Plants can be planted densely, resulting in growing more food in less space.
- **It requires less labor:** There are no weeds to pull or rows to plow.
- **It reduces the use of insecticides and pesticides:** Without soil, diseases can be eliminated or easily controlled. For organic growing, this is important.

PREPARING FOR WHAT COMES NEXT

In 2000, NASA started research growing fruits and vegetables for human consumption in controlled, ecological life-support systems. This was an opportunity to test hydroponics and it was determined to be the way NASA will grow food in space. One day, you could hear about how astronauts grew hydroponic crops in space stations and even on the moon!

In 2019, Emirates Flight Catering and Crop One started the world's largest hydroponic farm in the arid climate of Dubai, United Arab Emirates. It produces 5 tons of produce every day using less water than traditional growing methods.

New technologies in growing mediums, water delivery systems, and controlled environments mean vertical farming and other dense methods can produce more food than ever in smaller environments with less water.

Globally, hydroponics can potentially provide future answers for problems with food production in developing countries. Hydroponics can efficiently generate food crops from barren desert sand to mountainous regions too steep to farm. Other benefits might include the conservation of water in hostile environments. Hydroponics is even being used to grow food in arctic communities.

In urban areas, where traditional agriculture isn't possible, hydroponic gardens on rooftops, concrete schoolyards, and abandoned lots can be used to grow food.

Home gardening has experienced a resurgence of growing your own produce—from microgreens to fresh herbs and vegetables. Gardening at home allows you to eat healthier and brings you closer to the food you eat. Hydroponics provides clean, safe, and healthy food choices right in your own home!

THE BOOMING CANNABIS INDUSTRY

The legalization of cannabis in many states has expanded the hydroponic industry considerably. Taking cues from large tomato and other vegetable producers, commercial cannabis growers prefer to grow indoors so they can better control the conditions. (In fact, it's the preferred method for larger growers to grow commercially.) Hydroponics is also preferred because it's cleaner than soil and can increase the yield of plants.

◄ CONTENTS

1 HYDROPONICS BASICS

WHAT IS HYDROPONICS?

Hydroponics is a type of gardening that doesn't require soil. Instead, plants absorb nutrients directly from water through their root systems. This creates a clean and green growing environment, but it can also reduce the frustrations and disappointments that sometimes occur with traditional gardens. Whether you're gardening indoors or outdoors, hydroponics can make growing easier.

WHY USE HYDROPONICS?

Outdoor gardeners have to contend with many different variables: poor soil conditions, lack of sunlight, varying temperatures, growing seasons, insects, diseases, and even critters. Trying to grow edible plants indoors in soil can also mean dealing with fungi, mold, and mites. Hydroponics can minimize or even eliminate these concerns, giving you control over all these elements. In other words, with hydroponics, you don't have to constantly worry about Mother Nature ruining what you're trying to grow.

You don't need much space to grow all sorts of different plants with hydroponics. This kind of gardening can help eliminate food waste and almost guarantee instant success. You can easily grow organic and non-GMO food. Once you've harvested your first crops, you'll start to develop the confidence you need if you decide to upgrade from a simple tabletop system to something that could take up your entire basement.

HOW DO I GET STARTED?

Chapter 2 will give you an introduction to the different kinds of hydroponic systems, the lighting types, the growing mediums, and other equipment you need for a hydroponic garden. In subsequent chapters, you'll learn what you can grow, how to grow food and

flowers, and how to perform maintenance. At the end of this book is a brief troubleshooting guide to help ensure you have success with your hydroponic garden.

DENSITY MATTERS

Hydroponic gardens are perfect for small spaces because you can grow plants very densely. What you're trying to grow isn't competing for nutrients (because there's no soil), so you can plant microgreens, herbs, and different kinds of vegetables much closer together. This helps with food production and prevents waste. Specific chapters on the aforementioned plants will help you with planning options as well as planting decisions.

DID YOU KNOW:

The word "hydroponics" is derived from the Greek words "hydro," meaning water, and "ponos," meaning to labor or work. Growing with hydroponics means the water does all the work by replacing soil.

HOW A PLANT GROWS

Creating a productive growing environment should be the goal of every gardener. For many plants, this isn't difficult, but for others, it might be challenging. Before you start gardening, let's take a look at how a plant grows. Plants create new growth using a complex process called "photosynthesis." Using energy from the sun, they combine air, light, and water to make carbohydrates, which are the building blocks of plant growth. The right balance of nutrients enhances the process.

WHAT A PLANT NEEDS

All plants need the same things to grow: light, water, and air.

Light

Light provides the energy for photosynthesis, which is the primary component for plant growth. The sunlight absorbed at the leaves is combined with water and carbon dioxide from the air to produce carbohydrates.

Water

Water is necessary for the growth of all living things, including plants. Plants need a healthy root system to absorb the water (and nutrients) they need to grow. Plants use a remarkable amount of water. For example, a mature tomato plant uses a half a gallon of water a day.

Air

Plants need fresh air because they breathe like humans. They breathe in carbon dioxide and breathe out oxygen during the day and then they reverse that process at night.

Nutrients

Plants need vitamins and minerals for healthy growth just like we do. The minerals absorbed by the plant's roots play a vital part in how a plant grows. Nature uses complex chemistry in the soil to provide the nutritional elements for plants. With hydroponic growing, plants rely on you to provide the mineral elements, or nutrients, they need to grow.

THE LIFE CYCLE OF A PLANT

Like any living thing, plants have a life cycle: birth, reproduction, and death.

Seed

A plant's life cycle begins with a seed. Seeds are protected by a tough outer shell and are dormant until they germinate.

Germination

Moisture and warm temperatures initiate germination. When these conditions are met, enzymes in the seed give it the strength to burst open the outer shell. A new root begins to grow downward and a new shoot sprouts upward.

Seedling

Using the photosynthesis process, seedlings develop stems and leaves that will make food the plant will use to grow.

Maturity

The stem and leaves grow into a mature plant. You now have a plant you can admire and nurture.

Reproduction

Reproduction begins as the plant flowers. Once the flower is fertilized, the plant forms fruit that contains seeds, seed heads that contain nuts or grains, or spores. As the plant dies or releases its fruits, it disperses the seeds (or spores). This begins the life cycle all over again.

HOW HYDROPONICS WORKS

Hydroponics might seem like an unrealistic gardening method because it lacks soil. But with the right plan and equipment, a hydroponic system can work better than outdoor gardening. This plan involves using the right replacements for typical gardening elements, including soil.

GROWING CONTAINERS

Whether you use a pot, tray, or saucer, you need a container for all the elements for a hydroponic garden. See chapters 2 through 6 to learn more about what container works best with which plants.

GROWING MEDIUMS

These support plants while creating an even balance of air and water at the roots. Mediums are made of inert substances that can't carry organic pathogens or diseases. See Types of Growing Mediums to learn more.

WATER & NUTRIENTS

Hydroponic plants still need nutrients to grow, so their roots will absorb water and minerals directly from a nutrient solution you provide. See here to learn more about nutrients.

RESERVOIR

This holds water and the nutrient solution for the plant to use as needed. Some hydroponic systems use a water pump to circulate the nutrients through exposed roots, but other systems rely on capillary action to deliver nutrients.

WATER GAUGE

Using a water gauge is critical in hydroponics. It lets you see what the water level is in the reservoir and whether you need to add water. See chapters 2 through 6 to learn more specifics for each plant type as to what water levels are best for optimal success.

HYDROPONIC SYSTEMS

Although you can put together a DIY hydroponic system of the elements noted here, you can also buy a fully outfitted hydroponic system. See here to learn more about the different types of hydroponic systems.

SEEDS, SPROUTS, OR CUTTINGS

You'll typically start a hydroponic garden from seeds, but you can also use sprouts and plant cuttings. (See chapters 2 through 6 to learn what's best to use to start your hydroponic garden depending on what you're growing. Keep in mind that there are limits to what you can grow, but you still have a wide variety of options, which can provide you with many different growing experiences.

WHAT IS CAPILLARY ACTION?

This is the process by which molecules travel up a plant's root system. It's also the same process that works when the growing medium transfers water and nutrients to the plant from the reservoir. It's sometimes called "capillary effect" or "wicking." If you've dipped a paintbrush in paint and watched the paint travel up the bristles, you've witnessed capillary action. In hydroponics, capillary action is an important process for delivering water and nutrients to plants.

WHAT ABOUT SOIL?

Soil is difficult to work with indoors because of its complex chemistry. It's a breeding ground for fungi, diseases, bugs, and weeds. It also limits airflow to a plant's roots. By eliminating soil, hydroponics provides a clean and stable growing environment that gives you complete control. Hydroponic mediums are designed to stay wet and provide water to plants without changing their chemical makeup. There's just no need for soil in hydroponic gardening.

WHAT YOU CAN GROW

Although a hydroponic garden has enormous potential, you still have limitations on what you can grow. But knowing what you can grow will help you make the best decisions for your goals.

SPROUTS

These are the easiest crops to grow with hydroponics. They're simply sprouted seeds, so you can grow and harvest them in just a few days—and enjoy them in salads and sandwiches. Some popular sprouts include alfalfa, mung beans, and even broccoli. See All about sprouts to learn more.

MICROGREENS

These are basically smaller versions of larger plants and they're harvested just after their leaves have sprouted. Common microgreens include arugula, spinach, kale, and beets—all great for salads and added flavor to myriad dishes. They're ideal for hydroponic beginners because they take little time and effort to grow. See Growing Microgreens to learn more.

HERBS

These are also easy crops for hydroponic beginners because they require little effort. Common herbs you can grow include basil, thyme, mint, oregano, cilantro, and parsley. Just like with microgreens, after a short growing period, you'll have herbs you can use in your meals. See All about Herbs to learn more.

FRUITS & VEGETABLES

You can grow several outdoor crops hydroponically. Although fruits and vegetables grown this way take more time and planning, you

can now enjoy the thrill of biting into a sweet strawberry or a tasty tomato year-round. Other produce you can grow includes lettuce, green beans, and cucumbers. See Growing Vegetables to learn more.

FLOWERS

Most flowers need warm days and cool evenings—a temperature difference that makes them hard to grow indoors. Neither soil nor hydroponics determines whether flowers can be grown indoors. It's temperature and humidity. However, African violets, orchids, amaryllis, and daffodils are perfect for hydroponics. Flowers also require proper time and planning to ensure success. See All about Houseplants to learn more.

WHAT ABOUT CANNABIS?

If you can legally grow cannabis in your state or country, hydroponics is perhaps the easiest way to do that. The internet will be your best source for information on how.

SOME CONSIDERATIONS

Keep the following in mind as you plan and implement your hydroponic garden.

Space: If you're growing microgreens on your kitchen counter, then space isn't an issue. But if you want to grow vining plants, they need more room and light. See Garden Planning 101 to learn more.

Ambition: Even though hydroponics makes gardening easy, you still need to monitor your plants often as they grow. Larger gardens take more time. Consider how much time you have to spend on your hydroponic garden. Later chapters in this book will note what kind of time commitments you can expect to make.

Investment: A simple planter for herbs or microgreens can cost less than $20, but a large hydroponic garden with a circulating nutrient system and grow lights can cost anywhere from several hundred dollars to a thousand dollars. Your investment depends on your goals.

2 GETTING STARTED

GARDEN PLANNING 101

If you're considering expanding your garden or upgrading your system from a countertop garden to a freestanding system, there are some things to consider. Just like a traditional outdoor garden, deciding where to put a larger hydroponic garden requires a little planning.

CREATING YOUR PLAN

Although this book is mostly about creating a simple hydroponic system, whether you do or don't expand your garden to your basement, your patio, or to its own room in your dwelling, the following questions will help you determine how much space you can commit to a hydroponic garden as well as allow you to set goals if you find this method of gardening appealing.

- **What do you want to grow?** It's best to grow what you like to eat, but you might have some special requests from your family. Make a list.
- **How much space do you have for a new garden?** Even though you can grow a lot in a small space indoors, larger gardens will take up more space. Will you need to move your garden to your garage? Do you have an enclosed porch or patio? Do you want to use a larger part of your kitchen for your garden? Measure the space and draw it out. Don't forget to show windows, electrical outlets, and doorways in your sketch.
- **How much money do you want to spend?** Equipment for a larger garden can be a significant investment. While you might not know the answer right now, it's important to begin your planning with a budget. A larger garden means larger containers and reservoirs, a more complicated system, more

lights, and more, well, everything.

- **How much time do you have to spend on your garden?** Do you work at home? Can you enlist your children to help tend your garden? Will you be on vacation during peak harvest times? While you won't have to worry about weeding with a hydroponic garden, you want to consider the time to start seeds, transplant, and mix nutrients. Consider how many hours each week you can commit to tending your hydroponic garden.

FINDING THE PERFECT SPACE

Building a larger garden might mean moving your garden to a new location. Because you can set up your hydroponic system anywhere indoors, you might want to consider some creative spaces. As you look for the right space, here are a few things to consider.

- **Water access:** Do you have a water spigot or faucet or will you carry buckets of water to your garden?
- **Power source:** Pumps, grow lights, and power strips will need

an outlet or two. Double check that your electrical circuit is up to the load.

- **Drainage:** You'll need to change the nutrient solution periodically. What will be the most convenient way to get rid of the water?
- **Spillage:** Accidents happen. Can your flooring handle a spill?
- **Temperature:** Basements are fine, but your garage or enclosed porch might need an additional heat source in the winter if it's not already heated.
- **Airflow:** Fresh air is important for your garden. Do you have a ventilation source or will you need to set up a fan?

TYPES OF HYDROPONIC SYSTEMS

There are two kinds of hydroponic systems: passive and active. Which system you choose depends on what you're growing and where you'll put your system. The following pages detail the basics of these two types.

PASSIVE SYSTEMS

A passive system is great for getting started with a countertop or windowsill herb garden. It relies on the capillary action of the growing medium to pull water or the nutrient solution up to the roots from a reservoir in the growing container. This system is the most popular because it's inexpensive and versatile. This system has four key parts.

Growing Medium

This man-made or natural material supports the plant and has capillary properties to wick the nutrient solution up to the plant. Plants usually need a specific growing medium to help with this wicking action. See here to learn more about growing mediums.

Growing Container

This holds the growing medium and the plant to allow the medium to wick water and nutrients up from a reservoir. You can use pots, planters, trays, or other kinds of gardening containers to hold growing mediums and your plants.

Water Gauge

This measures how much water is in the reservoir. When the water gauge reads empty, it's time to add water.

Reservoir

Water passes through the growing medium to the reservoir at the

bottom of the grow container. You control the nutrients by adding them to the water. Plants prefer water at room temperature.

ABOUT LECA PEBBLES

LECA (lightweight expanded clay aggregate) pebbles are the most popular growing medium for passive systems. They're made by heating clay pellets the size of pencil erasers to 2600°F (1425°C). At these temperatures, the clay expands to the size of popcorn, developing tiny air spaces at the core and an extremely hard outer shell. These properties promote strong capillary action. LECA pebbles are a sterile ceramic that won't compact, decompose, or harbor mold or diseases. See here to learn more.

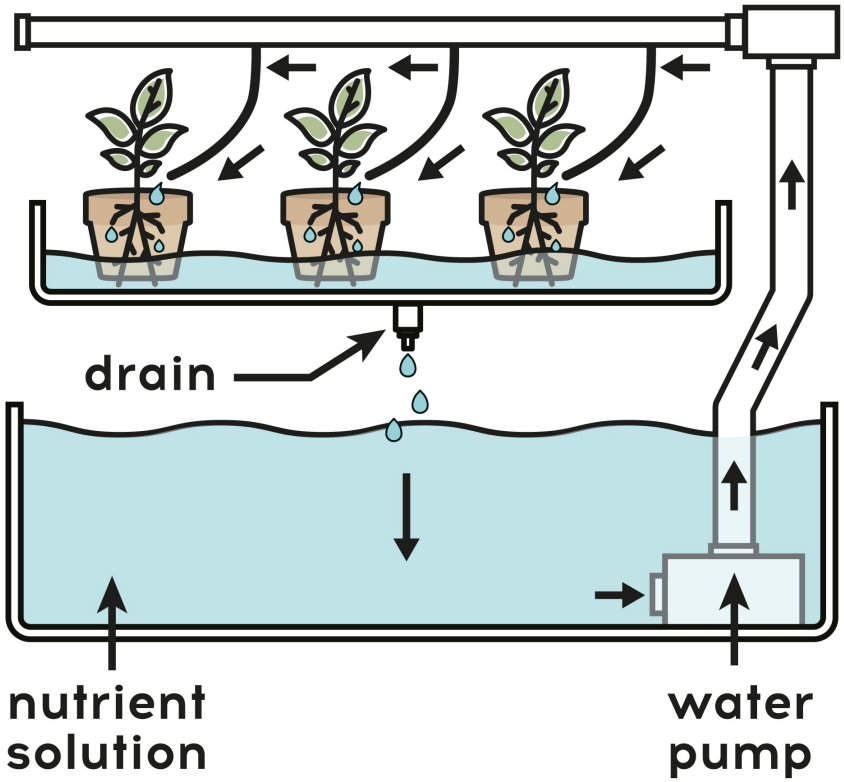
ACTIVE SYSTEMS

Active systems are generally for larger gardens. They use pumps

and electricity to circulate water and the nutrient solution to the plants. Some active systems grow plants in containers, while others support plants and circulate the nutrient solution through exposed roots. Active hydroponic systems are more elaborate than passive systems, but for certain garden sizes and crops, they're an efficient way to grow hydroponically. Here's a brief overview of the most common active systems—from simple to advanced.

Drip

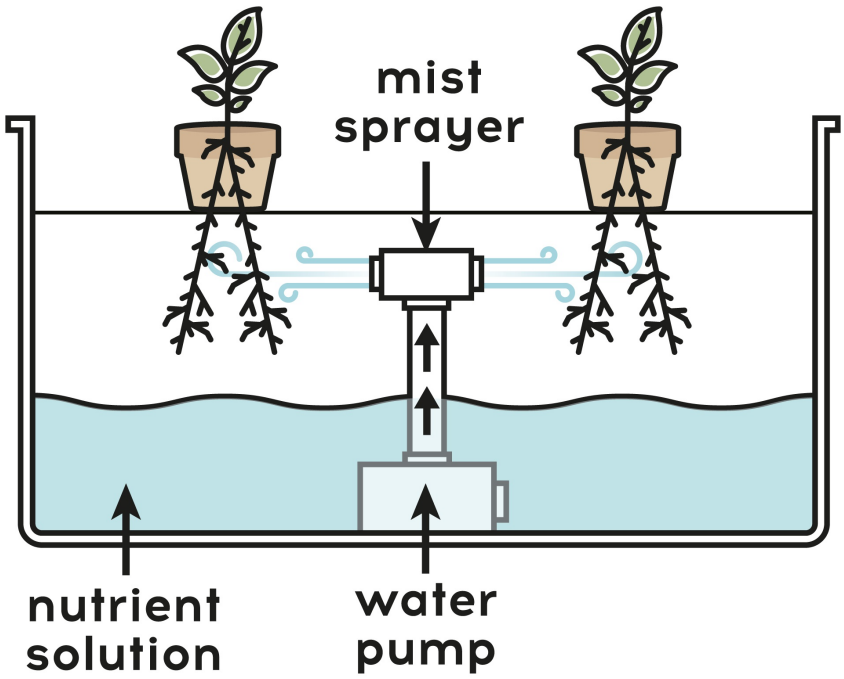
This is the simplest active system. In this system, plants grow in individual containers in a growing medium (usually LECA). A nutrient solution is pumped through tubes from a reservoir and slowly drips into the growing medium of the growing container before returning to the reservoir. For the home grower, you can install a drip system in patio-sized containers, making this system great for tomatoes and peppers.



ℹ Double-tap image to read the labels

Aeroponics

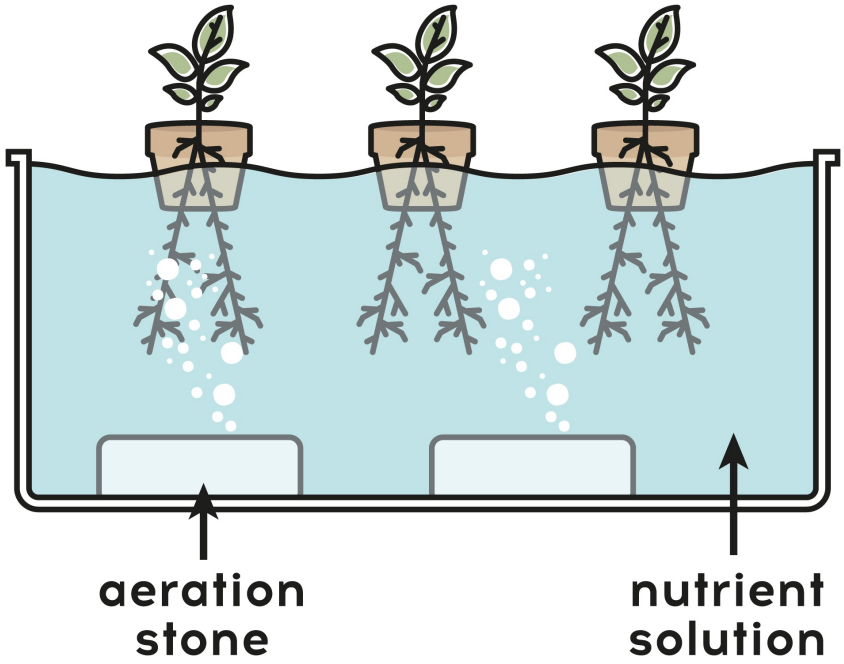
This system doesn't use a growing medium. Plants are suspended in the air above a reservoir of a nutrient solution. Ultrafine sprayers mist the roots with the nutrient solution at regular intervals. The exposed roots absorb the moisture and nutrients they need for healthy growth. Aeroponic systems are popular with hobbyists for growing small herb gardens on kitchen countertops with out-of-the-box hydroponic systems.



