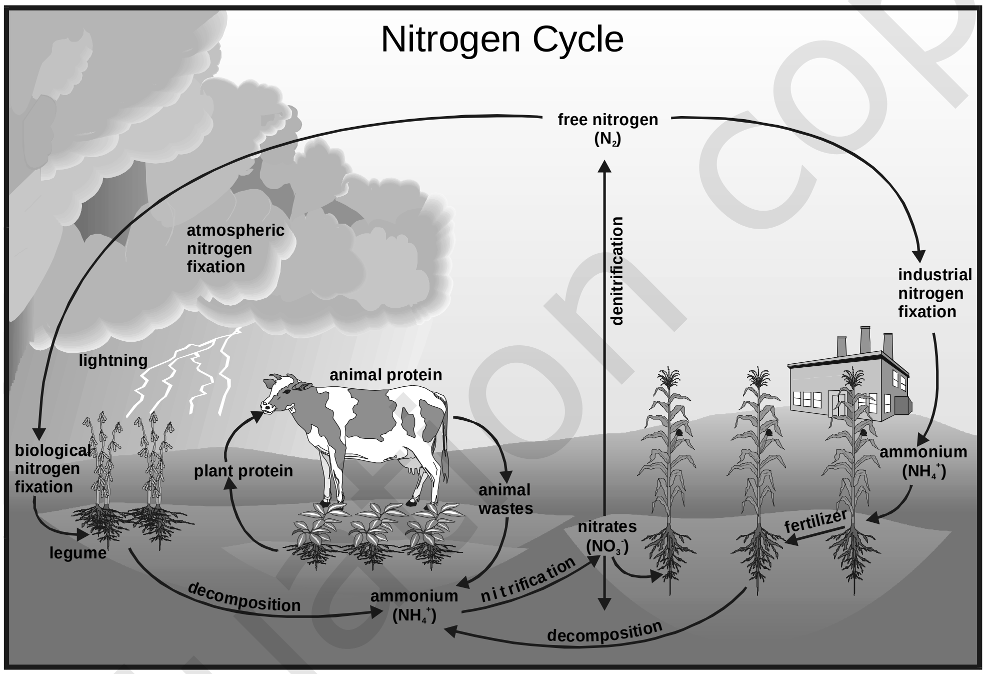
Ammonium Nitrogen

INTRODUCTION

The ammonium ion, NH_4^+, is an important member of the group of nitrogen-containing compounds that act as nutrients for aquatic plants and algae. In surface water, most of the ammonia, NH_3, is found in the form of the ammonium ion, NH_4^+. This fact allows us to approximate the concentration of all of the nitrogen in the form of ammonia and ammonium combined, commonly called ammonia nitrogen, by measuring only the concentration of the ammonium ions.



All plants and animals require nitrogen as a nutrient to synthesize amino acids and proteins. Most nitrogen on earth is found in the atmosphere in the form of N_2, but plants and animals cannot utilize it in this form. The nitrogen must first be converted into a useable form, such as nitrate, NO_3^-. These conversions among the various forms of nitrogen form a complex cycle called the *nitrogen cycle*, illustrated above.

In the nitrogen cycle, bacteria convert atmospheric nitrogen into ammonium in a process called *nitrogen fixation*. This process often occurs in the roots of leguminous plants such as alfalfa, beans, and peas.

Bacteria can also convert the nitrogen in decaying plant and animal matter and waste products in the soil or water to ammonium in a process called *ammonification*. Other sources of organic matter for ammonification include industrial waste, agricultural runoff, and sewage treatment effluent.

Sources of Ammonia

- Decaying plants and animals
- Animal waste
- Industrial waste effluent
- Agricultural runoff
- Atmospheric nitrogen

Some trees and grasses are able to absorb ammonium ions directly, but most require their conversion to nitrate. This process, called *nitrification*, is usually accomplished by bacteria in the soil or water. In the first step of nitrification, ammonium ions are oxidized into nitrite. The nitrite is then converted into nitrate, which can subsequently be utilized by plants and algae.

