FACT SHEET: Hydroponics in Fort Chipewyan

(Advanced)

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What is Hydroponics?

- Hydroponics is growing food without soil.
- We just have to give the plants the same conditions that soil would provide:
  - Water
  - Nutrients, including oxygen
  - Support
  - Good growing environment (temperature)

Why Grow Things Hydroponically?

Advantages

- Plants get what they need more easily so they grow faster.
- Plants need much smaller root systems so more energy goes into leaf and stem growth.
- With smaller roots, you can grow more plants in the same area. You can even stack them up.
- You can grow plants all year round – in cold climates or deserts.
- Hydroponics uses much less water than traditional gardening. (Water is captured and reused.)
- Automated systems make the work easier.

There Are Many Kinds of Hydroponic Systems

Wick Watering

Plants are supplied with a nutrient solution by capillary (wicking) action so no energy or moving parts are needed.

Ebb and Flood Systems

This uses a pump on a timer to repeatedly flood the plant roots with the nutrient solution.

Nutrient Film Technique NTF

A pump transports a nutrient solution on an inclined plane (in a tube), on which the plant roots lie. The roots are continuously watered in a thin “film” of nutrients.

Deep Water Culture DWC -

Well-rooted plants are placed in a net pot on a floating plate in the liquid reservoir, like a raft.

Drip Irrigation

Via a drip line, the nutrient solution is dripped onto the substrate around the plants.

Aeroponics

The roots of cuttings or plants do not hang in a liquid but in a mist of nutrient solution.

Aquaponics

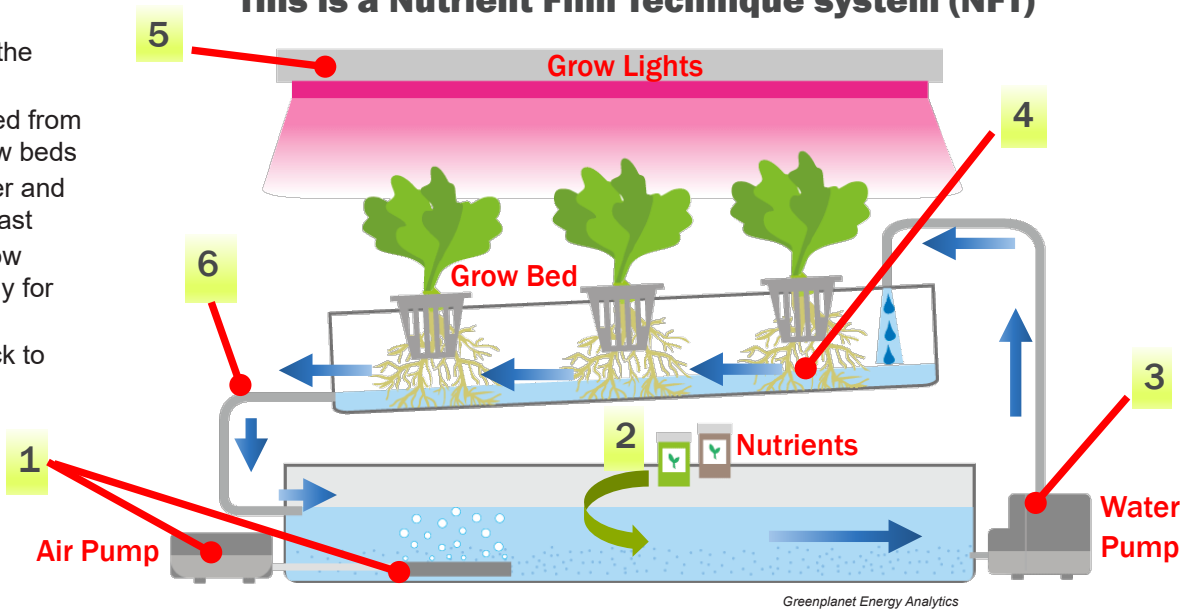
Combines aquaculture (fish farming) and hydroponics (plant breeding), so the water with fish excrements are used as nutrients for the plants.

How do hydroponic systems work?

1. Oxygen is added to the water with an air pump
2. Nutrients are added to the reservoir
3. Nutrient water is pumped from the reservoir to the grow beds
4. Plant roots absorb water and nutrients as they flow past
5. High efficiency LED grow lights provide the energy for growth
6. Water is gravity fed back to the reservoir

This is the type of system used in the Fort Chipewyan Growcer Unit

This is a Nutrient Film Technique system (NFT)



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What Can be Grown?

