PA Trout In the Classroom:

Water Quality

Nitrogen Cycle

Water Changes

The Nitrogen Cycle

Every aquarium establishes beneficial bacterial colonies through the nitrogen cycle, the biological conversion of toxic ammonia and nitrite into harmless nitrogen compounds (nitrates). The nitrogen cycle converts trout waste and uneaten food into safe by-products. Water quality fluctuates because of this cycle.

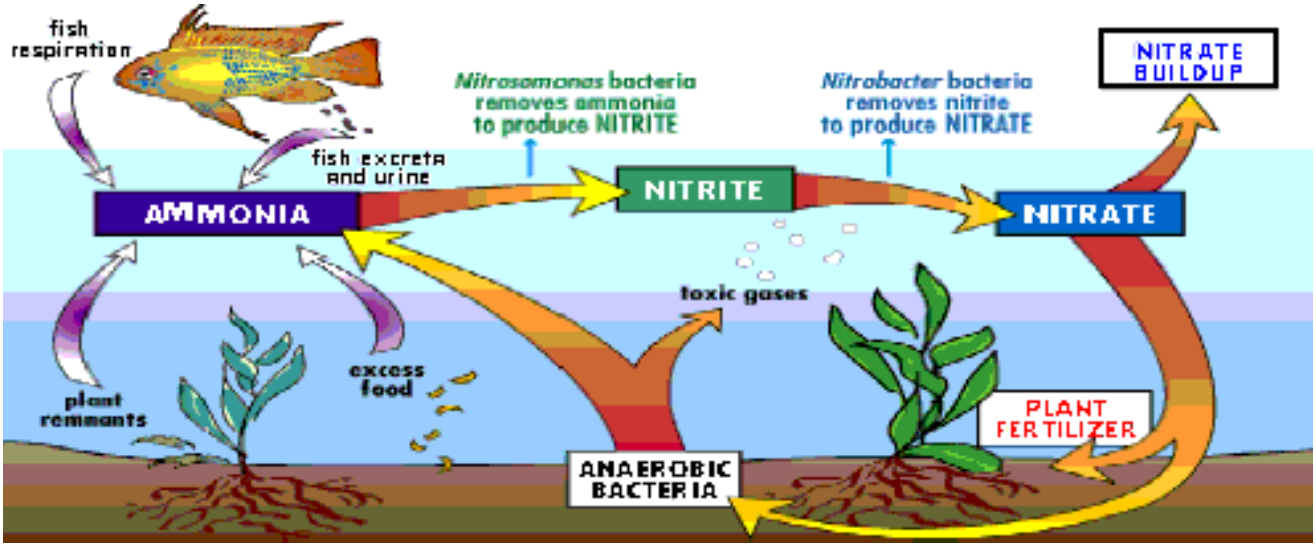


Diagram Credits: *Puffer Net*. N.p., n.d. Web. 23 June 2010 http://puffernet.tripod.com/nitrogencycle.html

CARE TIP: To assist with nitrogen cycling, add biological enhancer (Microbe Lift Special Blend) according to the product instructions to ensure beneficial bacteria colonies flourish in your classroom cold-water ecosystem. UV should be off before adding the enhancer and allow it to remain off for two (2) days for beneficial bacteria to colonize in the aquarium and filter. Once the aquarium has completed the nitrogen cycle, the process is complete and does not require repetition. It is important to remember:

- Stress is an underlying cause of fish death/disease
- Poor water quality is a cause of stress
- Water quality is improved with beneficial bacteria
- Bacteria and filtration work together to keep the aquarium clean for a finite period
- Long-term balance and health of the aquarium ecosystem require routine maintenance such as water changes and testing and maintaining clean filter media

Stages of Nitrogen Cycling

The nitrogen cycle begins when the trout hatches and begins to produce waste.

	Stage One: Add Microbe-Lift Nite-Out II as Product Directs
When	During the sac fry and swim-up stage when trout begin to produce excrement
Mortality	Ammonia spikes from the hatch and failure of some trout to feed will result in mortality.
Outcome	Ammonia levels may increase and remain elevated up to two (2) weeks.
Explanation	The nitrogen cycle begins when the trout begins to produce excrement. All excrement and uneaten food break down to form ionized/unionized ammonia. The freshwater master test kits provide a combined reading of Ammonium (NH4) and Ammonia (NH3).

