API® Lesson 2 | Understanding pH

This lesson plan provides a basic understanding of pH, what it is, why it is important, and how to adjust pH in an aquarium or pond. pH is an essential parameter when keeping and breeding ornamental fish in a community aquarium.

A properly set up aquarium is the basis to ensure the fullest measure of learning, pleasure and enjoyment with any aquarium. To understand what is "proper" we must understand what type of fish are being kept and where they are found in the wild. At the conclusion of this activity a better understanding of what the fish needs in terms of pH can be determined.

For Instructor/Teacher/Parent

Make sure to read through the entire lesson plan before beginning this with students/family members as materials will need to be purchased and information prep will need to be done.

Learning Objectives

After completing the activities outlined in this lesson plan, students should be able to:

- Provide a definition of pH
- Clearly explain why pH is important in an aquarium
- Discuss the pH based on the natural environment ornamental fish are native to.
- Why it's important to test your water, how to test, what the results mean and how to correct them

Length

This activity will take about 2 hours for completion of this exercise.

Materials to complete activity

- Aquarium (if you have completed lesson 1, you will already have an aquarium set up)
- Tap Water
- API® FRESHWATER MASTER TEST KIT OR
    - API pH TEST KIT and API HIGH RANGE pH TEST KIT OR
    - API 5-in-1 TEST STRIPS
- API KH (Carbonate Hardness) TEST KIT
- Cups or Beakers
- Lemon Juice
- Vinegar
- Milk of Magnesia

Key Terms

Review key terms (printable sheet included at the end of the lesson) with students/family members.

1) pH
2) pH SCALE (individual printable sheet included at the end of the lesson)
3) ACIDIC
4) BASIC (ALKALINE)
5) NEUTRAL
6) ALKALINITY (KH or CARBONATE HARDNESS)
7) BUFFERING
8) REAGENT INDICATOR
9) pH ADJUSTER
10) pH BUFFER
11) pH CRASH

Warm Up

Ask a couple of questions to warm up for the lesson:

1) Do you currently have any fish? If so, what kind?
2) What pH range is considered acidic or basic?
3) What region of the world are your fish naturally found in?
4) What is the pH of the region your fish are from?

Before You Start

1) For this lesson we're going to walk you through the basic pH for different environments.
   a) Note: Determining different types of environments or ecosystem is dependent on the type of fish selected. As an example, fish from South America prefer water with a lower pH (on average 6.5 or lower) and lower general hardness. Fish from African Rift Lakes are referred to as African Cichlids prefer water with a higher pH (8.2 to 9.0) and higher general hardness. It is important to determine the type of fish early so you can set up your aquarium to meet their specific needs.
2) The type of fish in aquariums is going to be a "Tropical" aquarium or "Cold water" aquarium. Tropical simply means warm water and this type of aquarium requires a consistent temperature. Most aquarium fish are tropical, however fish such as goldfish and Koi are considered cold water and do not require a heater. The temperature of the water does not interfere with or determine the pH.
3) A 'general community' aquarium has a cross selection of fish that will live in a neutral pH of 7.0 and moderate hardness. A mixed or general community aquarium will not replicate any specific environment and is often kept at a neutral pH of 7.0 or slightly higher at 7.5.
4) The pH is simply the measurement of the acidity of any given solution. Technically pH is defined as the negative logarithm of the hydrogen ion concentration or pH = log 1/[H+] or pH = -log[H+]. What this means is pH changes is logarithmic, so when pH changes on the pH scale it is a 10-fold difference. So minor changes in pH are drastic changes chemically to the fish.
5) The measurement of pH is applied to a scale of 0 to 14. The value of pH 7.0 represents neutrality or a solution where the hydrogen (H+) and hydroxyl (OH-) ions are in equivalent quantities. Below 7.0 is considered acidic and above 7.0 is alkaline or basic.