- Many kinds of plants can be grown hydroponically.
- Different systems have different capabilities.
  - Nutrient Film Technique Systems, for example, are most often used for growing leafy greens and herbs.
- Plants that do well in a hydroponic garden can include artichokes, beans, lettuce, spinach, tomatoes, cabbage, celery, beets, asparagus, broccoli, cauliflower, brussel sprouts, green beans, peppers, English cucumbers, marrows, peas, strawberries, blueberries and herbs
- Vegetables that grow beneath the soil, such as onions, leeks, carrots, parsnips, potatoes, yams and radishes will also grow hydroponically, but may require extra care.
- Some crops to avoid are corn, zucchini, summer squash, and vining plants. They can be grown in a hydroponic garden, but they are not space efficient and just not practical.

Grow Lights

commons.wikimedia.org

Getting the Light Right

- Plants need light to survive
- They use light in photosynthesis to create the energy needed for growth and survival.
- In nature this light comes from the sun.
- Regular indoor lights don't have the correct type of light "spectrum" that plants need.
- Special LED growlights are usually used to provide the best wavelength of light so they are the most efficient.

Advantages of LED Growlights

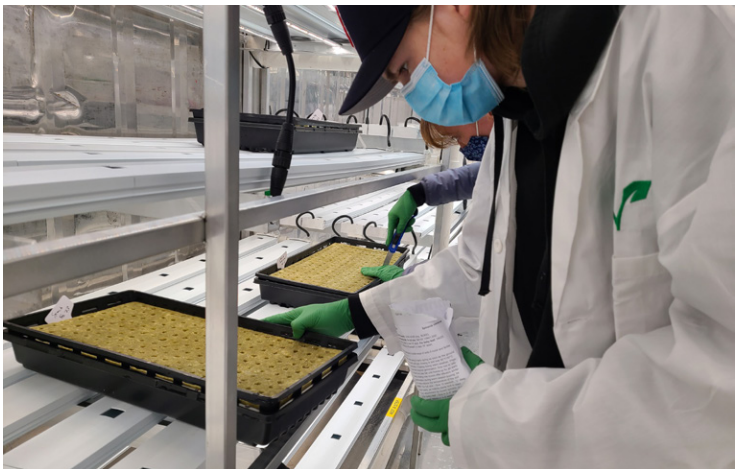
- LED's use less electricity. Grow lights use the most efficient wavelength so less power is needed.
- They also burn with less heat so they can be placed closer to plants for maximum benefit.
- LED's last longer.
- LED's can be set up to provide different color light as needed.
- Light timers can be used: lights on for up to 16h per day.

Plant Nutrients

It is important to ensure the plants receive all of the nutrients they need for healthy growth. These are often available in pre-mixed powders that can be added to the water.

There are two basic kinds:

- Macro Nutrients – those needed in large amounts
  - From the Environment - Carbon, Hydrogen, Oxygen
  - From Fertilizer - Primary
    - Nitrogen - for vegetative leafy growth
    - Phosphorous - for root & flower formation
    - Potassium - for fruit development
  - From Fertilizer - Secondary
    - Calcium, Sulfur, Magnesium
- Micro Nutrients – those needed in small amounts
  - From Fertilizer - Iron, Boron, Chlorine, Copper, Manganese, Molybdenum, Nickle, Zinc



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Close Monitoring is the Key

Things that may need to be watched and adjusted in many of the more complex hydroponic systems include:

- EC – electrical conductivity. This measures the amount of plant nutrients in the water.
- pH – "potential of hydrogen" measures the acidity of the water. This is important for plants to absorb nutrients.
- DO – dissolved oxygen. Plants need oxygen to survive
- Temperature – plants need a certain air and water temperature for best growth
- C02 - carbon dioxide – needed for plant growth

Some systems, like Fort Chip's, use a computer to help monitor these and in some cases, automatically adjust them.

Regular Maintenance is Important

The work involved in maintaining a hydroponics unit depends on its complexity. Here are some of the tasks that may be involved if you had a job working in a hydroponics facility:

GROWING

- Starting seeds
- Moving young seedling plants into the growbeds
- Harvesting + packaging + delivery / proper storage

MAINTAINING

- Fill the water reservoir + change out the old water every few weeks
- Ensure correct water flow and remove blockages in the plumbing
- Looking for insect pests + nutrient deficiencies

CLEANING

- Wear proper clothing
- Wash hands
- Inspect and clean pumps, filters, airstones, drip lines
- Clean plumbing fixtures, growbeds (remove algae, unwanted bacteria)
- Sanitize and clean the areas