	Stage Two: Ammonia Levels Decrease and Nitrite Levels Spike
When	
Mortality	Nitrite spikes may cause mortality.
Outcome	Ammonia levels may begin to decrease, and nitrate levels may begin to increase. Nitrites may remain elevated for up to two (2) weeks.
Explanation	Bacteria, Nitrosomonas, growth increases in the filter and converts the ammonia into toxic nitrite. If monitoring results show high nitrite levels, the Nitrobacter are working to establish in the aquarium.

	Stage Three: Nitrite Levels Decrease and Nitrate Levels Spike
When	Five to eight weeks following hatch
Mortality	Mortality decreases as toxic nitrite is converted to nitrate.
Outcome	Nitrite levels decrease, and nitrate levels increase.
Explanation	Nitrobacter convert the toxic nitrites into beneficial nitrates. The aquarium has completed cycling.

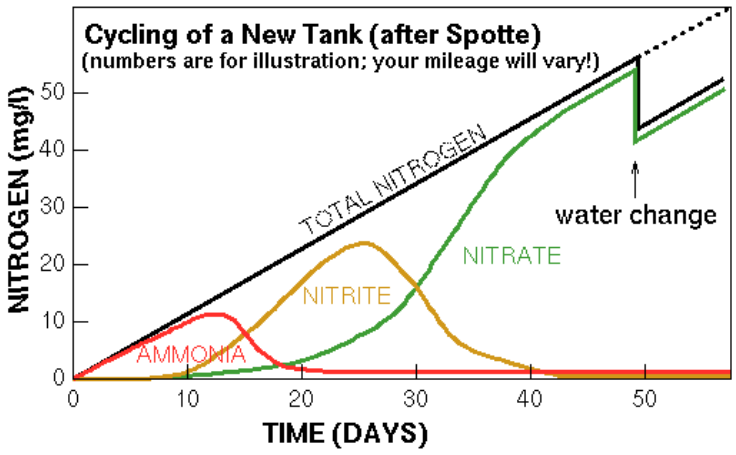


Diagram Credit: Narten, Thomas. *Biginning Fishkeeping*. N.p., n.d. Web. 23 June 2010. http://faq.thekrib.com/begin-cycling.html#cycle

WHAT TO AVOID DURING THE NITROGEN CYCLE

- Avoid changing the water too often. Changing tank water too often will delay the nitrogen cycling process and cause the trout stress. The tank needs to go through the initial ammonia and nitrite spike to cycle through completely. Only conduct a water change if the tank water parameters (i.e. ammonia and nitrites) are too high.
- Avoid changing the filter media in the beginning. Necessary beneficial bacteria are growing there to convert ammonia to nitrites and nitrites to nitrates.
- Avoid overfeeding. A rule of thumb is "when in doubt underfeed trout". Anything going into the tank will produce waste one way or another.

If nitrite and nitrate levels are stable, continue to observe the trout and record any abnormalities such as consistently swimming on their sides, swimming in circles, and/or not eating for several days.

STRUGGLING TO STABILIZE WATER PARAMETERS?

