

WHAT, HOW, WHY Teacher Guide

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Curriculum Connections

Science 14

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

Answer Keys (50 points)

Fill In (13 points)	Label (7 points)	
1. food	1. Plants	9. K
2. waste	2. Animals	10. G
3. clean	3. Bacteria 1	11. J
4. ammonia	4. Bacteria 2	12. H
5. nitrites	5. Ammonia	13. H
6. nitrates	6. Nitrite	14. F
7. growth / life	7. Nitrate	15. J
8. balance		16. A
9. less / 90% less	Match I (12 points)	17. E
10. seasons	1. I	18. G
11. fossil fuel / fuel / gas / diesel	2. E	19. D
12. smaller	3. L	20. I
13. fish waste / fish / waste / decomposing	4. B	
	5. F	
	6. A	
	7. D	
	8. C	

Match II (9 points)

Short Ans (3 + 6 pts)

Answers will vary

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

Science 20

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.

Science 30

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.

Useful Resources

Please see the other Aquaponics resources available at <https://www.3ne.ca/learning-resources/>

Exploring Employment - Two articles discussing aquaponics as a possible home business and training opportunities.

Activity 1: How to Test the Water - includes step-by-step on how to run chemical tests for Nitrates, Nitrites, pH and Ammonia. Also includes Excel Aquaponic Log Sheets for recording results. These can be used as printouts or in electronic form.

Coming Soon - Activity 2: What Water Tests Tell You - Taking the information collected from Activity 1 and learning the basics of how to interpret the data to make decisions about the care of the aquaponics unit. Includes questions and graph sheets.

Check for updated video resources on Greenplanet's YouTube Channel: <https://www.youtube.com/channel/UCbcT9RNR0o5bao4m9VBJQBA>



WHAT, HOW, WHY

What is Aquaponics?

Aquaponics is a system for growing food:

- ◆ Fish are raised in tanks of water where plants are also grown.
- ◆ The waste from the fish provides nutrients for the plants.
- ◆ The plants keep the water clean for the fish.

aquaculture +
(fish farming)

hydroponics
(growing plants using
water, not soil).

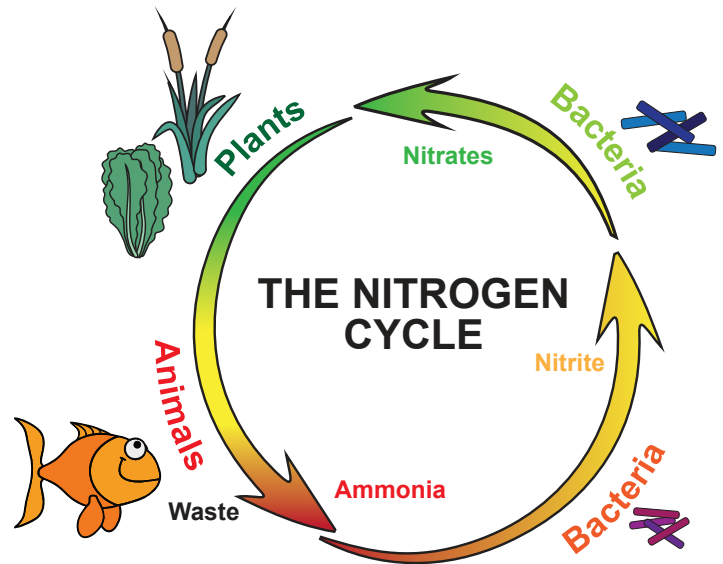
How Does It Work?

Aquaponics works because of the nitrogen cycle.

- ◆ In nature, when plants and animals produce waste or decompose (die and break down), ammonia is produced (NH_3).
- ◆ This ammonia is turned into nitrites and then into nitrates by two kinds of special bacteria.
- ◆ Plants need nitrates for growth and animals need plants to live.
- ◆ Then the cycle starts over again as plants and animals produce waste or decompose (die and break down). Everything is kept in balance.

Aquaponics uses the Nitrogen Cycle and keeps things in balance the same way nature does:

- ◆ The fish produce ammonia when they are fed and make wastes.
- ◆ Helpful bacteria turn this ammonia into nitrates which are used by the plants for growth.
- ◆ The plants clean the water that the fish need.



Why use Aquaponics?

Aquaponics Saves Water

- ◆ Aquaponics uses 90% less water than traditional farming.
- ◆ In traditional farming, only some of the water goes into the soil. A lot runs off or evaporates from the ground.
- ◆ In Aquaponics, most of the water is saved and reused.



