LESSON 2: ADDING BACTERIA

Lesson Objective

- To find out why bacteria are important in aquaponics.
- To learn what happens when an aquaponics system is “cycled.”

Lesson Materials

- Paper
- Art supplies for coloring (crayons, markers, colored pencils)
- Handout: Nitrogen Cycle (page 20)
- Handout: Nitrogen chart (page 20)

Additional Materials

You will also need a few materials for “behind the scenes” work:

- Cycling Kit: to cycle your system

- Freshwater Aquarium Test Kit: to monitor the ammonia, nitrite, nitrate and pH levels.

If you purchased an Aquabundance Aquaponics System, both a Cycling Kit and the Freshwater Aquarium Test Kit came with the system. If you do not have an Aquabundance System, you can purchase both kits at www.theaquaponicsource.com or local aquarium retail store.

Background Information

The real magic of aquaponics happens deep inside your grow beds. Within that wet, dark slimy world, the ammonia, liquid waste and solid waste from the fish are constantly being converted to plant food by the bacteria and worms that live there.

While there are literally hundreds of types of bacteria that will come to call your aquaponics system ”home”, there are two on which we primarily focus because they do the job of converting the toxic ammonia from the fish into benign nitrate: *Nitrosomonas* and *Nitrospira*. They are of a family of autotrophic bacteria called ‘nitrifying bacteria’. The central focus of the cycling process when we start up our aquaponics systems is to attract these two naturally occurring friends to our systems.

Nitrosomonas bacteria create nitrites as a bi-product of its consumption of ammonia. Those nitrites, which are still toxic to the fish and a poor source of nitrogen for the plants, attract the second type of nitrifying bacteria; *Nitrospira*. *Nitrospira* consume the nitrites and give off nitrates. Nitrates are largely harmless to your fish and an excellent source of nitrogen for your

plants.

The population of bacteria ultimately relies on the availability of ammonia, which comes from the fish. But temperature also affects the health and reproduction of nitrifying bacteria. The optimal temperature for bacteria reproduction is between 77-86° F (25-30°C). At 64°F (18°C) their growth rates decrease by 50%. At 46-50°F (8-10 °C) it decreases by 75%, and stops all together at 39°F (4°C). They will die off at or below 32°F (0°C) and at or above 120°F (49°C).

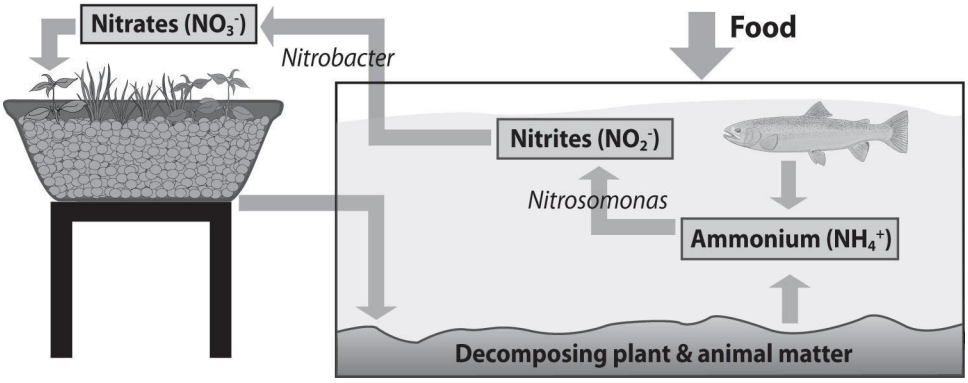
Assessment Answer Key

1. **a.** Fish give off ammonia.

