

Aquaponics Curriculum



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2709 Mondovi Road
Eau Claire, WI 54701 USA
800.830.1416
+1.715.830.2040
www.realityworks.com

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Table of Contents

Table of Contents	3
Author	4
Curriculum Structure	5
Lesson Structure	5
Lesson One – Introduction to Aquaponics	6
FOCUS: Thinking About Phenomena	7
LEARN: The Benefits of Aquaponics	9
REVIEW: Argumentative Paragraph	11
Lesson Two – Components of an Aquaponics System	13
FOCUS: Engineering an Aquaponics System	14
LEARN: Aquaponics System Diagram	15
REVIEW: Aquaponics Components Crossword Puzzle	17
Lesson Three – Fish Care	20
FOCUS: Fish Characteristics Brainstorm	21
LEARN: Fish Species and Fish Care	22
REVIEW: Fish Care Review	26
Lesson Four – Plant Care	29
FOCUS: Plant Sorting Activity	30
LEARN: Plants and Nutrients	32
REVIEW: Plant Care Quiz	38
Sources	43

Author



Dr. Jeffrey Christo is a teacher, school administrator, and thought leader in education. He supports strong programs in social studies, the arts, and STEM, which help students find fulfilling career paths while having dynamic, enriching learning experiences every day.

Dr. Christo is a lifelong learner who holds BA and MST degrees from Rowan University, a Doctorate in Educational Leadership from Walden University, and certifications as a teacher, curriculum supervisor, principal, and superintendent.

Curriculum Structure

The *Aquaponics Curriculum* is composed of the following lessons. Approximate lesson times are included.

Lesson	Title	Approximate Time
One	Introduction to Aquaponics	105 minutes
Two	Components of an Aquaponics System	120 minutes
Three	Fish Care	90 minutes
Four	Plant Care	90 minutes
	Total	6-7 hours

Lesson Structure

Each lesson begins with a Lesson Overview, Lesson Objectives, and a Lesson at a Glance table, which lists lesson activities, materials required, suggested preparation steps, and approximate class time.

Lesson Sections

The actual lesson follows the overview, which contains some of the sections described below.

FOCUS

Every lesson begins with a FOCUS activity intended to capture participants' attention. This may be in the form of a small or large class discussion, a game, a demonstration, or a review of previous lesson information. During this activity, participants are introduced to the topic of the lesson.

LEARN

The LEARN activity in each lesson varies in its presentation mode. It may be a slide presentation, group activity, or demonstration.

REVIEW

The majority of lessons end with a REVIEW activity intended to briefly review the lesson's key messages or main points.

Lesson One – Introduction to Aquaponics

Lesson Overview

In this lesson, participants learn the meaning of aquaponics, hydroponics, and aquaculture. Then participants analyze how aquaponics is a sustainable practice that provides social, economic, and environmental sustainability benefits.

Lesson Objectives

After completing this lesson, participants will be able to:

- Define aquaponics
- Compare aquaculture and hydroponics
- Identify problems that aquaponics can help solve
- Compare environmental, social, and economic benefits of aquaponics
- Explain how aquaponics is a sustainable solution

Lesson at a Glance

Activity	Materials	Preparation	Approximate class time
FOCUS	• <i>Introduction to Aquaponics</i> slide presentation • <i>Phenomenon-Problem Discussion Guide</i>	1. Print/Photocopy <i>Phenomenon-Problem Discussion Guide</i> (one per participant).	30 minutes
LEARN	• <i>Introduction to Aquaponics</i> slide presentation • <i>Sustainability Benefits Chart</i>	1. Print/Photocopy <i>Sustainability Benefits Chart</i> (one per participant).	45 minutes
REVIEW	• <i>Academic Paragraph Checklist</i> • <i>Introduction to Aquaponics</i> slide presentation	1. Print/Photocopy <i>Academic Paragraph Checklist</i> (one per participant).	30 minutes

Lesson One – Introduction to Aquaponics

FOCUS: Thinking About Phenomena

30 minutes

Purpose:

Participants are instructed on the basics of aquaponics. They will consider three phenomena: food deserts/swamps, drought conditions, and pollution - which can be solved with aquaponics.

Materials:

- *Phenomenon-Problems Discussion Guide*
- *Introduction to Aquaponics* slide presentation

Facilitation Steps:

1. Present slides 1-5 and explain the definition of aquaculture, hydroponics, and aquaponics.

Slide 1: Introduction Slide

Slide 2: Aquaponics

Our unit of study is the fascinating practice of aquaponics! Aquaponics is a method of growing crops in a water system where fish are also raised. It's a combination of hydroponics and aquaculture. Hydroponics is growing plants in a water system with no soil. Aquaculture is the practice of raising fish in a controlled environment.

Play the video:

[What is Aquaponics?](#)

YouTube Video Address:

<https://www.youtube.com/watch?v=yhcAOE2JOVs>

Slide 3: Thinking About Phenomenon

Slide 4: Defining Problems

Now let's start our lesson by analyzing a phenomenon and determining what type of problems these phenomena cause. Maybe we can solve some of these with aquaponics! Problem #1 is the phenomenon of food deserts and swamps. Problem #2 is the phenomenon of drought conditions. Problem #3 is the

phenomenon of fertilizer runoff.

Slide 5: Group Discussion

Now complete a think-pair-share activity. You have five minutes for the first step; think about the problems by yourself. Then complete the *Phenomenon-Problem Discussion Guide*. Then share your ideas with a partner or small groups sitting near you. Finally, share with the whole group.

Name: _____ Class: _____

Phenomenon-Problem Discussion Guide

Instructions: Consider each of the phenomena. Then write down 1-2 problems that each phenomenon may cause for people and communities.

