

## Chapter 8:

### How to maintain a healthy coldwater ecosystem in-class:

- **Nitrogen cycle** (*aquarium cycling*)
- **Water quality parameters**
- **Water changes**

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## Nitrogen Cycle (aquarium cycling)

Every aquarium goes through a process of establishing beneficial bacterial colonies known as the “Nitrogen Cycle” or aquarium cycling. The nitrogen cycle converts trout waste and uneaten food to safe by-products. Water quality fluctuations are a direct result of this cycle.

### Definition:

The biological process that converts ammonia and nitrite (*toxic to fish*) into relatively harmless nitrogen compounds (*nitrites*).

### Nitrogen cycle (*aquarium cycle*) stages, what to expect:

**NOTE:** To assist with aquarium cycling, add your biological enhancer according to directions (e.g. Microbe-Lift Special Blend. This will ensure good bacteria colonies flourish in your mini “coldwater ecosystem”. Your UV should be OFF before you add the enhancer. Leave it OFF for at least two days to allow the new bacteria to colonize in the aquarium and filter. Then turn it back ON.

### When does it begin:

The aquarium cycle will not begin until your trout hatch from their eggs and begin to excrete waste.

Stage 1 (ammonia spike) – Begin adding Microbe-Lift Nite-Out II according to directions	
When	Late November – early/mid December; When trout begin to excrete waste ( <i>sac fry and/or swim-up fry stage</i> )
Trout mortality/stress	Yes. You will experience trout mortality/stress during this stage not only because of the ammonia spikes, but also because trout that do not learn to feed will also be dying off.
What happens	Ammonia levels may increase and will stay elevated for 2 weeks until stage 2 begins.
Explanation	The cycle begins when your fish begin to excrete waste in your aquarium system. All waste and uneaten/decaying food breaks down to form ionized/unionized ammonia. The freshwater master test kits ammonia test gives a combined reading of Ammonium (NH <sub>4</sub> ) and Ammonia (NH <sub>3</sub> ).
Stage 2 (Ammonia decreases and nitrites spike)	
When	Late December – early/mid January
Trout mortality/stress	Yes. This is the stage when there will be another trout “die off” because of the nitrite spikes.
What happens	Ammonia levels should begin to decrease and nitrite levels will begin to increase. Nitrites will remain high for at least 2 weeks.
Explanation	Bacteria called “nitrosomonas” grow to sufficient quantities in the filter and then convert the ammonia to toxic nitrite. IF your monitoring results show high nitrite levels the “nitrobacters” are still trying to get established in the aquarium.
Stage 3 (nitrite decreases and nitrate spikes)	
When	January – early February (usually about 5-8 weeks after your trout hatched)
Trout mortality/stress	Very few if any. There is usually no die off at this time because the toxic nitrite is begin converted to less toxic nitrates
What happens	Nitrite levels begin to decrease and nitrate levels (not toxic) begin to increase.
Explanation	Nitrobacters convert the toxic nitrites to less toxic nitrates. Once your aquarium reaches this point it is said to have “cycled”.

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# Nitrogen Cycle

## *How it works in your aquarium*

**Make sure you add your biological enhancer (e.g. Microbe Lift Special Blend) when you first set-up your aquarium (directions for a “new” aquarium set-up). Once your aquarium has completed its nitrogen cycle (e.g. when nitrates become present), you no longer need to continue this process.**

### **What NOT to do during the nitrogen cycle:**

- Do not change your aquarium water too often. Changing your aquarium water too often will delay your aquarium cycling process and STRESS your trout. Only change water if your parameters (i.e. ammonia and nitrites) are off the charts. Your aquarium needs to go through the initial ammonia and nitrite spike in order to cycle through completely.
- Don't change filter media in the beginning – beneficial bacteria are growing there. Remember they are needed to convert ammonia to nitrites and then nitrites to nitrates.
- Don't overfeed– when in doubt underfeed your trout.
- Remember that anything going into the aquarium will produce waste one way or another.

If your nitrite and nitrate levels are good, continue to observe the trout and record any abnormalities (e.g. consistent swimming on their sides, swimming in circles, not eating for several days).

