



# Spring

## Middle Level Lesson Plan

**Topic** Life science: Diversity of life and classification

**Grade Level** 7-8

### Overview

QUEST *Spring* explores how a variety of organisms in the northern New England environment are affected by the changing seasons and how they react to the “rebirth” that comes with spring. One of the featured organisms (actually a composite organism) is the lichen, which comes in a variety of forms and structures. This teaching unit also helps students to understand that classification systems are not part of nature. They are created by humans to describe the vast diversity of organisms in the world, to suggest relationships among living organisms, and to frame research questions. It is through observing these patterns that biologists connect the multitude of individual organisms to theories of genetics, ecology, and evolution. Lichens are an interesting group of organisms, since they straddle two categories – fungus and alga – in the standard classification system.

### Introduction

According to national science standards guidelines, middle-school students should be developing the ability to observe patterns of similarity and difference that permeate the living world. This is greatly preferable to their simply knowing bits of information or classification categories about many different species. Through both hands-on and Internet activities in this teaching unit, students will study the patterns that are found within an unusual group of organisms called *lichen* and will be able to explain:

- What lichen is and how its parts (a fungus, an alga, and/or a cyanobacteria) function to support each other
- How the features and structures of lichen can vary, both from group to group and from species to species within a group, resulting in great diversity within one category of living organisms
- Why it is helpful to create a classification system for organisms

**Time Allotment** Four 45- to 65-minute class periods

**QUEST: Investigating Our World is a regional public television series  
seen on Maine Public Broadcasting Network, Vermont Public Television, and New Hampshire Public Television**



Major funding for Quest is provided by the National Science Foundation. Additional support is provided by Irving Woodlands and by gifts to More Connected, More Maine. The Campaign for Maine Public Broadcasting Network's Programming.





## Accessing Prior Knowledge

Students should already be able to explain the characteristics and requirements that are shared by all living things, and they should understand the attributes of common organisms. At the middle level, students should be moving from a study of external features and behavior patterns of organisms to internal structures and processes. Some familiarity with the process of photosynthesis would also be helpful.

## Concepts to Clarify

Students in the upper elementary to middle levels tend to classify organisms using a number of mutually exclusive groups rather than a hierarchy of groups. For example, some groups may be based on observed features while others are based on concepts. In addition, at both the elementary and the middle levels, students have a much more restricted understanding than biologists do for the word *plant*, often not recognizing trees, vegetables, or grass as plants.

## CONNECTIONS TO THE STANDARDS

<b>Maine Learning Results</b>	<b>New Hampshire Curriculum Framework</b>	<b>Vermont Learning Standards</b>	<b>National Science Education Standards</b>	<b>Benchmarks for Science Literacy</b>
<p><b>A. Diversity of Life</b> Grades 5-8</p> <p>A1. Compare systems of classifying organisms, including systems used by scientists.</p>	<p><b>Life Science</b></p> <p>3A. Curriculum Standards</p> <p>End of Grade 10: 2. Identify and describe similarities and differences among organisms of different but closely related taxa (groups).</p>	<p><b>Organisms, Evolution and Interdependence</b> Grades 5-8</p> <p>7.13.bb. Identify and use anatomical structures to classify organisms.</p>	<p><b>Content Standards</b> Grades 5-8</p> <p>Life Science 5. Diversity and adaptations of organisms...Although different species might look dissimilar, the unity among organisms becomes apparent from an analysis of internal structures, the similarity of their chemical processes and evidence of their common ancestry.</p>	<p><b>Chapter 5A: Diversity of Life</b> Grades 6-8</p> <p>3. In classifying organisms, biologists consider details of internal and external structures to be more important than behavior or general appearance.</p>

### Materials Needed

- TV and VCR
- QUEST *Spring* video
- One magnifier per student, or pair of students, for observing lichen
- A local study site with several types of lichen present (e.g., within the schoolyard or at a nearby wooded area, rocky area, beach, park, or older graveyard)
- Flagging tape, tongue depressors, or other materials for signs to mark and identify lichen study stations at the local study site.
- A variety of lichen samples for classroom use (This can be developed while preparing the study site; a good collection would include five or six pieces of at least three or four different types of lichen)
- Plastic baggies to hold dried lichen samples
- Diagrams and photographs of the internal and external structures of lichen. These can be found at:  
**What Is a Lichen?** <http://www.earthlife.net/lichens/lichen.html>,  
**Lichens of North America** <http://www.lichen.com>  
**Lichenland** <http://mgd.nacse.org/hyperSQL/lichenland/html/charlinks/body.html>
- Samples of scientific drawings of lichen to be used as exemplary models of scientific illustration  
Simple black and white drawings can be found at <http://www.fs.fed.us/r6/aq/lichen/drawings.htm>.
- Computers with Internet access for student use during the final two activities
- Student Handout 1: Uncovering the Secrets of Lichen
- Student Handout 2: Taking a Likin' to Lichen
- Student Handout 3: QUEST at Home – Spring Surprises

## I. Introducing the Concepts

**Note:** This introductory activity requires one class period of 45-60 minutes. The purpose of the activity is to engage students' curiosity – to get them to notice and to wonder about a diverse and unusual life form that has been under their noses all along. Each student will work with a partner or in a small group, observing several different examples of lichen and posing questions about these strange organisms. It is recommended that students *not* know the names of the lichen samples but simply observe them.