	Phenomenon	Problems For Citizens
1	Food Deserts and Food Swamps: Some communities are “food deserts” where there are few grocery stores or places to buy food. Others are “food swamps” where there are many fast-food options but few healthy choices.	
2	Drought Conditions: Increasing water use causes stress to the water supply for irrigation, animals, and people.	
3	Pollution from Runoff: Large volumes of pesticides and fertilizers are used for commercial farming. Rains can cause these chemicals to drain into nearby water sources.	

Lesson One – Introduction to Aquaponics

LEARN: The Benefits of Aquaponics

45 minutes

Purpose:

Participants research the sustainability of aquaponics and create a chart with social, environmental, and economic sustainability benefits.

Materials:

- *Introduction to Aquaponics* slide presentation
- *Sustainability Benefits Chart*

Facilitation Steps:

1. Begin by presenting slides 6-11 to go over the benefits of aquaponics.

Slide 6: LEARN introduction slide

Slide 7: Aquaculture

Let's remember that aquaponics is the combination of two food growing practices: hydroponics and aquaculture. Aquaculture is the controlled raising of fish or other sea animals. Shrimp and shellfish are also commonly raised through aquaculture.

Slide 8: Hydroponics

Remember that hydroponics is a farming process where crops are grown in a water system without soil. Nutrients are provided to the plants through the circulating water.

Slide 9: Benefits of Aquaponics

An aquaponics system provides many benefits compared to other methods of food production. First, aquaponics typically produces healthy food that is high in nutrients, such as fish and vegetables. Aquaponics systems use much less water than irrigation. Aquaponics systems do not need chemicals, such as pesticides or weed killers, that are frequently used in traditional

farming. Additionally, aquaponics systems produce a higher yield of food based on space, expense, and resources compared to any other type of food production.

Slide 10: Sustainability

Because of the benefits of aquaponics, it is considered a promising sustainable practice. Sustainability is a key engineering and public policy consideration. Sustainable practices are designed to be supported and maintained over time. These practices meet current needs while still looking toward the future. Sustainable practices use the world's limited resources wisely.

Slide 11: Type of Sustainability

There are three types of sustainability to analyze related to aquaponics: economic, environmental, and social. Economically sustainable practices offer long-term economic development for communities while helping produce affordable goods and services. Environmentally sustainable practices use natural resources wisely and avoid damage to natural environments. Socially sustainable practices have positive impacts on people and their lives.

2. Distribute the *Sustainability Benefits Chart*. Participants will use the reading links to fill out the chart. You may select options for this activity, such as individuals, partners, or groups working together to fill out the chart. Facilitate by circulating and helping as needed.

[7 Ways Aquaponics is Sustainable](#)

[Comparing the Sustainability of Aquaponics and Hydroponics Food Production Systems](#)

3. Call all participants to attention. As a whole group, facilitate a review of the class's research findings.

Name: _____ Class: _____

Sustainability Benefits Chart

Instructions: Use information from the links provided to list environmental, social, and economic benefits of aquaponics.

Social	Environmental	Economic

Lesson One – Introduction to Aquaponics

REVIEW: Argumentative Paragraph

30 minutes

Purpose:

Participants write an argumentative paragraph to apply the information from the LEARN activity and review the content.

Materials:

- *Academic Paragraph Checklist*
- *Introduction to Aquaponics* slide presentation

Facilitator Instructions:

1. Display slide 13 and distribute the academic paragraph checklist to participants.

Slide 13: Claim and Support

For the review, you will use the information you gathered to construct a brief argument in favor of aquaponics. When you write an argument, you are trying to prove a thesis or central idea using facts to support your assertion. This includes two parts: a claim and evidence. A claim is the central idea or main point you are trying to make. The evidence is facts that you use to support your claim.

2. Display slide 15 and explain the requirements of an academic paragraph. Explain the writing task and clarify any questions participants have.

Participants must first create a claim as the thesis statement of the paragraph.

Participants must make a positive claim about aquaponics based on the information they gathered during the LEARN segment. For example, participants may write, “Aquaponics provides many sustainability benefits” or “people and communities will see many sustainability benefits from aquaponics”.

Participants will support the claim with evidence from the *Sustainability Benefits Chart* and write two to three sentences explaining the evidence.

Participants will write one sentence with elaboration or further analysis of the claim and write a concluding sentence.

3. Participants will write academic paragraphs, using the checklist to self-monitor the writing process. Call on volunteers to read the paragraphs to the class, concluding the lesson.

Academic Paragraph Checklist

Instructions: Use the information from your *Sustainability Benefits Chart* to construct an academic paragraph. Make a positive claim about the sustainability of aquaponic agriculture. Support the claim with evidence and elaboration of your argument. Use the checklist below as you complete your paragraph.

_____ Topic sentence that makes a claim

_____ 2-3 sentences providing evidence for the claim

_____ One sentence of analysis and/or elaboration of your argument

_____ One sentence concluding the argument

Lesson Two – Components of an Aquaponics System

Lesson Overview

Participants take a closer look at the components that make up an aquaponics system.

