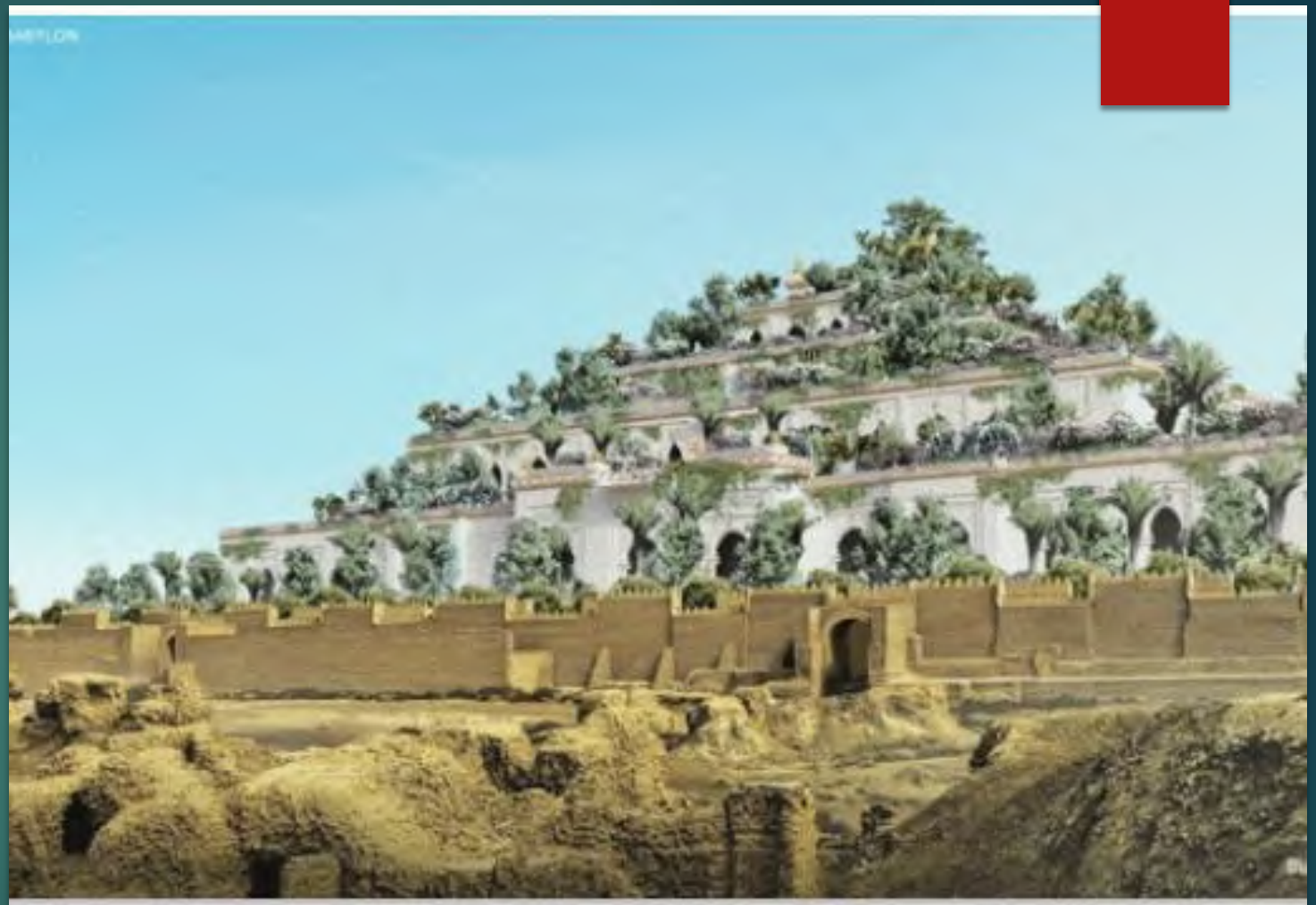
Hydroponic Gardening for the Home Gardener

- **Hydroponic gardening is not a new fad, its history dates as far as back the hanging gardens of Babylon, the Aztecs' floating gardens and recently, hydroponics were given a place within NASA's space program.**



Hanging Gardens of Babylon,
NeoMam Studios (CC BY-SA)

Hydroponic Grow Room on the International Space Station

One of two hydroponic systems installed at Farms & Fields in Owens Food Court at Owens Hall

What is Hydroponic Gardening

The word “hydroponic” comes from two Greek words *hydro* (“water”) and *ponos* (“labor”) meaning working with water.

It is a self-contained method of growing plants, herbs, vegetables, flowers, and fruits.. in nutrient-rich liquid instead of soil and can be scaled to any size.

A plant is suspended with a net pot which allows for the plant to grow above the water, while the roots go down through the netting and into the water solution.

In a hydroponic garden

the roots of the plant have contact with the nutrient solution

the roots get more oxygen since they are not buried in the ground, resulting in promoted growth.

Pros/Cons Of Hydroponic Gardening

PROS

In a hydroponic garden your plants mature up to 25% - 50% faster than in typical soil gardening.


