CYCLING:
STARTING UP AN AQUAPONICS SYSTEM
PART 1

BY SYLVIA BERNSTEIN

NO, CYCLING IN AQUAPONICS HAS NOTHING TO DO WITH BICYCLES... BUT IT DOES INVOLVE GETTING YOUR SYSTEM MOVING! SYLVIA BERNSTEIN EXPLAINS...
Bacteria are the magic in an aquaponics system that convert the fish waste to a near perfect plant fertilizer. In this article, and in future issues, we will de-mystify the process of establishing a beneficial bacteria colony in your aquaponics system. This process is often called system cycling. In this issue, I talk about cycling with fish and in the next issue I’ll go into how to cycle without fish. By the end of these two articles you will fully understand what you must do to initiate cycling and how to ensure its success. You will also understand what you can do to make the process less stressful for your fish and your plants, and what you can do to speed up the process.

**WHAT IS CYCLING?**

Cycling starts when your fish (or you) first add ammonia to your system. Ammonia (chemical formula NH₃) is a compound made of nitrogen and hydrogen. It can come either from your fish or from other sources that we will discuss in the next issue. Ammonia is toxic to fish (more on this later) and will soon kill them unless it is either diluted to a non-toxic level or converted into a less toxic form of nitrogen. Unfortunately, nitrogen as found in ammonia is not readily taken up by plants, so no matter how high the ammonia levels get in your fish tank, your plants will not be getting much nutrition from it.

The good news is that ammonia attracts nitrosomonas, the first of the two nitrifying bacteria that will colonize your system. The nitrosomonas convert the ammonia into nitrites (NO₂). This is a necessary step in the cycling process; however, nitrites are even more toxic than ammonia! But again there is good news because the presence of nitrites attracts the second kind of bacteria we require: nitrospira. Nitrospira convert the nitrites into nitrates, which are generally harmless to the fish and excellent food for your plants. Once you detect nitrates in your water and the ammonia and nitrite concentrations have both dropped to 0.5 ppm or lower, your system will be fully cycled and aquaponics will have officially begun!
To do their testing, most aquaponic gardeners use a product by Aquarium Pharmaceuticals called the API Freshwater Master Test Kit. This kit is easy to use, is inexpensive, and is designed for monitoring the cycling process in fish systems. You will also need a submersible thermometer to measure your water temperature. Temperature affects both the cycling rate and the health of your fish and plants once you are up and running.

**CYCLING WITH FISH**

Ammonia is the ingredient that starts the cycling process. You must have some means to feed ammonia into the system so that you attract the bacteria that are at the heart of aquaponics. There are two ways to introduce ammonia into your system: with fish and without (fishless). In this article we talk about cycling with fish, and tackle fish-less cycling in a future article.

**AMMONIA**

I cycled my first aquaponics system using fish and I suspect this is how most people approach cycling. In some ways it is the easier of the two methods because there are no extra inputs. However, it is definitely the more stressful of the two options because live critters are involved.

The idea is to add fish on day one and hope that they make it through the cycling process alive. The challenge is to get the system cycled fast enough that the ammonia concentration from the fish waste drops to a non-toxic level before the fish succumb from exposure to their own waste. I strongly recommend that you don’t stock to your tank’s mature capacity (1 lb. of adult fish per 5 to 10 gal. of water) but to less than half that. You might also want to consider these fish as sacrificial and perhaps use inexpensive fish from the pet store. They are likely more tolerant of ammonia than the prized game fish with which you may ultimately envision stocking your tank. Also, do not feed these fish more than once a day and then, only feed them a small amount.

"Cycling typically requires four to six weeks to complete. With this is mind, as you proceed you need a way to tell where you are in the cycling process."

To their testing, most aquaponic gardeners use a product by Aquarium Pharmaceuticals called the API Freshwater Master Test Kit. This kit is easy to use, is inexpensive, and is designed for monitoring the cycling process in fish systems. You will also need a submersible thermometer to measure your water temperature. Temperature affects both the cycling rate and the health of your fish and plants once you are up and running.

**CYCLING WITH FISH**

Ammonia is the ingredient that starts the cycling process. You must have some means to feed ammonia into the system so that you attract the bacteria that are at the heart of aquaponics. There are two ways to introduce ammonia into your system: with fish and without (fishless). In this article we talk about cycling with fish, and tackle fish-less cycling in a future article.

**AMMONIA**

I cycled my first aquaponics system using fish and I suspect this is how most people approach cycling. In some ways it is the easier of the two methods because there are no extra inputs. However, it is definitely the more stressful of the two options because live critters are involved.

The idea is to add fish on day one and hope that they make it through the cycling process alive. The challenge is to get the system cycled fast enough that the ammonia concentration from the fish waste drops to a non-toxic level before the fish succumb from exposure to their own waste. I strongly recommend that you don’t stock to your tank’s mature capacity (1 lb. of adult fish per 5 to 10 gal. of water) but to less than half that. You might also want to consider these fish as sacrificial and perhaps use inexpensive fish from the pet store. They are likely more tolerant of ammonia than the prized game fish with which you may ultimately envision stocking your tank. Also, do not feed these fish more than once a day and then, only feed them a small amount.
Fish excrete ammonia through their gills as a bi-product of their respiratory process. Without dilution, removal or conversion to a less toxic form of nitrogen, the ammonia will build up in the fish tank and eventually kill the fish. In addition, ammonia continually changes to ammonium (NH₄⁺) and vice versa, with the relative concentrations of each depending on the water’s temperature and pH. Ammonia is extremely toxic to fish; ammonium is relatively harmless. At higher temperatures and pH, more of the nitrogen is in the toxic ammonia form.