Lesson Objectives

After completing this lesson, participants will be able to:

- Explain how to maintain a fish tank
- Analyze how to set up grow beds
- Compare different growing mediums
- Explain how a siphon system works
- Use lights and fans to help plants grow

Lesson At a Glance

Activity	Materials	Preparation	Approximate class time
FOCUS	• <i>Components of an Aquaponics System</i> slide presentation	1. Prepare <i>Components of an Aquaponics System</i> slide presentation for viewing.	10 minutes
LEARN	• <i>Components of an Aquaponics System</i> slide presentation • Educational Aquaponics System • Pencils and paper for sketching a diagram	1. Prepare <i>Components of an Aquaponics System</i> slide presentation for viewing. 2. Prepare Educational Aquaponics System for class.	25 minutes
REVIEW	• <i>Components of an Aquaponics System Crossword</i> • <i>Components of an Aquaponics System Crossword – Answer Key</i>	1. Print the <i>Components of an Aquaponics System Crossword</i> (one per participant).	5-10 minutes

Lesson Two – Components of an Aquaponics System

FOCUS: Engineering an Aquaponics System

10 minutes

Purpose:

Participants watch a video demonstration of the parts of an aquaponics system to prepare for deeper analysis during the LEARN segment.

Materials:

- *Components of an Aquaponics System* slide presentation

Facilitation Steps:

1. Present slides 1-4 to the class.

Slide 1: Introduction slide

Slide 2: FOCUS introduction slide

Slide 3: What Do Aquaponics Systems Do?

Previously, we learned that aquaponics provides a sustainable source of healthy food. In this lesson, we will learn about the components of aquaponics systems so we can make one work! Let's begin by examining just what it is that an aquaponics system does.

Aquaponics systems provide a safe, clean, and sturdy tank to raise fish. They convert the waste from the fish into nutrient-rich nitrates, which are then moved along the system to provide food for the plants. Aquaponics systems are also made up of pumps, siphons, and pipes that move the water along and keep the whole system cycling.

Slide 4: Essentials of Aquaponics

Let's watch a video showing the major components of aquaponics and how they work.

[MUST-SEE Essential Equipment Guide for Aquaponics Systems \(All Levels of Growers\)](#)

2. Follow up after the video with questions to further stimulate interest and check for understanding. Suggested questions:
 - What are all the parts of the plumbing system?
 - What does the biofilter do?
 - How do the biofilter and the plants clean the water for the fish?
 - Why is there medium in the grow bed?

Lesson Two – Components of an Aquaponics System

LEARN: Aquaponics System Diagram

25 minutes

Purpose:

Participants learn about the components of an aquaponics system and then create diagrams of an aquaponics system to show they understand the cycle of water and nutrients from fish to biofilter, to grow bed, and back to the fish tank.

Materials:

- *Components of an Aquaponics System* slide presentation
- Educational Aquaponics System
- Pencils and paper for sketching a diagram

Facilitation Steps:

1. Present slides 5-15. Instruct about the fish tank and biofilter.

Slide 5: LEARN introductory slide

Slide 6: Major Components

The major components of an aquaponics system include the fish tank, biofilter, grow bed, medium, and plumbing.

Slide 7: Fish Tank

It all starts with the fish tank. The fish tank is a vessel used to raise fish and create nutrients for the system. Aquaponics tanks don't always look like a fish tank for a pet; they can come in many forms. The best tanks need to be sturdy, easy to clean, and large enough for the fish to swim comfortably. The reason it all starts here is that the fish waste will eventually become the food for the plants.

Slide 8: Biofilter

The biofilter is a section of the system that changes the ammonia waste from the fish into a healthier compound. Bacteria in the filter digests the ammonia and leaves nitrates as the waste.

That's great for the plants because nitrates are important fertilizers for them. The plants then absorb the nitrates in the grow bed. The water is then clean to return to the fish tank.

Show the class the fish tank and biofilter on your Educational Aquaponics System.

Slide 9: Grow Bed

The grow bed is a term for the hydroponic holding area for the plants. The grow bed consists of a container for the plants, a grow media, and water. The bed gets repeatedly flooded and drained of water as it cycles through the system.

Slide 10: Grow Medium

Since the plants do not rest in soil, they need something for support and to hold the roots in place. A medium is a solid material similar to soil in traditional agriculture. A good medium helps keep a good ratio of water, air, and dissolved oxygen in the system.

Show the class the grow bed and medium on your aquaponics system.

Slide 11: Comparing Grow Mediums

There are many options for mediums. Some are organic materials, such as coconut coir, peat, or pine, which are made of living matter. Other mediums are inorganic materials, like clay and sand. Each medium has its own set of properties related to how well it absorbs water, how much air it can trap, and how sturdy it is. Many growers use a mixture of several types.

Slide 12: Plumbing

The plumbing consists of a pump, pipes, and a siphon. One or more pumps are used to start the water moving throughout the system. The pipes connect each part of the system. The siphon is a special device that uses engineering to move the water with a design that uses gravity.

Slide 13: The Sump

All aquaponics systems use gravity to help move the water along. Eventually, the water will reach the lowest point, called the sump. The sump usually sits below the grow bed. The pump is used to pull the water from the sump back to the fish tank.

Slide 14: Siphon System

The siphon rests in the grow bed. The device detects the water level as it fills. When the bed is completely full, the siphon empties the water out of the grow bed and sends it back on its way to the pump. This is a critically important part of a large aquaponics system that keeps the roots from ever getting too wet or too dry.

Show students the components of the plumbing system on your aquaponics system.

2. Allow students to investigate the aquaponics system up close.
3. Assign the diagram activity from slide 15. Students create a diagram of the aquaponics system that includes the fish tank, plumbing components, biofilter, and grow bed.

Lesson Two – Components of an Aquaponics System

REVIEW: Aquaponics Components Crossword Puzzle

5-10 minutes

Purpose:

Participants complete a crossword puzzle to review and reinforce the vocabulary terms for the parts of the aquaponics system.