The lesson can be taught as a one-class field trip within the school site or at a nearby location such as a wooded area, rocky area, beach, park, or very old graveyard. Any potential site should be examined prior to class so that you can locate lichen samples (growing on rocks, tree bark, ditches, old gravestones, playground equipment, logs, buildings, etc.). These should be marked off as “stations” for students to circulate to and observe. If you stay in your classroom, you will need to make a collection of lichen for use there. Whether you stay in your classroom or go outside, you will need to identify multiple stations. The exact number of stations will depend on the number of pairs or groups of students in your class and on the variety of types of lichen that are present at your chosen site. Keep in mind that each group should observe at least three different types of lichen. Mark off each station with an index card or with some other means of identification. (A basic numbering system such as *Station 1*, *Station 2*, etc., works well.)



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(Visit Web sites such as <http://www.lichen.com> or others in the *Resources* section at the end of this teaching guide to see photographs of a wide variety of lichen forms.)

### Step 1

Begin the lesson by explaining that students will be studying a very unusual and ancient type of organism called lichen. Tell the class that they will be learning about how this organism is able to live. They will also explore the amazing diversity of these organisms, which have been living right under their noses. Students will see some different lichens and pose questions about them.

If necessary, you may wish to review the list of life processes that all organisms must be able to carry out in order to remain alive. These include respiration, using food for energy and growth, eliminating waste, responding to changes in the environment, and reproducing.

### Step 2

Have pairs (or small groups) of students circulate through the site, visiting at least three different stations. At each station, groups should observe the organism, discuss it, and record their thoughts and questions about it. Their written comments should follow the format described below.

- Each student (or group) should have a magnifier and an index card (or other handout) that prompts them as follows: "Observe the organism at your first station. It is called *lichen*. Think individually, then discuss with your partner(s) and record a hypothesis about how the lichen lives, i.e., how it is able to carry out all of its life processes. Record your ideas and also your questions about each lichen sample in your science notebook. Label each journal entry according to the lichen's station number."
- If you have not already done so, divide the class up. Have each group begin at a different station.
- Allow groups to spend approximately 8 to 10 minutes at each station. Announce when it is time for students to rotate to the next station. Continue this rotation until all groups have visited every station or have seen at least three types of lichen.

### Step 3

Facilitate a discussion in which groups share some of the things they noticed as they visited the stations. This should include their ideas about life processes as well as the questions they generated about the lichen they observed. Record students' questions on a sheet of chart paper. This list should remain posted for the remainder of the teaching unit. Allow students to offer ideas in response to the posted questions if they think that they know something about lichen.

## 2. Exploring the Concepts

**Note:** This activity requires one class period of 45-60 minutes. The purpose of the activity is for students to deepen their understanding of lichen – what it is and how it functions as an organism – so that they will be



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better able to appreciate the great diversity of these organisms in later activities. Here students will carefully observe, sketch, and label structures and properties of each type of lichen from a classroom collection. They will work again with partners or in small groups, rotating through stations (this time indoors). Each station should display a different variety of lichen.

If students have been known to draw hasty, inaccurate, or one-dimensional pictures in their science notebooks, it may be necessary first to discuss drawing as a way of accurately illustrating facts about organisms. For example, show the class scientific illustrations of lichen. (A good Web site that includes such illustrations is <http://www.fs.fed.us/r6/aq/lichen/drawings.htm>.) Discuss why students think that the illustrations are good. (Elicit the response that they illustrate in some way the lichen's structures.) Encourage students to look carefully at their lichen samples and to take their time when illustrating them. Instruct them to look at the lichen from different angles.

Each station in your classroom should exhibit a sample of a different lichen. A set of magnifiers should also be available at each station. The lichen samples should have visible structures that students can sketch. (One example might be fruiting bodies, such as the red "bubbles" on the top of British soldiers.) Include a photograph or a diagram of the internal or external structures of some of the lichen if you can find an image to match the particular type of lichen at a given station. (For images of various structures, visit the LichenLand site, coming in through the so-called front door at <http://imgd.nacse.org/hyperSQL/lichenland/index.html>. Choose the second box down, titled Lichenland Main Door. This page contains images of lichen structures, which you can select and print according to your particular classroom samples.)

