Stress Free Water Quality for Koi Owners

Good water quality is easiest way to keep your fish healthy!

Fish interact with their aquatic environment in many ways. Primarily, fish use their gills, skin and kidneys to take in and excrete water. The gills, most importantly, take up the oxygen in the water in exchange for carbon dioxide, while purging waste from the blood. The gill tissue is very sensitive to changes in the water around them. A fish's skin is protected from the water around it by a protective mucous coating. This slimy layer is a major barrier for a fish's immune system, containing antibodies and acting as a physical barrier. Lastly, a freshwater fish exists in an environment that is less dense than itself, which means water is constantly being taken up by a fish through its mouth, skin and gills. A fish in freshwater needs high functioning kidneys to remove the excess water and excrete it out as urine. Thus, the water a fish swims in is constantly being taken into a fish's body and consequently removed, or else the fish would swell and burst. All of these factors indicate how important water quality is in a fish's home environment. Any changes to any of these systems can lead to poor fish health and possibly death.

The way your water circulates around your fishes' home is important, too. Circulation pumps and filters are crucial in a pond habitat. Circulation pumps move water around your pond, making sure there are no dead spots to nurture toxic waste collection. Filters are broken into mechanical and biological systems. Mechanical filters remove debris from the water, such as leaves, sediment and other debris. Biological filters are home to millions of tiny bacteria colonies, responsible for converting harmful biological products (fish waste is primarily ammonia) into more neutral compounds. It is important that every pond has circulation pumps and both biological and mechanical filters in order to function properly.

Note: mg/L = ppm

Components of Water Quality

Nitrogen (Ammonia/Nitrite/Nitrate)

Ammonia is the main product of fish excretions (urine/feces). Ammonia, in other forms, is found in some household cleaners. High levels of ammonia are very toxic to fish. This is where your biological filters come in handy. Two main types of bacteria are responsible for breaking ammonia down into nitrite (NO_2^-) and then further down into nitrate (NO_3^-). Nitrite is another highly toxic compound and can cause a disorder called "Brown Blood Disease", or methemoglobin, by crossing into the blood through the gills and binding with hemoglobin, which creates methemoglobin. Hemoglobin is responsible for transporting oxygen in the blood, but cannot do this in the methemoglobin form. Essentially, methemoglobinemia causes a fish to suffocate since it cannot get any oxygen to its internal organs. Converting nitrite into nitrate protects the fish from a dangerous fate! Nitrate can be taken up by plants and used as food.

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However, most of the time, nitrate is removed from a system via regular water changes. No matter how many plants you have in your system, you should still perform water changes. Nitrate levels should be kept <20 mg/L. Ammonia and nitrite levels should be 0 mg/L.

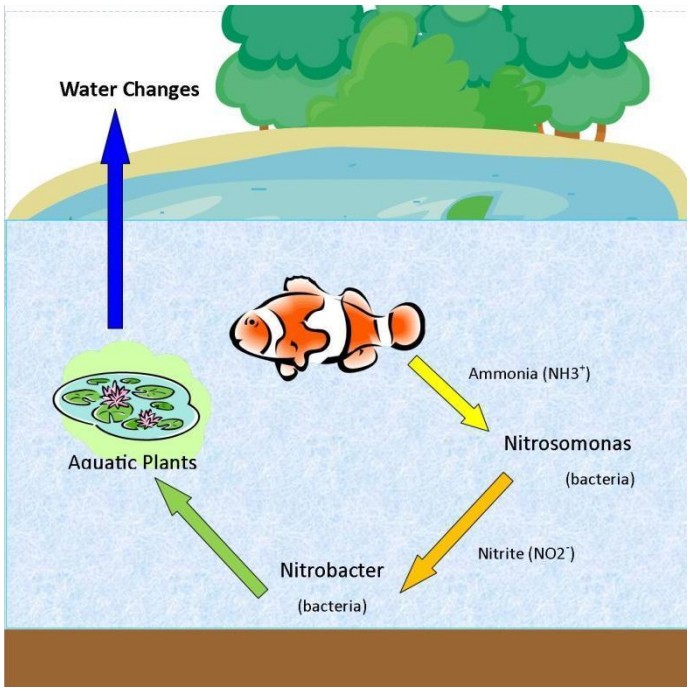

Figure 1: The Nitrogen Cycle

Oxygen

Oxygen is vital for the survival of all underwater animals. Instead of having lungs, like humans and marine mammals, fish take up oxygen through their gills. Oxygen can diffuse into the delicate gill tissue and binds to hemoglobin in the blood before being pumped all over the fish's body. Over the course of the day, oxygen levels change depending on fish activity and water temperature. Cold water is denser, and therefore can hold more oxygen. Pond features such as waterfalls and fountains are a great way to add aeration to your pond. Make sure to run these features all day and night long, so the fish have a constant source of fresh oxygen. If you do not have these features, airstones fed by aerators (air pumps) are easy additions. The airstone diffuses the flow of air into the pond, making it easier for the oxygen in the air to mix into the water. The minimum level of dissolved oxygen in your pond/tank should be 8-12 mg/L.