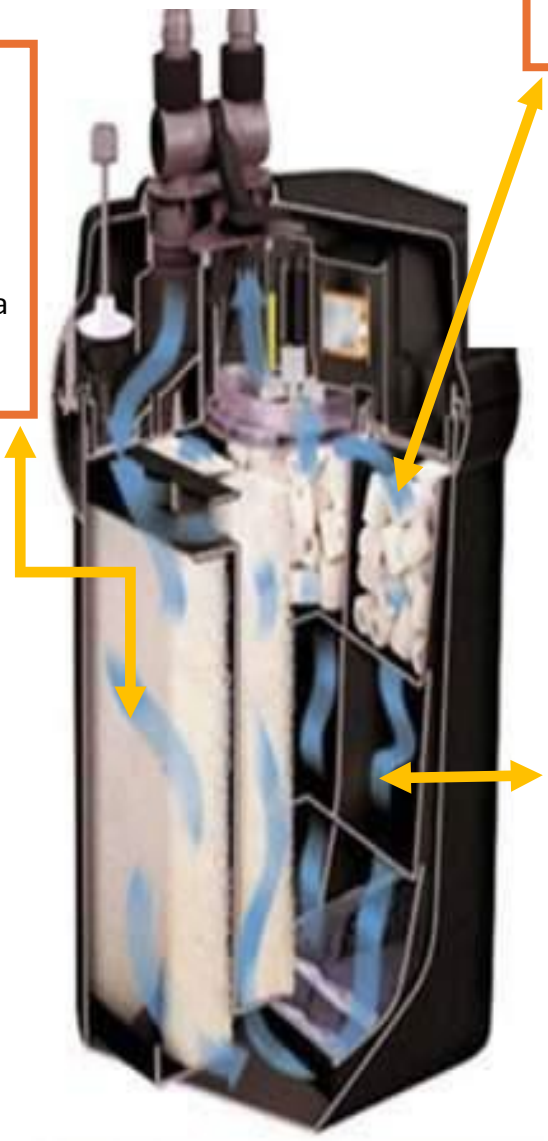
Contact a TIC coordinator with the water parameter data, a picture of the tank/filters, and the concern(s) at:

CONTACT - PENNSYLVANIA TROUT IN THE CLASSROOM

How the Filter System Aids the Nitrogen Cycle

BIOMAX: Ceramic rings with a complex pore system for beneficial bacteria to thrive. It reduces ammonia and nitrite and optimizes water movement to ensure sufficient contact time for biological filtration.

FOAM INSERTS: Inserts capture large particles for effective mechanical filtration. It reduces ammonia and nitrites by providing a large surface area for bacterial growth.



FLUVAL CARBON: A premium, low-ash carbon improves water clarity and color while removing odors. It provides surface area for absorption of impurities.

Monitoring Water Quality Parameters

Consistent monitoring establishes a framework of normalcy specific to your aquarium. If trout are thriving within the parameters of your aquarium, do not change those parameters based on other TIC classrooms or manual guides. What is "normal" for one aquarium may not work well for others. The best practice is to maintain stable water parameters. Regular water changes will keep the parameters stable with your source water. Do not try to adjust pH, hardness and alkalinity unless the release site is extremely different from the aquarium source water. Stabilized water parameters are more important than matching "normal" readings. Every aquarium ecosystem is different even within the same school.

Monitor every other day or every two days to lessen the stress on trout and prolong the life of the test chemicals. A daily monitor may cause undue worry with teachers and students as the aquarium completes the cycling process.

VARIABLES IMPACTING AQUARIUM WATER PARAMETERS	
Location	• Position the aquarium in a low traffic, but well-monitored area. Busyness causes stress. • Avoid positioning the aquarium near direct sunlight and heat sources. Sunlight and heat sources increase water temperature, overwork the chiller, and promote algae growth.
Water Source	Water from springs, creeks, well, and public sources will have differing parameter results.
Substrate	Pebbles, rocks, and wood will impact water parameters differently.
Overfeeding	Unconsumed food increases organic matter decomposition and increases ammonia and nitrite levels.
Mortality	Unremoved dead eggs and trout increase organic matter decomposition and increase ammonia and nitrite levels.
Hands	Failure to rinse hands prior to working with the aquarium introduces soap, body oils, and contaminants.

- **RESOURCE:** Material Safety Data Sheets (MSDS) for the Freshwater Master Test Kit is located at: PENNSYLVANIA TROUT IN THE CLASSROOM - HOME

AMMONIA

A cycled aquarium should have little to no ammonia readings.