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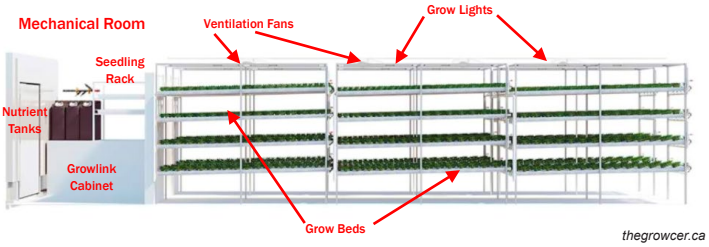
Hydroponics in Fort Chipewyan

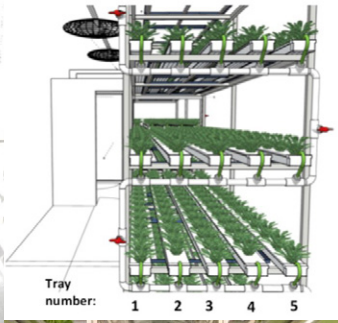
The ACFN project intends to reduce dependence on imported food and increase locally-grown food for the local community.

The first stage of this project was to set up a Growcer's state-of-the-art container farming system.

- It combines hydroponic technology with precision climate controls to enable the community to grow fresh produce year-round.
- This system is housed in a "Sea-Can" self-contained unit designed by the Growcer company and uses a Nutrient Film Technique.
- Fort Chipewyan has the first Growcer unit connected directly to a food market.



thegrowcer.ca



thegrowcer.ca

For More Information

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

How Hydroponics Works - How Stuff Works
https://home.howstuffworks.com/lawn-garden/professional-landscaping/hydroponics.htm

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

Video - Hydroponics: The Science of Growing Plants without Soil - Labroots
https://www.labroots.com/trending/videos/10250/hydroponics-science-growing-plants-without-soil

Video - The Science Behind Vertical Farming - Labroots
https://www.labroots.com/trending/chemistry-and-physics/12038/science-vertical-farming

CBC, March 28, 2020. *nasa.gov*

Astronauts can now grow their own lettuce on the International Space Station, and scientists say it's as healthy as the kind grown here on Earth.

Astronaut meals typically consist of dehydrated, pre-packaged foods, but those have been shown to lose nutrients over time. Since NASA is planning long duration space flights to Mars and the lunar south pole, scientists at the Kennedy Space Center have been trying to figure out how to feed the astronauts involved.

This lettuce is the first food grown, harvested, and eaten in space. Just as nutritious, and delicious.

The first crop of red leaf lettuce was grown on the International Space Station between 2014 and 2016.

The growing system, known as Veggie, involves vacuum-sealed seeds, pre-planted in a pillow filled with ceramic soil and fertilizer. When the astronauts were ready to start growing the lettuce, they put the pillow on a special root mat on top of a plate, bungee-cord it all down, and inject water inside. The root mat has wicks which are designed to deliver the water carefully to the plant to counteract the challenges of microgravity.

The team started with red leaf lettuce because it's a palatable crop that's relatively easy to grow. But since then, astronauts have grown different leafy greens and even flowers.

Salads in Space: CBC article with video clip

Leafy Greens Grown on Space Station - NASA article with video

QUESTION SHEET: Hydroponics in Fort Chipewyan

(Advanced)

Fill in the Blanks (17 points)

1. _____ is growing food without soil.
2. Hydroponics uses much _____ water than traditional gardening.
3. In order to grow without soil, plants are given water, _____ and _____ as well as a good growing environment.
4. Using hydroponics means plants need much smaller _____so more energy goes into leaf and stem growth.
5. The advantage of hydroponics in cold climates is that you can _____.
6. The Fort Chipewyan hydroponics unit uses a _____ _____ system. The best plants to grow in this system are _____ _____.
7. Plants use light in _____ to create the energy needed for growth and survival.
8. Regular indoor lights don't have the correct type of _____ that plants need.
9. Macro Nutrients are those needed _____
10. Nutrients that plants get from the environment include (3) _____, _____, _____.
11. The main or primary nutrients from fertilizer include (3) _____, _____, _____.

Planting seeds in Fort Chipewyan hydroponics farm.

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Short Answer (10 points total)

1. Briefly describe what each of the primary nutrients in fertilizers does for the plants. (2 points each)

2. Name AND describe TWO things that may need to be watched and adjusted in a hydroponics farm. (2 points each)

Matching (7 points)

___ 1. Live fish are raised in a tank and the “fertilized” water they produce is used to grow plants.

___ 2. Uses material that soaks up nutrient solution so no energy or moving parts are needed

___ 3. Plant are on a tilted shelf and a pump bathes the roots continuously with a light layer of nutrients.

___ 4. A large tub of nutrient solution has plants in net pots floating on the surface.

___ 5. Plant roots are repeatedly covered with nutrient solution using a pump on a timer.

___ 6. Nutrient solution is supplied a drop at a time around the plants.

___ 7. Plants hang in the air and are covered with a mist of nutrient solution.

a. Wick Watering

b. Aeroponics

c. Ebb and Flood Systems

d. Aquaponics

e. Drip Irrigation

f. Deep Water Culture

g. Nutrient Film Technique

Eating "home-grown" lettuce aboard the International Space Station
NASA

Short Answer (16 points total)

1. Describe one task from each category that you might do working in a hydroponics farm (1 points each):

   Growing _____

   _____

   Maintaining _____

   _____

   Cleaning _____

   _____

2. Describe TWO differences between the equipment used for hydroponics in Fort Chipewyan and that used by the astronauts on the International Space Station.(2 points ea.)