### Step 1

Distribute copies of Student Handout 1: Uncovering the Secrets of Lichen. Review the handout with students, which includes prompting questions for them to address at each station. Remind students to take the handout along as they rotate around the classroom.

### Step 2

Debrief students' station experiences by asking for volunteers to share the types of structures that they have discovered in the different lichen samples. Record a list of all structures on chart paper. Students' descriptions may be awkward at this point, since they probably have not yet had access to scientific terminology. Next, have students share all of the variations in properties that they found for each lichen structure or feature. Again, elicit questions, adding them to the class list that was generated in the previous activity. Then look over the questions with the class to see whether any have been answered during the course of their work today.

### Step 3

Students will most likely be quite curious about these unusual organisms and will want to learn more about them. Distribute copies of Student Handout 2: Taking a Likin' to Lichen. It offers basic life history information about lichen. If there is time during the class period, have students read the handout, or you can assign it as homework. When they have finished, lead a discussion so that students can share what they have learned and can ask any further questions they may have.



### Step 4

At the end of this activity, or early during the next activity, revisit the list of questions that were generated during the first activity. See which questions students can answer now that they have read Student Handout 2. It is important to help them focus on the external and internal structures of lichen and how the structures support the lichen in functioning.

## 3. Developing the Concepts

**Note:** This activity can be completed in one class period of 45-60 minutes. Students first will view a short segment of the *QUEST Spring* video to form a broader picture of the diversity of the organisms called lichen, particularly as they are found throughout northern New England. Students will then use their understanding of lichen morphology to create systems for classifying lichen, first in a simplistic way (according to color) and then using a strategy based on their own observation of some visible structure of the organism. They will use their classroom set of lichen samples, and they will also visit Web sites that provide basic information about how scientists actually categorize lichen into large groups based on growth form. Finally, they will use those large groups to try to organize their own lichen specimens.

### Step 1

Begin by having one or two volunteers briefly describe some of the lichen specimens they have seen so far. Point out the diversity of the organisms students have seen in just a few activities. Tell the class that they will be watching a short segment of a PBS video called *QUEST Spring*, which will allow them to see other examples of lichen from the northern New England region.

### Step 2

View the lichen segment from *QUEST Spring*, queuing the video at a segment toward the beginning of the program, just after segments about the Mount Washington Observatory and a field trip with naturalist Chris Lewey. The lichen segment begins with an image of lichen on Mount Washington and ends as the program segues to a section on plants, including fiddleheads.

### Step 3

Following the video segment, introduce the work students will be doing by repeating lichenologist Maloney's statement from the film: "With this incredible diversity, I could spend all day collecting them and trying to figure out what their secrets are." Share with students that there are about 14,000 species of lichen in the world, and more than 3,600 species in the U.S. and Canada.

Ask students the following question: "Why do you think that people who study organisms, such as lichenologists, take the time to classify them, study them, and put them into groups?" They should first think about the question individually, then discuss it with a partner, and finally talk about it with the whole class.



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### Step 4

Once the class has discussed the question, suggest, “Let’s try classifying lichen and see if our work will give us a better understanding of the process that is used by biologists. What would happen if we started a classification system that organized things by color?” Have students classify their classroom lichen specimens according to color, working either in small groups or as a whole class (depending on the number of specimens).

Ask students to think about the kinds of things they might learn about organisms if they were grouped with others of the same color. Would this one characteristic be enough to help people see and consider the great variety of types of lichen? Would it be enough information to tell them anything about how all the different lichen samples are related to one another?

Next, have students focus instead on grouping their lichen according to some other feature – for example, a structure or growth form that they have been able to observe and that interests them. After a few minutes, discuss the results of this second process. In what ways might this classification strategy give people a better understanding of lichen – their diverse types and how they are related?

Conclude this part of the activity by pointing out there is one step in the classification process that students have not yet done. That is to give their organisms names. Ask, “How will our work together be enhanced once we have names for our lichen?” Discuss the necessity of having agreed-upon names that can be used in communicating about organisms – to share ideas, new findings, and questions.

### Step 5

Provide students with access to online computers. Have them visit the three Web sites listed below to begin learning about how scientists classify lichen into three to seven large groups according to body type. You will also want to print out a master set of these pages that can be made available to students in the next activity.

■ **Fun Facts About Fungi:** <http://www.herb.lsa.umich.edu/Kidspage/lichens.htm>

Page 2 of 3 at this site gives a brief, clear description of each of the four lichen body types and provides a photograph of a typical example for each type (which students are likely to have seen in their studies).

■ **What Is Lichen?** <http://www.earthlife.net/lichens/lichen.html>

Pages 3-4 of 6 at this site are a wonderful supplement to the first site. They provide simple, clear diagrams of the internal structures of each of the four lichen body types that were shown as photographs on the previous site.