Week 1
Week 3
Week 5

The plants yield up to 4 times more

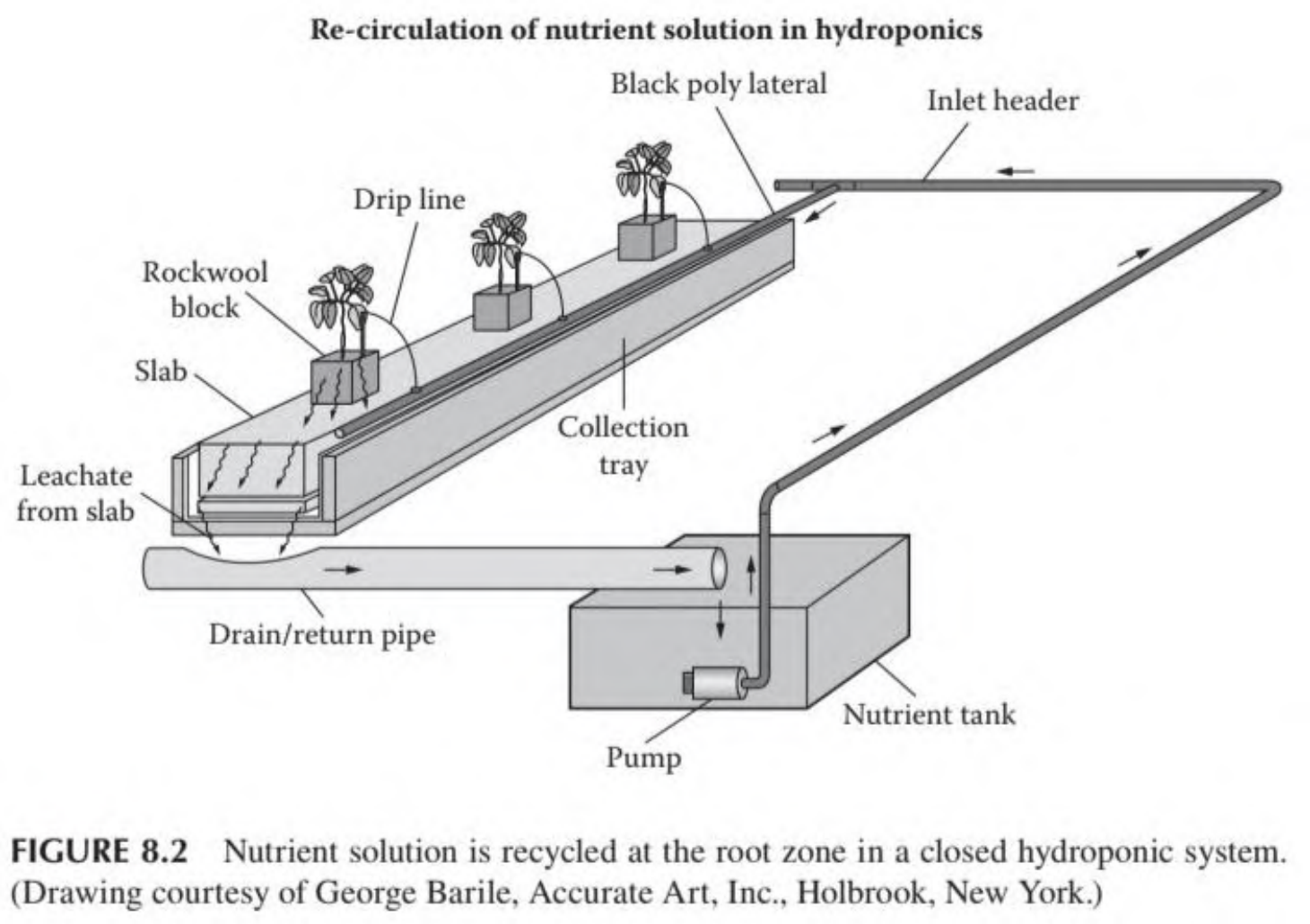


FIGURE 8.2 Nutrient solution is recycled at the root zone in a closed hydroponic system. (Drawing courtesy of George Barile, Accurate Art, Inc., Holbrook, New York.)

Despite the fact that hydro is in the name, hydroponic gardens use only 10% of the water a traditional soil-based garden does.

Fewer Nutrients/Less Fertilizer

Nutrients get directly to the plants roots in a controlled environment so there is no run-off polluting the environment.

An active hydroponic system. A water-based nutrient-rich solution flows over the roots in the grow medium. Photo by sustainableflatbush (flickr)

Promoted root growth

Q&A: Nutrient solution will still feed the root but you will not be able to remove plant from unit without taking it apart

Fewer Enemies

Takes up less space

Environmentally friendly

With no soil, there will be fewer pests and diseases to contend with and most pesticides aren’t necessary

Less Labor

No Weeding

PRO's Summary

You can grow plants anywhere, anytime of the year, regardless of climate.

Hydroponics are considered more sustainable than traditional gardening thanks to the growing system's efficient use of water, higher crop yields, less pesticides and environmentally friendly.

Cons

Requires Knowledge	**A certain amount of knowledge on the various systems is required.**
Safety	**Water and electricity are a dangerous combination. Certain Hydroponic systems need both water and electricity to manage the entire system.**
Electric Failure	**Without emergency provisions, the plants could die in hours.**

Fast Spreading Disease

No soil-based disease but if your system gets a water-based disease, it will spread rapidly to all the plants

Costs

Initial set up of sophisticated systems can be expensive. But over time the costs will even out However, there are many DIY systems that can be made at minimal costs

Algae

Algae can build up and harm the system without proper care

Components of a Hydroponic System

Nutrient-rich solution

is the most important part to the system. It is held in the reservoir gets pumped to the roots, sprayed on the roots or the roots are in direct contact.

Reservoir

The reservoir is the heart of the system, it holds everything your plants need to live: the nutrient solution, the water pump, an air stone or diffuser, and a lid to prevent light and contaminants from getting into the reservoir

Submersible pump

sits directly inside the reservoir and uses fittings and hoses to move water and hydroponic nutrients to the grow tray

Growing Tray

is a container built to hold one or more plants in a hydroponic system. Some are designed to hold hydroponic grow media, and others are built to hold plants in net pots.

Air Pump

Has three components: the air pump, the air stones, and the tubing. The air pump sits outside the nutrient solution reservoir and pumps air through plastic tubing to the air stones at bottom of the reservoir, that diffuse the air into bubbles.

Grow medium

Is the material that plants grow in and provides plant roots exposure to the nutrient solution and oxygen while supporting the plant weight and holding it upright

Growing medium should

Organic-made, biodegradable and environmentally friendly

Keep an even ratio of air to water.

Have the capacity to hold nutrients.

Help protect plants from pH changes over time.

Be inexpensive and easy to find

More Popular grow medium

rockwool
hemp cubes
clay pellets
perlite
vermiculite
rock
coconut core
foam sponge
plugs