***Weekly or once every other day water testing, not overfeeding your trout and conducting water changes based on your water quality test results, will keep your aquarium and fish healthy!***

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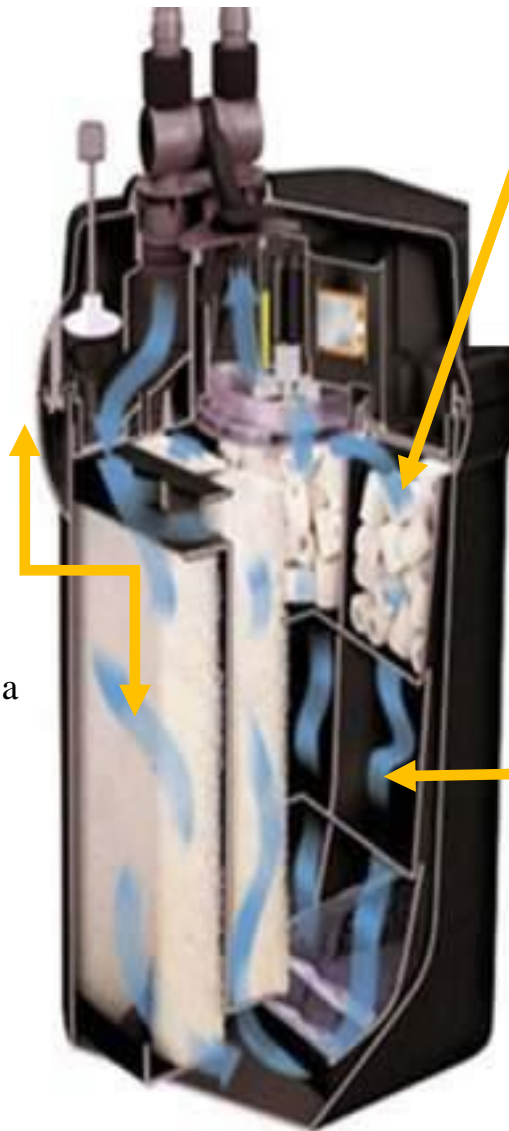
# Nitrogen Cycle

*Filter components that aid in the nitrogen cycle*

## *407 Fluval Canister Filter*

### **Foam Insert:**

Inserts that capture large particles for effective mechanical filtration. It helps reduce ammonia and nitrites by providing a large surface area for bacteria growth.



### **BioMax:**

Ceramic rings that have a complex pore system where beneficial bacteria can thrive. It helps reduce ammonia and nitrite. Also, the rings allow for ideal water movement, which ensures optimal contact time for biological filtration.

### **Fluval Carbon:**

A premium, low-ash carbon that improves water clarity and color, while also removing odors. It provides a great amount of surface area for absorption of impurities.

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# Nitrogen Cycle

## Diagram

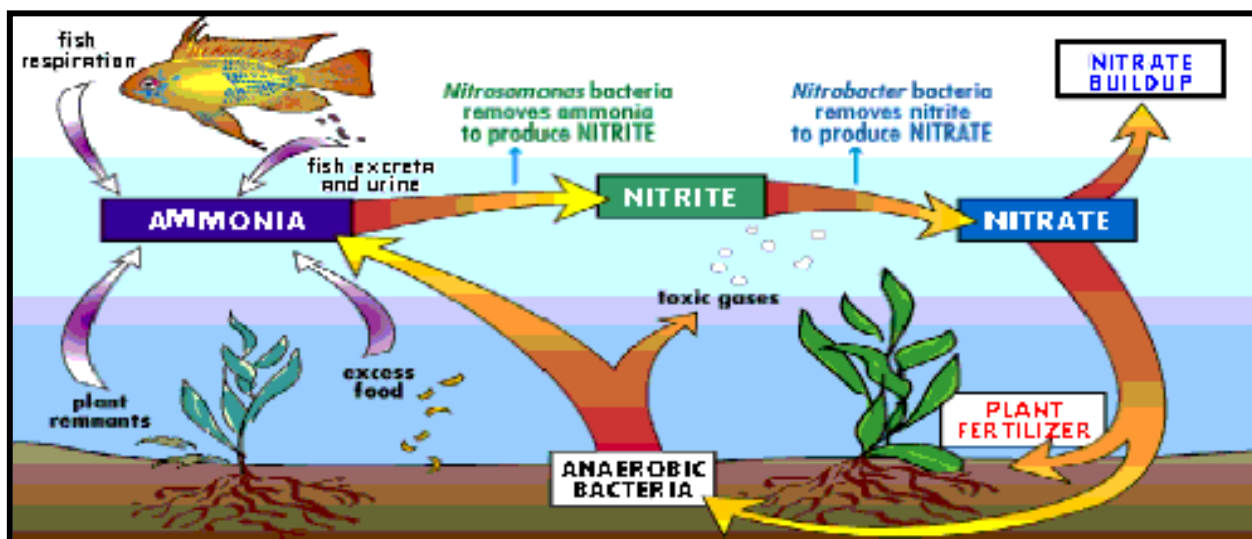


Diagram found at: *Puffer Net*. N.p., n.d. Web. 23 June 2010  
<http://puffernet.tripod.com/nitrogencycle.html> .