■ **LichenLand – Body Type:** <http://imgd.nacse.org/hyperSQL/lichenland/html/charlinks/body.html>

The cover page of this section of the Lichenland site invites students to “Learn below how to tell one body type from another.”

### Step 6

Have students apply what they have just learned about the major lichen groups by visiting sites with images of lichen specimens. Students can try to classify these online specimens using the growth form



categories they have learned about. Some good sites with lichen images include the following:

- Lichen Sampler: <http://www.lichen.com/sampler.html>
- Lichen Portrait Gallery: <http://www.lichen.com/portraits.html>
- Walton Hall Nature Trail Lichens Site: [http://www.open.ac.uk/Nature\\_Trail/Lichen.htm](http://www.open.ac.uk/Nature_Trail/Lichen.htm)

### Step 7

To conclude, pose a final, thought-provoking question that will help students transition to the next activity. Lead into the question by pointing out a quote from the Web site titled Lichens of North America <http://www.lichen.com/vocabulary.html>: "Lichens are arbitrarily classified into three to seven growth forms that do not reflect how they are related to each other. Different species within a genus may have different growth forms." Then ask, "Why do you think that the classification of lichen is so complicated?"

## 4. Synthesizing and Applying the Concepts

**Note:** This final activity will require one 45-60 minute class period. It will give students an opportunity to use their classroom lichen specimens, one or more online keys to the lichens, a reflective journal prompt, and a final discussion as a way of bringing together ideas that they have learned from all previous activities. In using a key, students will gain a deeper awareness of the great diversity of lichen, and they will see more ways in which specimens may be related based on body features. They will then take note of the amazing number of lichen varieties by finding listings of names in various lichen databases.

In preparation, you will need to visit Web sites of the various keys to lichens so that you can choose the most appropriate version(s) for your class. The most interesting and comprehensive sites can also be the most frustrating, unless you can clearly explain to students how each site works. You will also need to stress that the point of the activity is not to identify every lichen, but rather to see how various combinations of characteristics can narrow down choices in order to identify an organism. For an interactive Synoptic Key to the Lichen, visit the site that follows. Notice that by clicking on images of each lichen structure in the matrix, it is possible to learn about the terms, definitions, and variations in that structure. Upon becoming familiar with the structures, it is then possible to select a variation of each one so that the computer can combine the features and identify possible lichen varieties for the sample in question. This Web site can be found at: [http://mgd.nacse.org/cgi-bin/hyperSQL\\_gateway?hyperSQL/lichenland/hsq/inside.final\\_ed.hsql](http://mgd.nacse.org/cgi-bin/hyperSQL_gateway?hyperSQL/lichenland/hsq/inside.final_ed.hsql)

Other sites include one with a simpler, more traditional dichotomous key: <http://www.vvm.com/~jevans> (Select Botany, then Lichens, and then Key to Lichens upon reaching the site.) A site with an even simpler table of major lichen structures and selections can be found at: <http://eqbdqe.ciw.ca/eman/ecotools/protocols/terrestrial/lichens/part13.html>

### Step 1

Begin the activity by repeating the quote that you shared with the class at the close of the previous activity. Discuss your closing question about why the classification of lichen is so complicated. Someone may point out the huge number of possible permutations and combinations of fungus and algae/cyanobacteria that could come together to form such a wide variety of lichen organisms.



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Ask students to think about and then discuss ways in which it was helpful for them to learn about the system for classifying lichen according to morphology (body type). One thing to mention (if no one else does) is how this type of system can help an observer to focus on features that really distinguish patterns in how lichens live. As scientific observers, students are able to expand their awareness more than they would by just noting the lichens' colors.

Explain that students will return to a study of the original classroom lichen specimens. They will now try classifying them according to the scientific system that is used to make sense of these organisms.

### Step 2

Provide each pair, or small group, of students with one or more plastic bags containing lichen specimens. Also provide access to online computers. Explain that the keys students will use are organized to help them identify variations of several structures of the lichen organism, and that some of those structures have complex terminology associated with them. This process will help them to classify their own organisms on some level, although species details may differ slightly in some examples. Tell students that they may have questions about terminology that might need to be addressed by letting the computer choose certain features as appropriate, in order to avoid frustration.

As students review the Web sites and choose particular keys to work with, be sure to explain that they do not need to memorize the terms that are used. Rather, they may find it helpful to make notes of some important terms or bookmark key pages so that they can use the listings for reference. Some of the species on these sites may not be the same as those found in New England. However, the similarities will be sufficient to provide results that will seem familiar and will allow the same student outcome of finding patterns between organisms.