Droughts are happening more often. Aquaponics may help since it grows food with less water.

Grow Food Year-Round, Anywhere

- ◆ An aquaponics system can be built anywhere you have a power source.
- ◆ They are indoors so location, weather and seasons are not a problem.

Helps the Environment, Cost & Quality

- ◆ Aquaponics can reduce the costs and the amount of fossil fuel used for shipping food long distances.
- ◆ Growing local means produce is fresh!

Less Space Needed

- ◆ Aquaponics gives plants ideal growing conditions. You can grow plants closer together than plants grown in soil.
- ◆ Growbeds can also be stacked on top of one another. This is known as “vertical farming”. More plants can be grown in a smaller space.



This is “vertical farming”. Plants grown with aquaponics or hydroponics can be grown this way.

Aquaponics Makes Healthy Food

- ◆ Food grown with aquaponics is guaranteed to be organic.
- ◆ You can't spray pesticides on the plants as this will kill the fish.
- ◆ You can't use antibiotics on the fish as this will kill the bacteria needed to break down the ammonia.
- ◆ In aquaponics, the plants get their nutrients from the fish waste, so there is less need to add chemicals.
- ◆ This rich environment prevents the growth of dangerous bacteria.

Fish And Plants Together Solve Problems

- ◆ Fish farms have buildups of waste.
- ◆ Hydroponics uses human made plant food and has to have the water changed regularly (due to the buildup of nitrates).
- ◆ Both of these problems are solved using aquaponics.

Bonus – grow your meat and veg in one shot!

What Parts Are Needed for Aquaponics?

Fish Tank

This is where the fish live. Fish tanks can be different sizes depending on the number of plants you want to grow. You can figure out how many fish you need to supply nutrients for the plants.

Mechanical Filter

This is where most of the fish waste ends up. Small systems may have just a screen or net. Industrial systems will have something more complex.

BioFilter

The biofilter is where the bacteria convert the ammonia into useful nitrates for the plants. In smaller systems this is done by the growbed.

Growbed

This is where the plants are grown.

- ◆ There are many different types of growbeds - some made with PVC pipes, floating rafts on water or trays of gravel.
- ◆ Expanded clay pellets are often used in aquaponics and hydroponics. (See page 4)
- ◆ The top of the growbed is kept dry to prevent algae growth. The bottom is for root growth.
- ◆ The majority of the helpful bacteria live in the growbed in the tiny pores of the clay pellets.
- ◆ The best plants to grow here are leafy greens.

Water Pump

This electric device pushes the water from the fish tank up to the growbed.



Expanded clay pellets (Hydroton) are made by heating the clay to over 1000°C! As the balls heat up, they fill with bubbles and form into small marble-sized balls. They are ideal for growing plants in water.



Another type of growbed uses large tubs of water with thick foam rafts that floats on top. The foam rafts have holes where the seedlings are put to grow. The roots hang down into the water where they get the food and oxygen they need.

Bell Siphon

This device allows the water in the grow bed to fill up and empty back into the fish tank, over and over again.



- ◆ It works without electricity.
- ◆ The water fills the grow bed and delivers the nutrients from the fish waste to the roots of the plants and the helpful bacteria.
- ◆ When the water is drained, oxygen is pulled into the bed which is needed by the plants and helpful bacteria.

Air Pump

This pushes air down a hose into the water.

- ◆ Air stones at the end of this hose help make bubbles so that oxygen is added to the water.
- ◆ This extra oxygen is needed for plants, fish and the helpful bacteria.

Lights

LED grow lights are needed so indoor plants can get enough energy to grow.

Water Heater/Thermometer

Bacteria and some fish need warmer water so a heater and thermometer are kept in the tank.

