THE NITROGEN CYCLE

TEACHER'S GUIDE

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THE NITROGEN CYCLE

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THE NITROGEN CYCLE

TIME: 14 Minutes

INTRODUCTION

Nitrogen—it's one of the most important elements. Life, as we know it, could not exist without nitrogen atoms. Nitrogen is one of the most common elements, however, for it to be used by plants, it must be combined with other elements into biologically useful compounds.

This presentation explains the nitrogen cycle and outlines the way in which nitrogen atoms are recycled so that they can be used over and over again. The program also acquaints students with some of the ways in which humans interfere with the natural nitrogen cycle and what some of the consequences of such interference are.

GOAL OF THE PROGRAM

The goal of this presentation is to explain:

- How nitrogen atoms are recycled through nature,
- Some of the ways in which humans interfere, and
- The consequences of such interference.

STUDENT OBJECTIVES

After viewing the video and participating in the accompanying activities, 7th through 12th grade viewers should be able to achieve the following objectives:

- Describe the importance of nitrogen atoms to living organisms.
- Trace the flow of carbon atoms back and forth between the living and non-living world.

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- Define and describe the role of producers, consumers and decomposers in the nitrogen cycle.

- Define the process of nitrogen fixation and describe the ways in which it is carried out in nature.

- Describe some ways in which humans interfere in the natural nitrogen cycle and describe their consequences.

SUMMARY OF THE VIDEO

The presentation opens by introducing viewers to the importance of nitrogen to all living things. It then moves on to explain the various steps that are involved in recycling nitrogen atoms between living organisms and their environment. The video then closes with a discussion of some of the ways in which humans interfere with the nitrogen cycle and the consequences of such interference. There is a Video Instructional Quiz at the end of the video. See Follow-Up Activity 4 of this Teacher's Guide.

TEACHER PREPARATION

1. Preview the video and read this guide to determine how best to present this program to your class. A script of the video is also provided at the end of this guide.

2. Preview the blackline masters and duplicate the ones you intend to use.

FOCUS/INTRODUCING THE VIDEO

One effective way of introducing this presentation is to ask students to explain the importance of nitrogen and how it is made available to living things before they see the video. At this time you could also ask students to discuss any examples of ways in which humans interfere with the natural nitrogen cycle and what the impact of such interference may be.

In doing this students can either come up with their own separate explanations, or work cooperatively (whole/small group) to come up with a collective explanation.

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If students know very little about nitrogen, explain that life, as we know it, could not exist without nitrogen atoms. Encourage them to watch the video and to be prepared to answer questions after the viewing.

If students are working in small groups, have them share their results with the whole class. You can then facilitate a discussion in which students justify their explanations and critique those of other groups.

Once you have shown the video, you can encourage students to defend/modify their earlier positions.

Blackline Master 1, Vocabulary, could by used as a basis for class discussion and/or review prior to the A/V presentation. This could also help you determine how much your students know about the nitrogen cycle before viewing the video.

PRESENT THE VIDEO - TIME: 14 MINUTES

DISCUSSION TOPICS/QUIZ

The following discussion topics can be used in different ways. One approach is to use them to stimulate classroom discussion before or after the video presentation.

The same topics are also provided as **Blackline Master 2, Study Questions/Quiz**. Copies made from this master can be used as a quiz to test the students grasp of the subject either before or after the video is shown. Distribute this BLM and preview the questions with the students before viewing the video.

1. **What role do legumes play in the nitrogen cycle?**

   Some legumes, such as soybeans and clover, have a symbiotic, or mutually beneficial, relationship with bacteria that live in nodes, or swellings, that develop on their roots. These bacteria get food from the host legumes. In addition, they "fix" or convert soil nitrogen into compounds plants can use.

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2. **Describe how excess nitrogen from agriculture can kill fish.**

Water washing off of farm land can contain large amounts of nitrogen from fertilizers and animal manure. This excess nitrogen can cause aquatic plants to grow excessively. Eventually, when this overgrowth of plant material decomposes, the dissolved oxygen in the water is reduced to such a low level that fish will die from suffocation.

3. **Why is "fixed" nitrogen important?**

Even though the air around us is largely made up of nitrogen gas, most plants can't use it. They can only use nitrogen that has been "fixed," combined with other elements, into biologically useful compounds.

4. **What role does decay play in the nitrogen cycle?**

Decaying tissues from plants, animals or other organisms free, or release, the nitrogen atoms they contain. The next generation of organisms can then use these freed nitrogen atoms to make their own tissues.

FOLLOW-UP ACTIVITIES

1. **Blackline Master 1, Vocabulary**, is a list of terms related to the nitrogen cycle.