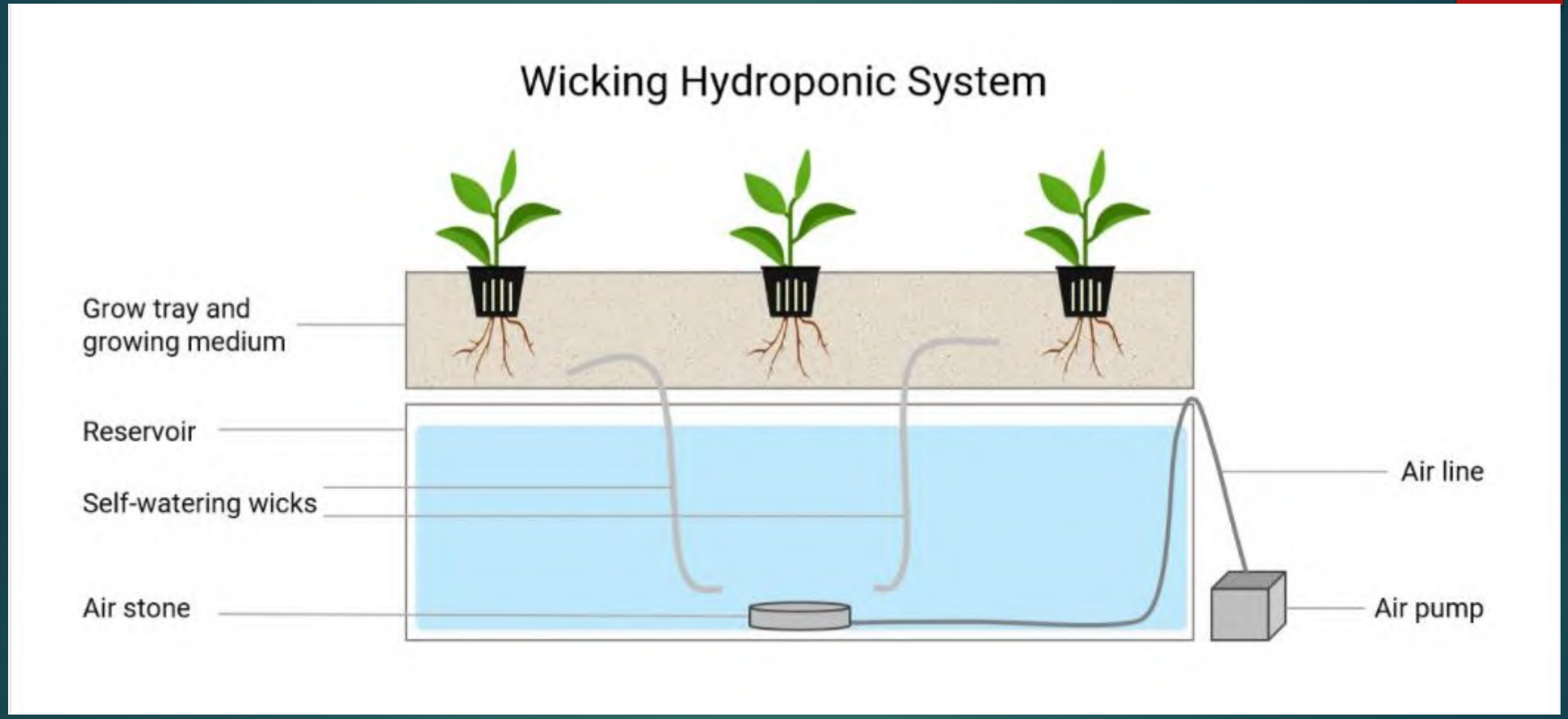
Q&A: Rockwoll not resuable

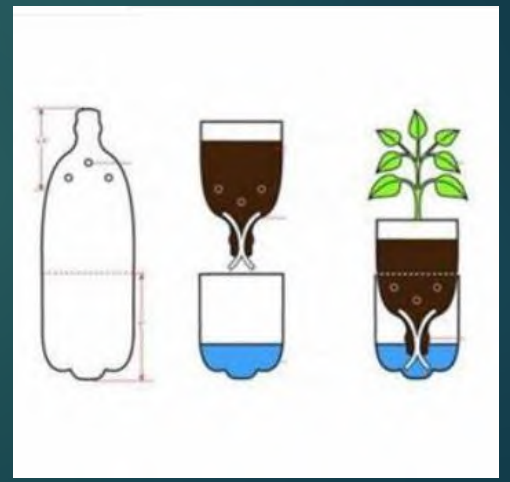
Net Pot

is a growing container with holes in the bottom and sides. The holes allow hydroponic nutrients to flow to the root zone and drain effectively providing aeration.

Q&A: Net Pots
reusable

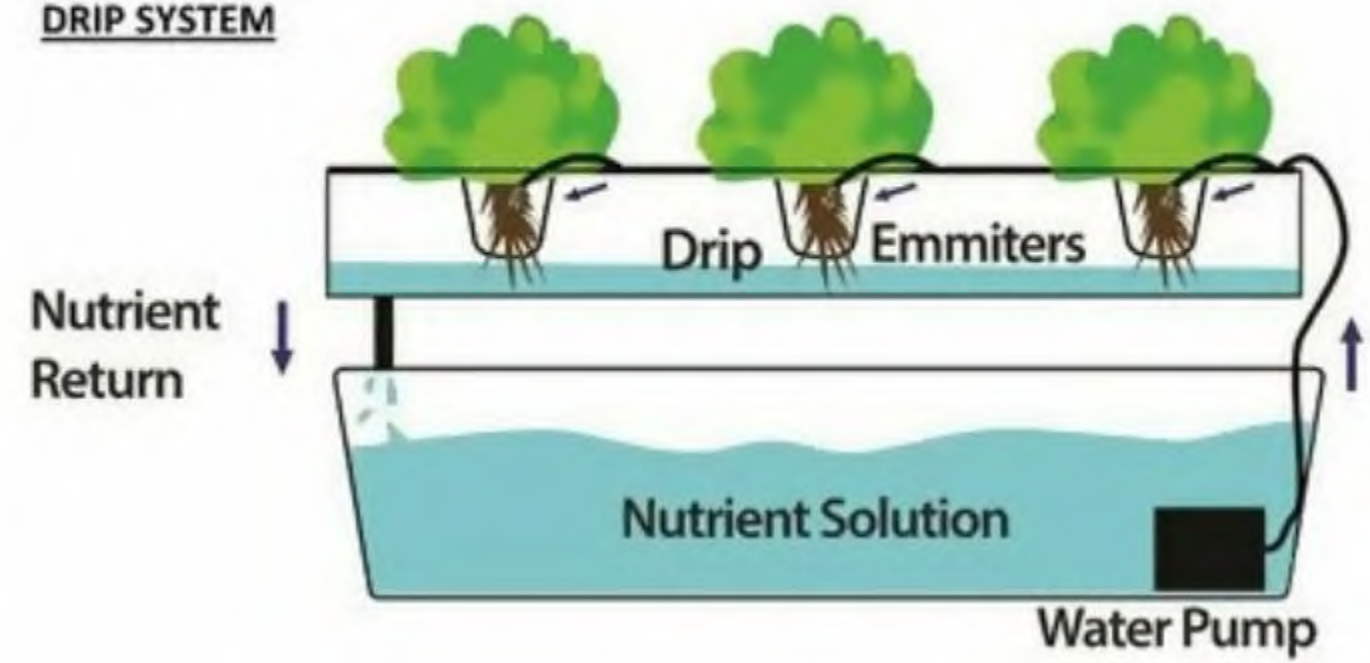
Hydroponic Systems


Wicking Hydroponic System
Grow tray and growing medium
Reservoir
Self-watering wicks
Air stone
Air line
Air pump



Drip System is one of the most popular hydroponic systems. It is basically, water and nutrients, slow-dripped into the growing tray which houses the plant's roots.

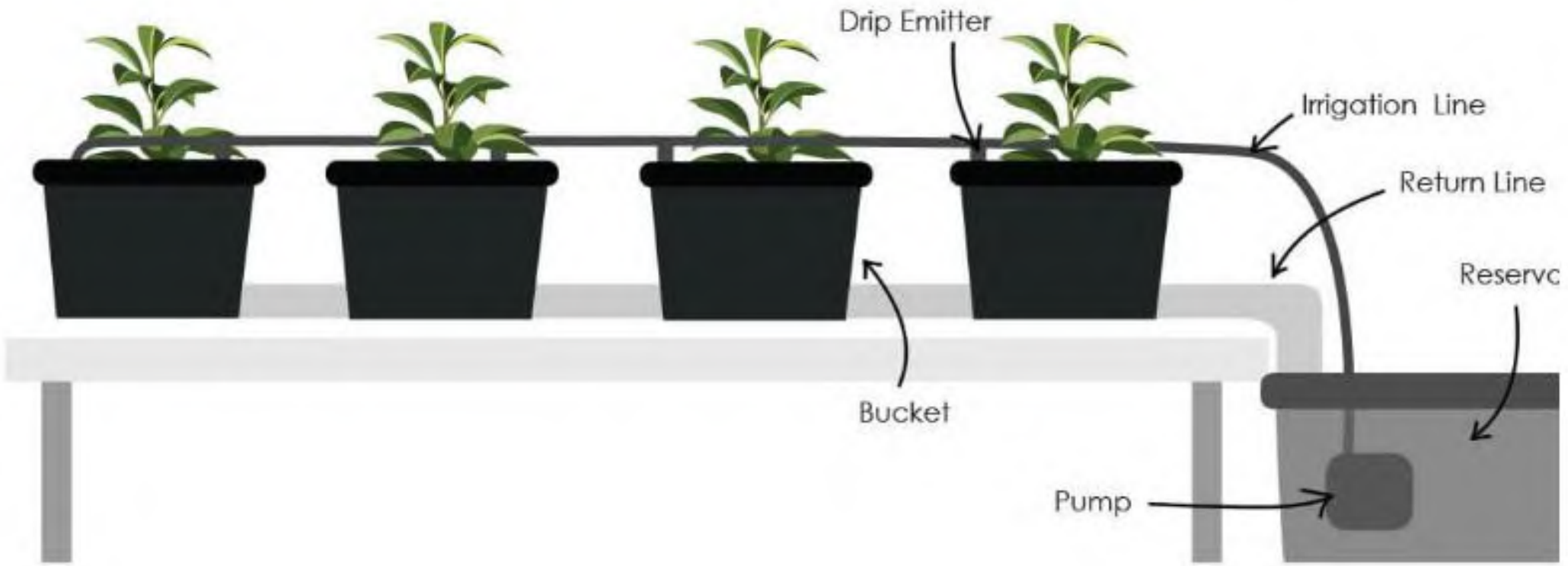
It is important to keep the growing medium damp. It should not be allowed to become either soaked through or completely dry.