6) The consistency of pH is attributed principally to the buffering water. The buffering factors are carbon dioxide (CO2), carbonate and bicarbonate ions in the water. pH is directly associated with the carbon dioxide levels. The more CO2 within the water the more it will react with the available buffers causing a shift downward in pH. An aquarium with a high plant or algae activity will have an elevated pH during the day (photosynthesis is high) and a lower pH at night (when respiration is high). If the change in pH is drastic, major effects can take place with the fish being kept.
7) Change in pH as a result of poor circulation is common. As an example, when fish are packed in a sealed bag with a small amount of water and oxygen with a starting pH of 8.0, a decrease in pH occurs over time. The decrease is due to the CO2 exceeding atmospheric equilibrium because of the barrier of the bag. Once the bag is opened, if the water is aerated to expel the CO2, the pH will rebound. If an aquarium does not have proper circulation, similar conditions can occur.
8) pH tends to drop in aquarium as a result of biological activity. Acids are produced from the fish, food wastes, and decaying organics that are processed by the biological activity of reducing proteins to ammonia, nitrite and nitrate. Most bacterial action utilizes oxygen and produces CO2. The production of acids and CO2 from this biological activity of nitrifying bacteria and other bacteria will lower the pH with the aquarium.

Instructions for Learning Activity

1. Fill a container with Tap Water
    a. Test the Tap Water for pH and record your results
    b. Test the Tap Water for KH and record your results
2. Fill a container with Tap Water and add ¼ teaspoon of lemon juice
    a. Test the Tap Water for pH and record your results
3. Fill a container with Tap Water and add ¼ teaspoon of vinegar
    a. Test the Tap Water for pH and record your results
4. Fill a container with Tap Water and add ½ teaspoon of Milk of Magnesia
    a. Test the Tap Water for pH and record your results
5. Fill a container with Aquarium Water
    a. Test the aquarium water for pH and record your results
    b. Test the aquarium water for KH and record your results
6. Record your results from your pH testing on the pH Scale (printable pH scale at the end of this lesson)
    a. Was your tap water neutral, acidic or basic?
    b. Is Lemon Juice an acid or base?
    c. Is Vinegar an acid or base?
    d. Is Milk of Magnesia an acid or base?
7. On the pH Scale line marked 0 to 14 - place each fish group based on region
    a. South American - Amazon (pH 6.5)
    b. Central American (pH 7.5)
    c. African Cichlid (Rift Lake Cichlids) (pH 8.2 to 9.0)
    d. South and Southeast Asia (pH 6.5)
    e. Congo River Basin (Zaire River) (pH 6.5)
    f. Saltwater (pH 8.2)

Understanding pH

Appropriate pH control in an aquarium is important because overly acidic or alkaline water can have harmful effects on aquarium life. Appropriate testing and adjusting of aquarium pH are crucial for the maintenance of fish health – for good color, wholesome appetite, successful breeding and disease resistance. Any change to pH to the proper level in an aquarium should be a gradual change overtime.

What is pH?

The pH level refers to the level of acidity in water using a scale of 0 to 14. A pH of zero is most acidic, while pH of 14 is most alkaline. Water with a pH of 7.0 is neither acidic nor alkaline and is considered "neutral". Most freshwater fish live in a pH range of 6.0 to 8.0, depending on their natural habitat. Marine fish and most African Cichlids come from environments with pH levels of 8.0 or higher.

Freshwater fish are found in habitats in all climatic regions of earth. Aquarium fish are primarily from the tropics and subtropics from six main regions. The main regions are 1) Amazon, 2) Central America 3) Congo River Basin 4) African Rift Lakes, 5) South and Southeast Asia, 6) Coastal (brackish and saltwater). We will generalize for the sake of discussion the pH of each region.