2. **Blackline Master 2, Vocabulary Review**, matches definitions and words from **Blackline Master 1.**

3. **Blackline Master 3, Study Questions/Quiz,** is a copy of the discussion topics arranged so that they can be used as a student pre-test or post-test/quiz, discussion, or as a take-home assignment.

Note: When using concept maps, the students are to fill in the boxes using the words from the list. The connecting words will help in the formation of meaningful sentences. These concept maps may be used in several ways: individual in-or-out-of-class assignments, small group class activities, and class discussions.

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4. **Blackline Master 4** is the **Video Instructional Quiz**, which is used with the video quiz at the end of the program or can be used separately.

5. **Blackline Master 5** is a concept map of **The Nitrogen Cycle.**

6. **Blackline Master 6** is a concept map dealing with **The Elements of the Nitrogen Cycle.**

7. **Blackline Master 7** is an activity dealing with **The Forms of Nitrogen.**

8. **Blackline Master 8** is a concept map dealing with **How Nitrogen is Fixed.**

9. **Blackline Master 9** is a concept map dealing with **Decaying Organisms.**

10. **Blackline Master 10** is an activity dealing with **Nitrogen: The Polluter.**

ANSWER KEY

Blackline Master 1, Vocabulary
This is a vocabulary sheet for distribution and discussion.

Blackline Master 2, Vocabulary Review

1. D
2. F
3. C
4. G
5. H
6. I
7. K
8. E
9. B
10. M
11. J
12. L
13. A

Blackline Master 3, Study Questions/Quiz
Copy of the discussion topics—the answers can be found under the section **Discussion Topics/Quiz (Page 3).**

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Blackline Master 4, Video Instructional Quiz

1. False - Nitrogen makes up about 78% or just over 3/4 of the air around us.
2. False - Soybeans are a legume, corn is not.
3. fertilizers
4. True
5. True
6. plants
7. False - Most nitrogen is fixed in the soil.
8. acid rain or acid precipitation
9. fixed
10. true

Blackline Master 5, The Nitrogen Cycle

A concept chart illustrating the nitrogen cycle. If students are asked to explain the cycle, answers will vary but should include:

Nitrogen makes up more than 3/4 of the air around us. Lightning causes some of the nitrogen and oxygen atoms in the air to combine, "fixing" nitrogen, forming a compound which then mixes with rain and other precipitation and falls to earth. Since most plants cannot use nitrogen in its gaseous form, nitrogen-fixing bacteria in root nodules convert atmo-spheric nitrogen into a form that other living things can use. After nitrogen has been fixed by the bacteria, it circulates repeatedly between organisms and the soil. Denitrifying bacteria help regulate the amount of nitrogen in circulation by changing some fixed nitrogen back into a gas.

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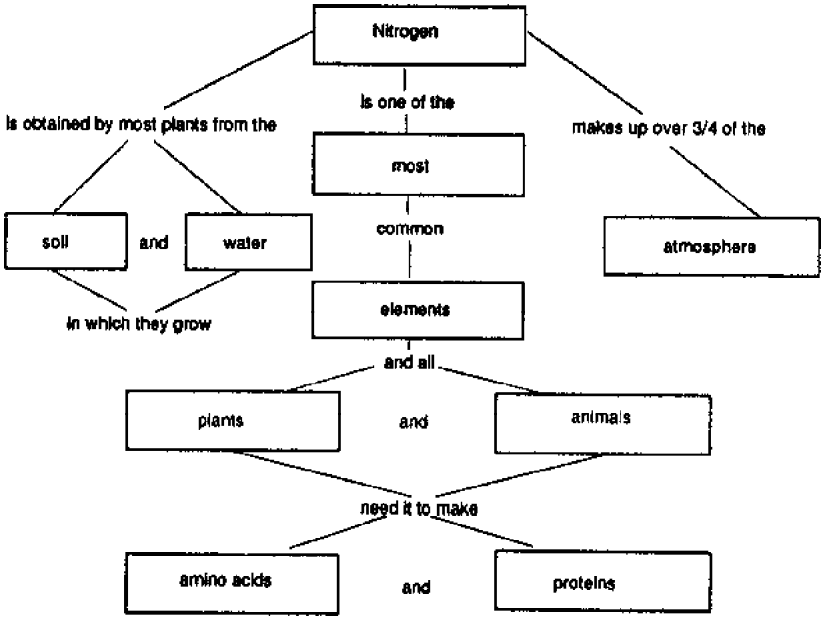
Blackline Master 6, Concept Map: Elements of the Nitrogen Cycle