ACCEPTABLE AMMONIA LEVELS	
Nitrates present in aquarium *(10ppm-40ppm)*	0 -1 ppm Ammonia is acceptable
Nitrates NOT present in your aquarium	0 - .25 ppm Ammonia is acceptable

How does it form?	Alevins and fry excrete waste leading to the production of ammonium (NH4) and ammonia (NH3).
Two chemical forms of Ammonia	
Ammonia	Favors high pH levels and high temperatures: toxic to trout
Ammonium	Favors low pH levels: not toxic to trout
*** The freshwater master test kit measures both ammonia and ammonium at the same time***	
Ammonia concern	Highly toxic to trout causing gill damage, anemia, and death.
Prevention	Avoid overfeeding and maintain cool water temperatures.

HIGH AMMONIA LEVEL SYMPTOMS AND MANAGEMENT	
Symptoms	Trout exposed to high Ammonia levels will exhibit eroded fin edges and thickened mucus covered gill filaments that cause respiratory distress.
MANAGEMENT	
Immediate	• Conduct small (10%) water changes. Use a siphon to remove any particulates (e.g. food/waste) from the bottom of the aquarium where Ammonia is most likely to develop. If Ammonia levels are higher than .5ppm, a larger 20-25% water change and/or multiple days of water changes may be required until levels drop. • Add biological enhancer (Microbe Lift Special Blend or Stress Zyme). Prime will detoxify the Ammonia, but water changes are still needed. • Avoid feeding the trout for a day or two.
Daily	• Feed smaller amounts of food • Remove excess food with the turkey baster 15-20 minutes following a feed to prevent excess water changes. Target where food is accumulating.

Long term	• Avoid excessive water changes that may disrupt water parameters and aquarium cycling • Continue adding biological enhancing product as directed to ensure beneficial bacteria populations are robust.
Mortality	Ammonia toxicity increases with higher pH levels and water temperatures.

NITRITES

A cycled aquarium should have little to no Nitrite levels (0-0.5 ppm).

ACCEPTABLE NITRITE LEVELS	
Nitrates present in aquarium *(10ppm-40ppm)*	0 -2 ppm Nitrite is acceptable
Nitrates NOT present in your aquarium	0 -.25 ppm Nitrite is acceptable

How does it form?	Ammonium ions mix with the water's beneficial bacteria (Nitrosomonas) and convert Ammonia into Nitrite.
What are Nitrites?	
Nitrites	• Inorganic ions that occur naturally during the nitrogen cycle • Metabolic products of microbial digestion in soil or water that decompose wastes containing organic nitrogen. The process produces ammonia oxidized into Nitrites. • Trout excrement and decaying eggs, fish, plants and food contain organic nitrogen

Concern	• Stress causing:
	  ○ Respiratory hardship
	  ○ Weakened immune system leading to susceptibility to disease, bacterial infections, and death

Prevention	Water monitoring two to three times weekly.

NITRITE POISONING SYMPTOMS AND MANAGEMENT	
Symptoms	Trout exposed to high levels of Nitrite demonstrate: • Lethargy • Congregating at the water surface • Light tan to brown gills • Pale coloration
MANAGEMENT	
Immediate	• Conduct partial water change (25%). • Continue adding biological enhancer (Microbe Lift Special Blend or Stress Zyme) and include a dose of Microbe Lift Nite Out II. • Avoid feeding the trout for a day or two. • Add one tablespoon salt per five gallons to lower trout stress levels and to assist in defending against infections
Daily	• Feed smaller amounts of food • Remove excess food with the turkey baster 15-20 minutes following a feed to prevent excess water changes. Target where food is accumulating.

Sharpe, Shirlie. *Nitrogen Cylce*. N.p., n.d. Web. 22 June 2010. http://freshaquarium.about.com/od/watercare/a/nitrates.htm.

NITRATES

A cycled aquarium should have little to no Nitrite levels (0-0.5 ppm).

ACCEPTABLE NITRATE LEVELS	
Nitrates	5-40 ppm. Nitrate is acceptable

How does it form?	Nitrite mixes with beneficial bacteria and converts Nitrite into Nitrate.
What are Nitrates?	
Nitrates	• Inorganic ions that occur naturally during the nitrogen cycle • Metabolic products of microbial digestion in soil or water that decompose wastes containing organic nitrogen. The process produces ammonia oxidized into Nitrites and then into Nitrates. • Trout excrement and decaying eggs, fish, plants and food contain organic nitrogen
Concern	Nitrates are seemingly harmless; however, levels exceeding 40 ppm. is an indicator that there is too much fish waste and food decay in the aquarium.
Prevention	Water monitoring two to three times weekly. Live aquatic plants naturally remove Nitrates.