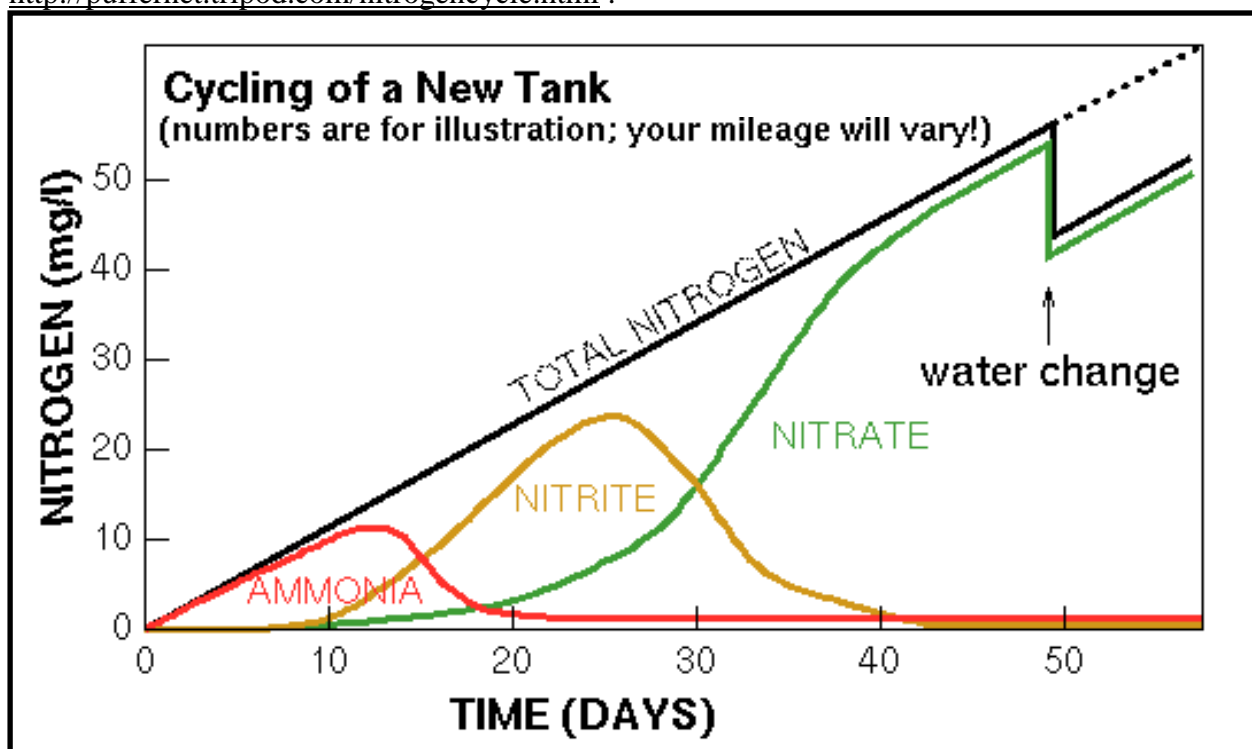


Diagram found at: Narten, Thomas. *Beginning Fishkeeping*. N.p., n.d. Web. 23 June 2010.  
<http://faq.thekrib.com/begin-cycling.html#cycle>  
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## Water Quality Parameters (Overview)

Parameters to be monitored	Optional parameters you may test	Parameters to check with water authority <i>** Both parameters, <u>in any concentration</u>, are LETHAL.</i>
Nitrites & Nitrates	Dissolved oxygen	Chlorine (Lethal in any concentration)
Temperature	Total dissolved solids	Chloramines
pH	Alkalinity	
Ammonia		

Consistent monitoring, *at least 2-3 times a week*, provides you with a picture of what is “normal” for your aquarium. If your trout are thriving within the parameters of your aquarium DO NOT change your parameters based on other TIC classrooms. What is “normal” for their aquarium may not be best for your trout. Your best friend regarding water parameters are to keep them stable. Regular water changes will keep the parameters stable with your source water. **DO NOT** try to adjust pH, hardness and alkalinity unless your release site is extremely different from your aquarium source water. The stability of your parameters is much more important than matching “normal” readings. Every aquarium is different, even in the same school.