Double-tap image to read the labels

Deep Water Culture (DWC)

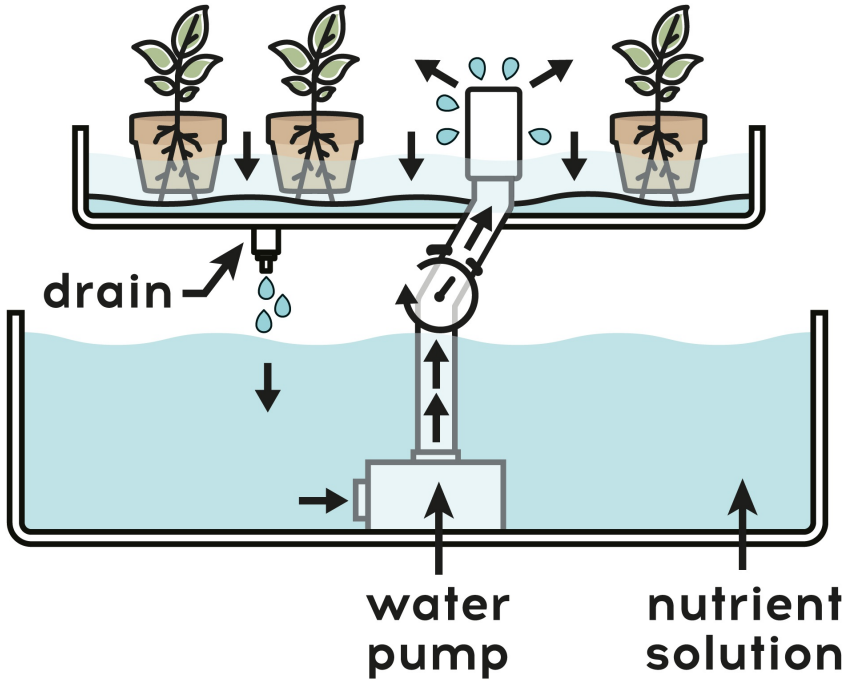
In this system, plants are placed in net pots or cups and the roots are submerged in the nutrient solution. An air pump or air stone constantly oxygenates the water, creating the oxygen roots need to grow. Most DWC systems have a set number of openings, which support individual plants. This system is great for growing continuous crops of lettuce or spinach for fresh salads.



ℹ Double-tap image to read the labels

Ebb & Flow

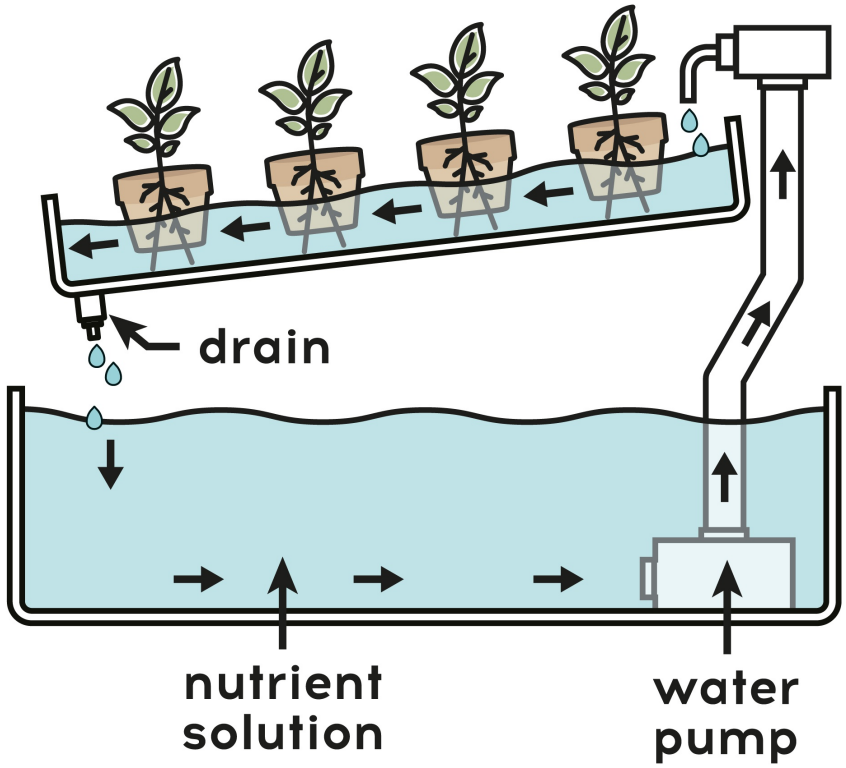
This is a popular and versatile system. Plants are set in individual growing containers on a tray above a reservoir of nutrient-rich water. Water is pumped up from the reservoir, flooding the tray. A drain slowly returns the water back to the reservoir. The growing tray is flooded several times a day and can stay flooded anywhere from several minutes to an hour or more. Hobbyists like this system because it can be set up for several plants or several hundred plants. It's great for growing larger vegetables that need support to stay upright.



ℹ Double-tap image to read the labels

Nutrient Film Technique (NFT)

This system uses a pump to circulate a nutrient solution to the plants from a reservoir. A NFT system doesn't use a growing container or a growing medium. Instead, plants are set up in tubes or channels, with their roots exposed. A nutrient solution is continuously pumped through the tubes or channels, keeping the roots moist. The tubes or channels are placed at an angle to allow gravity to drain the nutrient solution back into the reservoir. Plants thrive in a continuous flow of the nutrient solution, making this system a favorite for growing leafy greens, such as broccoli, lettuce, and spinach.



ℹ Double-tap image to read the labels

CHOOSING THE BEST SYSTEM

If you plan to expand your hydroponic garden, you might want to consider an upgraded system that will give you the best results for larger crops of vegetables, fruits, and herbs. Any of these systems will let you grow your entire hydroponic garden, but each one has unique features that make it a better choice for growing a specific crop. They can vary widely in cost. Once you review your choices, you can decide if you want to mix and match larger systems for specific plants or if you want to grow your entire garden in one type of system. Use the table on the following page to see what you can grow in whatever system you have.

BUYING OFF-THE-SHELF

Off-the-shelf active hydroponic systems might seem costly at first, but they might be the best value in the end. Components for DIY passive or active systems cost less, but you need to consider the time and energy it takes to design and build a system that will meet your needs. You might need some skills with a hammer, saw, and sealant to expand your garden. And dealing with technical issues while trying to grow plants will quickly make your project seem impossible.

USING A NUTRIENT FILM TECHNIQUE (NFT) SYSTEM

If you want to grow leafy greens, such as lettuce or spinach, that will be in continuous demand, a nutrient film technique (NFT) system might be your best bet. A NFT system will cost more, but it doesn't use growing containers or need a growing medium. If you buy a large enough NFT system, you'll always

be able to harvest a continuous crop.

Type of Plant	Preferred Hydroponic System(s)	
Eggplant	Drip • Accurate watering = bigger yields • Growing container can be altered to hold the support structure	Passive • Growing container can be altered to hold the support structure
Green beans	Drip • Accurate watering = bigger yields • Growing container can be altered to hold the support structure	Passive • Growing container can be altered to hold the support structure
Lettuce & spinach	NFT • Large, freestanding system with lights incorporated • Can grow a continuous crop • Can be expensive	DWC • Can grow a continuous crop • An inexpensive DIY project Passive • Best for windowsill growing
Tomatoes & peppers	Drip • Accurate watering = bigger yields • Growing container can be altered to hold the support structure	Passive • Analyze: costs and budget considerations • Growing container can be altered to hold the support structure
Herbs that like water (basil, chives, fennel & mint)	NFT • For growing a lot of plants at once	Passive • For windowsill, countertop, or outdoor growing
Herbs that don't like water (thyme, dill, oregano, parsley & sage)	Ebb and Flow • Gives you better control over watering	Passive • For windowsill, countertop, or outdoor growing
Fruit trees & bushes	Drip • Helps with faster growth and bigger yields	Passive • Gives you flexibility in where you grow
Strawberries	Passive	NFT

	• For windowsills, countertops, or growing in small spaces	• For growing larger crops and having bigger yields

Type of Plant	Preferred Hydroponic System(s)	
Eggplant	Drip • Accurate watering = bigger yields • Growing container can be altered to hold the support structure	Passive • Growing container can be altered to hold the support structure
Green beans	Drip • Accurate watering = bigger yields • Growing container can be altered to hold the support structure	Passive • Growing container can be altered to hold the support structure
Lettuce & spinach	NFT • Large, freestanding system with lights incorporated • Can grow a continuous crop • Can be expensive	DWC • Can grow a continuous crop • An inexpensive DIY project Passive • Best for windowsill growing
Tomatoes & peppers	Drip • Accurate watering = bigger yields • Growing container can be altered to hold the support structure	Passive • Analyze: costs and budget considerations • Growing container can be altered to hold the support structure
Herbs that like water (basil, chives, fennel & mint)	NFT • For growing a lot of plants at once	Passive • For windowsill, countertop, or outdoor growing
Herbs that don't like water (thyme, dill, oregano, parsley & sage)	Ebb and Flow • Gives you better control over watering	Passive • For windowsill, countertop, or outdoor growing
Fruit trees & bushes	Drip • Helps with faster growth and bigger yields	Passive • Gives you flexibility in where you grow
Strawberries	Passive • For windowsills, countertops, or growing in small spaces	NFT • For growing larger crops and having bigger yields

ℹ Double-tap image to read the labels

SETTING UP A SYSTEM

A hydroponic system is relatively simple, so you can set one up quickly and easily. The following information will help you get started.

BUYING A PASSIVE SYSTEM

A passive hydroponic system can be as simple as a planter that can cost as little as $15 for a small container. You can grow one to two plants in a small container or six to eight plants in larger models. Look for passive planters online or at a hydroponics-specific store. Your local garden center might also carry them at various times of the year.

A basic system includes an inner growing container, an outer watertight container, a water gauge, and a growing medium. Containers don't usually come with seeds. See here learn more about how to germinate seeds and what equipment you need.

BUYING AN ACTIVE SYSTEM

If you're willing to spend more, a variety of active countertop systems are also available for beginners. These kits come with pumps to circulate nutrients, starter seeds, and even adjustable lights. An active system can set you back from $100 to over $1,000, but if you're interested in continual crops of lettuce or slow-growing crops, such as strawberries, this system might be a better investment.

As a beginner, you might want to start with an inexpensive passive planter and upgrade to an active system as you expand your garden. The biggest difference in using an active system will be how fast your garden can grow. With a pump to circulate nutrients, your plants will grow faster, so you can produce more frequent crops.

Equipment Needed
Growing medium
Growing container
Water gauge
Outer container (reservoir)
Grow lights
Nutrients
Outlet or power strip
Seeds

The most common passive hydroponic system is an off-the-shelf tabletop kit that comes with nearly everything you need to get started, although some don't include lighting. Most beginner passive systems range from $15 to $60.

SETTING UP AN ADVANCED OFF-THE-SHELF SYSTEM

Countertop active systems are easy to find online and involve a little more time and money. While a passive system will require seedlings, more expensive active systems will often come with seeds in a medium ready to start. For some crops, such as lettuce or spinach, you'll need to continually replant.

Most off-the-shelf active hydroponic systems include:

- Growing medium (usually LECA)
- Large watertight container to serve as the reservoir
- Water level indicator
- Adjustable light
- Growing containers
- Submersible pump
- Automatic timer

- Nutrients
- Seeds in the growing medium

The simplest active hydroponic system is an aeroponic garden. Designed to be used on kitchen counters, these units have built-in reservoirs and pumps. They also include a light fixture with LED bulbs as well as timers for the pump and lights. They typically range in price from $100 to $1,000. You'll want to ensure you have an electrical outlet nearby for your system.

GROWING OUTDOORS WITH A PASSIVE SYSTEM

Passive hydroponic systems are popular for outdoor growing on patios and balconies because they don't require electricity. With a few simple adjustments, any passive planter can be set up for outdoor growing.

There's no control over how much water the system will collect in rainy weather. Too much water and the plants will suffer. Adding more water to a full reservoir will flood the plants.

To solve this, install a drain so excess water will flow away. Setting up an overflow drain is handy even if your plants aren't exposed to rain. Follow these steps to set up a drainage system:

1. Remove the outer container (the reservoir) and replace it with a shallow saucer or another watertight material.
2. Choose a new container, such as a heavy pot, that's sturdy enough to anchor the plants on windy days. Make sure the new container has a drain hole at the bottom.
3. Cut the watertight material to the desired depth. This is the new reservoir. Insert the material into the outer container.
4. Place the growing container, plant, and water gauge in the outer container.

TYPES OF LIGHTING

What kind of light you need for your hydroponic system depends on what you're growing. Although natural sunlight is best for hydroponic gardens, the following pages detail the kinds of hydroponics lights you can use if you don't have regular access to the sun.

FLUORESCENT LIGHTS

These lights are a popular choice for hydroponic gardens. Newer full-spectrum bulbs are great for beginners because they're designed to mimic sunlight. Typically, they're mounted in fixtures that can hold from one to eight bulbs. For herbs and microgreens, you'll need a fixture that can hold two bulbs. For vegetables that require high-intensity lighting, you'll need a fixture that holds four to eight bulbs. Because they produce minimal heat, fluorescent lights are safer and more effective than incandescent bulbs (which you shouldn't use for growing plants), and they can be mounted closer to the plants.

Fluorescent bulbs are identified by a code that includes a "T" rating followed by a number. The "T" rating means the bulb is tubular and the number is the bulb's diameter in eighths of an inch. For example, a T5 bulb would be 5/8 inches (1.5cm) in diameter. T5 bulbs are the most popular, but the bulb's diameter doesn't affect your plants.

LIGHT-EMITTING DIODE (LED) LIGHTS

LED lights emit virtually no heat and require little power to operate. These lights can accurately simulate sunlight and they can simultaneously produce the red and blue band spectrums needed for vigorous vegetative growth. See Buying a Lighting System to learn more about lights.

USING TIMER LIGHTS

Plants also need a period of darkness for their metabolism to work. During the day, they use the energy from the sun to form carbohydrates. At night, the process changes, but growth continues by cells dividing within the plant.

Plants aren't designed to create carbohydrates nonstop and it would be harmful to put them in light for 24 hours. A period of darkness is essential for plant development. When you buy your lights, make sure to also buy a timer so you can set it to automatically turn your lights on and off every day.

Metal halide (MH) and high-pressure sodium (HPS) bulbs used to be the most

popular high-intensity lights, but they've been replaced by LED technology. They were popular for years with commercial growers, especially for plants that require intense light, such as tomatoes. But they're expensive to purchase and operate. Home gardeners might come across these bulbs, but with the introduction of LED lights, they're no longer practical for home gardens.

BUYING A LIGHTING SYSTEM

If you can't place your hydroponic system near a sunny window or in another location that will receive sunlight, you'll need a lighting system. But you don't need a sophisticated, high-tech lighting system to grow healthy, happy plants. In fact, choosing lights doesn't need to be complicated or expensive. If you know what you want to grow, then you'll know what kind of lighting system you need.

ADJUSTING LIGHTING

To ensure your plants get the best exposure, keep your lights as close as possible to your plants. Adjustable frames help you maintain the intensity of the light because it decreases exponentially as the distance between the light and the plant increases. As your plants grow, adjust your lights frequently.

COLOR OF LIGHT

Light contains colors or wavelengths. Different colors of light affect plants in different ways. For example, red light spurs flowering, while blue light encourages leafy growth. Light color is described as the temperature of the light. Temperature values are defined in Kelvin (K). The higher the temperature (K), the brighter or bluer the light. The lower the temperature (K), the yellower the light. Normal household lighting has a color temperature rating around 3000K, whereas natural daylight has a color temperature rating of 6500K. To match the color of natural daylight, your light source for your plants should have a color temperature closer to 6500K.

FULL-SPECTRUM LIGHTING SYSTEM FOR

MICROGREENS, HERBS & LEAFY GREENS

You can successfully grow microgreens, herbs, and leafy greens (such as lettuce and spinach) with full-spectrum fluorescent lights bought off the shelf. The term “full spectrum” means they produce an even balance of blue and red light that’s well suited for growing plants.

Plants will get the best light when bulbs are placed about 6 to 8 inches (15 to 20cm) above the top of the plants. Make sure you can adjust the fixtures that hold the bulbs as the plants grow taller. You’ll need these items for a full-spectrum lighting system:

- Two full-spectrum fluorescent bulbs or one LED bulb (each being 3,500 to 4,500 lumens)
- Fixtures to hold the bulbs, plus hanging hooks or clips
- Tabletop-sized adjustable frame to hold the fixture so you can change the height
- Lighting timer for turning the lights on and off

HIGH-INTENSITY LIGHTING SYSTEM FOR FRUITS & VEGETABLES

Lighting requirements for growing vegetables (such as tomatoes, peppers, and green beans) or even fruit (such as strawberries) are more involved. Some vegetables need higher-intensity lighting—and that lighting should be able to cover a larger area, especially for plants that grow tall. You can use any full-spectrum fluorescent bulb or LED lamp and make them high intensity by increasing the number of bulbs or the size of the LED lamp. You’ll need these items for a high-intensity lighting system:

- Four to six full-spectrum fluorescent bulbs or two to three LED lamps (with each being 4,500 to 6,000 lumens)
- Fixture(s) to hold the bulbs, plus hanging hooks and clips
- Five-foot (1.5-meter) adjustable frame to hold the light

fixture(s) so you can change the height

- Power strip for multiple lights
- Light timer for turning the lights on and off

Because each light fixture will have its own power cord, if you'll be using more than one fixture, you'll need a power strip. For safety, make sure you secure the cord(s) and power strip to prevent tripping over them.

LIGHT MEASUREMENTS

There are three measurements you need to know before you buy bulbs.

Lumen

This is how much light a bulb puts out. The intensity of your light source is what powers photosynthesis for plants. The higher the lumen output, the brighter or higher intensity the light source. Optimal light for growing plants for food is in the 3,500 to 4,500 lumens range.

Watt

This is how much energy the bulb uses to actually produce the light. Wattage doesn't define the intensity of the light—it only measures the power of the light itself. Don't select your plant lights on wattage alone. Look at the lumens in the 3,500 to 4,500 range.

Lux

This is how much light a plant receives. If your plants don't seem to be thriving, use a light meter to measure the lux at your plant's leaves. It can possibly be significantly less than the lumens the bulb emits because the intensity of the light decreases rapidly when the plant is moved farther from a light source. The normal growing range is 20,000 to 35,000 lux for vegetables.

TYPES OF GROWING MEDIUMS

Although hydroponic plants don't grow in soil, they still need a growing medium. This sterile, inert material helps support your plants throughout the growing process. The following pages describe the growing mediums you can use in hydroponics.

GROWING MEDIUMS 101

Growing mediums for hydroponics offer these features:

- They wick water and nutrients up to the roots. They also provide oxygen to the roots.
- They allow for good drainage so the roots get air.
- They help keep your plants upright.
- They support a plant's root system.
- They retain the nutrient solution for a plant.

JUTE MAT

This mat is made of 100% natural jute fiber and is used for growing microgreens. Jute absorbs and distributes moisture evenly. Roots grow strong as they penetrate the mat without the worry of soil-borne diseases. A jute mat excellent for germinating seeds.

COCONUT FIBER

Also called “coconut coir,” this medium is a 100% natural material that comes from coconut husks. It has good water retention and drains well. It’s generally bought as a compressed block that expands when placed in water or as a small pod used for starting seeds. It’s used as the growing medium for leafy greens.

PERLITE

This is a lightweight, stable material that holds water and drains well. Made from volcanic rock that's been heated to 1800°F (985°C), perlite expands into sterile, soft white particles. It's very lightweight, but it can cause problems if your plants need a lot of stable support—mainly because the material is so light, it floats!

LIGHTWEIGHT EXPENDED CLAY AGGREGATE (LECA)

This material is made by heating specially prepared clay pellets to 3600°F (1985°C). The clay pellets expand, creating pebbles with a relatively hollow core and an extremely hard outer shell. These properties give the pebbles excellent capillary properties or wicking abilities. LECA is the most popular growing medium for the home grower, especially beginners.

ROCKWOOL

This medium is used for germinating seeds that will grow into seedlings. It's made by a process similar to making cotton candy. Molten rock is poured over a spinner, forming cotton candy–like fibers that are then pressed and cut into blocks. Rockwool has capillary properties that pull moisture and nutrients up to the seedling, creating an even balance of air and water at the roots. It's perfect for sprouting seeds and ideal for beginning hydroponic gardeners.

Gravel and lava rock aren't hydroponic mediums. Although they have excellent drainage capabilities, they don't have capillary properties or the ability to wick water and nutrients from the reservoir up to your plants.