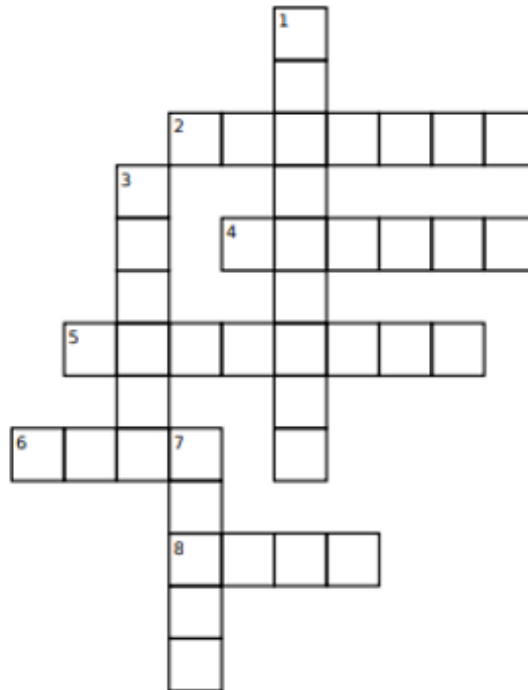
Materials:

- *Components of an Aquaponics System Crossword*
- *Components of an Aquaponics System Crossword – Answer Key*

Facilitation Steps:

1. Distribute the *Components of an Aquaponics System Crossword* to participants.
2. Participants complete the crossword puzzle using what they learned from the lesson and their diagrams of an aquaponics system.
3. Review the components on your aquaponics system and go over answers as a class with the answer key.

Components Of an Aquaponics System Crossword



Down:

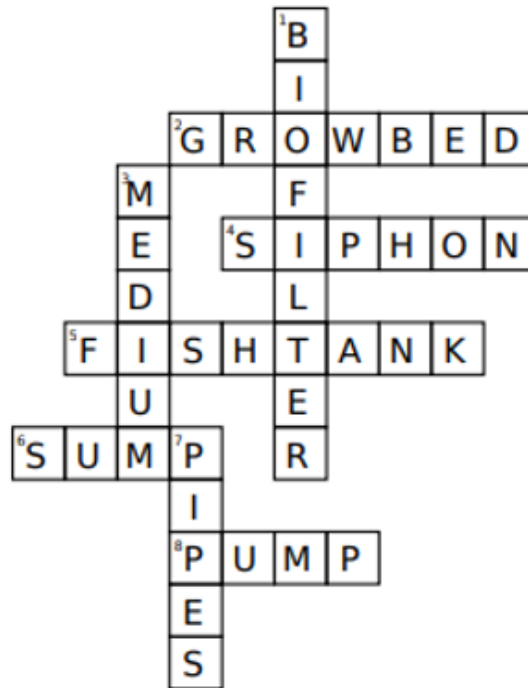
1. bacteria that converts fish waste to plant food
3. solid material for the plant roots
7. water flows through these

Across:

2. place where the plants are kept
4. regulates the water in the grow bed
5. where the fish live
6. water flows to this lowest spot by gravity
8. powers the water through the system

Components of an Aquaponics System

Crossword – Answer Key



Down:

1. bacteria that converts fish waste to plant food
3. solid material for the plant roots
7. water flows through these

Across:

2. place where the plants are kept
4. regulates the water in the grow bed
5. where the fish live
6. water flows to this lowest spot by gravity
8. powers the water through the system

Lesson Three – Fish Care

Lesson Overview

Participants will be introduced to common fish species and take a deeper dive by researching a specific species. Furthermore, participants will learn how to properly care for fish in an aquaponics system.

Lesson Objectives

After completing this lesson, participants will be able to:

- Compare common fish species
- Research facts about a fish species
- Explain how to care for fish in an aquaponics system

Lesson at a Glance

Activity	Materials	Preparation	Approximate class time
FOCUS	• <i>Fish Care</i> slide presentation	1. Prepare <i>Fish Care</i> slide presentation for viewing.	15 minutes
LEARN	• <i>Fish Care</i> slide presentation • <i>Fish Species Expert Jigsaw</i>	1. Print/photocopy <i>Fish Species Expert Jigsaw</i> (one per participant). 2. Prepare <i>Fish Care</i> slide presentation for viewing.	60 minutes
REVIEW	• <i>Fish Care Review Worksheet</i> • <i>Fish Care Review Worksheet – Answer Key</i>	1. Print/photocopy <i>Fish Care Review Worksheet</i> (one per participant). 2. Prepare <i>Fish Care</i> slide presentation for viewing.	10 minutes

Lesson Three – Fish Care

FOCUS: Fish Characteristics Brainstorm

15 minutes

Purpose:

Participants brainstorm important qualities that make a fish ideal for aquaponics.

Materials:

- *Fish Care* slide presentation

Facilitation Steps:

1. Present slides 1-5 to the class.

Slide 1: Introductory slide

Slide 2: Fish Care

Hello and welcome to today's lesson about fish care! Fish are the driving engine of the aquaponics system, and their proper care is essential to a successful system. In this lesson, we will discuss two topics: Types of fish and caring for fish.

Slide 3: Brainstorming

Engage participants in a think-pair-share brainstorm about qualities of a fish which make them ideal for aquaponics. Participants will have five minutes to list as many qualities as possible. Then participants are given five minutes to share their ideas with a small group or partner. Then move on to slide 4 to see how many of the participants' ideas match the standard ideals from aquaculturists.

Slide 4: Qualities of Fish

Some of the most important qualities include:

Accessibility: Are the fish easy to find and affordable?

Legality: Are the fish legal to be kept for aquaculture?

Feeding: Will the fish readily accept fish food?

Economically Valuable: Is there a market to sell the fish?

Easily Raised in Captivity: Are the fish tolerant of captive living conditions?