Animals require nitrogen as well. They obtain the nitrogen they need by eating plants or by eating other animals, which in turn have eaten plants.

If ammonium nitrogen levels in surface waters are too high, they can be toxic to some aquatic organisms. If the levels are only moderately high, plant and algal growth will usually increase due to the abundance of nitrogen available as a nutrient. This will have a ripple effect on other attributes of water quality, such as increasing biochemical oxygen demand and lowering dissolved oxygen levels. Dissolved oxygen levels can also be lowered when ammonium nitrogen is high due to the increased amount of nitrification occurring.

Effects of Ammonium Levels

- High levels
  - eutrophication
  - increased algal blooms
  - increased BOD
  - decreased DO
  - toxic to some organisms
- Low levels
  - limiting factor in plant and algal growth

If enough nutrients are present, *eutrophication* may occur. Eutrophication occurs when there is such an abundance of nutrients available that there is a significant increase in plant and algal growth. As these organisms die, they will accumulate on the bottom and decompose, releasing more nutrients and compounding the problem. In some cases, this process of eutrophication can become so advanced that the body of water may become a marsh, and eventually fill in completely.

If too little ammonium nitrogen is present, it may be the limiting factor in the amount of plant and algal growth. Ammonium nitrogen can quickly be converted into nitrites or nitrates; therefore, a low level of ammonium-nitrogen does not necessarily indicate a low level of nitrogen in general.

Expected Levels

Ammonium-nitrogen levels are usually quite low in moving surface waters. This is because there is little decaying organic matter collecting on the bottom. If there is a high level of ammonium nitrogen in a moving stream, it may be an indication of pollution of some kind entering the water. Ponds and swamps usually have a higher ammonium nitrogen level than fast-flowing water. While levels of ammonium nitrogen in drinking water should not exceed 0.5 mg/L, streams or ponds near heavily fertilized fields may have higher concentrations of this ion. Fertilizers containing ammonium sulfate, $(NH_4)_2SO_4$, or ammonium nitrate, NH_4NO_3, may result in runoff from fields containing a high level of ammonium ions.

Table 1: Ammonium Levels of Selected Rivers

Site	Ammonium (mg/L NH_4^+-N)
Mississippi River, Memphis, TN	0.07
Hudson River, Poughkeepsie, NY	0.08
Colorado River, Hoover Dam, AZ-NV	0.03
Willamette River, Portland, OR	0.09
Platte River, Louisville, NE	0.24

Summary of Method

A Vernier Ammonium Ion-Selective Electrode (ISE) is used to measure the concentration of ammonium nitrogen in the water, either on site or after returning to the lab.

AMMONIUM NITROGEN

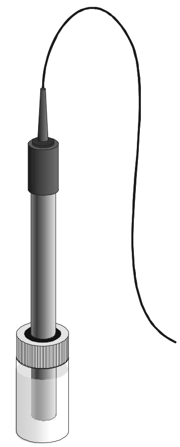
Materials Checklist

___ computer
___ Vernier computer interface
___ Logger *Pro*
___ Ammonium Ion-Selective Electrode
___ tissues
___ Low Standard (1 mg/L NH_4^+-N)
___ High Standard (100 mg/L NH_4^+-N)
___ wash bottle with distilled water
___ small paper or plastic cup (optional)

Advanced Preparation

The Vernier Ammonium Ion-Selective Electrode (ISE) should be soaked in the Ammonium High Standard solution (included with the ISE) for approximately 15–30 minutes. **Important:** Make sure the ISE is not resting on the bottom, and that the small white reference contacts are immersed. Make sure no air bubbles are trapped below the ISE.

If the ISE needs to be transported to the field during the soaking process, use the Short-Term ISE Soaking Bottle. Remove the cap from the bottle and fill it 3/4 full with High Standard. Slide the bottle's cap onto the ISE, insert it into the bottle, and tighten. **Important:** Do not leave the ISE soaking for more than 24 hours. Long-term storage should be in the Long-Term ISE Storage Bottle.