EQUIPMENT NEEDED

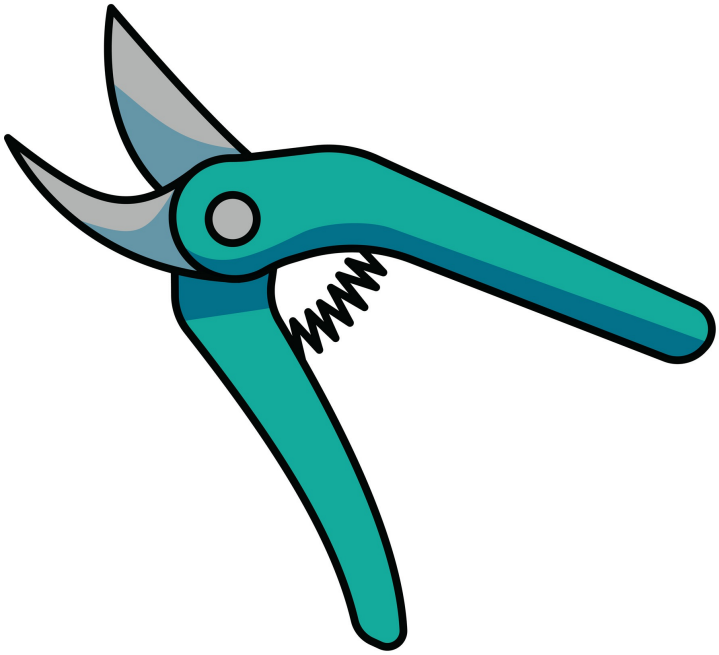
You don't need much to begin gardening hydroponically: A growing system, lighting, a growing medium, and seeds or sprouts make cultivating and caring for your hydroponic garden easy. Having the right equipment makes that job easy. With the following tools, you'll be gardening like a pro in no time!

Watering Can

This should be comfortable to hold. Try to match the can's size with your garden's size—from a small can for a countertop garden to a large one for a container of tomatoes. For ease of use, choose plastic over metal.

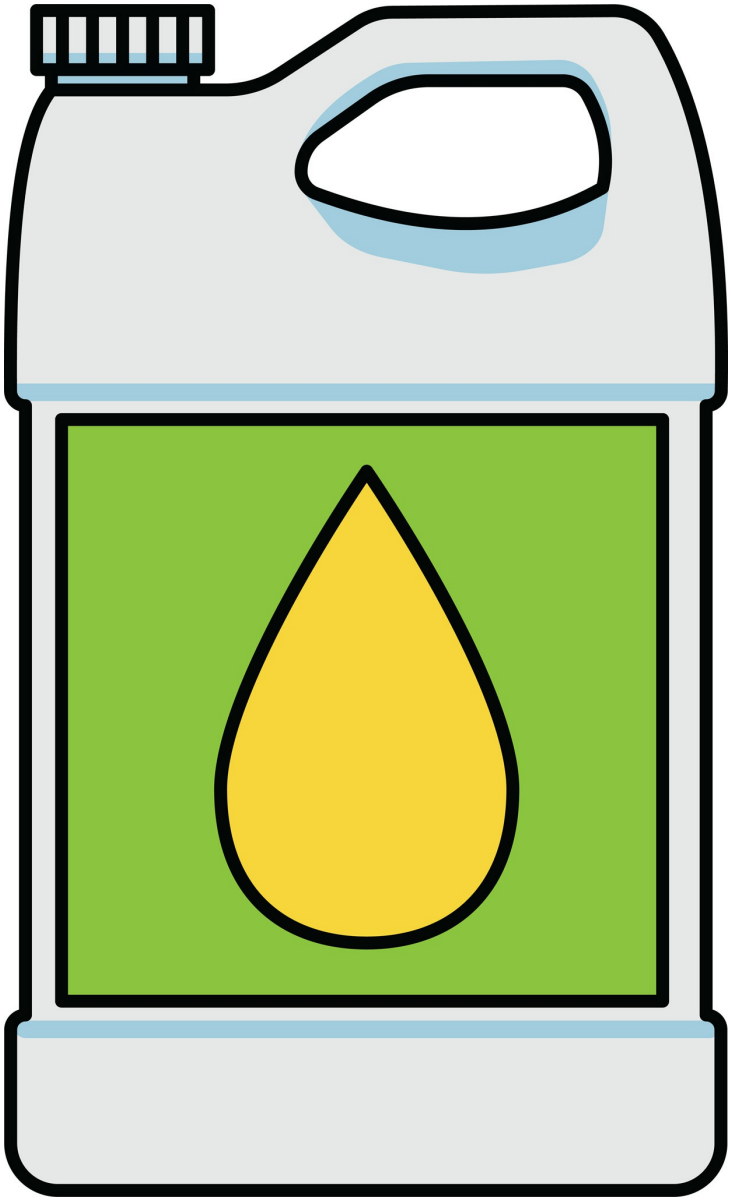
Pruners or Good Scissors

Good-quality pruners or scissors are a must. Many first-time growers are hesitant to trim their plants, but all gardens produce more for a longer period with frequent pruning. Choose a pair that's sharp and remember to keep either tool clean.



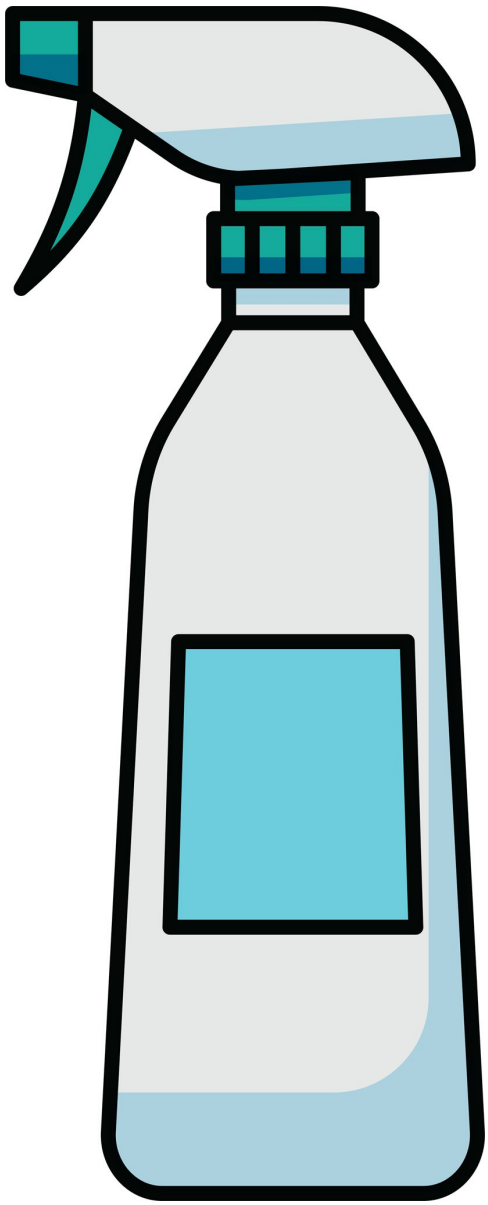
Neem Oil or Insecticidal Soap

Sooner or later, you're going to see insects. No need for harsh chemicals indoors. Neem oil and insecticidal soap are very effective when used properly. See here for specific remedies for dealing with insects.



Handheld Sprayer or Misting Bottle

If you're working with just a few plants, a misting bottle will work just fine for giving them a water shower as needed. If you have a larger number of plants, a handheld pressurized sprayer is a must for applying topical treatments, such as neem oil or insecticidal soap. (You won't use it for nutrients.)

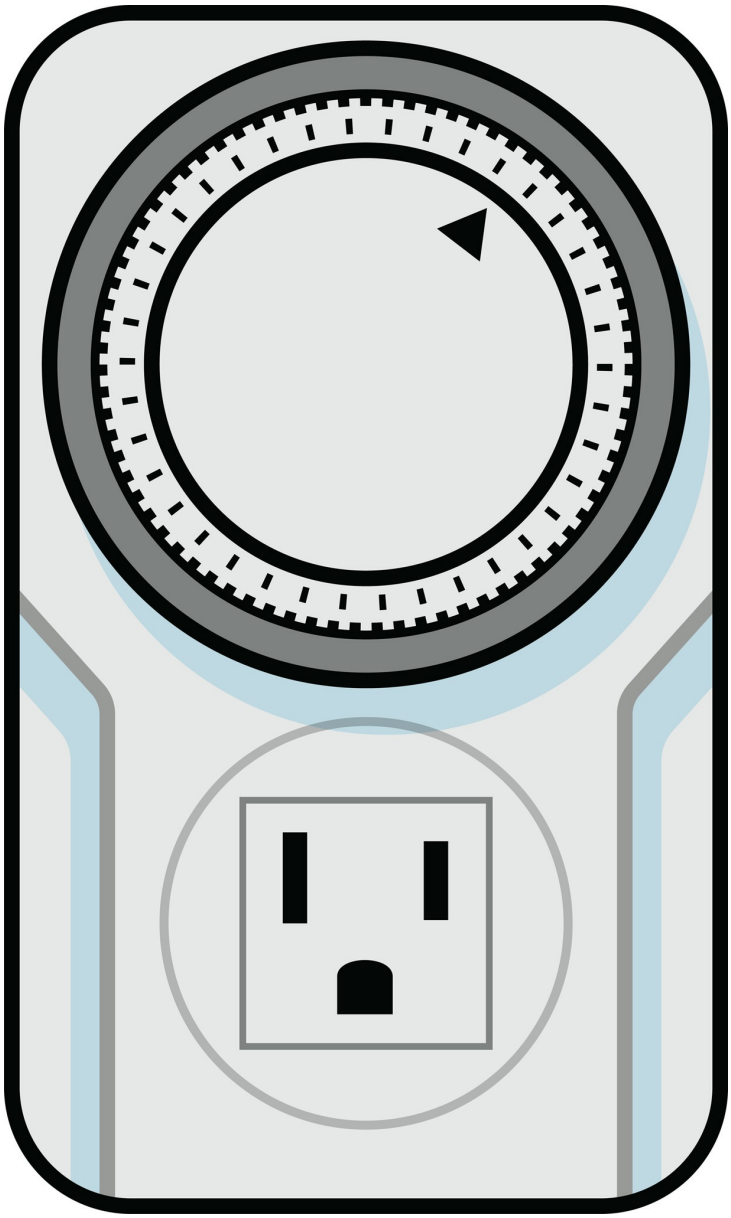


pH Meter

pH is the measure of the acidity or alkalinity of your nutrient solution, which effects your plants' ability to absorb nutrients. A pH meter makes checking your solution easy. See Monitoring the ph level to learn more.

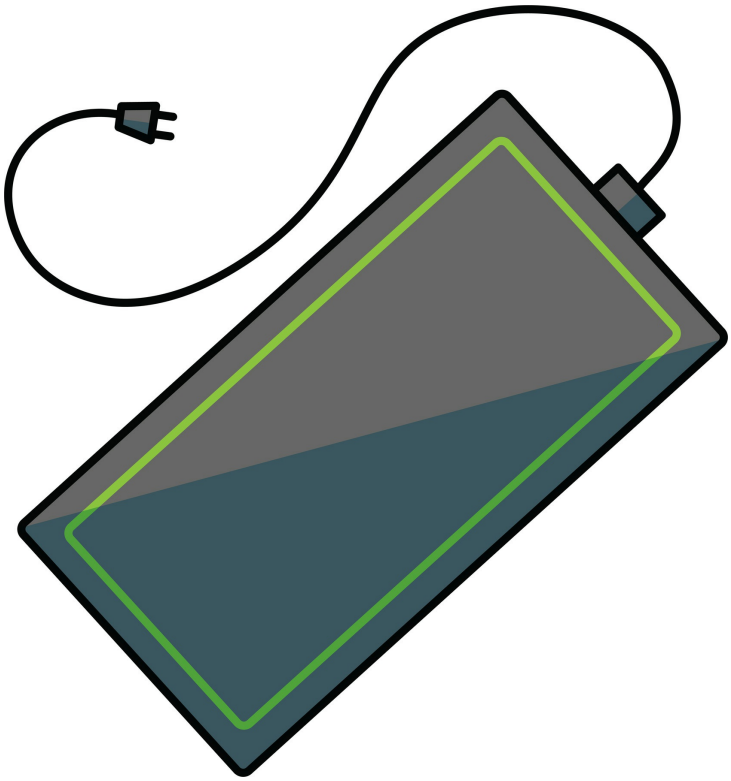
Timer

If you're using grow lights, they need a timer for turning them on and off. In a 24-hour cycle, plants need a period of darkness as much as they need light. A timer makes this easy because you don't have to remember to turn the lights on or off.



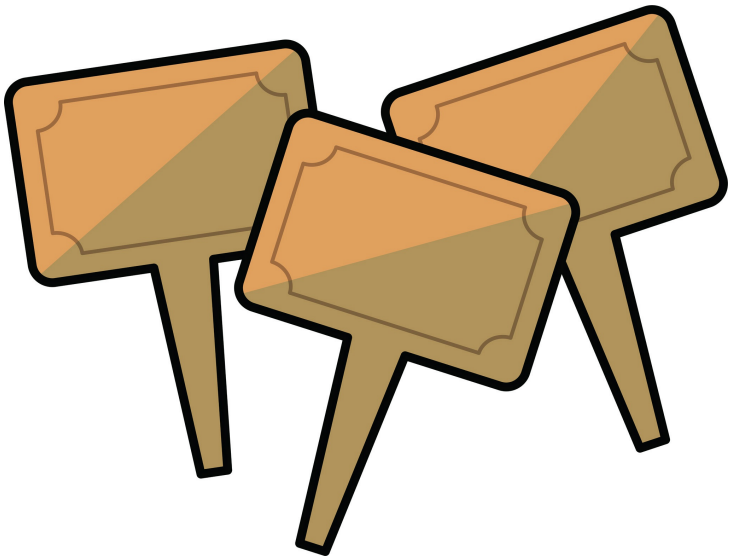
Heating Mat

You can find this at your local garden center or online. Most seeds need warm temperatures to germinate, so this mat is designed to gently warm the growing area to the 75°F to 85°F (24°C to 29°C) range. Look for one with a thermostat so you can regulate the temperature.



Plant Labels

These are plastic or wooden stakes used to identify your plants as well as document the planting date. You think you'll remember this information, but if you don't, these labels will be helpful reminders.



Buy a sturdy notebook or log book to track the dates for everything you do: from germinating seeds, harvesting crops, and applying neem oil or insecticide spray to performing maintenance as well as employing any troubleshooting methods. These dates will come in handy more often than you think.

MONITORING THE pH LEVEL

For your plants to have the most success, they need to have the right balance of nutrients. The following will help ensure your plants are getting the right pH level from their nutrient solution.

MANAGING PH

Once you start growing fruits and vegetables, you'll need to pay attention to the pH in your nutrient solution. The letters "pH" stand for "potential of hydrogen." pH measures the hydrogen ions present in your nutrient solution. Hydrogen ions regulate a plant's ability to absorb valuable nutrients. If the pH is too high or too low, the plant's root system won't absorb the nutrients it needs. The pH is a constant measurement of what's happening with the nutrient solution in the reservoir.

WHAT IS THE PH SCALE?

We measure pH on a scale of 1 to 14. A pH level of 7 is considered neutral. A solution with a pH level above 7 is considered alkaline or basic, while a pH level below 7 is considered acidic. The optimal nutrient solution for most vegetable plants would be slightly acidic, with a pH level between 5.5 and 6.5.

MEASURING PH

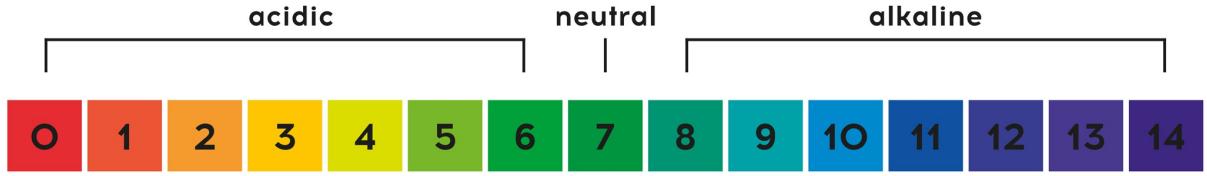
If you're growing fruits or vegetables, you need to check the pH level of the nutrient solution in the reservoir of your growing containers every couple days. The pH level tends to change as the plant absorbs nutrients from the water.

There are two easy tools for checking pH:

- **pH paper:** These strips have been treated to change color according to the pH values when dipped in the nutrient

solution. pH paper test kits are inexpensive and easy to use. They're the most common tool for one to two growing containers.

- **pH meter:** This is an inexpensive device with sensitive electrodes to measure pH. They're much more reliable than pH paper and useful if you're trying to diagnose an ongoing problem with your plants. If you have many large growing containers, a pH meter is faster and less expensive for frequent testing.



Double-tap image to read the labels

PH ADJUSTORS

To adjust the pH up or down, you need a liquid additive designed to make your nutrient solution more basic or more acidic. Look for premixed pH regulators for hydroponic gardening at an online hydroponics store. These additives are usually labeled as "pH up" and "pH down" for making adjustments. Follow the instructions on the label when adding the prescribed amount to the reservoir.

TESTING & ADJUSTING PH

1. Measure the pH of the nutrient solution in the reservoir by dipping the pH paper strip or pH meter directly into the nutrient solution.
2. Interpret the strip by matching it to the color chart included in the package or by reading the meter.
3. Follow the instructions and add the "pH up" or "pH down" adjustor directly to the growing container's reservoir.
4. Wait one hour and then retest the nutrient solution in the reservoir again.
5. If the nutrient solution is still out of range, repeat step 3.

A pH level is always described as a range. That's because pH readings for horticulture don't need to be an absolute precise value. If your pH falls within

the prescribed range, your plants will be happy.

DID YOU KNOW:

You can find a lot of DIY ideas for adjusting pH online, such as baking soda or acetic acid. They can be effective but can also trigger other changes in the nutrient solution. A premixed liquid additive designed for hydroponic systems will eliminate the guesswork for beginning growers.

◄ CONTENTS

3 GROWING MICROGREENS, HERBS & SPROUTS

ALL ABOUT NUTRIENTS

Nature uses complex chemistry to provide the nutritional elements plants use for growth. Bacteria, enzymes, and microbes break down organic matter and combine with water into a form a plant can absorb. In hydroponic gardening, your plants rely on you to provide them with what they need to grow. To get the best out of your garden, you need to know what to look for when choosing nutrients for your plants.

Total Nitrogen (N). 7.00%
  2.6% Ammoniacal Nitrogen
  4.4% Nitrate Nitrogen
Available Phosphate (P2O5). 9.00%
Soluble Potash (K2O). 5.00%
Calcium (Ca). 2.00%
Magnesium (Mg). 0.50%
  0.50% Water Soluble Magnesium
Boron (B). 0.02%
Chlorine (Cl). 0.10%
Cobalt (Co). 0.0015%
Copper (Cu). 0.0500%
  0.0500% Chelated Copper
Iron (Fe). 0.1000%
  0.1000% Chelated Iron
Manganese (Mn). 0.0500%
  0.0500% Chelated Manganese
Molybdenum (Mo). 0.0009%
Sodium (Na). 0.1000%
Zinc (Zn). 0.0500%
  0.0500% Chelated Zinc

READING A NUTRIENT LABEL

You can find off-the-shelf nutrient blends online or at gardening stores. The options and ingredients are endless. Fortunately, manufacturers are required to follow a set of rules when listing the chemical elements inside the package. To choose the best option for your garden, you need to look at three factors.

NPK rating

The numbers on the front panel of a nutrient package—known as the "NPK rating"—note the percentage of each macronutrient in the blend:

- The first number is the percentage of nitrogen (N).
- The second number is the percentage of phosphorus (P).
- The third number is the percentage of potash (K).

Look for an NPK blend that's evenly balanced. The percentages that make up the NPK rating on the label should contain nearly equal parts of each element. For example, if your fertilizer has 8-9-5 on the front panel, it contains 8% nitrogen, 9% phosphorus, and 5% potash, which is a good balance for growing vegetables hydroponically. As a general rule, try to keep the numbers within 10% of each other. An NPK of 30-10-5 might address a particular soil problem in an outdoor garden, but it's not a healthy mix for hydroponic gardening.

Nitrogen source

The first ingredient listed on the back panel of a nutrient package is nitrogen. If you see the word "urea" as the source of nitrogen, you don't have a nutrient blend you can use in a hydroponic garden. Plants can't absorb urea until it's broken down by enzymes and bacteria. Hydroponic growing doesn't have enzymes or bacteria. Unused urea eventually turns to salt, which can damage a plant's roots. Instead, look for "nitrate nitrogen" or "ammoniacal nitrogen" as the source for nitrogen.

Trace elements

You should see trace amounts of some or all of 12 elements listed

on the back panel of a nutrient package: boron, calcium, chlorine, cobalt, copper, iron, magnesium, manganese, molybdenum, silicon, sulfur, and zinc. Without all these micronutrients, your plants will lack important minerals they need for growing. See here to learn more about micronutrients as well as macronutrients for plants.