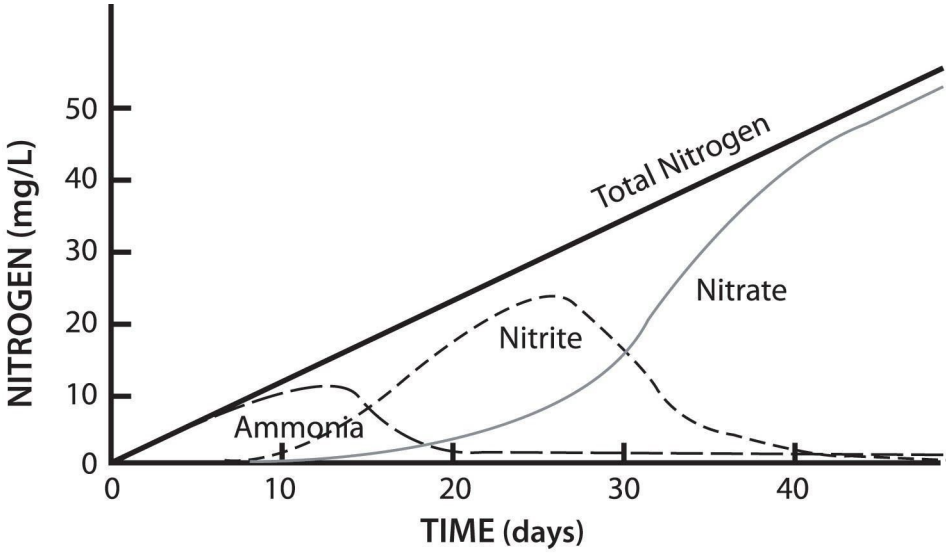
2. *Nitrospira* creates nitrates.

3. Plants need nitrogen to grow, produce fruit, and create green leaves.

Nitrogen Cycle



Nitrogen Chart



Student Guide – Why is bacteria added?

Vocabulary

Colonize – when bacteria grow and multiply

Nitrogen cycling – when bacteria that convert ammonia into nitrates colonize in an aquaponics system. Also known as "cycling".

Nitrosomonas - bacteria that convert ammonia into nitrites

Nitrites – what the *Nitrosomonas* bacteria produce from ammonia (toxic to fish)

Nitrospira – a bacteria that converts nitrites into nitrates

Nitrates – what *Nitrospira* bacteria produce from nitrites (practically harmless to fish, makes plants grow, produce fruit and have green leaves)

Lecture and Discussion

Ask: Who has a fish aquarium at home? Where is the filter and what does it look like?

- It's a box-shaped device hanging outside of the fish tank. It has a sponge, which must be changed periodically, for filtering fish waste.

Ask: Where do you think the filter is in an aquaponics system?

- It's mainly in the grow bed, and there are 3 parts to it: bacteria, plants and worms.

Today we are going to talk about the bacteria.

There are literally hundreds of types of bacteria that will live in our aquaponics system. We, however, will only focus on two: *Nitrosomonas* and *Nitrospira*. These are called "nitrifying bacteria" because they convert one form of nitrogen – ammonia – to another form – nitrites and nitrates.

Nitrosomonas and *Nitrospira* live everywhere you see slime in an environment where fish grow. They make the slime so they can stick to a surface and colonize (grow and multiply).

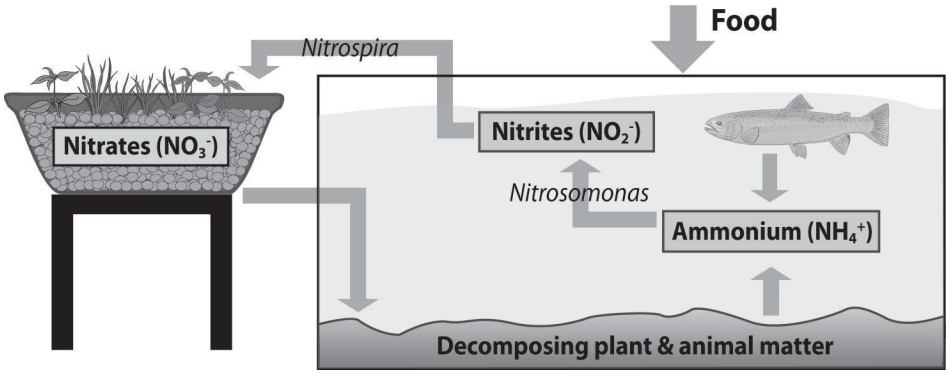
In an aquaponics system water travels from the fish tank, into the pump, through the pipes and hoses, into the grow bed and back down into the tank. Everywhere that fish water touches, nitrifying bacteria colonizes.

Ask: Knowing that *Nitrosomonas* and *Nitrospira* will grow on any surface that water touches, where do you think you'll find the bacteria in an aquaponics system?

- Inside the pipes and hoses, along the grow bed and fish tank walls, on the stones, and even on the plant roots.