ISE soaking for travel

Collection and Storage of Samples

1. This test can be conducted on site or in the lab. A 100 mL water sample is required.

2. It is important to obtain the sample water from below the surface of the water and as far away from shore as is safe. If suitable areas of the stream appear to be unreachable, samplers consisting of a rod and container can be constructed for collection. Refer to page Intro-4 of the Introduction of this book for more details.

3. If the testing cannot be conducted within a few hours, place the samples in an ice chest or a refrigerator.

Testing Procedure

1. Position the computer safely away from the water. Keep water away from the computer at all times.

2. Prepare the Ammonium Ion-Selective Electrode (ISE) for data collection.
   a. The ISE should be soaking in the High Standard. Make sure that it is not resting on the bottom of the container, and that the small white reference contacts are immersed.
   b. Plug the ISE Sensor into Channel 1 of the Vernier interface.

3. Prepare the computer for data collection by opening the file "10 Ammonium" from the *Water Quality with Vernier* folder of Logger*Pro*.

4. You are now ready to calibrate the Ammonium ISE.

   First Calibration Point

   a. Choose Calibrate ▸ CH1: Ammonium ISE (mg/L) from the Experiment menu and then click Calibrate Now.
   b. Type **100** (the concentration in mg/L NH_4^+-N) in the edit box.
   c. When the displayed voltage reading for Reading 1 stabilizes, click Keep.

   Second Calibration Point

   d. Rinse the ISE thoroughly with distilled water and gently blot it dry with a tissue. Be very gentle when blotting the membrane. **Important:** Failure to carefully rinse and dry the ISE will contaminate the standard.
   e. Place the tip of the ISE into the Low Standard (1 mg/L NH_4^+-N). Be sure that the ISE is not resting on the bottom of the bottle and that the small white reference contacts are immersed. Make sure no air bubbles are trapped below the ISE.
   f. After briefly swirling the solution, hold the ISE still and wait approximately 30 seconds for the voltage reading displayed on the computer screen to stabilize.
   g. Enter **1** (the concentration in mg/L NH_4^+-N) in the edit box.
   h. When the displayed voltage reading for Reading 2 stabilizes, click Keep, then click Done.

5. You are now ready to collect ammonium concentration data.

   a. Rinse the ISE with distilled water and gently blot it dry.
   b. Place the tip of the probe into the stream at Site 1, or into a cup with sample water from the stream. Make sure the ISE is not resting on the bottom and that the small white reference contacts are immersed. Make sure that no air bubbles are trapped below the ISE.
   c. Click ▸ Collect to begin data collection.
   d. Click Keep to begin a 10 s sampling run. **Important:** Leave the probe tip submerged for the 10 seconds that data is being collected.
   e. When the sampling run is complete, stop data collection and record the mean ammonium concentration value on the Data & Calculations sheet.

6. Return to Step 5 to obtain a second reading.

DATA & CALCULATIONS

Ammonium Nitrogen

Stream or lake: ______________________________ Time of day: ____________________________

Site name: __________________________________ Student name: __________________________

Site number: ________________________________ Student name: __________________________

Date: ______________________________________ Student name: __________________________

Column	A
Reading	NH_4^+ -N (mg/L)
1	
2	
Average NH_4^+ -N (mg/L)	

Column Procedure:

A. Record the ammonium nitrogen concentration as read from the computer.

Field Observations (e.g., weather, geography, vegetation along stream) ____________________________

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Test Completed: _________________ Date: ______

Vernier Lab Safety Instructions Disclaimer

THIS IS AN EVALUATION COPY OF THE VERNIER STUDENT LAB.

This copy does not include:

- **Safety information**
- **Essential instructor background information**
- **Directions for preparing solutions**
- **Important tips for successfully doing these labs**

The complete *Water Quality with Vernier* lab manual includes 16 water quality tests and essential teacher information. The full lab book is available for purchase at: http://www.vernier.com/cmat/wqv.html

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