HIGH NITRATE LEVEL SYMPTOMS AND MANAGEMENT	
Symptoms	Trout exposed to high levels of Nitrate demonstrate: • Disease Aquariums with high levels of Nitrate demonstrate: • Algae growth • Cloudy water
MANAGEMENT	
Management	• Conduct partial water change (20%-25%). • Add biological enhancer (Microbe Lift Special Blend or Stress Zyme) weekly. • Gravel vacuum waste from the bottom • Check filter foam and pad for waste build up and clean as needed • Drop the aquarium water level just below the filter output to increase aeration at the surface

Sharpe, Shirlie. *Nitrogen Cylce*. N.p., n.d. Web. 22 June 2010. http://freshaquarium.about.com/od/watercare/a/nitrates.htm.

CHLORINE

Chlorine is used to rid public water sources of harmful bacteria.

Concern	Chlorine is lethal to trout.
Prevention	Before using public water sources in the aquarium, contact the local water authority to confirm what chemicals are used to treat the water. Use a water conditioner based on the chemicals used to treat the water source.

REMOVING CHLORINE FROM THE WATER SOURCE
• Fill two (2) five-gallon buckets • Allow the buckets to rest for 48 hours; stir occasionally to aid in dissipating the chlorine. Adding an air stone will speed up the dissipation process as well • Always have two (2) chlorine-free buckets available for water changes or refill emergencies.
TREATMENT OPTIONS

• Use commercial dechlorinates such as:
  ○ Prime
  ○ API Tap Water Conditioner
  ○ AmQuel
  ○ Aquasafe Plus

CHLORAMINES

Chloramines, a combination of chlorine and Ammonia, are a disinfectant used by water treatment facilities to kill bacteria in public water sources. Neutralized by the digestive system, chloramines are safe for human and pet consumption, but are lethal to trout

Concern	Chloramine is lethal to trout. Trout breathe water through their gills, so chloramines enter the bloodstream immediately and impair the ability to absorb oxygen.
Prevention	Before using public water sources in the aquarium, contact the local water authority to confirm what chemicals are used to treat the water. Use a water conditioner based on the chemicals used to treat the water source.

Sioux Falls Water Purification Plant fact sheet

REMOVING CHLORAMINE FROM THE WATER SOURCE
• Before using public water in the aquarium, contact the local water treatment authority to confirm the chemicals used in treatment. • Ensure the labeling specifies the product neutralizes Ammonia.
ALTERNATIVE OPTIONS

• Commercial products to remove chloramines and Ammonia:
  o Seachem Prime
  o Jungle's "ACE"
  o Kent's "Professional Ammonia Detox"
  o Tetra "AquaSafe NH/CL Formula
  o Kordon's AmQuel

Information collected from:Gadd,Chuck. "Chlorine and Chloramines." Chuck Gadd's Planted Aquaria Pages.Ed.Chuck Gadd.N.P,n.d Web 10 June 2010. http://www.csd.net/~cgadd/aqua/art_chlorine.htm

TEMPERATURE

ACCEPTABLE TEMPERATURE	
Ideal Temperature Range	52-56 F
What Does Temperature Affect?	• Ammonia and oxygen • Trout metabolism • Trout stress levels
Prevention	• Ensure the added water during a water change is one to two degrees within the aquarium temperature • Use a digital thermometer to monitor temperature

