Three Nations ENERGY

Pop Bottle Hydroponics

A DIY PROJECT!

Grow plants easily without soil!

What is Hydroponics?

The word hydroponics comes from the Greek words *hydro*, meaning “water,” and *ponos*, meaning “work.” In hydroponics, no soil is used so the plant’s roots are given nutrients directly (“no work”). As long as the plants are also given warmth, light, support, and access to oxygen and carbon dioxide, they can thrive.

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Material List

- Water *(If you have high mineral content in your tap water, you should use bottled water.)*
- Scissors or utility knife
- Refundable plastic pop bottle (2L works best but smaller ones can be used.)
- Hydroponic nutrient powder like Jiffy Hydro Nutrient 10-5-10
  https://www.homehardware.ca/en/256g-10-5-10-hydroponic-plant-fertilizer/p/5026541
  https://www.canadiantire.ca/en/pdp/jiffy-hydro-hydroponics-nutrients-9-oz-1590287p.html
- Measuring cup
- 1/4 tsp measuring spoon
- Container to mix in (1L or more)
- Coconut **coir** *(see side bar info)*
- Wick - lantern wick or cotton yarn, a strip from an old sock or t-shirt, etc.
- Seeds - leaf lettuce, kale, spinach are the easiest. Or try chives, herbs (basil, mint) and even strawberries.

Watch the video instructions (optional):

https://www.youtube.com/watch?v=87A06gzcZZ0

Step 1

Soak the coconut coir in water for at least 15 minutes before use. Warning - dry coir can absorb 10x its weight in water so it might expand quite a bit.

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Step 2

Cut the top of the plastic bottle off, where the bottle begins to form a cone shape.

Step 3

Flip the top of the bottle upside down and place into bottom section.

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Did You Know?

Coir (pronounced COY-er) comes from coconut husks and is used for rugs, ropes, brushes, and to grow plants.

stock.adobe.com/ca/free

Coir is the middle fibrous coat of a coconut

Coir is very rot-resistant, helps keeps air in the soil, even when wet, and absorbs 30 percent more water than peat moss.

It is ideal for growing plants.

Don’t have Coir?
You can substitute a 1:1 mixture of peat moss and Perlite (or vermiculite). Use clean peat moss so you don’t grow unwanted mold.

Step 4

Measure the wick so that it will reach from the plant to the bottom of the bottle. You may need to leave enough length to tie a knot to prevent it from falling through.

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Step 5

Wrap the wick with enough paper towel to plug just the spout and stuff it in.

Step 6

Place coconut coir into the top cone of the bottle.

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Step 7

While wearing gloves, read the back of the nutrient package and measure out the water into a container. Add the correct amount of powdered nutrient and mix.

For JIFFY Hydro Nutrient 10-5-10:

Mix 4 cups of water with 1/4 teaspoon of nutrient powder.

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Step 8

Pour nutrient mixture into the bottom of your bottle, until the wick is half covered. Keep any leftover nutrient mixture in a cool dark place for future use.

Step 9

Plant 2 or 3 seeds. (Not all seeds will sprout so you need to plant extra.)

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Maintenance

- **Warmth** is more important than light when sprouting seeds but once they do, keep them in a sun lit area.
- For the first couple of days, check daily to make sure the **area around the seed is moist**. Add a little water if needed. As the plant grows, its roots will extend deeper and get better access to the nutrients sucked up by the wick.
- The nutrients may settle so you may need to **stir the nutrient solution twice a day**. Mixing air into the liquid is also helpful.
- **Top up the nutrient** water solution as needed but be sure to replace it **totally every two weeks**. (Evaporation can make the solution too strong and replacing it reduces the risk of algae/ bacteria growth.)

Did You Know?

What's in that powder used to feed the plants? Look at the back of the package:

Macro-nutrients:

- nitrogen 10%
- phosphate 5%
- potassium (potash) 10%

There is also trace amounts of the following **micro-nutrients**:

- calcium
- magnesium
- sulfur
- boron
- copper
- iron
- manganese
- molybdenum
- zinc

These are needed for plant growth but the coir does not supply them.

Hydroponic systems can be either <u>active</u> or <u>passive</u>.

Active means that nutrient solutions will be moved, usually by a pump. Large commercial hydroponic farms use this type.

Passive relies on some kind of a wick to naturally pull the water to the roots. This is why it is also called a wick watering system.

CHALLENGE!

What could you do to modify your set-up to be more like an active hydroponics system?