The beauty of these slimy bacteria is that they not only clean the fishes' water, but they also feed the plants. Here's how:

Handout: "Nitrogen Cycle" image

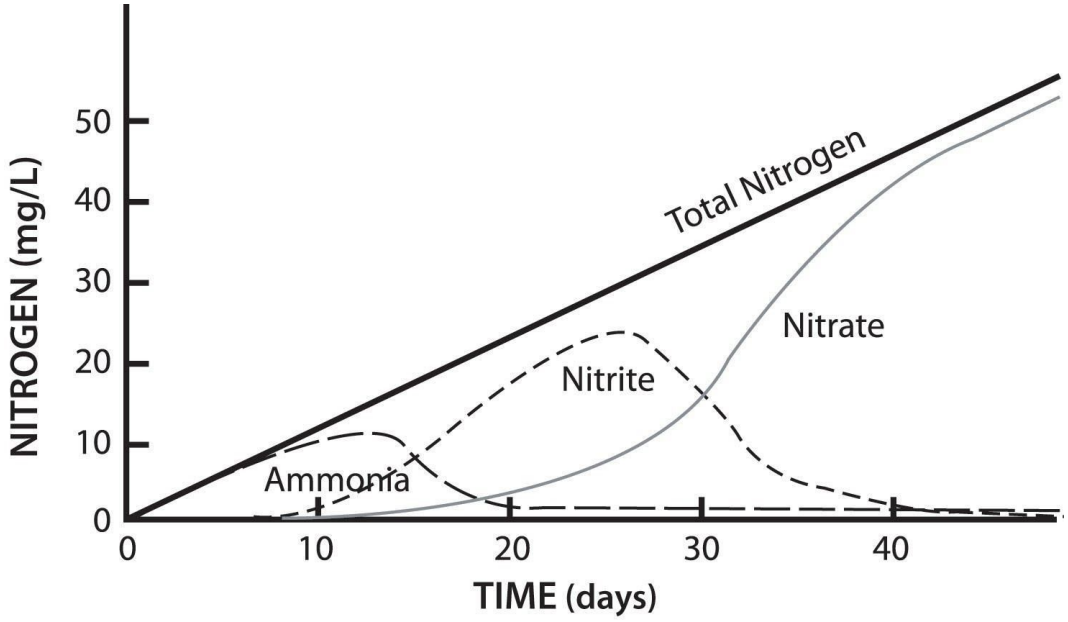


1. Fish produce ammonia from breathing. Ammonia is poisonous to the fish, and not a good food for the plants.

2. *Nitrosomonas* bacteria eat the ammonia, and change it into nitrites. Nitrites are a chemical that is also toxic to the fish and not a very good source of food for the plants.

3. Next, *Nitrospira* come along and eat the nitrites, converting them into nitrates. Nitrates are virtually harmless to the fish and a great source of nitrogen for the plants. Nitrogen helps plants grow quickly, produce more fruit, and create green leaves.

Handout: "Nitrogen" Chart



Over the next few weeks, the nitrite levels will rise and the ammonia levels will fall as the *Nitrosomonas* consume the ammonia.

Then, the nitrite levels will gradually fall and the nitrate levels will rise, as the *Nitrospira* bacteria eat the nitrites and create nitrates.

Activity

Draw your own picture of the nitrogen cycle:

- Show the fish giving off ammonia.
- *Nitrosomonas* gobbling up the ammonia and turning it into nitrites
- *Nitrospira* eating the nitrites and creating nitrates
- Plants absorbing the nitrates and growing tall and green

Conclusion

Review each child's picture to make sure they understand each step, the correct order of the steps, the bacteria names, and the compounds involved in the nitrogen cycle.

Extension

Science - Monitor the levels of nitrites and nitrates in your system for several weeks. You will see, first hand, how the level of nitrites rises as the *Nitrosomonas* start consuming the ammonia. Then, the levels of nitrates will gradually rise, as the level of nitrites fall. This rising and falling will happen until the system balances itself out and the cycling is complete.

Name_____ Date_____

Assessment 2 – Adding Bacteria

1. Think back to the picture you drew of the nitrogen cycle. What is the first step in the nitrogen cycle?

    a. Fish give off ammonia
    b. Plants absorb nitrogen
    c. *Nitrospira* eat the nitrites
    d. *Nitrosomonas* eat the ammonia

2. Which bacteria create nitrates: *Nitrosomonas* or *Nitrospira*?

3. Why do plants need nitrogen?