HYDROPONICS A Beginner's Guide to Building Your Own Hydroponic Garden By Tom Gordon

Drip Irrigation

Dutch Bucket System



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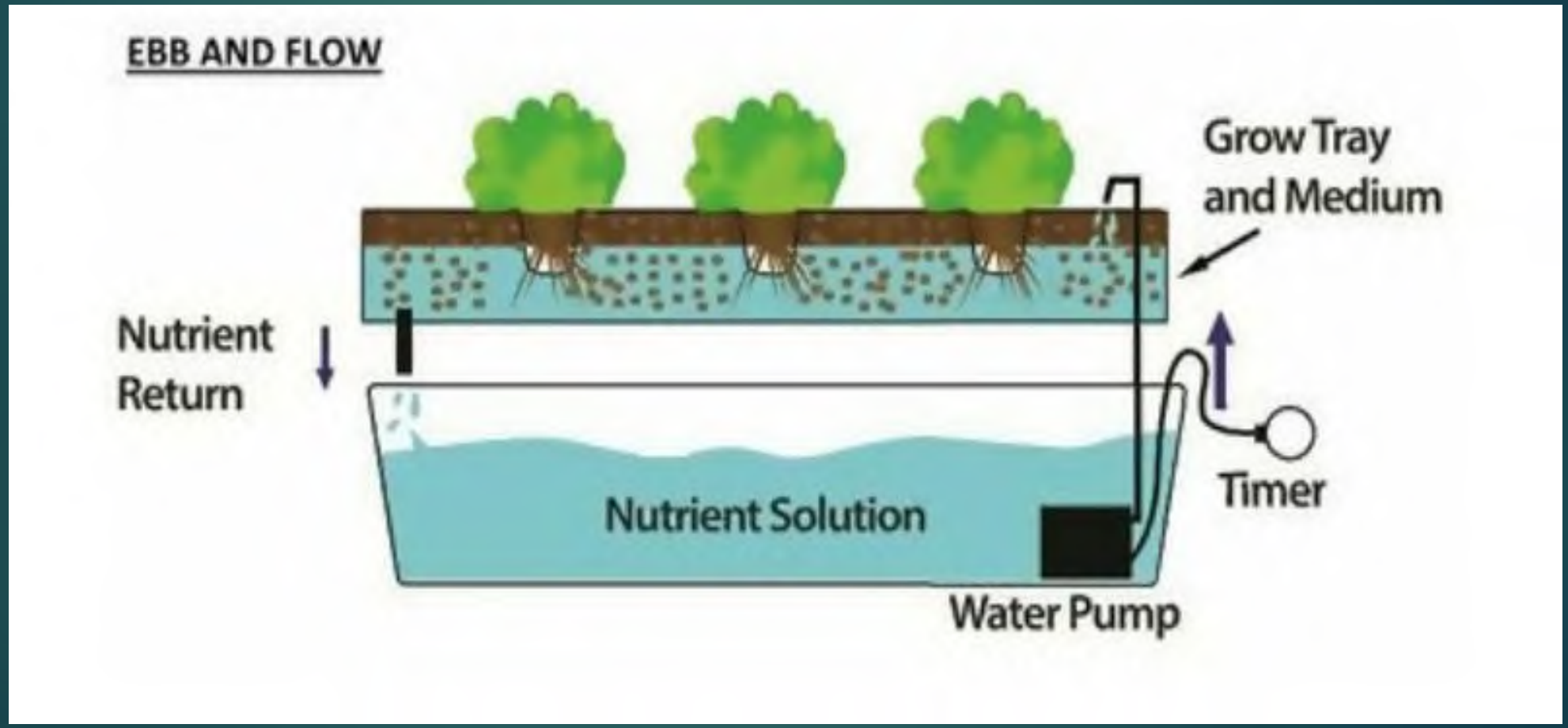
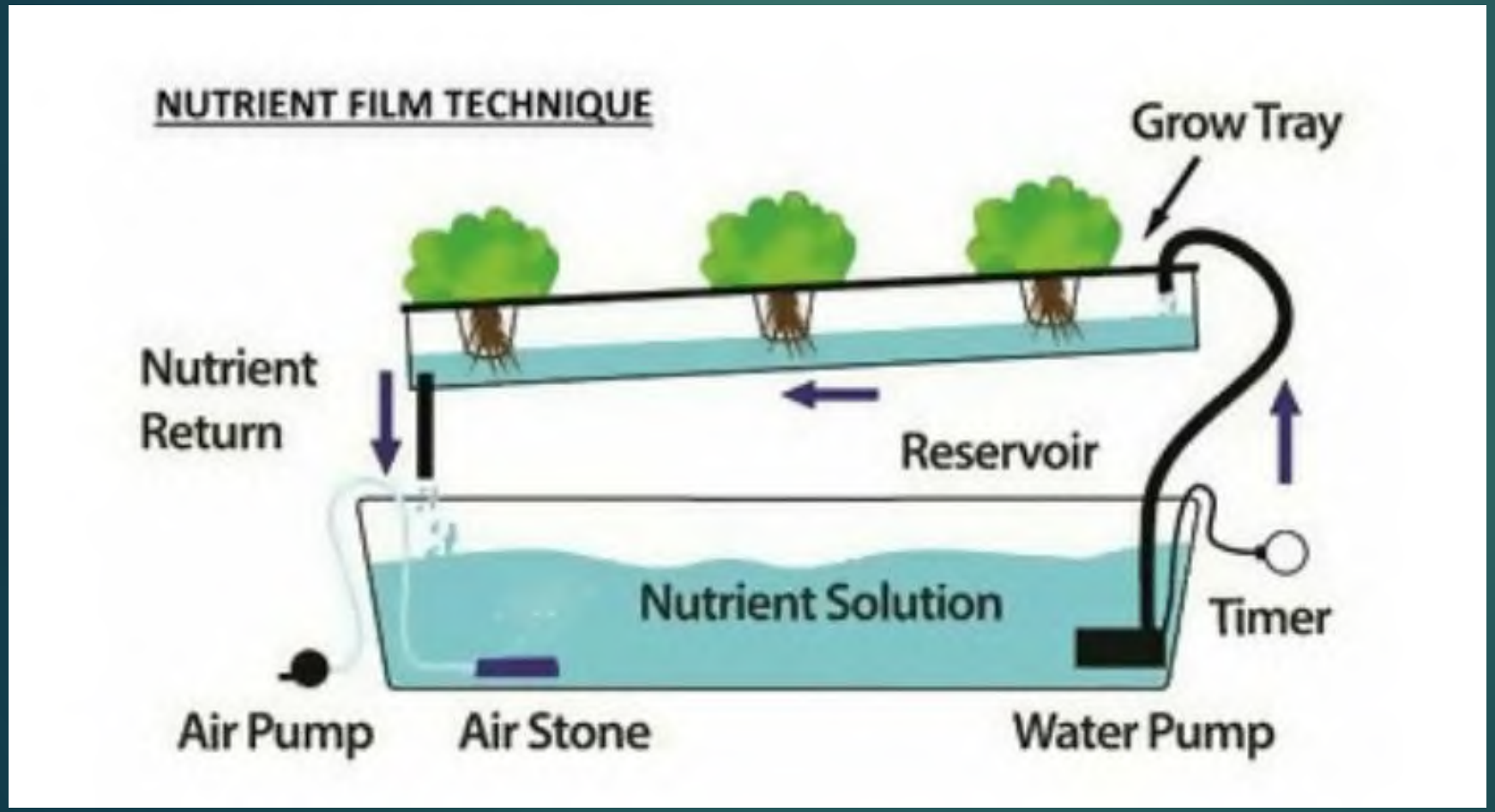
Ebb and Flow