- This garden is designed for only one plant – so you'll need to **clip off the weakest** looking seedlings with a pair of scissors, leaving only the healthiest.
- If you are growing spinach, lettuce, or basil, harvest the outer leaves and leave the smaller, less developed leaves to grow. You can keep harvesting over and over for at least a month using this method!
- Since the coconut coir is not providing nutrients like soil does, you can wash and reuse it up to 4 times.

Extra - How pH affects plants

A pH reading is a measurement of how acidic or basic (alkali) a solution is. The pH ranges from 0 (most acidic) to 14 (most basic). A pH of 7.0. in neutral (not acidic or basic). To give you an idea, lemon juice has a pH of about 2.0, drinking water ranges from 6.5 to 8.0, and household ammonia has a pH of 11.

When the pH is too low, plants start absorbing too many micronutrients. When the pH is too high, plant cannot absorb enough micronutrients. Either of these conditions cause the plants to be unhealthy. Hydroponic growers often test pH regularly and add chemicals to adjust this. Most plants like a pH of 6.5

Troubleshooting

If your plants do not do well, that is also an important observation. Troubleshoot the problem. Did you miss an instruction? Does the design or instructions need to be improved?

Check the Internet for help, like:

https://smartgardenguide.com/problems-with-hydroponics/

Extra Resources

3NE Hydroponics 101 Fact Sheet
https://www.3ne.ca/wp-content/uploads/2020/10/Hydroponics-101-Fact-Sheet-e.pdf

5 Ways to Start Hydroponic Gardening - The Spruce
https://www.thespruce.com/beginners-guide-to-hydroponics-1939215

Hydroponic Lettuce - University of Saskatchewan
https://gardening.usask.ca/article-lists/articles-growing-information/hydroponic-lettuce.php

Small-scale hydroponics - University of Minnesota
https://extension.umn.edu/how/small-scale-hydroponics#growing-systems-2644460

Hydroponics systems - Hydroponic Urban Gardening
https://www.hydroponic-urban-gardening.com/hydroponics-guide/various-hydroponics-systems/

Video: Hydroponic farming looks to offer food stability across Canada - CBC
https://www.youtube.com/watch?v=GjCDQgjRcMo

Did You Know?

To discourage algae growth, wrap aluminum foil, dark plastic, or paper around the setup to block light from the water and roots.

What is Aquaculture?

Video - Ontario food bank harvesting fresh fish and greens indoors - Canadian Press
https://www.youtube.com/watch?v=Phek-1qpqoGo

CHALLENGE!

Share your photo records with other people doing this activity. Compare what worked and what didn't. Networking can help everyone learn more.

Why Use Hydroponics?

- Hydroponics is done indoors so weather and climate are not an issue. Growing seasons are extended.
- Hydroponics allows food to be grown in areas not traditionally used for farming. Soil is a limited resource.
- Plants grow faster in hydroponic gardens because they don't expend energy growing extensive root systems to find nutrients. That energy can go into growth and fruit and flower production.
- Hydroponics recycles and conserves water so it uses less water than traditional farming.

The world population is growing and technological advancements such as hydroponics can help with this problem.

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thegrowcer.ca

This is an **active** hydroponics system (called a nutrient film technique system or NFT), like the one in the ACFN Growcer Unit in Fort Chipewyan.

Observation Sheet

Learning involves good observation.

Pro Tip - *Use a smart phone or camera to record your information. Be sure to use good lighting. Place a ruler next to your plant to show the actual size when taking each photo.*

DATE (yyyy/mm/dd)	**OBSERVATION** - Record ALL observations - plant condition, nutrient addition/ changes, insects, mold, etc.	**HEIGHT (cm)**
	When were the seeds planted?	
	When did the first sprouts appear?	
	When did the second set of leaves develop?	
	week 1	
	week 2	
	week 3	
	week 4	
	week 5	
	week 6	
	week 7	

QUESTIONS

1. Explain what “hydroponics” means.

_____

_____

2. Plants need nutrients to grow and what else?

_____

_____

_____

3. What do the prefixes micro- and macro- mean? (Look this up.)

_____

_____

4. Where does coir come from?

_____

5. Name 3 reasons coir is used for growing plants.

_____

_____

_____

6. List the three macro-nutrients needed by plants.

_____

7. Mark which of the following is NOT a micro-nutrient needed by the **roots** of plants (look for 3):

☐ calcium	☐ copper	☐ fluoride
☐ magnesium	☐ iron	☐ molybdenum
☐ sulfur	☐ lead	☐ zinc
☐ boron	☐ manganese	☐ lithium

8. Name two reasons for using hydroponics?

_____

_____

_____

Fill In The Blanks

9. When sprouting seeds, _____ is more important than light.

10. It is important that the area around the seed is kept _____ for the first couple of days.

11. _____ the nutrient solution _____ a day to keep the nutrients from settling.