### Step 3

A way to conclude the activity and leave a lasting impression of the great diversity within lichen types is to have students visit Web sites with databases that list lichens from around the world. A site at the University of Hawaii provides many database links: <http://www.botany.hawaii.edu/cpsu/hmpage.html>. (Note that this site does not always function. It is an excellent resource when it can be reached.) Another site, for the Herbarium at the University of Minnesota, lists the 135,000 lichens from all over the world that make up their collection: <http://www.tc.umn.edu/~wetmore/Herbarium/HERBHOME.htm>. Finally, a site at the University of Tartu in Estonia provides an amazing introduction to The Second Updated World List of Cetrarioid Lichens. The site includes insight into the family/genus/species levels of classification as well as an immense alphabetical listing of lichen varieties. If students have noticed any names of lichenologists on the previous resource Web sites, it might be of interest (and a bit surprising) to see some of those people listed as lichen species names in this resource.

### Step 4

Refer back to the list of questions that was generated in the very first activity. With the class, check to see whether any questions have not been answered yet. Ask students if any of the Web sites or other resources they have worked with might have the answers. If not, discuss how students might go about



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finding them. Consider suggesting a class correspondence with the lichen “listserv” for teachers (<http://pathfinderscience.net/so2/listserv/>) or with some of the contact people from sites in the Resources section at the end of this teaching unit.

Have groups share and discuss unusual or surprising findings. If time allows, offer this quote (by lichenologist Trevor Goward) for students to consider: “Lichen are fungi that have discovered agriculture.”

Ask students, “What does this quote mean to you?” **Note:** You may choose to use the quote and your follow-up question as an assessment tool.

## 5. Extending the Concepts

### Quest at Home

Distribute copies of Student Handout 3: *QUEST at Home: Spring Surprises*. Review the handout with students before they take their copies home. Agree upon a due date for students to return to class with their findings.

### Student Projects

Here are two options for extending your classroom study of lichens:

**1.** Carry out an environmental monitoring investigation into air quality in your area, using protocols and tools that have been designed for classroom use.

**Lichens, Tardigrades, and SO<sub>2</sub> Research.** This research has indicated that lichens and some very small organisms living on them can be used to assess atmospheric levels of sulfur dioxide (SO<sub>2</sub>). An excellent Web site provides background about the research to date (including methodology, conclusions, and further research). The site also offers sections on Guided Research and Student Research, and includes tools such as real-time, interactive lichen mapping, a 100-circle lichen grid, and a link to the lichen listserv.

<http://www.kancrn.org/so2>

**Lichens: Air Pollution, Lichens and Mosses.** This article is a very nice introduction to the use of lichen as an indicator of air quality. It would be a helpful reference if students were going to go further in their research using lichen. <http://www.mpm.edu/collect/botany/lichens.html>

**Methodology for Volunteer/School Monitoring Projects Using Lichens.** This site from Halifax, Nova Scotia, provides many pages of resources for setting up a research project in your classroom.

<http://eqb-dqe.cciw.ca/eman/ecotools/protocols/terrestrial/lichens>

**2.** Study some of the human uses of lichen, including lichens for dyes, foods, and antibiotics. Related articles are provided at the following Web sites:



**Useful Lichens.** Human uses of lichen are explained and demonstrated through photography on pages 3-5 of this site. <http://mgd.nacse.org/hyperSQL/lichenland/html/biology/meeting.html>

**Lichens and People.** Traditional as well as modern uses of lichen are highlighted here, along with excellent photographs. <http://www.lichen.com/people.html>

### Community Connections

The lichen collection at the University of Maine Herbarium consists of approximately 3,000 specimens, with about 80 percent from Maine and 20 percent from other parts of North America. The herbarium is located at the University of Maine on the Orono campus. (To visit, go to Deering Hall, Room 202, between 8:00 and 4:30 and sign out the key.) <http://www.umesci.maine.edu/biology/herbarium/lichens.html>

New Hampshire and Vermont share the Forest Stewardship Information Exchange. This organization provides periodic newsletters with information about activities and resources related to environmental stewardship. The Web link provided here includes a newsletter about lichen and addresses of contacts throughout northern New England. [http://www.fs.fed.us/na/durham/coopforest/stewardship/pdf/fallwinter\\_1998.pdf](http://www.fs.fed.us/na/durham/coopforest/stewardship/pdf/fallwinter_1998.pdf)

### Career Opportunities

The American Bryological and Lichenological Society (ABLS) is an organization devoted to the scientific study of all aspects of the biology of lichen-forming fungi. Members are both professionals and amateurs with an interest in these organisms. The society holds summer meetings, publishes a quarterly journal and an information bulletin called Evansia, and sponsors a specimen exchange. Students with a curiosity about the life of a professional naturalist could visit this organization's Web site and links: <http://www.unomaha.edu/~abls>