Also known as the Flood and Drain System. Popular with home growers. The medium that contains the roots is flooded at timed intervals.



Nutrient Film Technique

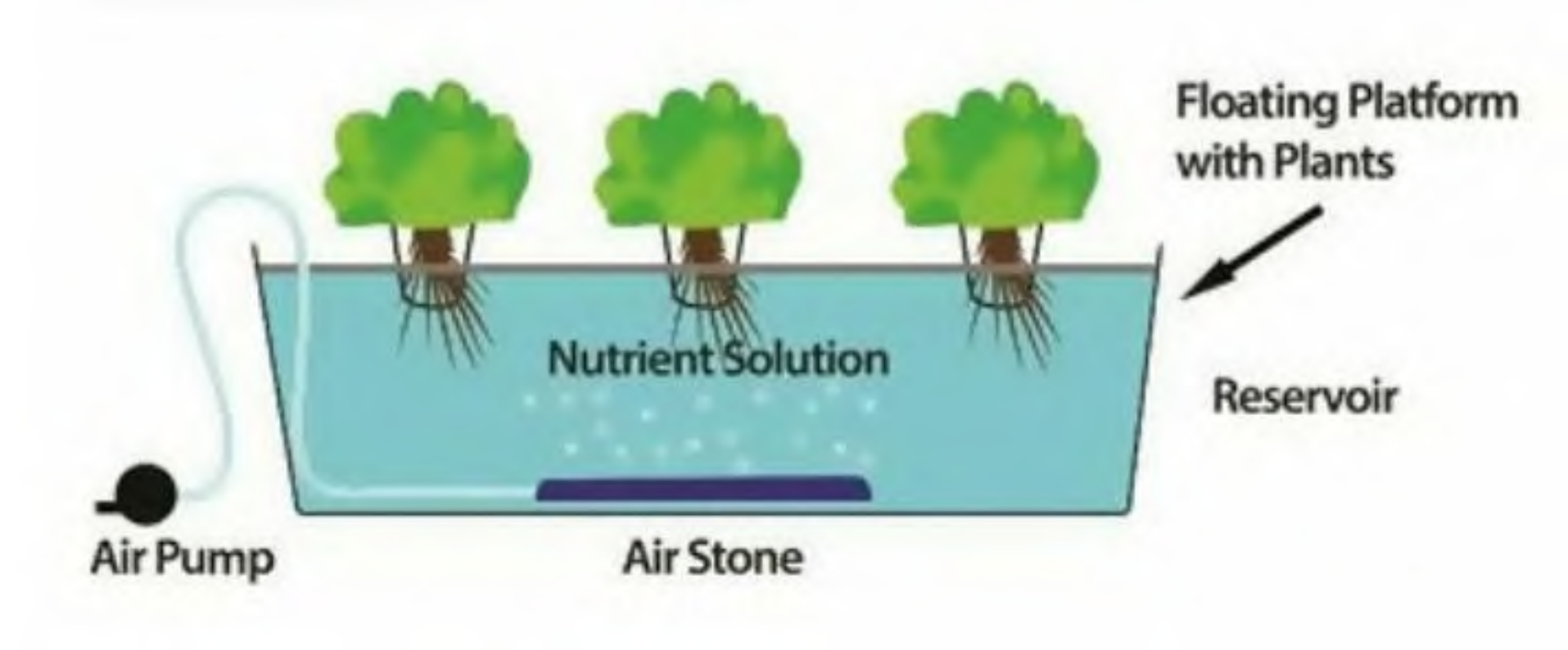
Ideal for small, quick-growing plants. The reservoir tank sits underneath the growing compartments and contains nutrient-enriched water. Plants sit in a basket on the tray with their roots suspended through a hole.




ADD: Algae in clear tube switch to black tube

Water Culture

Popular for commercial farming as it is an inexpensive method for large-scale usage. It is equally as popular with the smaller homesteaders because there are low initial setup costs and it can be as small or large as the available space.



Water System

Floating Gardens

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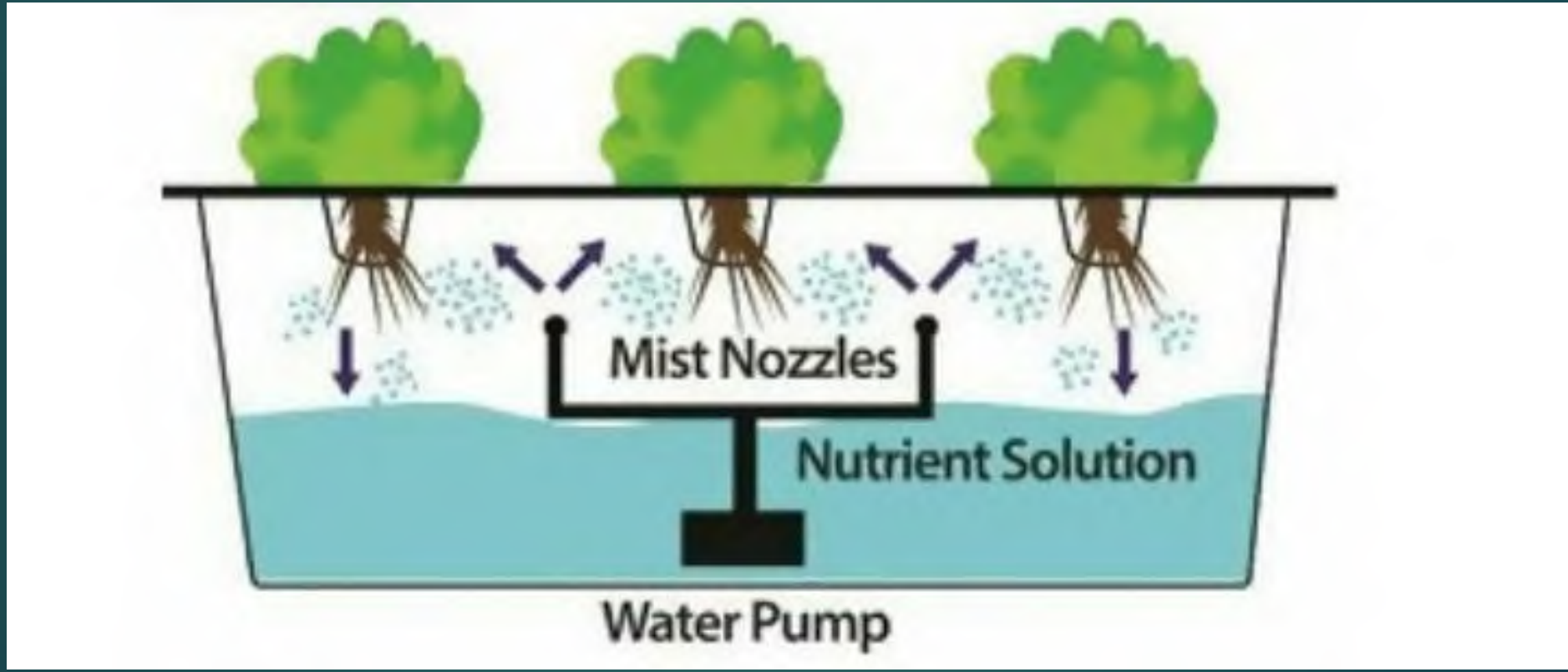
Aeroponics

Is one of the leading hydroponic systems. It's a great method for any indoor gardener.