1. The Amazon varies between river systems such as the Rio Negro can have a lower pH than the Amazon itself. Fish from the Amazon depending on time of year can see lower pH values such as 4.5 to slightly above 7.0. We generalize the pH average of Amazonian fish at 6.5 for most aquarium keeping.
2. Central America cichlids and livebearers from this region typically are found in harder water with a pH value of 7.5
3. Congo River Basin (Zaire River) is close to the tropical rain forests of the Amazon. Because of the jungle like character of the region we can generalize the pH at 6.5 for most aquarium fish from this region
4. African Rift Lakes are primarily from Lake Tanganyika, Malawi and Victoria, noting there are others as well. Because of the geology of this region the water tends to be harder, higher in salts with a general pH value of 8.2. Some regions of the lake can be even higher.
5. South and Southeast Asia includes southern India, Sri Lanka through Indonesia and the Philippines over to New Guinea. Much of this region are heavily mountain streams that include dense forests. It also receives strong monsoons bringing voluminous tropical rains. The water is commonly soft acidic water with a lower pH. We generalize the pH average of South and Southeast Asia fish at 6.5 for most aquarium keeping.
6. Coastal and Marine environments is relatively constant, ordinarily staying with a pH range of 7.6 to 8.4, with an average pH level of 8.2. This would include saltwater fish only aquariums and reef aquariums

One very important fact to remember about the pH scale is that it is logarithmic. For example, a pH level of 6 is 10 times more acidic than a pH of 7, and a pH of 5 is 100 times more acidic than a pH of 7. Understanding why gradual changes are essential. Sudden changes in pH of great amounts can be stressful or even lethal to your fish. To keep tropical fish and goldfish healthy and colorful, it is necessary to maintain a stable pH in the correct range.

How to Maintain the Proper pH level in your aquarium

The first thing to determine is the pH and KH of your tap water. Now you have a starting point for what type of fish are best suited based on your tap water. If you desire to keep fish that require pH levels different than your tap water, it will need to be adjusted. There are other options such as collection rainwater, another is to source RO (reverse osmosis)/DI (Deionized) water. RO/DI can often be sourced from your local aquarium store.

pH can be adjusted using acid or basic solutions such as API pH DOWN or API pH UP. These products will adjust your water up or down to the desired pH. Remember, if your KH (buffering capacity) is high it will be harder to lower your pH to an acidic range. When you add in pH DOWN it will adjust both the KH (Carbonate Hardness) and the pH, so depending on your starting value it may take several doses to get to your desired levels. Gradual changes in pH overtime are best.

You can use commercial buffers to set and hold your pH to the desired level. API PROPER pH adjusts aquarium water to a selected pH (6.5, 7.0, 7.5 or 8.2) and buffers the water to remain stable at the selected pH. As PROPHER pH dissolves, it's pre-set pH level of 6.5, 7.0, 7.5 or 8.2 will gradually raise or lower aquarium water to the prescribed level and will stabilize that level through buffering action.

Important note: All true commercial buffers below a pH of 7.8 are phosphate based. Any aquarium pH product below 7.8 that is not phosphate-based is simply a pH adjuster and will not stabilize the pH of your aquarium. While phosphate is normally considered an algae-promoting nutrient, the phosphate level in PROPER pH 6.5, 7.0 and 7.5 will bind to trace elements, such as iron. Without essential trace elements, algae and aquatic plants grow very poorly. Therefore, do not use PROPER pH 6.5, 7.0 or 7.5 in planted aquariums. PROPER pH 8.2 does not contain phosphate and is completely safe for aquariums that contain plants.

Questions

- Pass out the Questions worksheet (printable sheet included at the end of the lesson) to each student/family member.
- Review the answers to the questions during the discussion section of the lesson.

Discussion

- After finishing the items above including the questions and key terms, engage students/family members in a brief discussion about the lesson:
    - Where are fish found?
    - What kinds of fish do we have in the aquarium?
    - What is the desired pH level for the fish you are keeping or desire to keep?
    - How do organics or fish waste affect the pH of aquarium water?

Quiz

- Once you've finished the discussion, pass out the Quiz worksheet (printable sheet included at the end of the lesson) to each student/family member.
- Have them complete the quiz and then review the answers/have an open discussion about the answers with them. Answers are below.