When to monitor		
Once every other day or once every two days		
Reason for less monitoring	Less interaction = less stress on trout	Prolongs the life of your test chemicals
	Decrease worries for teachers and students while the aquarium goes through the cycling process	

Variables that impact aquarium water parameters	
Aquarium location	Hallways/unmonitored classroom = sabotage; trout stress from constant crowds
	Close to window with direct sunlight = increased temperatures & chiller use; algal growth
	Close to heaters = fluctuating temperatures
Water source	Water from springs, creeks, public will all have different parameter results
Type of substrate	Pebbles, rock, wood will all impact water parameters depending on the type
Overfeeding	Too much food increases organic matter decay = increased ammonia & nitrites
Dead eggs/fingerlings	Increase levels of decaying organic matter = increased ammonia & nitrites
Rinsing hands	NOT rinsing hands before working with aquarium introduces soaps; oils; contaminants to aquarium

**Safety note:** Material Safety Data Sheets (MSDS) for the Freshwater Master Test Kit is on the PA TIC website.

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## Ammonia

<b>How do they form</b>	As alevins and fry develop and grow while excreting waste, both ammonium ions (NH <sub>4</sub> ) and ammonia (NH <sub>3</sub> ) are produced.
<b>Two chemical forms of ammonia</b>	
Ammonia	Favors high pH levels and high temperatures: toxic to trout
Ammonium	Favors low pH levels: not toxic to trout
<i>** your freshwater master test kit measure both ammonia and ammonium at the same time**</i>	
<b>Ammonia concern</b>	Highly toxic to trout
	High levels cause gill damage, anemia and death
<b>Prevention</b>	Do NOT overfeed. Main cause of ammonia increases
	Maintain cool water temperatures

### Ammonia issues:

<b>Symptoms</b>	Respiratory stress
	Trout exposed to high ammonia levels over time will exhibit eroded fin edges and thickened mucus covered gill filaments
<b>Remedies</b>	
Immediate	Conduct small (10%) water changes. When doing this use your siphon clean and take water and any particulates (e.g. food/waste) from the bottom of your aquarium. That is where ammonia will settle most. If ammonia levels are higher than .5ppm may require a larger 20-25% water change and/or multiple days of water changes until level drops
	Continue to add your biological enhancer (e.g. Microbe Lift Special Blend or StressZyme). Prime will detoxify ammonia, water change still needed to remove.
	Do not feed your trout for a day or two
Daily	Feed smaller amounts of food
	Use a turkey baster to take out excess food 15-20 minutes after trout feed. This will prevent excess water changes and targets areas where food tends to accumulate.
Long term	Do NOT conduct too many water changes. Too many water changes = aquarium not cycling
	Ensure that your good bacteria populations are healthy by continuing to add your biological enhancing product per its directions.
<b>Mortalities</b>	The toxicity of ammonia increases with higher pH levels and water temperatures

### Acceptable ammonia levels for brook trout:

Nitrates present in aquarium (10ppm-40ppm)	0 -1 ppm ammonia is O.K.
Nitrates NOT present in your aquarium	0 - .25 ammonia is O.K. any higher will stress trout
<b>A cycled aquarium should have little to no ammonia readings.</b>	

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## Nitrites and Nitrates

(Information on nitrites and nitrates were collected from: Sharpe, Shirlye. *Nitrogen Cycle*. N.p., n.d. Web. 22 June 2010. <<http://freshaquarium.about.com/od/watercare/a/nitrates.htm>>.)