TEMPERATURE FLUCTUATION SYMPTOMS AND MANAGEMENT	
Symptoms	• Below 38 F will suppress trout appetites and slows digest processes leading to starvation • Above 68 F dissolved oxygen levels lessen causing trout to gasp at the surface of the water and/or crowd near the filter outflow and chiller coil. Lack of oxygen and stress can result in death.
MANAGEMENT	
Management	• Manage temperature with the chiller unit and thermometer readings

pH

ACCEPTABLE pH	
Ideal Temperature Range	6-8.2
What Does pH Affect?	• Stress levels
Prevention	• Monitor parameters two to three times weekly • Maintain pH levels consistent to the water source used in water changes

pH FLUCTUATION SYMPTOMS AND MANAGEMENT	
Symptoms	• Excitable trout jumping out of water or racing • Sluggish trout staying at the surface of the water

MANAGEMENT	
Management	• Conduct partial water changes • Test the source water and aquarium pH. Both waters should be within +0.5 standard pH units to successfully exchange water. • If pH levels are dramatically different between aquarium and source water, conduct 10% water changes daily until aquarium pH mirrors source water pH. • Use commercial reagent pH downer or upper found at pet stores

DISSOLVED OXYGEN

Dissolved oxygen (DO) is the amount of oxygen, measured in parts per million (ppm), that will dissolve in water at a given temperature. Trout are active and consume a lot of oxygen from the water.

ACCEPTABLE TEMPERATURE	
Ideal Dissolved Oxygen Levels	10-12 ppm
What Does Temperature Affect?	• 8 ppm is the minimum for egg and alevin development • 5 ppm is the minimum for fry health
Prevention	• Colder water temperatures increase dissolved oxygen levels

TEMPERATURE FLUCTUATION SYMPTOMS AND MANAGEMENT	
Symptoms	• Reduced appetites • Crowding at incoming water flow • Swimming near the surface with gaped mouths • Rapid gill cover movement
MANAGEMENT	
Management	• Add aeration (air stones) • Lower water levels to create a mini waterfall at the filter outflow • Reduce or stop feeding for a day or two • Decrease trout density if low dissolved oxygen levels persist

WATER CHANGES

Maintaining clean aquarium conditions and hearty bacterial colonies are two (2) key factors for raising healthy trout. Developing a small water change schedule for the aquarium effectively builds a healthy aquarium ecosystem. Monitoring water quality on a weekly basis and understanding what is "normal" for the aquarium helps in establishing a water change schedule.

WHEN TO CONDUCT WATER CHANGES	
AVOID CHANGES:	• No changes are required prior to hatch • No changes are required when water quality parameters are stable and healthy for both trout and aquarium.
CONDUCT CHANGES:	• Changes are required when water quality parameters are abnormal to the baseline standards of the aquarium. Refer to "Water Quality Parameters" • Changes are required if there has been potential contamination • Changes normally begin two-three weeks after feeding begins

BEST PRACTICES

- Small, partial water changes aid in maintaining stable parameters
- Large water changes are not recommended unless it is vital, or small water changes are no longer effective in maintaining parameters
- Develop a water change schedule suitable to aquarium conditions. Every aquarium is different.
- Too many large water changes (greater than 50% water exchange) can affect the Nitrogen Cycle causing trout die-off later in their growth cycle.
- Monitor parameters every two to three days or twice weekly
- Remove dead fish and excess food promptly
- Avoid overfeeding

CONDUCTING WATER CHANGES	

Water changes require fresh, dechlorinated, clean water.	• Two five-gallon buckets of dechlorinated water must always be available
	  ○ Allow two five-gallon buckets to rest for at least 48 hours. Stir occasionally to expedite the dissipation process.
	  ○ Consider adding a de-chlorination agent. De-chlorination agents can be purchased at pet stores.
	• Ensure the exchange water is within a few degrees of the aquarium water. Frozen water bottles or dechlorinated ice may be added to reduce temperatures.

Clean the aquarium.	• Wipe the aquarium sides with a clean, soap-free sponge.
Prime and use the Siphon Kleen or Python Aquarium Vacuum according to directions.	• Use a five-gallon bucket to catch wastewater and any trout accidentally sucked up • Move the vacuum in an up and down motion when cleaning the gravel to roll/spin the gravel for a more thorough clean • Begin cleaning at the most food-dense area • Avoid removing too much water at one time
Add water.	• Slowly add new water to the level prior to cleaning