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3. CHALLENGE: What could be some of the DISADVANTAGES of using hydroponics? Use your imagination and/or check the Internet for ideas. List at least 3 ideas. (3 points each) _____

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ANSWER KEY

Fill in the Blanks (17 points)

1. _____Hydroponics_____ is growing food without soil.
2. Hydroponics uses much ____less_____ water than traditional gardening.
3. In order to grow without soil, plants are given water, ___nutrients____ and ___support___ as well as a good growing environment.
4. Using hydroponics means plants need much smaller ___root system_____so more energy goes into leaf and stem growth.
5. The advantage of hydroponics in cold climates is that you can __grow all year round__.
6. The Fort Chipewyan hydroponics unit uses a __nutrient film___ system. The best plants to grow in this system are ___leafy greens__.
7. Plants use light in __photosynthesis__ to create the energy needed for growth and survival.
8. Regular indoor lights don't have the correct type of __light spectrum___ that plants need.
9. Macro Nutrients are those needed __in large amounts___
10. Nutrients that plants get from the environment include (3) __Carbon__, __Hydrogen__, __Oxygen__.
11. The main or primary nutrients from fertilizer include (3) __Nitrogen__, __Phosphorous__, __Potassium_.

Short Answer (10 points total)

1. Briefly describe what each of the primary nutrients in fertilizers does for the plants. (2 points each)

- Nitrogen - for vegetative leafy growth
- Phosphorous - for root & flower formation
- Potassium - for fruit development

2. Name AND describe TWO things that may need to be watched and adjusted in a hydroponics farm. (2 points each)

- EC – electrical conductivity. This measures the amount of plant nutrients in the water.
- pH – "potential of hydrogen" measures the acidity of the water. This is important for plants to absorb nutrients.
- DO – dissolved oxygen. Plants need oxygen to survive
- Temperature – plants need a certain air and water temperature for best growth
- C02 - carbon dioxide – needed for plant growth

Matching (7 points)

1. d	3. g	5. c	7. b
2. a	4. f	6. e	

Short Answer (16 points total)

Describe one task from each category that you might do working in a hydroponics farm (1 points each):

GROWING
- Starting seeds/move to growbeds
- Harvesting/packaging/delivery/storage

MAINTAINING
- Fill/change water reservoir
- Check water flow/remove blockages in the plumbing
- Check for insect pests/nutrient deficiencies

CLEANING
- Wear proper clothing/ Wash hands
- Inspect and clean equipment/plumbing/areas

12. Describe TWO differences between the equipment used for hydroponics in Fort Chipewyan and that used by the astronauts on the International Space Station.(2 points ea.)

- "Veggie" system
- vacuum-sealed seeds,
- pre-planted in a pillow filled with ceramic soil and fertilizer.
- placed on root mat (with wicks) on top of a plate,
- bungee-cord it all down
- inject water inside.

13. CHALLENGE: What could be some of the DISADVANTAGES of using hydroponics? Use your imagination and/or check the Internet for ideas. List at least 3 ideas. (3 points each)

Answers will vary - great topic for discussion.

- Compared to a traditional garden, a hydroponics system is more expensive to set up.
- A power outage means no pumps so a crop can be lost rather quickly.
- Hydroponics requires constant monitoring and maintenance.
- Waterborne diseases and insect pests can become a problem.
- Problems affect plants quicker in a closed system.
- There is a sharper learning curve.
- Cost of electricity may be high and source may not be environmentally sustainable.

This fact sheet goes well with the Pop Bottle Hydroponics Activity (and Teacher Resource) at:

https://www.3ne.ca/learning-resources/

Three Nations ENERGY

Be sure to visit www.3NE.ca

- Sustainable Food Centre Project: https://www.3ne.ca/community-projects/sustainable-food-centre/
- News about the Growcer Hydroponics Unit: https://www.3ne.ca/news/
- Check out the Learning Resources: https://www.3ne.ca/learning-resources/
- Share job opportunities with your students: https://www.3ne.ca/jobs-more/

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.