About nitrite (NO <sub>2</sub> <sup>-</sup> ) and nitrate (NO <sub>3</sub> <sup>-</sup> ):		
What are they	Inorganic ions that occur naturally and are part of the nitrogen cycle	
	Metabolic products of microbial digestion in soil or water that decomposes wastes containing organic nitrogen. This process produces ammonia which is then oxidized into nitrites and then nitrates.	
Wastes that contain organic nitrogen	Animal feces	Decaying plants; animals; food

### Nitrites:

How do they form	When ammonium ions (NH <sub>4</sub> <sup>+</sup> ) mix with water the beneficial bacteria ( <i>nitrosomonas</i> ) can then convert ammonia to nitrite (NO <sub>2</sub> <sup>-</sup> ).
Nitrites are toxic to trout	Increased levels of nitrites causes stress on trout.
	Stress leads to respiratory hardship and a weakened immune system, which makes the trout more susceptible to disease, bacterial infections and death.
Prevention	You need to test for nitrites each time you monitor your aquarium (2-3 times a week)

### High nitrite issues: (*nitrite poisoning*)

Symptoms	Lethargy & congregating near the water surface
	Light tan to brown gills
	Tan to brown looking blood ( <i>in this case your trout would appear pale in color</i> )
Remedies	Partial water change (25%)
	Dose your aquarium with Microbe Lift Nite Out II and continue to add your bacterial enhancer per its directions (e.g. Microbe Lift Special Blend or StessZyme)
	Do not feed your trout for a day or two
	Addition of salt to “de-stress” your trout and help fight off infections (Follow Aquarium Set Up, page 34) 1 tablespoon/5 gallons

### Acceptable levels of nitrites (*as experienced by the TIC staff with Trout In the Office (TIO)*)

Nitrates present in aquarium ( <i>10ppm-40ppm</i> )	0 – 2 ppm nitrites is O.K.
Nitrates NOT present in your aquarium	0 - .25 ppm nitrites is O.K. any higher will stress trout
A cycled aquarium should have little to no ammonia or nitrite readings (0-.5).	

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## Nitrites and Nitrates Continued...

### Nitrates:

<b>How do they form</b>	When nitrite ( $\text{NO}_2^-$ ) mixes with water the beneficial bacteria ( <i>nitrobacters</i> ) will convert nitrite ( <i>toxic</i> ) to nitrate ( $\text{NO}_3^-$ ) ( <i>harmless when at low levels 10ppm – 40ppm</i> )
<b>Nitrates are seemingly harmless</b>	Nitrate can and is usually present in aquarium to a certain extent.
	At levels below 40ppm it is harmless; however, readings at/over 40ppm will begin to stress your trout.
	Nitrate readings at/over 40ppm is an indication that there are too many fish and/or waste in your aquarium.
<b>Prevention</b>	You need to test for nitrites each time you monitor your aquarium (2-3 times a week. Live plants will remove nitrates from water

### High nitrate issues:

<b>Symptoms</b>	Diseased, unhealthy fish
	Algae growth: Nitrates promote growth of algae which creates cloudy water. The algae growth will eventually increase your amounts of ammonia and nitrites.
<b>Remedies</b>	Partial water change (20-25%)
	Add bio enhancer product (Microbe lift Special Blend or StressZyme) weekly
	Increase aeration at the surface of your aquarium water by dropping the water level just below the filter output

### Acceptable levels of nitrate (*as experienced by the TIC staff with Trout In the Office (TIO)*)

<b>5 – 40 ppm</b>	Nitrate at these levels will not stress your trout
<b>What to do if they are higher than 40ppm</b>	Partial water change (20-25%) Gravel vacuum waste from bottom, check filter foam and pad for buildup of waste and clean if necessary
	Make sure you add your biological enhancer (e.g. Microbe Lift Special Blend or StressZyme) after your water change according to the directions

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## Chlorine and Chloramines

Many water companies have switched from chlorine to chloramines to treat water.

<b>Concern</b>	Chlorine and chloramines are both lethal to trout.
	Unlike chlorine, chloramines cannot be removed by allowing your water to sit for 48 hrs
<b>What to do</b>	BEFORE using public water for your aquarium, contact your local water authority to see what they treat their water with
	Depending on what they treat the water with will determine what type of water conditioner you should use.

### Chlorine

Chlorine is typically what most water authorities treat their water with to rid public water sources of harmful bacteria.

#### **How to remove chlorine from your water:**

<b>1.</b>	Fill up two 5 gallon buckets. DO NOT use gallon jugs, they do not provide enough surface area of water for proper chlorine dissipation.
<b>2.</b>	Allow the buckets to sit for at least 48 hours before placing them into your aquarium
<b>3.</b>	While your buckets are sitting, you should also occasionally stir the water to help dissipate the chlorine more rapidly. If you have a small air pump and air stone, adding an air stone will help the chlorine dissipate faster.
** Always have at least 2 chlorine free buckets available for water changes**	

#### **Other options:**

##### **You can also use commercial dechlorinators such as:**

Prime	AmQuel
API Tap water conditioner	Aquasafe Plus

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## Chlorine and Chloramines Continued...