The Lichenology site includes a listing on page 3 of 4 titled Homepages of Lichenologists. By visiting some of these sites, you can get a sense of the kinds of publications and interests of scientists. <http://www.botany.hawaii.edu/cpsu/hmpage.html>

To see one representative example of a lichenologist's homepage, visit the page of Kristin Palmqvist: <http://www.plantphys.umu.se/research/kikki.shtml>

The Lichens of North America site grew out of the activities of Sylvia and Stephen Sharnoff, who did the photographic field work for the book Lichens of North America. Page 3 of 3 provides links to their own Web pages in addition to a brief summary of the life of Sylvia Sharnoff, who died recently of cancer, but whose work and love for the field of lichenology live on. (There is also an e-mail address listing for Stephen Sharnoff, a possible contact for student questions.) <http://www.lichen.com>



### Resources

What Is a Lichen? This is an excellent collection of clear diagrams and simple descriptions of lichen body parts and types.

<http://www.earthlife.net/lichens/lichen.html>

Lichens of North America. This site provides a wealth of information about lichen, including background on lichen biology and the environment (as well as growth forms and structures), environmental studies using lichen, lichen images, lichen and wildlife, lichens and people, and useful links. <http://www.lichen.com>

Welcome to the World of Lichenology. This site at the University of Hawaii opens with three links: home page of lichens and lichenologists; international associations of lichenologists; and pictures of lichen. From these three, there are links to a vast variety of resources, from images and databases to organizations and individual lichenologists. (Note: This site has been down occasionally, but it is so helpful that it is worth trying to see if a connection can be made.)

<http://www.botany.hawaii.edu/cpsu/lichen1.html>

University of Minnesota Lichen Herbarium. From this site, it is possible to link to a variety of lichen database Web sites, including Lichens of the U.S. and Canada.

<http://www.tc.umn.edu/~wetmore/Herbarium/HERGBHOME>

Fun Facts about Fungi – Lichen Pages. This site has a good three-page introduction to lichen, including photographs and descriptions of lichen uses (e.g., dyes, food sources, and soil construction). Of particular value is a bibliography (Further Reading), which lists reference books that can serve as hard-copy resources.

<http://www.herb.lsa.umich.edu/Kidpage/lichens.htm>

LichenLand – Fun with Lichens. This site, from the Department of Botany and Plant Pathology at Oregon State University, offers a great introduction to lichen. Lichenland – the Lite Version has simple descriptions and an interesting answer for the question “Why should I care about lichens?” Other segments include an interactive key and photographs of lichen specimens that are useful to humans as dyes.

<http://imgd.nacse.org/hyperSQL/lichenland>



## **Uncovering the Secrets of Lichen**

In this activity, you will be learning more about the ancient and unusual life form called lichen – what it is and how it functions as an organism. You will be carefully observing, sketching, and labeling structures and properties of each type of lichen from our classroom collection. You will also be looking at images (photos and drawings) of structures that you may not be able to see with just a magnifier.

### **Step 1**

Go to the first station. Begin your journal entry by noting down the name of the station (for example, “Station 1”).

### **Step 2**

Using a magnifier, observe the lichen sample at the first station. Carefully sketch this sample (from several angles if necessary). Be very careful to draw all of its parts (or “structures”) and features. Your sketch should be as complete as possible.

### **Step 3**

Label each structure or feature on your drawing with descriptors. These should include the color; texture, hardness, brittleness, shape, surface the lichen is growing on, etc.

### **Step 4**

If your station includes a diagram or a photograph, review it. It will probably help show you more about the structures of your lichen variety than you have been able to see with your magnifier. If any of the structures in the diagram or photo are actually things that you have included in your sketch, add the scientific labels for these structures to your own drawing.

### **Step 5**

When your teacher announces a switch, move on to the next station. Repeat steps 1 through 4.



## Taking a Likin' to Lichen

### WHAT IS LICHEN?

**Lichen** is a living organism with a body that is made up of members from either two or three different kingdoms – always a **fungus** (Kingdom Fungi) plus one or more **algae** (Kingdom Protista) and/or **cyanobacteria** (Kingdom Monera).

This alliance helps all parts of the lichen to survive successfully. Survival would usually be impossible otherwise if the different parts of the lichen were to try living on their own. This relationship, in which different organisms live together and all benefit, is called **sybiosis**.

A Flash Animation movie called *What Is a Lichen?* can be found at the Web site listed below by scrolling about halfway down the page (just before the section about Tardigrades): <http://www.kanrcm.org/so2/cbackground.cfm>.

### WHAT ABOUT THE FUNGUS PART?

Each type of lichen has a different species of fungus. (About 20 percent of all existing fungus species are involved in lichen partnerships.)

