

- Submitted by Saluki

This article describes the Nitrogen Cycle in basic terms. It is crucial for any aquarist to understand the Nitrogen Cycle on at least a basic level before putting any fish in his or her tank. I cover this topic in two parts. The first part discusses the nitrogen cycle in general terms, and the second part discusses how to cycle a tank.

An Introduction to The Nitrogen Cycle

In order to understand “cycling a tank, you must first understand the Nitrogen Cycle. When we refer to “cycling” what we mean is establishing the nitrogen cycle in your tank. “Nitrogen Cycle” is a term used to refer to the way waste from the fish is naturally broken down from toxic substances to substances that are far less toxic. This is a natural process that will occur anywhere waste from organisms is present whether it is in a lake or stream or in a fish tank.

When fish (or any other organism, including humans) produce waste, one of the chemicals in that waste is ammonia (NH₄). Ammonia is highly toxic to fish and other animals. If it is present in your aquarium at detectable levels, your fish are in danger. Fortunately, there are naturally occurring bacteria that “eat” ammonia. Unfortunately, their waste from eating the ammonia is a class of substances called nitrites (various salts of nitric acid containing the NO₂- radical). Nitrites are also highly toxic to fish. If there are detectable nitrites present in your tank, your fish are in danger.

Again, we are fortunate that there are other naturally occurring bacteria that “eat” nitrites. The

waste from these bacteria contains nitrates (salts of nitric acid containing the NO₃- radical). Nitrates are still somewhat toxic to fish, but not nearly as toxic as ammonia or nitrites. It is acceptable to have relatively low detectable concentrations of nitrates in your tank. For oscars (and other fish susceptible to HITH), you want to keep the nitrates at or below 20 ppm. For other less-susceptible fish, a nitrate concentration of around 40 ppm is acceptable. The only reliable cost-effective way to reduce nitrates in a freshwater tank is through water changes.

Since all of the substances discussed above contain nitrogen, this process of converting ammonia to nitrites to nitrates is collectively called the Nitrogen Cycle. The bacteria that are involved in this process are collectively called "nitrifying bacteria".

How to "Cycle" a Tank

The goal of cycling a tank is to introduce these nitrifying bacteria into some part of the tank and/or tank system. In order to survive and flourish, these bacteria need the following:

Water: The kind of bacteria we want in our tanks live in water. If they dry out, they die. Never let your biomedium dry out.

Oxygen: These bacteria are in a class of bacteria referred to as "aerobic". This means that they need air (specifically, oxygen) to live. If your tank is overstocked (or underfiltered) to the point where the fish are depleting the available oxygen, your bacteria (as well as your fish) will start dying off.

Nutrients: Your tank will only support enough nitrifying bacteria to convert the existing nutrients (waste from the fish) into nitrates. If there were any more, they would starve. If there are less, your bacterial colonies will grow until their numbers are able to exactly handle the load. For this reason, if you suddenly increase the load by adding more fish or feeding more than normal, your tank will experience a “mini-cycle” where ammonia and nitrites will be present until the bacterial colonies grow to meet the new demand.

A Home: Bacteria need a place to live. They can colonize pretty much any hard surface where the other necessities are available, but the insides of a filter provide an ideal environment for the bacteria, with running oxygenated water constantly flowing across the surface. For this reason, you will want some kind of porous media in your filter to act as biomedium.

As long as these requirements are met, nitrifying bacteria will automatically start to colonize your tank as soon as ammonia is present. However, this process of growing bacterial colonies takes time, and this time is commonly referred to as “cycling” a tank.

As fish waste builds up, the ammonia concentration in the tank starts to rise. Meanwhile, ammonia eating bacteria start to colonize the tank. Once this ammonia eating bacteria is present in sufficient numbers, the ammonia levels start to drop. All the while, these bacteria are converting the ammonia into nitrites, so the nitrite levels start to rise in the tank. At this time, the nitrite eating bacteria populations start to grow. When the nitrite eating bacteria population is large enough, the nitrite concentrations will diminish, and the nitrate concentrations will start to build. When ammonia and nitrites are not detected in the tank water, and nitrates are rising steadily, your tank is cycled.

The traditional method of cycling a tank is to place a few cheap hardy fish in the tank, and use them to build up the ammonia necessary to establish nitrifying bacteria in your tank. This method works, and is probably still by far the widest used cycling method, but it has some serious drawbacks. These include:

- The fish normally either die, or suffer permanent damage from ammonia and/or nitrite toxicity. This process is quite hard on the fish. If you try to make it easier on the fish by doing lots of water changes, it will make the cycle take longer.

- The process takes a long time. Average cycling times by this method are around 4 to 6 weeks. It is tough to buy a brand new tank, and have to sit there and look at it with a few small fish in it for a month and a half. The overwhelming temptation is to add more fish. This just leads to more problems.

When you are done, your tank is ready to support the exact load that you had in it during the cycle. If you add more fish, you must do so very slowly (one at a time over several weeks), or your tank will go through more cycles as you add more fish.

Many aquarists use various more modern techniques to cycle their tanks. These include taking a filter from an established tank and putting it on the new tank. This method works well, but is not an option if this is your first tank. For this reason, a technique of fishless cycling has been developed by devoted fishkeepers (originally by Chris Cow, a Ph.D. in Organic Chemistry, but later supplemented by various hobbyists). This involves the addition of chemical ammonia to a tank without any fish to allow the proper bacteria to develop before the fish ever enter the tank. This process is faster than traditional cycling, eliminates the suffering of the fish in the cycling tank, and allows you to fully stock your tank right away after the cycle is complete. It is an all-around winner for the budding aquarist.

For all of the gory details of ammonia and nitrite oxidizing bacteria, and a discussion of their requirements in detail, [please review this article](#)