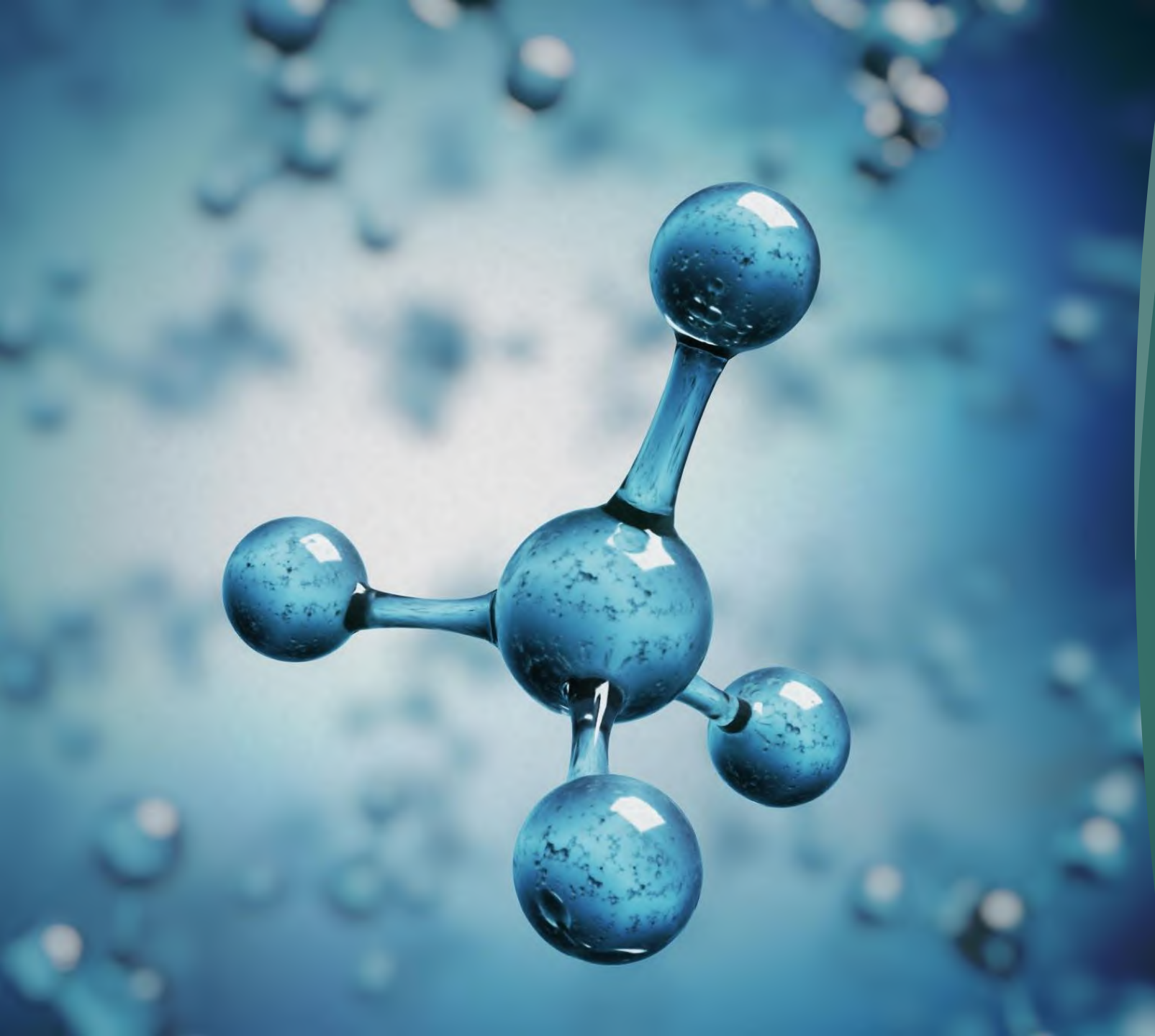


"Aerogarden" kitchen unit. (Courtesy of AeroGrow, Boulder, Colorado.)

Vertical Tower System

pH/Nutrient Solution

This is ultimately the most important part, besides your plants! Without a nutrient solution, you are not going to be able to grow your plants



The hydroponic solution determines the availability of the various minerals/nutrients/ elements to the plant.

pH

The pH is a measure of the acidity or alkalinity.

pH less than seven it is acidic, seven is neutral, and greater than seven is alkaline.

Most plants prefer a pH between 6.0 and 7.0

Specific crops require different optimum pH ranges. Lettuce likes a pH between 5.8 and 6.1, tomatoes, peppers, and cucumbers prefer a pH from 5.5 to 7.5.