CHOOSING THE RIGHT NUTRIENT BLEND

Nutrient formulas are blended for different types of plants. Some need more nitrogen, while others need more phosphorus. The differences help gardeners encourage specific growth in vegetables or flowers. Herbs and vegetables generally benefit from an evenly balanced formula of nitrogen, phosphorus, and potash, which means the NPK numbers will be nearly the same. Look for the standard 8-9-5 for vegetables or herbs. A mix of 10-20-10 is perfect for orchids.

TERMS DEFINED

The following terms can be confusing. Here's a brief explanation.

Plant food

The real food plants use for growth is air, light, and water. Through photosynthesis, plants use energy from the sun to combine them to make carbohydrates. If you don't get these elements right, your choice of nutrients won't matter.

Plant nutrients

These are mineral elements collected by the roots and used to enhance photosynthesis. Because growing mediums don't provide nutrients, you need to know what nutrient blend is right for the plants you're growing.

Plant fertilizer

Outdoor gardeners use the term "fertilizer" and hydroponic growers prefer the term "nutrients." They're the same thing.

WHAT MACRONUTRIENTS & MICRONUTRIENTS DO

Plants need 18 elements for growth. Carbon, hydrogen, and oxygen are available in the air. You need to add the rest in your nutrient blend. The following charts detail what each element helps your plant with.

	Micronutrients
Boron	Affects at least 16 functions, including flowering, pollen germination, fruiting, cell division, water relationships, movement of hormones, cell wall formation, membrane integrity, calcium uptake, and the movement of sugars
Calcium	Influences water movement, cell growth, and division; required for the uptake of nitrogen and other minerals
Chlorine	Involved in the movement of water in cells
Cobalt	Required by nitrogen-fixing bacteria; formation of B_{12} vitamin
Copper	Necessary for nitrogen metabolism; part of enzyme systems that develop carbohydrates and proteins
Iron	Catalyst for the synthesis of chlorophyll; essential for new growth
Magnesium	Needed for the functioning of enzymes for carbohydrates, sugars, and fats; fruit and nut formation; the germination of seeds
Manganese	Boosts enzyme activity for photosynthesis, respiration, and nitrogen metabolism
Molybdenum	Structural part of enzymes that reduces nitrates; essential for protein formation
Silicon	Builds resistance to sucking insects and fungi; improves the tolerance to heat, drought, and cold
Sodium	Improves nitrogen metabolism and water movement
Zinc	Improves nitrogen metabolism in many plants; helps with water movement

Macronutrients	
Nitrogen	Used for stem and leaf growth
Phosphorus	Enhances flower and fruit formation
Potassium	Adjusts water balance; improves stem rigidity and cold hardiness; enhances flavor, color, and oil content of fruits

ORGANIC FERTILIZERS

Organic fertilizers are animal- or plant-based materials that come from once-living organisms, including animal waste, crop residue, compost, and numerous other by-products.

Buying organic sounds good, but when it comes to nutrients, most organic fertilizers are incomplete. They usually contain only one or two elements, which means you'll need to blend two or more products. The result is uncontrollable and difficult to measure, and it usually carries an odor. Why take that chance when you can buy a product that provides complete, balanced nutrition?

HOMEMADE NUTRIENTS?

While a DIY concoction might seem like a cheaper—and easier—approach, your blend won't have the trace elements you need. Without them, your plants won't be getting everything they need to grow. The over-the-counter solutions are generally better for the money.

TOP-NOTCH NUTRIENTS

Precision and sophistication in nutrient blends for hydroponic growing has reached unprecedented levels in recent years. This has been driven in large part by cannabis growers who want to grow the most potent plants possible.

ALL ABOUT SEEDS

Starting your hydroponic garden from seeds has two main advantages: They're free of insects and diseases, and you can transfer the seedlings to hydroponic systems without any problems. If you use starter plants from a garden center, you'll need to do a little work to get their soil-trained roots used to growing hydroponically. See Germinating Seeds to learn more.

Days to Emerge . . . . . 5–10 days
Seed Depth . . . . . .½"
Seed Spacing . . . . . .1"
Row Spacing . . . . . .12"
Thinning . . . When 1" tall thin to 2" apart
Maturity . . . . . .30 days

Date Seed Sown:

READING A SEED PACKAGE

Although not all seed packets look the same, most cover similar information. Most seeds are marketed for outdoor gardeners, but the following terms (or similar language) are what you should look for on seed packets to ensure success with your hydroponic garden.

When in doubt, ask a store employee.

Requirements for seed germination

Growing hydroponic plants from seeds is relatively easy, and with a little practice, you'll be growing like a pro in no time. But what you need to do to germinate seeds can vary widely depending on what you're wanting to grow. Most seeds germinate better in the dark, but some require light. Some seeds do best when soaked overnight before planting. The seed packet will tell you what conditions are best for germination. See here to learn how to germinate seeds.

Days to germinate

Some seeds germinate in a few days, whereas others take weeks. Knowing how long it takes to germinate is helpful and will keep you from worrying when some seeds take longer to sprout than others.

Days to maturity

This number represents how long it takes for a plant to go from planting to maturity. Knowing how long it will take a particular variety to mature is helpful when planning your garden as well as if you need to time when you want to harvest your plants.

Coverage/number of seeds

Some seeds are tiny, while others are much larger, so the number of seeds in a packet can vary. Coverage is the amount of space you can plant depending on how closely together you plant each seed. For hydroponic gardening, you'll plant much more densely, especially for microgreens.

Treated

Some seeds are prone to rot if growing conditions aren't ideal. The package will tell you if the seeds have been treated with a chemical fungicide to protect them until they sprout. This process is for outdoor growing but not hydroponics. If seeds have been treated, don't use them for hydroponics.

USING NON-GMO & ORGANIC SEEDS

If growing organic and non-GMO food is important to you, look

for these specific kinds of seeds.

Organic

These are harvested from plants grown with organic methods according to USDA organic standards.

Non-GMO

Genetically modified organism (GMO) seeds have had their DNA altered in ways nature never intended (like correcting common gardening problems, such as too-late ripening or disease resistance). They've also have genes added for improved growth, nutritional content, or pest resistance. Most gardeners prefer non-GMO seeds.

Hybrid

These seeds have been modified by cross-pollinating two varieties of closely related species with each other. By using natural plant reproduction and then harvesting the seeds, the result is a plant with more desirable traits. Hybrids can be bred for such genetic traits as faster ripening, disease resistance, or larger fruit size. Don't confuse hybrid seeds with genetically modified (GMO) seeds.

Heirloom

These have been passed down from generation to generation within a family or community. They yield unique varieties that aren't commercially available. Plants grown from heirloom seeds are identical to the parent plant and they're favored for their flavor, productivity, or uniqueness.

GERMINATING SEEDS

GETTING STARTED

Seed germination means bringing dormant seeds to life. Soaking seeds in water starts the process by softening the outer shells. As moisture brings the seeds to life, they expand with great force, splitting the outer shells and sprouting embryonic roots. As the new roots absorb moisture from the growing medium, new shoots will begin to grow.

What you need to do to germinate seeds will work for all growing situations. The main difference will be the medium, which will change based on what you'd like to grow:

- **Sprouts:** canning jar or growing tray
- **Microgreens:** jute mat

- **Herbs and seedlings:** rockwool cubes or coconut coir pods

HOW TO GERMINATE SEEDS

Most seeds need a dark, warm, moist climate with temperatures in the 70°F to 78°F (21°C to 26°C) range to germinate.

1. Soak the seeds and growing medium in plain water for several hours or overnight.
2. Place the growing tray on a heating mat and arrange the growing medium in the growing tray.
3. Sprinkle the seeds over the growing medium. They don't need to be buried.
4. Cover the tray with a humidity dome and cover the dome with a kitchen towel.
5. Keep the seeds moist by thoroughly misting with water every morning and night.
6. When root hairs emerge, place the dome slightly ajar on the tray to allow air to pass over the seeds.
7. When you see green tips start to emerge, remove the dome and place the tray near a sunny window or under grow lights.
8. Water new seedlings by pouring ½ inch (1.25cm) of water into the tray, not on top of the seedlings. Wait until the tray is dry to the touch before rewatering.

Equipment Needed
Growing medium
Heating mat
Watertight tray
Seeds
Humidity dome
Misting bottle
Kitchen towel

TIPS FOR SUCCESS

Be patient: Growing conditions for germinating seeds varies. Most seeds like it dark, but some want light. Germination times can vary, but seeds should usually sprout in several days after planting. Always read the seed packet for instructions.

Feed properly: Young seedlings are very sensitive to fertilizer. Don't apply nutrients until the seedlings have developed several leaves and then only at half strength.

Monitor daily: You should check on the seeds every day to assess their progress and ensure they don't run out of moisture. Dampen the seeds daily with a spray bottle to keep them moist.

ALL ABOUT SPROUTS

Growing sprouts is an excellent way to begin your indoor gardening experience. They're easy to grow, they don't require a lot of light, and they're ready to eat in a few days. And the best part? They're packed with vitamins, minerals, and antioxidants. You'll find plenty of ways to use sprouts—and you can feel good about eating them because of their nutritional value.

Sprouts You Can Grow
Alfalfa
Broccoli
Cabbage
Lentils
Mung beans
Peas
Radishes
Sunflowers

Equipment Needed
Canning jar or sprouting tray
Cheesecloth or a sprouting lid with a mesh insert
Rubber band or twine (if using cheesecloth)
Kitchen towel
Seeds

HOW TO GROW SPROUTS

Sprouts are tender, young germinated seeds. Instead of allowing

seedlings to mature into fully grown plants, you harvest them at the sprouting stage—about four to six days after planting. Sprouts are among the easiest plants to grow because you don't need much space or special equipment. You can easily grow them on your kitchen countertop because unlike most plants, they don't need sun either. In fact, they grow best away from direct sunlight.

Not all seeds are good for sprouting. Seeds used for sprouting are different from seeds you plant in your garden. You'll save time by purchasing your sprouting seeds and equipment from a hydroponics specialty store or online. (You might not find them at your local garden center.) See here to learn more about how to grow sprouts.

Sprouting trays are designed specifically for sprouting seeds. There are two types of trays for sprouting: One setup has an inner tray with small holes in the bottom that sits in a watertight outer tray. Another setup uses a grid that sits on top of a watertight tray. Either kind works well for sprouts.

GROWING SPROUTS

Sprouting seeds to eat as crunchy additions to salads and healthy dishes is less complicated than starting seeds for microgreens or mature plants. You simply have to coax them into life and enjoy! You don't need nutrients, a growing medium, or a growing container—only a few pieces of equipment. Make sure to choose seeds specially labeled as "sprouting seeds" or "seeds for sprouting" instead of regular garden seeds.

1. Soak 2 tablespoons of seeds in a canning jar for at least 8

hours. (If you're going to transfer the seeds to a sprouting tray, soak 4 tablespoons of seeds in the jar.)

2. After 8 hours, cover the jar opening with two layers of cheesecloth or a lid with a fine-mesh insert. If using cheesecloth, use a rubber band or twine to hold it in place. Drain the water.
3. If you're going to continue to sprout your seeds in the jar, place the jar at an angle on a kitchen towel to allow the seeds to spread out. If you're using a growing tray, evenly spread the seeds over the tray and place the lid on the tray. Rinse the seeds every morning and evening to keep them moist—but don't let them sit in water.
4. Place the jar or sprouting tray in bright light, but avoid direct sun.

HARVESTING & STORING SPROUTS

Harvest your sprouts after four to six days. On the day of harvest, place your sprouts in sunlight for 15 minutes and watch them come to life! The key to storing sprouts is to keep them dry. After harvesting, spread them on a paper towel to remove excess moisture or let them sit in a strainer for 8 to 12 hours after their final rinse. Either way, they should feel dry to the touch. Store sprouts in an airtight container in the fridge for up to five days. Eat

them as soon as possible because fresher is always better. Add them to salads, sandwiches, soups, stir-fries, and smoothies.

IS IT A FUNGUS?

It's normal to see what looks like white mold-like growth just before rinsing. You're probably looking at root hairs, especially if you're growing broccoli or radishes. If your sprouts really do have mold or a fungus, the most common causes are poor airflow or insufficient draining after rinsing. You can improve airflow by slightly raising the lid on your sprouting tray for more airflow. Also, make sure you're thoroughly draining the sprouts after rinsing. Sprouting trays are more effective at preventing mold than canning jars. If your sprouts are still white after rinsing, they have mold. Moldy sprouts aren't worth salvaging. Start over with a new crop.

ALL ABOUT MICROGREENS

Microgreens are simply young versions of the same plants you might grow in an outdoor garden. With a hydroponic garden, microgreens are harvested 8 to 15 days after planting—when they're only 1 to 3 inches (2.5 to 7.5cm) tall. When you harvest plants at such a young age, all their flavors are more concentrated than their full-grown relatives.

Sprouts You Can Grow
Arugula
Basil
Broccoli
Cabbages (Chinese and red varieties)
Clover
Collard greens
Fenugreek
Kale
Leafy lettuce varieties
Mustards (Green Wave, Red Giant, and Ruby Streaks varieties)
Peas
Radishes (all varieties)
Watercress
Wheatgrass

Equipment Needed
Watertight tray

Humidity dome
Jute mats
Misting bottle
Seeds
Full-spectrum fluorescent or LED lights (if you don't have a sunny window)
Heating mat (optional)
Kitchen towel (optional)

HOW TO GROW MICROGREENS

Growing microgreens is almost foolproof. Once you decide what you want to grow, simply start a new crop every couple weeks. With only 8 to 15 days growing time needed from planting to harvest, scheduling a steady supply of fresh microgreens is easy.

Many seeds require warm temperatures to germinate. A seedling heating mat placed under the growing tray will provide the gentle heat needed for seeds to sprout. Some seeds need soaking before planting, while others prefer darkness to sprout. Always read the instructions on the seed packet for presoaking, light preference, or special temperature requirements before planting. See here to learn more about how to grow microgreens.

GROWING MICROGREENS

Microgreens are grown in trays rather than pots. The best growing medium for microgreens is jute mats that anchor the seedlings as they grow. Jute mats are a sterile growing medium that eliminates fungal and mold issues that commonly attack seedlings growing in soil. Remember to check your seed packets for information on germination temperature and lighting.

1. Place the jute mat in the growing tray. (The mat should fit the tray.) Pour tap water over the mat and soak for several hours

(or overnight). The mat will turn dark brown when it's saturated. Once it's saturated, dump out any excess water. You don't want the mat to float. (If your growing tray is larger than one mat, place as many mats in your tray as you need to fit the tray, but stack them.)

2. Generously sprinkle seeds on top of the mat. The seeds should be close together but not touching. They're perfectly fine sitting on top of the mat. As they germinate, their roots will penetrate the mat to stabilize the plants as they grow. Heavily mist the seeds with tap water.
3. When the seeds glisten with moisture, cover the tray with a humidity dome. Place the tray in a dark location or use a kitchen towel to cover the tray. Thoroughly mist the seeds with tap water every day for two to three days, leaving the seeds in the dark. Seeds will sprout in about three to four days, with tiny white root hairs forming. If the seed packet says the seeds need a particular temperature, use a heating mat under the tray.
4. When you start to see tiny green tips start to emerge, move the tray into the bright sun or under the grow lights. Without adequate light, your seedlings will become tall and leggy—a condition that's almost impossible to correct. Place the lights 4 to 6 inches (10 to 15.25cm) above the top of the plants for maximum intensity. Adjust the height as the seedlings grow.
5. The seedlings will start using more water. Keep some water in the tray to prevent the mat from drying out. When adding water, use a "bottom watering" technique: Pour water into a corner of the tray and tilt the tray back and forth. The mat will gently and evenly absorb the water. By day 5, your plants should start looking delicious! (Some varieties take longer—be patient.)

HARVESTING & STORING MICROGREENS

When the first two leaves appear, it's time to harvest microgreens. This can be anywhere from 8 to 15 days after planting depending on the type of plant. For the freshest flavor, harvest only what you

need for your soup, salad, or sandwich and keep the rest growing. This is as fresh as you can get! However, you'll want to harvest your entire crop before they grow too large.

You can harvest microgreens in two ways: snipping the greens with scissors just above the jute mat or gently pulling the entire plant from the mat. Microgreen roots are also edible, offering a lot of fiber and a pleasant, crunchy flavor to your meals.

Microgreens will keep their crunchy flavor for a week or more after harvesting when stored properly. Simply place them in the fridge and keep them dry. That means no misting before cutting and no rinsing after cutting. For best results, line a resealable plastic bag with paper towels. Place the microgreens between the paper towels, then close the bag. The paper towels will absorb moisture and keep your greens dry. Wash them just before eating.

ALL ABOUT HERBS

You can buy fresh herbs at the supermarket, but they're not as fresh as herbs you can grow at home. Fresh herbs at your fingertips automatically adds a new dimension to your cooking. Imagine snipping a few sprigs of fresh parsley to liven up your omelet. Or fresh basil for your spaghetti sauce. And there's never any waste. The plant will continue to grow and provide fresh herbs almost indefinitely.

Herbs You Can Grow
Basil
Chives
Coriander
Dill
Fennel
Oregano
Parsley
Rosemary
Sage
Thyme

Equipment Needed
Watertight tray
Humidity dome
Rockwool cubes (or coconut coir pods)
Misting bottle
Seeds

Full-spectrum fluorescent or LED lights (if you don't have a sunny window)
Heating mat (optional)
Kitchen towel (optional)
Growing container
LECA pebbles
Nutrients

HOW TO GROW HERBS

If you've been growing sprouts or microgreens hydroponically, growing herbs is simply adding another step to the process. When it comes to growing herbs in your hydroponic garden, you can grow nearly every kind. For those herbs you harvest partially (like thyme) or for those that complete their growing cycle quickly (like basil), you can easily replant. Hydroponic gardening means you can grow herbs more densely, more quickly, and at any time of the year.

You need adequate light for growing herbs. A bright, sunny window will work, but if you want to be as successful as possible, invest in a full-spectrum lighting system to keep your crop growing. See here for more on plant lights.

You can grow herbs in individual containers or combine them in a single planter because they have the same watering and light requirements. See here to learn how to grow herbs.

NUTRIENTS FOR GROWING HERBS

Herbs are fast growers, and once the plants are past the seedling stage, they'll benefit from nutrients applied at full strength. The label on your nutrient package will tell you what dilution rate is full strength. For best results, use a balanced nutrient formula that promotes healthy leaf and stem growth. A typical NPK ratio for herbs is 7-9-5. See here for more on nutrients.

PRUNING

Pruning encourages full, bushy plants that look better and are healthier than tall, spindly plants. As your plants grow and you harvest them, you'll want to trim your herbs back, but never take more than one-third of the total leaves at a time. Many first-time growers are hesitant to cut back their plants. Don't be! Herb gardens will produce more for a longer period with frequent pruning—even if you don't use the cuttings.

GROWING HERBS

Herbs are simple to grow in a passive system or in an active countertop system. You simply need to start the seeds and let them develop into mature plants. Because these herbs will grow past the microgreen stage, you'll start each new seedling in a rockwool cube. Once each plant is established, it's easy to transplant each seedling to a hydroponic growing container or a countertop system as it matures.

1. Place the rockwool cubes in a bucket filled with tap water and soak them until they're saturated. Place the cubes in a watertight tray.
2. Carefully sprinkle the seeds over the cubes. Density varies with each type of plant and this is listed on the seed packet. Ideally, you want only one plant in each cube. If you plant too many seeds in each cube, as they grow, you'll have to separate them. As the seeds germinate, the roots will grow down into the rockwool cubes to nurture and support the seedlings.
3. Mist the seeds with tap water. Once the seeds glisten with moisture, cover the tray with a humidity dome and cover the dome with a kitchen towel. Thoroughly mist with water every day for two to three days, leaving the seeds in the dark. In most cases, seeds will sprout in three to four days as tiny white root hairs form. Root hairs are often mistaken as mold. If it's white and attached to a root, it's a root.
4. When you start to see tiny green tips start to emerge, move the tray under the grow lights. Place the lights 4 to 6 inches (10 to 15.25cm) above the top of the plants for maximum intensity. Adjust the height as the seedlings grow.
5. When the growing tray is dry to the touch, add ½ inch (1.25cm) of water to the tray. Water the seedlings by pouring water into

a corner of the tray instead of directly onto the plants. The rockwool cubes will gently wick the moisture up to the seedlings. Don't add more water until the tray is again dry to the touch.

6. Mature seedlings are 2 to 3 inches (5 to 7.5cm) tall and their roots are growing out of the bottom of the rockwool cubes. At this point, the seedlings are ready to be moved to the hydroponic system you've chosen for your garden. Think of this as repotting your plants—but without the potting soil. See here to learn more about how to repot your seedlings.

HARVESTING & STORING HERBS

Having fresh herbs at your fingertips immediately elevates your cooking. Herbs are harvested one clipping at a time depending on what the recipe (or your imagination) calls for. Some herbs, such as thyme and parsley, should be refrigerated for storage. Others, such as basil, should be stored at room temperature. It's best to harvest just what you'll need and store them in dry, sealed containers.

MOVING SEEDLINGS TO CONTAINERS

If you're starting seedlings for an herb or vegetable garden, you'll need to move them to their new hydroponic growing environment once they mature. If you're using an active system, such as an ebb and flow system or an aeroponic system, follow the system's instructions for transferring your plants to their new home. But if you're using a passive system, your plants are ready to transfer to a hydroponic planter. The following will help you with this transition.