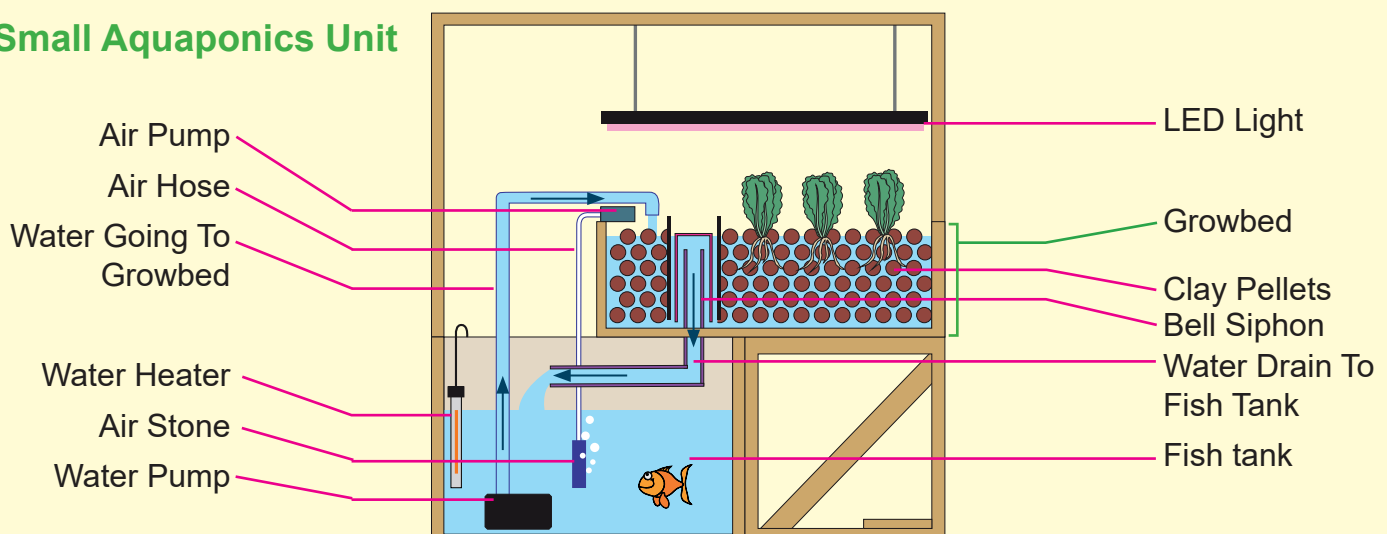
Test Kit

This measures the amount of ammonia and other chemicals in the water to make sure everything is kept in balance.



Aquaponics unit in the lobby of Keyano College in Fort Chipewyan

Small Aquaponics Unit



CHECKPOINT: The What, How, Why of Aquaponics (50 points)

Fill In The Blank

(13 points)

- Aquaponics is a system for growing _____
- _____ from the fish provides nutrients for the plants
- Plants keep the water _____ for the fish
- In nature, when animals produce waste, _____ is produced
- In nature, bacteria first turns ammonia into _____.
- Different bacteria turn nitrites into _____.
- Plants need nitrates for _____
- Plants are eaten by animals which produces waste so everything is kept in _____.
- Aquaponics uses _____ water than traditional farming
- With aquaponics, location, weather and _____ are not a problem.
- Aquaponics reduces use of _____ by reducing the need to ship food long distances.
- More plants can be grown in a _____ space using aquaponics.
- Instead of buying plant food, aquaponics gets the plant food from _____.

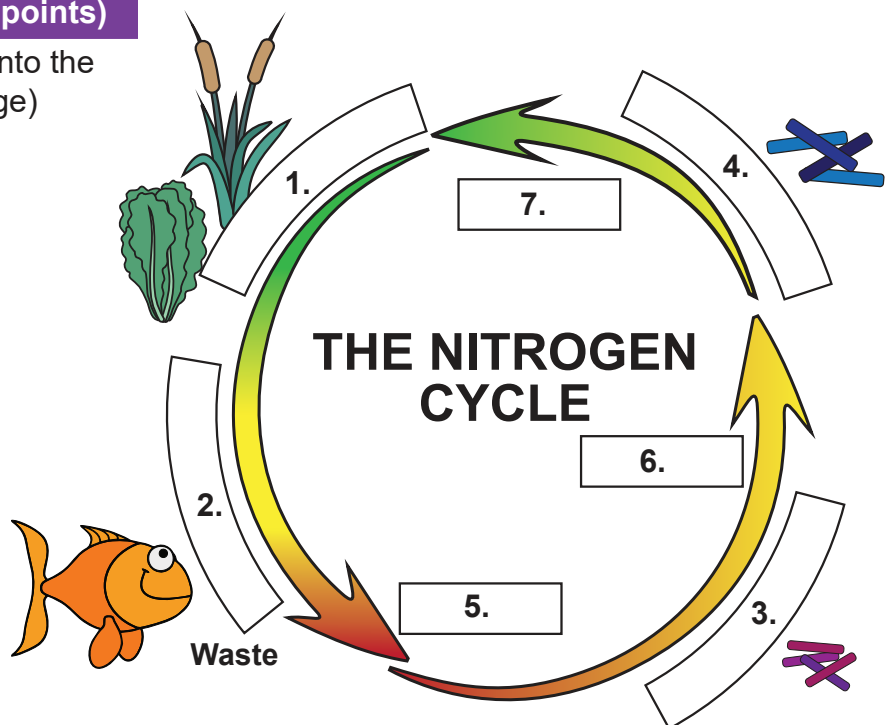
Label

(7 points)