Hearty: Are the fish species free of diseases and parasites?

Sensitivity: Are the fish able to live in varied water temperatures and varied water quality?

Slide 5: Video

[What are the BEST FISH for aquaponics?](#)

Lesson Three – Fish Care

LEARN: Fish Species and Fish Care

60 minutes

Purpose:

Participants will learn about fish species and their proper care in an aquaponics system. Then participants complete a jigsaw research assignment where each group develops an expertise in one fish species.

Materials:

- *Fish Care* slide presentation
- *Fish Species Expert Jigsaw*

Facilitation Steps:

1. Present slides 6-22 to the class.

Slide 6: LEARN introductory slide

Slides 7-8: Tilapia

Let's begin an overview of popular fish species used for aquaculture. First, we have the tilapia. Tilapia are rapidly growing fish who average about a pound when fully grown. They prefer warm waters and are extremely hardy fish that tolerate most water conditions. They are also a very popular fish for eating. Because of its ease to raise and ready market for fish fillets, many aquaculturists consider it the ideal fish.

Slides 9-10: Catfish

Another popular fish used in aquaponics are a variety of catfish species. Catfish grow quickly and have a very high yield. They are generally adaptable to many water conditions and are strong, hardy fish. Catfish filets are a popular food item throughout the United States.

Slides 11-12: Salmonids

As you can tell by the name, this fish family includes salmon and trout. Unlike the other species, salmon and trout prefer cool water temperatures. They are a popular food item are

desirable for their high nutrient content. They can be more difficult to raise since they are sensitive to water temperature and conditions.

Slides 13-15: Ornamental Fish

Ornamental fish species are grown for their appearance rather than as food items. Some common examples of ornamental fish are koi, goldfish, and many types of tropical fish.

There is a market for ornamental fish for landscaping industry where they are used to beautify ponds or fountains. Many types are hardy and tolerant of water conditions and temperatures. One thing to be aware of is that ornamental fish sometimes give off more waste products and this can overwhelm a system in some cases. Most ornamental fish are inedible or unpopular for food, so the sales market may be limited.

Slide 16: Non-Fish Species

Aquaponics systems can also be populated with other water-dwelling creatures. The most common fish alternatives are crayfish, prawns, and shellfish, like oysters and mussels.

Slide 17: Fish Care

Slide 18: Feeding

To begin the whole system, fish must be fed an appropriate diet every day. You must provide nutritious food of the proper mix for the species you keep. Make sure to check on the feeding habits of the fish every day. If they begin to feed less aggressively, they may be suffering from stress or disease. Make sure to avoid overfeeding as too much food will create a dirty fish tank.

Slide 19: Temperature

Aquaculturists must check temperature each day. Both warm- and cold-water species can be kept in an aquaponics system successfully if the temperature is regulated. Some species are very sensitive to temperature changes and are thus harder to keep in aquaculture.

Slide 20: Check for Critters

As a living ecosystem, aquaponics systems are susceptible to a variety of unwanted organisms. You must check the fish tank for these pests. First, beware of any parasites that may grow on your fish or in the tank. Any fish with abnormal growths that may be a parasite should be removed from the tank and checked out. You may also see insects or their larvae invade the system, and they need to be removed as soon as possible. Finally, check for any dead fish in the tank. This happens from time to time no matter how well you care for the fish. A dead fish can contaminate the system with waste, so they also should be removed and discarded.

Slide 21: Plumbing Maintenance

The primary way to keep fish healthy is to ensure a healthy and safe water environment. To do this, perform routine checks on the plumbing system to make sure the pump and pipes are clean and operational. Make sure to check the plumbing daily to ensure that it is operating. Clean the pipes about once per month.

Slide 22: Check the Levels

You must monitor the water in the aquaponics system and check the levels of pH, ammonia, and nitrates. The pH is a measurement of the balance between acid and alkaline in the water. Each fish species has a preferred pH range. The ammonia is the waste product from the fish, which is then turned to nitrates by the biofilter. Remember that the nitrates are the plant food. If the ammonia level is too high, there may be too many fish in the system or the biofilter may need to be checked. If there are too many nitrates, then there may not be enough plants to match the amount of fish.

2. Assign the *Species Expertise Jigsaw*.

Participants will work in groups to conduct species-specific research to determine care guidelines.

Assign the following site as a starting point:

<https://gogreenaquaponics.com/blogs/news/what-are-the-best-fish-for-aquaponics>

3. Each group presents their findings aloud to the class.

Fish Species Expert Jigsaw

Instructions: Work as a group to research one fish species. Your group will then become the expert on this species. Each group will present their findings. Use the graphic organizer to record your findings.

Ideal Temperature	
Ideal pH range	
Required tank size	
Advantages	

Disadvantages	
Fun Facts	

Lesson Three – Fish Care

REVIEW: Fish Care Review

10 minutes

Purpose:

Participants complete a fill-in-the-blank review worksheet to consolidate knowledge of fish species and fish care.

Materials:

- *Fish Care Review Worksheet*
- *Fish Care Review Worksheet – Answer Key*

Facilitation Steps:

1. Distribute the *Fish Care Review Worksheet*.
2. Participants complete the *Fish Care Review Worksheet*. Allow two to four minutes.
3. Conduct a class worksheet review sharing answers.

Fish Care Review Worksheet

Instructions: Using the terms in the word bank, fill in the blanks with the correct answer.