**Chloramines** (*content below was modified from: Sioux Falls Water Purification Plant fact sheet*)

Chloramines are another type of disinfectant used by water authorities to kill harmful bacteria in water. They are a combination of chlorine and ammonia. Chloramines are safe for humans and other animals because when water containing chloramines are swallowed they are neutralized by the digestive system before reaching the blood stream.

<b>Concern</b>	Chloramines are lethal to trout. They, unlike humans and other animals, do not just swallow water they breathe it; therefore, the chloramines enter directly into their blood stream, making it difficult for their blood to carry oxygen.
	Cannot be removed by allowing your water to sit out for 48 hours
<b>What to do</b>	BEFORE using public water for your aquarium, contact your local water authority to see what they treat their water with
	Depending on what they treat the water with will determine what type of water conditioner you should use.

### How to remove chloramines:

(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](http://www.csd.net/~cgadd/aqua/art_chlorine.htm))

1.	Use a commercial dechlorinator that specifically states that it also removes ammonia	
Products that remove chloramines and ammonia:		
	Seachem Prime	Tetra “AquaSafe NH/CL Formula
	Jungle’s “ACE”	Kordon’s “AmQuel”
	Kent’s “Professional Ammonia Detox”	
If the label doesn't specifically mention that it neutralizes ammonia, then don't depend on it to safely treat water containing chloramines.		

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## Temperature and pH

### Temperature

<b>Ideal temperature range for trout</b>	52-56 °F
<b>What does temperature affect</b>	Ammonia and oxygen concentration
	Trout metabolism
	Sudden increase or decrease will stress trout in any life stage
<b>Prevention</b>	When doing a water change, make sure the new water is within 1-2 degrees Fahrenheit of water in the aquarium.
	Use a standard aquarium and digital thermometer to monitor temperature.

### Temperature issues:

<b>Symptoms</b>	Below 38°F will suppress fish appetites and slows digest processes.
	Above 68°F = partial digestion of food and holds less dissolved oxygen. Trout will gasp for oxygen at water surface and crowd near the filter outflow and/or chiller coil.
<b>Remedies</b>	Adjust temperatures accordingly using the chiller unit and thermometer.
<b>Mortalities</b>	Cold water (below 40°F) leads to starvation.
	Warm water (above 68°F) die from lack of oxygen and stress.

### pH

pH is an indicator of water acidity or alkalinity. pH values range from 1 to 14. A pH of 7 is neutral.

<b>Ideal pH range for trout</b>	6 – 8.2
<b>What does temperature affect</b>	A sudden increase or decrease will cause severe stress or death of trout.
<b>Prevention</b>	Monitor your parameters at least 2-3 times per week
	Don't increase or decrease pH if it doesn't match other TIC aquariums. Should remain close to your source water you use for water changes.

### pH issues:

<b>Symptoms</b>	Severe cases trout will become excited, jumping out of water, racing back and forth.
	Mild cases your fish may become sluggish and stay near the surface of the water.
<b>Remedies</b>	Conduct partial water change. Know the source water pH and aquarium pH. They should be within +0.5 standard pH units to safely exchange the water. If drastically different perform small (10%) water changes daily until it is close to source water.
	Use store purchased reagent: pH “downer” or pH “upper”; purchase at local pet store
<b>Mortalities</b>	Death may occur immediately or shortly after a rapid change in pH

# Dissolved Oxygen

## Dissolved Oxygen

Dissolved oxygen (DO) is defined as 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.

<b>Ideal dissolved oxygen levels</b>	10-12 ppm
	8ppm is the absolute minimum for developing eggs and alevins
	5ppm is the absolute minimum for fry
	The colder your water the MORE dissolved oxygen you will have

### Low dissolved oxygen issues:

<b>Symptoms</b> <i>(usually occurs at DO levels less than 6ppm)</i>	Trout reduce eating; crowd incoming water flow; swim near the surface with gaped mouths; display rapid gill cover movement
<b>Remedies</b>	Add aeration (additional airstones) and lower water level so that your filter outflow creates a mini waterfall.
	Check your water temperature: decrease slowly if needed
	Reduce or stop feeding for a day or two
	Decrease fish density if low dissolved oxygen levels persist
<b>Mortalities</b>	Death will accelerate quickly until the issue is resolved

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## Water changes

Keeping the aquarium clean (*i.e. free of extra food and other decaying matter*) and bacterial colonies healthy are two important jobs for all TIC aquariums. Developing a small water change schedule for your aquarium is a great way to keep your overall system healthy.