The fungus is considered the main partner in any lichen. It cannot photosynthesize its own food, so it partners up with an alga or cyanobacteria that can. The fungus protects its partner(s) by enclosing them. This keeps them from drying out and shades them from strong sunlight. The fungus gives off an acid that dissolves the rock or other surface that the lichen lives on. In this way, it obtains both a place to live and minerals to support the photosynthesis process. It also absorbs rainfall from the surface, bringing in vital nutrients for the photosynthesis process. (This is especially important because the lichen has no roots in the ground that can take in water, which is one of the more common ways in which plants acquire the water they need for life.)

As a benefit, the fungus gets its only nutrient – sugars – from the photosynthesizing organism(s). The fungus has special threads (called **hyphae**) that contact the cell walls of the algae or cyanobacteria and absorb up to 80 percent of the sugars that are produced, through diffusion, into the fungal cells.

### WHAT ABOUT THE ALGAE OR CYANOBACTERIA PART?

The algae and/or cyanobacteria ("photosynthesizing partners") in lichen are far fewer than the fungi partners. Therefore, any species of algae or cyanobacteria that is part of a lichen partnership is probably part of *many* kinds of lichen, combining with a different fungus each time. Many, but not all, of these photosynthesizing partners can exist on their own in some places, but are able to live and spread in much harsher environments than usual by partnering with fungi.

The photosynthesizing partner contains a green pigment called **chlorophyll**. Chlorophyll enables the lichen to make food for itself. It uses energy from sunlight to manufacture sugars out of carbon dioxide in air and the elements of water. This process is called **photosynthesis**.

As a benefit from the lichen partnership, the involved organisms get protection (from weather mostly, especially from drying out). The fungus forms a protective surface that offers a stable and constant environment.

### WHAT IS A LICHEN'S BODY LIKE?

Only certain algae and fungi can join together to form a lichen. Each combination forms a unique kind of **thallus** (body). Some lichen are hard to see; others grow very large and are very noticeable. Lichen bodies do not resemble either the fungus or the photosynthesizing partner. However, the shape, appearance, and consistency of the lichen depend mostly on the type of fungus partner that is involved.

Most lichen bodies are made up of these parts:

#### 1. Top surface (Cortex):

A tough, protective “skin” that does not easily lose water; this outer covering is actually a mesh of tightly packed fungal threads called hyphae.

#### 2. Second layer (Photosynthetic layer):

A colony of green algae or cyanobacteria that lives just under the cortex, this layer can absorb light from the sun and use that energy to manufacture food.

#### 3. Third layer (Medulla) – in some lichen, this is the bottom layer:

Nutrients are stored in this layer, which is made out of a looser layer of hyphae (fungal threads) than the cortex. If this is the lowest layer of the lichen, then it rests on the surface on which the lichen lives (rock, for example).

#### 4. Lower Cortex (or Central cone):

Some lichen have an entire bottom layer of tightly packed hyphae called the lower cortex. Others have just one connecting spot, also made of hyphae, which is called the central cone.

### HOW DO LICHEN REPRODUCE?

Lichen reproduce mostly when small pieces of the body break off and are blown around, landing in a spot where a new lichen (a clone of the original) can begin to grow. Lichen also can make reproductive packages called *soredia* or *isidia*. These stick up from the lichen's surface, break off, and grow into new lichen. In both cases, there is only one source of genetic material, so the process is called **asexual reproduction**.

Another way of reproducing is only possible in some types of lichen, and the odds against its success are very high. This strategy involves spores, special reproductive bodies that are made by the lichen's fungus. Spores can land on another surface and can grow new lichen, but *only* if they capture a new photosynthetic partner after they land. (Some even steal a partner from other lichens!) Because this involves the combining of genetic material from two organisms, it is called **sexual reproduction**.

### WHERE CAN LICHEN LIVE?

A surprising fact is that lichen is the *dominant vegetation* on 8 percent of the earth's land surface. Given the right amounts of light, moisture, clean air, and freedom from competing organisms, a lichen can live in generally unfavorable habitats throughout the world – including the Arctic, Antarctica, and desert areas. Lichen forms vast, continuous mats in the northern boreal forest, which can be found in the northern areas of Vermont, New Hampshire, and Maine.

Lichens are pioneers on rock, desert sand, cleared soil, dead wood, animal bones, and living bark. They are remarkably resistant to drought and can even absorb moisture from the air if the humidity is high. They dry out slowly, allowing the photosynthesizing partner to make food for as long as possible.