Ammonia	Catfish	Goldfish	High	Trout
Insects	Koi	Nitrates	Overfeeding	Low
Parasites	pH	Salmon	Tilapia	

1. The _____ is often called the “perfect fish” for aquaponics.
2. _____ and _____ are cold-water fish that can be challenging to keep in aquaponics.
3. Some fish, such as _____ and _____, are raised for ornamental purposes instead of food.
4. The popular _____ is prized in aquaculture for its fast growth and high yield.
5. Make sure to check your tank for _____ and _____ every day.
6. Check the levels of _____, _____, and _____ in your tank.
7. _____ can cause a buildup of extra biological matter in the fish tank.
8. If ammonia levels are too _____, the water will be toxic to plants and fish.
9. If nitrate levels are too _____, there won’t be enough food for the plants.
10. What is the most important thing you learned about fish care in this lesson?

Fish Care Review Worksheet – Answer Key

Instructions: Using the terms in the word bank, fill in the blanks with the correct answer.

Ammonia	Catfish	Goldfish	High	Trout
Insects	Koi	Nitrates	Overfeeding	Low
Parasites	pH	Salmon	Tilapia	

1. The **tilapia** is often called the “perfect fish” for aquaponics.
2. **Salmon** and **trout** are cold-water fish that can be challenging to keep in aquaponics.
3. Some fish, such as **koi** and **goldfish**, are raised for ornamental purposes instead of food.
4. The popular **catfish** is prized in aquaculture for its fast growth and high yield.
5. Make sure to check your tank for **parasites** and **insects** every day.
6. Check the levels of **pH**, **ammonia**, and **nitrates** in your tank.
7. **Overfeeding** can cause a buildup of extra biological matter in the fish tank.
8. If ammonia levels are too **high**, the water will be toxic to plants and fish.
9. If nitrate levels are too **low**, there won’t be enough food for the plants.
10. What is the most important thing you learned about fish care in this lesson?

Answers will vary

Lesson Four – Plant Care

Lesson Overview

Participants learn about plants and their care in an aquaponics system. In the FOCUS section, participants brainstorm a list of plants and sort them into plant types. Then participants learn about the characteristics that make certain plants conducive to aquaponics. Finally, participants learn about the proper balancing of pH and nutrients in the system.

Lesson Objectives

After completing this lesson, participants will be able to:

- Compare different plants for aquaponics
- Describe the nutrients needed for plant growth
- Explain how to monitor pH and nutrients in an aquaponics system

Lesson at a Glance

Activity	Materials	Preparation	Approximate class time
FOCUS	• <i>Plant Care</i> slide presentation • <i>Plant Sorting Worksheet</i>	1. Print/photocopy <i>Plant Sorting Worksheet</i> (one per participant). 2. Prepare slide presentation for viewing.	20 minutes
LEARN	• <i>Plant Care</i> slide presentation • <i>Aquaponics Plant Care</i> worksheet • <i>Aquaponics Plant Care – Answer Key</i> • Educational Aquaponics System	1. Print/photocopy <i>Aquaponics Plant Care</i> worksheet (one per participant). 2. Prepare slide presentation for viewing.	60 minutes
REVIEW	• <i>Plant Care Quiz</i> • <i>Plant Care Quiz – Answer Key</i>	1. Print/photocopy <i>Plant Care Quiz</i> (one per participant).	20 minutes

Lesson Four – Plant Care

FOCUS: Plant Sorting Activity

20 minutes

Purpose:

Participants work in groups to sort different plants into categories. This will get participants thinking about different characteristics of plants.

Materials:

- *Plant Care* slide presentation
- *Plant Sort Worksheet*

Facilitation Steps:

1. Give each participant the *Plant Sort Worksheet*.
2. Share slides 1-3.

Slide 1: Introductory slide

Slide 2: FOCUS introductory slide

Slide 3: Plant Categories

3. Give participants 10 minutes to complete the worksheet to the best of their ability.
4. Call the class back together to share answers to each sort of plants in the worksheet:
 - Leafy greens
 - Herbs
 - Fruits and vegetables
 - Root vegetables
 - Flowers

Plant Sort Worksheet

Instructions: Write down as many plants as you can in each section of the worksheet.

Leafy Greens	Herbs
Root Vegetables	Fruits
Flowers	

Lesson Four – Plant Care

LEARN: Plants and Nutrients

60 minutes

Purpose:

Participants compare the characteristics of plants used in aquaponics, understand the nutrients needed for plant growth, and determine how to care for plants.

Materials:

- *Plant Care* slide presentation
- *Aquaponics Plant Care* worksheet
- *Aquaponics Plant Care – Answer Key*

Facilitation Steps:

1. Present slides 4-10.

Slide 4: LEARN introductory slide

Slide 5: Plant Selection

What are the ideal plant candidates for our aquaponic systems? Firstly, fast-growing plants with shallow roots are the best for this setup. They soak up nutrients without causing imbalances in the system. Secondly, plants that love continuous water flow are a perfect fit; they make the most of the nutrient-rich environment created by the fish. Plant species with high nutrient demands thrive in our systems. Plants in the system need to soak up all that fish waste to keep a balance.

Slide 6: Leafy Greens

Leafy greens are the speediest growers in the plant world! They grow fast, have shallow roots, and soak up the nutrients from fish waste. That makes them perfect for aquaponics! They thrive in our systems because they're great at absorbing nutrients. The continuous water flow provides them with the perfect environment to grow lush and green. These are the easiest plants to grow in aquaponics.

Slide 7: Herbs

Herbs are the are small plants that are used as spices, medicines, or for their smell. You might know basil, dill, mint, or oregano for example. They're compact, smell amazing, and are super versatile, whether for cooking or medicinal purposes. In aquaponics, they work well! Their small size means we can grow lots of varieties, harvest often, and meet the high demand for these flavorful and aromatic plants.