GROWING CONTAINERS

The size and shape of the growing container you choose can vary depending on how many rockwool cubes you're transferring. You can place each individual plant it its own small growing container or several different kinds of plants in one large planter.

Perhaps you'd like a large container of basil or tomatoes and peppers on your apartment balcony? If so, choose a container large enough for several cubes and seedlings. Planting several seedlings in one container means you'll get a plant that grows more fully and more quickly.

4-inch (10cm) container	Holds 1 to 2 rockwool cubes
5-inch (12.5cm) container	Holds 2 to 3 rockwool cubes
7-inch (17.5cm) container	Holds 5 to 7 rockwool cubes

Equipment Needed
Growing container
LECA pebbles
Decorative outer pot
Water gauge

1. Soak the LECA in a bucket or tub of tap water for several hours or overnight.
2. Fill the bottom of a growing container with the LECA pebbles. Layer them to ½ inch (1.25cm) forasmallcontainer and to 1 inch

(2.5cm) or more for a larger container.

3. Place the seedlings (and their growing cubes) in the growingcontainer. Because the seedlings only have roots to the bottom of the cubes, be sure to plant them deeply enough so the roots will be near the water. Allow enough space between the cubes for at least one row of pebbles to fit in between them.
4. Once the cubes are placed in the pot, add saturated pebbles around and in between the cubes. Pack down the pebbles after planting. Be aggressive—you won't crush the roots. You don't want any air gaps in the growing medium, especially around the cubes.
5. Add a layer ofLECA on top of the cubes. Don't worry if you cover a few leaves.
6. Insert a water gauge into the growingcontainer. Place thecontainer in a decorative outercontainer. The outercontainer serves as the reservoir. Begin watering with nutrients at full strength as recommend on thenutrientlabel. Water from the top, letting the water and nutrients flow through the plants and into the reservoir. Check the water gauge, and add water and nutrients as needed.
7. Keep the level of the nutrient solution at the"Maximum" level in the reservoir for the first week. This will help the new roots grow toward the water. For active systems, increase the watering intervals. After the first week, the plants should have established new roots and you can return to normal watering. For a passive system, wait until the water gauge reads "Minimum" before rewatering.

4 GROWING VEGETABLES

ALL ABOUT VEGETABLES

There's almost no better feeling than growing a vegetable in your garden that you can harvest at a moment's notice and have with tonight's dinner. Accomplishing this is even easier when you grow your vegetables hydroponically.

Vegetables You Can Grow
Bok choy
Collard greens
Crookneck squash
Cucumbers (all varieties)
Eggplant
Green beans (bush types)
Leaf lettuce (all varieties)
Peppers (all edible varieties)
Romaine lettuce
Spinach
Swiss chard
Tomatoes (bush or patio types)
Zucchini

Equipment Needed
Watertight tray
Humidity dome
Rockwool cubes (or coconut coir pods)
Misting bottle
Seeds
Kitchen towel

Heating mat (optional)
6-inch (15.25cm) growing container for intermediate growing
Large growing containers for mature plants
Wire racks or bamboo poles for support
Garden netting (cut into small pieces)
LECA pebbles
Full-spectrum fluorescent lights with four to six bulbs or LED lights that cover at least 3 x 3 feet (0.90 x 0.90 meters), with 4500 lumens
Adjustable frame for holding multiple light fixtures
Light timer
Power strip
pH meter
Nutrients

Plants that are "dwarf size" or "container size" are more compact. Tomatoes labeled as "determinate" will grow to 3 to 4 feet (0.90 to 1.25 meters) when mature; "indeterminate" varieties will grow to 6 feet (1.75 meters) or more.

HOW MUCH LECA DO YOU NEED?

LECA is usually sold by volume rather than weight because the weight changes as the pebbles absorb moisture. Wet or dry, the pebbles never change in size. Most LECA is manufactured in Europe, so you'll find it sold in liters. Use the following guide to determine how much LECA you need. LECA can be expensive with shipping, but it doesn't deteriorate and you can use it over and over.

Container Size	Amount of LECA Needed
10 x 8 inches (25 x 20cm)	10 liters (2.6 gallons)
10 x 10 inches (25 x 25cm)	13 liters (3.4 gallons)
12 x 10 inches (30.5 x 25cm)	18 liters (4.7 gallons)
12 x 12 inches (30.5 x 30.5cm)	22 liters (5.8 gallons)
14 x 12 inches (36 x 30.5cm)	30 liters (7.9 gallons)
14 x 14 inches (36 x 36cm)	35 liters (9.2 gallons)

GROWING VEGETABLES

Growing vegetables hydroponically is a great way to grow food in small amounts, even though the number of produce you can grow at one time is limited. The equipment you need is a little more complicated than growing herbs or microgreens, but the harvest is worth it.

GETTING STARTED

Whatever you grow needs room to expand beyond the confines of its container. For larger plants, consider a sunroom or patio. Smaller plants, such as leaf lettuces, can grow on a countertop or windowsill.

To start your vegetables from seeds, follow the same process as starting herbs, as detailed shared in Growing Herbs. You'll germinate the seeds and nurture them into seedlings. Once the seedlings have sprouted, see here for how to transplant them to 5- to 6-inch (12.5 to 15.25cm) growing containers.

Once the plants are 8 to 10 inches (22 to 25cm) tall and the roots start to grow out of the bottom of the container, they're ready to transfer to larger containers. (See Moving Seedlings to Containers to learn more.) Spacing is important at this stage. Space small plants 6 to 8 inches (15.25 to 22cm) apart and space large plants 12 to 18 inches (30.5 to 46cm) apart. The seed packet will give you more information on how large a plant will grow and how densely you can plant. Pruning the leaves of larger plants so they don't overlap another plant will encourage branching and won't affect the yield.

LIGHT INTENSITY NEEDS

Vegetables require intense light coverage for maximum success. Fluorescent fixtures should have at least four to six bulbs and LED lights need to cover a minimum of 3 x 3 feet (0.90 x 0.90 meters), with 4500 lumens. Different vegetables can require different

amounts of light, so if you notice some plants thriving while others have poor color, you might need to add lights and some sort of adjustable frame to mount them. You want the light source to always be 8 to 10 inches (20 to 25cm) above the plant. See here to learn more about lights.

SUPPORT SYSTEM NEEDS

Vegetable plants need stability in the container to keep them growing upright. Once they start bearing vegetables, tall plants do best with a cage or multiple bamboo supports. Vining plants will need supports for their vines and nets to hold their heavy yield. Training plants to grow vertically leaves heavy vegetables hanging, so for larger produce, make hammocks (from garden netting or use nylon stockings or other material) you can tie to the support structure.

1. Fill a large growing container one-fourth full of saturated LECA.
2. Tip the plant's current growing container on its side and remove the plant. Place the plant on top of the LECA ina large container but deep enough for stability. Fillany spaces with LECA. (Don't worry if you bury a couple lower leaves.) Pack down theLECA after planting.
3. Install the support system in thecontainer by either inserting it into the LECA or attaching it to thecontainer. Make sure it's secure.
4. Insert the water gauge into the LECA. Add water with full-strength nutrient solution to thecontainer until the gauge reads "Maximum."
5. The new plant's roots are still growing to reach the reservoir,sopour 1 to 2 cups of nutrient solution over the LECA twice a week for the first 2 weeks. If you're planting in an active system instead of apassiveone, follow these instructions but add nutrients at regular intervals.

HARVESTING & STORING VEGETABLES

Harvest vegetables as soon as they mature. Pick green beans and peas when they’re smooth and bright green. Tomatoes can be harvested when they start changing colors. Harvest cucumbers

when they're just big enough to eat. Always use pruners or scissors when harvesting rather than pulling the vegetable from the vine, which can damage the plants. Storage for vegetables varies depending on the specific vegetable. For the freshest flavor, eat vegetables the same day they're harvested.

COMPANION PLANTING FOR VEGETABLES

Many different vegetables grow well side by side, providing each other with natural support and protection. You can plant recommended vegetables together in the same large growing container.

GETTING STARTED

Use the chart on the next page to learn which plants grow well together. While a major benefit of hydroponics is avoiding common garden pests, your plants are still susceptible to diseases. But companion planting can help.

NUTRIENTS FOR GROWING VEGETABLES

Vegetable plants are fast growers and need a lot of nutrients to produce vegetables. Apply nutrients at full strength. (Read the label for the exact amount.) The nutrient balance should emphasize flowering and fruiting over leaf and stem growth. That means an NPK ratio with a low first number (nitrogen) and high second and third numbers (phosphorus and potassium). Too much nitrogen and you'll get lush vegetative growth but limited fruit production. The pH level of the nutrient solution should be in the 5.5 to 6.5 range. This is a low pH level and will probably require an additive. See here to learn more about pH.

Type of Plant	Growing Characteristics	Companion Plants
Green beans & peas	These need intense light. They're fast growers that need support. Train these plants to grow up strings or use wire fencing or bamboo poles for bracing.	Radishes or cucumbers
Cucumbers (all varieties)	These grow in moderate light but need high humidity. Dry air from central heating can make these plants difficult to grow indoors during winter months.	All leaf lettuce varieties or radishes
Eggplant	High light levels and at least 12 to 14 hours of light are essential for plant development.	All herbs, radishes, and leafy varieties of lettuce. Don't grow these with peppers or tomatoes to avoid transferring common diseases.
Peppers (all edible varieties)	High light levels and warm temperatures are needed for plant development. You can plant a combination of varieties together.	All leaf lettuce varieties and spinach
Radishes	This fast-growing crop does well when planted under larger plants.	Green beans, peas, eggplant, or tomatoes
Squash & zucchini	High light levels and at least 12 to 14 hours of light are essential for plant development.	All leaf lettuce varieties and spinach
	The higher the light level, the better the yield. Indeterminate	Herbs (especially basil), leaf lettuce (all

Tomatoes	or bush varieties are recommended for indoor gardens.	varieties), radishes, and spinach
Spinach & lettuce	These will grow in moderate light. Because they prefer cool, humid growing conditions, choose heat-tolerant varieties for growing indoors.	Often grown under taller plants, such as tomatoes, or with eggplant, squash, zucchini, green beans, or peas

ALL ABOUT LEAFY GREENS

Some of the most popular, delicious, and, most importantly, easy vegetables to grow hydroponically are fresh, crunchy greens. The crisp flavors of greens that go from garden to table mean you'll never buy commercially produced lettuce or spinach again.

GETTING STARTED

Greens are easy to grow and ready to harvest in four to six weeks. Leafy varieties grow upright leaves and don't form a head. Loose-leaf lettuce grows faster and yields a bigger harvest, making it a better choice for your garden.

You can grow leafy greens in a passive system by starting the seeds in a tray and transferring the seedlings to grow containers. See Moving Seedlings to Containers to learn how to do this. You can also grow leafy greens in a countertop active system, such as an aeroponic garden. Depending on the active system you're using, check the instructions for starting seeds.

Equipment Needed
Watertight tray
Humidity dome
Rockwool cubes (or coconut coir pods)
Misting bottle
Seeds
Full-spectrum fluorescent lights or LED lights
Nutrients

Leafy Greens You Can Grow

Arugula
Bibb lettuce
Bok choy
Buttercrunch lettuce
Kale
Red leaf lettuce
Romaine lettuce
Spinach
Swiss chard

ROCKWOOL VS. COCONUT COIR

Coconut coir is a better medium for leafy greens if you plan to maintain an ongoing crop. Because you can't reuse rockwool cubes, you'll have to throw them away as you harvest your crop. Because you'll most likely have a larger number of plants for leafy greens, coconut coir is a less expensive way to start your leafy greens.

HOW TO GROW LEAFY GREENS

You can grow leafy greens in a sunny window, but if you use full-spectrum fluorescent or LED lights, you'll have better results. Artificial lights will give you more compact, dense plants with better flavors. Leafy greens grow quickly and will reach 12 to 18 inches (30.5 to 46cm) high in 4 to 6 weeks. Make sure your lights are adjustable so they can maintain optimal growing distance from the plants. Lettuces and other greens prefer cool growing environments in the 65°F to 75°F (18°C to 24°C) range. If the air temperature rises over 75°F (24°C), greens start producing chemicals that result in a bitter taste.

NUTRIENTS FOR LEAFY GREENS

Leafy greens need a lot of nitrogen for growing strong leaves, so you'll need to use nutrients with a high nitrogen number for the NPK. Apply nutrients at full strength. (Read the label for the proper amount.) Look for an NPK of 15-5-5 for leafy greens. For peak flavor, grow these plants in a nutrient solution with a pH reading of

5.5 to 6.5. You'll probably have to use a pH adjuster to get your nutrients to this pH range. See here to learn more about pH.

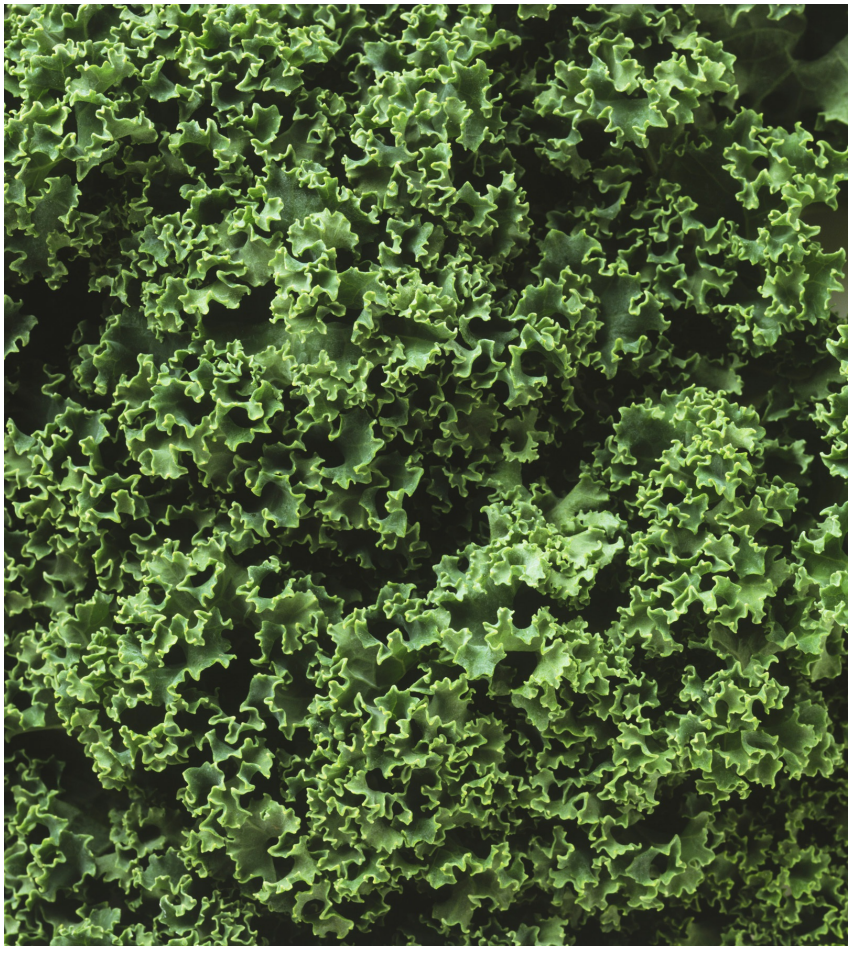
HARVESTING & STORING LEAFY GREENS

You should harvest leafy greens as soon as they mature in four to eight weeks or they'll turn bitter. Check the seed packet for the precise time frame for maturity. To harvest leafy greens, cut the larger outer leaves from the plant first and allow the center leaves to continue growing. Keep harvesting this way until the plant turns bitter or dies back.

Leafy greens won't regrow after you harvest them, so you'll want to plan for a continual crop, restarting seeds before you run out. When the variety you're growing has reached the desired size, simply trim the leaf close to the root. You can rinse and dry the leaves to store in the refrigerator. Use within a few days for best results. Store leafy greens in the refrigerator and keep them dry. Wrapped in a paper towel and stored in plastic bags, they should last for several days before losing their flavor and crunch.

GROWING LEAFY GREENS

The best way to grow leafy greens is to start your plants from seeds. Depending on the number of plants you want to grow, coconut coir pods will be the most economical way to begin. Also, keep in mind that lettuce seeds need light and cool temperatures to germinate.



1. Place the coconut coir pods in a bucket filled with tap water and soak them until they're saturated. Place the pods in a watertight tray.
2. Pinch a few seeds between your thumb and forefinger, then carefully sprinkle the seeds over each coconut coir pod. As the seeds germinate, the roots will grow down into the pods to nurture and support the seedlings.

3. Mist the seeds with tap water. Once the seeds glisten with moisture, cover the tray with a humidity dome, but don't cover the tray with a kitchen towel—lettuce seeds need light to germinate. Thoroughly mist with tap water every day for two to three days. In most cases, seeds will sprout in three to four days, with tiny white root hairs forming. Root hairs are often mistaken as mold or a fungus. If it's white and attached to a root, it's not mold—it's just a root.
4. When you start to see tiny green tips start to emerge, remove the humidity dome and place the tray in a sunny window or under grow lights. Place the lights 4 to 6 inches (10 to 15.25cm) above the top of the plants for maximum intensity. Adjust the height as the seedlings grow.
5. When the growing tray is dry to the touch, add ½ inch (1.25cm) of water to the tray. Water the seedlings by pouring water into the tray instead of onto the plants. The pods will gently wick the moisture up to the seedlings. Don't add more water until the tray is dry to the touch.
6. Mature seedlings are 2 to 3 inches (5 to 7.5cm) tall and their roots are growing out of the bottom of the coconut coir pods . At this point, the seedlings are ready to be moved to the hydroponic system you've chosen for your garden. If you'll be using grow ing containers, think of this as repotting your plants —but without the soil. (See here to learn more about how to repot seedlings.) Systems that don't use grow ing containers will have openings for the plants. Simply insert your seedlings into these openings. When you transplant your seedlings, you'll want to ensure you use the right size to fit in a rack, stand, or aeroponic or hanging planter.
7. After transplanting, start applying nutrients at full strength. Check the pH level of the nutrient solution several days after planting to make sure it's in the 5.5 to 6.5 range.

STANDS & RACKS

If you're growing your greens in containers, you'll want some sort of rack or stand to hold them all. This makes watering

easier and your lighting more efficient. Some stands even have systems for attaching lights and adjusting them. Many racks for greens have multiple rows, which makes them efficient for harvesting and rotating a crop. With greens, you'll constantly be harvesting and starting new seeds in order to maintain a constant supply.

You can also use an active system that uses a pump to circulate nutrients through the slots where greens grow. These systems don't use a growing container or a hydroponic medium, and they can sit on a countertop or stand on their own in a corner. You'll need an electrical outlet nearby for the motor as well as the lighting system. Follow the system's instructions for starting seeds and transferring seedlings to their new homes.

Lettuce seeds can be smaller than a grain of sand, so don't worry if you get more than one or two seeds in each starter cube. Because lettuce seeds are difficult to plant evenly, many seed companies offer "pelleted" seeds, which are seeds that have been coated with an inert material (usually clay), making them larger and easier to handle.

◄ CONTENTS

5 GROWING FRUITS

ALL ABOUT FRUITS

Growing your own berries or picking fruit from your own tree can be extremely satisfying. Hydroponic gardening helps you grow fruit in a controlled environment–whether it's strawberries on a rack in your kitchen or a lemon tree on your screened-in porch. Not all fruits are candidates for indoor growing, but there are several kinds of fruits that will thrive in the same conditions we live in daily.

Fruits You Can Grow
Avocados
Blueberries
Calamondin orange trees
Dwarf bananas
Fig trees
Key lime trees
Meyer lemon trees
Olive trees

Pineapple plants
Strawberries

Equipment Needed
8-inch or 10-inch (20 to 25cm) growing container for starter plants (Use a size that accommodates the roots.)
12- x 10-inch (30.5 x 25cm) or 14- x 12-inch (36 x 33cm) container for growing mature plants (smaller containers for fruit bushes; larger containers for fruit trees)
Outer container to fit the inner container
10 to 15 liters (2.6 to 4 gallons) of LECA pebbles
Bucket for soaking the LECA pebbles
Full-spectrum fluorescent lights with four to six bulbs or LED lights that cover at least 3 feet x 3 feet (0.90 x 0.90 meters), with 4500 lumens
Adjustable frame to hold multiple light fixtures
Light timer
Power strip
Nutrients
Water gauge
Planter caddy (optional) (If your container is large and heavy, make sure you purchase a planter caddy. A caddy is a rolling base for your planter that makes it easy to move heavy containers.)

HOW TO GROW FRUIT BUSHES & TREES

Fruits (except strawberries) generally grow as a tree or a bush and they can reach 12 to 15 feet (3.7 to 4.5 meters) tall. However, you can easily find miniature versions—called “dwarf trees”—that are perfect for indoor growing. In some cases, dwarf trees can still grow to 8 to 10 feet (2.4 to 3 meters) tall, so pruning will be necessary as they mature. Make sure the tree is labeled “self-pollinating.” Self-

pollinating trees can pollinate their own flowers and won't need a second tree to bear fruit. Fruit trees grow into sturdy plants that generally don't need support.