Monitoring your water quality on a weekly basis and knowing what is “normal” for your aquarium is key to understanding your TIC aquarium and whether or not it needs a water change. What is “normal” or suitable for your aquarium may not be for another TIC classroom aquarium.

### When to conduct water changes:

<b>Do NOT conduct water changes</b>	When your trout are still eggs water changes are not needed until after the trout begin to produce increased levels of waste.
	When water quality parameters are at a healthy level for <u>your trout</u> and <u>your aquarium</u> .
<b>DO conduct water changes</b>	If your water quality parameters are abnormal according to your “normal” aquarium readings ( <i>Refer to the “water quality parameter” section of guide</i> )
	If you fear other contaminants were placed into the aquarium
<b>Generally water changes do not begin or are not necessary until about 2-3 weeks after you begin feeding them.</b> <b>Small partial water changes are a great way to keep your parameters stable and provide fresh clean water to your fish. Large water changes are not recommended unless it is vital (nitrogenous compounds are extremely high) or small water changes do not fix the water quality problem.</b> <b>Develop a water change schedule to suit your aquarium as every aquarium is different.</b> <b>(e.g. 10% weekly, 10-20% biweekly, 20-25% monthly)</b>	

<b>Too many LARGE water changes</b>	Too many large water changes (>50%) can throw off your Nitrogen Cycle.
	If the aquarium never cycles you may have a trout die off later in the year.

### How to keep aquarium water healthy:

<b>1.</b>	Monitor all parameters every two or three days. At least twice a week.
<b>2.</b>	Remove dead fish. One dead fish can/will spread disease. ( <i>You can use a turkey baster to remove small fish and the siphon clean vacuum when they are 1” or more</i> )
<b>3.</b>	Do NOT overfeed
<b>4.</b>	Using a turkey baster remove excess food after feeding your trout

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# Water changes

## *Continued...*

Conducting water changes:	
<b>1.</b>	Water changes need to be done with fresh, dechlorinated, clean water
a)	You should always have at least two 5 gallon buckets of “aged”/dechlorinated water ready at ALL times
i.	How to “age” water = fill two 5 gallon buckets of water and allow them to sit out for at least 48 hours. Stir the water occasionally to help dissipate the chlorine
ii.	In addition to “aging” your tap water, you may also use a dechlorination agent. This item can be purchased at a local pet store. <ul style="list-style-type: none"> <li>If using aged water make sure the temperature is within a few degrees of aquarium, dechlorinated ice or frozen water bottles may be necessary to drop the bucket temperature.</li> </ul>
<b>3.</b>	Clean the sides of the aquarium using only a sponge (NO SOAP)
<b>4.</b>	Prime and use the Siphon Kleen or Python aquarium vacuum according to the instructions
a)	Use a 5 gallon buck to catch the waste water. This will help catch any trout that get sucked into the vacuum.
b)	When using the aquarium vacuum, move it up and down when cleaning the gravel so that it rolls/spins around in the vacuum. This will allow you to clean the gravel more thoroughly.
c)	Make sure you start cleaning in the areas where you typically feed the trout, then move on to other areas.
d)	Work quickly as the vacuuming process does stress the trout.
e)	Make sure you don’t take too much water out at a time. It is easy to lose track when cleaning.
<b>6.</b>	As you clean the aquarium using the gravel cleaner; you will remove about 5 gallons of water.
a)	When you are done cleaning the gravel, add new water up to the level it was before cleaning.
b)	If you change more than 25% of the water make sure the new water is the same temperature as the aquarium water. If it is not you run the risk of “shocking” your trout.
c)	Plan ahead, if you plan on changing out 25% you should refrigerate or store your dechlorinated water outside if it is cold enough before adding it to your aquarium.
d)	Add the water slowly, trying not to create a major disturbance to your trout

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# **Chapter 9:**

# **Record Keeping**

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