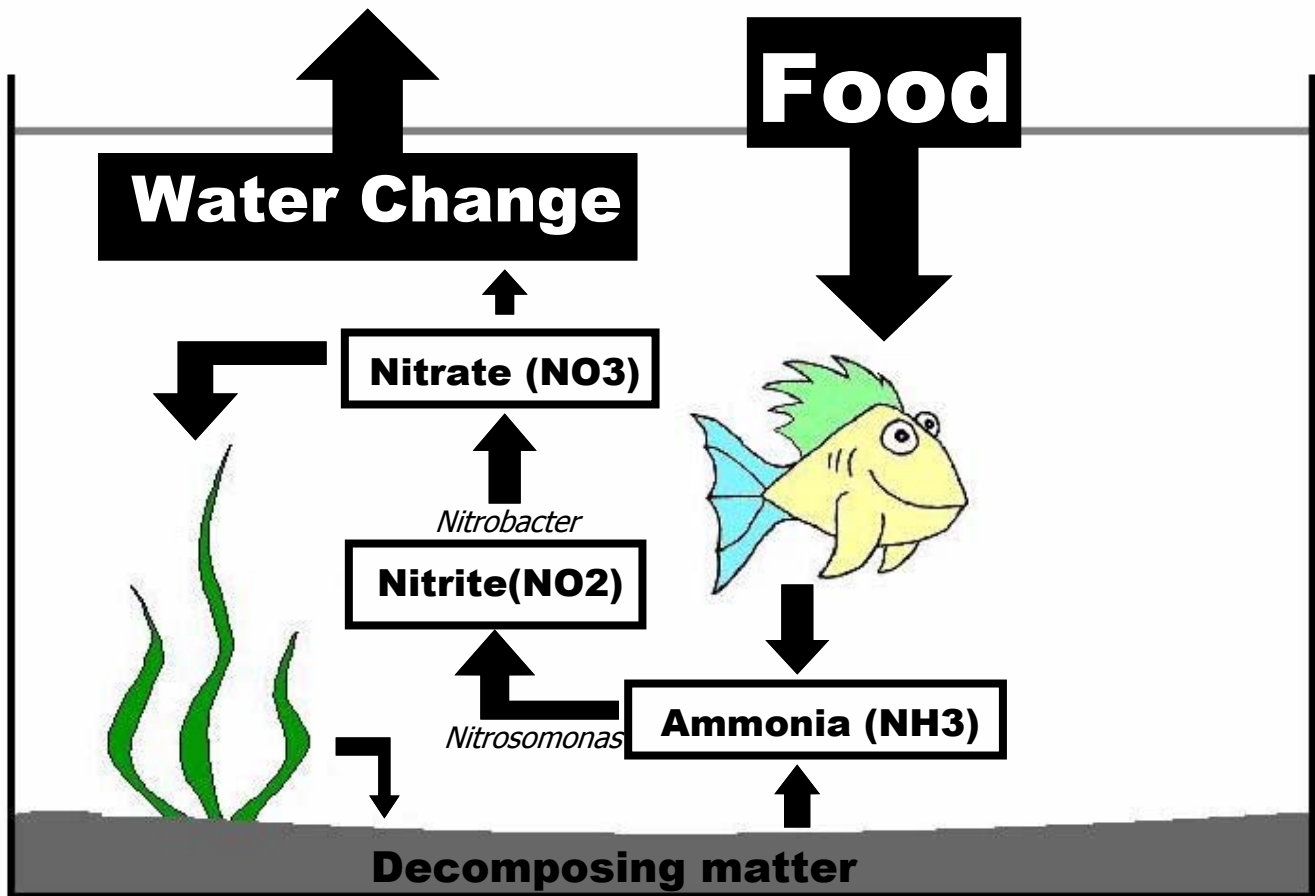


Fish in the Classroom Education Program

The Nitrogen Cycle

The Nitrogen Cycle



Water at a glance appears to be pretty boring stuff. However, many small chemical and biological reactions are constantly taking place in even a small drop of water. In a fish tank, where animals eat, sleep, reproduce, and go to the bathroom, the condition, or quality, of the water is constantly changing.

The waste produced by a fish causes the water to become toxic. In nature, plants, worms, beneficial bacteria, and other

organisms work together to break down the waste created from fish, leftover food, and dead matter. In a healthy, well-established aquarium, the fish waste is consumed in a process called the nitrogen cycle by billions of tiny beneficial bacteria that colonize the gravel and filter media. These bacteria make long term fish care possible. In a new aquarium the bacteria must grow and colonize the tank before many fish can be added. Hobbyists refer to this process as "cycling".

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About the Nitrogen Cycle

Fish produce ammonia in their waste. Even in small amounts, ammonia can burn gills, irritate the skin and eyes and cause internal tissue damage. This ammonia will quickly pollute the water and can kill the fish if it is not eventually removed. In nature, the **ammonia** (NH_4) is converted into **nitrite** (NO_2), and then into **nitrate** (NO_3), by naturally occurring bacteria in a process called **nitrification**. This process can be recreated in the home aquarium, and is necessary for the health of the fish.