Fruit trees or bushes grow much slower than vegetables and take several years to produce fruit. But they don't have to be confined to your gardening area. With their vibrant appearance, they can be a welcome addition to your living space if you have a sunny window.

Fruit trees require intense light to bear fruit. Plants living in a sunny window might need additional lighting during winter months when sunlight is scarce. Many gardeners move their fruit trees outdoors to a deck or patio for the summer. The extra sunlight and humidity will invigorate your trees after spending a long winter indoors.

The most practical way to start fruit trees or bushes is buying starter plants. Growing fruit trees or bushes from seeds is a timely and tedious process for beginners that involves soaking the seeds and chilling them to the right temperature before planting. Successful germination can be spotty and can take months. Nurturing seedlings into viable plants takes at least a year.

Starter plants are generally two years old and have been grafted to maintain a small size. They're also more disease-resistant. Many plants online are shipped "bare root" (which means there's no growing medium and they're not actively growing) and are ready to be planted into a hydroponic system right away. See here to learn how to transfer trees growing in soil to hydroponics.

Resist the temptation to move your fruit trees in and out depending on the weather. Wait until the temperatures warm up before moving them outdoors and watch for chilly temperatures at night. Be sure to shield your plants from direct sun the first couple weeks outdoors and keep them close to the house to discourage birds if fruit has set. A preventative spray of neem oil every six to eight weeks will also keep the bugs away.

GROWING FRUITS

Fruit trees or bushes grow much slower than vegetables and they can take several years to produce fruit. But with their glossy leaves and tree-like appearance, they're beautiful to have in sunny spots in your home while you wait. Large containers using passive hydroponics work best to display fruit trees and bushes in living areas.

1. Fill the bottom of a grow ing container about one-fourth full with LECA.
2. Place the tree on top of the LECA and add more LECA to cover about 2 inches (5cm) above the roots.
3. Pack down the LECA after planting. Be aggressive—you won't

crush the roots. You don't want any air gaps in the LECA . For passive systems, place the growing container inside an outer container. Insert the water gauge. Use the drip system for active hydroponics.

4. Apply nutrients at full strength. Check the pH of the nutrient solution several days after planting to make sure it's in the 5.5 to 6.5 range. Compared with vegetables, fruit trees are slow growers even though you apply nutrients at full strength. Look for a balanced nutrient that has an NPK rating with even numbers. The pH level will probably require an additive. See here to learn more about pH.

WATERING & MAINTAINING YOUR TREES

After your new transplant has established itself in its new home and appears healthy, you'll want to change your watering strategy to ensure the roots get the air they need to grow. With a passive system, water from the top until the reservoir is full and the water gauge says "Maximum." Then wait until the plant uses all the water in the reservoir and the water gauge reads "Minimum" before rewatering. This will typically be about two weeks or more. For active systems, increase the intervals between waterings.

You'll only need to repot your fruit trees when the roots are bursting through the sides of the growing container. To repot, simply increase the size of the new container by several inches. Add a new base of the LECA, then simply move the entire root system (including attached LECA) from the existing container to the new container. Add fresh pebbles around the sides and tap down for stability.

Regular pruning will keep your fruit trees and bushes stronger and looking their best. Prune any time of year except when they're blooming or developing fruit. Simply trim any branches that are growing beyond your tree's desired size. New growth will quickly replace any branches you've removed.

HARVESTING & STORING FRUITS

Once your fruit tree begins to yield fruit, leave it on the tree (or bush) until it's ripe. Fruit doesn't continue to ripen after harvesting, so leaving it on the tree will ensure it's at its ripest when you pick it. Wait until the fruit is full of color and can be easily removed from the plant before harvesting. For large fruit, use pruning shears or scissors to clip the fruit from the tree if it doesn't pull away easily.

Every rule has an exception: Avocados don't ripen on the tree. Pick them when they're still dark green and hard to the touch. To ripen, let them sit for two weeks at room temperature or until they're softer to the touch.

Store fruit in a cool and dry place. Once you've cut into a fruit, store it in a sealed container or plastic wrap in the refrigerator for up to a few days.

GROWING STRAWBERRIES

Most commercial strawberries are grown hydroponically and the method is easy to adapt to your home. Starting strawberry plants from seeds takes patience. You might need to wait at least a month for the seeds to germinate and up to a year for plants to produce fruit.

GETTING STARTED

Starter plants from your local garden center are the quickest and easiest way to get your strawberries growing, but their roots will need to be trained from soil to hydroponic growing. (See here to learn how to transfer a plant from soil to hydroponics.) Strawberry plants are usually available during the early spring and newly planted seedlings will take about six months to mature and produce fruit.

GROWING CONDITIONS

Make sure you have suitable indoor growing conditions for your strawberries. The temperature will need to drop to at least 60°F (16°C) at night and not rise above 75°F (24°C) during the day. Otherwise, your fruit won't have the texture or flavor you'd like. If the temperature in your growing area rises above 80°F (27°C) , your strawberries will stop producing altogether.

CHOOSING YOUR PLANTS

Out of nearly 600 varieties, there are two types of strawberry plants that are suitable for indoor growing. *June bearing* are the most popular. They produce large strawberries once a year during a three-week period in the spring. *Everbearing* don't produce fruit all season. They produce a smaller crop in the spring and another in the fall. The growth cycle spans an entire year and repeats annually. Rather than occupying valuable space for an entire year, many gardeners simply start with new plants every spring.

LIGHTING NEEDS

Strawberries need bright light but not the intense light other fruiting plants need to grow. A light fixture with two full-spectrum fluorescent bulbs or an LED light with 3500 lumens is adequate. Strawberries will also grow under larger fruit or vegetable plants in larger gardens.

NUTRIENT NEEDS

Apply nutrients at full strength according to the label instructions. Use a balanced nutrient solution that has an NPK rating with even

numbers. The pH level of the nutrient solution should be in the 5.5 to 6.0 range. This is a low pH level and will probably require using an additive with your nutrients to lower the pH. See here to learn more about pH.

HOW TO GROW STRAWBERRIES

Once their roots have been retrained, you can plant strawberries in 4- to 6-inch (10 to 15.25cm) passive containers. (See Retraining Plants from Soil to Hydroponics to learn more). You can plant your strawberries in large racks, window boxes, or even hanging planters. Strawberry plants produce runners, which you'll want to trim to ensure the plant puts energy into producing fruit. As flowers appear, hand-pollinate them by using a dry paintbrush or cotton swab.

DID YOU KNOW?

You don't have to set your thermostat at 60°F (16°C) to grow strawberries. All houses have microclimates where temperatures can be hotter or colder than the ambient temperature in the room. A windowsill, porch, or garage can provide the right conditions.

RETRAINING PLANTS FROM SOIL TO HYDROPONICS

Starter plants from your local garden center grow in soil, so you'll need to retrain their roots for hydroponic growing. Removing the soil from the plant's roots forces the plant to convert its soil roots to hydroponic roots. Growing new roots takes time and can be stressful for the plant. Putting new transplants on a heating mat for two to three weeks will give those new roots a boost. There are two ways to acclimate soil plants to hydroponics depending on which type of hydroponic system you'll be using.

Equipment Needed
Grow lights (full-spectrum fluorescent or LED)
Growing container
Clear plastic saucer to fit under the growing container (to act as a temporary reservoir)
LECA pebbles
Tall water glass
Heating mat

METHOD 1: ACTIVE SYSTEM

If you have an active system, such as an aeroponics system or one with a water pump, you'll simply acclimate your plants in a glass of water.

1. Remove the plant from its container and rinse the roots under water to remove all the soil.
2. Place the plant in a tall glass of water. Use tap water that's not from a water softener. Set the plant in a sunny window or under grow lights. For faster results, place the glass on a heating mat. Replace the water every couple days to give the roots the oxygen they need to grow. Don't use nutrients because they can be harmful to newly developed roots.
3. After two weeks, if your plant appears healthy, your new starter plant should be ready to move to a hydroponic system.

METHOD 2: PASSIVE SYSTEM

If you're using passive hydroponics or an active system that uses growing containers, you'll need to transfer the soil plants to a hydroponic growing container with a growing medium.

1. Remove the plant from its container and rinse the roots under water to remove all the soil.
2. Choose a growing container that's the same or a smaller size

than the container the plant was in. If in doubt, use a smaller container to provide better airflow to the roots. Soak the LECA in plain water for several hours or overnight.

3. Repot your plant in LECA just as you would when transferring seedlings to a growing container. (See Moving Seedlings to Containers to learn more.) Don't use a decorative outer pot. Simply place the growing container on the saucer as a temporary reservoir.
4. Place the plant and saucer in a sunny window or under grow lights. A heating mat will encourage faster root growth. Water the new transplant with plain water to 1 inch (2.5cm) deep in the saucer and check frequently, maintaining about 1 inch (2.5cm) of water in the saucer. Don't use nutrients because they can be harmful to newly developed roots. Continue this process until you see new roots growing out of the bottom of the growing container.
5. After two to four weeks for vegetables or four to six weeks for fruit-bearing plants, you should see new roots. You're now ready to repot into a new growing container and add a water gauge and nutrients.

6 GROWING HOUSEPLANTS

ALL ABOUT HOUSEPLANTS

You can grow houseplants hydroponically with many of the same techniques you use for growing fruits and vegetables. Houseplants need to be retrained for hydroponic growing, but once you convert them, you'll eliminate the uncertainties that come with growing in soil. Passive pots and planters are the most practical for houseplants because you can move them easily and they don't require pumps or electricity.

Houseplants You Can Grow
African violets
Amaryllis
Bamboo
Bromeliads
Christmas or Thanksgiving cactus
Devil's ivy
English ivy
Hibiscus
Jade plant
Kentia palm
Monstera
Narcissus
Parlour palm
Peace lily
Ponytail palm
Rubber tree plant
Spider plant

Equipment Needed
Growing container
Decorative outer container
Water gauge
LECA pebbles
Heating mat (optional)
Humidity tray (optional)
Rooting solution to give the new roots a boost (optional)

LECA Needs	
Planter Size	**Amount of LECA**
4 inches (10cm)	½ liter (0.13 gallons)
5 inches (12.5cm)	1 liter (0.26 gallons)
6 inches (15.25cm)	1.25 liters (0.33 gallons)
8 inches (20cm)	3.5 liters (0.92 gallons)
10 inches (25cm)	7 liters (1.8 gallons)

WHY HYDROPONICS FOR HOUSEPLANTS?

Overwatering is the number one killer of houseplants. Once you

replace soil with LECA, you can rely on your water gauge to tell you when to pour the nutrient solution over the LECA. At the same time, air passes through the pebbles, promoting the airflow that roots need for healthy growth. Removing the soil also eliminates mold, mildew, and common pests often associated with houseplants.

RETRAINING ROOTS

You won't be able to simply repot your houseplants into a hydroponic growing medium and expect them to thrive. You'll need to retrain their roots to accept nutrients in a new way. While you learned the process for garden starters for your vegetable garden, the process for houseplants is a bit more complicated because of a new watering regimen to encourage new growth. See Converting Houseplants from Soil to Hydroponics to learn more.

ORCHIDS & OTHER ORNAMENTALS

You can also train tropical flowering plants, such as orchids and African violets, to grow hydroponically. You can even use hydroponics to grow plants that bloom from bulbs. (See Growing from Bulbs to learn more.) Most flowering plants have specific seasonal timetables for blooming, which hydroponics doesn't change. Your bulbs and orchids only bloom when they're ready.

CHOOSING THE BEST HOUSEPLANTS FOR HYDROPONICS

Any plant that grows in a pot can be grown hydroponically. Some houseplants are easy to convert to hydroponics, while others will need assistance. The following details the best houseplants for hydroponics.

PLANNING FOR SUCCESS

Use the table on the following page to learn which houseplants you can grow hydroponically. Plants with thick leaves and stems transplant easily. Switching from soil to hydroponics temporarily interrupts the flow of moisture up to the plant until the roots adapt to their new surroundings. But because these plants store moisture in their thick leaves and stems, they're not effected by an interruption of moisture from the roots.

Other plants need a little coaxing during the transition because they refuse to convert their existing roots and insist on growing new ones. Growing new roots takes time. Warm temperatures at the root zone promote root growth. Good humidity at the leaves helps the plant endure while new roots are forming.

Plants with thin leaves and fragile roots are difficult to transplant. Removing soil from delicate roots can damage them, which interrupts the flow of moisture from the roots to the plant. Plants with thin leaves and stems can't store moisture, and they suffer when the steady flow of moisture from the roots is interrupted.

NUTRIENTS FOR HOUSEPLANTS

Houseplants are slow growers, so apply nutrients at half the recommended strength. When choosing nutrients for foliage plants,

look for an NPK rating where the numbers are all roughly the same. Remember to avoid urea-based nitrogen. The recommended pH level is neutral, which is the 6.5 to 7.5 range.

If your houseplants produce flowers, you want to look for nutrients that are low in nitrogen and high in phosphorus. That would be an NPK rating with a low first number and a high middle number, such as 3-12-6. The pH level for flowering plants should be in the 5.0 to 6.0 range.

You won't use nutrients with new transplants for the first couple waterings because they can be harmful to new, tender roots. Instead, use plain water or look for products designed to encourage new root growth. When the gauge reads "Minimum," it's time to add water to the transplants. After the first few times you add plain water, you can start to apply the nutrient solution at half strength according to the label instructions.

Easy Transplants		Plants That Need Coaxing	Plants That Are Difficult to Transplant
Cast-iron plant (*Aspidistria elatior*)	Mother-in-law's tongue (*Dracaena trifasciata*)	Aluminum plant (*Pilea cadierei*)	Areca palm (*Dypsis lutescens*)
Chinese evergreen (*Aglaonema* Jubilee) (*Aglaonema* Midnight Bay) (*Aglaonema* Silver Bay) (*Aglaonema* Maria) (*Aglaonema* White Rain)	Parlour palm (*Chamadorea elegans*)	Asparagus fern (*Asparagus densiflorus*)	Bamboo palm (*Chamadorea siefrizii*)
Corn plant (*Dracaena* Janet Craig) (*Dracaena* Warneckii)	Peace lily (*Spathiphyllum*)	Crown of thorns (*Euphorbia milii*)	Boston fern (*Nephrolepis exaltata*)
Dumb cane (*Dieffenbachia*)	Ponytail palm (*Beaucarnea recurvata*)	Nerve plant (*Fittonia argyroneura*)	Devil's ivy (*Epipremnum aureum*)
Hawaiian schefflera (*Arboricola*)	Radiator plant *(Peperomia)*	Song of India (*Dracaena reflexa*)	Maiden hair fern (*Adiantum*)
Heartleaf philodendron (*Philodendron hederaceum*)	Rubber fig (*Ficus decora*)	Umbrella plant (*Schefflera amate*)	Swedish ivy (*Plectranthus australis*)
Kentia palm (*Howea forsteriana*)	Spider plant (*Chlorophytum comosum*)	Weeping fig (*Ficus benjamina*)	Table fern (*Pteris cretica Mayi*)
Monstera (*Philodendron monstera*)	Velvet leaf philodendron (*Philodendron micans*)		Triangle palm (*Dypsis decaryi*)

ℹ Double-tap image to read the labels

ONLY TROPICAL FLOWERING PLANTS

If you're converting flowering plants, consider if they're annuals or tropical flowering plants. Annuals only bloom for a single season, while tropical flowering plants grow continuously. Annuals aren't good candidates for hydroponic growing because their life span is only for one season.

CONVERTING HOUSEPLANTS FROM SOIL TO HYDROPONICS

Converting houseplants from soil to hydroponics is a little more involved than transferring starter plants for vegetables. Removing the soil without damaging the roots is more challenging because houseplants have been growing in their pot longer and have more roots. Houseplants also grow slower, so the transition from soil roots to water roots takes longer. The opposite page details how to transfer your houseplants from soil to hydroponics.

Equipment Needed
Houseplant growing container
Decorative outer container
Water gauge
LECA pebbles
Heating mat (optional)
Humidity tray (optional)

Rooting solution to give the new roots a boost (optional)

Most houseplants will do just fine after repotting and adapt to a hydroponic environment right away. However, some plants might need a little TLC. A new transplant might droop or lose a few leaves in the beginning. If this happens, simply remove any dying leaves with scissors so the plant can focus its energy on new growth. New growth is always the best indicator of how your plant is doing, so if you see new growth, your transplant is doing just fine!

1. Soak the LECA in plain water for several hours or overnight.
2. Remove the plant from its current container and rinse the roots under water to remove all the soil. Be careful not to damage the roots. If necessary, soak the plant for several hours or overnight.
3. Cover the bottom of a growing container with the saturated LECA. Place the plant or cutting on top of the LECA and fill around it with more LECA. Hold the plant steady while adding LECA so the roots remain deep in the container for stability. Don't worry if you cover leaves. Pack the LECA after planting. Be aggressive—you won't crush the roots.
4. Place the container in a decorative container. Insert the water gauge.

WATERING YOUR NEW PLANT

Keep your water level at "Maximum" for the first week. After that time, remove the growing container from the outer container, then run clear water through the LECA to remove any impurities that might have built up around the roots, especially the new ones. Return the plant to the outer container and let it sit dry for a day or two. Then start watering to only halfway on the gauge and wait until the gauge reads empty before rewatering.

TIPS FOR SUCCESS

- Use only healthy plants. Hydroponics won't revive sick or diseased plants.

- Begin with small plants. Practice the conversion process before trying it on larger plants.
- The best time to transplant is from April to October. Late spring, summer, and early fall are the most active growing season for houseplants.
- Don’t transfer newly purchased plants. If you’ve just bought plants, give them a few weeks to acclimate to your growing environment.
- Use a growing container with openings in the side for airflow. It should also be the same size or slightly smaller than the existing pot.
- As plants grow, they release moisture into the air through their leaves in a process called “transpiration.” Raising humidity at the leaves slows the rate of transpiration, reducing the pressure on new roots to perform. To increase the humidity, place a plant in its new container directly on a humidity tray.

STARTING HOUSEPLANTS FROM CUTTINGS

Using cuttings to start a plant can help you propagate or restart your houseplants because they'll be adapted to a hydroponic environment from the beginning. Whether you have cuttings from a devil's ivy, a drooping spider plant, or other kinds of houseplants, the following pages will help you grow new plants from those cuttings. Propagation works for nearly any plant except for cactuses and succulents.

Equipment Needed
Houseplant growing container
Decorative outer container
Water gauge
LECA pebbles
Heating mat (optional)
Humidity tray (optional)
Rooting solution to give the new roots a boost (optional)

1. Vining plants are great candidates for cuttings—an ideal way to create a new plant from an old favorite. Cut a long vine into sections with one or two leaves on the stem.
2. For vining plants and non-succulents, remove the lower leaves and place the cuttings into a glass of water. Make sure the stem and node where the leaves were attached are entirely submerged. After a few days, you should see roots begin to form. Replace the water with fresh water every few days. Don't use nutrients yet.
3. Continue replacing the water until the cuttings have roots at

least 2 inches (5cm) long. Once they're established, you can transfer them to a growing container. See Moving Seedlings to Containerspages to learn more.

For new cuttings, 4- or 5-inch (10 or 12.5cm) growing containers are the best size. If you want to grow a larger plant, combine rooted cuttings from several smaller growing containers into a larger container after they've adapted to growing in the LECA. Roots don't grow at temperatures below 68°F (20°C). The heating mat you use for your seedlings is an effective tool for keeping your new cuttings warm.

WATER & NUTRIENTS

Keep your water level at “Maximum” for the first two weeks. After that time, remove the growing container from the outer container and run clear water through the LECA to remove any impurities that might have built up around the roots. Return the growing container to the outer one and start watering to only halfway on the gauge. Wait until it reads empty before rewatering.

If a plant gets too much water, the roots will suffocate. Getting the

right balance of air and water at the roots is the key to successful transplanting. That means waiting until all the water has used up before rewatering. Once your plant adapts to hydroponics, watering will be much easier. When you see droopy leaves, chances are those new roots need air, not more water.

Use a balanced nutrient solution that has an NPK rating where the numbers are all roughly the same. Apply nutrients at half the recommended strength. Remember to avoid urea-based nitrogen. The recommended pH level for houseplants is neutral, which is the 6.5 to 7.5 range.

GROWING ORCHIDS

Orchids grow best hydroponically and don't require retraining. In fact, orchids you buy or receive as a gift are already growing in a hydroponic medium (such as bark, moss, coconut coir, or charcoal). Repotting an orchid helps creates an ideal balance of water and airflow at the roots. When the blooms have faded is a great time to repot in a new container.

Equipment Needed
Houseplant growing container
Decorative outer container
Water gauge
LECA pebbles

1. Soak the LECA pebbles for a few hours or overnight to saturate them.
2. Place a layer of LECA pebbles in the bottom of the growing container.
3. Remove the orchid from its old container and gently remove the bark and any growing medium from the roots. Rinse the roots with tap water. Trim away any dead or decaying roots, including any that are overly soft, rotted, or smell bad. Be aggressive when trimming dead roots. Trim the flower stalk (flower spike) at least two nodes from the bottom of the plant.
4. Place the orchid on top of the LECA and add more to fill the container. Tap the LECA down so it fills in around the roots.
5. Insert the water gauge and place the container in a decorative outer pot.