Standard test kits measure total ammonia (ammonia plus ammonium) without distinguishing between the two forms. The chart provided on the following page gives the maximum long-term levels of ammonia in mg/L (ppm) that can be considered safe at a given temperature and pH.
You will need to monitor your tank water daily during cycling for elevated ammonia levels. If those levels exceed the levels on the chart provided, you should dilute through a water exchange by pumping out up to one-third of your tank’s water and replacing it with fresh, de-chlorinated water.

**ADJUSTING pH**

During cycling with fish, you should try and keep your pH between 6 and 7. The range does not go below 6 because most fish prefer slightly alkaline water and few fair well below 6. The range does not go above 7 because of the ammonia toxicity issue described earlier (higher pH readings suggest higher ammonia concentrations). So how do you keep pH in such a tight range? The first rule is, whatever you do to adjust pH in aquaponics, do it slowly! Fast, large pH swings are very stressful on fish and will be much more of a problem than having pH that is out of range. Shift your pH no more than 0.2 per day and you should be fine. The safest way to do this is to use diluted phosphoric acid. Don’t use citric acid as it is antibacterial! If you need to raise pH, alternately add calcium hydroxide—also known as hydrated lime or builder’s lime—and potassium carbonate (or bicarbonate) or potassium hydroxide (pearl ash or potash).

Typically, you will be trying to lower pH during cycling, and then once your system is cycled you will probably notice that the pH will fall and you then need to switch to keeping it up. You will probably find that it is easier...
to increase pH than it is to decrease it. The ideal pH of a mature aquaponics system is 6.8 to 7. This is a compromise between what the plants prefer, i.e., a slightly acidic environment of 5.5 to 6.5, and what the fish and bacteria prefer, i.e., a slightly alkaline environment as we discussed before.

**NITRITE**
Nitrite is to fish like carbon monoxide is to air breathers. The nitrite will bind with the blood in place of oxygen and keep the fish from getting the oxygen it needs. Fish poisoned with nitrites die of what is called brown blood disease. If the nitrite levels in your tank rise above 10 ppm while you are cycling your system with fish, you should do a water exchange as discussed above.

**ADDING PLANTS**
I recommend adding plants to your new aquaponic system as soon as you start cycling. Plants can take up nitrogen in all stages of the cycling process to varying degrees, from ammonia, nitrites and nitrates, but they will be happiest when cycling is complete and the bacteria are fully established because so many more nutrients become available at this stage.

When plants are first transplanted, they focus on establishing their root systems in their new environment. You may initially see some signs of stress—yellowing or dropped leaves—and you will probably not see any new growth for a few weeks. This is fine. Adding plants to your system right away lets them go through the rooting process early on and readies them to start removing the nitrogen-based fish waste from your aquaponics system as soon as possible.

I recommend adding some Maxicrop to get your plants off to a good start during cycling. Maxicrop is derived from Norwegian seaweed, is organic and is used primarily as a growth stimulant, especially to enhance plant root development. It is extremely effective at giving plants a leg up after being transplanted into your new aquaponics system, is absolutely harmless to the fish, and probably beneficial for the bacteria. You can find Maxicrop in garden centers, hydroponic stores and online in both liquid and dry form.
While there are no hard and fast rules about how much Maxicrop to add during cycling, I recommend about a quart of the liquid product for every 250 gal. of water. It will turn your water almost black but don’t worry; this will clear up after a week or so.

**SPEEDING UP THE PROCESS**

Cycling is in some sense akin to any hunting activity that uses a lure. We start by putting out the ammonia. This attracts the nitrosomonas bacteria which in-turn produces nitrites. The nitrites attract the nitrospira bacteria that produce the nitrates that are harmless to the fish and delicious to the plants. These two beneficial nitrifying bacteria are naturally present in the environment. As I stated earlier, this process will take four to six weeks if done with fish, or as little as 10 days to three weeks if done fishless. But what if you could speed that up significantly? What if instead of waiting for the bacteria to show up to the party, they actually are part of the party to begin with? You can do this by introducing nitrifying bacteria into your aquaponics system.
**ADDING BACTERIA**

While there are many ways to do this, they all boil down to two basic strategies: use bacteria from an existing aquaculture or aquaponics operation or from a near-by pond, or instead, purchase bacteria from a commercial source. Good sources of beneficial bacteria from existing systems are ranked here, starting with the best:

- Grow media from an existing aquaponics system
- A high-quality nitrifying bacteria product
- Filter material (floss, sponge, biowheel, etc.) from an established, disease-free aquarium.
- Gravel from an established, disease-free tank. (Many local pet and aquarium stores will give this away if asked.)
- Other ornaments (driftwood, rocks, etc.) from an established aquarium
- Squeezings from a filter sponge (any pet and aquarium store might be willing to do this.)
- Rocks from a backyard pond with fish in it

**MANAGING WATER TEMPERATURE**

Water temperature dramatically affects cycling speed. The optimal temperature range for the water is 77 to 86°F. At 64°F, bacteria growth slows by 50%. At 46 to 50°F it decreases by 75%, and stops all together at 39°F. It will die off at or below 32°F and at or above 120°F.

**IN CONCLUSION**

Cycling with fish is the most widespread and straightforward of the cycling techniques, and it certainly works. However, it is stressful to your fish and therefore somewhat stressful for you. Next month we’ll go over another technique called fishless cycling that uses pure ammonia to cycle your system. Either way, it’s time to get up and grow! MY