### INTERESTING FACTS ABOUT LICHEN

- Lichen are thought to be among the oldest living things on earth. Certain lichen are estimated to be more than 200,000 years old – more ancient than some of the oldest redwood trees.
- Because of their age, lichen can be used to estimate the dates of certain geological events.
- Lichen grow very slowly, often less than 1 mm per year. This is mainly because they tend to live in environments where water is available for only short periods.
- Lichen produce more than 500 unique biochemical compounds that are used by them for the following reasons:
  - to control light exposure
  - to repel herbivores (by making themselves taste bad)
  - to kill microbes
  - to discourage plants from competing with them for space
- Humans use many of these same chemicals from lichen. Some are used as pigments (for dyeing fabrics and, today even more important, for making litmus paper – strips of paper that are used to test the acidity of liquids). Others are used as antibiotics (for medicine and in deodorants – for example, the company Tom's of Maine sells a natural deodorant that incorporates lichen into its mixture).
- Different lichen species vary in sensitivity to air pollution, so scientists can use them to monitor air quality.



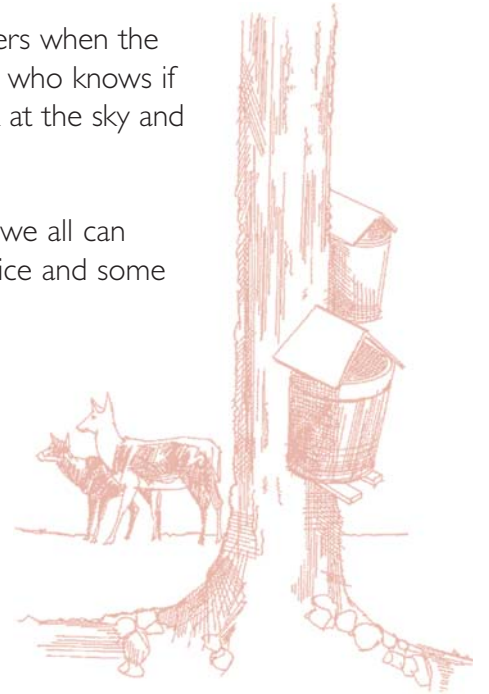
# Spring Surprises

You're on a Quest!

Have you ever spoken with an “old timer,” someone who remembers when the maple sap runs, when the fiddlehead ferns emerge each year, and who knows if the spring peepers are early or late? Can anyone you know look at the sky and predict with precision the week when the trout lilies will bloom?

This may seem a bit miraculous sometimes, but the exciting thing is that we all can become trained to recognize patterns in nature. It just takes a little practice and some record keeping to get us started.

On a warm spring day, nothing is more exciting than going out on a search through your backyard, neighboring fields, or nearby forests, looking for signs of the season. In this activity, your family can go together on a quest for spring. You will need to keep track of a few key indicators of your choosing, and you will need to store your information to compare against your findings in future years. You will also learn about a Web site that lets people all over the country keep track of the “migration” of spring every year.



## Getting Started



First you must decide what to look for and record. Some people prefer to observe birds, while others like examining flowers or ferns. Perhaps you'd even like to follow the emergence of different plants that grow in ditches along the road. Whatever your fancy, it will be helpful to have a field guide to help you identify what you have found. (Some good ones include the Peterson field guide series; the Golden guides – the longer, more complete Golden versions rather than the pocket ones; and the National Geographic series.) Field guides can be found in the library and/or in the nature section of your local bookstore. You can also visit a Web site like [www.amazon.com](http://www.amazon.com) and search for “field guides” and “flowers,” or whichever category your family has selected.

## Keeping Track

With field guide in hand, all you need now is a place to keep track of your findings and a commitment to **watch and record at least once every week** or so. For each observation entry, be sure to record the following:

- the **date**
- a description of the **weather that week** (especially general temperature trends and any unusual weather patterns)



- a listing of **what you sighted** on that date (this should include the name of the organism and a reference page in your field guide; you might also include a sketch with notes)
- a description of **where** the sighting was made (so that you can return on a yearly basis to watch for the same signs)

You will really enjoy digging out your records next year and reviewing them to see how the new season compares.

## Need Help?

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A nice example of a general-purpose nature journal can be found at:  
<http://www.nenature.com/NotesArchive/NatureJournal0930Thru100602.htm>.

Finally, you might be interested to know of a Web site where people from all over the United States work together to track the migration of spring. The site is called Journey North: <http://www.learner.org/jnorth>  
 Visitors to this site choose an indicator that they will watch out for. Then, while they are waiting for spring to come to their area, they can periodically check on the progress of their indicator as it creeps ever northward. Archives are available now for viewing the events of prior years.

Have fun on your **QUEST!**



**QUEST: Investigating Our World is a regional public television series  
 seen on Maine Public Broadcasting Network, Vermont Public Television, and New Hampshire Public Television**



Major funding for Quest is provided by the National Science Foundation. Additional support is provided by Irving Woodlands and by gifts to More Connected, More Maine. The Campaign for Maine Public Broadcasting Network's Programming.