12. Replace nutrient water solution totally every _____. to avoid the risk of _____growth.

13. Discourage algae growth in the nutrient solution by wrapping the bottle in _____.

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TEACHER RESOURCES

ANSWER KEY (Out of 33 points)

1. Explain what “hydroponics” means. 4

In hydroponics, no soil is used so the plant’s roots are given nutrients directly (“no work”)

2. Plant need nutrients to grow and what else? 5

-warmth, light, support, and access to oxygen and carbon dioxide

3. What do the prefixes micro- and macro- mean? 2 (Look this up.)

Macro - large

Micro - very small

(The terms are near opposites of one another.)

4. Where does coir come from? 2

Coir comes from the middle (fibrous) coat of a coconut

5. Name 3 reasons coir is used for growing plants. 3

-is very rot-resistant

- helps keeps air in the soil

-absorbs a lot of water (30% more than peat moss)

6. List the three macro-nutrients needed by plants. 3

- nitrogen
- phosphate
- potassium (or potash)

7. Mark which of the following is NOT a micro-nutrient needed by the **roots** of plants (look for 3): 3

☐ calcium	☐ copper	☒ fluoride
☐ magnesium	☐ iron	☐ molybdenum
☐ sulfur	☒ lead	☐ zinc
☐ boron	☐ manganese	☒ lithium

8. Name two reasons for using hydroponics? 4

weather is not an issue / food can be grown anywhere / plants grow faster / it uses less water / more food is needed.

Fill In The Blanks 7

9. When sprouting seeds, **warmth** is more important than light.

10. It is important that the area around the seed is kept **moist** for the first couple of days.

11. **Stir/mix** the nutrient solution **twice** a day to keep the nutrients from settling.

12. Replace nutrient water solution totally every **two weeks** to avoid the risk of **algae/bacteria** growth.

13. Discourage algae growth in the nutrient solution by wrapping the bottle in **aluminum foil**.

More Challenges

Set up experiments to test any of the following

Remember to state a hypothesis, plan your procedures, include a control and take good records of your observations.

- Rate of plant growth in nutrient rich solutions versus nutrient poor solutions in a hydroponic system.
  - Hint: seed plants in identical hydroponics containers. Give half of the plants nutrient enriched water and the other half pure water.
- Effect of acidity of the water on plant growth. T
  - Hint: plant seeds in identical hydroponics containers. Give all plants nutrient rich water. Make the water in the reservoir acidic (pH = 5 or lower) for a third of the plants, basic (pH = 9 or higher) for another third, and neutral (pH = 7) for the last third.
- Rate of plant growth in traditional (nutrient rich) soil versus a hydroponics system.
- Can you give plants too many nutrients?

Alberta Curriculum Connections

7	Science	Unit A: Interactions and Ecosystems	- Illustrate how life-supporting environments meet the needs of living things for nutrients, energy sources, moisture, suitable habitat, and exchange of gases
		Unit B: Plants for Food and Fibre	-Investigate plant uses; and identify links among needs, technologies, products and impacts -Investigate life processes and structures of plants, and interpret related characteristics and needs of plants in a local environment -Analyze plant environments, and identify impacts of specific factors and controls - Describe methods used to increase yields, through modifying the environment
8	Science	Topic E: Freshwater and Saltwater Systems	- Recognize that fresh water and salt water contain varying amounts of dissolved materials, particulates and biological components; and interpret information on these component materials - Analyze human impacts on aquatic systems; and identify the roles of science and technology in addressing related questions, problems and issues
		Unit C: Environmental Chemistry	- Investigate and describe, in general terms, the role of different substances in the environment in supporting or harming humans and other living things
9	Science	Unit C: Cycling of Matter in Living Systems	- Analyze plants as an example of a multicellular organism with specialized structures at the cellular, tissue and system levels
		Unit D: Energy Flow in Global Systems	- Explain the response of humans to impacts on climate change
14	Science	Unit C: Investigating Matter and Energy in the Environment	- Describe the relationship between photosynthesis and cellular respiration in terms of biological energy storage - Identify life functions common to living systems
		Unit D: Investigating Matter and Energy in the Environment	-Assess the impact of modern agricultural technology on the natural pathways of recycling matter -Explain how various factors influence the size of populations -Describe the relationship between land use practices and altering ecosystems
20	Science	Unit D: Changes in Living Systems	General Outcome 3: Students will analyze and describe the adaptation of organisms to their environments, factors limiting natural populations, and evolutionary change in an ecological context.
30	Science	Unit D: Energy and the Environment	General Outcome 1: Students will explain the need for balancing the growth in global energy demands with maintaining a viable biosphere.