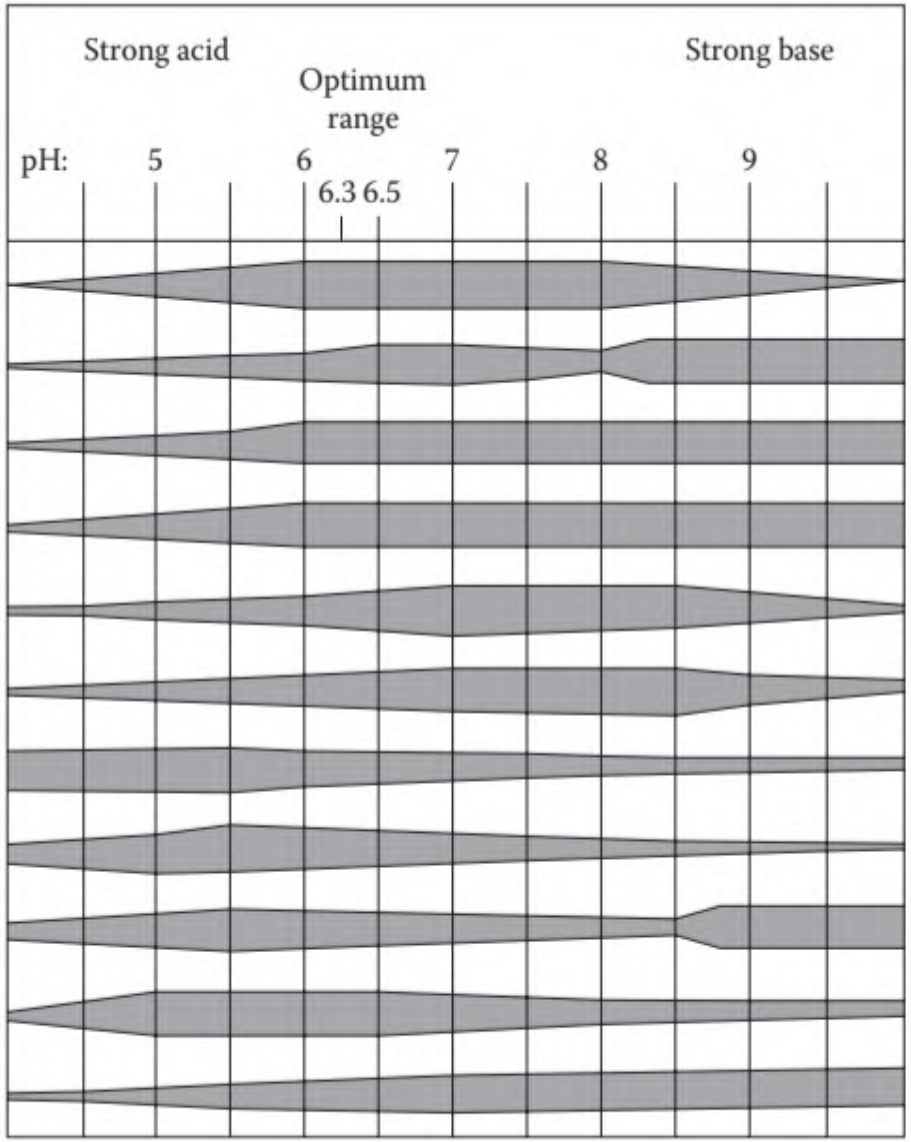


FIGURE 7.1 The effect of pH on the availability of plant nutrient uptake. (Drawing courtesy of George Barile, Accurate Art, Inc., Holbrook, New York.)

Vegetable	Ideal pH	Vegetable	Ideal pH
Artichoke	6.5 – 7.5	Lettuce	6.1 – 7.0
Asparagus	6.0 – 8.0	Mushroom	6.5 – 7.5
Beans	6.1 – 7.5	Mustard	6.0 – 7.5
Beet Root	6.0 – 7.5	Onion	6.0 – 7.0
Broccoli	6.0 – 7.0	Parsnip	5.5 – 7.5
Brussel Sprouts	6.0 – 7.5	Pea	6.0 – 7.5
Cabbage	6.0 – 7.5	Peanut	5.0 – 6.5
Carrot	5.5 – 7.0	Pepper	5.5 – 7.0
Cauliflower	5.5 – 7.5	Potato	4.5 – 6.0
Celery	6.0 – 7.0	Pumpkin	5.5 – 7.5
Chicory	5.0 – 6.5	Radish	6.0 – 7.0
Corn	5.5 – 7.0	Rhubarb	5.5 – 7.0
Cress	6.0 – 7.0	Sweet Patato	5.5 – 6.0
Cucumber	5.5 – 7.5	Shallot	5.5 – 7.0
Garlic	5.5 – 7.5	Soybean	5.5 – 6.5
Horseradish	6.0 – 7.0	Spinach	6.0 – 7.5
Kale	6.0 – 7.5	Tomato	5.5 – 7.5
Kohlrabi	6.0 – 7.5	Turnip	5.5 – 7.0
Leek	6.0 – 8.0	Water Cress	5.0 – 8.0
Lentil	5.5 – 7.0	Watermelon	5.5 – 6.5

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pH Testing


GENERAL HYDROPONICS
pH
Test Indicator
Wide Spectrum
pH 4.0 to 8.5
Super-Concentrated
Just 3-5 drops per test
6.0
6.5
30 ml (1 fl oz)


HYDRION
5.5-8.0
Plastic pH
Indicator Strips
5.5-8.0
100 strips
5.5
5.8
6.0
6.2
6.4
6.6
6.8
7.0
7.2
7.4
7.6
8.0


POOL & SPA WATER CHEMISTRY
taylor
K-2005
Complete (high)
taylor

pH adjustments

Buy pH up (potassium hydroxide) and pH down (nitric or phosphoric acid) rather than making your own from concentrated acids. Commercial mixes are buffered and safe to use.

Nutrients/Minerals

Minerals that are required for plant growth and development are termed "Primary" which include carbon (C), hydrogen (H), and oxygen (O)

TABLE 1: Form, source, mode of uptake and major functions of the 16 plant essential nutrients.

Nutrient family	Nutrient	Percentage of plant	Form taken up by plants (ion)	Mode of uptake	Major functions in plants
Primary	Carbon	45	Carbon dioxide (CO_2), bicarbonate (HCO_3^-)	Open somates	Plant structures
	Oxygen	45	Water (H_2O)	Mass flow	Respiration, energy production, plant structures
	Hydrogen	6.0	Water (H_2O)	Mass flow	pH regulation, water retention, synthesis of carbohydrates

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The "secondary" (macro or major) elements that come from the nutrient solution include nitrogen (N), phosphorus(P), potassium(K), sulfur (S), calcium (Ca), and magnesium (Mg).

TABLE 1: Form, source, mode of uptake and major functions of the 16 plant essential nutrients.

Nutrient	Nutrient	Percentage	Form taken up	Mode of uptake	Major functions in plants
	Nitrogen	1.75	Nitrate (NO_3^-), ammonium (NH_4^+)	Mass flow	Protein/amino acids, chlorophyll, cell formation
	Phosphorus	0.25	Dihydrogen phosphate ($H_2PO_4^-$, HPO_4^{2-}), phosphate (PO_4^{3-})	Root interception	Cell formation, protein syntheses, fat and carbohydrate metabolism
	Potassium	1.5	Potassium ion (K+)	Mass flow	Water regulation, enzyme activity
Secondary	Calcium	0.50	Calcium ion (Ca^{2+})	Mass flow	Root permeability, enzyme acitivity
	Magnesium	0.20	Magnesium ion (Mg^{2+})	Mass flow	Chlorophyll, fat formation and metabolism
	Sulfur	0.03	Sulfate (SO_4^{2-})	Mass flow	Protein, amino acid, vitamin and oil formation

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Other elements needed in very small amounts are termed "micro-", (minor, or trace) elements.
Which include iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B), molybdenum (Mo), and chlorine (Cl).

TABLE 1: Form, source, mode of uptake and major functions of the 16 plant essential nutrients.

Nutrient family	Nutrient	Percentage of plant	Form taken up by plants (ion)	Mode of uptake	Major functions in plants
Micro	Chlorine	0.01	Chloride (Cl^-)	Root interception	Chlorophyll formation, enzyme activity, cellular development
	Iron	0.01	Iron ion (Fe^{2+}, Fe^{3+})	Root interception	Enzyme development and activity
	Zinc	0.002	Zinc ion (Zn^{2+})	Root interception	Enzyme activity
	Manganese	0.005	Manganese ion (Mn^{2+})	Root interception	Enzyme activity and pigmentation
	Boron	0.0001	Boric acid (H_3BO_3), borate (BO_3^{3-}), tetraborate (B_4O_7)	Root interception	Enzyme activity
	Copper	0.0001	Copper ion (Cu^{2+})	Mass flow	Enzyme activity
	Molybdenum	0.00001	Molybdenum ions ($HMoO^{4-}$, MoO_4^{2-})	Mass flow	Enzyme activity and nitrogen fixation in legumes

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Nutrient mixes are available as liquid or granules.

Either one works, so it's a matter of personal preference and what works best by your particular system.