WATERING YOUR ORCHIDS AFTER REPOTTING

Orchid roots need to breathe, so be stingy with the water. For the first couple weeks, remove the inner growing container and simply run plain water through the LECA. Don't use nutrients yet. Drain the water and return the plant to the outer container with no water in the reservoir. Repeat this process once or twice a week.

In two to three weeks, you can start watering and apply nutrients at half strength. Pour the nutrient solution over the LECA until the red indicator on the gauge moves, then stop pouring. Wait until the plant has used up all the water before rewatering. If your plant uses

up all its water in two weeks, start watering to one-fourth on the gauge. Make sure the container is completely dry before rewatering. Because orchids are seasonal growers, they might drink up to two to three times more water during their growing season. They'll use less in their blooming and resting seasons.

NUTRIENTS FOR ORCHIDS

Orchids grow on a limited diet of nutrients. They're also sensitive to water quality and harsh chemicals. Don't use water that's passed through a water softener. During the growing season, use a balanced fertilizer that has an NPK rating with (or close to) even numbers.

Apply the nutrient solution every watering at half the recommended amount on the package. Avoid nutrients with urea-based nitrogen.

When you see a flower spike (or stalk) forming, switch to a nutrient that's low in nitrogen and high in phosphorus to encourage large, colorful blooms. Apply nutrients at half the recommended amount on the package while the plant is in bloom. After the flowers have faded, remove the flower stems, leaving two nodes from the bottom, cut back on water, and skip nutrients altogether until you see new growth. Avoid nutrients that advertise they'll make your plants bloom.

TEMPERATURE MATTERS

Orchids need at least a 15- to 20-degree Fahrenheit (8- to 12-degree Celsius) change between daytime and nighttime temperatures in order to start a blooming cycle, but that doesn't mean you need to adjust your thermostat. All rooms have microclimates where the temperature can be hotter or colder. On a winter day, the sun can raise the temperature in a sunny window to 90°F (32°C) or more. On a cold night, the temperature in that same window can drop to 50°F (10°C). That's a 40°F (22°C) difference and should trigger your orchids to bloom.

Once blooms appear, move your plant out of the sun and display it wherever it looks best. The orchid has built up all the energy it needs to complete the blooming cycle. Cool temperatures prolong the blooms.

GROWING FROM BULBS

Hydroponics makes growing houseplants, such as amaryllis, narcissus, tulips, and irises, from bulbs a clean and easy process. Bulbs differ from houseplants in how they grow hydroponically. The bottom of the bulb should be wet to produce roots, but the sides of the bulb need to stay dry. They can be grown in a planter with LECA or even in special vases or containers that keep all the bulb upright and dry except for the roots.

Equipment Needed
Houseplant growing container
Decorative outer container
Water gauge
LECA pebbles
Heating mat (optional)
Humidity tray (optional)

1. Soak the LECA in plain water for several hours or overnight.
2. Cover the bottom of a growing container with saturated LECA. You'll want to use a growing container that's about 2 inches (5cm) larger than the bulb. However, for a more dramatic display, you can plant multiple bulbs in one container. Make sure you choose one large enough to accommodate your bulbs, especially when they're planted close together.
3. Plant the bulbs (pointed ends up) deep enough in the LECA for a single layer of LECA to cover the top of the bulb. This is slightly deeper than planting in soil. If you're planting multiple bulbs, be sure to allow at least 1 inch (2.5cm) between the bulbs so they don't look crowded as they grow. Insert the water gauge.

4. Place the decorative container or planter in a sunny window.

GROWING CONDITIONS

Bulbs you buy are dormant, which means they're alive but not growing. They've also been stored in a cooler for 8 to 12 weeks at 40°F (4°C), which prepares them for blooming. When they're planted, watered, and placed in a sunny window, their roots will spring to life and new blooms will start.

CARE & FEEDING OF BULBS

Water your bulbs sparingly at the beginning. Nutrients aren't necessary because the bulbs have stored up all the energy they need to grow and bloom. Pour water over the LECA until the red indicator on the gauge moves, then stop. Wait until the growing container is completely dry before rewatering.

When you see leaves appear, increase the watering to the half mark on the gauge, but make sure the plants use up all the water before rewatering. Because you planted your bulb more deeply than a regular plant, it should stay dry, but you should periodically check to ensure only the very bottom of the bulb is in water.

Rotate the containers frequently as the plants grow because they'll bend toward the sun. When the first blooms appear, move your planter away from window and display your flowers wherever they'll look their best. Cool temperatures will prolong the life of the flowers.

Bulbs are susceptible to overwatering because the outer shells need to breathe. If the growing medium around the bulbs is constantly wet, the bulbs will start to decay. If you plant bulbs in growing containers or even special vases designed to grow bulbs in water, new roots will grow from the bottom of the bulb and can remain wet.

7 MAINTENANCE

ROUTINE MAINTENANCE

Although the plants you grow hydroponically don't need attention every day, the systems they grow in do need and deserve scheduled checks. These and the following pages offer techniques to help you not only have a well-maintained system but also a clean environment in which your hydroponic plants will thrive and flourish.

GOOD UPKEEP WILL RESULT IN GREAT SUCCESS

A hydroponic garden is easier to maintain than a backyard garden, but there are still a few tasks you should schedule on a regular basis to keep your system in top form—no matter if you have a passive system or an active system:

- Check your system every two to three days. (See below for what to look for.)
- Clean your system every three to four weeks. (See the next page for specific cleaning tips.)
- Check and clean your equipment before planting new crops to ensure problem-free harvests.

CHECKING YOUR SYSTEM WHILE A CROP IS GROWING: EVERY 2 TO 3 DAYS

While plants are growing in your system, you should take the following steps every few days to ensure everything is well with your plants:

- Trim away any dead or dying leaves.
- Remove any plants that have droopy or discolored leaves or

are falling over.

- For active systems, make sure pumps are operating properly.
- Check the water level in your active system reservoir or the water gauge in your passive pot or planter.
- Check the pH of the nutrient solution in the reservoir of your active system or planter. See Monitoring the ph level to learn more about pH.
- Prepare the nutrient solution at the recommended amount in a separate container before adding to the reservoir.
- If your garden is outdoors, you should check pH and nutrient concentration after every rain shower.

MAINTENANCE TO PERFORM EVERY 3 TO 4 WEEKS

Every few weeks, you should complete the following steps to ensure your system is running at optimal levels:

- For an active system, flush the system with clear water by draining the nutrient solution from the reservoir and then filling the reservoir with plain water. Run the system for three to four hours, then remove the water and refill the reservoir with fresh nutrient solution.
- For a passive system, flush the system by simply removing the inner container, holding it over a sink or bucket, and running plain water through the pebbles for a minute or more. Return the plant to its outer container and fill the reservoir with the recommended amount of nutrients.
- In an ebb and flow system, the nutrient solution tends to stick to the sides of the growing containers and flood tray when the system drains. Flushing the system with a mix of clear water and hydrogen peroxide every three to four weeks will help

keep your system clear of residue buildup while it has plants in it. Ensure that if you have a system with plants growing in it that you don't use anything but hydrogen peroxide to flush the system. Other cleaning solutions will damage your plants.

- If you're using an active system, pay special attention to pumps and other moving parts when you do maintenance. If you find anything amiss, take the proper steps (including consulting the owner's manual) to ensure your system is running as efficiently as possible.

MINERAL RESIDUE ON LECA

In passive systems, It's common to find a white coating of mineral deposits on LECA pebbles at the top of the growing container. This residue is from unused nutrients or other impurities in your water. The wicking action of the LECA pebbles has pushed these elements to the top of the container, where they're easy to remove. Simply discard any pebbles with residue—they're impossible to clean—and replace them with fresh pebbles. You'll have then eliminated 90% of the impurities from your system.

SYSTEM MAINTENANCE BETWEEN CROPS

To keep your hydroponic garden at its best, you'll need to perform some maintenance between planting new crops. The following information notes what equipment you need for this as well as what steps to take.

Maintenance Equipment Needed
Log book (for keeping track of cleaning schedules, crops, and any equipment that might need to be replaced)
Vinegar
Household bleach
Hydrogen peroxide (food-grade if possible)
Scrub brush
Toothbrush
Rubber gloves and goggles
Large bucket

HARD WATER DEPOSITS

The white residue that collects on reservoirs, water gauges, and other system equipment is made up of leftover mineral salts and nitrates from nutrients. Removing these deposits from all the components will keep your system operating efficiently and eliminate buildup of chemical elements that can become toxic to your plants. If you have hard water, the buildup will be more difficult to remove. See here to learn how to clean hard water deposits.

CLEANING PASSIVE SYSTEMS BETWEEN CROPS

- Once you've harvested your crop, remove the growing medium and any plant material from each growing container. Remove any nutrient solution in the reservoir or outer growing container.
- Clean the LECA for reusing. (See the opposite page to learn how to do this.)
- Save any nutrient solution you drain from the reservoir for use on outdoor plants or nonhydroponic houseplants.
- Use a scrub brush to clean the sides and bottom of the growing container as well as the outer container with a household bleach solution (1 part bleach to 10 parts water). Then rinse the container with clean water. Use the rubber gloves for scrubbing and the goggles if you're spraying cleaning solution or bleach.
- Clean any soil or other residue from your seed-starting and gardening equipment. Clean with a bleach solution to remove any contamination from other plants.

CLEANING ACTIVE SYSTEMS IN BETWEEN CROPS

- Empty the reservoir and fill the system with clear water and sterilizing solution (hydrogen peroxide or bleach solution) mixed according to the instructions at the bottom of this page.
- Run the system for three to four hours.
- Check for leaks around pipe fittings.
- Drain the system and flush with water.
- Scrub the inside of the reservoir to remove nutrient residue.
- Scrub the nozzles of spray bottles and misters with a toothbrush.

- Check the timing on the pump to make sure the pump is turning on and off at the times you want.

CLEANING & REUSING LECA

- Dry out the pebbles. Spread them out in a tray and place the tray in the sun for a couple hours.
- Remove any dead roots and other debris. While standing in an outdoor breeze (or in front of a fan), pour the pebbles from one bucket to another. Repeat this several times.
- Discard any pebbles that have white residue. (They can't be cleaned.)
- Sterilize the pebbles by soaking them overnight in a mild bleach solution: 1 part bleach to 10 parts water.
- Rinse the pebbles with clear water. The LECA is ready to be used again.

CLEANING SOLUTIONS

These ratios work best for safely cleaning your hydroponic system. Always read the label to understand the chemicals you're using and never mix chemicals in their concentrated form. Don't mix bleach and hydrogen peroxide because that can create a toxic result.

- **Hydrogen peroxide (35% food-grade):** 3 parts peroxide to 10 parts water
- **Hydrogen peroxide under 10% concentration:** can be used directly
- **Household bleach:** 1 part bleach to 10 parts water

LIGHTING & OTHER EQUIPMENT MAINTENANCE

Inoperable pumps, clogged water gauges, dim light bulbs, and leaking reservoirs can take some of the fun out of your indoor garden. Every few months, you should inspect your system to address the following concerns.

LIGHTING MAINTENANCE

Plants can tell when the quality of light diminishes. Light bulbs lose their effectiveness over time, even though the human eye won't recognize this. Make a note on your calendar for when you should replace your bulbs. To ensure maximum intensity, plan to replace bulbs slightly ahead of schedule. Use the following guidelines to help you determine when to replace your lights.

- Fluorescents bulbs will last about 2 years when operating 12 to 14 hours per day. To replace them, simply remove the old bulb from the fixture and install a new one. Look for fluorescent bulbs with digital ballasts because they use 30% less electricity to operate.
- LED bulbs will last 10 years. Depending on your fixture, you might not be able to replace your LED bulbs. Follow the manufacturer's instructions if you're able to easily replace them.

Bulbs and reflectors are prime areas for collecting dust and will benefit from a wipe down with a damp cloth every couple weeks. Clean the cords, inspect the plugs, and clear garden areas around electrical outlets to prevent fire hazards. Use your maintenance log to write down when you've performed any kind of light maintenance.

SYSTEM LEAKS

You might discover a puddle of water one day, which means you have a leak in your system. Hardware stores carry trays that are designed to catch leaks under fridges, which are perfect for catching water under large systems. For passive systems, the most common source of leaks are cracks in the reservoir or outer growing containers. Check for moisture under the outer container to avoid damaging the windowsill, floor, or carpet. To fix a leak, replace the reservoir or growing container.

FAILING PUMPS

If your pump has stopped working or, worse, it's making an odd noise or producing smoke or sparks, unplug your system immediately. Check the manufacturer's guidelines for troubleshooting and repair instructions or to see if it will need to be replaced entirely. A pump that's properly maintained has a life span of about four years. If you're using an NFT system, you'll want to have a backup pump because plants deteriorate quickly when the nutrient solution stops circulating.

ELECTRICAL MAINTENANCE

If your hydroponic system, heating mat, or light fixtures have a frayed or broken electrical cord, replace it immediately. Once per year (or more often if you prefer), you should plan to do a thorough visual inspection of all your electrical equipment as well as your electric outlets. If you find frayed wires or broken plugs, you can purchase rewiring kits or electrical tape at your local hardware store. Other electrical equipment might need to be replaced entirely to make sure you don't create a fire hazard.

DISPOSING OF FLUORESCENT TUBES

Fluorescent tubes require special handling when they're replaced because they contain mercury. Dispose of them at a hardware store that has a recycling bin or take them to your local recycling center.

CLEANING HARD WATER DEPOSITS

Tap water is the easiest—and best—water to use with your hydroponic garden. The drawback to tap water is that some of the minerals or additives, such as high concentrations of calcium, magnesium, chalk, and lime, can leave deposits on your equipment and in your system. The following will help you remove these deposits.

ELIMINATING HARD WATER DEPOSITS

Unlike the mineral buildup from nutrients, hard water deposits on your equipment are harder to scrub clean and can cause some problems. Water softeners are popular for moderating hard water but aren't acceptable for your hydroponic plants. Softened water is treated with a sodium-chloride mix that's harmful to plant roots and blocks the plant from absorbing nutrients. Instead, take the following steps to clean hard water deposits:

- For mineral buildup in your reservoirs, heat a 50/50 white vinegar/water solution on the stove until it's hot to the touch but not boiling. Scrub any surfaces, letting the solution sit before rinsing with plain water.
- For active systems, run a warm 50/50 white vinegar/water solution through the pump for two to three hours to remove deposits inside pipes and tubing. Rinse with plain water.
- Soak nozzles, water gauges, and any other system components in the 50/50 white vinegar/water solution for 20 minutes to remove deposits. Shake or circulate to remove mineral deposits from small openings. Use a toothbrush to scrub where

necessary. Rinse with plain water.

- Make sure you don't combine vinegar with hydrogen peroxide. The two will create a toxic acid that's not safe to breath. Be careful not to mix hydrogen peroxide with bleach because this will create an explosive gas.

CHANGING YOUR WATER SOURCE

If you're tired of dealing with hard water deposits, you can consider installing a rainwater collection system or reverse osmosis system to improve the water quality for your garden.

Rainwater has low concentrations of minerals and is an excellent source of water for hydroponic gardens. Check at your local hardware store or online for a large selection of systems to collect rainwater, such as barrels that connect to downspouts.

Reverse osmosis removes chlorine, chloramine, fluoride, calcium, and magnesium by passing water through a series of filters but requires some investment to install. You can buy reasonably priced (about $200 to $300) reverse osmosis systems that attach to the faucet or fit under the sink. If you have a small hydroponic garden, you can use distilled water for mixing your nutrients. However, this might not be practical for larger systems.

8 TROUBLESHOOTING

DIAGNOSING & TREATING INSECT INFESTATIONS

If you suspect insects, act immediately. One adult female can lay thousands of eggs—and they can hatch in five days or less. The insect population will multiply and your entire garden will become infested. Use the following chart to help you find and resolve any insect issues.

Problem	Symptoms	Treatment
Spider mites	They puncture holes in leaves to suck out plant fluids, causing leaves to yellow, dry up, and fall off. You have spider mites if the undersides of leaves are dusty or small spiderwebs form where leaves meet the stem.	**Spray with neem oil or insecticidal soap.**
Thrips	These small winged insects suck sap from leaves and flowers. They're invisible to the naked eye, so shake your foliage over a white sheet of paper and use a magnifying glass to see if you have thrips.	**Spray with neem oil.**
Aphids	They feed on plant juices and stunt new growth. Less than an ⅛ inch (3mm) long, they're typically black or green. They leave a sticky, sugary "honeydew" substance that quickly becomes moldy black.	**Prune areas of high infestation, then spray with neem oil.**
Whiteflies	These tiny insects suck juices from the plant, leaving white spots and yellowing on the leaves. Like aphids, they also produce "honeydew." To confirm you have them, shake the leaves and watch for tiny flies to appear. Or hang sticky tape traps around the room.	**Spray with insecticidal soap or neem oil early in the morning.**

Fungus gnats	These often walk or fly over a growing medium. They feed on decaying roots, slowing growth and causing bacterial infection. To detect them, place sticky tape traps near the growing medium.	**Dry the growing medium. Spray neem oil or insecticidal soap on the medium.**
Mealy bugs	They live in groups protected by a white, cottony-looking substance where leaves meet the stem. Like aphids, they also leave behind "honeydew."	**Spray with neem oil or insecticidal soap.**
Nematodes	These microscopic worms attack a plant's roots. The most common source of nematode infestation is starter plants that have been grown in soil.	**Remove infected plants and replace or sterilize the growing medium.**

USING NEEM OIL

Neem oil can help combat insects, fungal problems, mold, root rot, and other common diseases. Dilute neem oil with water and spray it directly onto the leaves or, for root problems, pour it directly on the roots. You can buy premixed neem oil, but making your own is more effective. To make 1 quart of neem oil spray, combine these ingredients in a sprayer:

- 1 quart of warm water (110°F to 120°F [43°C to 49°C])
- 1 teaspoon of cold-pressed neem oil concentrate
- 1 drop of household dish soap

Shake well and use within 24 hours. Always use 100% cold-pressed neem oil because azadirachtin—the active ingredient that helps

repel insects—deteriorates with heat. If you have hard water, use distilled or bottled water.

This spray eradicates the adults but won't affect the eggs. To eliminate insects for good, spray a plant three times at weekly intervals. Damage from fungi or diseases won't disappear. Remove the damaged leaves and spray the area every couple days until the problem stops progressing.

Neem oil is the most effective treatment, but it carries an unpleasant odor that smells like garlic and nuts. Insecticidal soap is a good alternative.

USING INSECTICIDAL SOAP

Dishwashing soap will work, but a soap made with vegetable oils, such as Castile, eradicates bugs and mixes easily with water. The fatty acids dissolve the insects' exoskeleton, causing them to dehydrate.

Insecticidal soap has just two ingredients, which ensures a fresh batch of spray every time. Premixed insecticidal sprays are diluted and contain additives. To make 1 quart of insecticidal soap, combine these ingredients in a sprayer:

- 1 quart of warm water (110°F to 120°F [43°C to 49°C])
- 1 teaspoon of insecticidal soap

To increase the potency, you can also add:

- ½ teaspoon of garlic or ½ teaspoon of crushed red pepper flakes (pungency helps repel chewing insects)
- ½ teaspoon of apple cider vinegar (helps with powdery mildew)
- 1 tablespoon of vegetable oil (helps the spray stick longer)

Shake well and use within 24 hours.

With either spray, make direct contact with the insects. Spray until the solution drips off the leaves, focusing on the bottom sides of the leaves, where bugs like to hide. Don't spray in direct sunlight or

extreme hot or cold temperatures, but you can use either spray until the day you harvest.

DIAGNOSING NUTRIENT & LIGHTING PROBLEMS

Your plants rely on you the grower to provide the nutritional elements plants need to grow. The following information will help you detect and fix nutrient and lighting problems with your hydroponic system.

TRIAGE 101

You can grow strong, healthy plants by simply sticking to the basics. Knowledge of chemistry or micronutrient dosing isn't necessary. Just some basics tips will help.

- Know how to read the label so you know what you're using. See here to learn how to read a nutrient label.
- Inexpensive nutrients are never a bargain. Invest in good nutrients.
- Use up your nutrients in one year or less. Don't combine concentrated nutrients. They'll react and form a solid mass you can't use for your plants.
- Premixed formulas are the best choice for beginner gardeners. They're easy to dilute for new plantings as needed.
- Replace the nutrient solution during routine maintenance—if not sooner. If you don't replace a solution over time, it won't be as effective.

WHAT TO LOOK FOR

Before diagnosing nutrient problems, make sure you do some basic checks. That information will help direct you to a treatment solution.

- Check the ph level of the nutrient solution and make adjustments as needed. See Monitoring The pH Level to learn more about pH.
- Check the NPK rating of the nutrient solution you're using. You might need a different blend. See here to learn more about the NPK rating.
- If the pH is in your recommend range and the NPK seems accurate, empty the reservoir, clean it, and start with fresh nutrients.

ADJUSTING LIGHT LEVELS

Knowing the light requirements for each plant in your garden will help maximize the light in your growing area. Leggy growth as well as small and thin leaves are sure signs of inadequate light. Increasing the power of the light source or moving plants closer to the light will solve the problem. Check the light bulbs often and replace as needed.