Place the correct labels for the diagram into the blanks below. (See hints at bottom of page)

- _____
- _____
- _____
- _____
- _____
- _____
- _____

Nitrate	Bacteria 1	Ammonia
Nitrite	Bacteria 2	
Plants	Animals	

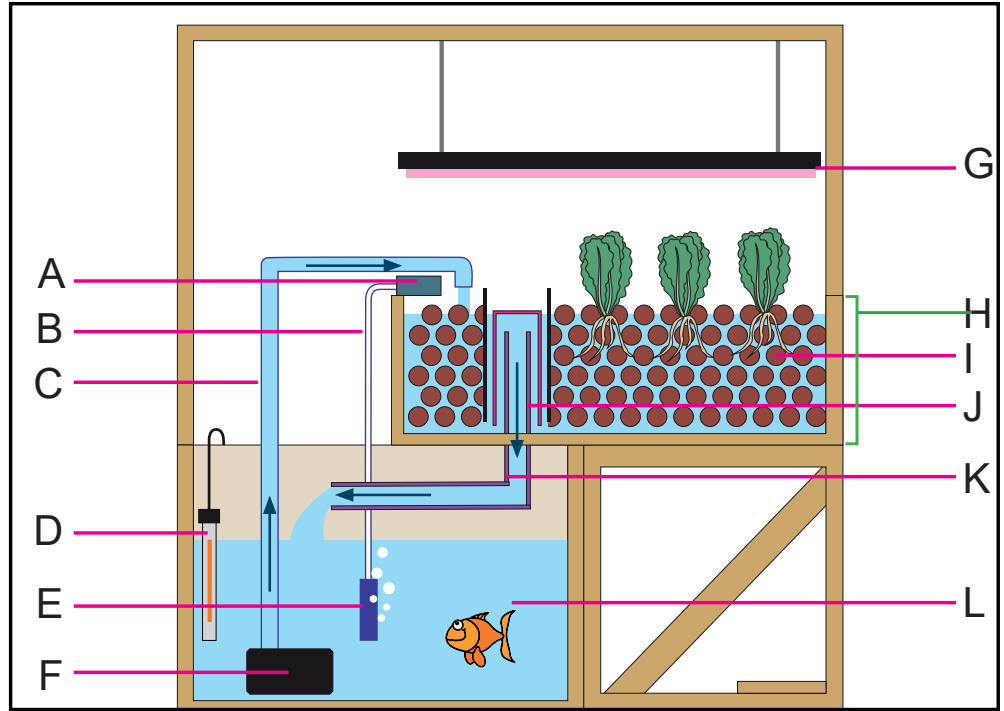


Matching I

(12 points)

Place the correct letter from the diagram into the blanks below.

- ___ 1. Clay pellets
- ___ 2. Air stone
- ___ 3. Fish tank
- ___ 4. Air hose
- ___ 5. Water pump
- ___ 6. Air pump
- ___ 7. Water heater
- ___ 8. Water pipe to growbed
- ___ 9. Water drain to fish tank
- ___ 10. LED light
- ___ 11. Bell siphon
- ___ 12. Growbed



Matching II

(9 points)

Place the correct letter from the diagram above into these blanks.

- ___ 1. where the fish live
- ___ 2. the plants are grown here
- ___ 3. electric device that pushes water from the fish tank up to the growbed
- ___ 4. device allows the water in the grow bed to fill up and empty back into the fish tank, over and over again
- ___ 5. pushes air down a hose into the water.
- ___ 6. helps break air into bubbles to add oxygen to the water.
- ___ 7. provides light energy to the plants
- ___ 8. keeps the water warm for bacteria and fish
- ___ 9. these are made from clay and support the plants

Short Answer

(3 points + 6 points)

1. What do you think the biggest advantage of using aquaponics is? Explain your answer.

2. Do you think aquaponics could work in Fort Chipewyan? Give TWO reasons and explain your answers.