pH and Alkalinity

The pH of water is a measurement of the free hydrogen ions dissolved in the solution. Very acidic solutions have a lower pH (1-5), such as stomach acid, where very basic solutions have a higher pH (9-12), such as drain cleaner. Most koi are happy in a pH around 7-8, with specific species being more or less tolerant. The most important thing about pH is that it does not swing through a wide range throughout the course of a day. A pH of 7.4 rising to 7.6 is the most

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change you want to see over the course of a day. In order to protect against swings in pH, your water must contain buffers. Buffers are compounds that bind to hydrogen ions, keeping the pH steady. Buffering capacity of your water is also known as the alkalinity or KH. It is important to have an alkalinity of at least 150 mg/L or higher in order to keep your tank/pond's pH stable. If you do not have a high alkalinity in your system, check the water you are adding to top off the system. If the alkalinity of the water you are adding is low, you may need to add buffers to the water yourself.

Total Hardness

Hardness is determined by the levels of calcium and magnesium containing compounds in your water. Calcium is required for some internal reactions and is necessary for growth. It is recommended that your water have a total hardness around 150 mg/L. Water with a high total hardness will not impact your fishes' overall health. However, some fish owners have seen black spots form on koi with high total hardness. These black spots are completely benign and will cause no health issues. Pipes and pumps are more susceptible to high total hardness and can become coated in calcium deposits that need to be removed.

Temperature

Although not a chemical component of water quality, temperature is very important. Like pH, you do not want your temperature swinging drastically throughout the day. In outdoor ponds, this is hard to control. During very hot days, it is a good idea to give your fish some shade so they can escape from the warmer water. Putting a shade structure over your pond will not only help with temperature control, but also minimize debris falling into your pond. Buy a reliable thermometer and check your pond's temperature daily.

Chlorine & Chloramine

Chlorine is added to some tap water to kill harmful bacteria; it is similar to the products used in pools and hot tubs to keep them sanitary for human use. However, even very small amounts can kill all the fish in your system. Chlorine damages fish gill tissue, causing them to eventually suffocate. Chloramine, a combination of chlorine and ammonia, was developed as a more stable compound and less likely to form carcinogenic products than chlorine. However, chloramine adds even more ammonia to your system! Both chlorine and chloramine are detrimental to your fishes' health. Be sure to check your source tap water before adding it to any system. Add a dechlorinator specific to your water containing chlorine or chloramine. Usually well water contains little or no chlorine, but it is safer to know for sure!

Copper

Copper used in construction and as pipes can also lead to high levels of copper in your system, which may have serious impacts on your fish. Copper pipes break down over time and should be replaced, while copper filaments discarded during construction projects should be kept

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away from the pond. When not using copper to treat a pond, the level should be 0 mg/L. If you are using copper to treat your pond, keep the level 0.15-0.2 mg/L. Beware that some fish may be very sensitive to copper and even therapeutic levels may be lethal. Invertebrates are also extremely sensitive to any copper in a system. If you have any invertebrates in your system, NEVER use copper. This includes zooplankton (*Artemia*, rotifers, etc.) and snails. Alkalinity can affect the actual amount of copper being added to a system, since some of the buffers will bind to the copper being added. Systems with an alkalinity less than 100 mg/L should try treatments other than copper. For instance, there are algae and parasite treatments available that contain a low level of copper that will not harm your fish.

Hydrogen Sulfide

Hydrogen sulfide is that smell of rotten eggs from cleaning a neglected pond. If your system has not been thoroughly cleaned for years, layers of debris pile up on the bottom of your pond and form pockets of hydrogen sulfide. This compound is highly toxic to fish and can cause massive die-offs within 24-48 hours. A fish flashing on the bottom of the pond may release a toxic cloud of hydrogen sulfide at any time. If you are undertaking a major pond/tank cleaning that has been ignored for too long, remove all fish before your begin to clean.

Water Quality Parameters

Ammonia	0 mg/L
Nitrite	0 mg/L
Nitrate	<20 mg/L
Oxygen	>8-12 mg/L
pH	7-8*
Alkalinity	>150 mg/L
Hardness	>150 mg/L
Temp	Site dependent
Chlorine/Chloramine	0 mg/L
Copper	0 mg/L
Hydrogen Sulfide	0 mg/L

*pH – more important to keep at constant level

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