Slide 8: Fruits and Veggies

Fruits and veggies come in all shapes and sizes, and you surely know dozens of varieties. Some sprawl like vines, while others grow on a bush or tree. While some do well in aquaponics due to the nutrient-rich setting, some might need a bit more space. They are not recommended for beginning aquaponics. Tomatoes, peppers, cucumbers, and cauliflower are the best options for aquaponics.

Slide 9: Root Vegetables

Root veggies, like carrots, potatoes, yams, beets, and radishes, are popular food items. They're a bit different as their deep roots need more space, which can be a challenge in aquaponics.

Slide 10: Flowers

Flowers bring color and diversity to our gardens! Some are ornamental, grown just for their colorful looks, while others are edible or have medicinal uses. In aquaponics, they can serve multiple purposes. From stunning visuals to edible blossoms, aquaponic growers need to be sure there is a large enough market for the chosen flower to sell. Marigolds, sunflowers, and roses are popular in aquaponics.

2. Direct participants to reading passages. Participants should use the reading selections as a resource to complete the assignment. If participants do not have access to the internet, the teacher can print a copy of the articles for each group OR participant.
 - a. <https://gogreenaquaponics.com/blogs/news/a-guide-to-successful-plant-management-for-aquaponics>
 - b. <https://gogreenaquaponics.com/blogs/news/how-to-start-planting-in-aquaponics>
3. Assign Part 1 of *Aquaponics Plant Care*.
4. Present Slides 11-16

Slide 11: Nutrient Requirements

Plants have their own essential nutrient checklist, and these seven components are the largest needs: light, nitrogen, phosphorous, potassium, calcium, sulfur, and magnesium. Light provides energy through photosynthesis, while nitrogen, phosphorus, and potassium are the trio responsible for growth, flowering, and fruiting. Calcium and sulfur are the building blocks for strong cell structures, while magnesium ensures enzyme activity. Each of these nutrients is critical for a plant's overall health and development, much like a balanced diet is for us humans.

Slide 12: Trace Nutrients

Plants also need tiny amounts of some other nutrients. Though they are not needed in large amounts, they are essential. In fact, iron deficiency is one of the most common problems in aquaponics.

Slide 13: Fish Food = Plant Nutrients

Fish waste is broken down into ammonia by bacteria, then converted into nitrites and finally nitrates, which is plant superfood! This nitrogen cycle is the key to plant and fish health. The

whole process starts from the fish food. The fish food needs to be rich in the essential nutrients so they can be passed on to the plant.

Slide 14: pH and Nutrient Monitoring

You must also measure and balance the pH level in the system. pH is a scale that determines the balance between acids and alkaline in the aquaponics system. Without the proper balance, the plants cannot absorb the nutrients. The pH scale stretches from 1-14, with a balanced level of around 6.5 to 8.0 being most conducive to most aquaponics. It is essential to check the fish and plant species ideal pH as it varies.

Slide 15: pH Monitoring

Picture pH as the gateway to nutrient absorption in plants. When pH levels are off, it's like shutting the door on essential nutrients! Acidic conditions might hinder phosphorus uptake, while alkaline environments can limit iron absorption. Maintaining the right pH is like creating a VIP entry for nutrients into your plants' systems, ensuring that they get all the necessary fuel for growth.

Slide 16: Nutrient Monitoring

There are four steps to monitoring nutrient levels. First, growers should always observe the plants to see if they are growing well. Just like a human who is ill, plants will show symptoms, like wilting leaves or slow growth. You will also need to test the nutrients and interpret the results regularly. When there are identified deficiency in nutrients, then growers use a combination of fish food and other additives to archive the proper balance.

5. Assign Parts 2 and 3 of *Aquaponics Plant Care*.
6. Review the answers as a whole group once everyone is finished.

Aquaponics Plant Care

I. Plant Characteristics: What am I?

Write the name of the plant type after each clue below.

1. I grow under the ground, which makes me a bad choice for aquaponics. What am I?
2. I grow fast and soak up nutrients from the water. Start with me, I am the easiest to grow in aquaponics. What am I?
3. Some people use me for medicines or food, but mostly I am bought as a pretty decoration. What am I?
4. I come in a wide variety of tasty and healthy treats. I am used for all sorts of food items. What am I?
5. I might be small and compact, but my smell and taste pack a big impact. Add a little bit of me to food dishes for a great flavor accent and smell. I grow well in an aquaponic system. What am I?

II. Plant Care: Vocabulary

Consider the following vocabulary terms that you learned in the presentation. Then write the correct vocabulary word after each definition presented.

Word bank:

Trace nutrients

Fish food

pH

Photosynthesis

Monitoring

Vocabulary (Continued)

1. The balance of acid and alkaline (bases) present in a substance.
2. Element that is essential for plant life, but only in small amounts.
3. Where the nutrients that eventually get to the plant originate.
4. The process that converts light into energy.
5. Check the nutrient levels and observe the plants for any signs of yellowing.

III. Nutrient List

List 10 nutrients that are essential for plants in an aquaponics system.

Aquaponics Plant Care – Answer Key

I. Plant Characteristics: What am I?

Write the name of the plant type after each clue below.

1. I grow under the ground, which makes me a bad choice for aquaponics. What am I?

Root vegetable

2. I grow fast and soak up nutrients from the water. Start with me, I am the easiest to grow in aquaponics. What am I?

Leafy greens

3. Some people use me for medicines or food, but mostly I am bought as a pretty decoration. What am I?

Flowers

4. I come in a wide variety of tasty and healthy treats. I am used for all sorts of food items. What am I?

Fruits and veggies

5. I might be small and compact, but my smell and taste pack a big impact. Add a little bit of me to food dishes for a great flavor accent and smell. I grow well in an aquaponic system. What am I?