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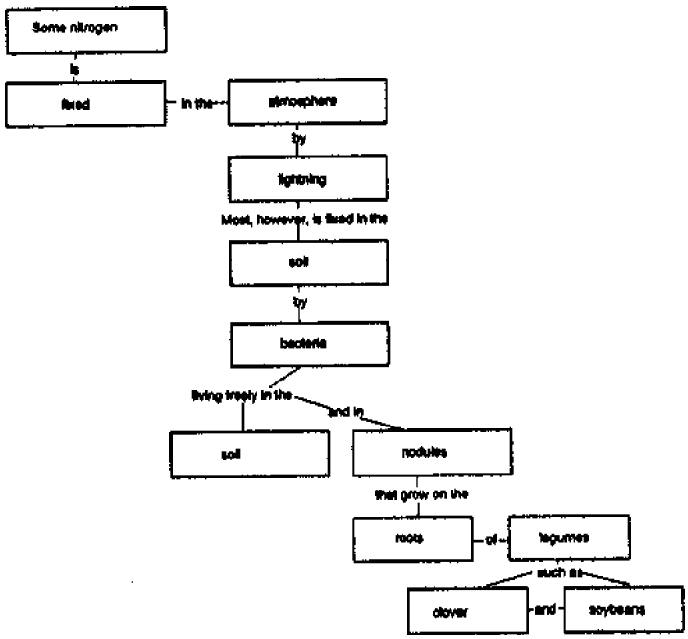
Blackline Master 7, Forms of Nitrogen

1. Nitrogen	6. fixed
2. atmosphere	7. combined
3. gas	8. elements
4. wrong	9. biologically
5. organisms	10. compounds

Blackline Master 8, Concept Map:
How Nitrogen is Fixed



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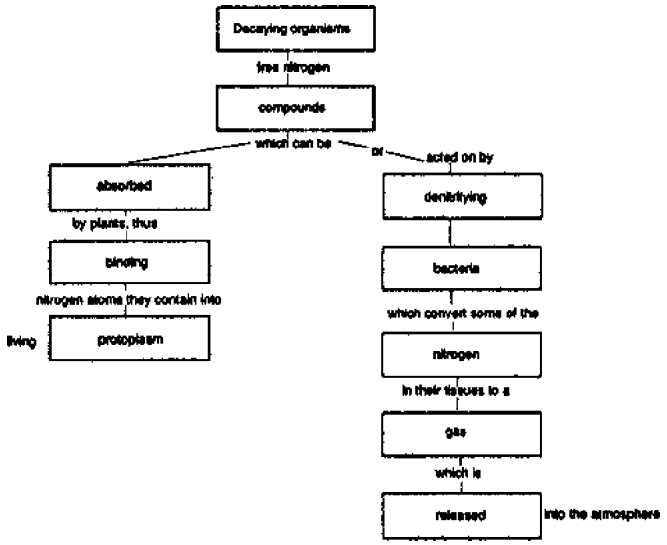
Blackline Master 9, Concept Map:
Decaying Organisms



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Blackline Master 10, Nitrogen: The Polluter

1. fertilizers
2. manure
3. polluted
4. waterways
5. rain
6. nitrogen
7. emissions
8. electric
9. exhausts
10. fossil-fueled

SCRIPT OF *THE NITROGEN CYCLE*

Ferns and fish; bears and butterflies; petunias and prairie dogs—the variety of life with which we share this earth is truly amazing.

But, as different as living things can be, they all share one thing in common. They all need certain life-giving chemicals to survive.

One of the most important of these is nitrogen, and today we'll see how living things get the nitrogen they need, and how it's recycled through nature.

All living things---be they birds, a mushroom on a rotting log, 'gators on the prowl, or any other organism---must have nitrogen.

Without it, they can't make the amino-acids, proteins, and other compounds they must have. Most plants absorb the nitrogen they need from the soil or water in which they grow.

Animals, in turn, get the nitrogen they need by eating plants, or, in the case of meat-eaters, by eating animals that feed on plants.

But no matter how organisms get their nitrogen, the fact remains, without it they'd die. Obviously then, it's vital that nature doesn't run out of nitrogen. And, at first glance, it wouldn't seem there's much chance of that.

That's because nitrogen makes up more than three-fourths of the air around us. And with the atmosphere that rich in nitrogen, you would think that there would be more than enough to go around.

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That’s not the case, however, because the nitrogen in the air around us is the wrong kind. And that's because most plants can’t use nitrogen in the pure gas form in which it occurs in the atmosphere. Instead, they need nitrogen that’s been fixed, or combined with other elements, into compounds.