1. Describe your favorite fish in your aquarium and what region of the world they are found and the pH of the region.
    - As an example: Swordtails are commonly found in Central America and produce live bearing babies. The pH of this region is generally 7.5
2. Why can we not just add tap water to an aquarium without testing it? What does testing for pH tell us?
    - Common tap water contains disinfectants such as chlorine and chloramines and are highly toxic to aquarium life. Both tap water and well water can contain heavy metals such as copper, lead and zinc also a concern to aquarium life. The use of a water conditioner, like API Stress Coat, instantly makes tap water safe by detoxifying heavy metals and neutralizing chlorine and chloramines.
3. If water is acidic where would the pH be found on the pH scale?
    - Below 7.0
4. How does the temperature change in water relate to the pH level?
    - Temperature does not have any effect on the pH of the water.
5. When using commercial buffers below 7.8 what needs to be considered?
    - Commercial buffers below 7.8 are phosphate based and will bind with some trace elements that plants need. If keeping live plants in aquariums with a pH below 7.8 commercial buffers are not desired and adjusting pH with pH UP or pH Down is better.
6. Define the pH scale?
    - The pH scale ranges from 0 to 14. 7.0 is neutral, below 7.0 is acidic and above 7.0 is alkaline/basic.
7. What is the pH ranges that most aquarium fish are commonly kept at?
    - Most aquarium fish live in ranges from 6.5 to 8.2. The desired pH range that is ideal for specific fish species can vary greatly from species to species. Fish from the Amazon normally prefer a pH of 6.5 or even lower. Fish from the African Rift Lakes called African Cichlids prefer a pH of 8.2 or even higher. Fish from Central America normally do best at a pH around 7.5. When we mix a grouping of fish from around the world together, we call that a community aquarium and normally target a pH of 7.0. It is easy to test the pH of your water using the API FRESHWATER MASTER TEST KIT.

KEY TERMS

pH

a measure of acidity of a solution. pH is the measure of the hydrogen ion (H+) activity of a solution

pH SCALE

describes the hydrogen ion (H+) concentration of a solution on a scale of 0 to 14

ACIDIC

substance with a pH less than 7

BASIC (ALKALINE)

substance with a pH greater than 7

NEUTRAL

substance with a pH of 7

ALKALINITY (KH or CARBONATE HARDNESS)

the ability of water to neutralize acids without an increase in pH. This parameter is primarily a measure of bicarbonates (HCO3-) and carbonates (CO3--)

BUFFERING

the ability of the water to stabilize changes in pH

REAGENT INDICATOR

chemicals that show whether the given solution is acidic or basic by comparing a color change of the test solution

pH ADJUSTER

material liquid or powder that will adjust the pH of a solution (i.e. aquarium water) up or down

pH BUFFER

a combination of an acid or base with a salt which, when in solution, tends to stabilize the pH of a solution

pH CRASH

when levels in a solution fall as a result of very low or zero alkalinity (KH)