Problem	Symptoms	Treatment
Nitrogen deficiency	Lower leaves are yellow and the rest of the plant is light green. Plant growth is stunted because it's not absorbing enough nitrogen.	Change to a nutrient solution with a higher first number in the NPK.
Potassium deficiency	Stunted growth and poor flowering are caused by underdeveloped roots.	Change to a nutrient solution with a higher middle number in the NPK.
Iron, magnesium, or zinc deficiency	Leaves or new growth will have yellowing between the veins. Check for dark veins between the yellowed portions. Make sure iron, magnesium, and zinc are listed on the label of your nutrient solution.	Switch nutrients as necessary. Empty the reservoir and start over with a fresh nutrient solution. Check the pH level and adjust as necessary.
Fluoride toxicity	Tips of the leaves are burned.	Stop watering with tap water. Mix distilled water with your nutrients.
Too much calcium	New leaves are distorted or hook-shaped. Check the calcium level in your nutrient solution and decrease that if possible.	Flush the root system of affected plants with clear water. Empty the reservoir and start over with a fresh batch of nutrients. Check the pH level and adjust as necessary.
Blossom end rot	The blossom ends wither after the bloom has set. (This might also mean your plants are too dry.)	Check the nutrient solution to make sure calcium is listed. Check the pH level and adjust as necessary. Adjust your watering schedule and ensure the water gauge is at

		maximum.
Small fruit	Your plant likely has a magnesium deficiency.	Check the nutrient solution to make sure magnesium is listed. Switch nutrients as necessary. Empty the reservoir and start over with a fresh nutrient solution. Check the pH level and adjust as necessary.

DIAGNOSING & TREATING FUNGI & DISEASES

Fungi and diseases can occur in even the best setups. The following information will help you detect and eliminate fungal or bacteria problems that might occur in your hydroponic system.

WHAT TO LOOK FOR

Typical fungal and bacteria problems are easy to spot. Some common ones include:

- Powdery white spots on leaves, stems, or fruits
- Tiny brown spots on the bottom of leaves
- Black or brown lesions on leaves, stems, or fruit

ELIMINATING FUNGI & MOLD

Follow these tips to eradicate fungi and mold in your hydroponic garden.

- Wear clean clothes and wash your hands when working with your plants.
- Keep tools clean and sanitize them with hydrogen peroxide after trimming plants with bacteria or diseases.
- Clean up spills. Many disease problems are caused by water and humidity.
- Trim dead leaves and branches and remove all debris.
- Maintain good airflow. Allow enough space between plants for them to breathe. Install a fan if necessary.

CONTROLLING FUNGI & MOLD

Fungi and diseases can appear unexpectedly. Protecting your garden with a preventative maintenance routine will keep your plants healthy and productive. Spraying your plants every four to six weeks with neem oil or insecticidal soap will prevent fungi and diseases before they start. Neither spray will affect the taste of fruits or vegetables.

Unfortunately, you can't reverse damage to leaves caused by fungal or bacterial problems. Remove the infected leaves and spray the area with neem oil or insecticidal soap every couple days until the spread has stopped.

SPRAYING WITH APPLE CIDER VINEGAR

You can use apple cider vinegar to destroy mold and eliminate those pesky white spots from your plants. In a spray bottle, combine 2 tablespoons of apple cider vinegar and 1 quart of water. Shake well. Spray onto infected leaves and stems every couple days until all traces of mold are gone.

Problem	Symptoms	Treatment
Powdery mildew	This looks like a white powder sprinkled over the leaves, which become curled and distorted before turning yellow and falling off. This occurs in cool, damp conditions.	Remove the infected leaves. Raise the temperature and lower the humidity. Spray with neem oil or insecticidal soap once a week until the powdery mildew is gone.
White mold	This fuzzy substance covers leaves and stems. White mold can also grow on the top layer of the growing medium. It's contagious and can spread to other plants. High humidity, lack of light, and poor airflow are the primary causes.	Improve the light levels and airflow. Spray with neem oil or apple cider vinegar every couple days until the mold is gone.
Black spot fungus	This starts as tiny black spots on leaves –no bigger than a pinhead–and as it develops, those black spots become ringed with yellow. Soon, the entire leaf turns yellow and falls off. Black spot fungus develops if temperatures drop into the fifties and humidity levels are high.	Bright light and good airflow can stop black spot fungus from spreading. Spraying infected leaves with neem oil or insecticidal soap every couple days will eliminate the fungus that causes black spot.
Bacterial blight	Symptoms of bacterial blight are dark brown spots with yellow rings on the leaves. Eventually, the disease causes plant foliage to die. Plants with insect damage are more likely to	Remove the infected plants.

	contract the disease than healthy plants because insects create openings for the bacteria to infect the plant.	
Root rot	This causes a plant to suddenly wilt and die. It especially occurs on new transplants. The best defense is to be stingy with water and spraying new roots with hydrogen peroxide before planting.	Remove the infected plants.

COMMON PROBLEMS WITH SPROUTS

For the best results when growing sprouts, follow the directions shared in Growing Sprouts. The following will help you resolve any issues.

Problem	Solutions
Seeds failing to sprout	• The temperature is too cold. Place the sprouting tray on a heating mat. • The seeds are too old. Discard them and start a new batch.
Mold	• Not rinsing seeds thoroughly when watering. Discard them and start a new batch.
Sprouting takes longer than four to six days	• Not waiting long enough. Most seeds germinate in a couple days, but some take longer. (Check the seed packet for the germination time.)
Sprouts not turning green	• Not enough light. Move the growing container to get more light– either from natural light or from a grow lamp. Avoid direct sun.
Fruit flies	• Not rinsing seeds thoroughly or poor airflow might cause this. • If seeds haven't germinated, rinse the seeds and tray, then keep the tray cover off to allow for some airflow. • If seeds have germinated, discard them and start a new batch.

COMMON PROBLEMS WITH MICROGREENS

For the best results when growing microgreens. The following will help you resolve any issues.

Problem	Solutions
Seeds not germinating	• The temperature is too cold. Place the seed tray on a heating mat. • Not waiting long enough. Most seeds germinate in a couple days, but some take longer. (Check the seed packet for the germination time.)
Mold & mildew	• New roots can look like mold appearing as wispy white strands at the base of the new plant. Move the growing tray to bright light as soon as the seeds sprout and remove the tray cover. If the white material is root growth, it will recede in a day or two. If it's mold, it will continue to grow and cover the seedlings, so discard the seeds and start over. Seedlings should be moved into light as soon as they sprout. • Too much water. Make sure the seeds aren't soaking in water. • Poor airflow. Adjust the cover on the growing tray so fresh air circulates around the seedlings.
Plants falling over	• This is called "damping off." Fungi or mold attacks the seedlings at their base and the stems can't support the new growth. This is caused by overwatering or poor airflow. Damping off isn't recoverable. Start a new crop with less water and better airflow.
Plants growing tall & leggy	• Inadequate light. Increase the available light.
Plants turning yellow	• Microgreens generally look yellowish after germination. They'll turn green if you place them in a bright light.
Plants taste bitter	• Waited too long to harvest. Harvest plants after two sets of leaves appear for peak flavor.

COMMON PROBLEMS WITH HERBS

For the best results when growing herbs, follow the directions shared in Growing Herbs. The following will help you resolve any issues.

Problem	Solutions
Mold on seedlings	• Poor airflow. Seedlings should be moved into the light as soon as they begin to sprout.
Seeds not sprouting	• The temperature is too cold. Place the growing tray on a heating mat. • Not enough time has passed for germination. Check the seed packet for the germination time. • Using the wrong growing environment. Check the instructions on the seed packet. • Seeds are too old. Discard them and start a new batch.
Seedlings looking wilted, droopy, or like they're dying after transplanting	• This sort of reaction isn't unusual. Your plant is in shock but should perk up in a couple days. Make sure it has good light and the roots are getting fresh nutrient solution.
Tall, leggy plants with small leaves	• Lack of light. Herbs need lots of light when growing indoors. Add lights to your growing setup or adjust the lights for intensity.
Leaves turning black or looking scorched	• Too much direct sun. Herbs enjoy sun, but they can burn if they get too much. Move your plants out of direct sun or adjust your light source away from the plants just a bit.
Leaves that are light green in color	• Nutrient deficiency. See All About Nutrients for the recommended NPK. • Make sure your nutrients contain all the needed micronutrients. • Make sure the pH is in the 6.5 to 7.5 range. If the pH is out of range, nutrients can be blocked.
Plants turning yellow	• Too much moisture. Adjust the nutrient solution if needed and use the water gauge to determine when to add

	nutrients.
Plants beginning to droop & dying for no apparent reason	• Some herbs are annuals and grow for only one season. • Root rot from too much water. Empty the reservoir so the roots get more air. Plants might be unrecoverable.
Plants growing well but are tall & spindly	• All herbs require pruning, even if you don't use cuttings. New growth from where the plant was pruned will result in a stronger, more compact plant.
Plants beginning to flower (known as "bolting")	• The temperature is too hot. • This might be from a nutrient deficiency and plants might be starved.
Plants deteriorating after blooming	• Flowering signals the end of a plant's life cycle as well as a new life cycle because the plant also produces seeds when flowering. Regular pruning keeps the plant in the growth cycle and extends the plant's life.
Plants growing well, but the leaves are getting smaller & smaller	• Herbs don't grow forever (even perennial herbs). In this case, the plants are getting old. Start new plants from seeds or cuttings.

COMMON PROBLEMS WITH FRUITS & VEGETABLES

For the best results when growing fruits and vegetables. The following will help you resolve any issues.

Problem	Solutions
Mold on seedlings	• Too much water and poor airflow. Seedlings should be moved into light as soon as they sprout.
Seeds not sprouting	• The temperature is too cold. Place the container on a heating mat. • Not enough time has passed for germination or the wrong growing environment was used. Check the instructions on the seed packet. • Seeds are too old. Discard and start with a new batch.
Seedlings falling over	• Called "damping off," fungi or mold attacks the seedlings and the stems can't support new growth. Caused by overwatering or poor airflow. Start a new crop with less water and better airflow.
Seedlings looking dead after transplanting	• Not unusual. They'll perk up in a couple days. Give them good light and make sure the roots are getting water.
Starter plants from soil dying after transplanting into hydroponics	• The temperature is too cold. Place the container on a heating mat. • Improper watering. Allow plants to dry out between waterings. • Starting with weak plants. Only buy plants that look sturdy and have good color. Never attempt to rescue ailing starter plants.
New growth looking weak & leggy	• Inadequate light. (These plants need lots of light.) Move the lights closer to the plant or invest in more powerful lighting.
Weak stems on mature plants	• Lack of light. Move the lights closer to the plant or invest in more powerful lighting.
Plants growing well but	• The flowers aren't pollinated and the

not bearing fruit	plants need more light.
Plants growing too large	• Look for plants designed for container gardening. Many vegetables come in “dwarf size” or “bush varieties.” “Determinate” tomatoes only grow 4 feet (1.2 meters) high. “Indeterminate” plants grow very tall.
Blossoms dropping off	• Once plants bloom, make sure you watering them. If they’re too dry, the blooms will fall off.
Deformed fruit	• This is caused by extreme temperatures or too much or too little water.
Leaves with poor color & curling	• Look for spider mites. See Diagnosing & Treating Insect Infestations to learn how to eradicate them.
Powdery spots on the leaves	• Powdery mildew. See Diagnosing & Treating Fungi & Diseases to learn how to eliminate mold.
Leaves that are light green in color	• Nutrient deficiency. Make sure the pH is in the 6.5 to 7.5 range. If the pH is out of range, nutrients can be blocked.
Leafy greens growing really tall	• The temperature is too high. Most leafy greens grow in cool weather. Move the growing area to a cooler spot (basement or garage). Grow outdoors in spring or fall. Install better airflow.
Leafy greens tasting bitter	• Waited too long to harvest. The plant also got too many nutrients.
Leafy greens with burnt edges	• Too much light. These don’t need as much light as other vegetables.
Tiny cobwebs on leaves or leaves are curling	• Citrus trees are magnets for insects, especially spider mites. Prevent insects by spraying the plant once a month with neem oil or insecticidal soap. See here to learn more about how to combat insects.

Shiny, sticky substance on leaves	• Spray the plant three times a week with neem oil or insecticidal soap while gently scrubbing the plant with a soft-bristled brush.
Fruit trees not producing fruit	• Lack of light. Move the plant outdoors if possible, but avoid direct sun the first couple days. • Flowers aren't getting pollinated. Use a small, soft paintbrush and dab the center of each flower..
Fruit trees dropping fruit	• Avoid cold air drafts in winter. • Raise the humidity by lowering the temperature.

COMMON PROBLEMS WITH HOUSEPLANTS

For the best results when growing houseplants. The following will help you resolve any issues.

Problem	Solutions
Very long stems & small leaves	• The plant needs more light. Move it to a window or add a light.
Plant dropping green leaves	• Check the environment. This could include temperature, light, or airflow. Change the plant's environment and see if the condition improves.
Lower leaves turning yellow	• Overwatering. Empty the reservoir and let the plant sit dry for a couple days so the roots get air.
Leaves pale in color	• Nutrient deficiency. Check the needed NPK for the plant you're growing to ensure it gets the needed micronutrients. • Make sure the pH is in the 6.5 to 7.5 range. If the pH is out of range, nutrients can be blocked.
Shriveled leaves	• Look for insects on the undersides of leaves. • Roots aren't sending moisture up to the leaves because they're suffocating from too much water. Empty the reservoir and let the plant sit dry for a couple days.
Scorched leaves that turn black	• Too much direct sun. Prune affected leaves–they won't turn green again.
Insect infestation	• See here to learn more about how to combat insects.

◂ TROUBLESHOOTING CONTENTS

COMMON PROBLEMS WITH ORCHIDS

For the best results when growing orchids. The following will help you resolve any issues.

Problem	Solutions
Orchid not flowering	• Not enough light. • Orchids need a 15- to 20-degree Fahrenheit (8- to 12-degree Celsius) change in temperature from day to night to initiate a flowering cycle.
Dead flowers	• Cut the flower spike off at the base of the plant. A new flower spike will appear when the plant blooms again. Orchids have growing seasons and blooming seasons. Some orchids flower for months; others flower for only a couple weeks.
Wrinkled & limp leaves	• The plant is dehydrated because the roots are suffocating. • Remove the plant from the container and cut away rotted roots. • Repot the plant in a fresh growing medium and reduce watering so the roots get the air they need to grow.
Leaves falling off	• This is caused by crown rot or root rot from overwatering. • The plant won't recover.
Lower leaves turning yellow & falling off	• This is normal if it's one or two leaves. • If it's many leaves, the roots are too wet from overwatering.
	• This isn't uncommon with new plants

Flower buds turning yellow & falling off	you just brought home. Your plant has traveled a long way to get to your house and is having difficulty adjusting to its new environment. Be patient.
Black areas on leaves that turn crispy brown	• Orchids that haven't been outdoors can burn in the sun in 15 minutes. Prune affected leaves–they won't turn green again.
Roots growing outside the container	• Orchids have aerial roots that help them cling to rocks and trees. Don't try to bury these roots.
Insect infestation	• See here to learn more about how to combat insects.

RESOURCES

FOR HYDROPONIC SUPPLIES:

EasyGroHydro
426 Golden Beach Blvd.
Venice, FL 34285
www.EasyGroHydro.com

True Leaf Market
175 W. 2700 South
Salt Lake City, UT 84115
www.trueleafmarket.com

Gardeners Supply Company
128 Intervale Road
Burlington, VT 05401
www.gardeners.com

HydroponicSupplyUSA.com
(internet only)

FOR SEEDS:

Botanical Interests
660 Compton St.
Broomfield, CO 80020
www.botanicalinterests.com

Johnny's Seeds
955 Benton Ave.
Winslow, ME 04901
www.johnnyseeds.com

FOR GREENHOUSE SUPPLIES:

CropKing
134 West Drive

Lodi, OH 44254
www.cropking.com

Farmtek
1440 Field of Dreams Way
Dyersville, IA 52040
www.farmtek.com

One of the best resources for beginner gardeners is your local hydroponics store. They'll be glad to share their experience with hydroponic growing and help you choose the system that will work best for you.

PHOTO CREDITS

DK would like to thank the following for their kind permission to use their photography:

Shutterstock: Elizaveta Galitckaia

Shutterstock: Dmytro Tyshchenko

Shutterstock: Floki

Dorling Kindersley: Peter Anderson

Dorling Kindersley: Rob Streeter

Dorling Kindersley: Will Heap

Dorling Kindersley: Will Heap

Shutterstock: Maridav

Shutterstock: nikkytok

Shutterstock: SeDmi
Shutterstock: Sarah2

Shutterstock: spline_x
Shutterstock: kiri11
Shutterstock: domnitsky

Shutterstock: rukawajung

Shutterstock: Jaume Capella Villalonga

Shutterstock: Parilov

Alpha: Helene Dujardin

Shutterstock: luchschenF

Shutterstock: Da Antipina

Shutterstock: Ellyy

Shutterstock: Nataliia Zhekova

Shutterstock: Nata Bene

Dorling Kindersley: Will Heap

Dorling Kindersley: Will Heap

Dorling Kindersley: Will Heap

Dorling Kindersley: Steve Gorton

Dorling Kindersley: Peter Anderson

Dorling Kindersley: Gary Ombler

Dorling Kindersley: Will Heap

Dorling Kindersley: Will Heap

Dorling Kindersley: Rob Streeter

Dorling Kindersley: Jeremy Hopley

Dorling Kindersley: Rob Streeter

Shutterstock: Lipa23

Dorling Kindersley: Rob Streeter

Shutterstock: Firn

Shutterstock: Egorov Igor

Shutterstock: Elizaveta Galitckaia

◄ CONTENTS

ACKNOWLEDGMENTS

First and foremost, I want to thank my wife, Arlene Macallister-Harms, for introducing me to hydroponics 30 years ago. I was a skeptic at first, but the advantages of hydroponic growing soon became obvious. I was surprised to learn I could grow everything from herbs and vegetables to houseplants and orchids without soil! I wouldn't be here sharing this information without your knowledge and support. Your suggestions and ideas are as much a part of this book as mine are. You've been a terrific partner in life *and* business all these years.

I also want to thank our best friend, Jeanette Rodenbaugh, who introduced my wife to the European method of hydroponic growing in 1978.

Writing a book doesn't happen without help. Organizing your thoughts and putting them on paper is a unique talent all on its own. An enormous and heartfelt "thank you" to my writing partner, Renee Wilmeth. This book wouldn't have been possible without your help and encouragement every step of the way. You kept me on track to meet our deadlines, and your energy and enthusiasm were contagious.

I want to thank my editor, Christopher Stolle, who somehow knew how to structure a book on gardening without being a gardener himself. This book wouldn't be half as useful without your ideas and suggestions. I also want to thank Lindsay Dobbs for designing and illustrating the book as well as Laura Robbins for her illustrations.

And finally, appreciation and gratitude to all the gardeners, growers, and nursery workers who have shared their knowledge and experience with me over my 40 years in the horticulture industry. "Plant people" are some of the best people you'll ever find to work with!

◄ CONTENTS

ABOUT THE AUTHOR

Jeree Harms is a lifelong gardener—of sorts.
He grew up in a farming family in the Midwest and at the age of 17 decided farming wasn't in his future, so he moved to Chicago to attend college, earning a degree in computer sciences.

After working for AT&T for several years, Jeree realized the corporate world wasn't for him either, so he left and opened a tropical plant store in Chicago in 1973. (His family thought he was nuts!)

The store quickly became successful. Within
a couple years, the company grew into a thriving interiorscape company, leasing and maintaining plants in such places as hotels, corporate offices, and shopping malls.

In 1990, at a trade show in Florida, he was introduced to growing plants hydroponically by Arlene Macallister, an enthusiastic entrepreneur from New Jersey. After experimenting with hydroponics, he was quickly sold on the idea
of growing plants without soil.

He sold his business in Chicago, moved to New Jersey, and started a plant business called Creative Hydroponics. This time, everything was grown hydroponically. The advantages of hydroponics became obvious, and as the new company thrived, it started a hydroponic nursery in Florida. And as they say, the rest is history. And oh, by the way, that enthusiastic entrepreneur he met at that trade show in 1990 became his wife!

Jeree and Arlene are semi-retired in Florida and frequently speak at garden clubs, orchid societies, and Master Gardener groups about the advantages of hydroponic growing. They have an internet business that sells hydroponic supplies called EasyGroHydro (www.EasyGroHydro.com).

Publisher Mike Sanders
Editor Christopher Stolle
Designer Lindsay Dobbs
Contributing Writer Renee Wilmeth
Illustrators Lindsay Dobbs (see Equipment needed, All about Nutrients, All about seeds)
& Laura Robbins (see Active systems)
Proofreader Polly Zetterberg
Indexer Beverlee Day

DIGITAL PRODUCTION
Digital Programme Manager Miguel Cunha
Senior Manager Lakshmi Rao
Senior Producer Suruchi Kakkar
Assistant Producer Neha Khanna
Production Manager Nain Singh Rawat
Production Coordinator Manish Bhatt

First American Edition, 2022
Published in the United States by DK Publishing
6081 E. 82nd Street, Indianapolis, IN 46250

Published in the United States by Dorling Kindersley Limited.

ISBN: 9780744045710

This digital edition is published in 2022

eISBN: 9780744059496

Library of Congress Catalog Number: 2021944234

For the curious

www.dk.com