Liquid fertilizers are easy to use.

You just pour it into the water reservoir as per bottle instructions.

The downside to using liquid fertilizer is that it is more expensive and bulkier to store.


HUMBOLDTS SECR
GROW & BLOOM
BASE B
World's Best Base Nutrient Syste
1-4-2
HUMBOLDTS SECRET
GROW & BLOOM
BASE A
World's Best Base Nutrient System
4-0-1


TOWER
GARDEN
MINERAL BLEND
A
2-0-0
TOWER
GARDEN
MINERAL BLEND
B
0-1-3
TOWER
GARDEN
BY JUICE PLUS+

Granulated fertilizer is more cost effective, easier to store, and often comes in bulk.
However, it has to be mixed prior to use and it doesn't always dissolve completely.

ADD: Miracle Grow not for Hydroponic missing micro elements (usually found in soil


MASTERBLEND
CELEBRATING 30 YEARS
PREMIUM FERTILIZERS
4-18-38
Tomato & Vegetable Formula
For continuous liquid feed programs
Guaranteed Analysis
Total Nitrogen (N)
3.5% Nitrate Nitrogen
8.5% Ammoniacal Nitrogen
Available Phosphate (P2O5)
Soluble Potash (K2O)
Magnesium (Mg) (Total)
0.50% Water Soluble Magnesium (m
Boron (B)
Copper (Cu)
0.06% Chelated Copper (Cu)
Iron (Fe)
5.40% Chelated Iron (Fe)
Manganese (Mn)
2.00% Chelated Manganese (Mn)
Molybdenum (Mo)
Zinc (Zn)
0.09% Chelated Zinc (Zn)
www.POWERGROWSYSTE
PowerGrow
ORGANICS + AQUAPONICS
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CALCIUM NITRATE
Nitrate Nitrogen
Soluble Calcium as (Ca)
Nutrients derived from: Calcium Nitrate (Hydrated
Calcium Nitrate Double Salt
CAUTION: Keep out of reach of Children
ORDER MORE AT
PowerGrowSystems.com
PowerGrow
AQUAPONICS + ORGANICS
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MAGNESIUM SULFATE
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Nutrient Deficiencies

Symptoms	Deficiency
Entire plant is light green in color; lower leaves are yellow; growth is stunted	Nitrogen
Entire plant is bluish-green, often developing a red or purplish cast; lower leaves may be yellow, drying to a greenish-brown to black color; growth may be stunted	Phosphorous
Leaves have a papery appearance; dead areas along the edges of the leaves; growth is stunted	Potassium
Lower leaves turn yellow along the tips and margin and between the veins; the lower leaves wilt	Magnesium
Young stems and new leaves die	Calcium
Leaf tissue between the veins is lighter in color; yellowed; papery in appearance	Zinc
Leaf tissue appears yellow, while the veins remain green	Iron
Leaf edges appear dark green or blue; leaf edges curl upward; young leaves permanently wilt	Copper
Young leaves turn pale green, while the older leaves remain green; plant is stunted and spindly	Sulfur
Growth is stunted; lower leaves have a checkered pattern of yellow and green	Manganese
Leaves are stunted, pale green, and malformed	Molybdenum
Young leaves are scorched at tips and margins	Boron

Occasionally, the nutrients in a hydroponic system are used up faster than they can be replaced, and the plants will show a nutrient deficiency. A quick fix for most of the deficiencies is to spray the leaves with an all-purpose, foliar fertilizer, although this will not completely solve the problem. The best remedy is to change the nutrient solution every week instead of every two weeks. In some cases, it may be necessary to switch to a different type of hydroponic fertilizer, if the same deficiencies persist. There are several books on hydroponics that give other

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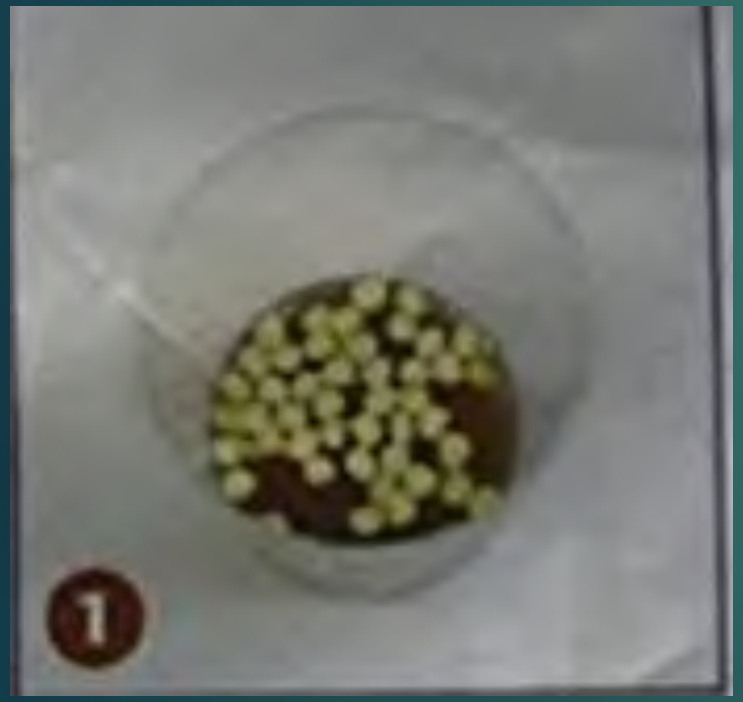
Keep the nutrient solution in the reservoir between 65-75 degrees Fahrenheit.

If the temperature is too low, plants will think the season is ending and will stop growing. You will need a hydroponic water heater which is submersible and heats the nutrient solution to the ideal range

If the temperature rises too high, plants will be unable to hold onto oxygen and growth will slow. In this case a hydroponic water chiller may be necessary. It connects to your water pump and sends cold water into the reservoir.

Seed Starting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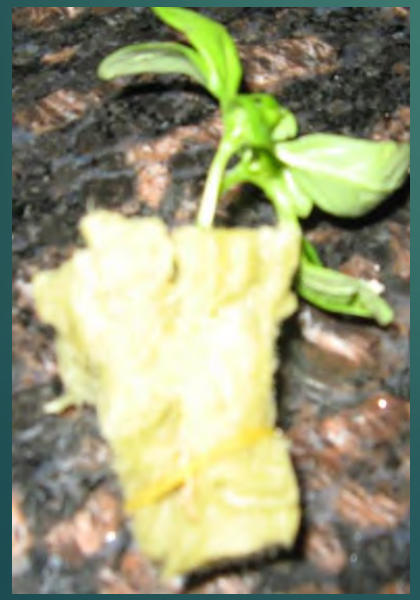
Transfer Soil Seedling to hydroponic net pod



Suggested Reading

Grow More Nutritious Vegetables Without Soil, James D. Taylor, Santa Anna, Calif.: Parkside Press Publishing Co., 1983.

Home Hydroponics...and how to do it!, Lem Jones, New York, N.Y.: Crown Publishers, Inc., 1977.

Hydroponic Food Production, 4th ed., Dr. Howard Resh, Santa Barbara, Calif.: Woodbridge Press, 1989.

Hydroponics for the Home Gardener, Stewart Kenyon, Toronto, Ont., Canada: Van Nostrand Reinhold Ltd., 1979.

Reviewed by Suzanne Piovano, Laboratory Specialist, Horticulture

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Q & A