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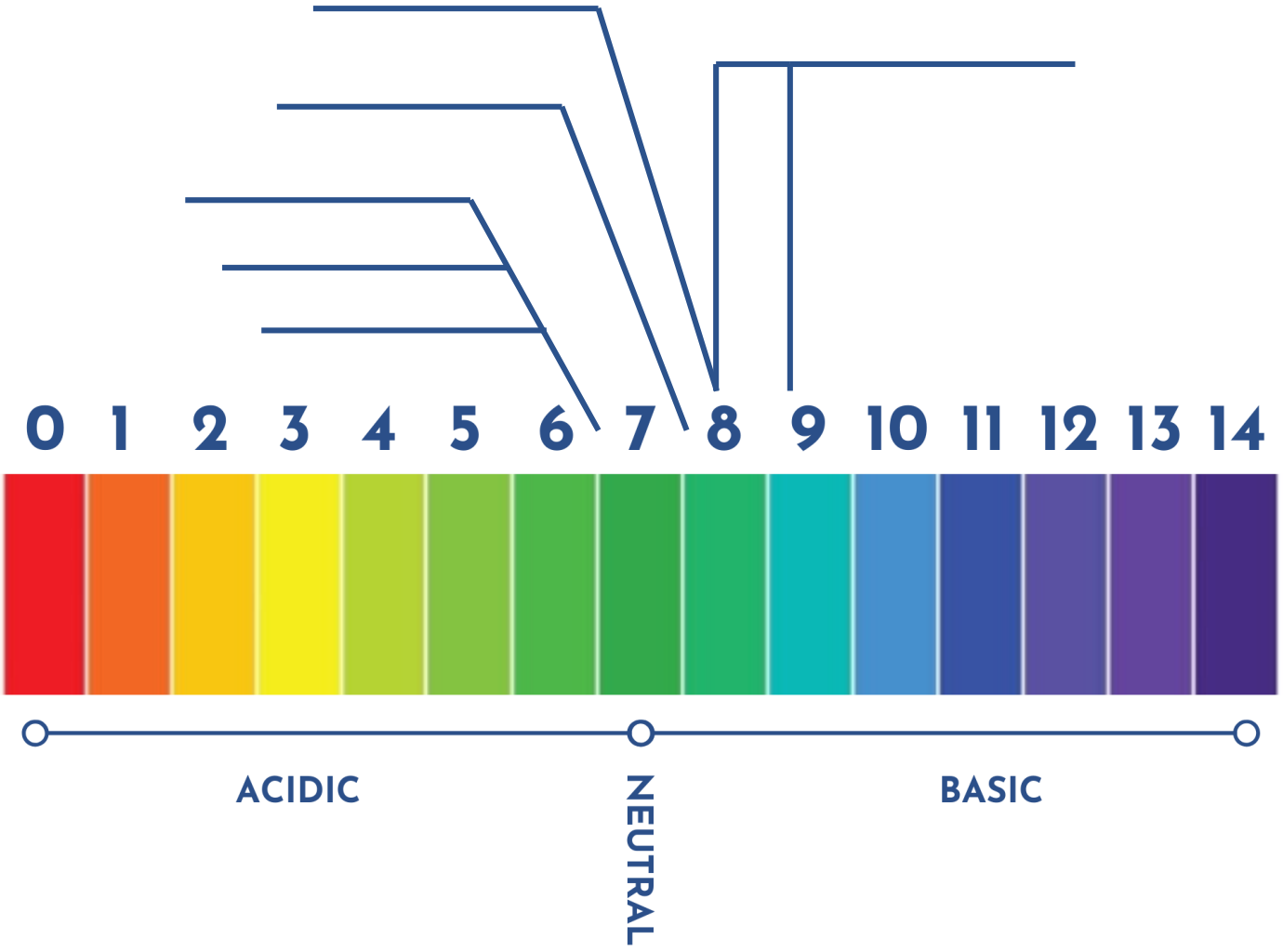
pH SCALE

Fill in the fish group on the corresponding lines for learning activity #7 in the lesson to mark their pH number on the pH scale.



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QUESTIONS

1. Name each type of fish in the aquarium.

2. Where are these fish found?

3. What is the desired pH level for the fish you are keeping or desire to keep?

4. How do organics or fish waste affect the pH of aquarium water?

QUIZ

1. Describe your favorite fish in your aquarium and what region of the world they are found and the pH of the region.

2. Why can we not just add tap water to an aquarium without testing it? What does testing for pH tell us?

3. If water is acidic where would the pH be found on the pH scale?

4. How does the temperature change in water relate to the pH level?

5. When using commercial buffers below 7.8 what needs to be considered?

6. Define the pH scale?

7. What is the pH ranges that most aquarium fish are commonly kept at.

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CONTACT US & ADDITIONAL RESOURCES

For more information regarding this lesson plan, API® brand, or any general fishkeeping questions and/or comments, feel free to contact us below.

- Website: https://apifishcare.com/
- Telephone Number: 1-800-847-0659