Here's how it works: A fish eats some food and goes to the bathroom, producing *ammonia*. Toxic ammonia is oxidized by Nitrosomonas bacteria and converted to *nitrite*. With fish around to produce more ammonia, Nitrosomonas will never run out of food, and will continue to produce nitrite.

Nitrite can also irritate the skin, burn gills, and have a negative effect on the circulatory system, making the fish more susceptible to parasites and disease. Nitrobacter bacteria consume the *nitrite* and produces *nitrate* as an end product. Nitrate is much less toxic to fish, and some aquariums use anaerobic bacteria to convert nitrate into harmless nitrogen gas. Nitrate is eventually removed from most aquariums during a water change.

Getting Started

To get the bacteria to grow in your tank you will need ammonia to feed the bacteria. One technique, called fishless cycling, uses bottled ammonia to start the colony; however it is much easier for a beginner to cycle a tank using a few hearty live fish, especially when used in conjunction with bottled liquid bacteria found in most pet stores.

Your first fish should be hearty fish that can tolerate poor water conditions for extended periods of time. These fish will add the ammonia to the water to jumpstart the nitrogen cycle. Feed these fish sparingly during the first month, and watch them closely for signs of disease. The fish will be exposed to dangerous levels of ammonia and nitrite which will make them more susceptible to parasitic, fungal and bacterial disease. Following the proper methods for cycling a tank will reduce fish stress and illness.

What Happens Next

On the second or third day after adding fish, begin testing the water for ammonia. You should notice it starting to rise (regular tap water has an ammonia reading of 0). **Have students take an ammonia test every day and record the results in your log book and on your graph.** Perform water changes as needed.

Feed your fish sparingly and watch for anything that may indicate health problems, such as rapid breathing, swollen red skin, ragged fins, erratic swimming or attempts to jump out of the water. **If the fish appear to be suffering, perform a water change or add an ammonia-removing aquarium product to the water.** This will slow or halt the cycling process, but it could save the lives of your fish.

Within a week, ammonia levels should still be on the rise. You may notice the water becoming cloudy. This discoloration is caused by the bacteria growing at a rapid rate and is a sign that things are progressing as planned.

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On the seventh day, test the water for nitrite, which should start to form as the Nitrosomonas bacteria use the ammonia and convert it to nitrite. **Continue testing for ammonia and nitrite once a day, and have students record their results on the graph and log book.**

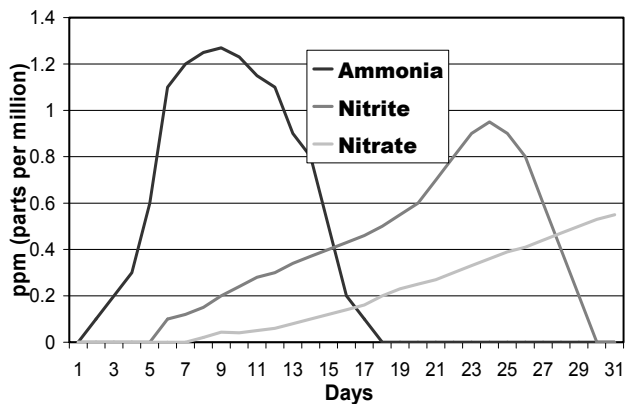
As the days pass you will begin to notice a decline in ammonia levels and a rise in nitrite levels. During this time the Nitrosomonas has grown to keep up with the current amount of fish waste in the tank. The Nitrobacter, however, is just beginning to grow. Over the next few weeks as the Nitrobacter colonizes the tank the nitrite level will rise and then drop. A drop in nitrite indicates that the nitrite is successfully converted into nitrate by the bacteria and that the cycling process is almost complete. Some aquariums will take longer than others to complete this step.

ammonia and nitrite levels once a week. Reasons for any abnormal readings should be uncovered immediately; however the tank will go through "mini cycles" as more fish are added.

Future Maintenance

To keep bacteria levels in your tank healthy, remember that the bacteria colonize the gravel and filter media. When you clean your aquarium by performing a gravel vacuum or a filter change, you are depleting some of the bacteria in the tank. To avoid problems, always keep your gravel wet and never bleach your gravel or rinse it in tap water. Also, never perform a filter change and a gravel vacuum in the same week. If you have to remove the gravel, keep it covered with water from the tank, and if you wish to change the gravel completely, you will have to re-establish the bacteria colonies on the new gravel and re-cycle the tank. Keeping these common sense practices in mind will help to ensure that you will have a beautiful, healthy aquarium.

Nitrogen Cycle Graph



Continue to test and record ammonia and nitrite levels daily until both remain at 0 for at least a week. Now your tank has been cycled and you are ready to add more fish. Begin testing