Fortunately, nature has several different ways of doing this.

Lightning is one of them. It causes nitrogen and oxygen atoms in the air to combine. The resulting nitrogen compound then mixes with rain and falls to the earth where it undergoes chemical changes that make it easier for plants to absorb the nitrogen it contains.

Such lightning-powered fixation provides large amounts of nitrogen for plants. However, far more is fixed in the soil, a fact farmers have long taken advantage of by rotating crops, such as corn, that quickly use up soil nitrogen with soybeans, peas, clover and alfalfa. Such plants are called "legumes."

Legumes act as natural "fertilizer factories," and they pump large amounts of nitrogen back into the soil.

And here we see the small pea-shaped nodules that grow on the roots of soybeans and other legumes. These nodules are at the heart of the legume’s amazing natural fertilization process. They're caused by bacteria, such as the ones we see here, magnified millions of times, in this cross section of a soybean nodule. These bacteria fix, or change, nitrogen into a form plants can use, and they live in a symbiotic, or mutually beneficial, relationship with legumes.

As their part of the bargain, the host legumes supply the carbohydrates the bacteria use as food. In return, the bacteria convert, or “fix," nitrogen gas in the soil into compounds the host legumes can use. This process often produces surplus nitrogen that's released into the soil, thus fertilizing it.

As important, however, as the bacteria are that live with soybeans and other legumes, they’re not the only microbes that fix nitrogen. The soil also is home to free-living, nitrogen-fixing bacteria. Like those living with legumes, these microbes also fix nitrogen. Once nitrogen has been fixed, in one way or the other, plants, such as grass, can then absorb it and make it part of their own tissues.

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When animals eat these plants, some of the nitrogen in them is used by the animals to synthesize, or make, their own tissues.

So far today, we've seen how lightning and bacteria fix nitrogen atoms into compounds that can be used by plants and made part of their tissues and those of the animals that eat them.

This binding of nitrogen atoms into living plant and animal tissues is the synthesis, or "building up," part of the nitrogen cycle.

In addition, the nitrogen cycle also has a "down" side. This, the decay--or breaking down-- side of the cycle, takes place when dead organisms, manure, and other such wastes, decay and, in the process, free nitrogen compounds from their rotting tissues thus making them available for use by a new generation of living things.

Not all the nitrogen compounds freed by decay are reused immediately, however. Instead, some are acted upon by various so called "denitrifying" bacteria. These bacteria get energy from decaying tissues. And in so doing, they convert some of the nitrogen in the rotting tissues into free nitrogen gas. This gas is released back into the environment where it's free to begin the cycle all over again.

Earlier, we saw how farmers benefit from nature's nitrogen cycle by planting soybeans and other legumes, such as clover, to restore nitrogen to their fields. Farmers also become involved in the nitrogen cycle when they use artificial fertilizers. Many modern high-yield crops need the extra nitrogen such fertilizers provide.

Unfortunately, however, their use is not problem-free. In many areas, water supplies have been seriously polluted by nitrogen. For example, the water in some areas is so loaded with nitrogen that it's hazardous to drink.

Experts think that nitrogen fertilizers cause much of this pollution when they seep down through the soil into the underground water supply.

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Even large waterways, such as the Chesapeake Bay, America's largest estuary, are being polluted by nitrogen. In the Bay's case, most of the problem comes from nitrogen-rich fertilizers and the millions of tons of manure, and the nitrogen it contains, that good old "Bossy" and her likes produce. These nitrogen-rich pollutants wash off farms and into the many streams and rivers that run into the Bay.

This excess nitrogen can cause water plants to grow so fast that conditions develop which rob the water of its dissolved oxygen, suffocating fish and other organisms in the process.

But today's modern farming techniques, and the huge amounts of fertilizer, and the manure-producing animals that so often are a part of it, isn't the only human activity that's upsetting the nitrogen cycle. The exhausts from our fossil-fuel powered vehicles and the emissions from our electric generating plants also add large amounts of nitrogen to the environment. And when water in the atmosphere combines with this nitrogen pollution, it often returns to earth as the acid rain, snow, or other precipitation that's helping to ravage so many of the world's woodlands.

Acid precipitation is also making many of our waterways so acid that a large number of aquatic species, many of which are of great commercial importance, are being seriously harmed.

As we've seen today, nitrogen is vital to all life. Without it there could be no plants, animals, or other organisms—no life at all.

Fortunately, the natural recycling process we call the nitrogen cycle assures that we, and all other living things, get all we need.

The Video Instructional Quiz follows, which can be found on Blackline Master 4. Answers to the quiz are on page 6 of this Teacher's Guide.

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