Herbs

II. Plant Care: Vocabulary

Consider the following vocabulary terms that you learned in the presentation. Then write the correct vocabulary word after each definition presented.

Word bank:

Trace nutrients

Fish food

pH

Photosynthesis

Monitoring

Vocabulary (Continued)

1. The balance of acid and alkaline (bases) present in a substance.

pH

2. Element that is essential for plant life, but only in small amounts.

Trace nutrients

3. Where the nutrients that eventually get to the plant originate.

Fish food

4. The process that converts light into energy.

Photosynthesis

5. Check the nutrient levels and observe the plants for any signs of yellowing.

Monitoring

III. Nutrient List

List 10 nutrients that are essential for plants in an aquaponics system.

1. Nitrogen
2. Phosphorus
3. Potassium
4. Calcium
5. Sulfur
6. Magnesium
7. Boron
8. Copper
9. Chloride
10. Zinc
11. Molybdenum
12. Iron
13. Manganese

Lesson Four – Plant Care

REVIEW: Plant Care Quiz

20 minutes

Purpose:

Participants recall information from the lesson with a quiz.

Materials:

- *Plant Care Quiz*
- *Plant Care Quiz – Answer Key*

Facilitation Steps:

1. Distribute the quiz. You can choose to allow participants to use their previous work and/or internet links to help them.
2. Give participants five minutes to complete the quiz.
3. Review answers as a class.

Plant Care Quiz

Instructions: Match the plant type to the correct answer. Then choose the correct answer from the multiple choices provided.

Part I. Matching (5 points each)

- | | |
|--------------------------|------------------------|
| 1. Leafy greens | marigolds, roses |
| 2. Herbs | basil, ginger, oregano |
| 3. Fruits and Vegetables | carrots, potatoes |
| 4. Root vegetables | strawberries, tomatoes |
| 5. Flowers | lettuce, kale, spinach |

II. Multiple choice (5 points each)

6. What does pH measure?
 - a. Speed of water evaporation
 - b. Balance of acid and base level
 - c. Amount of nutrients
7. Which of the following pH readings is likely good for aquaponics?
 - a. Between 98 and 102
 - b. 7.1
 - c. 13.5
 - d. 2.2
8. What does it mean if something is a “trace” nutrient?
 - a. It contains iron
 - b. They are not very important for the plant
 - c. The plant needs only a small amount
9. What do growers provide as the key to stimulating photosynthesis?
 - a. Water
 - b. Light
 - c. Fish
 - d. Plastic

10. What signs should alert a grower to nutrient deficiency?
 - a. Low nitrogen and potassium levels on a water test
 - b. You observe wilting, yellowing leaves
 - c. The plants show slow, stunted growth
 - d. All the above
11. Why does fish food matter to plants?
 - a. Bigger fish are better for plants
 - b. It will help sell the fish
 - c. The nutrients in the food eventually find their way to the plants
12. How often should you monitor nutrient levels?
 - a. Once or twice a week
 - b. hourly
 - c. Once per month
13. How can growers adjust unbalanced nutrients?
 - a. Remove the plants and turn off the light
 - b. Add in some snails and clean the pipes
 - c. Adjust fish food and sprinkle in additives
14. What is considered a “perfect” plant for aquaponics?
 - a. Potato
 - b. Banana
 - c. Lettuce
15. Which action is a step in the nutrient monitoring process?
 - a. Plant monitoring
 - b. Nutrient testing
 - c. Interpreting results
 - d. Balancing nutrients
 - e. All the above
 - f. None of the above

III. Plant Care Paragraph (25 points)

Write a paragraph on the back of this sheet describing how you will care for plants in an aquaponics system. Include a topic sentence, three ideas from the lesson, and a concluding sentence.

Answer Key Plant Care Quiz

Part I. Matching (5 points each)

- | | |
|--------------------------|------------------------|
| 1. Leafy greens | marigolds, roses |
| 2. Herbs | basil, ginger, oregano |
| 3. Fruits and Vegetables | carrots, potatoes |
| 4. Root vegetables | strawberries, tomatoes |
| 5. Flowers | lettuce, kale, spinach |

II. Multiple choice (5 points each)

6. What does pH measure?
- a. Speed of water evaporation
 - b. Balance of acid and base level**
 - c. Amount of nutrients
7. Which of the following pH readings is likely good for aquaponics?
- a. Between 98 and 102
 - b. 7.1**
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- b. It will help sell the fish
- c. **The nutrients in the food eventually find their way to the plants**

12. How often should you monitor nutrient levels?

- a. **Once or twice a week**
- b. hourly
- c. Once per month

13. How can growers adjust unbalanced nutrients?

- a. Remove the plants and turn off the light
- b. Add in some snails and clean the pipes
- c. **Adjust Fish food and sprinkle in additives**

14. What is considered a “perfect” plant for aquaponics?

- a. Potato
- b. Banana
- c. **Lettuce**

15. Which action is a step in the nutrient monitoring process?

- a. Plant monitoring
- b. Nutrient testing
- c. Interpreting results
- d. Balancing nutrients
- e. **All the above**
- f. None of the above

III. Plant Care Paragraph (25 points)

Write a paragraph describing how you will care for plants in an aquaponics system. Include a topic sentence, three ideas from the lesson, and a concluding sentence.

I will care for the plants in our system by monitoring the plants and adjusting nutrients, so they thrive. It is vital to check on the plants themselves to look for any sign of yellowing or wilting. Also, I will check the nutrients each week with a test. By analyzing these results, I will adjust the nutrients by changing fish food or adding minerals. This way, the system will stay balanced and help plants grow.

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